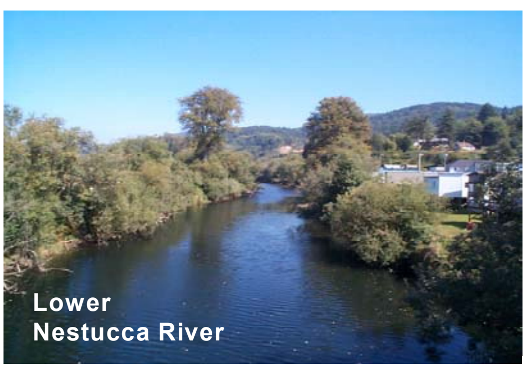
Nestucca Bay Watershed
Total Maximum Daily Load (TMDL)



Prepared by
Oregon Department of Environmental Quality

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Draft Nestucca Bay Watershed Total Maximum Daily Load (TMDL)

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EXECUTIVE SUMMARY

Introduction

The following document contains the required components for a Total Maximum Daily Load (TMDL) as described by the United States Environmental Protection Agency (EPA) for compliance with the Federal Clean Water Act. The document and its appendices provide a thorough analysis of pollutant sources and accumulation processes in the Nestucca Bay Watershed. The analyses are complex in many cases. Every attempt has been made to thoroughly describe and explain assumptions and methods and to make the results as clear as possible.

Water Quality Summary

Legal Requirements

Under Section 303(d) of the Clean Water Act, the EPA or its state delegates are required to develop a list of the surface waters in each state that do not meet Water Quality Standards (WQS). These standards are developed by each of the states to protect "beneficial uses" and must be approved by EPA. The resulting "303(d) list" is based on the best available data and , in most cases, must be revised every 2 years. The list submitted by the State of Oregon in 1998 and approved by the EPA is the most recent source of this information. Water bodies that are listed as impaired must have Total Maximum Daily Loads (TMDL) developed for each pollutant for which that waterbody is "listed." There may be waterbodies that are listed for "pollution" (e.g., habitat modification, flow modification) that do not require a TMDL.

The Nestucca Bay Watershed includes all surface waters that ultimately drain to Nestucca Bay. The principal waterbodies are the Nestucca and Little Nestucca Rivers. Each of these drainages includes beneficial uses of their own as well as being sources of pollutants to the Bay. Although other beneficial uses are also affected by pollutant loads, the most sensitive uses are cold water aquatic life and water contact recreation in the rivers, and shellfish harvesting in the Bay. By ensuring that the most sensitive beneficial uses are supported, these TMDLs will ensure that less sensitive uses are also protected.

Listed Parameters

Waterbodies in the Nestucca Bay Watershed have been listed as water quality limited for temperature, bacterial contamination and sedimentation. In the rivers, the migration, rearing and spawning of salmonid fish are put at risk by high water temperatures (those that exceed 64°F for migration and rearing, or 55°F if spawning is occurring). The migration and rearing criterion is in effect all year, but is most likely to be violated in the summer. Shellfish harvesting is dependent on waters with minimal concentrations of fecal bacteria. Bacteria in the rivers are the primary source of the impairment of bay waters, which support recreational shellfish harvesting. The upper reaches of the Nestucca River (above Powder Creek) and East Beaver Creek are listed as impaired due to excessive sedimentation. Excessive sedimentation can result in streambeds that are unsuitable for spawning of salmonid fishes.

TMDLs included in this document have been developed for these parameters to protect the salmonid fish and recreational use in the rivers, and shellfish harvesting in the Bay. In general, allocations for each of the parameters are in effect for the entire watershed, not only on reaches that are formally listed.

Temperature

Temperatures of water exceed the criteria for protection of anadromous salmonid fish during the critical part of the year for migration and rearing. These excessive temperatures actually occur primarily in the lower elevation reaches of the river, downstream of Powder Creek. Although temperatures in the upper watershed are cooler than the criterion, they are still elevated above potential temperatures and thus contribute to the high water temperatures downstream. Water from Powder and Niagara Creeks both contribute significantly to excessive temperatures in the lower watershed. Even without these contributions, temperatures would exceed the criteria due to a lack of riparian vegetation and widened channels in the lower elevations due to an increase in the heat load to the river from solar radiation.

Bacteria

Elevated concentrations of bacteria in rivers can affect their water contact recreational use for swimming and result in large loads of fecal bacteria entering the Bay. Concentrations in the Bay that exceed a median of 14 MPN/100 ml (MPN = "most probable number", a statistical estimate of the number of bacteria or colonies in a water sample) limit its use for shellfish harvesting. Sources of bacteria in the watershed include rural and urban residential development (failing septic systems), urban stormwater runoff, livestock management and other agricultural activities, and several wastewater treatment plants that discharge either to the Rivers or the Bay.

Sedimentation

Sedimentation in the Nestucca Bay watershed has occurred over the years due to a combination of natural events and human activities. Large fires and floods have led to large sediment loads from surface and streambank erosion, and mass failures. Forestry and road building activities have exacerbated these conditions, particularly in the period from 1960 through 1990. Road building, road maintenance, and tree harvest techniques combined to cause increases in the amount of sediment reaching creeks and rivers, resulting in streambeds that received excessive amounts of fine particles. These fine sediments make the substratum unsuitable for salmon spawning and egg incubation. Practices and conditions have changed since the upper Nestucca River and East Beaver Creek were listed as impaired. While parts of the subbasin are still impaired due to excessive sedimentation, most of the sources are in the lower elevation portions of the watershed.

Allocations

Load Allocations were developed for each of the parameters for non-point sources (NPS) and background, and Wasteload Allocations were developed for point sources. NPS sources are land uses that contribute pollutants from diffuse areas. These include forestry, agriculture, rural residential and urban development. Point sources discharge directly to waterbodies and their contributions are controlled through limits set in National Pollutant Discharge Elimination System (NPDES) permits. There are three permitted point sources in the Nestucca Bay Watershed, all of which are sewage treatment plants.

Temperature

Temperature Load Allocations for non-point sources are aimed at controlling heat from solar radiation and are expressed in terms of system potential effective shade and channel width. Effective shade is the most straightforward parameter to measure and is easily translated into quantifiable water management objectives. System Potential effective shade levels in the watershed ranged from 50% to 90%. System potential was determined through modeling of shade from topography, potential tree heights and densities, and narrowed channel widths. System potential conditions are the most protective allocation and rely on the environment to provide as much natural effective shade as possible. By simulating these system potential conditions, potential temperatures were calculated for the mainstem of the Nestucca River. Under system potential conditions, 100% of the river miles along mainstem reaches are expected to achieve temperatures less than the standard of 64°F (17.8°C).

Wasteload Allocations for point sources assume that effluent will not cause an increase in ambient temperature outside a defined “mixing zone.” Mixing zones have been defined for some sources, but are generally no more than 25% of the river flow. The allowable effluent temperature is a function of the flow rate of the river, the flow rate of the discharge and the system potential temperature of the water at the point of discharge. Wasteload allocations will have different limits depending on the time of year. The facilities that discharge during the critical period (low flow) will have to meet the 64°F (migration and rearing) criterion from May through September, and the 55°F (spawning) criterion from October through April. The spawning criterion reflects the use of the lower reaches of the rivers by chum salmon.

Bacteria

Bacterial concentrations and flow accumulation rates were analyzed with an event-based unit-load model. The model uses estimated peak flow, runoff concentrations of bacteria for various land uses, and bacteria die off rates to predict total bacteria concentrations and loads in streams. This model was calibrated with flow and bacteria concentration data from recent storms. The dilution of the rivers with saltwater as they enter the Bay was determined through analysis of salinity gradients between the river mouth and shellfish harvesting areas of the Bay, resulting in a dilution ratio of 2:1 for the Little Nestucca and 3:1 for the Nestucca River. Therefore, to achieve the bacterial standard of 14 fecal coliforms/100 ml in the Bay, the Little Nestucca and Nestucca Rivers would need to meet instream limits of 28 and 42 fecal coliforms/100ml at their respective mouths.

Allocations are determined separately for each river, and are based on subbasin specific percent reductions in runoff concentrations from all land uses as a function of flow. Each river will be required to meet the instream limit at the mouth. The allowable runoff concentrations range from fairly high in cleaner rivers to very low depending on land use and flow rate in the rivers. Runoff concentrations refer to incipient runoff prior to flowing into creeks, streams, or rivers. This assumes that bacteria will decay and be diluted sufficiently to meet the instream targets.

Sedimentation

The sedimentation allocation requires that system potential vegetation and channel widths be established throughout the Nestucca Bay Watershed. This will result in greater stablization of streambanks and improve streambed conditions. A target measure of less than 20% streambed fines is defined as an endpoint.

Margin of Safety (MOS)

The Margin of Safety provides assurance that water quality standards will be met if the allocations are higher than the loading capacity of the water body. The temperature TMDL has both implicit and explicit margins of safety. The implicit MOS is derived from using conservative assumptions in modeling so that the allocations will also be conservative relative to the loading capacity. In addition, the temperature TMDL has an explicit margin since the temperature in the mainstem of the Nestucca River is expected to be below the numeric criterion in the temperature standard, but this potential assimilative capacity will not be allocated to either point or non-point sources of heat. MOSs for the bacterial and sedimentation are also implicit in that they rely on conservative assumptions in modeling.

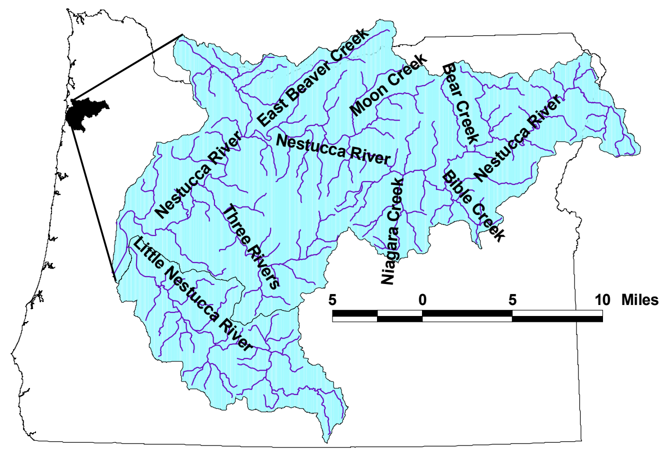
Water Quality Management Plan

A Water Quality Management Plan (WQMP) is included as a companion document to the TMDLs. This document explains the roles of various land management agencies, federal, state, and local governments, as well as private landowners in implementing the actions necessary to meet the allocations in the TMDLs. It also includes directly or by reference the statutes, rules, ordinances, local plans, and all other known mechanisms for implementation. The WQMP for the Nestucca Bay Watershed focuses specifically on:

- State Forest Lands (Forest Practices Act);
- Federal Forest Lands (Northwest Forest Plan);
- Private Agricultural Lands (North Coast Basin Agricultural Water Quality Management Area Plan – SB1010);
- County Ordinances;
- The Nestucca/Neskowin Watershed Council Action Plan
- Regional stormwater controls, including the option of a storm water permit for Small Cities.
- Tillamook National Estuary Program – Portions that apply to Tillamook County.

CHAPTER I – OVERVIEW AND BACKGROUND

1.1 Introduction



The Nestucca Bay Watershed lies near the northwest corner of Oregon on the western side of the Coast Range Mountains. The majority of water flowing into Nestucca Bay is carried by the Nestucca and Little Nestucca Rivers. The headwaters of the Nestucca River are at approximately 2200ft (~680 m) in the Coast Range. The only impoundment on the river is near these headwaters behind McGuire Dam, which has little effect on summer flow rates. The majority of the watershed is contained within Tillamook County, though there are small portions in Yamhill County. The watershed is approximately 30 miles long at its greatest dimension, and the Nestucca River is approximately 50 miles long. The Little Nestucca River is approximately 20 miles long, flowing mostly through southern Tillamook County, but its marshy headwaters are in Yamhill County at an elevation of approximately 600 feet (180 m).

The watershed includes vast forests, rich agricultural lands, several small communities, a small bay supporting shellfish, and abundant habitat for salmon and trout. The forests are managed mostly by the US Forest Service and Bureau of Land Management, though there are significant private holdings of forestland. Agricultural lands are all privately owned and predominantly support a dairy and cheese-making industry. The towns of Pacific City and Cloverdale are located on the Nestucca River. The town of Hebo is on Three Rivers, a tributary of the Nestucca River. There is very little development along the shores of the Bay. There is no commercial shellfish harvesting in the Bay currently, though there is a recreational shellfish and crab fishery. The Nestucca Bay Watershed has historically sustained a popular sport fishing industry and the breeding grounds and nursery for offshore fisheries.

The Nestucca Bay Watershed supports populations of Spring Chinook, Fall Chinook, Summer Steelhead, Winter Steelhead, Coho Salmon, Chum Salmon, Sea-Run Cutthroat, and Resident Cutthroat Trout. Coho salmon are currently listed as threatened, and Winter Steelhead are a candidate for listing by the National Marine Fisheries Service under the Federal Endangered Species Act. Habitat for these species has been in decline in the watershed for many years resulting from a variety of problems including large, intense forest fires, removal of riparian vegetation communities, flow modification, and direct habitat modification. These events have resulted in rivers that are wide and shallow, and hence will receive more direct sunlight than what would be expected under natural conditions. Excessive summertime temperatures, excessive amounts of fine sediments and diminished availability of appropriate spawning gravels in some areas, and reduced cover all lead to poor habitat quality.

Nestucca Bay also supports recreational shellfish harvesting, and the rivers are used for recreational swimming and wading. Concentrations of bacteria in waters of the Rivers and the Bay generally allow safe use for recreational activities. Concentrations in the Bay occasionally result in increased risk of disease from eating shellfish harvested from the Bay. Sources of bacteria in the watershed include rural and urban residential development (failing septic systems), urban stormwater runoff, livestock management and other agricultural activities, and three wastewater treatment plants that discharge to the Nestucca River.

As a result of these temperature, sedimentation, flow and habitat modification, and bacterial contamination problems, some river reaches in the Nestucca Bay Watershed and the Bay have been listed under section 303(d) of the Clean Water Act as impaired water bodies. This listing requires development of a Total Maximum Daily Load (TMDL) for temperature, bacteria, and sedimentation. Though there are also listings for flow and habitat modification, these reflect conditions or the effects of pollutants or practices, rather than pollutants themselves. TMDLs have not been developed for these latter conditions.

1.2 Total Maximum Daily Loads

1.2.1 What is a Total Maximum Daily Load

The quality of Oregon's streams, lakes, estuaries and groundwater is monitored by the Oregon Department of Environmental Quality (DEQ). This information is used to determine whether water quality standards are being violated and, consequently, whether the *beneficial uses* of the waters are *impaired*. *Beneficial uses* include fisheries, aquatic life, drinking water, recreation and irrigation. Section 303(d) of the Federal Clean Water Act requires the EPA or delegated states such as Oregon to set water quality standards and to prepare a list of water bodies whose water quality does not meet these approved water quality standards. The resulting list (the "303(d) list") is a comprehensive catalog of all waterbodies in the state that fail to meet one or more water quality criteria based on available data.

The term *water quality limited* is applied to streams, lakes and estuaries where required treatment processes are being used, but violations of State water quality standards occur. With a few exceptions, such as in cases where violations are due solely to natural causes, the State must establish *a Total Maximum Daily Load* or *TMDL* for any waterbody designated as *water quality limited*. A *TMDL* is the total amount of a pollutant (from all sources) that can enter a specific waterbody without violating the water quality standards.

The total permissible pollutant load is allocated to point, non-point, background, and future sources of pollution, along with a margin of safety. *Wasteload Allocations* are portions of the total load that are allotted to point sources of pollution, such as sewage treatment plants or industrial dischargers. The *Wasteload Allocations* are used to establish effluent limits in discharge permits. *Load Allocations* are portions of the *Total Maximum Daily Load* that are attributed to either natural background sources, such as soils, or from non-point sources, such as urban, agriculture or forestry activities. *Allocations* can also be set aside in reserve for future uses. Simply stated, *allocations* are quantified measures that assure water quality standard compliance. The *TMDL* is the integration of all these developed *Wasteload* and *Load Allocations.*

1.2.1.1 Elements of a TMDL

The required elements of a TMDL that must be submitted to EPA include:

1. A description of the geographic area to which the TMDL applies;
2. Specification of the applicable water quality standards;
3. An assessment of the problem, including the extent of deviation of ambient conditions from water quality standards;
4. Evaluation of seasonal variations
5. Identification of point sources and non-point sources;
6. Development of a loading capacity including those based on surrogate measures and including flow assumptions used in developing the TMDL;

7. Development of Waste Load Allocations for point sources and Load Allocations for non-point sources;
8. Development of a margin of safety.

The U. S. Environmental Protection Agency (EPA) has the responsibility under the Clean Water Act to approve or disapprove TMDLs that states submit. When a TMDL is officially submitted by a state to EPA, EPA has 30 days to take action on the TMDL. In the case where EPA disapproves a TMDL, EPA must establish the TMDL.

1.2.2 TMDLs Addressed in this Report

This report contains TMDLs for the following parameters :

- **Temperature** – based on the 303(d) listing of approximately 41.5 miles of rivers and streams in the Nestucca River and Niagara and Powder Creeks;

- **Bacteria** – based on the 303(d) listing of Nestucca Bay due to elevated concentrations of fecal coliform bacteria that exceed the criteria for shellfish harvest (Bay).

- **Sedimentation** – based on the 303(d) listing of 34.3 miles of river in the Nestucca River and East Beaver Creek.

Table 1. Water bodies in the Nestucca Bay Watershed listed as water quality limited under section 303(d) of CWQ (DEQ 1998)

Waterbody Name	Boundaries	Parameter	Criteria	Season
Niagara Creek	Mouth to Headwaters	Temperature	Rearing 64 F (17.8 C)	Summer
Powder Creek	Mouth to Headwaters	Temperature	Rearing 64 F (17.8 C)	Summer
Nestucca River	Mouth to Powder Creek	Temperature	Rearing 64 F (17.8 C)	Summer
Nestucca Bay	Bay	Bacteria (fecal coliform)	Marine and shellfish growing area	Year Around
Beaver Creek, East Fork	Mouth to Headwaters	Sedimentation	Narrative	Year Around
Nestucca River	Powder Creek to Headwaters	Sedimentation	Narrative	Year Around
Beaver Creek, East Fork	Mouth to Headwaters	Habitat Modification	Narrative	Year Around
Nestucca River	Powder Creek to Headwaters	Habitat Modification	Narrative	Year Around
Nestucca River	Mouth to Powder Creek	Flow Modification	Narrative	Year Around

This TMDL relies on a watershed approach and aspects of the TMDL are applicable to the entire Nestucca and Little Nestucca River Watersheds.

1.3 TMDL Implementation

1.3.1 Water Quality Management Plans (WQMPs)

Implementation of TMDLs is critical to the attainment of water quality standards. The support of Designated Management Agencies (DMAs) in implementing TMDLs is essential. In instances where DEQ has no direct authority for implementation, DEQ works with DMAs on implementation to ensure attainment of water quality standards.

DEQ intends to submit a WQMP to EPA concurrently with submission of TMDLs even though EPA has no approval authority for the WQMP. This WQMP is appended to the TMDL document as Appendix D.

The following are elements of the WQMPs that will be submitted to EPA:

1. *Condition assessment and problem description*
2. *Goals and objectives*
3. *Identification of responsible participants*
4. *Proposed management measures*
5. *Timeline for implementation*
6. *Reasonable assurance*
7. *Monitoring and evaluation*
8. *Public involvement*
9. *Costs and funding*
10. *Citation to legal authorities*

1.3.2 Existing Water Quality Programs and Designated Management Agencies

There are several existing planning and legal mechanisms for addressing pollutant loading in the Nestucca Bay Watershed. Following are descriptions of several of these laws and plans and the legally responsible Designated Management Agencies for some of the lands in the watershed.

Northwest Forest Plan

In response to environmental concerns and litigation related to timber harvest and other operations on Federal Lands, the United States Forest Service (USFS) and the Bureau of Land Management (BLM) commissioned the Forest Ecosystem Management Assessment Team (FEMAT) to formulate and assess the consequences of management options. The assessment emphasizes management alternatives that comply with existing laws while maintaining the highest contribution of economic and social well being. An interim and long-term scheme that protects aquatic and associated riparian habitats adequate to provide for threatened species in a network of late-successional forests is the “backbone” of ecosystem management on federal lands. Biological objectives of the Northwest Forest Plan include assuring adequate habitat on Federal lands to aid the “recovery” of late-successional forest habitat-associated species listed as threatened under the Endangered Species Act and preventing species from being listed under the Endangered Species Act.

Oregon Forest Practices Act

The Oregon Forest Practices Act (FPA) contains regulatory provisions intended to: classify and protect water resources; reduce the impacts of clearcut harvesting; maintain soil and site productivity; ensure successful reforestation; reduce forest management impacts to anadromous fish; conserve and protect water quality and maintain fish and wildlife habitat; develop cooperative monitoring agreements; foster public participation; identify stream restoration projects; recognize the value of biodiversity; and monitor/regulate the application of chemicals. Oregon’s Department of Forestry (ODF) has adopted Forest Practice Administrative Rules (1997) that define allowable actions on State, County and private forestlands. Forest Practice Administrative Rules allow revisions and adjustments to the regulatory parameters it contains. Several revisions have been made in previous years and it is expected that the ODF, in conjunction with DEQ, will continue to monitor the success of the Forest Practice Administrative Rules and make appropriate revisions when necessary to address water quality concerns.

Senate Bill 1010

Senate Bill 1010 requires the Oregon Department of Agriculture (ODA) to develop Water Quality Management Plans for agricultural lands where such actions are required by State or Federal Law, such as TMDL requirements. ODA is developing these plans for basins throughout the state. The North Coast Basin Agricultural Water Quality Management Area Plan was approved by the Board of Agriculture in June 2000. The Water Quality Management Plan was crafted so that landowners in the local area can determine the best means of preventing and controlling water pollution resulting from agricultural activities. Local stakeholders will be asked to take corrective action against identified problems such as soil erosion, nutrient transport to waterways and degraded riparian areas. It is the ODA's intent to establish individual farm plans on a voluntary basis. However, Senate Bill 1010 allows the ODA to use civil penalties when necessary to enforce against agricultural activity that is found to transgress parameters of administrative rules ODA has adopted in association with an approved basin Water Quality Management Plan. ODA has expressed its intention to work with the local stakeholders and other state and federal agencies to implement the North Coast Basin Water Quality Management Plan and to enforce the associated Oregon Administrative Rules where necessary.

National Pollutant Discharge Elimination System (NPDES)

The Oregon Department of Environmental Quality (DEQ), under delegation from the EPA, requires permits for any point-source discharges of wastewater to waters of the state. These discharges include those from sewage treatment plants, industries, food processors, and a variety of other activities that require discharge through a defined conveyance. Permits establish the amount of a given pollutant that may be discharged to waters of the state, and are designed to ensure that the load of that pollutant will not result in impairment of the waterbody. There are also permits required for certain types of non-point source discharges from municipalities, industries, and construction activities that result in runoff directly or as a result of stormwater management.

Oregon Plan

The State of Oregon has formed a partnership between Federal and State agencies, local groups and grassroots organizations that recognizes the attributes of aquatic health and their connection to the health of salmon populations. The Oregon Plan considers the condition of salmon as a critical indicator of ecosystems (CSRI, 1997). The decline of salmon populations has been linked to impoverished ecosystem form and function. In response, the Oregon Plan has committed the State of Oregon to the following obligations: an ecosystem approach that requires consideration of the full range of attributes of aquatic health, focuses on reversing factors for decline by meeting objectives that address these factors, develops adaptive management and a comprehensive monitoring strategy, and relies on citizens and constituent groups in all parts of the restoration process. The intent of the Oregon Plan is to conserve and restore functional elements of the ecosystem that supports fish, wildlife and people. The Oregon Plan is designed to build on existing State and Federal water quality programs, namely: the Federal Clean Water Act, Coastal Zone Non-point Pollution Control Programs, the Northwest Forest Plan, Oregon's Forest Practices Act, Oregon's Senate Bill 1010 and Oregon's TMDL Program.

Tillamook Bay National Estuary Project.

The Tillamook Bay National Estuary Project developed a Comprehensive Conservation and Management Plan for improving many aspects of environmental and water quality in the Tillamook Basin. Many of the aspects of this project addresses the role of county ordinances that if developed and enacted would also be in effect in the Nestucca Bay Watershed. There were also actions identified that would encourage environmental protection through existing programs that regulate land use practices. These latter actions addressed increased funding for projects determined important in the improvement of forestry and agricultural practices that are regulated under the Forest Practices Act and Senate Bill 1010.

Nestucca Neskowin Watershed Council Action Plan

The Nestucca Neskowin Watershed Council has been very active both in assessing the environmental quality in the Nestucca Bay Watershed and developing and prioritizing an Action Plan for future projects. The actions in the plan range from enhancement of riparian vegetation to long-term monitoring of water quality in the watershed.

1.3.3 Implementation and Adaptive Management Issues

1.3.3.1 Implementation Measures

The goal of the Clean Water Act and associated Oregon Administrative Rules is that water quality standards shall be met or that all feasible steps will be taken towards achieving the highest quality water attainable. This is a long-term goal in many watersheds, particularly where non-point sources are the main concern. To achieve this goal, implementation must commence as soon as possible.

TMDLs are numerical loadings that are set to limit pollutant levels such that in-stream water quality standards are met. DEQ recognizes that TMDLs are values calculated from mathematical models and other analytical techniques designed to simulate and/or predict very complex physical, chemical and biological processes. Models and techniques are simplifications of these complex processes and, as such, are unlikely to produce an exact prediction of how streams and other waterbodies will respond to the application of various management measures. It is for this reason that the TMDLs have been established with a margin of safety.

WQMPs are plans designed to reduce pollutant loads to meet TMDLs. DEQ recognizes that it may take some period of time—from several years to several decades after full implementation before management practices identified in a WQMP become fully effective in reducing and controlling non-point source pollution. In addition, DEQ recognizes that technology for controlling non-point source pollution is, in many cases, in the development stages and will likely take one or more iterations to develop effective techniques. It is possible that after application of all reasonable best management practices, some TMDLs or their associated surrogates cannot be achieved as originally established.

DEQ also recognizes that, despite the best and most sincere efforts, natural events beyond the control of humans may interfere with or delay attainment of the TMDL and/or its associated surrogates. Such events could be, but are not limited to, floods, fire, insect infestations, and drought.

In this TMDL, pollutant surrogates have been defined as alternative targets for meeting the TMDL for temperature and sedimentation. The purpose of the surrogates is not to bar or eliminate human access or activity in the watershed or its riparian areas. It is the expectation, however, that WQMPs will address how human activities will be managed to achieve the surrogates. It is also recognized that full attainment of pollutant surrogates (system potential vegetation, for example) at all locations may not be feasible due to physical, legal or other regulatory constraints. To the extent possible, WQMPs should identify potential constraints, but should also provide the ability to mitigate those constraints should the opportunity arise. For instance, at this time, the existing location of a road or highway may preclude attainment of system potential vegetation due to safety considerations. In the future, however, should the road be expanded or upgraded, consideration should be given to designs that support TMDL load allocations and pollutant surrogates such as system potential vegetation.

If a non-point source that is covered by this TMDL complies with its WQMP or applicable forest practice rules, it will be considered in compliance with the TMDL.

DEQ intends to regularly review progress of WQMPs to achieve TMDLs. If and when DEQ determines that WQMPs have been fully implemented, that all feasible management practices have reached maximum expected effectiveness and a TMDL or its interim targets have not been achieved, DEQ shall reopen the TMDL and adjust it or its interim targets and its associated water quality standard(s) as necessary.

The implementation of TMDLs and the associated management plans is generally enforceable by DEQ, other state agencies and local government. However, it is envisioned that sufficient initiative exists to achieve water quality goals with minimal enforcement. Should the need for additional effort emerge, it is expected that the responsible agency will work with land managers to overcome impediments to progress through education, technical support or enforcement. Enforcement may be necessary in instances of insufficient action towards progress. This could occur first through direct intervention from land management agencies (e.g. ODF, ODA, counties and cities), and secondarily through DEQ. The latter may be based in departmental orders to implement management goals leading to water quality standard attainment.

An unlisted source may be issued a permit for discharge of the pollutant causing impairment, without modification of the TMDL, if it is demonstrated that the discharge will not cause or contribute to a violation of the water quality standard (See 40 CFR 122.44(d) in the NPDES permitting regulations). New discharges that achieve water quality standards at end-of-pipe would be candidates for permitting without a TMDL modification. For instance, it may be allowable for a new facility to discharge at a concentration lower than the water quality criterion (where accumulation of the pollutant is not a concern). Similarly, in temperature impaired waters, it may be allowable for a new facility to discharge wastewater that is cooler than the temperature standard without modification of the TMDL. The demonstration that the new discharge will not cause or contribute to a violation of the water quality standard would be included in the Fact Sheet for the permit in question.

1.3.3.2 Adaptive Management

In employing an adaptive management approach to this TMDL and WQMP, DEQ has the following expectations and intentions:

- On a five-year periodic basis, DEQ will review the progress of the TMDL and the WQMP.
- In conducting this review, DEQ will evaluate the progress towards achieving the TMDL (and water quality standards) and the success of implementing the WQMP.
- DEQ expects that each management agency will also monitor and document its progress in implementing the provisions of its component of the WQMP. This information will be provided to DEQ for its use in reviewing the TMDL.
- As implementation of the WQMP proceeds, DEQ expects that management agencies will develop benchmarks for attainment of TMDL surrogates, which can then be used to measure progress.
- Where implementation of the WQMP or effectiveness of management techniques are found to be inadequate, DEQ expects management agencies to revise the components of the WQMP to address these deficiencies.
- When DEQ, in consultation with the management agencies, concludes that all feasible steps have been taken to meet the TMDL and its associated surrogates and attainment of water quality standards, the TMDL, or the associated surrogates is not practicable, it will reopen the TMDL and revise it as appropriate. DEQ would also consider reopening the TMDL should new information become available indicating that the TMDL or its associated surrogates should be modified.

CHAPTER 2 – NESTUCCA BAY WATERSHED DESCRIPTION

2.1 Geographic Description

The Nestucca and Little Nestucca watersheds are located in northwest Oregon occupying approximately 371 square miles. The hydrologic unit (HUC) containing the Nestucca and Little Nestucca, classified accordingly as a 'subbasin' or 4th field watershed, is 17100203 (USGS, 1989). There are additional watersheds located within this HUC (i.e., Miami, Kilchis, Trask, Wilson, and Tillamook Rivers), but located within the Tillamook Bay watershed, for which a separate set of TMDLs has been developed. The present document only covers information pertaining to the rivers draining into the Nestucca Bay (i.e., Nestucca and Little Nestucca River watersheds).

The Nestucca and Little Nestucca Rivers originate in the forested Coast Range Mountains and flow westward to estuary/tidal areas. Headwater streams predominately originate in the conifer forests of the Coastal Mountains at over 2,000 feet elevation (the highest point in the watershed is 3,133 feet in elevation). All of the river systems flow for a short length through low gradient and tidally influenced areas and is easily seen in the shaded relief developed for topography.

2.2 Land Ownership and Land Uses

The largest landholder in the Nestucca and Little Nestucca subbasins is the United States Forest Service (36.4% of the surface area). Private lands account for 128 square miles (34.5% of the surface area) that occurs throughout the watershed. The Bureau of Land Management manages approximately 63 square miles within these watersheds (17% of the surface area). State Forests cover approximately 5.1% of the surface area. **Figure 1** displays land ownership within the Nestucca and Little Nestucca watersheds.

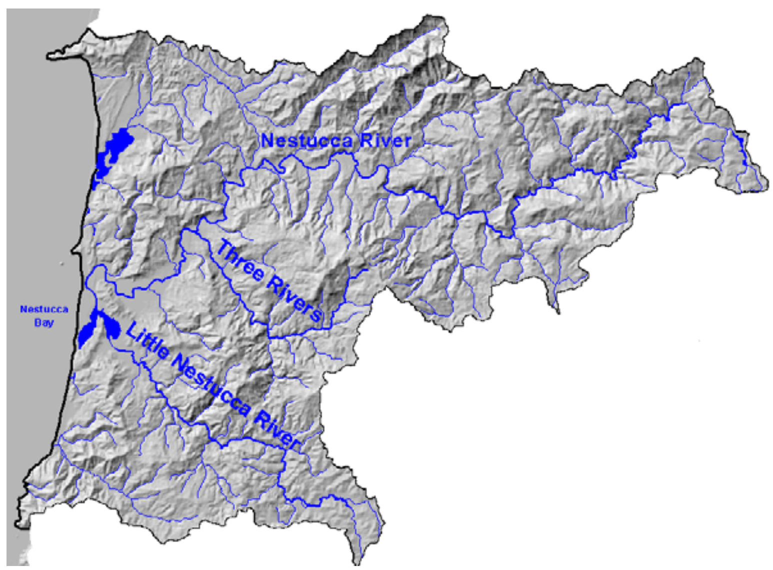


Figure 2 shows the land uses within the Nestucca and Little Nestucca watersheds identified by USGS (1979). Forested land uses predominate in the Nestucca and Little Nestucca watersheds, with 93.6% if the watershed area mapped as conifer and mixed forests. Crop and pasture land uses are confined to low gradient areas near tidally influence areas and comprise 4.2% of the watershed area. Urban areas compromise less than one percent of the surface area (0.7%).

Over 93 percent of the surface area within these watersheds is Forested

Figure 1. Land Ownership within the Nestucca and Little Nestucca watersheds

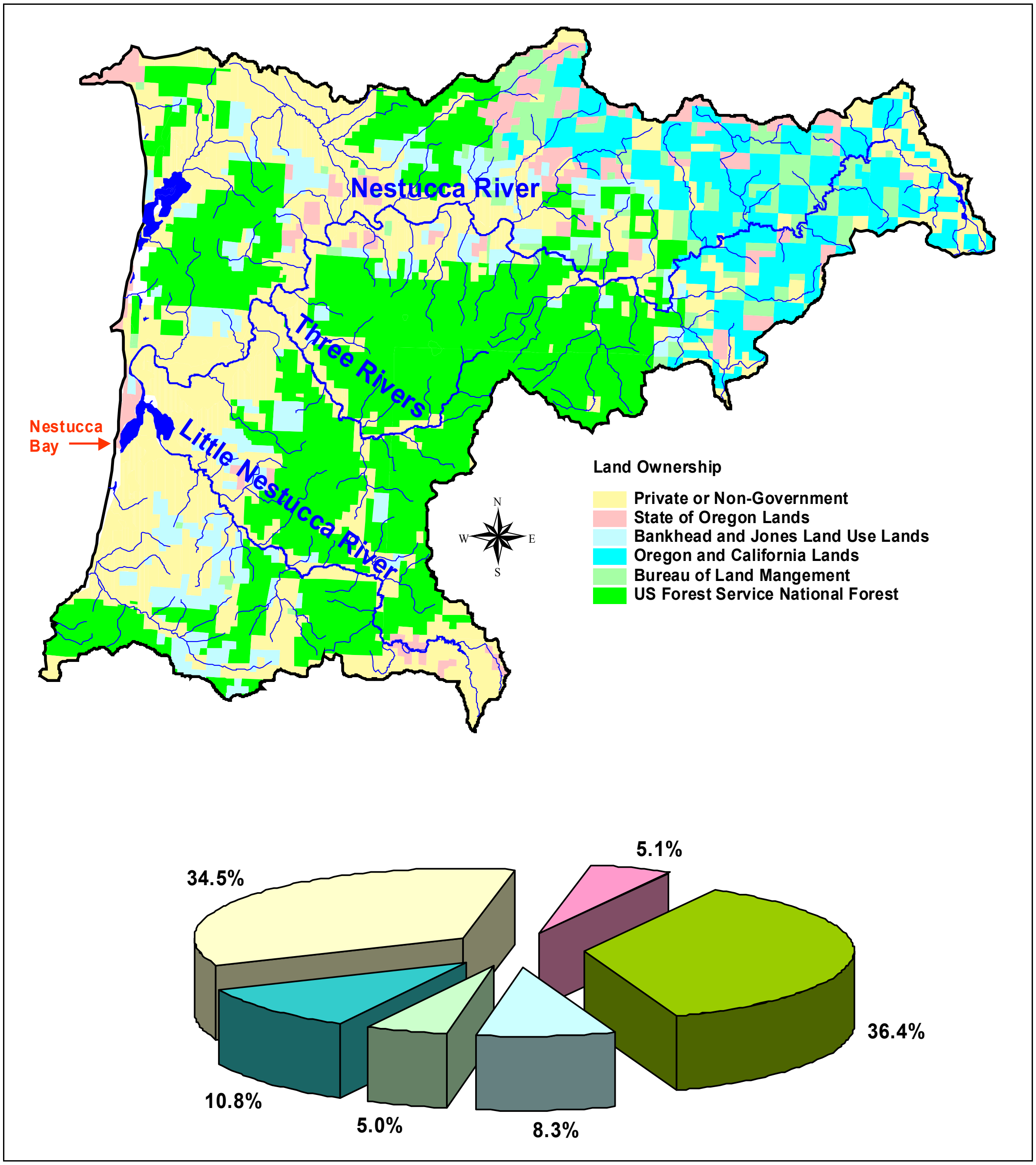
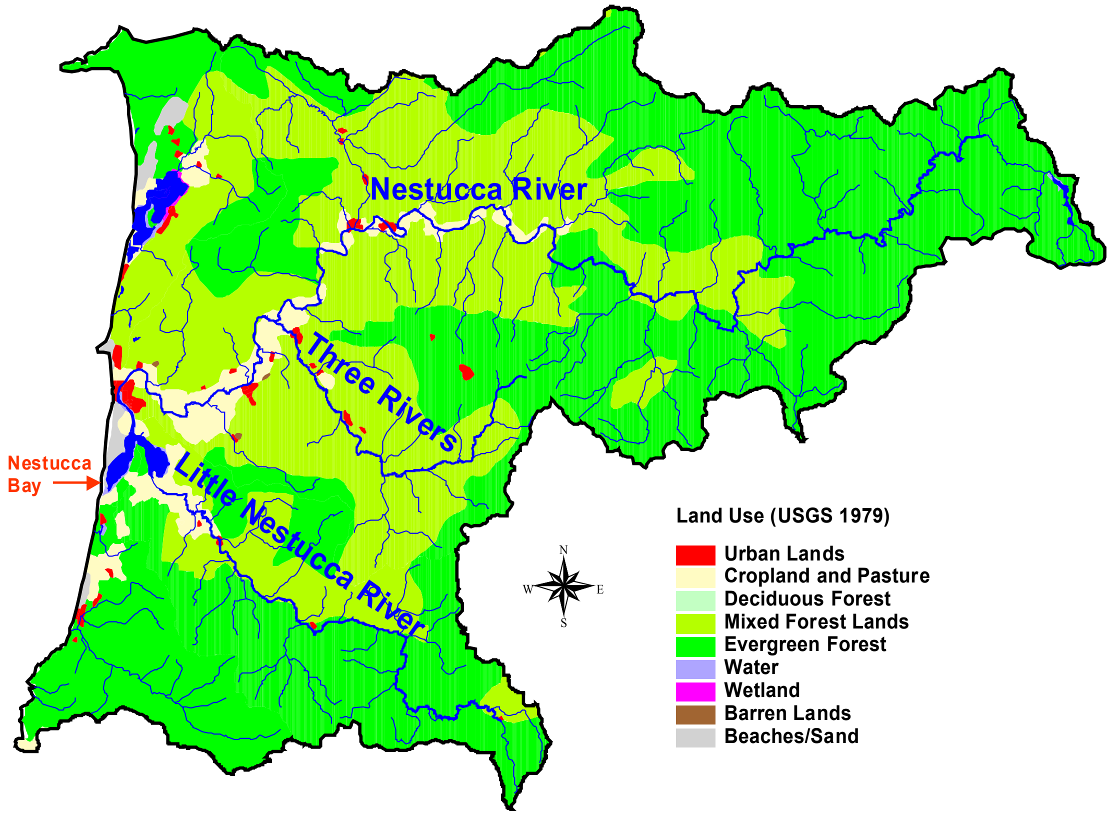
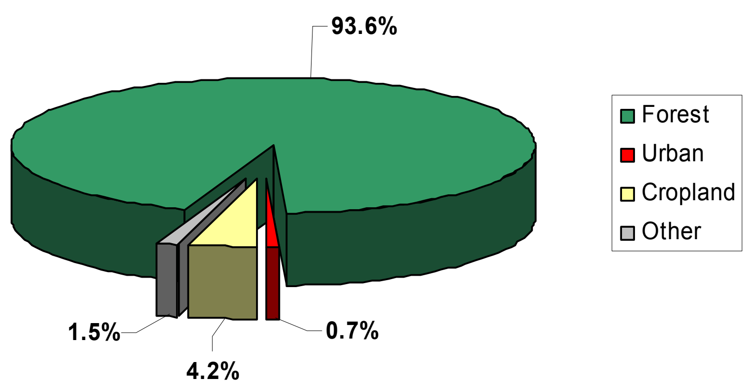


Figure 2. Land Use within the Nestucca River Subbasin (USGS, 1979)





2.3 Climate

2.3.2 Precipitation

The climate of the Nestucca Bay Watershed is influenced by proximity to the Pacific Ocean and elevation. Climatic conditions can vary considerably, a function of *orographic*[1] influence and ocean effects. The Coastal Mountains within these basins often receive between 120 and 180 inches of annual precipitation, most as rainfall. Lower portions of the watershed, closer to Hebo, receive average annual precipitation totals between 70 and 100 inches. **Figure 3** graphically displays average annual precipitation (rainfall equivalent). Precipitation totals are greatest in winter and spring months (November through April), while less precipitation is received in summer and early fall months (May through October). Air temperatures in the Nestucca and Little Nestucca Watersheds are mild throughout the year. The Pacific Ocean has a moderating effect on air temperature, much more so at close proximity to the ocean. Accordingly, summertime air temperatures may be much higher in areas only a few miles inland relative to areas near the ocean.

The Nestucca and Little Nestucca Watershed receive an average of 120 to 180 inches of precipitation annually, comprised largely as rainfall. Fall, winter and spring are usually wet seasons, while summertime is often drier. However, rainfall patterns vary considerably throughout the watershed and from year to year

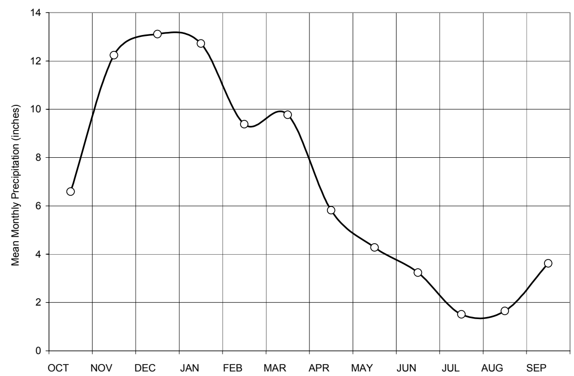
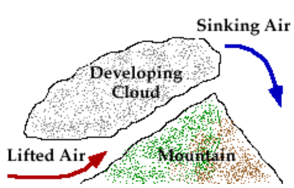
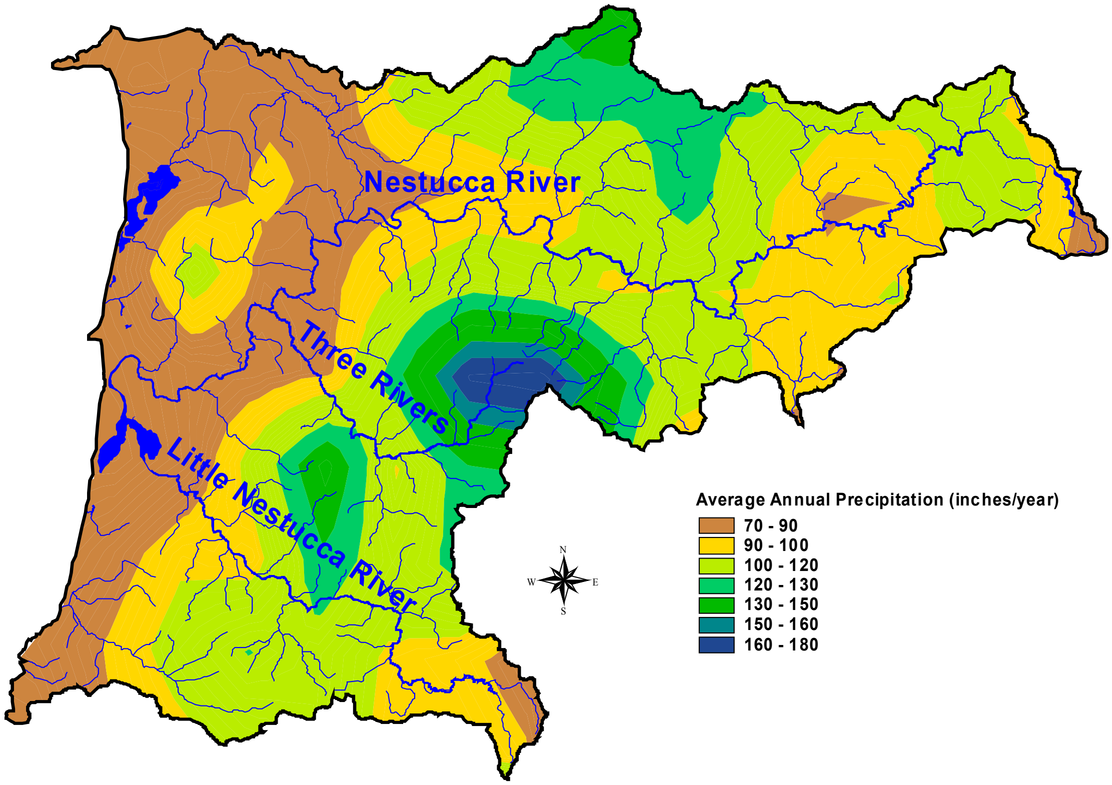


Table 3. Average Monthly Climate Data for Cloverdale Oregon (1961 to 1990)													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Air Temperature (°F)													
Mean	44	46	47	49	53	57	60	61	60	54	48	44	52
Maximum	50	54	55	58	62	66	70	71	70	64	55	51	61
Precipitation (inches)													
Minimum	37	39	39	40	43	47	50	50	49	45	41	38	43
Mean	13	9	10	6	4	3	2	2	4	7	12	13	84
Extreme 24 hour	7	3	3	2	2	3	3	3	3	3	4	6	7
Precipitation (days)													
.01 inches or more	20	18	20	16	14	10	6	7	10	14	21	21	177
0.1 inches or more	17	15	17	13	10	7	3	4	7	11	18	18	141
0.5 inches or more	9	7	8	4	3	2	1	1	3	5	10	9	62
1.0 inches or more	4	3	2	1	1	1	0	0	1	2	3	4	21



[1] Orographic Precipitation is caused by surface winds that are forced to rise against mountains. The winds cool as they rise against the mountain slopes the moisture in the air condenses and changes into rain. Precipitation formed by winds rising against mountains is orographic (from the Greek word oros, "mountain").

Figure 3. Average Annual Precipitation in the Nestucca and Little Nestucca Subbasins



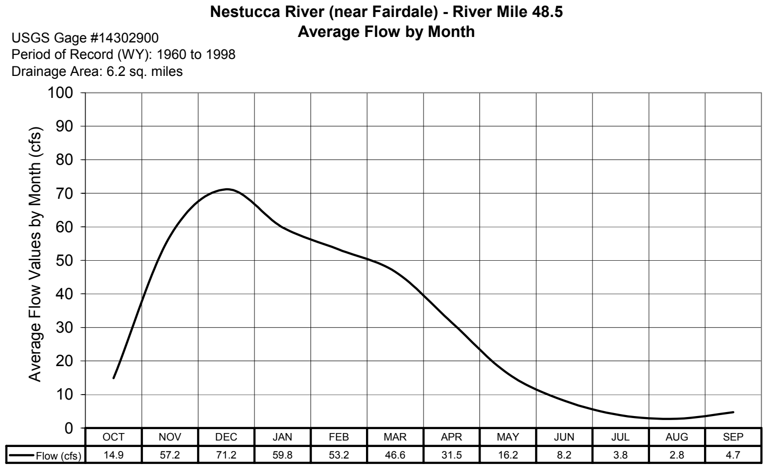
2.3.3 Flow

Daily stream flow measurements have been collected in the Nestucca watershed at two U.S. Geological Survey (USGS) gages (USGS #14303600 and USGS #14302900) since 1964. Flow data from the gage near Beaver has not been reported since 1996 when the State of Oregon Water Resources Division began maintaining this gage. Flow data files were processed by DEQ staff to quantify *return periods*[2]. Statistical descriptions of temporal and spatial flow regimes/patterns require many years of daily collected flow data. This duration of flow data does not exist in the Little Nestucca River and Three Rivers (Nestucca subbasin).

- ***10 year low flows are roughly 50 cfs in lower reaches (RM 13.6), but flow rates are generally much lower in the headwaters (RM 48.5).***
- ***Summer average low flows are approximately 110 cfs.***
- ***Wintertime high flows are generally greater than 2,000 cfs.***

[2] Duration periods for which flows were averaged were 1 day, 7 days and 14 days. Return periods estimations were performed using the Log Pearson Type III distribution for the following *return periods*: 1 year, 2 years, 5 years, 10 years, 25 years, 50 years and 100 years. Average monthly flows were also calculated. Return flows are presented as *XQY*, where "*X*" represents the flow duration (days) and "*Y*" represents the return period (years). For example, a *7Q10* would represent the 7-day average flow that occurs on average once every 10 years. Therefore, the probability that seven-day duration 10-year *return period* flow (7Q10) conditions will occur during any year is 10%.

Figure 4. Monthly Flow Averages in the Nestucca River



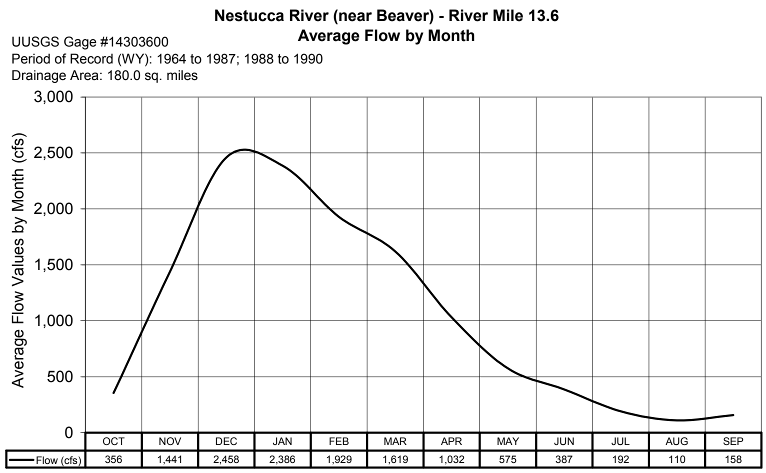
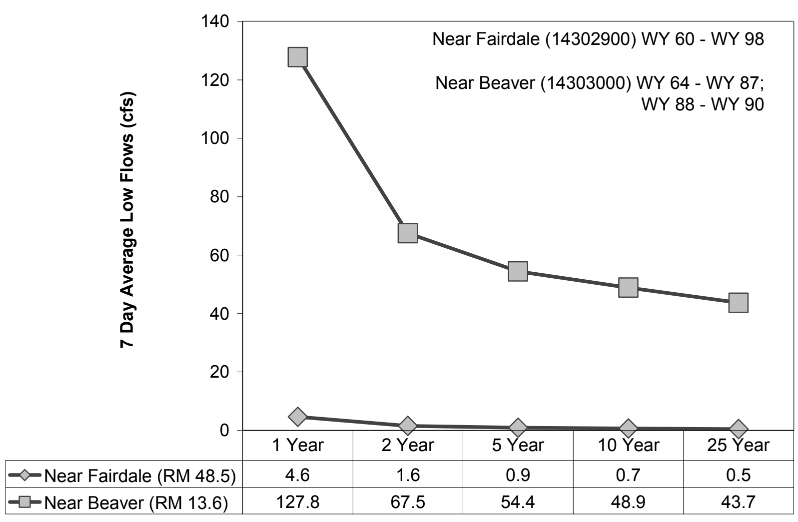


Figure 5. Nestucca River Log Pearson Type III Low Flow Statistics



CHAPTER 3 – TOTAL MAXIMUM DAILY LOADS

Summary of Temperature TMDL Development and Approach

Why Is Temperature Important?

Excessive summer water temperatures in several tributaries and mainstem reaches throughout the Nestucca watershed are reducing the quality of rearing habitat for chinook, coho and chum salmon, as well as steelhead trout and cutthroat trout. Primary watershed disturbance activities which contribute to surface water temperature increase include past forest management within riparian areas, current timber harvest in near stream areas and outside the riparian zone, agricultural land use within the riparian area, road construction and maintenance, and rural residential development near streams and rivers. As a result of water quality standards (WQS) exceedances for temperature, waters in the Nestucca and Little Nestucca watersheds are on Oregon's 1998 303(d) list.

Scope

All lands (371 square miles) with streams that drain to the Nestucca Bay within HUC 17100203 are included in the temperature TMDL. All land uses are included: lands managed by the State of Oregon, the U.S. Forest Service (USFS) and Bureau of Land Management (BLM), private forestlands, agricultural lands, rural residences, military lands and urban areas.

Applying Oregon's Temperature Standard

Oregon's temperature standard is developed to ensure protection of the most sensitive beneficial uses. These uses in the Nestucca Bay Watershed are cold-water fishes, namely salmonids that are quite sensitive to elevated water temperature. The criteria for salmonid protection require that the temperature will not exceed 64°F during periods of migration and rearing, or 55°F during periods when spawning occurs. In areas where the numeric criteria are being exceeded, the Department considers attainment of system potential conditions to serve as compliance with the temperature standard. This is acheived through restoration/protection of riparian vegetation, channel morphology, and hydrologic processes.

Development of System Potential Conditions

System potential conditions are comprised of riparian and channel morphology parameters. The reduction in thermal loading needed to meet the water quality standard is evaluated using a variety of data (ground level, GIS and remote sensing) and analytical modeling. The Department assessed potential vegetation with field measurements and literature regarding vegetation distributions. Channel morphology was assessed via the application of hydrologic principles and distributions of current channel geometry. Flows were evaluated with instream measurements. DEQ calculated the thermal effects associated with achieving both riparian and channel morphology system potential conditions. Other factors, such as groundwater/stream interactions and floodplain/stream connection, are more difficult to quantitatively assess and are indirectly addressed through the riparian and channel morphology TMDL targets.

Temperature TMDL Overview

Stream temperature pollutants are identified as human-caused increases in solar radiation loading and warm water discharges. The resultant TMDL loading capacities are expressed as pollutant loading limits for both non-point and point sources of pollution. Allocations of the pollutant load are provided to all sources of pollution in the Nestucca Bay watershed. Surrogate measures are also provided to non-point sources of pollution to help translate the loading capacity and to provide a clear list of site specific targets for management and implementation considerations.

3.1 Stream Temperature TMDL

3.1.1 Temperature Pollutant Identification

The pollutants identified for stream temperature pollution are human caused increases to solar radiation loading at the stream surface and warm water discharge to surface waters.

With a few exceptions, such as in cases where violations are due to natural causes, the State must establish *a Total Maximum Daily Load* or *TMDL* for any waterbody designated on the 303 (d) list as violating water quality standards. A *TMDL* is the total amount of a pollutant (from all sources) that can enter a specific waterbody without causing violation of the water quality standards.

Water temperature change is an expression of heat energy exchange per unit volume:

$$\Delta Temperature \propto \frac{\Delta Heat \quad Energy}{Volume}.$$

Anthropogenic increase in heat energy is derived from solar radiation as increased levels of sunlight reach the stream surface and raise water temperature. The pollutants targeted in this TMDL are (1) human caused increases in solar radiation loading to the stream network and (2) warm water discharges of human origin.

3.1.2 Temperature Target Identification – CWA §303(d)(1)

The stream temperature TMDL targets protection of the most sensitive beneficial use: salmonids. Oregon's stream temperature standard, which is based on the temperature requirements of salmonids, is designed for protection during all salmonid life stages. Several numeric criteria and other triggers for the temperature standard establish factors for designating surface waters as water quality limited. The temperature standard specifies that anthropogenic (i.e. human caused) impacts that cause stream heating should be removed. The TMDL targets this "no anthropogenic warming" condition. A stream condition that has no anthropogenic induced warming is considered to be at the system potential.

3.1.2.1 Salmonid Stream Temperature Requirements

Stream temperatures above 64°F (17.8°C) are considered sub-lethal and can be stressful for cold water fish species, such as salmon and trout.

Salmonids, often referred to as cold water fish, and some amphibians are highly sensitive to temperature. In particular, Chinook salmon (*Oncorhynchus tshawytscha*) and bull trout (*Salvelinus confluentus*) are among the most temperature sensitive of the cold water fish species. Oregon's water temperature standard employs logic that relies on using these *indicator species,* which are the most sensitive. If temperatures are protective of *these indicator species*, other species will share in this level of protection.

If stream temperatures become too hot, fish die almost instantaneously due to denaturing of critical enzyme systems in their bodies (Hogan, 1970). The ultimate *instantaneous lethal limit* occurs in high temperature ranges (upper-90°F). Such warm temperature extremes may never occur in the Nestucca Bay Watershed.

More common and widespread, however, is the occurrence of temperatures in the mid-70°F range (mid- to high-20°C range). These temperatures cause death of cold-water fish species during exposure times lasting a few hours to one day. The exact temperature at which a cold water fish succumbs to such a thermal stress depends on the temperature that the fish is acclimated to, and on life-stage of development. This cause of mortality termed the *incipient lethal limit*, results from breakdown of physiological regulation of vital processes such as respiration and circulation (Heath and Hughes, 1973).

The most common and widespread cause of thermally induced fish mortality is attributed to interactive effects of decreased or lack of metabolic energy for feeding, growth or reproductive behavior, increased exposure to pathogens (viruses, bacteria and fungus), decreased food supply (impaired macroinvertebrate populations) and increased competition from warm water tolerant species. This mode of thermally induced mortality, termed indirect or *sub-lethal*, is more delayed, and occurs weeks to months after the onset of elevated temperatures (mid-60°F to low-70°F). **Table 1** summarizes the modes of cold water fish mortality.

Table 2. Modes of Thermally Induced Cold Water Fish Mortality

(Brett, 1952; Bell, 1986, Hokanson et al., 1977)

Modes of Thermally Induced Fish Mortality	**Temperature Range**	**Time to Death**
Instantaneous Lethal Limit – Denaturing of bodily enzyme systems	> 90°F > 32°C	Instantaneous
Incipient Lethal Limit – Breakdown of physiological regulation of vital bodily processes, namely: respiration and circulation	70°F - 77°F 21°C - 25°C	Hours to Days
Sub-Lethal Limit – Conditions that cause decreased or lack of metabolic energy for feeding, growth or reproductive behavior, encourage increased exposure to pathogens, decreased food supply and increased competition from warm water tolerant species	64°F - 74°F 20°C - 23°C	Weeks to Months

3.1.3 Sensitive Beneficial Use Identification

Oregon Administrative Rules (OAR Chapter 340, Division 41, Section 202, Table 1) lists the "Beneficial Uses" occurring within the Nestucca Bay Watershed (**Table 2**). Numeric and narrative water quality standards are designed to protect the most sensitive beneficial uses. Salmonid spawning and rearing are the most sensitive beneficial uses in the Nestucca Bay Watershed. Other sensitive uses (such as drinking water and water contact recreation) are applicable throughout the subbasin.

Salmonid fish spawning, incubation, fry emergence, and rearing are deemed the most temperature-sensitive beneficial uses within the Nestucca Bay Watershed.

Table 3. Beneficial uses occurring in the Nestucca Bay Watershed

(OAR 340 – 41 – 202)
Temperature-Sensitive Beneficial uses are marked in gray

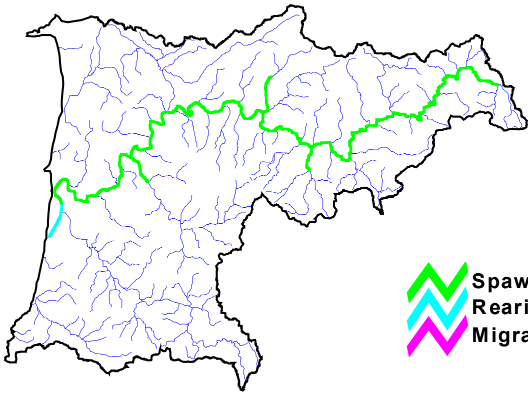
Beneficial Use	***Occurring***	***Beneficial Use***	***Occurring***
Public Domestic Water Supply	✓	Anadromous Fish Passage	✓
Private Domestic Water Supply	✓	Salmonid Fish Spawning	✓
Industrial Water Supply	✓	Salmonid Fish Rearing	✓
Irrigation	✓	Resident Fish and Aquatic Life	✓
Livestock Watering	✓	Wildlife and Hunting	✓
Boating	✓	Fishing	✓
Aesthetic Quality	✓	Water Contact Recreation	✓
Commercial Navigation & Trans.		Hydro Power	

Beneficial uses and the associated water quality standards are applicable throughout the Nestucca and Little Nestucca subbasins. In applying standards and restoration, it is important to know where existing salmonid spawning locations are and where they are potentially attainable. Salmonid spawning and the quality of the spawning grounds are particularly sensitive to water quality and streambed conditions. **Figure 6** identifies the locations where anadromous salmonids (*Oncorhynchus*) are known to occur in the Nestucca and Little Nestucca subbasins. **Figure 7** displays and **Table 3** lists the various habitats (migration, spawning and rearing) for the four major anadromous salmonids present in the Nestucca Bay watershed (ODFW data):

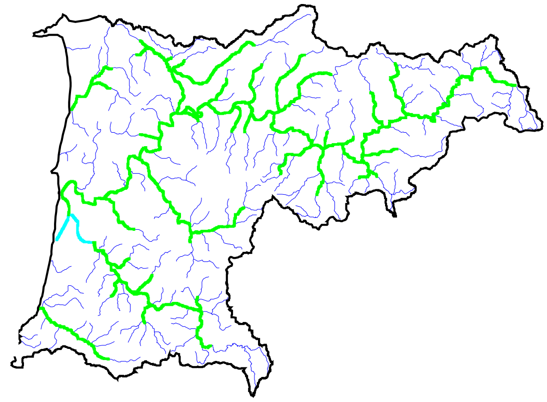
- Chinook Salmon (Spring and Fall) – *Oncorhynchus tshawytscha*
- Chum Salmon (Dog Salmon) - *Oncorhynchus keta*
- Coho Salmon (Silver Salmon) - *Oncorhynchus kisutch*
- Steelhead (Winter and Summer) - *Oncorhynchus mykiss*

Figure 6. Chinook Salmon, Coho Salmon, Chum Salmon and Steelhead Trout Distributions (ODFW). Range of dates indicate spawning and incubation periods for each species.

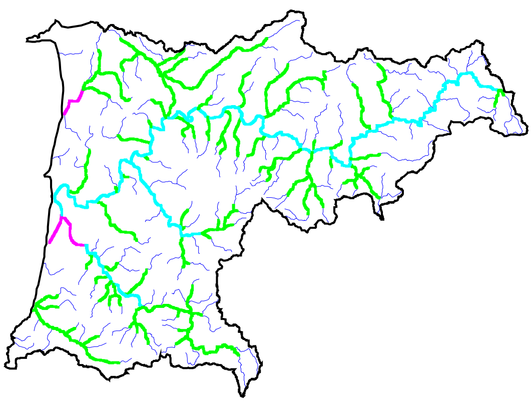
Spring Chinook
September 1 to January 31



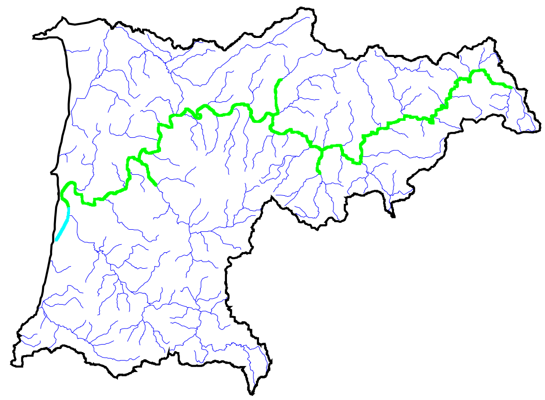
Fall Chinook
October 1 to April 30



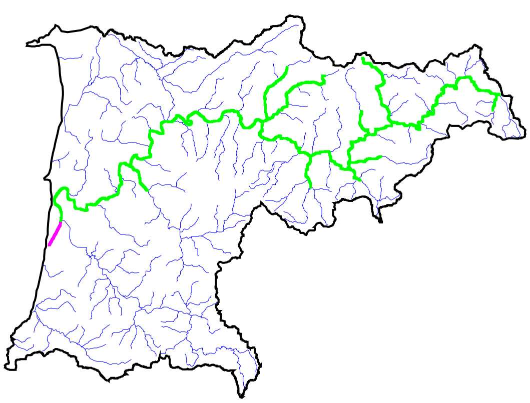
Coho
October 1 to May 31



Chum
October 1 to April 30



Summer Steelhead
January 1 to June 30



Winter Steelhead
December 1 to July 31

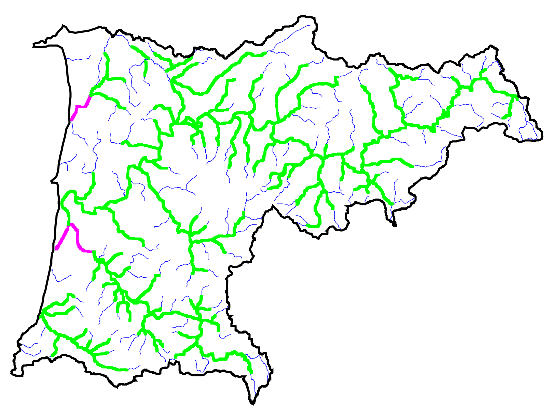


Table 4. Nestucca Bay Watershed Spawning Periods of Use by Species (Rick Klumph, ODFW)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult Migration/Holding												
Spring Chinook					Range	Peak	Range	Range	Range			
Summer Steelhead	Range	Range			Range	Peak	Peak		Range	Range	Range	Range
Sea-Run Cutthroat	Range	Range	Range	Range	Range	Peak	Peak	Peak	Peak	Peak	Peak	Range
Coho	Range	Range							Range	Range	Peak	Peak
Chum										Range	Peak	Peak
Fall Chinook								Range	Range	Range	Peak	Range
Winter Steelhead	Range	Peak	Peak	Peak							Range	Range
Resident Cutthroat	Range	Range	Range	Range	Range	Range	Range	Range	Range	Range	Range	Range
Spawning												
Spring Chinook									Peak	Peak		
Summer Steelhead	Range	Peak	Range	Range								
Sea-Run Cutthroat	Range	Peak	Peak									Range
Coho	Range	Range								Range	Peak	Peak
Chum	Range									Range	Peak	Peak
Fall Chinook	Peak	Range	Range							Range	Range	Peak
Winter Steelhead	Range	Range	Range	Peak	Peak							
Resident Cutthroat	Range	Peak	Peak									Range
Incubation												
Spring Chinook	Range								Range	Range	Peak	Peak
Summer Steelhead	Range	Peak	Peak	Range	Range	Range						
Sea-Run Cutthroat	Range	Range	Peak									Range
Coho	Range	Range	Range	Range	Range					Range	Range	Peak
Chum	Peak	Range	Range	Range						Range	Peak	Peak
Fall Chinook	Range	Peak	Peak	Range						Range	Range	Range
Winter Steelhead	Range	Range	Range	Range	Peak	Peak	Peak					Range
Resident Cutthroat	Range	Range	Peak	Peak	Peak							Range
Rearing												
Spring Chinook	Range	Range	Range	Range	Range	Range	Range	Range				Range
Summer Steelhead	Range	Range	Range	Range	Range	Range	Range	Range	Range	Range	Range	Range
Sea-Run Cutthroat	Range	Range	Range	Range	Range	Range	Range	Range	Range	Range	Range	Range
Coho	Range	Range	Range	Range	Range	Range	Range	Range	Range	Range	Range	Range
Chum	**No Freshwater Rearing Period**											
Fall Chinook	Range	Range	Range	Range	Range	Range	Range	Range	Range	Range		
Winter Steelhead	Range	Range	Range	Range	Range	Range	Range	Range	Range	Range	Range	Range
Resident Cutthroat	Range	Range	Range	Range	Range	Range	Range	Range	Range	Range	Range	Range
Peak Smolt Outmigration												
Spring Chinook					Peak	Peak						
Summer Steelhead					Peak							
Sea-Run Cutthroat					Peak	Peak						
Coho				Peak	Peak							
Chum				Peak								
Fall Chinook					Peak	Peak						
Winter Steelhead					Peak							
Resident Cutthroat	**Grow to Adulthood and Remain in River**											

Peak = Peak Use Period
Range = Range of Use

3.1.4 Water Quality Standard Identification

A seven-day moving average of daily maximums (7-day statistic) was adopted as the statistical measure of the stream temperature numeric criteria. Absolute numeric criteria are deemed action levels and indicators of water quality standard compliance. Unless specifically allowed under a DEQ-approved surface water temperature management plan (as required under (OAR 340-041-0026(3)(a)(D)), no measurable surface water temperature increase resulting from anthropogenic activities is allowed in State of Oregon Waters determined out of compliance with the temperature standard. A much more extensive analysis of water temperature related to aquatic life and supporting documentation for the temperature standard can be found in the *1992-1994 Water Quality Standards Review Final Issue Papers (DEQ, 1995)*.

It is important to understand the State of Oregon's temperature standard and that there is more to it than just a 64^{o}F criterion. Specifics for the Nestucca Bay Watershed temperature standard can be found in OAR 340-041-202(2)(b)(A) and in **Appendix C**.

The temperature standard applicable in the Nestucca Bay Watershed specifies that "no measurable surface water temperature increase resulting from anthropogenic (human induced) activities is allowed" unless specifically allowed under a DEQ-approved management plan, when trigger temperatures are exceeded (see temperature standard below - i through viii).

Nestucca Bay Watershed Temperature Standard - OAR 340-041-202(2)(b)(A)(i-viii)

To accomplish the goals identified in OAR 340-041-120(11), unless specifically allowed under a DEQ-approved surface water temperature management plan as required under OAR 340-041-026(3)(a)(D), no measurable surface water temperature increase resulting from anthropogenic activities is allowed:

(i) In a basin for which salmonid fish rearing is a designated beneficial use, and in which surface water temperatures exceed 64.0°F (17.8°C);

(ii) In the Columbia River or its associated sloughs and channels from the mouth to river mile 309 when surface waters exceed 68.0°F (20.0°C);

(iii) In waters and periods of the year determined by DEQ to support native salmonid spawning, egg incubation, and fry emergence from the egg and from the gravels in a basin which exceeds 55.0°F (12.8°C);

(iv) In waters determined by DEQ to support or to be necessary to maintain the viability of native Oregon bull trout, when surface water temperatures exceed 50.0°F (10.0°C);

(v) In waters determined by DEQ to be ecologically significant cold-water refugia;

(vi) In stream segments containing federally listed Threatened and Endangered species if the increase would impair the biological integrity of the Threatened and Endangered population;

(vii) In Oregon waters when the dissolved oxygen (DO) levels are within 0.5 mg/l or 10 percent saturation of the water column or intergravel DO criterion for a given stream reach or Basin; and

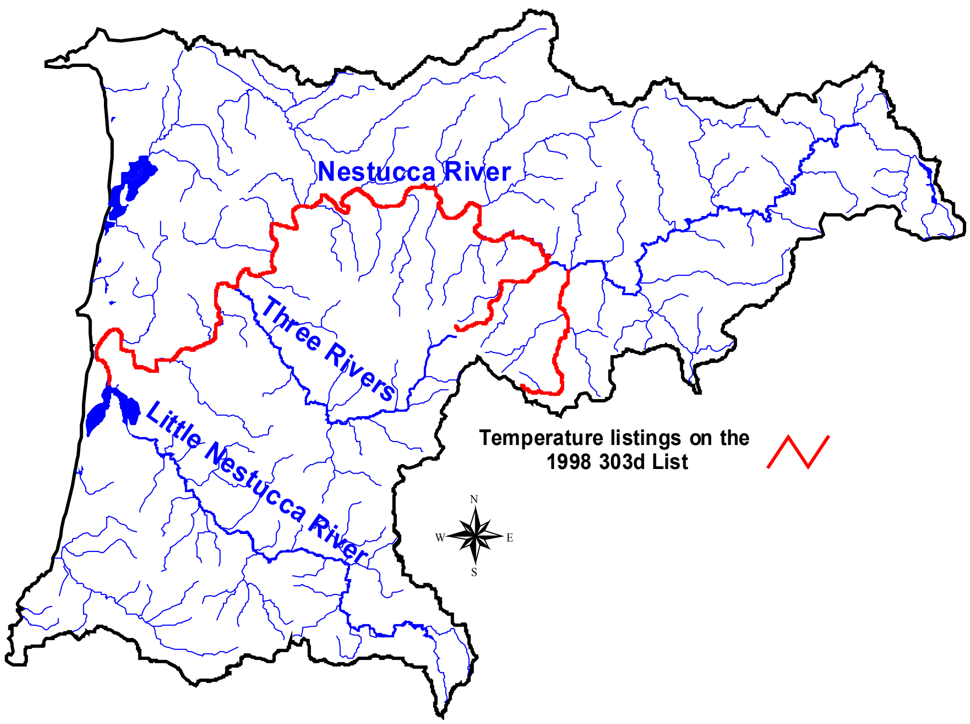
(viii) In natural lakes.

3.1.4.1 Deviation from Water Quality Standard (Temperature Impairments)

Monitoring has shown that water temperatures in the Nestucca Bay Watershed often exceed numeric criteria of the State water quality standard. Accordingly, several stream segments within the Nestucca Bay Watershed are on the 1998 §303(d) list for exceeding numeric temperature criteria (**Table 4** and **Figure7**).

Table 5. 1998 303(d) Nestucca Bay Watershed Temperature Limited Waterbodies	
Location:	• Nestucca River (Mouth to Powder Creek) • Powder Creek (Mouth to Headwaters) • Niagara River (Mouth to Headwaters)

Figure 7. Segments on the 1998 §303(d) List for Temperature.



As part of the TMDL effort for the Nestucca and Little Nestucca River Watersheds, hourly stream temperatures were measured at various locations throughout the Nestucca Bay Watershed during the summer of 1999. Stream temperatures follow a longitudinal (downstream) heating pattern, where smaller tributaries are cooler than the mainstem reaches. **Figure 9, 10, and 11** displays stream temperature as a function of measured perennial stream distance from headwaters for the Nestucca River, Three River, and Little Nestucca River, respectively. A detailed description of collected water quality data is presented in **Appendix A**.

Figure 8. Observed 7-Day temperatures in the Nestucca River Watershed during 1999.

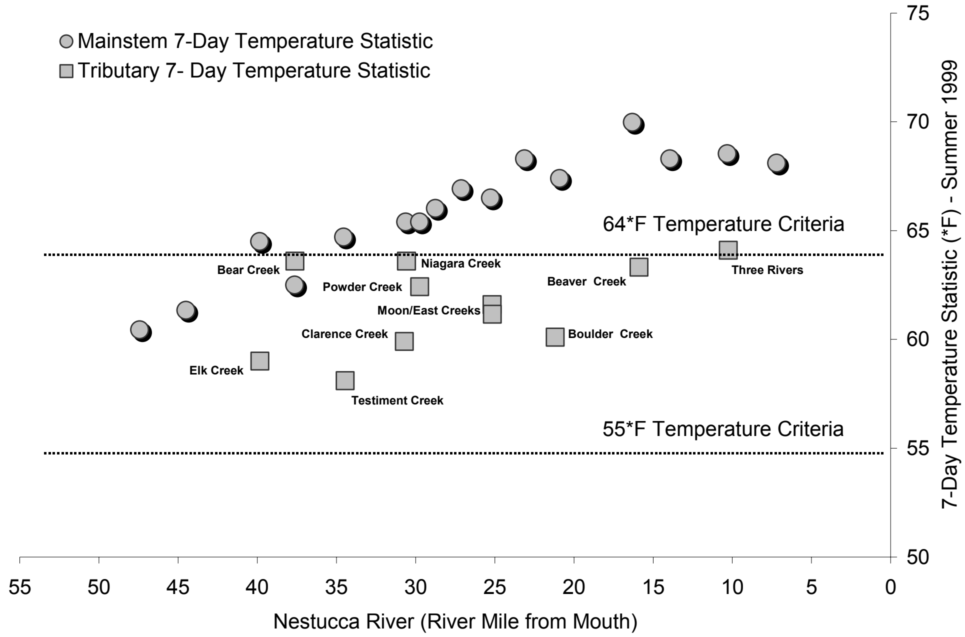


Figure 9. Observed 7-Day temperatures in Three Rivers and its tributaries during 1999.

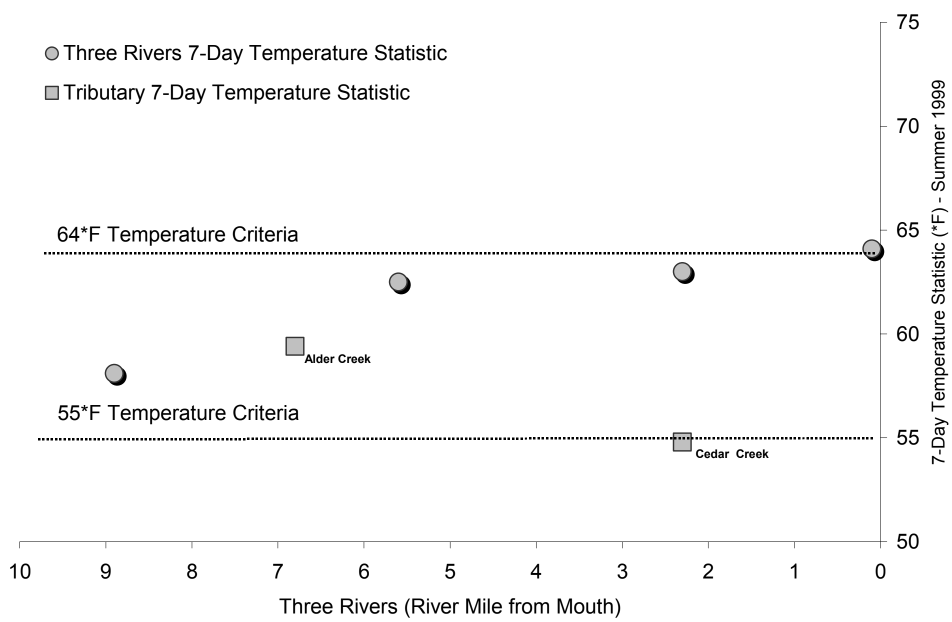
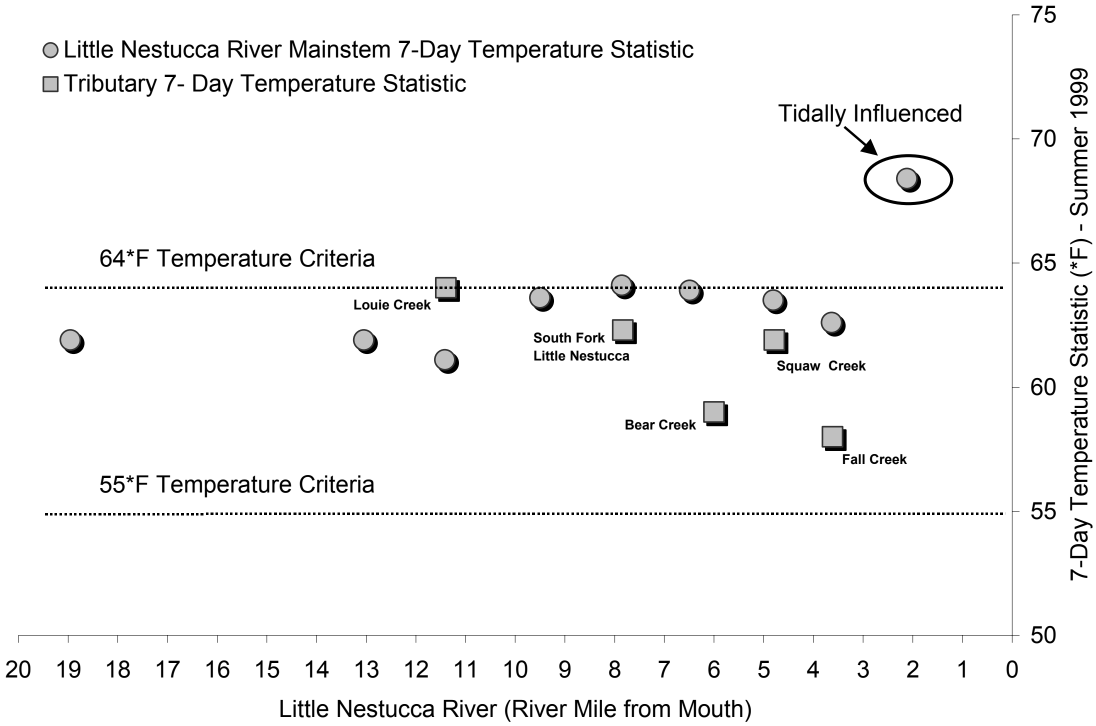


Figure 10. Observed 7-Day temperature Statistics in the Little Nestucca Watershed during 1999.



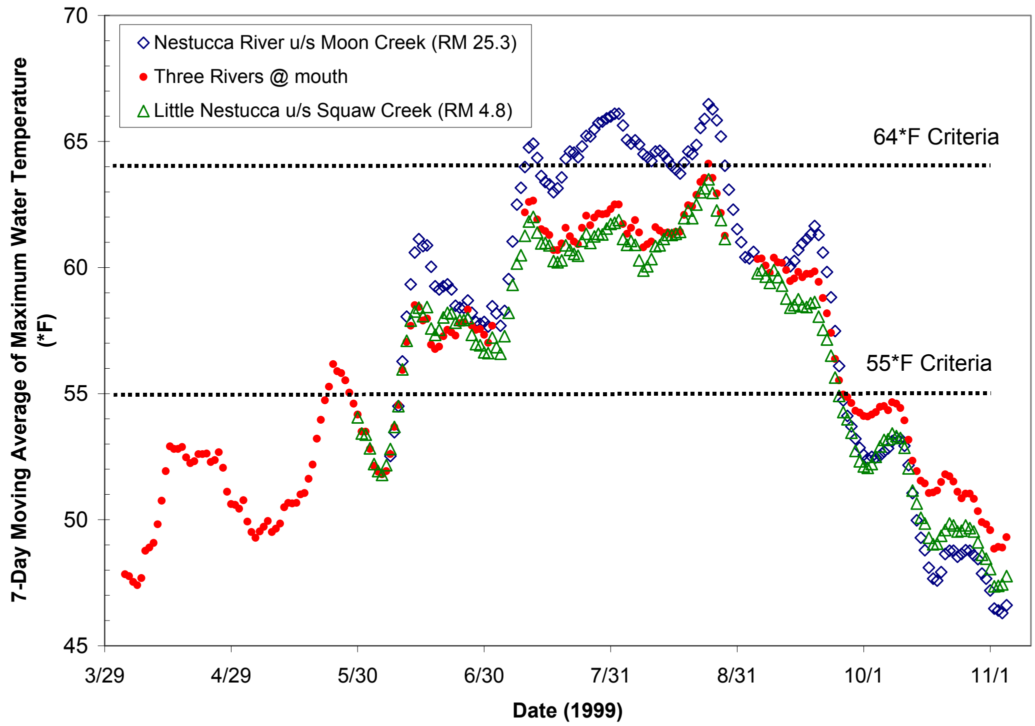
3.1.5 Seasonal Variation – CWA §303(d)(1)

Stream reaches within the Nestucca and Little Nestucca subbasins experience prolonged warming starting in late spring and extending into the fall. Maximum temperatures typically occur in July and August and the 64°F numeric criterion is exceeded (see **Figures 9, 10** and **11).** The TMDL focuses the analysis during this critical period. It is also important to note that the 55°F numeric criterion is violated during the month of September.

The critical temperature period occurs when stream temperatures are above the numeric criterion.

The critical temperature period occurs from May through October

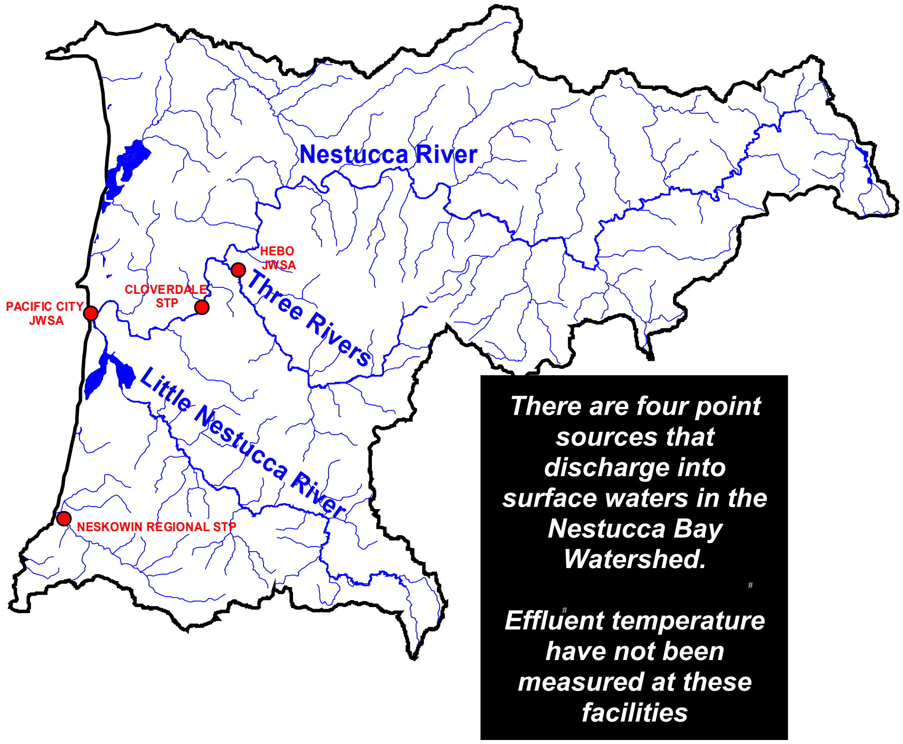
Figure 11. Seasonal variations in temperature in the Nestucca, Three Rivers, and Little Nestucca Watersheds in 1999.



3.1.6 Existing Sources – CWA §303(d)(1)

3.1.6.1 Point Sources

NPDES Permitted Facilities



Warm point source discharges in the Nestucca Bay Watershed are sources of stream heating. Four NPDES permitted discharge points are mapped and presented below. One of these, Neskowin Regional STP, discharges in a separate subwatershed (Neskowin Creek). Discharge temperature data have not been collected from these facilities. Dry Weather design discharge rates are very low for these facilities and range from 0.0 cfs (No Summer Discharge) to 0.56 cfs. Though there may be no temperature data available for some of the discharges in the watershed, effluent temperatures are typically on the order of 72°F.

Table 6. NPDES Permitted Facilities

Facility Name	City	Receiving Water	Permit Type	Flow Rate (cfs)[3]	Current Critical Temp.
Hebo Joint Water and Sewer Authority STP	Hebo	Three Rivers	NPDES	0.039	No Data
Cloverdale Sanitary District STP	Cloverdale	Tide water of the Nestucca River	NPDES	0.06	No Data
Pacific City Joint Water and Sewer Authority STP	Pacific City	Nestucca Bay	NPDES	0.56	No Data
Neskowin Regional Sewer Authority STP (Discharges to Neskowin Creek – Outside of Watershed)	Neskowin	No Summer Discharge	NPDES	NSD	No Data

[3] Dry Weather design flow

3.1.6.2 Nonpoint Sources

Riparian vegetation, stream morphology, hydrology, climate, and geographic location all influence stream temperature. While climate and geographic location are outside of human control, riparian condition, channel morphology and hydrology are affected by land use activities. Human activities that contribute to degraded thermal water quality conditions in the Nestucca and Little Nestucca Watersheds are associated with agriculture, forestry, roads, urban development and rural residential related riparian disturbance.

Specifically, the elevated summertime stream temperatures attributed to anthropogenic nonpoint sources result from the items listed below:

1. ***Near stream vegetation disturbance/removal*** *reduces stream surface shading via decreased riparian vegetation height, width and/or density, thus increasing the amount of solar radiation reaching the stream surface (shade is commonly measured as percent effective shade or open sky percentage). Riparian vegetation also plays an important role in shaping the channel morphology, resisting erosive high flows and maintaining floodplain roughness.*
2. ***Channel modifications and widening*** *(increased width to depth ratios) increases the stream surface area exposed to energy processes, namely solar radiation. Near-Stream Disturbance Zone (NSDZ) widening decreases potential shading effectiveness of shade-producing near-stream vegetation. Specifically, excessive NSDZ widths in the lower portion of the Nestucca River reduce shading potential. Observed channel widths in the Little Nestucca and Three Rivers did not indicate that channel conditions detrimentally influenced shading potentials.*

Elevated summertime stream temperatures attributed to nonpoint sources in the Nestucca and Little Nestucca Watersheds result from riparian vegetation disturbance (reduced stream-surface shade) and channel widening (increased stream surface area exposed to solar radiation).

Current water diversions in the basin potentially can reduce flows significantly enough to exacerbate temperature impairments. Although there are currently permitted diversions for out-of-channel use totaling approximately 64 cfs (NNWC 1998), many of these diversions are not being used and those that are used may not be diverting water at the same time. However, further reductions in streamflow resulting from additional diversions could have a direct impact on stream temperatures.

The 1000-foot running average of current and system potential effective shading conditions and ground level shade measurements (point measurements using “Solar Pathfinder”) for the Nestucca River, Little Nestucca River and Three Rivers are presented in **Figure 12**. These ground-truthing shade measurements indicate that many locations within the Nestucca and Little Nestucca Watersheds are currently at system potential effective conditions. However, there are also many regions where current effective shade levels are well below system potential conditions.

Measurements of Near-Stream Disturbance Zone (channel) width were also made for each of the three main watersheds (**Figure 13**). These measurements indicate that many of the areas of the Nestucca River are wider than what would be optimal for providing shade and indicates that streambanks have eroded significantly in many areas. Wider NSDZs reduce the effectiveness of shade by causing a greater surface area of the stream to be exposed to solar radiation. Median NSDZ was calculated at each of 2120 points along the river, based on 10 contiguous 100-foot segments. Simulations of system potential temperature include reductions in the NSDZ width to less than or equal to the current median width as measured by a best-fit equation describing the running median of ten 100-foot segments (See Appendix A, p 108).

Comparison of the vegetation and NSDZ curves demonstrates a significant difference between the current condition and the potential in all of the sub-watersheds. The lack of effective shading has resulted from removal of trees throughout the watershed, and a subsequent widening of stream and river channels.These conditions persist in some reaches, while others (upper reaches of Nestucca River) have been reforested over time.

Figure 12. Effective Solar Loading and Shade Profile – Current Condition and System Potential. The System Potential-Allocated Condition is the Loading Capacity. Tidal area from river mile 0 through river mile 7 was not simulated.

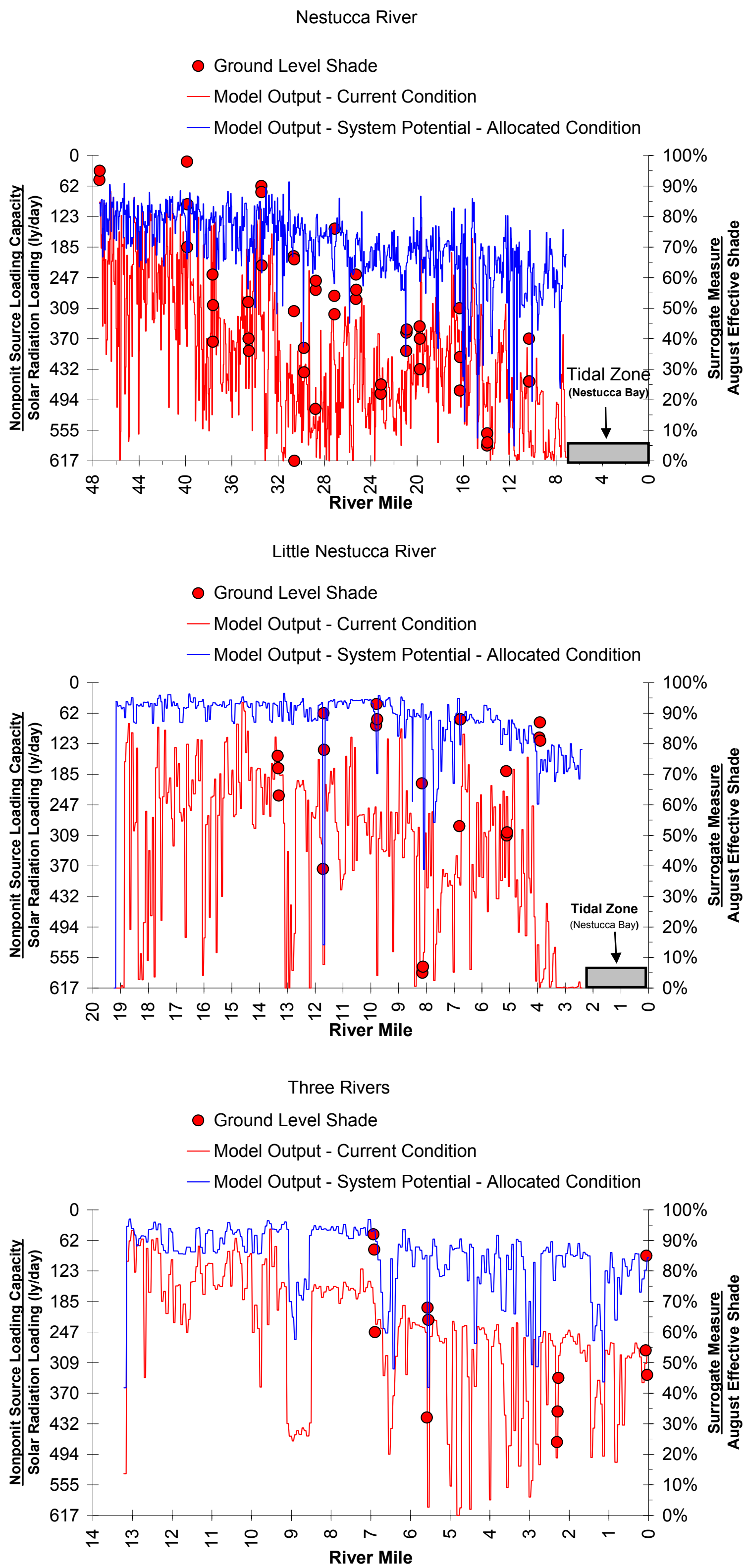
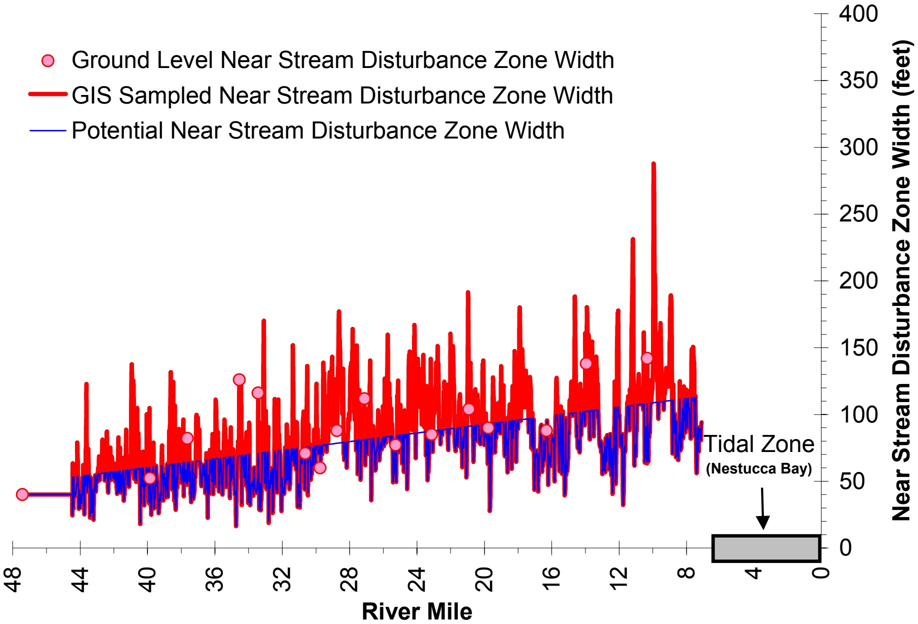


Figure 13. Current and Potential Channel Widths. Blue Areas are Existing Widths Less than a regression equation of the 1000-ft running Median Value (n=2120). Tidal area from river mile 0 through river mile 7 was not simulated.



Natural Sources and Stream Temperature

Natural conditions that may impact riparian vegetation and result in elevated stream temperature include drought, fires, insect damage to riparian vegetation, diseased riparian vegetation and windthrow and blowdown in riparian areas. The processes in which natural conditions affect stream temperatures include increased stream surface exposure to solar radiation and decreased summertime flows. Legacy conditions (increased width to depth ratios and decreased levels of stream surface shading) that currently exist are, in part, a result of repeated and severe forest fires. The largest, most devastating fire occurred in 1845 when over 1.5-million acres of the Coast Range burned, leaving only small stands of trees surviving. Later fires included the Mt. Hebo burn in 1910 north of the Cloverdale area, and later the Tillamook burn, which burned the northern part of the watershed.

3.1.7 Loading Capacity – 40 CFR 130.2(f)

The loading capacity provides a reference for calculating the amount of pollutant reduction needed to bring water into compliance with standards. EPA's current regulation defines loading capacity as "*the greatest amount of loading that a water can receive without violating water quality standards*." (40 CFR § 130.2(f)).

The water quality standard states that ***no measurable surface water temperature increase resulting from anthropogenic activities*** is allowed in the Nestucca Bay Watershed when the appropriate criteria are exceeded. The pollutants are human-caused increases in solar radiation loading (non-point sources) and warm water discharge (point sources).

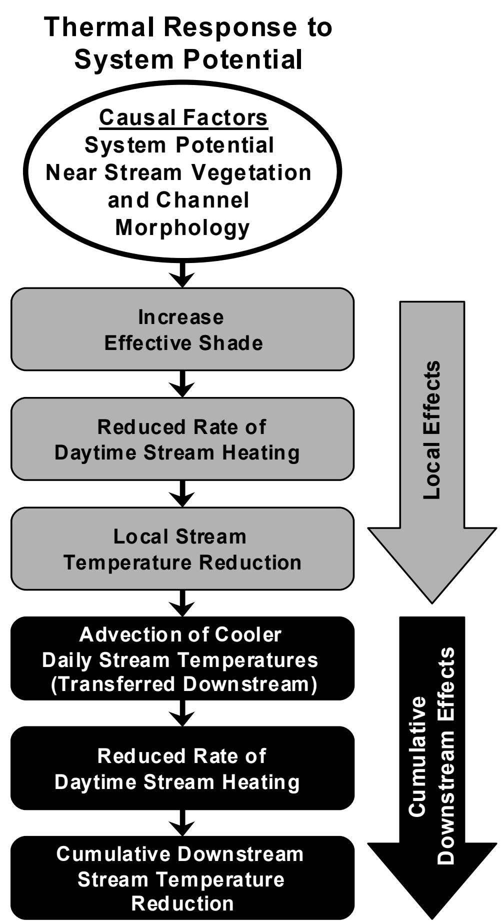
*The Water Quality Standard mandates a **Loading Capacity** based on the condition that meets the **no measurable surface water temperature increase resulting from anthropogenic activities when the temperature standard is exceeded.** This condition is termed **System Potential** and is achieved when (1) non-point source solar radiation loading is representative of a near stream vegetation and channel morphology conditions without human disturbance and (2) point source discharges cause no measurable temperature increases in surface waters.*

Loading capacity in the Nestucca Bay Watershed was calculated from: (1) solar radiation loading profiles for the Nestucca River (expressed as Langleys per day) based on potential near stream vegetation characteristics and channel morphology conditions without anthropogenic disturbance, and (2) NPDES permitted point source effluent discharge temperature limits

3.1.7.1 System Potential Simulation

Loading capacity in the Nestucca Bay Watershed is largely controlled by non-point source influences of heat to the system. Heat accumulates through much of the watershed by direct solar radiation loading. System potential was estimated as August solar radiation levels that would reach the stream surface under conditions where anthropogenic activities would not measurably increase temperature. **The system potential radiation load is the loading capacity (Figure 12).**

Current conditions were modeled and calibrated using recently collected data. These data included continuous temperature, flow, near-stream vegetation, channel width and depth. Temperature data from mainstem sites and many smaller tributaries were included in the model (**refer to Figure 8**). System potential conditions were derived from existing conditions and characteristics of each of the sub-watersheds. Effective shade, tree height and density, channel width and depth were all measured in the field. These features were measured on a very fine scale using existing GIS databases and by digitizing Digital Orthophoto Quadrats (See Appendix A). Simulations were performed by increasing near-stream vegetation to potential height, width and density, and adjusting channel morphology as described in **Appendix A**. Simulations were performed for the Nestucca River, with Three Rivers subbasin included as a tributary. Temperatures in the Little Nestucca River subbasin did not violate the water quality criterion in 2000, was not listed, and so was not simulated. The model predicted significant reductions in daily maximum stream temperature under system potential conditions. Diurnal temperature fluctuations were also moderated. Daily minimum stream temperatures were reduced slightly.



System Potential shade was simulated in a mathematical model (Heatsource 6.5) by increasing tree heights and densities to those expected in mature riparian communities. These tree heights were obtained from foresters with the Oregon Department of Forestry, Tillamook State Forest (Wayne Auble, personal communication) and the US Forest Service (Hebo Ranger District, Siuslaw National Forest, John Johanssen, personal communication). RiparianTree heights for all species that this information was available for averaged 175 feet in upland areas and 125 feet in lowland areas. The lesser averages in the lowlands were due to greater proportions of deciduous trees in these areas.

System potential channel widths were based on existing channel widths as measured through analysis of aerial photos. System potential widths are reduced to an estimate of the current median channel width, which steadily increases with distance from headwaters to the mouth. This resulted in a reduced overall channel width, but simulated channels below headwaters were never narrower than a significant portion of the river upstream, thus would provide adequate capacity for normal flow in the river (refer to **Figure 13**).

Individual near stream vegetation and channel morphology simulations were performed for the mainstem segment of the Nestucca River. Results from these single parameter simulations confirm the importance of both riparian vegetation and channel morphology as stream parameters that influence stream heating processes (**Figure 14**).

When both system potential riparian vegetation and channel morphology were simulated together, the stream heating rate was affected to a greater extent than by either factor singly. Increasing height and width of near stream vegetation increased the effective shade throughout each stream system. In effect, the shadows created by the vegetation are longer. Decreased near-stream disturbance zone widths and wetted widths decrease the stream surface area and allow vegetation to more effectively shade this surface area (refer also to **Figure 12**). Healthy near-stream vegetation and channel morphology are physically related. Channel morphology is often affected by riparian vegetation condition. Improvements in riparian condition would likely lead to improvements in channel morphology. In the case of stream thermodynamics, the riparian vegetation and channel morphology combine to increase the effect of casting shadows across the stream surface.

While the TMDL is primarily concerned with maximum daily stream temperature, it is important to consider the cumulative downstream effects that produce daily maximum stream temperatures. System potential conditions produce local effects that include site-specific increases in shade, reductions in daytime stream heating and stream temperature reductions. Cumulative downstream effects also impact stream temperatures. The transport of cooler water downstream coupled with the reduced rate of daytime heating produce the cumulative effect of stream temperature reductions. Changes in upstream temperature often affect the temperatures of downstream areas.

The cumulative effect of the system potential conditions is demonstrated in the simulated cooler downstream steam temperatures and narrower range of daily temperatures (**Figure 15**). The daily minimum temperatures reflect less daytime heat absorption, less daytime heat retention, and less heat advection (downstream transfer). When upstream sources of heat energy are reduced, the cumulative effect results in reduced nighttime and morning stream temperatures that allow for a cooler starting point for the daily heating.

Figure 14. Nestucca River Model Output for Current Condition, Potential Near Stream Vegetation and Potential Channel Morphology, and System Potential including both potential vegetation and channel morphology (August 3, 1999 - 5:00 PM). Tidal area from river mile 0 through river mile 7 was not simulated.

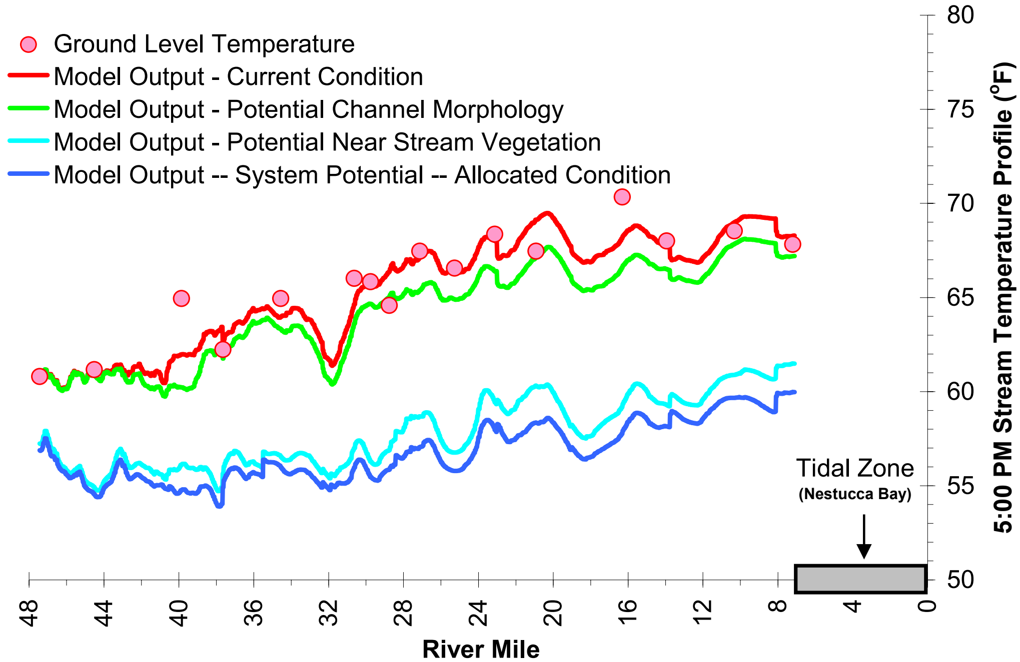
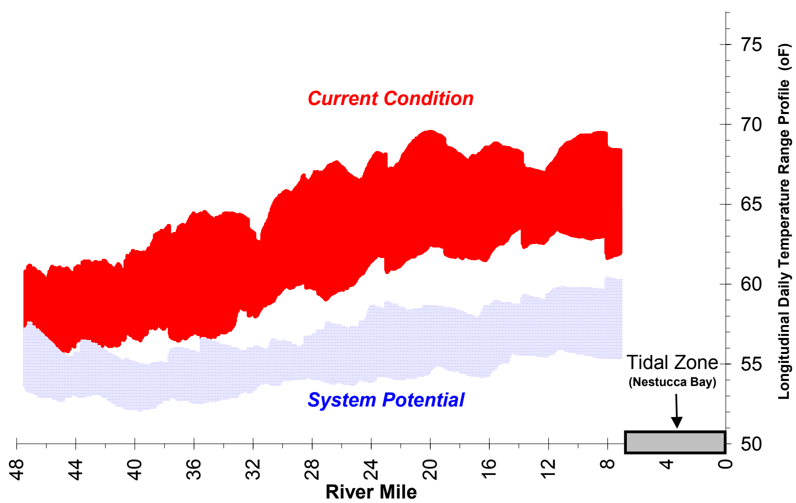


Figure 15. System potential temperature ranges in the Nestucca River.



Since daily heat influx is reduced, the diurnal rate of stream warming is also lower. In summary, the observed system potential temperature result from the following relationships:

- *Less diurnal fluctuation*
- *Lower daily maximum values*
- *Lower daily minimum values*

3.1.7.2 Loading Capacity (Point Sources)

The Loading Capacity is dependent on the available assimilative capacity of the receiving water (river). For rivers whose system potential temperatures are at or above the temperature standard for a given period, there is no assimilative capacity and the loading capacity is zero. This means that the discharge of pollutants would not be allowed to increase the concentration of that pollutant outside of an appropriate mixing zone. The loading capacity of the Nestucca River was presented in **Figure 12**. These loading rates are in terms of solar radiation and % effective shade, and provide the amount the river will absorb with the system potential riparian conditions in place. Ultimate temperatures at system potential were presented in **Figure 14** and indicate what the temperature will be relative to the numeric criteria of the water quality standard.

Point Source Discharges in the watershed are currently permitted only for sources on the Nestucca River and Three Rivers. Under system potential conditions, the Nestucca River is expected to meet the numeric criteria of the water quality standard throughout its length. Temperatures are expected to decrease below the migration and rearing temperature criterion (64°F) in the area where the wastewater discharges operate to approximately 60°F or less (**Figure 15**).

3.1.7.3 Loading Capacity (Non-Point Sources)

As stated previously, **the system potential radiation load is the loading capacity**. Results of the simulations demonstrate that with system potential conditions, water temperatures throughout the subbasin should meet or fall below the numeric criteria of the water quality standard during the critical period.

3.1.8 Allocations – 40 CFR 130.2(g) and 40 CFR 130.2(h)

Loading capacity will be available for allocation where surface water temperatures throughout a given river decrease below the standard by an amount sufficient to accommodate either point-source or non-point source influences. In general, modeling and provision of an adequate margin of safety has indicated there will be no assimilative capacity for either point or non-point sources of heat in the watershed. As a result, point sources will not be allowed to measurably increase the temperature of the stream outside of a defined mixing zone. Within the confines of the mixing equations used below for allocating effluent temperatures, expansion of existing point sources will be allowed as long as they do not cause an increase in temperature outside of the defined mixing zone. Similarly for new sources, they will be allowed as long as the discharge of heated water does not cause an increase in temperature outside of the defined mixing zone, and the additional heat load will not cause a violation of water quality standards.

3.1.8.1 Wasteload Allocations (Point Sources) - Temperature wasteload allocations are determined based on defined conditions, or may be calculated for a discharge given site-specific flow and temperature information. Surface water discharges into receiving waters must not exceed the temperatures listed in **Table 7** for appropriate river and effluent flows as specified. The wasteload allocation is the maximum allowable effluent temperature that, in combination with all sources, will remain within the loading capacity (as calculated through Equation 1). Permitted pointsource discharges only occur on the Nestucca River and Three Rivers.

There are two wastewater discharges within the basin but not included in the Allocations. Neskowin Regional Sewer Authority STP is technically within the Nestucca watershed for purposes of determining TMDLs. It discharges to Neskowin Creek, which is not listed for temperature, and data indicate that it is not water quality limited for temperature. Moreover, this treatment plant does not discharge during the summer, further removing its effects from the system. Pacific City Joint Water and Sewer Authority STP discharges to the Nestucca River estuary. The estuary is protected by a different standard than are freshwaters, and is currently not listed as water quality limited. This standard allows "no significant increase above natural background temperatures…." These facilities will not receive allocations, but will have appropriate limits in their NPDES permits.

Point Source allocations (**Table 7**) are the allowable effluent temperatures derived by DEQ (**using Equation 1**) and apply throughout the year. The assumptions used in evaluating the "no measurable increase as measured by 0.25°F at the edge of the mixing zone relate to both the standard and mixing zone policy. Wasteload allocations generally are based on a 0.25°F allowable increase above system potential at the edge of the mixing zone using 25% of the receiving water volume for mixing.

Future point sources and expansion of existing sources will be limited by the same requirements as are allocated here. No measurable increase in temperature will be allowed outside of the defined mixing zone, and no discharge can cause the river to exceed the loading capacity.

Equation 1. Wasteload Allocation Calculation when system potential temperature is greater than the appropriate numeric criterion.

$$WLA = \frac{\left[\left(Q_E + \frac{1}{4}Q_R\right)\cdot\left(T_P + \Delta T\right)\right] - \left(\frac{1}{4}Q_R \cdot T_P\right)}{Q_E}$$

where,
WLA = Load Allocation (Allowable Effluent Temperature)
T_P = System Potential Temperature
ΔT = Allowable Temperature Increase at Edge of Mixing Zone (0.25°F)
Q_E = Facility Design Flow
Q_R = Receiving Water Flow

Critical Period

Critical periods for wasteload allocations are determined by distribution and use of the rivers by salmonid fishes based on information from ODFW (refer to **Table 3** and **Figure 6**). The critical period is the entire year for migration and rearing, and from September through July for salmon spawning by various species in combination. Wasteload allocations are calculated based on the spawning criterion of 55°F for all salmonid species. The results of the allocation calculations allow discharge of water warmer than would normally be produced by a wastewater treatment plant. This is due to the relatively small flow rates from treatment plants relative to river flow rates, even under low flow conditions. Where calculated effluent limits exceeded the incipient lethality limit for salmonids (77°F), that limit was substituted for the effluent limit.

Table 7. Temperature Allocation Summary for point sources in the Nestucca Bay Watershed. These allocations are in effect throughout the year.

Facility Name	***Receiving Water***	***Wasteload Allocation*** ***Allowable Effluent Temperature***
Hebo Joint Water and Sewer Authority STP	Three Rivers	77°F
Cloverdale Sanitary District STP	Nestucca River	77°F
Future Sources	Any Surface Waters in River	No Measurable Increase Outside of Mixing Zone

3.1.8.2 Surrogate Measures and Load Allocations (Non-point Sources) – *40 CFR 130.2(i)*

Portions of the loading capacity are typically divided among natural, human and future non-point pollutant sources. **Table 8** lists load allocations (i.e. distributions of the loading capacity) according to land-use. In the Nestucca Bay Watershed, the loading capacity of the system is all allocated to natural sources. No assimilative capacity exists for the other sources. This requires that heat from non-point sources reduce temperature inputs to reach system potential conditions. The means of achieving these conditions is through restoration and protection of riparian vegetation and narrowing of stream channel widths. The remainder of this section describes how those conditions are assessed.

Load Allocations (Non-Point Sources) *- Since the* ***Loading Capacity*** *targets system potential (i.e. no measurable temperature increases from anthropogenic sources), 100% of the* ***Loading Capacity*** *is allocated to natural sources*

Table 8. Temperature Non-Point Source Allocation Summary

Non-Point Sources	
Source	*Loading Allocation* *Distribution of Solar Radiation Loading Capacity*
Natural	100%
Agriculture	0%
Forestry	0%
Urban	0%
Future Sources	0%

The Nestucca Bay Watershed Temperature TMDL incorporates measures other than "*daily loads*" to fulfill requirements of §303(d). Although a loading capacity for heat energy is derived [e.g. Langleys per day], it is of limited value in guiding management activities needed to solve identified water quality problems. In addition to heat energy loads, this TMDL allocates "*other appropriate measures*" (or surrogates measures) as provided under EPA regulations [40 CFR 130.2(i)].

The *Report of Federal Advisory Committee on the Total Maximum Daily Load (TMDL) Program"* (FACA Report, July 1998) offers a discussion on the use of surrogate measures for TMDL development. The FACA Report indicates:

> *"When the impairment is tied to a pollutant for which a numeric criterion is not possible, or where the impairment is identified but cannot be attributed to a single traditional "pollutant," the state should try to identify another (surrogate) environmental indicator that can be used to develop a quantified TMDL, using numeric analytical techniques where they are available, and best professional judgment (BPJ) where they are not. The criterion must be designed to meet water quality standards, including the waterbody's designated uses. The use of BPJ does not imply lack of rigor; it should make use of the "best" scientific information available, and should be conducted by "professionals." When BPJ is used, care should be taken to document all assumptions, and BPJ-based decisions should be clearly explained to the public at the earliest possible stage.*
>
> *If they are used, surrogate environmental indicators should be clearly related to the water quality standard that the TMDL is designed to achieve. Use of a surrogate environmental parameter should require additional post-implementation verification that attainment of the surrogate parameter results in elimination of the impairment. If not, a procedure should be in place to modify the surrogate parameter or to select a different or additional surrogate parameter and to impose additional remedial measures to eliminate the impairment."*

Surrogate Measures in Temperature TMDL

- System Potential Effective Shade: Shade from riparian vegetation that will grow based on average growth rates and tree heights for species that will grow in a given area. Achieved through restoration of riparian vegetation that provides shade directly and that reduces streambank erosion;
- System Potential Channel Widths: resulting from stabilized streambanks due to restored riparian vegetation. Increases effectiveness of riparian shade by reducing surface area of stream that must be shaded.

Over the years, the term shade has been used in several contexts, including its components such as shade angle or shade density. For purposes of this TMDL, shade is defined as the percent reduction of potential direct beam solar radiation load delivered to the water surface. Thus, the role of effective shade in this TMDL is to prevent or reduce heating by solar radiation and serve as a linear translator to the solar loading capacities.

The non-point source assessment demonstrates that stream temperatures warm as a result of increased solar radiation loads, due to anthropogenic disturbance to near stream vegetation and channel morphology. A loading capacity for radiant heat energy (i.e., incoming solar radiation) can be used to define a reduction target that forms the basis for identifying a surrogate. The specific surrogate used is percent effective shade (expressed as the percent reduction in potential solar radiation load delivered to the water surface). The solar radiation loading capacity is translated directly (linearly) by effective solar loading. The definition of effective shade allows direct measurement of the solar radiation loading capacity.

Factors that affect water temperature are interrelated. The surrogate measures (percent effective shade and channel width) rely on restoring/protecting riparian vegetation to increase stream surface shade levels and reducing the near-stream disturbance zone width (by reducing stream bank erosion and stabilizing channels), which will reduce the surface area of the stream exposed to radiant energy. Shade is more effective on narrow streams than on wider streams given the same flow of water at a given point because shadows cast by trees cover a greater percentage of the stream surface. Effective shade screens the water's surface from direct rays of the sun. Highly shaded streams often experience cooler stream temperatures due to reduced input of solar energy (Brown 1969, Beschta et al. 1987, Holaday 1992, Li et al. 1994).

3.1.9 Reasonable Assurance

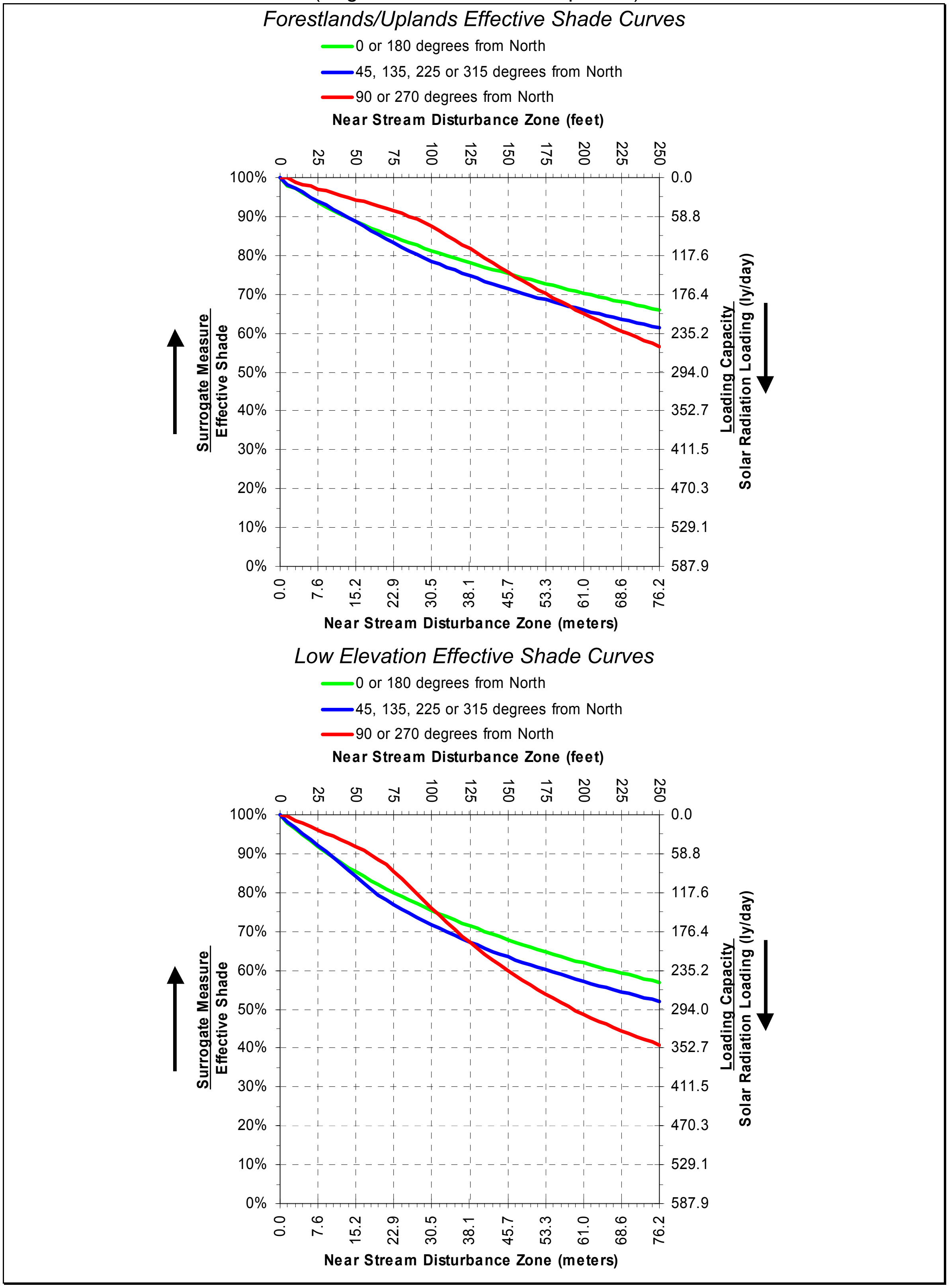
The TMDL for temperature has been developed to provide targets for control of pollutants that will ensure water quality standards are protected. Along with these targets for compliance, it is necessary to provide reasonable assurance that appropriate and timely measures are taken that will result in meeting these allocations. The basis of reasonable assurance for TMDLs is the Oregon Plan for Salmon and Watersheds and appropriate federal, state and local statutes, rules and regulations . This plan is a partnership between Federal and State agencies, local groups and grassroots organizations, that recognizes the attributes of aquatic health and their connection to the health of salmon populations. The Oregon Plan considers the condition of salmon as a critical indicator of ecosystems (CSRI, 1997).

The specific measures and regulations that will result in attainment of TMDL allocations are described in the accompanying Nestucca Bay Watershed TMDL Water Quality Management Plan. This plan has been specifically developed to address implementation of measures that provide reasonable assurance that the TMDL allocations will be met. The WQMP is included with the TMDL as Appendix D.

3.1.10 Site Specific Effective Shade Surrogate Measures

A load allocation in terms of Langleys per day is not very useful in guiding non-point source management practices. Percent effective shade is a surrogate measure that can be calculated directly from the loading capacity. Additionally, percent effective shade is simple to quantify in the field or through mathematical calculations. **Figure 16** displays effective shade curves that can be applied across areas where the site-specific surrogate measures are not developed. Given a measured or estimated Near-Stream Disturbance Zone and the directional aspect of a stream, the percent effective shade or the solar radiation loading can be estimated from the following graphs. In these graphs, forest/uplands curves should be used from the headwaters through lower gradient reaches, as from Meadow Lake of the Nestucca River down to Blaine. Low elevation curves should be used in lower gradient reaches, as from Blaine downstream to the Mouth of the Nestucca River. These are potential shade estimates based on the factors described. For any particular point on a stream, shade may be more or less than these graphed values, but shading should approach these values when averaged over a stream reach.

Figure 16. Reach-Averaged Effective Shade Measures as a Function of Channel Width (August Solar Radiation Exposure)

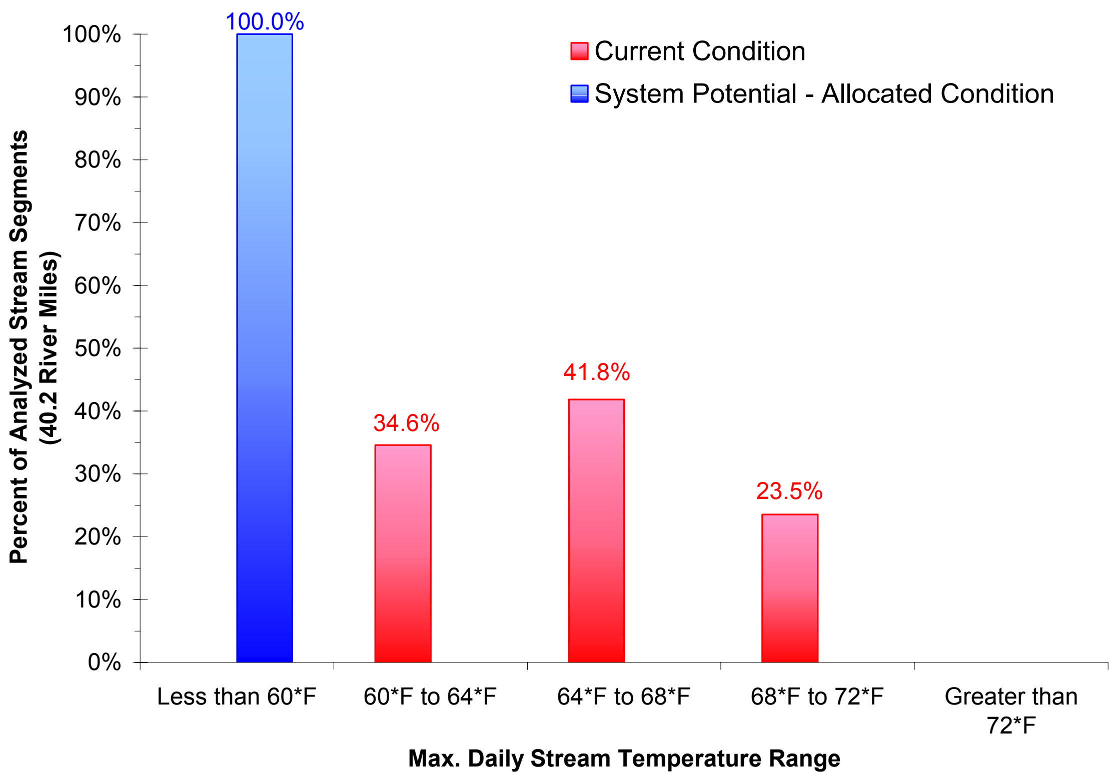


3.1.11 Water Quality Standard Attainment Analysis - – CWA §303(d)(1)

*Maximum daily temperatures (displayed in **Figure 18**) represent the system potential when **no measurable surface water temperature increase resulting from anthropogenic activities** is allowed.*

A total of 40.2 river miles in the Nestucca River Mainstem, from the headwaters to Cloverdale Bridge (River Mile 7.2) were analyzed and simulated during the critical period (August 3, 1999). **Figure 17** compares the current maximum daily temperatures with those that result with system potential conditions. Generally speaking, analyzed rivers currently experience critical condition maximum daily temperatures in the upper-60°F to low 70°F range. Under the allocated system potential condition, maximum daily temperatures shifted to below the 60°F range in the mainstem Nestucca River. In 1999, 65.3% of the analyzed stream network had critical condition maximum daily temperatures greater than 64°F. Under the system potential, no reach in the Nestucca River above Cloverdale Bridge experience maximum daily temperatures greater than 64°F.

Figure 17. Distribution of Current Condition and System Potential Maximum Daily Stream Temperatures in the Nestucca River mainstem (August 3, 1999)



3.2 Bacteria TMDL

Summary of Bacterial TMDL Development and Approach

Why Is Bacterial Contamination Important?

Bacterial contamination from a variety of sources accumulates in rivers, streams and Nestucca Bay throughout the year. This contamination is most severe during winter storms, but concentrations are sufficiently high during both wet and dry weather to impair water quality relative to recreational and commercial shellfish harvesting in Nestucca Bay.

Scope

All lands with streams that drain to Nestucca Bay within HUC 17100203 are included in the bacterial TMDL. All land uses are included: lands managed by the State of Oregon, the U.S. Forest Service (USFS) and Bureau of Land Management (BLM), private forestlands, agricultural lands, rural residences, military lands and urban areas.

Assessing Bacterial Contamination Processes and Setting Loads

To evaluate bacteria loading in the Nestucca Bay Watershed, an event based, unit load model was used. The model uses estimated peak flow, Event Mean Concentrations (EMC) for various land uses, and bacteria die off rates to predict total bacteria concentration and loads in the streams. Five major geographic databases were used in this project: soils, land use, precipitation pattern, watersheds, and distance from the stream. These five databases were overlaid in ArcView® to create a composite GIS database that was used for estimating peak flow, travel time of overland flow in the watershed, the bacteria die-off rate as function of the travel time, and bacteria load. These parameters were modeled for all locations in the watershed. To calculate loading to the Bay, a bacteria die-off rate was incorporated for travel time instream to the Bay.

Bacterial TMDL Overview

The bacteria TMDL provides an analysis of the sources and concentrations of fecal bacteria throughout the year in the Nestucca Bay Watershed. Loading capacity of the Bay is determined as a function of concentrations at the mouths of major rivers that drain to the Bay. Allocations are expressed in terms of concentrations of bacterial in runoff for each land use in the Nestucca and Little Nestucca River Watersheds.

3.2.1 Pollutant Identification

The pollutants identified for stream and bay bacterial pollution are human caused point and non-point source discharges of fecal bacteria loading to surface waters.

The pollutant causing impairment of 303(d) listed waters is fecal coliform bacteria. These bacteria are produced in the guts of warm-blooded vertebrate animals, and indicate the presence of pathogens that cause illness in humans. Although non-domestic animals are sources of the bacteria, human controlled sources demonstrably account for the greatest proportion in rivers and Nestucca Bay.

The method of fecal coliform bacteria analysis has also changed over time, with some DEQ samples analyzed using the Most Probable Number (MPN) technique and some analyzed using the membrane filtration technique (MF). According to *Bacterial Indicators of Pollution* (Pipes, 1982) “the differences between MPN estimates and MF counts were not of any practical significance mainly because of the inherently low degree of reproducibility of the MPN estimates.” Fecal coliform data have been combined for this report regardless of the analytical technique.

3.2.2 Target Identification – CWA §303(d)(1)

The bacterial TMDL is designed to protect two sensitive beneficial uses in two different landscape situations. Bacteria impair the recreational use of rivers if concentrations exceed those determined through epidemiological studies to cause illness through body contact at a rate of 8 or more cases per 1000 swimmers. Bacterial levels in estuarine shellfish harvesting waters must be lower than those used for body contact, as shellfish filter large volumes of water and accumulate bacteria and the pathogens at concentrations higher than found in ambient water. Although recreational uses in rivers are considered safe if bacterial concentrations are higher than those allocated in this TMDL, protection of shellfish harvesting is a more sensitive beneficial use, and requires lower concentrations in the rivers to ensure low concentrations in the Bay. The TMDL targets river concentrations that will limit the loading to the Bay and result in low concentrations in shellfish harvesting beds. Concentrations that meet the estuarine/shellfish criterion will also result in rivers meeting the recreational contact standard.

The indicator bacterium used by DEQ for assessing bacterial contamination for recreational waters changed in 1996 from fecal coliform bacteria to *E. coli*, the species associated with gut flora of warm-blooded vertebrates. In general, *E. coli* are a subset of Fecal Coliform bacteria. This change was made in part because *E. coli* is a more direct reflection of contamination from sources that also carry pathogens harmful to humans and is correlated more closely with human disease. Fecal coliform bacteria are still used in the standard as the indicator for protection of human health in assessing water quality in commercial shellfish harvesting areas. These areas and monitoring of water quality associated with them are under the jurisdiction of the Oregon Department of Agriculture (ODA). Since there are two standards that use two different indicators, DEQ still samples and analyzes water for both. This has resulted in a large data set of paired samples that allow statistical analysis and development of a mathematical relationship. Although the relationship is significant, bacterial concentration estimates in environmental samples are not very precise, as indicated by substantial variability among paired and duplicate samples. Concentrations of fecal coliform bacteria modeled to meet targets at the river mouths were converted to *E. coli* concentrations (per Cude 2001) for relevance to current and likely future monitoring activities (see **Appendix B** for conversion).

3.2.3 Sensitive Beneficial Use Identification

Beneficial uses in the Nestucca Bay Watershed are defined in the Oregon Administrative Rules **(Table 9)**. The key beneficial uses affected by elevated concentrations of fecal bacteria are body contact recreation in rivers, and fishing (shellfish harvesting) in the Bay. There is a recreational shellfishery, although the Bay currently has no areas with specific use designations for commercial shellfish harvesting. Recently collected data indicates that shellfish harvesting would not be supported at all times in all parts of the Bay.

Table 9. Beneficial uses occurring in the Nestucca Bay Watershed
(OAR 340 – 41 – 202)
Bacteria -Sensitive Beneficial uses are marked in gray

Beneficial Use	***Occurring***	***Beneficial Use***	***Occurring***
Public Domestic Water Supply	✓	Anadromous Fish Passage	✓
Private Domestic Water Supply	✓	Salmonid Fish Spawning	✓
Industrial Water Supply	✓	Salmonid Fish Rearing	✓
Irrigation	✓	Resident Fish and Aquatic Life	✓
Livestock Watering	✓	Wildlife and Hunting	✓
Boating	✓	Fishing [1]	✓
Aesthetic Quality	✓	Water Contact Recreation	✓
Commercial Navigation & Trans.		Hydro Power	

1 = Fishing beneficial use includes shellfish harvest.

3.2.4 Water Quality Standard Identification

Bacterial criteria for the waters of the North Coast-Lower Columbia Basin are contained in the Oregon Administrative Rules **(Table 10 and Appendix C of this document)**. The criteria for "bacteria in shellfish waters" apply to Nestucca Bay and the criteria for "recreational contact in water" applies to all other waters in the watershed. The beneficial uses affected by elevated bacteria levels are primary contact recreation (swimming) and shellfish harvesting (fishing).

Table 10. Water quality standards for the North Coast Basin of Oregon.

Use	Description
Marine and Estuarine Shellfish Growing Waters: DEQ OAR 340-41-205 (2)(e)(A)(ii) **Oregon Dept. of Agriculture** OAR 603-100-0010:	A fecal coliform median concentration of 14 organisms per 100 ml, with not more than ten percent of the samples exceeding 43 organisms per 100 ml. Fecal coliform median or geometric mean MPN of the water sample results shall not exceed 14 per 100 ml, and not more than 10% of the samples shall exceed 43 colonies per 100 ml for a 5 tube decimal dilution test. A minimum of the most recent 15 samples collected under adverse pollution conditions from each sample station shall be used to calculate the median or geometric mean and percentage to determine compliance with this standard.
Recreational Contact in Water OAR 340-41-205 (2)(e)(A)(i):	Prior to March 1996: a geometric mean of five fecal coliform samples should not exceed 200 colonies per 100 ml, and no more than 10% should exceed 400 colonies per 100 ml. Effective March 1996 through present: a 30-day log mean of 126 *E. coli* organisms per 100 ml, based on a minimum of five samples; and no single sample shall exceed 406 *E. coli* organisms per 100 ml.

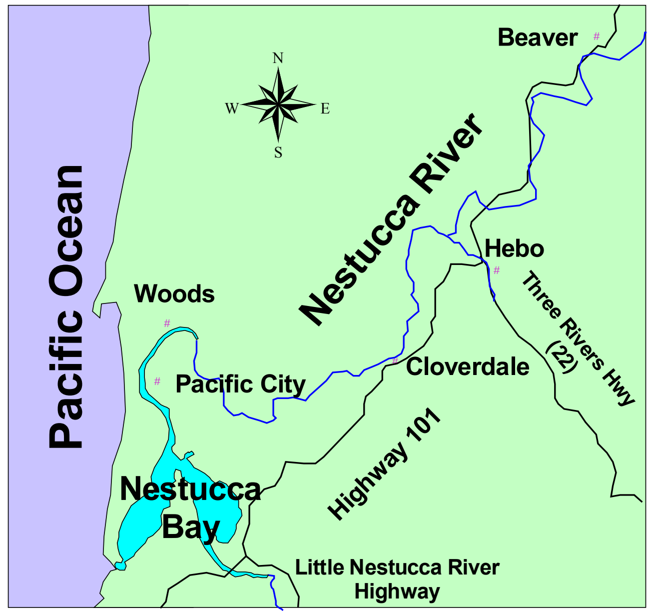
Data is available to assess compliance with the shellfish criterion based on fecal coliform bacteria in the Bay and recreational contact criteria based on the *E. coli* in rivers.

3.2.5 Deviation from Water Quality Standard (Bacterial Impairments)

3.2.5.1.Nestucca Bay

Nestucca Bay is currently listed as water quality limited due to elevated concentrations of bacteria in the Bay relative to the shellfish harvesting criterion. There currenly are no commercial shellfish harvesting areas approved in the Bay, but there is a recreational shellfishery. There are no ongoing monitoring programs that assess the bacterial concentrations in the Bay, though recent data have been collected to both assess and model bacterial loading to the Bay.

Nestucca Bay receives water from the Nestucca and Little Nestucca Rivers, as well as some direct urban, rural, and rural residential lands. The Cities of Woods and Pacific City are on the tidally influenced section of the Nestucca River and are sources of some urban runoff. Dairy pastures in the lowlands of the basin are sources of bacteria, although there is relatively little pasture immediately on the shores of the Bay. There are three wastewater treatment plants in the basin; Pacific City and Cloverdale on the Nestucca River; and Hebo on Three Rivers, a tributary to the Nestucca River. The Nestucca/Neskowin Watershed Council has conducted an ongoing monitoring program in the watershed since 1999 that has been characterizing *E. coli* concentrations weekly at 9 stations.



The Bay is divided into two lobes; the western lobe is a direct outlet of the Nestucca River, and the eastern lobe carries the Little Nestucca River into the western lobe of Nestucca Bay and on to the ocean. Tidal influences mix waters from all sources (ocean, runoff and both rivers) throughout the entire Bay before discharging out the mouth to the Pacific Ocean. Concentrations in the eastern lobe, draining the Little Nestucca River, have been modestly higher than in the western lobe in both the summer (dryweather) and winter (wetweather) sampling surveys. This is likely due in part to the more direct influence of seawater on bacterial mixing and decay in the western lobe.

3.2.5.2. Nestucca Bay Watershed – Long-Term Data

Much of the long-term data for the Nestucca Bay Watershed is based on fecal coliform as the indicator, reflecting the water quality criteria for contact recreation and shellfish harvesting beneficial uses prior to 1996. Still, there is relatively little data over the period from 1968 to 1998, with most of the data concentrated near DEQ's ambient monitoring site in Cloverdale. These data are most appropriately compared to the fecal coliform criteria in effect prior to 1996. Data collected by the Nestucca Neskowin Watershed Council is reported in a later section.

Summer Data

The fecal coliform criterion of 400 MPN/100 ml was the 91st percentile value for the summer months at all stations from 1969-98. This means more than 90% of values were less than the 400 MPN/100 ml criterion for a single sample **(Figure 18)**. Only at the river mile 4.7 station was the geometric mean (225 counts/100 ml) greater than the criterion of 200 counts/100 ml **(Table 11)**

Figure 18. Concentrations of fecal coliform bacteria (n=58) collected by DEQ at stations on the Nestucca River during the low-flow period of the year; June through September. River Mile 0 represents the mouth of each river.

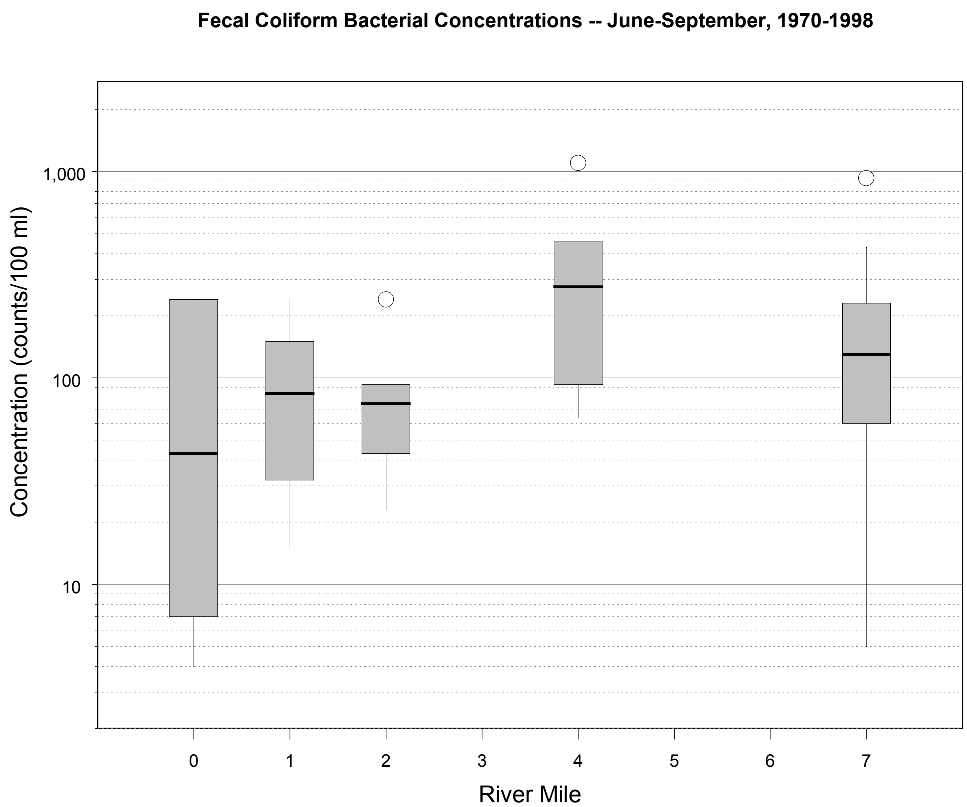


Table 11. Geometric Means of fecal coliform bacteria from (DEQ,1968-1998) at stations on the Nestucca River.

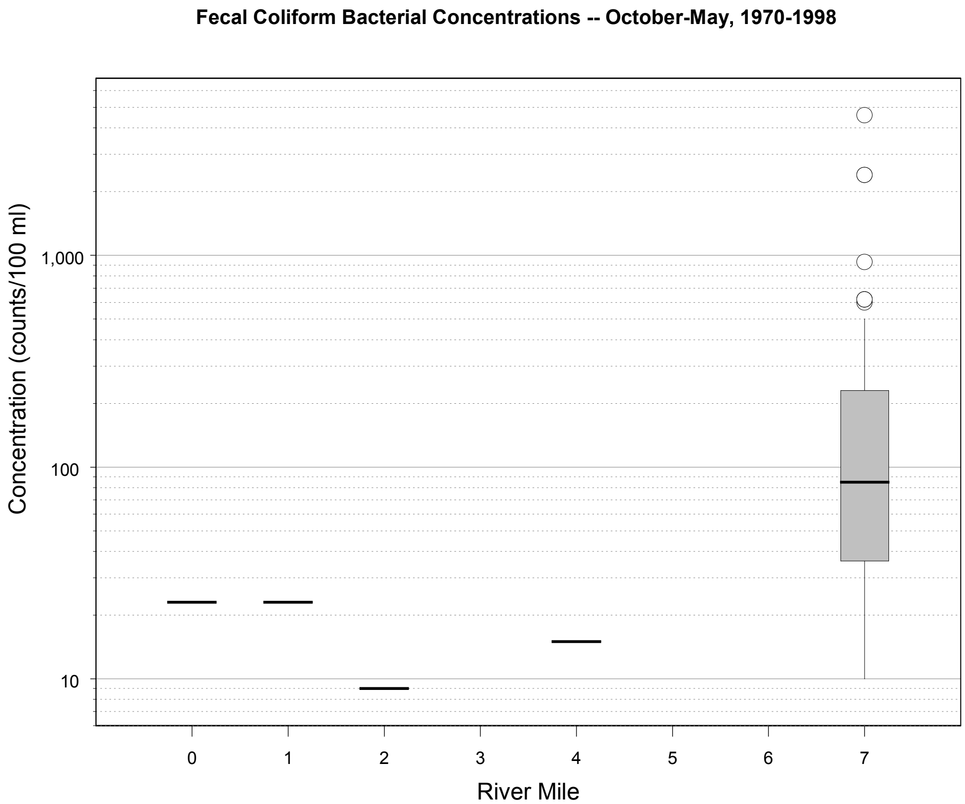
Station	Summer Geometric mean	Winter Geometric mean
Nestucca River at Mouth	36	NA
Nestucca River at Pacific City Bridge	114	NA
Nestucca River at Woods City Bridge	71	NA
Nestucca River – River Mile 4.7	225	NA
Nestucca River at Cloverdale	116	106

NA = insufficient samples to calculate statistic.

Fall-Winter-Spring Data

Very little long-term data was available for the wet period of the year (October through May) and most of this was from a single station in Cloverdale. Wet-weather sampling was limited to the ongoing ambient monitoring by DEQ at this site. The 90th-percentile values for fall-winter-spring months was 614 MPN/100 ml at this station. The fecal coliform criterion of 400 MPN/100 ml was the 82nd percentile value for the fall-winter-spring months from 1969-98. This means more than 80% of values were less than 400 MPN/100 ml **(Figure 19)**, but that the criterion was violated overall at this station. The geometric mean was 106 MPN/100 ml at Cloverdale **(Table 11)**, the only station with a meaningful number of samples (n=60) for this statistic.

Figure 19. Concentrations of fecal coliform bacteria (n=64) collected by DEQ at stations on the Nestucca River during the wet period of the year; October through May. River Mile 0 represents the mouth of each river.



Monthly DEQ Data Distribution
Concentrations in samples collected by DEQ at the Cloverdale station over the period from 1968 through 1998 were distributed among months throughout the year **(Figure 20)**. In general there were between 5 and 12 samples for each month over this period. Though limited, this allows the discussion of monthly median concentrations. These data suggest a pattern of lowest concentrations during the period from January through May, while concentrations were relatively elevated from June through December with highest median concentrations in October. Only May and October values were greater than the 90th percentile criterion of 400 counts/100 ml. The remainder were comfortably below that limit. Only October geometric means were greater than the criterion of 200 counts/100 ml.

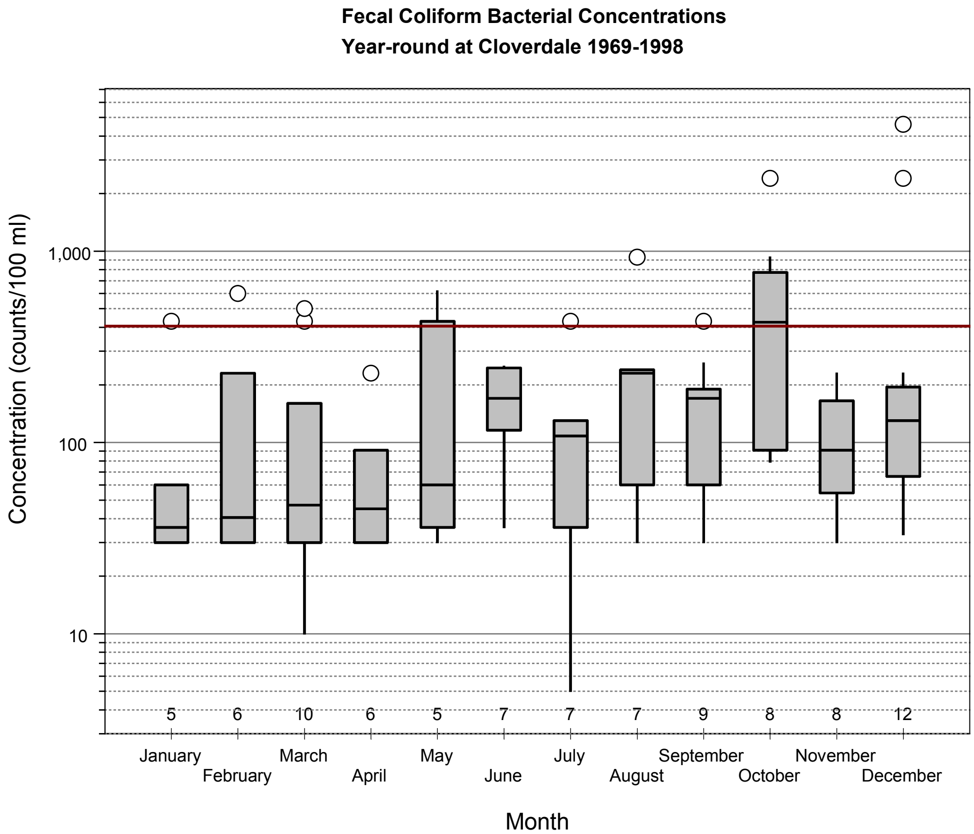


Figure 20. Monthly Distribution of fecal coliform sample values (n=89) on the Nestucca River at Cloverdale from 1968-1998. Number of samples comprising each box is at the bottom of the plot.

Weekly Data Distribution – Nestucca-Neskowin Watershed Council
Additional instream data has been collected weekly since 1999 by the Nestucca/Neskowin Watershed Council (NNWC) at stations distributed throughout the watershed. Though these data indicate *E. coli* concentrations, they can be compared roughly to the fecal coliform data from earlier monitoring. They also directly address the recreational criterion for the rivers.

Geometric means of E. coli concentration from summer of 1999 through summer of 2001 indicate a pattern of higher concentrations from mid-summer through fall or early winter, with relatively low concentrations in winter through early spring **(Figure 21)**. Raw concentrations were fairly high during summer storms and in early fall storms **(Figure 22)**. Later winter and early spring storms tended to reflect lower concentrations, suggesting that bacteria accumulated over the summer was mobilized in early storms, then tended not to accumulate in concentrations sufficient to result in large loads during storm events. This would be consistent with typical patterns of accumulation of pollutants from various sources (land application of manure, urban and commercial landuses) followed by a flushing in runoff during rainfall events.

The highest concentrations in these storms resulted in geometric means on the order of 300 –500 MPN/100 ml at some stations. High concentrations generally did not persist for long periods.

Figure 21. 30-day period Geometric means of *E. coli* concentrations (includes estimated values) in weekly samples at four stations in the Nestucca Bay Watershed from 1999-2001 (Source: Nestucca/Neskowin Watershed Council)

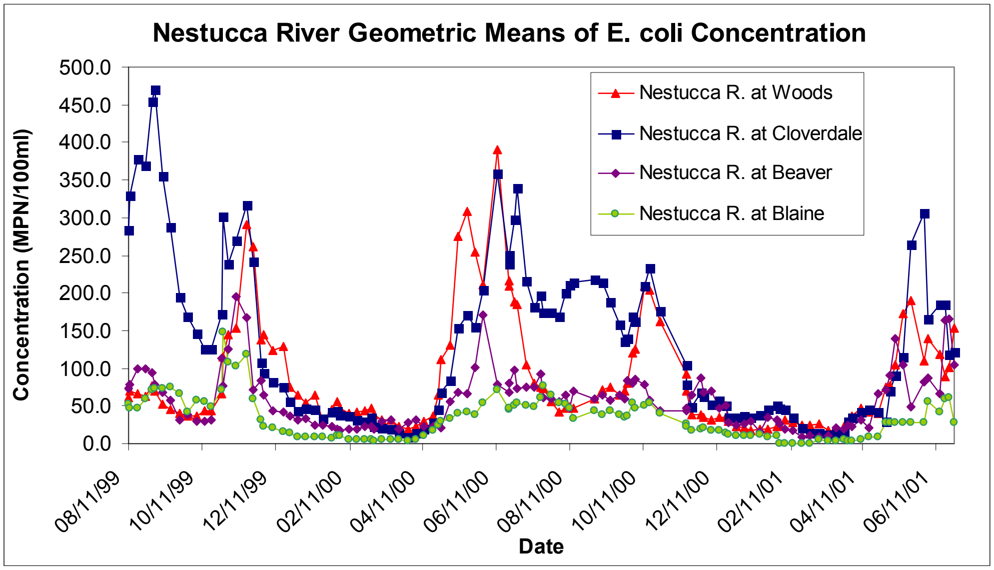
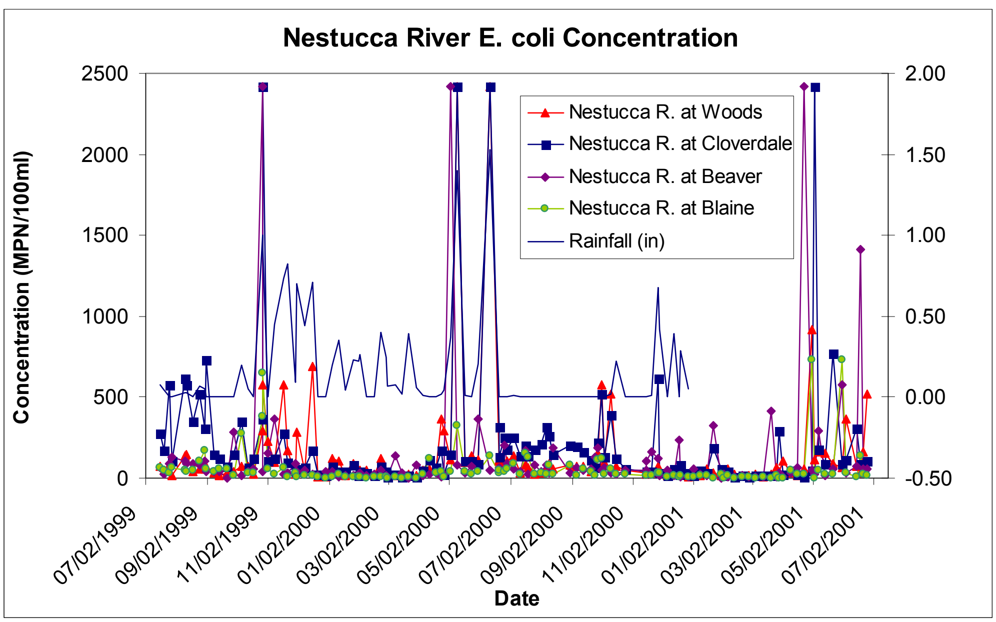


Figure 22. *E. coli* concentrations (includes estimated values) in weekly samples at four stations in the Nestucca Bay Watershed from 1999-2001 (Source: Nestucca/Neskowin Watershed Council)

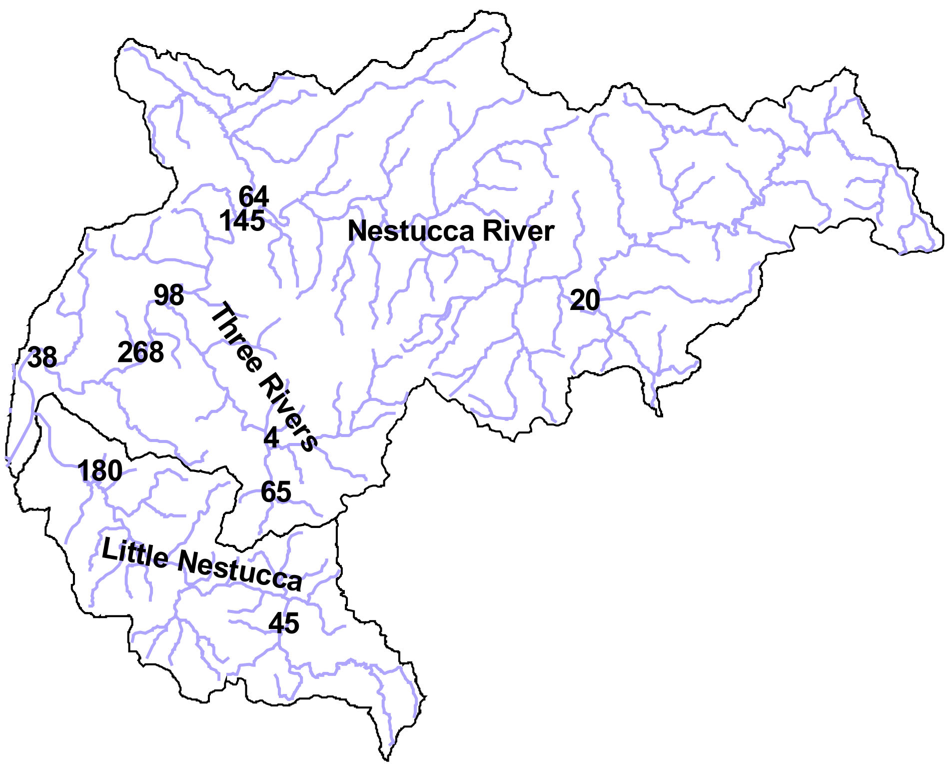


3.2.5.3 Nestucca Bay Watershed Surveys –Dry-weather and Stormwater Sampling

Dry-Weather Sampling

A dry-weather, multiple-day sampling event was performed by DEQ in August 1999 throughout the watershed to characterize bacterial concentrations. Rivers were sampled for *E. coli* concentrations and the Bay was sampled for fecal coliform. Concentrations among stations were generally higher than in the wet-weather sampling, probably indicating there was less flow to dilute bacteria loads entering the river from various sources. Geometric mean concentrations exceeded the recreational criterion (126 MPN/100 ml) at 3 places in the watershed (**Figure 23**); the Nestucca River at Woods and Beaver, and the Little Nestucca River near the mouth. The upper most sampling station on the Nestucca River during dry weather was at Rocky Bend campground. This station was not used in a later wet-weather survey because rural residential uses were located upstream, and this site was intended to reflect forest sources only.

Figure 23. Geometric means of fecal coliform bacteria concentration in Nestucca River watershed during dry-weather study; August 1999.



Wet-Weather Sampling

A survey designed specifically to sample stormwater occurred once in the watershed during February of 2000. Rivers were sampled for *E. coli* concentrations and the Bay was sampled for fecal coliform. The uppermost station was further upstream than during dry-weather sampling (Rocky Bend Campground) to ensure the samples represented forest runoff conditions without rural residential sources. Concentrations of bacteria during this storm fit the general pattern observed in long-term monitoring data. Though concentrations were generally elevated during the middle of the event, the highest concentrations were not as high as would be expected in an early season (e.g., November) storm. Storms during this part of the year provide one-day rainfall amounts that are generally slightly less than storms in late fall and early winter **(Table 12)**.

Bacteria concentrations only exceeded the maximum allowable single-sample criterion of 406 MPN/100 ml at Woods **(Figure 24)**. Geometric means were also less than the geometric mean criterion (126 MPN/100 ml) at all stations except Woods, where the value was 192 MPN/100 ml **(Figure 25)**. Values in the upper watershed were generally very low (<2 MPN/100 ml), suggesting that forested areas providing the vast majority of water in the basin contained relatively small loads.

Table 12. Average, median, and maximum 1-day rainfall amounts from 1961-1999 in inches.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average	0.44	0.37	0.32	0.22	0.14	0.11	0.05	0.05	0.12	0.24	0.46	0.47
Count	1208	1101	1209	1170	1178	1170	1209	1209	1170	1209	1169	1178
%Days >0.25 in.	45%	40%	39%	29%	20%	13%	5%	7%	15%	26%	49%	47%
%Days >0.5 in.	30%	26%	25%	15%	9%	7%	3%	3%	8%	18%	33%	31%
%Days >0.75 in.	21%	17%	13%	8%	5%	3%	2%	1%	4%	12%	21%	22%
%Days >1 in.	14%	11%	7%	4%	2%	2%	1%	1%	3%	7%	14%	14%

Figure 24. Concentrations of E. coli in stormwater samples throughout the Nestucca Bay Watershed in February, 2000.

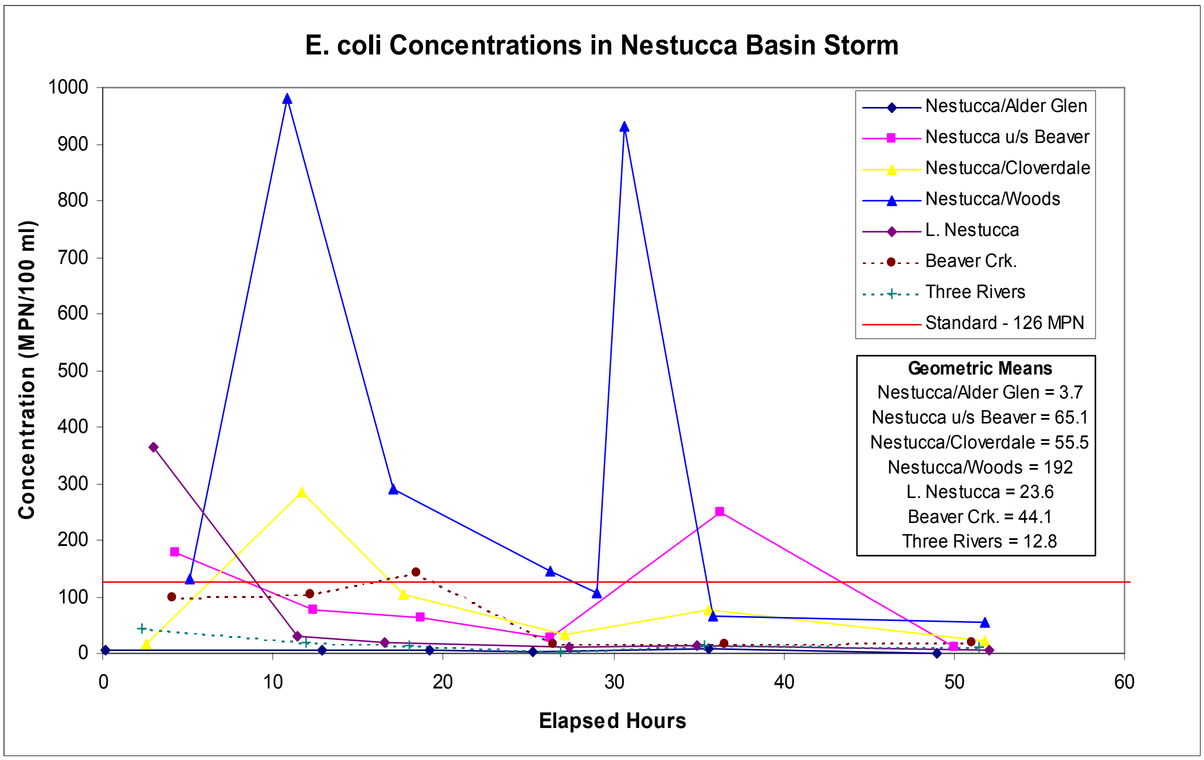
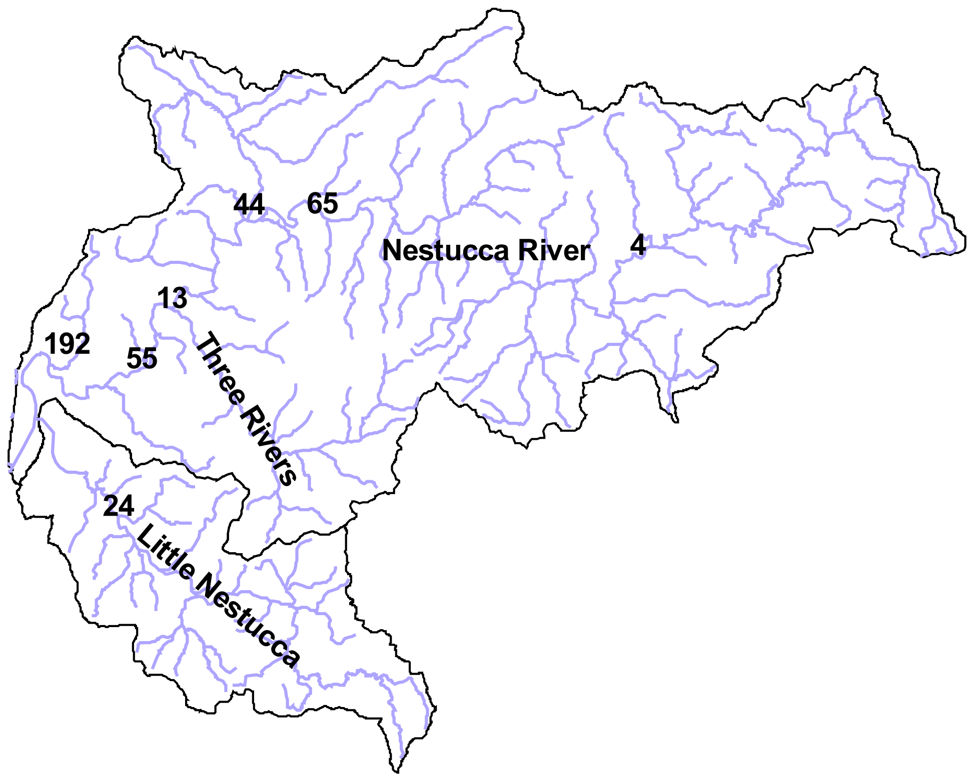
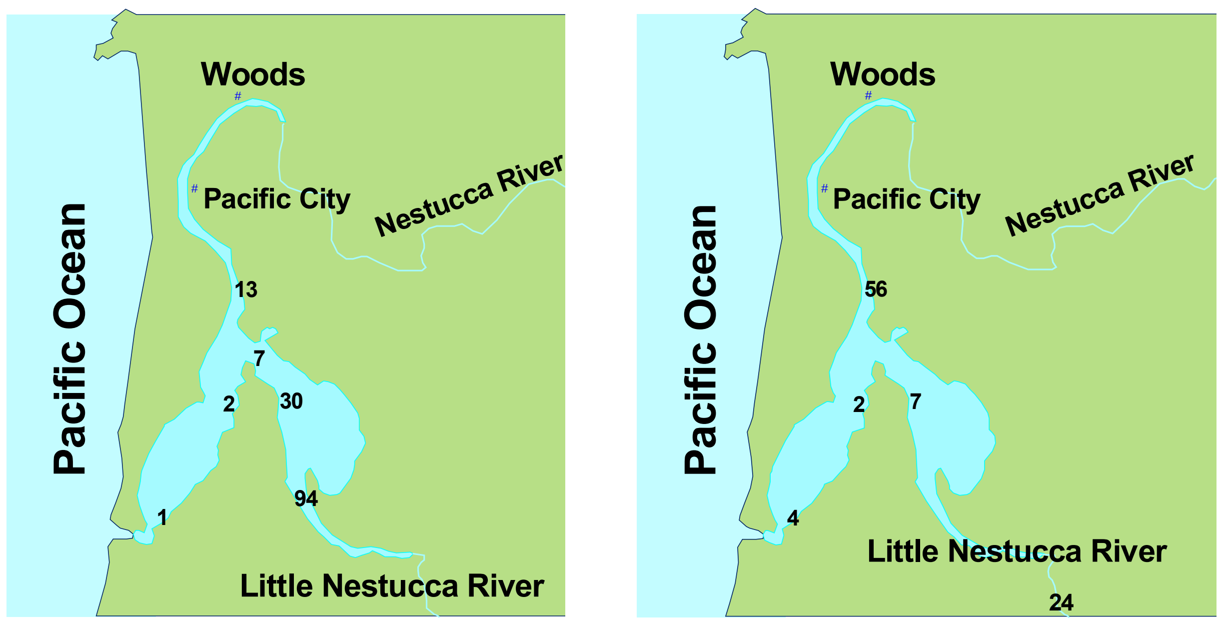


Figure 25. Geometric means of fecal coliform bacteria concentration in Nestucca River watershed during wet-weather study; February 2000.



Nestucca Bay
Nestucca Bay was sampled during wet- and dry-weather surveys in August 1999 and February 2000. The concentrations, although low overall compared to many other estuaries, were slightly higher during the dry-weather than the wet-weather surveys (Figure 26). The geometric mean of concentration only exceeded the criterion for protection of shellfish harvesting (14 MPN/100 ml) in the eastern lobe of the Bay. All other sample concentrations within the Bay were relatively low.

Figure 26. Geometric means of fecal coliform bacteria concentration in Nestucca Bay during August 1999 dry-weather study (left), and February 2000 wet-weather study (right). Fewer bay stations were sampled during wet weather due to logistical constraints.



3.2.6 Source Identification

3.2.6.1 Point Sources

The Nestucca Bay drainage basin has three domestic wastewater treatment plants that discharge to rivers. The locations and permit limits are summarized below in **Table 13**. **Table 14** lists the facilities covered by NPDES permits in Nestucca Bay Watershed and indicates where they are located. The permits for types of facilities other than NPDES do not discharge to surface waters, or discharge water that is not expected to be a significant source of fecal bacterial contamination.

Table 13. Individual NPDES Permits and current Permit Limits. All permit limits are based on *E. coli* as the indicator.

Facility Name	Discharge Point	Permit Limits
Hebo Joint Water and Sewer Authority STP	Three Rivers at RM 0.75 To Nestucca River at RM	Monthly geometric mean of 126 /100 ml No sample exceeding 406 /100 ml
Cloverdale Sanitary District STP	Nestucca River at RM 7	Monthly geometric mean of 126 /100 ml No sample exceeding 406 /100 ml
Pacific City Joint Water and Sewer Authority STP	Nestucca River at RM 1	Monthly geometric mean of 126 /100 ml No sample exceeding 406 /100 ml

Table 14. DEQ Wastewater Permits in the Nestucca Bay Watershed (does not include construction permits).

Facility ID	River Mile	Common Name	City	Category	Type
104818/A	0.3 (N)	Nestucca River Trailer Court	Beaver	Domestic	WPCF
110326/A	0.1 (N)	Riverhouse Food Products (ABN)	Cloverdale	Domestic	GEN54
102774/A	0.1 (N)	Wi-Ne-Ma Christian Camp	Cloverdale	Domestic	WPCF
109796/A	5.7 (N)	Tri-Agg, Inc.	Cloverdale	Individual	GEN12A
17318/A	7.0 (N)	Cloverdale Sanitary District	Cloverdale	Domestic	NPDES
100058/B	0.75 (TR)	Hebo Joint Water-Sanitary Auth.	Hebo	Domestic	NPDES
64440/A	2.2 (TR)	Cedar Creek Hatchery	Hebo	Agriculture	GEN03
66100/A	2.0 (N)	Pacific City Joint Water-Sanitary Auth.	Pacific City	Domestic	NPDES

N = Indicates distance from mouth of Nestucca River
TR = Indicates distance from mouth of Three Rivers

3.2.6.2 Non-point Sources

There are several types of land use in the Nestucca Bay Watershed, each of which is a potential source of bacterial runoff. Land uses have been broken down into more discreet categories for bacteria than for temperature. These uses differentiate between agriculture, agriculture/forest margins, farm buildings, and rural residential uses for instance. Confined animal feeding operations (CAFOs) are included in the farm building and farm building/agriculture category. Runoff from each of the land use types contributes to instream fecal coliform concentration and each category was included in the modeling of bacterial accumulation. Failing septic systems, which may be associated with either urban or rural residential development, may also contribute bacterial loads to the rivers.

Although land uses were divided into many categories, the majority of the area was accounted for by just a few of these land uses **(Figure 28)**. Concentrations of bacteria in runoff from these land use types were derived from literature and from analysis of samples from the watershed **(Table 15)**.

Figure 27. Landuse distributions in the Nestucca Bay Watershed.

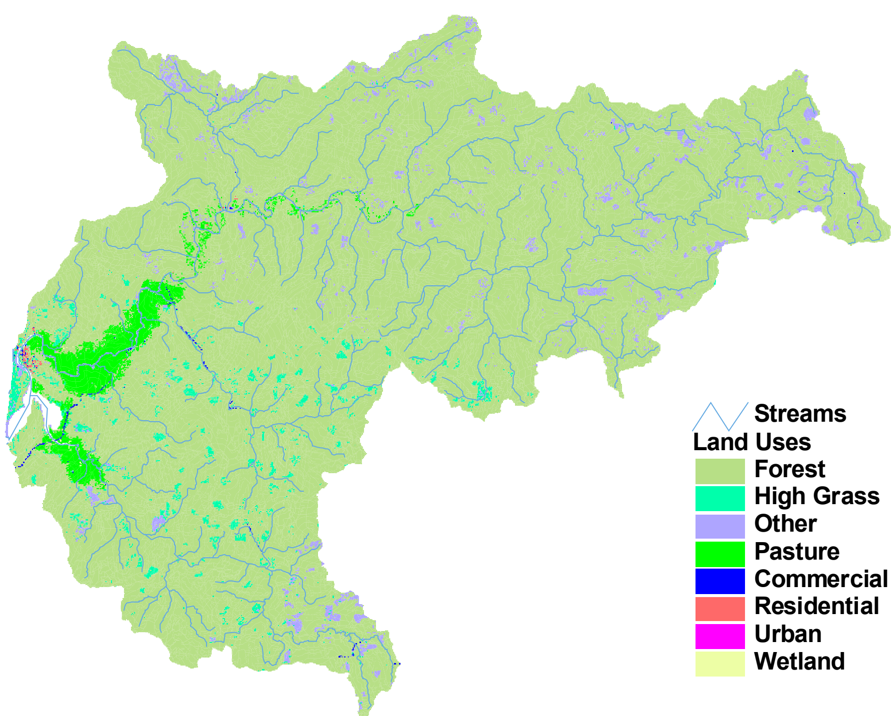


Table 15. *E coli* concentrations for sources

Forest Land Use: The forest land use concentration was based on samples collected from forest runoff in the Nestucca bay basin. The flow weighted average runoff concentration for a forested site was 10 MPN/100 mL. The forest land use concentration was also adjusted in the model to approximate the average instream concentration of 10 MPN/100 mL measured at the upstream forested site. **Residential Land Use:** No residential outfalls were identified in the Nestucca Bay basin. The runoff concentration of 1400 MPN/100 mL was based on samples collected from an urban storm water outfall at Cloverdale Bridge collected during the February 2000 storm event. **Urban Land Use:** The runoff concentration of 1400 MPN/100 mL was based on samples collected from an urban storm water outfall at Cloverdale bridge collected during the February 2000 storm event. **Pasture Land Use:** Pasture land use was assumed to include animal grazing. The runoff concentration was based on the range of values from samples collected from agricultural operations in the Nestucca Bay basin during the February 2000 storm event. Flow weighted averages from 3 outfalls ranged from 3400 MPN/100 mL to 14000 MPN/100 mL. **CAFOs:** CAFO locations and number of adult animals were provided by Oregon Department of Agriculture. Bacteria contributions from CAFOs were assumed to include manure application on fields. Manure was assumed to be spread on 1/2 acre per adult animal (Dean Moburg, NRCS, personal communication). Runoff concentrations were based on the range of runoff concentrations recorded in the Nestucca Bay basin. Although CAFOs are prohibited from discharging to surface waters, many are currently a source of contaminated runoff. **Point Sources**: E coli concentrations and flow from the waste water treatment plants were taken from Discharge Monitoring Reports covering (approximately) the period of January 1999 to July 2000. **Septic Systems:** No sanitary survey information was available for the Nestucca Bay basin. According to the county sanitarian, the area around the town of Beaver is most likely to have failing septic systems due to the age of the systems (Wes Greenwood, personal communication). Using data from "DEQ Final Report Oregon On site Experimental Systems Program, December 1982", the flow and concentration of septic tank effluent was estimated. It was assumed that 100% of the effluent flowed overland. The resulting load is calculated by the following equation:
(200 gallons/day)(3.7854 L/gallon)(1000ml/1 L)(20000 counts/100 ml) = 1.51 x 10^8 counts/day

3.2.7 Loading Capacity

The shellfish standard has two components. Both of these components must be met for compliance with the standard. The numeric limits in the standard are based on two points in the distribution of sample values. The 50^{th} percentile (or "median" can also be met with a geometric mean) may not exceed 14 MPN/100 ml, and the 90^{th} percentile ("no more than 10% of samples may exceed") value may not exceed 43 MPN/100 ml.

The loading capacity is set to meet the shellfish criteria requiring that the median of fecal coliform concentration be no greater than 14 MPN/100 and no more than 10% of samples may exceed 43 MPN/100 in the Bay. Despite this focus on the shellfish criteria, the loading capacity will also be protective of rivers to protect contact recreation.

This loading capacity relies on achieving low concentrations of bacteria in the rivers and dilution with bacteria-free water in the Bay. River water is diluted by saline Bay water and conductivity increases with distance into the Bay from the river mouths. Dilution ratios were different between the Nestucca and Little Nestucca Rivers **(Table 16)**. A dilution ratio of approximately 3:1 for the Nestucca River and a ratio of 2:1 for the Little Nestucca River were based on examination of the salinity data from monitoring stations throughout the Bay. Details of this dilution calculation are in **Appendix B**.

Numeric criteria are simply multiplied by the dilution multiple to determine the target at the mouth of each of the rivers. These ratios result in geometric mean concentrations of 42 MPN/100 ml (3x14 MPN/100 ml) at the mouth of the Nestucca, and 28 MPN/100 ml (2x14 MPN/100 ml) at the mouth of the Little Nestucca River. These loading capacities of 42 and 28 MPN (fecal coliform)/100 ml at the Nestucca and Little Nestucca river mouths, respectively, are in effect throughout the year to attain the shellfish criterion in the Bay. This load will also ensure attainment of the recreational water quality criteria in the Rivers and Bay.

Table 16. Dilution Factors at River Mouths.

Station Description	Waterbody	Dilution +1	Fecal Coliform Target at Mouth	*E. coli* Target at Mouth[1]
Nestucca Bay West Lobe at East Channel	Nestucca River	3	42	28
Nestucca Bay East Lobe at West Channel	Little Nestucca River	2	28	18

1 = Based on regression between analyses of samples for both *E. coli* and Fecal Coliform. See Appendix B.

3.2.7.1 Current loads

To evaluate bacteria loading in the Nestucca Bay Watershed, an event-based, unit-load model was used. The model uses estimated runoff volume, runoff concentrations for various land uses, and bacteria die off rates to predict total bacteria concentration and loads in the streams. Details of this model are discussed in Appendix B. Concentrations were estimated based on data or literature values **(refer to Table 15)** and then adjusted to provide the best fit to measured concentrations of bacteria.

3.2.7.2 Background:

Background is defined as the concentration of bacteria in water where there are no known human sources. Sites in forest lands that had historical data available were selected for data review. The median concentration of all the instream fecal coliform samples collected at the sites was 10 COUNTS/100 ml in all seasons. The value was chosen as the background instream concentration.

3.2.7.3 Seasonal Variation:

Seasonal differences were addressed in the allocations in two ways. First, winter (October through May) and summer (June – September) flows were simulated using daily mean flow in the Nestucca River based on a gage near Beaver operated by USGS from 1964 through 1995. Once the flow distribution was calculated for the river **(Table 17)**, storms with rainfall intensities that resulted in acceptably similar flows were modeled to determine loading rates. Secondly, the instream decay coefficient was increased for the summer allocation simulation to reflect higher decay resulting from higher temperatures during summer.

Table 17. Flows chosen for model simulations of runoff concentrations (data source: Nestucca River near Beaver – 1964-1995).

Season	Percentile	Flow at Beaver gage (Upper Cloverdale) (cfs)	Modeled Flow rates (cfs)
Winter	90%	3840	4023
Winter	50%	1270	1370
Summer	90%	595	643
Summer	50%	197	183

3.2.8 Allocations

Allocations are the amounts of bacteria that various sources are allowed to discharge. In the case of point sources, these allocations will guide the development of NPDES permit limits. In the case of nonpoint sources, they will be targets that management practices will be designed to meet.

3.2.8.1 Point Source Allocations

Although these limits are based on fecal coliform indicator bacteria, allocations have been calculated to allow point source dischargers to meet these limits based on the *E. coli* bacterial indicator.

The point sources in the Nestucca River Watershed are given a basic allocation of 42 fecal coliform counts/100 ml plus an increased allowance accounting for instream decay where appropriate. In converting this basic allocation to an *E. coli* indicator, the target at the mouth of the River becomes 28 E. coli counts/100 ml (**see Appendix B**). This basic allocation allows a concentration of 28 MPN/100 ml at the river mouth prior to dilution, with no more than 10% of samples exceeding a limit of 90 MPN/100 ml prior to dilution.

Discharges to the Nestucca River were given the basic allocation described above, but are also given an allowance for decay based on seasonal temperature, water velocity, and how far upstream a facility is located. Since decay is both time and temperature dependent, a longer period of time in warmer water results in greater die-off of bacteria. Decay rates are generally higher in the summer when temperatures are higher and velocities are lower than in winter. Decay was calculated for both low and high flows (50^{th} and 90^{th} percentiles) in summer and in fall-winter-spring (see Appendix B, Table 38). For each season and flow, the effluent concentration that would decay to the geometric mean criterion (28 E. coli/100 ml) and the 90^{th} percentile target value (90 E. coli/100 ml) were calculated. These calculations produced 8 values for each discharge (2 targets at each of 4 flow rates). For each target, the lower concentration in each season was chosen as the allocation. These resulting allocations are presented in **Table 18**. Calculated allocations that exceeded the recreational contact criteria were set at those criteria to ensure compliance with that standard.

General permits for operations and facilities in the basin other than sewage treatment plants (STPs) were not expected to produce or discharge bacteria, so are not allocated **(refer to Table 14)**. All facilities that were expected to discharge bacteria were included in the model. There are no permitted discharges in the Little Nestucca River. Expansion of existing sources or new sources will be given the same effluent limits as modified by an instream decay allowance. This end-of-pipe effluent limit ensures that discharges will not cause concentrations that result in the target at the mouth being exceeded.

Table 18. Allocations of *E. coli* concentrations for individual NPDES permitted facilities.

Facility Name	**Discharge Point**	**FWS** Geometric Mean	**Summer** Geometric Mean[1]	**FWS** 90^{th} percentile	**Summer** 90^{th} percentile[1]
Pacific City Joint Water and Sewer Authority STP	Nestucca River	34	71	110	229
Cloverdale Sanitary District STP	Nestucca River	57	126	182	406
Hebo Joint Water and Sewer Authority STP	Three Rivers	78	126	252	406

FWS = Fall-Winter-Spring; October through May;
Summer = June through September;
1 = Calculated concentrations were higher than recreational contact standard criteria and were set at those criteria. In addition to these allocations, all concentrations are constrained by **OAR 340-41-0205(2)(e).**

3.2.8.2 Non-point Source Allocations

As discussed previously, the allocations are set to meet a concentration of 42 fecal coliform counts/100mL at the mouth of the Nestucca River and 28 counts/100mL at the mouth of the Little Nestucca River. Allocations have been converted to represent *E. coli* concentrations as this is much more likely to be measured than fecal coliform. The allocation method allows for attainment of the criteria to be determined for each river separately through different runoff concentrations. Runoff concentrations also vary by flow rate (a seasonal consideration). Median and 90th percentile flow rates were estimated from continuous flow data near Beaver from 1964 through 1995 **(Table 19)**. Storms with precipitation and duration that would produce these flows were modeled and used as the basis for determining the current loading to the Bay (Table 10). Winter and summer high and low flows in the Little Nestucca River were estimated by using the same storm characteristics (rainfall and duration) as determined for the Nestucca River median and 90th percentile flows.

Allocation concentrations presented below are those associated with each land use prior to mixing with a waterbody. These concentrations in runoff would be diluted locally by the indicated volume of river water without causing the concentration to exceed the instream recreational standard or the river mouth allocation. Confined Animal Feeding Operations (CAFOs) do not receive an allocation as they are allowed zero discharge under the terms of their NPDES permits. Failing septic systems also do not receive an allocation since the failure is a result of poor maintenance and is prohibited under state law.

Each run of the model produced target runoff concentrations for each land use and an instream concentration at the mouth of a given river. Initial runoff concentrations for each land use were calibrated for the February 2000 storm. Simulations for each river were run at a range of flows that corresponded to the Nestucca River flow at various sized flow events (**Tables 10 and 11**). The cumulative loads for each river were reduced with subsequent model runs until the instream concentration at the mouth approximated the allocation target of 42 fecal coliform COUNTS/100 ml in at the mouth of the Nestucca River and 28 COUNTS/100 ml at the mouth of the Little Nestucca River.

The vast majority of the basin is covered by forestlands, which generally do not discharge high concentrations of bacteria. Concentrations could not be reduced below current levels. Of the other land uses only pasture is of sufficient area to have an effect on bacterial concentrations in the rivers. Reductions in concentrations from urban, residential, and commercial uses had no effect on instream concentrations in modeled scenarios.

The Little Nestucca River will require a greater reduction under all flow conditions than the Nestucca River. This is due to the small size of the basin (62 mi^2), which results in less flow available to dilute runoff concentrations, and poorer dilution by saltwater in the east lobe of Nestucca Bay. Farm buildings and pastures that have had manure applied to them are set at zero allocation because of the effluent guideline requiring CAFOs to have a zero discharge to surface waters.

Table 19. Storms modeled to approximate winter and summer flows in Nestucca River.

Season	Precipitation (inches)	Storm Length (days)	Flow at Beaver gage (Upper Cloverdale) (cfs)
Winter October - May	2.05	3	4023
	1.41	2	1370
Summer June - September	1.50	4	643
	0.74	3	183

Allocations are provided for two flow regimes in each of two seasons. The seasons are from October through May (Fall-Winter-Spring) and June through September (Summer). For flows from very low through the higher flow regime, the seasonal allocation for low flows is in effect. For flows above the 90th percentile, the seasonal allocation for high flows is in effect.

Table 20. Allocations for bacteria in runoff from various land uses[1] in the Nestucca and Little Nestucca Rivers. Concentrations are incipient runoff prior to mixing with surface waters. Numbers in **(parentheses)** are current condition runoff concentrations.

Nestucca River		**Target Runoff Allocations by Landuse [1] (E. coli counts/100 mL)**				
Season[4]	**River Flow Rate (cfs)**	**Forest (10)**	**Commercial (1400)**	**Pasture (4000)**	**CAFOs (10000)**	**Urban and Residential (1400)**
Winter October-May	**4023**	10	1100	2300	0	1100
	1370	10	1100	2300	0	1100
Summer June-September	**643**	10	1100	4000[3]	0	1100
	183	10	1100	4000[3]	0	1100

Little Nestucca River		**Target Runoff Allocations by Landuse [1] (E. coli counts/100 mL)**				
Season[4]	**River Flow Rate (cfs)[2]**	**Forest (10)**	**Commercial (1400)**	**Pasture (4000)**	**CAFOs (10000)**	**Urban and Residential (1400)**
Winter October-May	**1321**	10	1400	700	0	1400
	451	10	1400	540	0	1400
Summer June-September	**211**	10	1400	540	0	1400
	61	10	1400	740	0	1400

1 = Forest bacterial concentrations were considered at a natural minimum, so were not given allocations. Farm Buildings, and Ag/Farm Buildings are not allowed to discharge under conditions of CAFO permits and were given a zero allocation; failing septic systems are not allowed under state law, so were not given allocations.
2 = Flow and precipitation in the Nestucca River subbasin were used to model flows in the Little Nestucca River, and all modeling was based on these relationships.
3 = Modeled concentrations were higher than the current condition. Antidegradation policy does not allow unnecessary degradation from point and nonpoint sources of pollution.
4 = Within each season, lower flow rate runoff allocations are in effect until flow exceeds higher rate. At higher flow rate and above, corresponding runoff allocation is in effect.

3.2.9 Reasonable Assurance

The TMDL for bacteria has been developed to provide targets for control of pollutants that will ensure water quality standards are protected. Along with these targets for compliance, it is necessary to provide reasonable assurance that appropriate and timely measures are taken that will result in meeting these allocations. The basis of reasonable assurance for TMDLs is the Oregon Plan for Salmon and Watersheds and appropriate federal, state and local statutes, rules and regulations. This plan is a partnership between Federal and State agencies, local groups, and grassroots organizations that recognizes the attributes of aquatic health and their connection to public health and the health of salmon populations. The Oregon Plan considers the condition of salmon as a critical indicator of ecosystems (CSRI, 1997).

The specific measures and regulations that will result in attainment of TMDL allocations are described in the accompanying Nestucca Bay Watershed TMDL Water Quality Management Plan. This plan has been specifically developed to address implementation of measures that provide reasonable assurance that the TMDL allocations will be met. The WQMP is included with the TMDL as Appendix D.

3.2.10 Seasonal Variation

Seasonal variation has been considered in characterization of the watershed and in development of the loading capacity and the structure of allocations. Allocations are based on flow rates that are largely a seasonal feature. Decay in the model and in determining allocations for pointsource discharges is based in part on the seasonal variations in temperature. Overall the allocations reflect the changing conditions associated with seasons.

3.3 Sedimentation

Summary of Sedimentation TMDL

Why Is Sedimentation Important?

Sediment accumulation is a natural outcome of erosional and fluvial processes. Landslides and surface erosion provide a continual supply of sediments of a range of particle sizes. When the rate of erosion is increased by human activities, by fires, and by floods, more sediments are delivered to a stream than the channel morphology and flow characteristics are capable of moving downstream and to the sea. In nature, the measurable dimension, pattern and profile of a river develop over time to move the amount of water and sediment supplied by surrounding uplands. Protracted increases in the amount of either water or sediment will result in a change in one or all of those measurable features. Excessive proportions of fine sediments in river bottoms make the surface unsuitable for spawning by salmonid fishes.

Scope

All lands (371 square miles) with streams that drain to the Nestucca Bay within HUC 17100203 are included in the sedimentation TMDL. Within this watershed there are two areas that have been specifically listed under section 303(d) of the Clean Water Act as being impaired; the upper Nestucca River upstream of Powder Creek, and East Beaver Creek. Discussions of sedimentation in the watershed are focussed on these listed waterbodies.

Applying Oregon's Water Quality Standards to Sedimentation

*The State of Oregon does not have a standard that specifies a concentration of sediment or a proportion of bottom sediments that will protect beneficial uses of salmonid spawning. The state does have narrative criteria that restrict the "*formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to fish or other aquatic life or injurious to public health, recreation, or industry.*" In addition, targets for sediment quality that indicate high quality habitat for salmonid spawning are being adopted as endpoints for determining compliance with standards.*

Development of System Potential Conditions

System potential conditions comprised of riparian and channel morphology parameters are common to this TMDL and the temperature TMDL presented in Section 3.1. The same measures of system potential that are expected to achieve temperature criteria are believed to be effective in achieving sedimentation targets. Decreased channel widths (Near-Stream Disturbance Zones) resulting from system potential vegetation along rivers will stabilize streambanks and reduce erosion that causes sedimentation.

Sedimentation TMDL Overview

Sources of instream sedimentation have been identified throughout the watershed as deriving from forestry activities and agricultural clearing of riparian vegetation in lowland areas. Forestry-related sources are associated with road building and harvesting on steep slopes. These activities have been sharply limited in recent years in the Upper Nestucca watershed, but continue to some extent on private lands in East Beaver Creek. Analysis of the bottom sediments in the Upper Nestucca Watershed indicated that this area has recovered substantially from a variety of practices and events, and targets for instream fine sediments are currently met. Historical data on the frequency of landslides of varying sizes in the East Beaver Creek watershed indicates there has been excessive sediment delivered to rivers resulting from forestry activities. The lower Nestucca River is severely impacted by fine sediments, a result of initial and maintenance removal of riparian vegetation in the lower gradient reaches of the River. The TMDL requires that system potential riparian vegetation and channel morphology be established and maintained throughout the watershed as a means of controlling streambank erosion. An endpoint measure of $\leq$ 20% instream fines is included as a surrogate load allocation.

Fine sediments can adversely affect fish and other aquatic organisms by: 1) killing salmonids, reducing growth, or reducing disease resistance; 2) interfering with the development of eggs and larvae; 3) modifying natural movements and migration of salmonids, and 4) reducing the abundance of food organisms (Newcombe and McDonald 1991). While some of these impacts are the result of suspended sediments affecting fish and other organisms physiologically, deposition of fine sediments in streambeds largely affects fishes ability to successfully feed and reproduce. Excessive fine sedimentation can alter the abundance and composition of prey organisms and sedimentation of spawning beds (redds) can significantly impair the success of juvenile emergence.

The current TMDL includes assessments of both depositional sediment and suspended sediments, but the listing and the TMDL address only the depositional portion of sediment balance in the watershed. Sedimentation in the watershed was the cause of the original listing, and there is no evidence that the listing should be broadened to address suspended sediments (e.g., turbidity) as well. However, concentrations of suspended sediments (expressed as turbidity) are indicators of ongoing supplies of fine sediments in the watershed. Their inclusion here is as supporting information only.

3.3.1 Pollutant Identification

The pollutant causing water quality impairments is excessive sediment resulting from land use practices within the Nestucca River Watershed and the East Beaver Creek Watershed. These clean sediments are from non-point sources associated with forestry, roads, and agricultural maintenance of riparian areas.

3.3.2 Target Identification

The Environmental Protection Agency (EPA) and the State of Oregon do not have numeric water quality standards for streambed fines. Excessive fine sediment is addressed through application of state narrative criteria which restricts “the formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to fish or other…” beneficial uses. For listing purposes, a target of 20% streambed fines was used as an indicator of fine sediment impairment to salmonids (the most sensitive “resident biological community”). This target is based on documentation that formed the basis for interim guidance (PACFISH) for managing federal lands, ODFW habitat benchmarks (Foster, etal 2001), and other studies of sediments in salmonid habitats. Final PACFISH documentation (USFS/BLM 1995) did not include riparian management objectives based on area fines because it was inappropriate to set standards that would be applied over a large region (much of 4 western states) that included variable geology and a wide range of environments (Mike Lohrey, personal communication).

The ODFW benchmarks are specific to streams based on gradient and differing parent sediment sources. Oregon Department of Fish and Wildlife habitat benchmarks indicate a range of substrate fines thresholds above which conditions were “undesirable.” The midpoint of these limits was 20% area fines for streams with sedimentary parent materials, as are found in the streambanks of the lower elevation portions of the watershed., though desirable conditions ranged from 8% to 12% fines depending on slope and parent material. This indicator is specific to riffle and glide reaches where currents continually move fine sediments through and salmonids preferentially spawn. Other features (e.g., pools) may be storage areas for fine sediments between large flushing events.

A variety of other sources support the target as appropriate for use as an allocation. A composite of studies of fry emergence related to fine sediments in substrates demonstrated substantial declines in emergence at proportions greater than 20% fines by surface area (Phillips, etal 1975; Hausle and Cobel 1976; and McCuddin 1977; all in Bjornn and Reiser 1991). Results of some studies (Bjornn and Reiser 1991) indicated embryo sensitivity to fines varied among species, but several salmonids (cutthroat and rainbow trout, kokanee, and chinook salmon) showed sensitivity beginning at approximately 20% fines.

Management plans for the Snake River basin have also indicated 20% fines as a threshold for protecting salmoinid habitat (Rhodes, 1995). Anderson, etal (1992 in Rhodes, 1995) recommend maintaining "surface fines and fines by depth in channel substrate at less than 20% in salmon spawning habitat. Where conditions are lower than standards, maintain them." Rhodes, etal (1994 in Rhodes, 1995) recommend "average surface fine sediment <20% in spawning areas with no increase allowed when surface fine sediment is <20%."

For these reasons, the Department has decided, the target for the TMDL should be based on percent fine sediment as indicated above. The loading capacity for sedimentation will be defined as:

- **20 percent streambed area fines in riffle and glide reaches.**

Long-term monitoring and the adaptive management nature of this TMDL will be used to evaluate this goal over time.

3.3.3 Sensitive Beneficial Use Identification

Beneficial uses in the Nestucca Bay Watershed are defined in the Oregon Administrative Rules **(Table 21)**. The key beneficial uses affected by elevated concentrations of fecal bacteria are body contact recreation in rivers, and fishing (shellfish harvesting) in the Bay. There is a recreational shellfishery, although the Bay currently has no areas with specific use designations for commercial shellfish harvesting. Recently collected data indicates that shellfish harvesting would not be supported at all times in all parts of the Bay.

Table 21. Beneficial uses occurring in the Nestucca Bay Watershed
(OAR 340 – 41 – 202)
Sedimentation -Sensitive Beneficial uses are marked in gray

Beneficial Use	***Occurring***	***Beneficial Use***	***Occurring***
Public Domestic Water Supply	✓	Anadromous Fish Passage	✓
Private Domestic Water Supply	✓	Salmonid Fish Spawning	✓
Industrial Water Supply	✓	Salmonid Fish Rearing	✓
Irrigation	✓	Resident Fish and Aquatic Life	✓
Livestock Watering	✓	Wildlife and Hunting	✓
Boating	✓	Fishing	✓
Aesthetic Quality	✓	Water Contact Recreation	✓
Commercial Navigation & Trans.		Hydro Power	

3.3.4 Water Quality Standard Identification

Oregon water quality standards related to sedimentation include:

> _Sedimentation_ [OAR 340-41-205(2)(j)] - "The formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to fish or other aquatic life or injurious to public health, recreation, or industry shall not be allowed."
>
> _Biological criteria_ (OAR 340-41-027) - "Waters of the State shall be of sufficient quality to support aquatic species without detrimental changes in the resident biological communities."

3.3.5 Deviation from Water Quality Standards and 303(d) Listings

The Nestucca River upstream of Powder Creek and East Beaver Creek from its mouth to headwaters are included on the §303(d) list due excessive sedimentation. This listing was based on an extensive survey of the basin by fisheries biologists in the mid- 1980s (Baker, C. 1986). Based on their best professional judgement, each of many waterbodies was given qualitative rankings for whether they were meeting the requirements of salmonid fishes. Based on these rankings, the Nestucca and East Beaver Creek did not support salmonid fish habitat, and one feature that caused this was excessive fine sediments in spawning areas. There may also have been portions of the basin that suffered from a paucity of gravel appropriate for spawning.

3.3.5.1. Historical Influences

A variety of influences on the Nestucca Basin have historically resulted in altered streambeds. Fires had burned various portions of the watershed beginning in the mid-1800s through 1919, and aerial photos from 1930 indicated there were only isolated stands of timber remaining (McDonald and Schneider 1992). Additional fires over the next 20 years, including the Tillamook Burn, affected more of the watershed, including East Beaver Creek. These burns caused large-scale erosion of hillslopes and streambanks, providing sediments of all grainsizes to the rivers. With time the finer grains of these sediments were flushed through the system, leaving extensive gravels and boulders appropriate for salmon spawning.

There is a natural chronic source of fine sediment in Bear Creek, a tributary to the Nestucca River in the upper watershed. Accoding to BLM (unpublished report):

> *"Soil creep in the Bear Creek subwatershed is a chronic source of sediment to both the lower portion of Bear Creek and the Nestucca River below bear Creek. A thick layer of fine-textured soils formed in weathered sedimentary rocks are moving downslope over approximately 350 acres. The result of this creep activity is a continuous supply of soil material to the stream in the form of encroaching banks and small-scale bank failures. During high flows, material is carried into the stream by direct water erosion, undercutting and local bank slumping."*

The failure of the Meadow Lake dam in the upper Nestucca in late 1962 had significant effects on streambeds, banks and hydrology. Upper portions of the watershed were scoured down to bedrock, and riparian vegetation and streambanks were eroded away. In the upper watershed, this resulted in both diminished availability of spawning gravels and an excess of fine sediments (Baker, etal 1986; McDonald and Schneider, 1992, NNWC 1998).

3.3.5.2 Current Conditions

Sedimentation in the Nestucca River and its watersheds are currently quite different than when the studies resulting in listing were done. Recent data on sedimentation in the upper Nestucca River cannot be directly compared to the qualitative information used for the listing. Recent data compare favorably to current targets for substratum sediment composition (e.g., Foster, etal 2001) for the protection of salmonids. Less data is available for East Beaver Creek, but early trends in landslide occurrence and recent turbidity data suggest there is relatively little fine sediment being deposited in the in the Creek, and that the Beaver Creek system is not a significant source of sediment to the Nestucca River.

3.3.5.2.1 Turbidity

Turbidity in this section is used as an indicator of ongoing fine sediment distribution. Turbidity is not a surrogate for depositional sediments, though excessive fine sediment deposition would likely be coincidental with elevated turbidity. Though there is relatively little turbidity data to address historical conditions, it is unlikely that turbidity was significantly lower than it has been in recent years. Turbidity data collected by DEQ from 1973 through 2000 was mostly centered on one site in Cloverdale **(Figure 29)**. Tubidity value were generally low, with some ranging up to 35 NTU. Values from the site at Alder Glen campground in the upper watershed were collected during a storm event, and are also low.

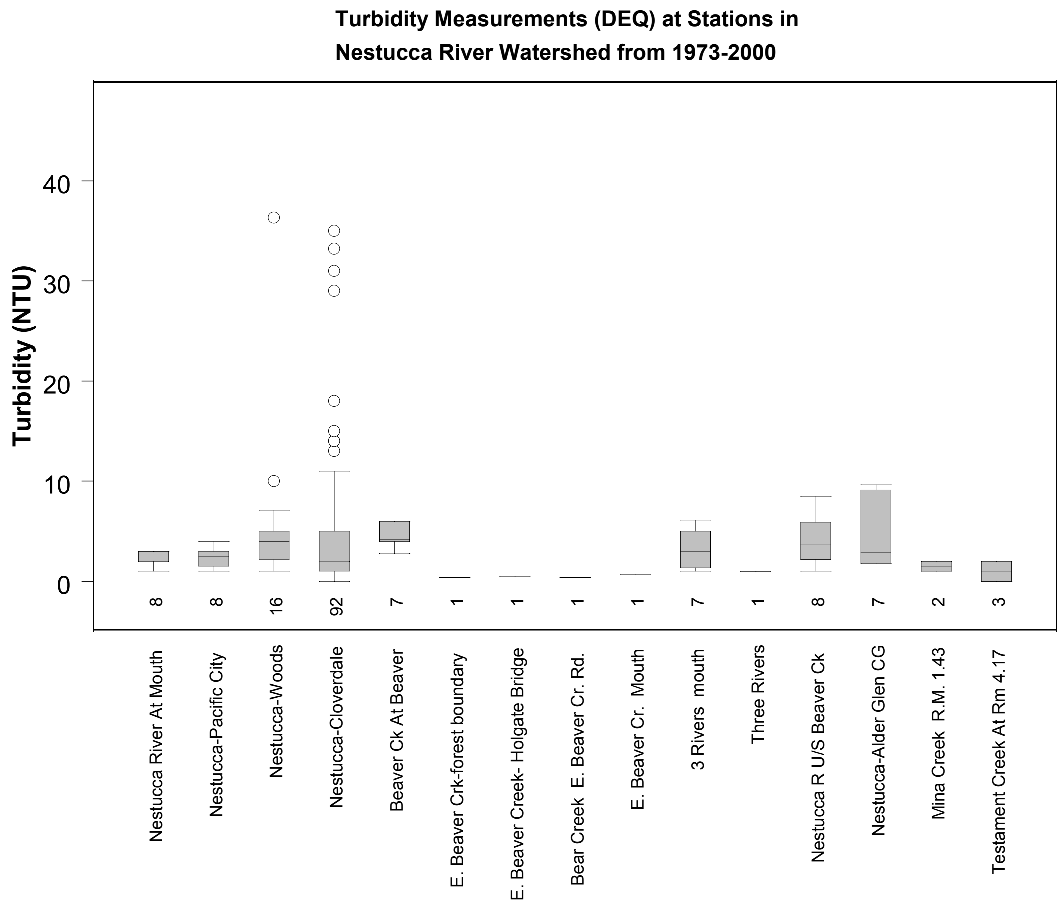


Figure 28. Distribution of turbidity measurements in ongoing monitoring from 1973-2000 by DEQ. The number of samples comprising each box plot is indicated at the bottom of the graph.

Turbidity has also been monitored weekly throughout the watershed since mid-1999 by the Nestucca-Neskowin Watershed Council **(Figure 30)**. Turbidity has generally been quite low except during storm events **(Figure 31)**. Even during storm events, however, values have typically been low, and the effects of these events were short-lived. Recent monitoring data for the Nestucca Bay Watershed suggests that amounts of suspended sediments are generally low throughout the watershed. With the exception of some very large storm events that mobilized suspended sediments throughout the subbasin, turbidity remained low in samples over a two-year period. Moreover, turbidity during the October 1999 storm was highest in the lower parts of the watershed. Turbidity from this event lasted for several weeks, but the apparent source was natural soil creep in Bear Creek, with relatively little sediment originating in the Beaver Creek drainage. This suggests that, although there may have been significant short-term sediment loads originating in the upper Nestucca subbasin, sediment sources in the lower elevation areas contributed significant sediments loads as well. Beaver Creek did not appear to be a significant source of sediments.

Figure 29. Turbidity values from samples at stations throughout the Nestucca Watershed from 1999-2001 by Nestucca-Neskowin Watershed Council. Turbidity is scale is logarithmic for viewing convenience. Large triangles (Δ) indicate 90th percentile value.

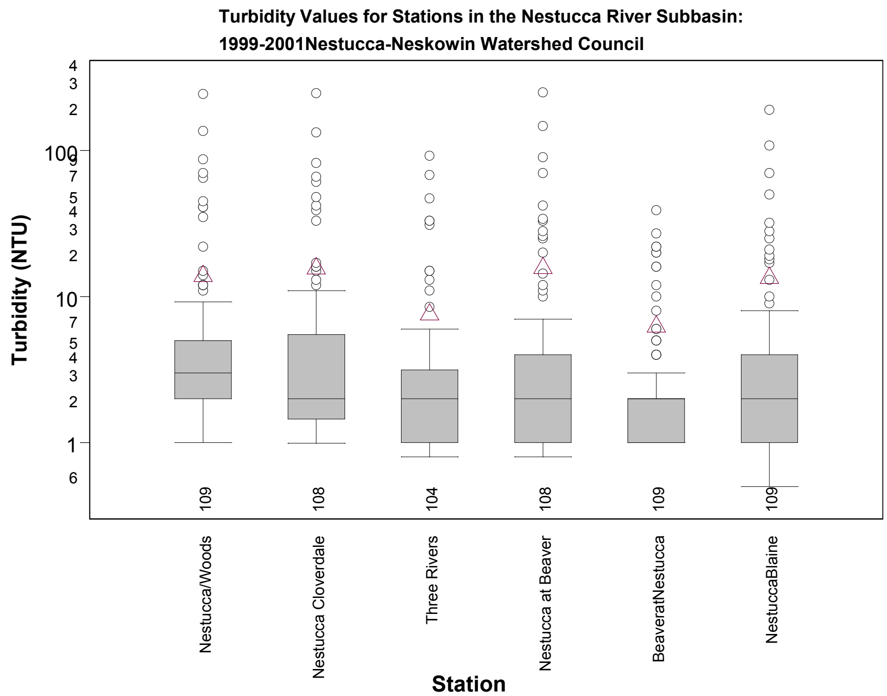
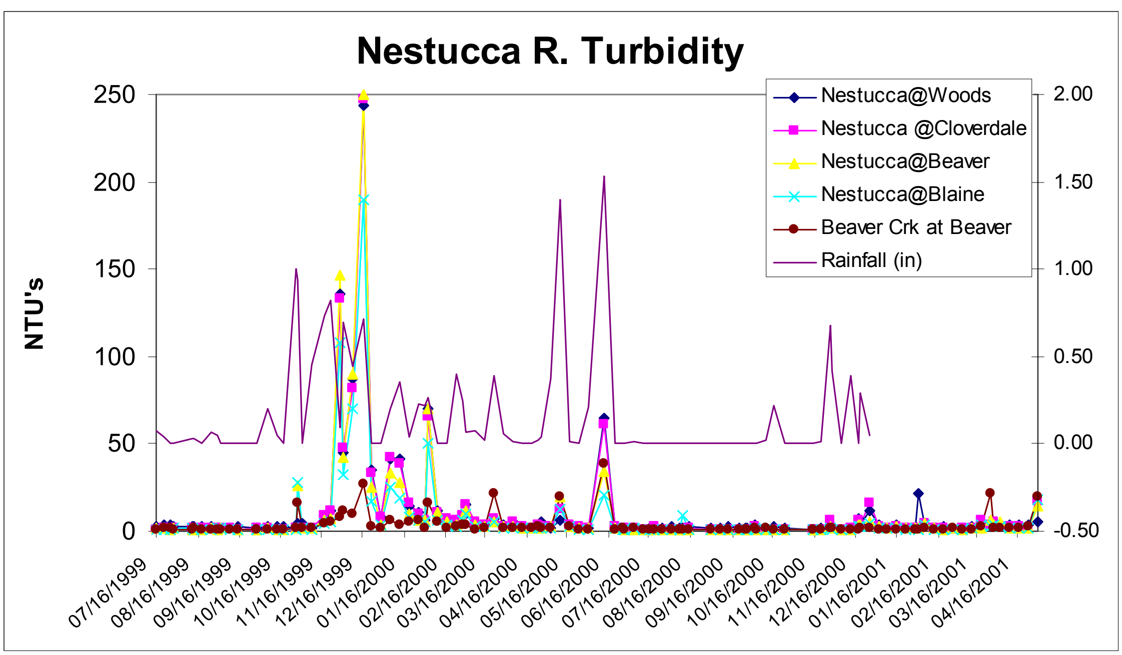


Figure 30. Turbidity at stations throughout the Nestucca Subbasin from 1999 to 2001 (NNWC). Rainfall data from Oregon Climate Service (Oregon State University).



3.3.5.2.1 Surficial Sediments in the Nestucca River Watershed

Management of forests in the upper Nestucca River subbasin began in approximately 1960 (Baker 1986, McDonald and Schneider 1992). From this time on, sources of sediments in the upper Nestucca Watershed were most likely management related. Though significant harvest in the upper watershed has not occurred since 1990, there were some persistent conditions (roads and regeneration areas) that resulted in production of fine sediments until recently.

A recent survey (1997) of the Upper Nestucca River Watershed suggests that the relative abundance of fine sediments in the substratum has been reduced and is currently meeting targets established for support of salmonid spawning. The Oregon Department of Fish and Wildlife(ODFW) conducted a survey of the mainstem of the Nestucca River from Alder Glen (at Bear Creek) to Meadow Lake under contract to the Bureau of Land Management (BLM). Results of this survey indicate that most of the area below the Meadow Lake and above Bear Creek meet the target of 20% fines or less in surficial sediments of riffle and glide reaches of the river **(Figure 32)**. The 90th percentile value of percent fine sediments in riffle and glide reaches combined was 20%. This means that less than 10% of samples among these types of reaches exceeded the target of 20%.

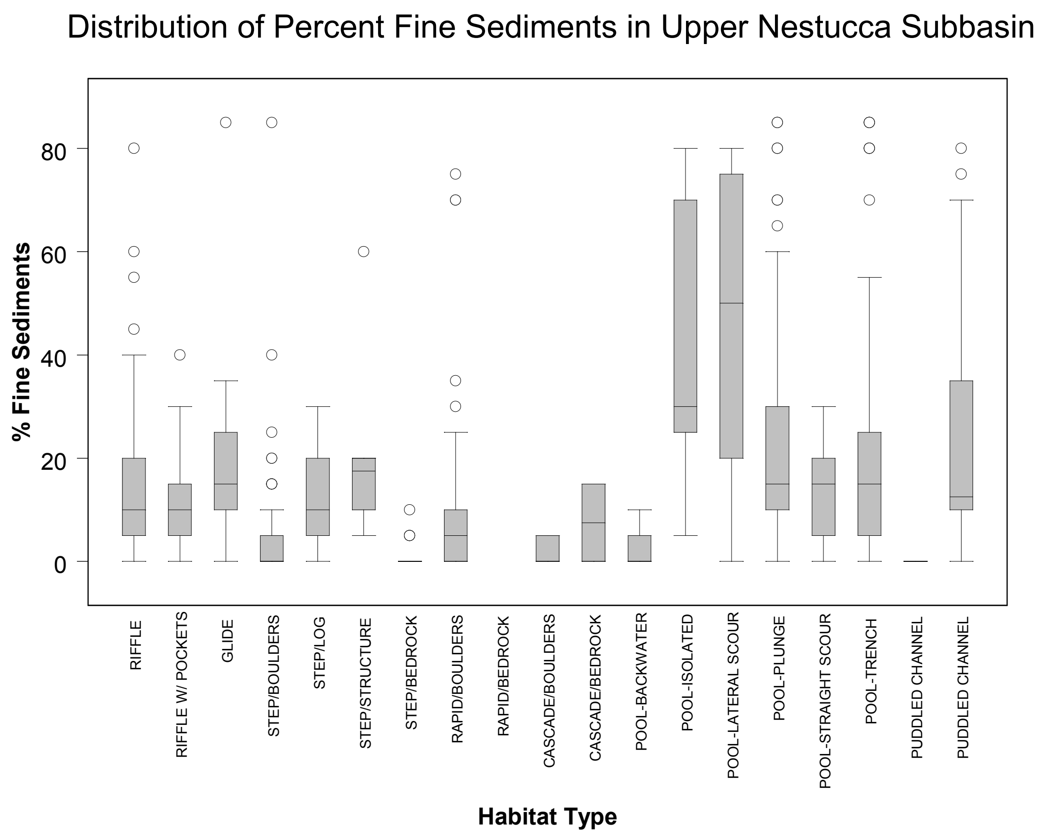


Figure 31. Distribution of fine surficial sediments among different channel types in 1997 survey of the Upper Nestucca River (ODFW).

The Meadow Lake area, and lower gradient reaches downstream of Powder Creek do not meet this target. The 90th percentile value in the Meadow Lake area, a low gradient relict lake bottom downstream of McGuire Reservoir Dam, was 100% fines. Downstream reaches were surveyed by DEQ during the summer of 1999 and visual estimates were made of the proportion of fines comprising surficial sediments. The distribution of these measures was strongly affected by the measures at two stations, Nestucca River at Cloverdale, and Nestucca River upstream of Beaver Creek. Percent fines at these stations were 100% and 90%, respectively **(Table 22)**. Other stations generally had lesser proportions of fine sediments, but several still were greater than the target of 20%.

Table 22. Estimates of proportion of fine sediments at stations in the lower Nestucca River (ODEQ, 1999).

Station	Percent Fines
Nestucca River u/s Niagra Cr.	20
Nestucca River u/s Powder Creek	10
Nestucca R. at Cochran Br.	10
Nestucca R. at MP 10	45
Nestucca R. at MP 8	30
Nestucca R. d/s Alder Creek (MP 5)	0
Nestucca River d/s of Boulder Cr (Blaine Rd 5th Bridge)	10
Nestucca River at Rusty Bridge (4th Bridge)	40
Nestucca River u/s of Beaver Cr.	90
Nestucca R. u/s Sailing Cr.	15
Nestucca River u/s of Three Rivers	10
Nestucca River at Cloverdale	100
90th Percentile Value	85.5

3.3.5.2.2 Surficial Sediments in the East Beaver Creek Watershed

Large flood events in 1964-65 and in 1972 also caused significant damage to East Beaver Creek. Following on the heels of these flood-related damages, road building and harvest operations increased significantly through the late 1960s and 1970s. East Beaver Creek (and Moon Creek) watershed is one of the most susceptible to landslides in the Nestucca watershed (Pilot Watershed Analysis, BLM/USFS unpub.). The physical nature of East Beaver Creek (steep volcanic slopes and friable surface soils) resulted in an unusual rate of roads crossing steep, failure prone slopes, each of which increased the risk of road-related failures and sediment discharge to streams. Road building, road maintenance, and tree harvest techniques combined to cause increases in the amount of sediment reaching creeks and rivers, resulting in streambeds that received excessive amounts of fine particles.

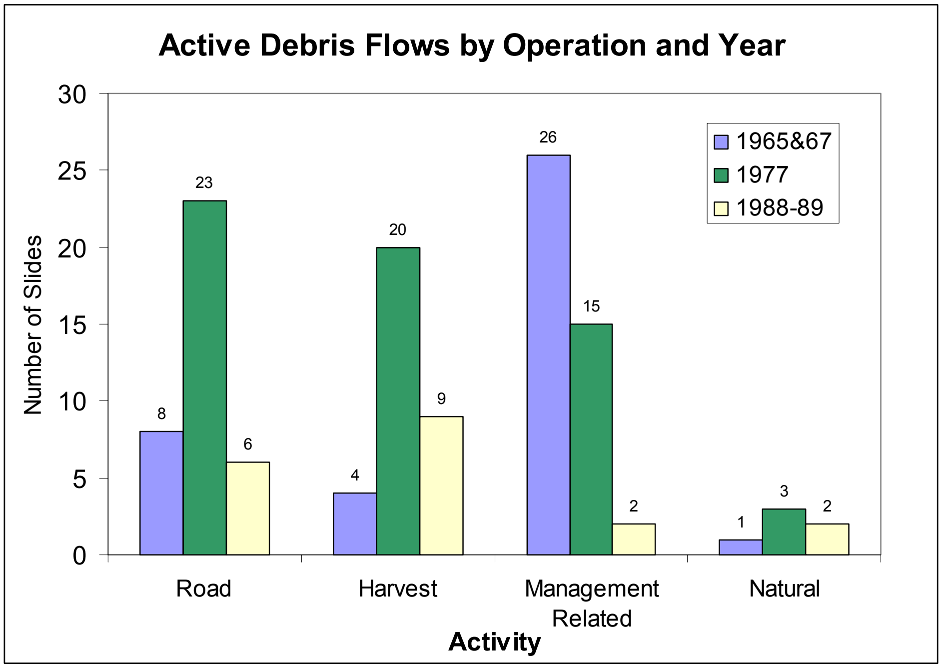
These practices, coupled with naturally unstable and steep terrain in the East Beaver Creek Watershed, resulted in significant increases in the number of landslides associated with logging roads and river crossings. “Between 1965 and 1977, debris flows caused by road construction within the East Beaver and Moon Creek subwatershed increased three-fold while the number of natural debris flows remained low” (based on aerial photographic analysis – Pilot Watershed Analysis, BLM/USFS unpub.). Not only the number of slides, but the amount of sediment delivered to streams likely increased during this time. In general, by 1988, the number of debris flows and slides were reduced, but over all sources, still exceeded the number of “natural” flows and slides **(Figure 33)**.

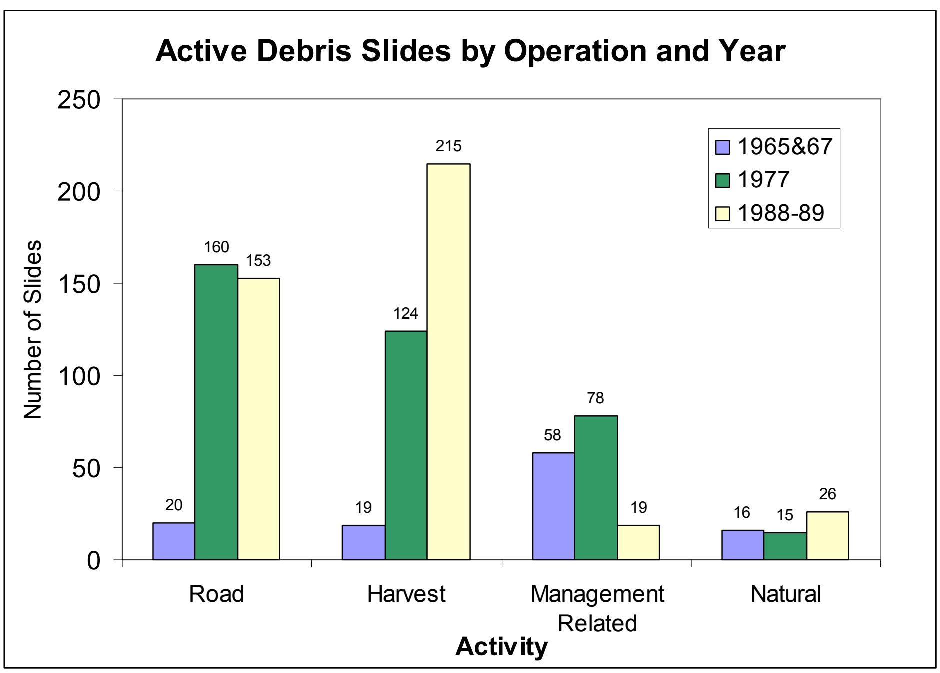
May (1999), in a ground-level survey in the Central Oregon Coast Range, reported that debris flows and slides in clearcut areas and associated with roads produce much higher loads of sediments than those from unmanaged areas.
The Oregon Department of Forestry (1999) conducted a ground level landslide survey following the intense storms of 1996. They surveyed 145 miles of channel over an area of 51.7 square miles. Although the study indicated that aerial photos underestimated landslides in mature forests, the estimated rate of landslides in harvested areas and associated with road failures were

higher than in older, unmanaged forests. These results are similar to the other cited studies, though the relative magnitude of differences between managed and unmanaged forests may have been lower in the ODF study.

A recent stream survey of a lower reach in East Beaver Creek indicates fine sediments in the stream bottom have been reduced (ODFW 2000). This survey of the lower 1000 meters upstream of the confluence with Beaver Creek indicates a high proportion of riffle habitat (62%) and low concentrations of fines in surficial sediments. Fines in riffles of these reaches were 5% or lower overall in the survey.

Figure 32. Relative abundance of debris flows and debris slides in the East Beaver Creek subbasin from 1965 through 1989 (Pilot Watershed Analysis, BLM/USFS unpub).





3.3.6 Source Identification

Fine sediments in the watersheds are principally from non-point sources. Agricultural clearing and maintenance of riparian areas in the lower elevations of the watershed have resulted in unstable streambanks that fail and collapse into the river. Forestry operations that historically have developed roads and harvested on extreme slopes have resulted in an accelerated rate of mass failures throughout the upland forested areas of the Watershed. The practices that resulted in many of these failures have been revised with new laws.

3.3.7 Loading Capacity

Identification of the instream sediment loading capacity is the first step for the development of TMDLs. The loading capacity is defined as the greatest amount of a pollutant that water can receive without exceeding water quality standards. As noted above, an instream streambed fines target of less than 20 percent streambed area fines has been established as surrogate for sediment loading. This the limit that the Nestucca Bay Watershed can accommodate without exceeding the state's narrative sedimentation criteria. Thus, the sediment loading capacity for all streams listed for sedimentation in the Nestucca Bay Watershed is that amount of sediment resulting in no more than 20 percent streambed area fines.

3.3.8 Load Allocations/Surrogate Measures

A *Load Allocation* (LA) is that portion of non-point source loading that a particular source may provide without causing the water quality criteria to be violated. The sum of load allocations and wasteload allocations (from pointsources) and a margin of safety may not exceed the loading capacity. While load allocations are traditionally expressed as "mass per time", the TMDL regulation also provides for the expression of allocations in "other appropriate measures". It is not appropriate for streambed fines to be expressed as a load. Thus, another appropriate measure will be utilized in this TMDL.

Percent streambed fines decrease with the increase in woody riparian vegetation **(Figure 34)**. The observed data also indicate that when an established deciduous/mixed/conifer riparian community exists, the loading capacity of 20% streambed fines will be attained. Surrogate measures developed in the temperature TMDL provide for the establishment of a deciduous/mixed/conifer riparian community that will provide shade and stabilize streambanks, and reduce channel width throughout the subbasin. These same surrogate measures can be utilized as load allocations for the sedimentation TMDL.

Current conditions in the Upper Nestucca River Watershed meet this target in most riffle and glide reaches (90^{th} percentile). Surveyed areas of East Beaver Creek also currently meet this target. Given that vegetation within the Watershed currently does not meet the shade or the channel width requirements established for the temperature TMDL (this document), development of system potential riparian vegetation required under that TMDL should continue to improve sedimentation conditions in the watershed. Continued development of system potential vegetation along streambanks throughout the watershed provides an explicit margin of safety by reducing sedimentation beyond the loading capacity.

The load allocations for the Nestucca Bay Watershed and for the tributaries to the Nestucca River are:

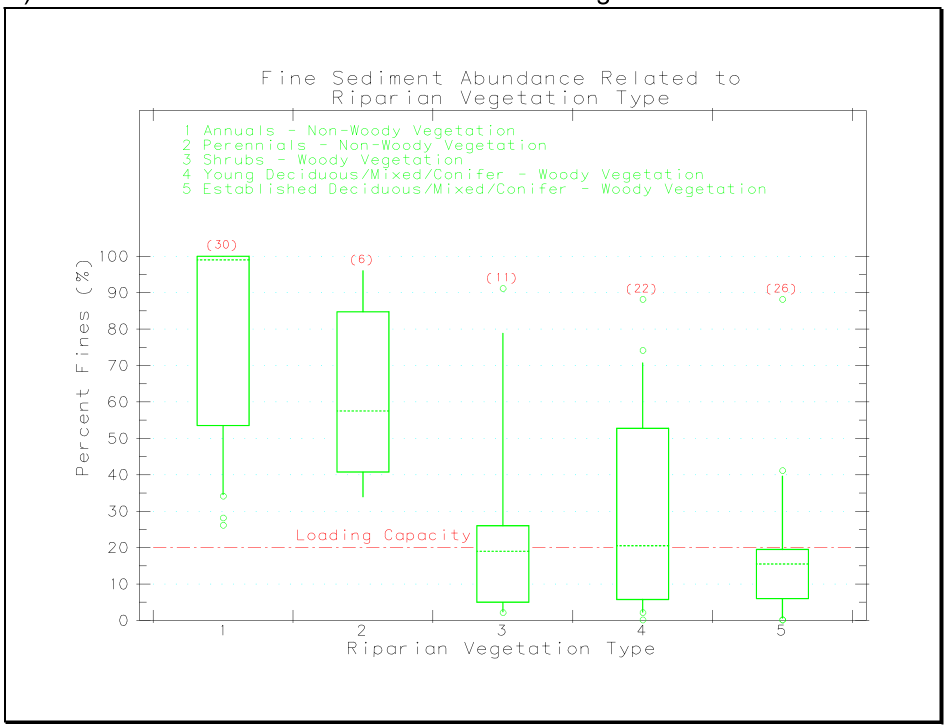
- **20 percent streambed area fines in riffle and glide reaches.**

This measurable streambed characteristic will be achieved throughout the watershed by providing the surrogate measures called for in the temperature TMDL to establish system potential conditions as follows:

- Development of system potential riparian vegetation called for in the temperature TMDL that will restore/protect riparian areas and serve to reduce stream bank erosion by increasing stream bank stability via rooting strength and near-stream roughness and decrease the near-stream disturbance zone dimension.

These allocations apply to all landuses (agriculture, forestry, urban) throughout the watershed.

Figure 33. Stream Bed Percent Fines Related to Various Riparian Vegetation Types (ODFW data, 1996). Red annotation line indicates the 20% fines target.



3.3.9 Wasteload Allocations

Wastewater treatment plants, and thus point sources in Nestucca subbasin, are not considered a source of fine sediment and thus no wasteload allocations have been developed.

3.3.10 Surrogate Measures

For a discussion of surrogate measures refer to section **3.1.8.2 Surrogate Measures and Load Allocations** in the Temperature TMDL. Surrogate measures have also been adopted for Sedimentation control. The surrogates are the same as those allocated for temperature. Retention and restoration of System Potential shade is expected to result in stable stream banks and a decrease in landslide failures associated with riparian zones.

3.3.11 Reasonable Assurance

The TMDL for sedimentation has been developed to provide targets for control of pollutants that will ensure water quality standards are protected. Along with these targets for compliance, it is necessary to provide reasonable assurance that appropriate and timely measures are taken that will result in meeting these allocations. The basis of reasonable assurance for TMDLs is the Oregon Plan for Salmon and Watersheds and appropriate federal, state and local statutes, rules and regulations. This plan is a partnership between Federal and State agencies, local groups, and grassroots organizations that recognizes the attributes of aquatic health and their connection to public health and the health of salmon populations. The Oregon Plan considers the condition of salmon as a critical indicator of ecosystems (CSRI, 1997).

The specific measures and regulations that will result in attainment of TMDL allocations are described in the accompanying Nestucca Bay Watershed TMDL Water Quality Management Plan. This plan has been specifically developed to address implementation of measures that provide reasonable assurance that the TMDL allocations will be met. The WQMP is included with the TMDL as Appendix D.

3.3.12 Seasonal Variation

The goal of this TMDL is year-round achievement of the loading capacity. Due to the nature of the loading capacity and allocations assigned in this TMDL, a discussion of seasonal variations in sediment delivery and transport processes in the Nestucca Bay Watershed was not necessary in developing the TMDL.

3.4 Margins of Safety – CWA §303(d)(1)

The Clean Water Act requires that each TMDL be established with a margin of safety (MOS). The statutory requirement that TMDLs incorporate a MOS is intended to account for uncertainty in available data or in the actual effect controls will have on loading reductions and receiving water quality. A MOS is expressed as unallocated assimilative capacity or conservative analytical assumptions used in establishing the TMDL (e.g., derivation of numeric targets, modeling assumptions or effectiveness of proposed management actions).

3.4.1 Two Types of Margin of Safety

The MOS may be implicit, as in conservative assumptions used in calculating the loading capacity, Waste Load Allocation, and Load Allocations. The MOS may also be explicitly stated as an added, separate quantity in the TMDL calculation. In any case, assumptions should be stated and the basis behind the MOS documented. The MOS is not meant to compensate for a failure to consider known sources. **Table 21** presents six approaches for incorporating a MOS into TMDLs.

Table 23. Approaches for Incorporating a Margin of Safety into a TMDL

Type of Margin of Safety	*Available Approaches*
Explicit	1. Set numeric targets at more conservative levels than analytical results indicate. 2. Add a safety factor to pollutant loading estimates. 3. Do not allocate a portion of available loading capacity; reserve for MOS.
Implicit	1. Conservative assumptions in derivation of numeric targets. 2. Conservative assumptions when developing numeric model applications. 3. Conservative assumptions when analyzing prospective feasibility of practices and restoration activities.

The following factors may be considered in evaluating and deriving an appropriate MOS:

- ✓ *The analysis and techniques used in evaluating the components of the TMDL process and deriving an allocation scheme.*
- ✓ *Characterization and estimates of source loading (e.g., confidence regarding data limitation, analysis limitation or assumptions).*
- ✓ *Analysis of relationships between the source loading and instream impact.*

- ✓ *Prediction of response of receiving waters under various allocation scenarios (e.g., the predictive capability of the analysis, simplifications in the selected techniques).*

- ✓ *The implications of the MOS on the overall load reductions identified in terms of reduction feasibility and implementation time frames.*

A TMDL and associated MOS, which results in an overall allocation, represents the best estimate of how standards can be achieved. The selection of the MOS should clarify the implications for monitoring and implementation planning in refining the estimate if necessary (adaptive management). The TMDL process accommodates the ability to track and ultimately refine assumptions within the TMDL implementation-planning component.

3.4.2 Margins of Safety used in Nestucca Bay Watershed TMDLs

A MOS has been incorporated into the temperature, bacteria, and sedimentation assessment methodologies. The MOS for temperature in the Nestucca Bay Watershed has both explicit and implicit components, while those for the Bacteria and Sedimentation TMDLs are implicit.

For temperature, conservative estimates for groundwater inflow and wind speed were used in the stream temperature simulations. Specifically, unless measured, groundwater inflow was assumed to be zero. In addition, wind speed was also assumed to be at the lower end of recorded levels for the day of sampling. Recall that groundwater directly cools stream temperatures via mass transfer/mixing. Wind speed is a controlling factor for evaporation, a cooling heat energy process. Further, cooler microclimates and channel morphology changes associated with late seral conifer riparian zones were not accounted for in the simulation methodology.

Calculating a numeric MOS is not easily performed with the methodology presented in this document. In fact, the basis for the loading capacities and allocations is the definition of system potential conditions. It is illogical to presume that anything more than system potential riparian conditions are possible, feasible or reasonable.

To ensure that the temperature standard is met, the difference between the estimated system potential temperature (approximately 60°F) and the migration and rearing criterion will be allocated to an explicit margin of safety, rather than allocating to point or non-point sources.

The margin of safety for the bacteria TMDL is also addressed through conservative modeling. First, no salinity or temperature effects on bacteria decay rate in the Bay were considered. Increased salinity in the Bay would be expected to decrease the bacteria concentrations through higher decay rates. Secondly, the model accounted for dilution by summer storm baseflow under all conditions; winter storm baseflow would be higher and lead to greater dilution instream for a given runoff load. By underestimating the dilution effects of baseflow in winter storms the modeled concentrations will appear higher than actual.

The margin of safety for sedimentation has both implicit and explicit features and is based on the analysis of the watershed in terms of current vegetation, channel width, and sedimentation conditions. Sedimentation conditions in the upper watershed are currently meeting the standard, even as the system potential riparian vegetation and channel widths required for allocations are yet to be achieved. This suggests that sedimentation targets will be met long before system potential conditions of riparian vegetation and Near Stream Disturbance Zone have been achieved. The same implicit margin of safety applied to the Temperature TMDL, therefore, also applies to the sedimentation TMDL, and there is also an explicit margin of safety as the allocation is more conservative than the analytical results suggest is necessary to achieve the sedimentation target.

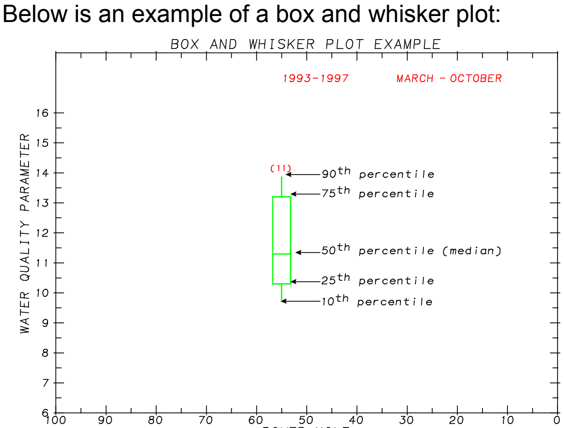
GLOSSARY OF TERMS

A

Abatement -- Reducing the degree or intensity of, or eliminating, pollution.
Acidic -- The condition of water or soil that contains a sufficient amount of acid substances to lower the pH below 7.0.
Acre -- A measure of area equal to 43,560 square feet (4,046.87 square meters). One square mile equals 640 acres.
Active Bank Erosion: Estimates from observation of the active stream bank erosion as a percentage (%) of the total reach length.
Adaptation -- Changes in an organism's structure or habits that allow it to adjust to its surroundings.
Adaptive management -- The process of implementing policy decisions as scientifically driven management experiments that test predictions and assumptions in management plans, and using the resulting information to improve the plans.
Alevin -- The developmental life stage of young salmonids and trout that are between the egg and fry stage. The alevin has not absorbed its yolk sac and has not emerged from the spawning gravels.
Allocation – Refers to the load allocation (nonpoint sources) and wasteload allocation (point sources). Specifically, an allocation is the division of the loading capacity between nonpoint and point sources of pollution.
Alluvial -- Deposited by running water.
Alluvium -- Sediment or loose material such as clay, silt, sand, gravel, and larger rocks deposited by moving water.
Anadromous -- Fish that hatch rear in fresh water, migrate to the ocean (salt water) to grow and mature, and migrate back to fresh water to spawn and reproduce.
Anthropogenic Sources of Pollution: Pollutant deliver to a water body that is directly related to humans or human activities.
Appropriate -- To authorize the use of a quantity of water to an individual requesting it.
Aquatic ecosystem -- Any body of water, such as a stream, lake or estuary, and all organisms and nonliving components within it, functioning as a natural system.
Aquatic habitat -- Habitat that occurs in free water.
At-risk fish stocks -- Stocks of anadromous salmon and trout that have been identified by professional societies, fish management agencies, and in the scientific literature as being in need of special management consideration because of low or declining populations.
Augmentation (of stream flow) -- Increasing steam flow under normal conditions, by releasing storage water from reservoirs.

B

Bank stability -- The properties of a stream bank that counteract erosion, for example, soil type, and vegetation cover.
Bank Building Event: A hydrologic event (usually high flow condition) that deposits sediments and organic debris in the flood plain and along stream banks.
Bankfull width -- The width of a river or stream channel between the highest banks on either side of a stream.
Bar (stream or river bar) -- An accumulation of alluvium(gravel or sand) caused by a decrease in water velocity.
Barrier -- A physical block or impediment to the movement or migration of fish, such as a waterfall (natural barrier) or a dam (man-made barrier).
Base flow -- The sustained portion of stream discharge that is drawn from natural storage sources, and not effected by human activity or regulation.
Bed load -- Sediment that moves near the streambed.
Bed Material -- The sediment mixture of which a streambed, lake, pond, reservoir, or estuary bottom is composed.
Beneficial Use: Legislatively approved use of water for the best interest of people, wildlife and aquatic species.
Blowdown -- Trees felled by high winds.
Boulder -- A large substrate particle that is larger that cobble, >256 mm in diameter.
Box and Whisker Plots: Water quality parameters and instream physical parameters are reviewed below using box and whisker plots for illustration. Below is an example of a box and whisker plot:



Example of box and whisker plot.

The box plots have river mile on the X-axis with the water quality parameter on the Y-axis. The box represents the data at the sampling sites, from upstream to downstream. Each box represents a summary of the data:

The upper corner of each box is the 75th percentile (75 percent of the data are below that concentration), and the lower corner is the 25th percentile (25 percent of the data are below that concentration). The upper and lower tails are the 90th and 10th percentiles, respectively. Points above and below the tails represent data higher and lower than the 90th and 10th percentiles. The dashed line in the box is the median concentration for that site (half of the data fall above and below that concentration).

Brackish -- Having a somewhat salty taste, especially from containing a mixture of seawater and fresh water.

Braided stream -- A complex tangle of converging and diverging stream channels (Anabranches) separated by sand bars or islands. Characteristic of flood plains where the amount of debris is large in relation to the discharge.

Buffer strip -- A barrier of permanent vegetation, either forest or other vegetation, between waterways and land uses such as agriculture or urban development, designed to intercept and filter out pollution before it reaches the surface water resource.

Buoyancy -- The tendency of a body to float or rise when submerged in a fluid.

C

Canopy -- A layer of foliage in a forest stand. This most often refers to the uppermost layer of foliage, but it can be used to describe lower layers in a multistoried stand. Leavs, branches and vegetation that are above ground and/or water that provide shade and cover for fish and wildlife.

Canopy closure -- The degree to which the canopy (forest layers above one's head) blocks sunlight or obscures the sky.

Canopy density -- The degree to which the canopy (forest layers above one's head) covers a unit area. Commonly measured with a concave or convex densiometer or estimated from aerial photography.

Carrying capacity -- The maximum number of organisms that a certain habitat can sustain over the long term.

Catchment -- (1) The catching or collecting of water, especially rainfall. (2) A reservoir or other basin for catching water. (3) The water thus caught.

Channel -- An area that contains continuously or periodically flowing water that is confined by banks and a stream bed.

Channelization -- The process of changing and straightening the natural path of a waterway.

Channel Complexity: Implied high pool frequency of pools and large woody debris (instream roughness).

Channel Simplification: The loss (absence) of pools and large woody debris that is important for creating and maintaining channel features such as: substrate, stream banks and pool:riffle ratios.

Check dam -- A small dam constructed in a gully or other small water course to decrease the streamflow velocity, minimize channel erosion, promote deposition of sediment and to divert water from a channel.

Classic old growth -- Forest stands with unusually old and large trees that also meet criteria for old-growth forest.

Clay -- Substrate particles that are smaller than silt and generally less than 0.004 mm in diameter.

Clean Water Act: Established in 1977, is an amendment to the 1972 Federal Water Pollution Control Act which set the groundwork for regulating pollutant discharges into U.S. waters. The Clean Water Act makes discharging pollutants from a point source to navigable waters illegal without a permit. The Clean Water Act amendments of 1977 were aimed at toxic pollutants. In 1987, the Clean Water Act was reauthorized and focused on sewage treatment plants, toxic pollutants, and authorized citizen suit provisions. The Clean Water Act allows the EPA to delegate administrative and enforcement aspects of the law to the state agencies. In states with this EPA given authority of Clean Water Act implementation, the EPA still plays the role of supervisor.

Clear-cut harvest -- A timber harvest method in which all trees are removed in a single entry from a designated are, with the exception of wildlife trees or snags, to create an even-aged stand.

Climax -- The culminating stage in plant succession for a given site where the vegetation has reached a highly stable condition.

Coarse woody debris (CWD) -- Portion of a tree that has fallen or been cut and left in the woods. Usually refers to pieces at least 20 inches in diameter.

Cobble -- Substrate particles that are smaller than boulders and are generally 64-256 mm in diameter. Can be further classified as small and large cobble. Commonly used by salmon in the construction of a redd.

Coefficient of determination (r-squared) -- The percentage of variation of the independent variable (y) that is attributed to its linear regression in the dependent variable (x).

Confluence -- (1) The act of flowing together; the meeting or junction of two or more streams; also, the place where these streams meet. (2) The stream or body of water formed by the junction of two or more streams; a combined flood.

Conifer -- A tree belonging to the order Gymnospermae, comprising a wide range of trees that are mostly evergreens. Conifers bear cones (hence, coniferous) and needle-shaped or scalelike leaves.

Contaminate -- To make impure or unclean by contact or mixture.

Correlation Coefficient (R): Used to determine the relationship between two data sets. R-values vary between –1 and 1, where "–1" represents a perfectly inverse correlation relationship and "1" represents a perfect correlation relationship. A "0" R-value indicates that no correlation exists:

$$R = \frac{1}{n} \cdot \sum_{i=1}^{n} (x_i - \mu_x) \cdot (y_i - \mu_y)$$

Cover -- Vegetation used by wildlife for protection from predators, or to mitigate weather conditions, or to reproduce. May also refer to the protection of the soil and the shading provided to herbs and forbs by vegetation.
Crown -- The upper part of a tree or other woody plant that carries the main system of branches and the foliage.
Crown cover -- The degree to which the crowns of trees are nearing general contact with one another.
Cubic feet per second (cfs) -- A unit used to measure water flow. One cfs is equal to 449 gallons per minute.
Culvert -- A buried pipe that allows streams, rivers, or runoff to pass under a road.
Cumulative Effects -- The combined environmental impacts that accrue over time and space from a series of similar or related individual actions, contaminants, or projects.

D

Dam -- A concrete or earthen barrier constructed across a river and designed to control water flow or create a reservoir.
Debris flow -- A rapid moving mass of rock fragments, soil, and mud, with more that half of the particles being larger that sand size.
Debris torrent -- Rapid movement of a large quantity of materials (wood and sediment) down a stream channel during storms or floods. This generally occurs in smaller streams and results in scouring of streambed.
Deciduous -- Trees and plants that shed their leaves at the end of the growing season.
Decommission: The removal of a road to improve hillslope drainage and stabilize slope hazards.
Depressed stock -- A stock of fish whose production is below expected levels based on available habitat and natural variations in survival levels, but above the level where permanent damage to the stock is likely.
Determinate Coefficient (R^2): The R^2 value represents "goodness of fit" for a linear regression. An R^2 value of "1" would indicate that all of the data variability is accounted for by the regression line. Natural systems exhibit a high degree of variability; R^2 values approaching "1" are uncommon. A value of "0" would indicate that none of the data variability is explained by the regression.
Dewatering -- Elimination of water from a lake, river, stream, reservoir, or containment.
Dike -- (1) (Engineering) An embankment to confine or control water, especially one built along the banks of a river to prevent overflow of lowlands; a levee. (2) A low wall that can act as a barrier to prevent a spill from spreading. (3) (Geology) A tabular body of igneous (formed by volcanic action) rock that cuts across the structure of adjacent rocks or cuts massive rocks.
Discharge -- Volume of water released from a dam or powerhouse at a given time, usually expressed in cubic feet per second.
Distribution (of a species) -- The spatial arrangement of a species within its range.
Disturbance -- A force that causes significant change in structure and/or composition through natural events such as fire, flood, wind, or earthquake, mortality caused by insect or disease outbreaks, or by human-caused events, e.g., the harvest of forest products.
Ditch -- A long narrow trench or furrow dug in the ground, as for irrigation, drainage, or a boundary line.
Diversion -- The transfer of water from a stream, lake, aquifer, or other source of water by a canal, pipe, well, or other conduit to another watercourse or to the land, as in the case of an irrigation system.
Draft -- Release of water from a storage reservoir.
Drainage -- An area (Basin) mostly bounded by ridges or other similar topographic features, encompassing part, most, or all of a watershed and enclosing some 5,000 acres.
Dredging -- Digging up and removing material from wetlands or waterways, usually to make them deeper or wider.
Drought -- Generally, the term is applied to periods of less than average or normal precipitation over a certain period of time sufficiently prolonged to cause a serious hydrological imbalance resulting in biological losses (impact flora and fauna ecosystems) and/or economic losses (affecting man). In a less precise sense, it can also signify nature's failure to fulfill the water wants and needs of man.
Duff layer -- The layer of loosely compacted debris underlying the litter layer on the forest floor.

E

Early seral stage forest -- Stage of forest development that includes seedling, sapling, and pole-sized trees.
Ecological Health -- The state of an ecosystem in which processes and functions are adequate to maintain diversity of biotic communities commensurate with those initially found there.
Ecological interaction -- The sum total of impacts of one species on another species, or on other members of the same species.
Ecologically significant -- Species, stands, and forests considered important to maintain the structure, function, and processes of particular ecosystems.
Ecosystem -- The biological community considered together with the land and water that make up its environment. Or a unit comprising interacting

organisms considered together with their environment.
Ecosystem diversity -- The variety of species and ecological processes that occur in different physical settings.
Ecosystem management -- A strategy or plan to manage ecosystems to provide for all associated organisms, as opposed to a strategy or plan for managing individual species.
Eddy -- A circular current of water, usually resulting from an obstruction.
Edge -- Where plant communities meet or where successional stages or vegetative conditions with plant communities come together.
Edge effect -- "The drastically modified environmental conditions along the margins, or ""edges,"" of forest patches surrounded partially or entirely by harvested lands."
Effective old-growth forest -- Old-growth forest largely unmodified by external environmental influences from nearby, younger forest stands.
Effluent -- (1) Something that flows out or forth, especially a stream flowing out of a body of water. (2) (Water Quality) Discharged wastewater such as the treated wastes from municipal sewage plants, brine wastewater from desalting operations, and coolant waters from a nuclear power plant.
Elevation -- Height in feet above sea level.
Embankment -- An artificial deposit of material that is raised above the natural surface of the land and used to contain, divert, or store water, support roads or railways, or for other similar purposes.
Embeddedness -- The degree to which dirt is mixed in with spawning gravel.
Embryo -- The early stages of development before an organism becomes self supporting.
Emergence -- The process during which fry leave their gravel spawning nest and enter the water column.
Emigration -- Referring to the movement of organisms out of an area. See immigration and migrating.
Empirical -- (Statistics) Based on experience or observations, as opposed to theory or conjecture.
Endangered species -- Any species of plant of animal defined through the Endangered Species Act as being in danger of extinction throughout all or a significant portion or its range, and published in the Federal Register.
Endangered Species Act (ESA) -- A 1973 Act of Congress that mandated that endangered and threatened species of fish, wildlife, and plants be protected and restored.
Endemic -- Native to or limited to a specific region.
Energy -- The ability to work (i.e., exert a force over distance). Energy is measured in calories, joules, KWH, BTUs, MW-hours, and average MWs.
Enhancement -- Emphasis on improving the value of particular aspects of water and related land resources.
Entrainment -- (Streams) The incidental trapping of fish and other aquatic organisms in the water, for example, used for cooling electrical power plants or in waters being diverted for irrigation or similar purposes.
Ephemeral Streams -- Streams which flow only in direct response to precipitation and whose channel is at all times above the water table.
Epilimnion -- The upper region of a thermally stratified lake, above the thermocline, and generally warm and well oxygenated.
Erosion -- Wearing away of rock or soil by the gradual detachment of soil or rock fragments by water, wind, ice, and other mechanical, chemical, or biological forces.
Escapement (Spawning) -- The portion of a fish population that survives sources of natural mortality and harvest to reach its natal spawning grounds.
ESU -- "Evolutionarily Significant Unit; a ""distinct"" population of Pacific salmon, and hence a species, under the Endangered Species Act."
Eutrophic -- Usually refers to a nutrient-enriched, highly productive body of water.
Eutrophication -- The process of enrichment of water bodies by nutrients.
Evaporation -- The physical process by which a liquid (or a solid) is transformed to the gaseous state. In Hydrology, evaporation is vaporization that takes place at a temperature below the boiling point.
Evolutionarily significant unit (ESU) -- "A definition of ""species"" used by NMFS in administering the Endangered Species Act. An ESU is a population (or groups of populations) that (1) is reproductively isolated from other conspecific population units, and (2) represents an important component in the evolutionary legacy of the species."
Exotic species -- Introduced species not native to the place where they are found (e.g., Atlantic salmon to Oregon or Washington).
Extinction -- The natural or human induced process by which a species, subspecies or population ceases to exist.

F

Fauna -- (1) A term used to describe the animal species of a specific region or time. (2) All animal life associated with a given habitat, country, area, or period.
Federal land managers -- This category includes the Bureau of Indian Affairs; the Bureau of Land Management; the National Park Service, all part of the U.S. Department of the Interior; and the Forest Service, U.S. Department of Agriculture.
Federal project operators and regulators -- Federal agencies that operate or regulate hydroelectric projects in the Columbia River Basin. They include the Bonneville Power Administration, the Bureau of Indian Affairs, the Bureau of Reclamation, the Corps of Engineers and the Federal Energy Regulatory Commission.

Fill -- (Geology) Any sediment deposited by any agent such as water so as to fill or partly fill a channel, valley, sink, or other depression.
Fine Sediment: Sand, silt and organic material that have a grain size of 6.4 mm or less.
Fingerling -- Refers to a young fish in its first or second year of life.
Fire Regime: The frequency, extent, intensity and severity of naturally occurring seasonal fires in an ecosystem.
Fish and wildlife agencies -- This category includes the Fish and Wildlife Service, U.S. Department of the Interior; the Idaho Department of Fish and Game; the Montana Department of Fish, Wildlife and Parks; the National Marine Fisheries Service, U.S. Department of Commerce; the Oregon Department of Fish and Wildlife; and the Washington Department of Fish and Wildlife.
Fishery -- The act, process, or occupation of attempting to catch fish, which may be retained or released.
Fitness -- The relative ability of an individual (or population) to survive and reproduce (pass on it's genes to the next generation) in a given environment.
Flash Flood -- A sudden flood of great volume, usually caused by a heavy rain. Also, a flood that crests in a short length of time and is often characterized by high velocity flows. It is often the result of heavy rainfall in a localized area.
FLIR Thermal Imagery: Forward looking infrared radiometer thermal imagery is a direct measure of the longer wavelengths emitted by all bodies. The process by which bodies emit longwave radiation is described by the Stefan-Boltzmann 4th Order Radiation Law. FLIR monitoring produces spatially continuous stream and stream bank temperature information. Accuracy is limited to 0.5^{o}C. FLIR thermal imagery often displays heating processes as they are occurring and is particularly good at displaying the thermal impacts of shade, channel morphology and groundwater mixing.
Flood Plain: Strips of land (of varying widths) bordering streams that become inundated with floodwaters. Land outside of the stream channel that is inside a perimeter of the maximum probable flood. A flood plain is built of sediment carried by the stream and deposited in the slower (slack waters) currents beyond the influence of the swiftest currents. Flood plains are termed “living” if it experiences inundation in times of high water. A “fossil” flood plain is one that is beyond the reach of the highest current floodwaters.
Floodplain (100-year) -- The area adjacent to a stream that is on average inundated once a century.
Flood Plain Roughness: Reflects the ability of the flood plain to dissipate erosive flow energy during high flow events that over-top streams banks and inundate the flood plain.
Flora -- (1) A term used to describe the entire plant species of a specified region or time. (2) The sum total of the kinds of plants in an area at one time. All plant life associated with a given habitat, country, area, or period. Bacteria are considered flora.
Flow -- The amount of water passing a particular point in a stream or river, usually expressed in cubic-feet per second (cfs).
Flow augmentation -- Increased flow from release of water from storage dams.
Fluvial -- Migrating between main rivers and tributaries. Of or pertaining to streams or rivers.
Forest canopy -- The cover of branches and foliage formed collectively by the crowns of adjacent trees and other woody growth.
Forest fragmentation -- The change in the forest landscape, from extensive and continuous forests of old-growth to mosaic of younger stand conditions.
Forest land -- Land that is now, or is capable of becoming, at least 10 percent stocked with forest trees and that has not been developed for nontimber use.
Forest landscape -- Land presently forested or formerly forested and not currently developed for nonforest use.
Fragmentation -- The process of reducing size and connectivity of stands that compose a forest.
Freshet -- A rapid temporary increase in stream flow due to heavy rains or snow melt.
Fry -- A stage of development in young salmon or trout. During this stage the fry is usually less than one year old, has absorbed its yolk sac, is rearing in the stream, and is between the alevin and parr stage of development.

G

Gabion -- A wire basket or cage that is filled with gravel and generally used to stabilize stream banks and improve degraded aquatic habitat.
Gaging station -- A particular site in a stream, lake, reservoir, etc., where hydrologic data are obtained.
Gallery -- "(1) A passageway within the body of a dam or abutment; hence the terms ""grouting gallery,"" ""inspection gallery,"" and ""drainage gallery."" (2) A long and rather narrow hall; hence the following terms for a power plant: ""valve gallery,"" ""transformer gallery,"" and ""busbar gallery."""
Gallons per minute (Gpm) -- A unit used to measure water flow.
Gap Analysis -- A method for determining spatial relationships between areas of high biological diversity and the boundaries of National Parks, National Wildlife Refuges (NWR), and other preserves.
Geographic information system (GIS) -- A computer system capable of storing and manipulating spatial (i.e., mapped) data.
Glide -- A section of stream that has little or no turbulence.
Gradient -- Vertical drop per unit of horizontal distance.

Grass/Forb -- An early forest successional stage where grasses and forbs are the dominant vegetation.
Gravel -- See cobble.
Gray Water -- Waste water from a household or small commercial establishment which specifically excludes water from a toilet, kitchen sink, dishwasher, or water used for washing diapers.
Groundwater -- Subsurface water and underground streams that can be collected with wells, or that flow naturally to the earth's surface though springs.

H

Habitat -- The local environment in which a organism normally lives and grows.
Habitat conservation plan (HCP) -- An agreement between the Secretary of the Interior and either a private entity or a state that specifies conservation measures that will be implemented in exchange for a permit that would allow taking of a threatened or endangered species.
Habitat diversity -- The number of different types of habitat within a given area.
Habitat fragmentation -- The breaking up of habitat into discrete islands through modification or conversion of habitat by management activities.
Hazardous materials -- Anything that poses a substantive present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed.
Headwater -- Referring to the source of a stream or river
Healthy stock -- A stock of fish experiencing production levels consistent with its available habitat and within the natural variations in survival for the stock.
Heavy metals -- Metallic elements with high atomic weights, e.g., mercury, chromium, cadmium, arsenic, and lead. They can damage living things at low concentrations and tend to accumulate in the food chain.
Herbaceous -- Vegetation or parts of plants with little or no woody tissue.
Homing -- The ability of a salmon or steelhead to correctly identify and return to their natal stream, following maturation at sea.
Hydraulic head -- The vertical distance between the surface of the reservoir and the surface of the river immediately downstream from the dam.
Hydric -- Wet.
Hydrologic unit -- A distinct watershed or river Basin defined by an 8-digit code.
Hydrology -- The scientific study of the water of the earth, its occurrence, circulation and distribution, its chemical and physical properties, and its interaction with its environment, including its relationship to living things.
Hypolimnion -- The lower zone of a thermally stratified lake, below the thermocline, and usually depleted in oxygen during summer stagnation.
Hyporheic zone -- The area under the stream channel and floodplain that contributes to the stream.

I

Impact -- A spatial or temporal change in the environment caused by human activity.
Impoundment -- A body of water formed behind a dam.
Impaired waterbody: Any waterbody of the United States that does not attain water quality standards (designated uses, numeric and narrative criteria and antidegradation requirements defined at 40 CFR 131), due to an individual pollutant, multiple pollutants, pollution, or an unknown cause of impairment.
In-situ -- In place. An in-situ environmental measurement is one that is taken in the filed, without removal of a sample to the laboratory.
Incidental take -- """Take"" of a threatened or endangered species that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity."
Incipient Lethal Limit: Temperature levels that cause breakdown of physiological regulation of vital bodily processes, namely: respiration and circulation.
Incised River -- A river which cuts its channel through the bed of the valley floor, as opposed to one flowing on a floodplain; its channel formed by the process of degradation.
Indicator (Organism) -- (Water Quality) An organism, species, or community that shows the presence of certain environmental conditions.
Indicator Species: Used for development of Oregon’s water temperature standard as sensitive species that if water temperatures are reduced to protective levels will protect all other aquatic species.
Indigenous -- Existing naturally in a region, state, country, etc.
Infiltration (soil) -- The movement of water through the soil surface into the soil.
Inflow -- Water that flows into a reservoir or forebay during a specified period.
Instantaneous flows -- The velocity of a volume of water.
Instantaneous Lethal Limit: Temperature levels where denaturing of bodily enzymes occurs.
Instantaneous Rate Of Mortality -- The natural logarithm (with sign changed) of the survival rate. The ratio of number of deaths per unit of time to population abundance during that time, if all deceased fish were to be immediately replaced so that population does not change. Also called; *coefficient of decrease.
Instream cover -- The layers of vegetation, like trees, shrubs, and overhanging vegetation, that are in the stream or immediately adjacent to the wetted channel.

Instream Roughness: Refers to the substrate (both organic and inorganic) that is found in the stream bank.
Instream flow work group -- An interagency group that simulated the effects of various fish flow regimes by using hydropower regulation computer models. The group was composed of technical experts and water resource managers from the fish and wildlife agencies, federal dam operators and regulators, and state water management agencies.
Instream flows -- See flows.
Intermittent Flow: Stream flow that ceases seasonally, at least once a year.
Intermittent stream -- Any nonpermanent flowing drainage feature having a definable channel and evidence of scour or deposition. This includes what are sometimes referred to as ephemeral streams if they meet these two criteria.
Irrigation diversion -- Generally, a ditch or channel that deflects water from a stream channel for irrigation purposes.
Isolation -- Absence of genetic crossing among populations because of distance or geographic barriers.

J

Jeopardy -- A finding made through consultation under the Endangered Species Act that the action of a federal agency is likely to jeopardize the continued existence of a threatened or endangered species.
Juvenile -- Fish from one year of age until sexual maturity.

K

Key watershed -- As defined by National Forest and Bureau of Land Management District fish biologists, a watershed containing (1) habitat for potentially threatened species or stocks of anadromous salmonids or other potentially threatened fish, or (2) greater than 6 square miles with high-quality water and fish habitat.
Kilowatt (KW) -- The electrical unit of power which equals 1,000 watts or 1.341 horsepower.
Kilowatt-hour (kWh) -- A basic unit of electrical energy that equals one kilowatt of power applied for one hour.

L

Landing -- Any place on or adjacent to the logging site where logs are assembled for further transport.
Landscape -- A heterogenous land area with interacting ecosystems that are repeated in similar form throughout.
Landscape diversity -- The size, shape, and connectivity of different ecosystems across a large area.
Landscape features -- The land and water form vegetation, and structures that compose the characteristic landscape.
Landslide -- A movement of earth down a steep slope.
Large woody debris -- Pieces of wood larger than 10 feet long and 6 inches in diameter, in a stream channel.
Langley: A unit of solar radiation equivalent to one gram calorie per square centimeter of irradiated surface.
Late seral stage forest -- Stage in forest development that includes mature and old-growth forest.
Leave strips -- Generally narrow bands of forest trees that are left along streams and rivers to buffer aquatic habitats from upslope forest management activities.
Legacy Condition: Past land management and historical disturbance affect the conditions that are currently observed in a stream channel. Present conditions may reflect chronic or episodic events that no longer occur.
Levee -- An embankment constructed to prevent a river from overflowing (flooding).
Limiting factor -- "A requirement such a food, cover or spawning gravel that is in shortest supply with respect to all resources necessary to sustain life and thus ""limits"" the size or retards production of a fish population."
Limnetic -- Referring to a standing water Ecosystem (ponds or lakes).
Limnology -- The study of lakes, ponds and streams.
Litter layer -- The loose, relatively undercomposed organic debris on the surface of the forest floor made up typically of leaves, bark, small branches, and other fallen material.
Littoral zone -- The region of land bordering a body of water.
Load Allocation (LA): A term referred to in the Clean Water Act that refers to the portion of the receiving waters loading capacity attributed to either to one of its existing or future non-point sources of pollution or to natural background sources.
Loading Capacity: A term referred to in the Clean Water Act that establishes an accepted rate of pollutant introduction to a waterbody that is directly related to water quality standard compliance.

M

Macroinvertebrate -- Invertebrates visible to the naked eye, such as insect larvae and crayfish.
Mainstem -- The principle channel of a drainage system into which other smaller streams or rivers flow.
Managed forest -- Any forestland that is treated with silvicultural practices and/or harvested.
Margin of safety – When establishing the loading capacity a portion may be reserved (i.e. not allocated to non-pointed or point sources of pollution) so that the allowed pollutant loading becomes conservative.

Mass movement -- The downslope movement of earth caused by gravity. Includes but is not limited to landslides, rock falls, debris avalanches, and creep. It does not however, include surface erosion by running water. It may be caused by natural erosional processes, or by natural disturbances (e.g., earthquakes or fire events) or human disturbances (e.g., mining or road construction).
Maximum Sustainable Yield -- The largest average catch or yield that can continuously be taken from a stock under existing environmental conditions. (For species with fluctuating recruitment, the maximum might be obtained by taking fewer fish in some years than in others.) Also called; maximum equilibrium catch ; maximum sustained yield; sustainable catch.
Mean (μ): Refers to the arithmetic mean:

$$\mu = \frac{1}{n} \cdot \sum x_i \ .$$

Mean Seal Level (MSL) -- A measure of elevation above sea level.
Measured Daily Solar Radiation Load: The rate of heat energy transfer originating from the sun as determined by using a Solar Pathfinder©.
Median: A value in the data in which half the values are above and half are below.
Megawatt-hour (MWh) -- A unit of electrical energy equal to one megawatt or power applied for one hour.
Megawatts (MW) -- A megawatt is one million watts or one thousand kilowatts, a measure of electrical power or generating capacity. A megawatt will typically serve about 1,000 people. The Dalles Dam produces an average of about 1,000 megawatts.
Mesic -- Moderately wet.
Migrant -- Life stage of anadromous and resident fish species which moves from one locale, habitat or system (river or ocean) to another.
Migrating -- Moving from one area of residence to another.
Minimum spanning tree -- A means of depicting nearest genetic neighbors. The tree is an undirected network of smallest genetic distances between genetic samples superimposed on multidimensional scaling graphs to reveal local distortion (pairs of points which look close together in one dimension, but which are far apart in other dimensions).
Mitigating measures -- Modifications of actions that (1) avoid impacts by not taking a certain action of parts of an action; (2) minimize impacts by limiting the degree or magnitude of the action and its implementation; (3) rectify impacts by repairing, rehabilitating, or restoring the affected environment; (4) reduce or eliminate impacts over time by preservation and maintenance operations during the life of the action; or (5) compensate for impacts by replacing or providing substitute resources or environments.
Mitigation -- The act of alleviating or making less severe. Generally refers to efforts to alleviate the impacts of hydropower development to the Columbia Basins salmon and steelhead runs.
Monitor -- To systematically and repeatedly measure conditions in order to track changes.
Morphology -- The structure, form and appearance of an organism.
Mortality -- The number of fish lost or the rate of loss.

N

Natal stream -- Stream of birth.
Native stock -- An indigenous stock of fish that has not been substantially affected by genetic interactions with non-native stocks or by other factors, and is still present in all or part of its original range.
Natural Mortality -- Deaths in a fish stock caused by predation, pollution, senility, etc., but not fishing.
Natural selection -- Differential survival and reproduction among members of a population or species in nature; due to variation in the possession of adaptive genetic traits.
Natural Sources of Pollution: Pollutant delivered to a water body that is directly related to processes that are inherent to normal processes unaffected by humans.
Naturally spawning populations -- Populations of fish that have completed their entire life cycle in the natural environment without human intervention.
Near Stream Disturbance Zone – The distance between shade producing near stream vegetation. This dimension is measured from digital orthophoto quads (DOQs) images at less than 1:5,000 scales. Where near stream vegetation is absent, the near stream boundary is used, as defined by armored streambanks or where near stream areas are unsuitable for vegetation growth due to external factors (i.e. roads, railroads, building, rock surfaces, etc.)
Non-point source pollution -- Pollution that does not originate from a clear or discrete source.

O

Off-channel area -- Any relatively calm portion of a stream outside of the main flow.
Old-growth associated species -- Plant and animal species that exhibit a strong association with old-growth forests.
Old-growth forest -- A forest stand usually at least 180-220 years old with moderate to high canopy closure; a multilayered, multispecies canopy dominated by large overstory trees; high incidence of large trees; some with broken tops and other indicators of old and decaying wood (decadence); numerous large snags; and heavy accumulations of wood, including large logs on the ground.
On-site -- Usually refers to projects or activities designed to address harm caused to fish and wildlife at the site of the harm.

Outfall -- The mouth or outlet of a river, stream, lake, drain or sewer.
Outmigration -- The migration of fish down the river system to the ocean.
Overstory -- Trees that provide the uppermost layer of foliage in a forest with more that one roughly horizontal layer of foliage.
Oxbow -- An abandoned meander in a river or stream, caused by neck cutoff. Used to describe the U-shaped bend in the river or the land within such a bend of a river.

P

Parameter -- "A ""constant"" or numerical description of some property of a population (which may be real or imaginary). Cf. statistic."
Pathogens -- Any agent that causes disease, such as a virus, protozoan, bacterium or fungus.
Peak flow -- Refers to a specific period of time when the discharge of a stream or river is at its highest point.
Perennial Flow: Stream flow that persists throughout all seasons, yearlong.
Perennial streams -- Streams which flow continuously.
Physiological -- Pertaining to the functions and vital processes of living organisms and the organs within them.
Phytoplankton -- Microscopic floating plants, mainly algae, that live suspended in bodies of water and that drift about because they cannot move by themselves or because they are too small or too weak to swim effectively against a current.
Plankton -- Minute floating forms of microscopic plants and animals in water which cannot get about to any extent under their own power. They form the important beginnings of food chains for larger animals.
Plume -- The area of the Pacific Ocean that is influenced by discharge from the Columbia River, up to 500 miles beyond the mouth of the river.
Pluvial -- Of rain, formed by the action of rain, for example a body of water.
Point Source (PS) -- (1) A stationary or clearly identifiable source of a large individual water or air pollution emission, generally of an industrial nature. (2) Any discernible, confined, or discrete conveyance from which pollutants are or may be discharged, including (but not limited to) pipes, ditches, channels, tunnels, conduits, wells, containers, rolling stock, concentrated animal feeding operations, or vessels. Point source is also legally and more precisely defined in federal regulations. Contrast with Non-point Source (NPS) Pollution.
Point Source (PS) Pollution -- Pollutants discharged from any identifiable point, including pipes, ditches, channels, sewers, tunnels, and containers of various types. See Non-Point Source (NPS) Pollution.
Pollutant -- (1) Something that pollutes, especially a waste material that contaminates air, soil, or water. (2) Any solute or cause of change in physical properties that renders water unfit for a given use.
Pool -- A reach of stream that is characterized by deep low velocity water and a smooth surface.
Pool/riffle ratio -- The ratio of surface area or length of pools to the surface area or length of riffles in a given stream reach; frequently expressed as the relative percentage of each category. Used to describe fish habitat rearing quality.
Population -- A group of individuals of the same species occupying a defined locality during a given time that exhibit reproductive continuity from generation to generation.
Population density -- Number of individuals of a species per unit of area.
Population dynamics -- The aggregate of changes that occur during the life of a population.
Population viability -- Probability that a population will persist for a specified period across its range despite normal fluctuations in population and environmental conditions.
Potential Daily Solar Radiation Load: Based on the Julian calendar, for any particular location on earth, there exists a potential rate of heat energy transfer originating from the sun.
Primary Channel Length: Length of the primary channel located in the survey reach. Units are meters.
Primary Channel Width: Bankfull width of a stream reported in meters.
Productivity -- A measure of the capacity of a biological system. Also used as a measure of the efficiency with which a biological system converts energy into growth and production.

R

Range (of a species) -- The area or region over which an organism occurs.
Rate: A measurable occurrence over a specified time interval.
Reach -- A section of stream between two defined points.
Reach Averaged: An average that is based on the occurrence of a property weighted by the occurrence frequency over perennial stream length.
Rearing habitat -- Areas in rivers or streams where juvenile salmon and trout find food and shelter to live and grow.
Recovery -- Action that is necessary to reduce or resolve the threats that caused a species to be listed as threatened or endangered.
Recovery/restoration -- The reestablishment of a threatened or endangered species to a self-sustaining level in its natural ecosystem (i.e., to the point where the protective measures of the Endangered Species Act are no longer necessary).
Redd -- A nest of fish eggs covered with gravel.
Redd Counts -- A spawning female salmon prepares a series of nests, called a redd, in suitable

areas of streams by turning onto her side and beating her caudal fin up and down. Primary factors affecting suitability of spawning habitat include the size of rocks in the substrate and stream flow (high enough to provide adequate aeration for the eggs; low enough to prevent erosion of the nest). A completed redd is a shallow depression in the stream bottom with a rim extending to the downstream end. During spawning, the female continuously digs upstream, covering previously deposited eggs with gravel. Most redds occur in predictable areas and are easily identified by an experienced observer by their shape, size, and color (lighter than surrounding areas because silt has been cleaned away). Redd counts are conducted annually in certain heavy use areas of streams called index streams, which are usually surveyed repeatedly through the spawning season. Colored flags are sometimes placed on nearby trees to identify redds so that they will not be counted repetitively. Annual redd counts are used to compare the relative magnitude of spawning activity between years.
Rehabilitation -- Short-term management techniques that restore fish stocks decimated or destroyed by natural or man-made events.
Reservoir -- A body of water collected and stored in an artificial lake behind a dam.
Restoration -- The renewing or repairing of a natural system so that its functions and qualities are comparable to its original, unaltered state.
Riffle -- A reach of stream that is characterized by shallow, fast moving water broken by the presence of rocks and boulders.
Riparian area -- An area of land and vegetation adjacent to a stream that has a direct effect on the stream. This includes woodlands, vegetation, and floodplains.
Riparian habitat -- The aquatic and terrestrial habitat adjacent to streams, lakes, estuaries, or other waterways.
Riparian vegetation -- The plants that grow rooted in the water table of a nearby wetland area such as a river, stream, reservoir, pond, spring, marsh, bog, meadow, etc.
Riprap -- Usually refers to rocks or concrete structures used to stabilize stream or river banks from erosion.
River Channels -- Natural or artificial open conduits which continuously or periodically contain moving water, or which forms a connection between two bodies of water.
River Kilometer (RKm) -- Distance, in kilometers, from the mouth of the indicated river. Usually used to identify the location of a physical feature, such as a confluence, dam, or waterfall.
River miles (RM) -- Miles from the mouth of a river to a specific destination or, for upstream tributaries, from the confluence with the main river to a specific destination.
River Reach -- Any defined length of a river.
River Stage -- The elevation of the water surface at a specified station above some arbitrary zero datum (level).
Riverine -- Relating to, formed by, or resembling a river including tributaries, streams, brooks, etc.
Riverine habitat -- The aquatic habitat within streams and rivers.
Rock -- See cobble.
Rootwad -- The mass of roots associated with a tree adjacent or in a stream that provides refuge and nutrients for fish and other aquatic life.
Run (in stream or river) -- A reach of stream characterized by fast flowing low turbulence water.
Runoff -- Water that flows over the ground and reaches a stream as a result of rainfall or snowmelt.

S

Salmonid -- Fish of the family Salmonidae, that includes salmon and steelhead.
Sand -- Small substrate particles, generally referring to particles less than 2 mm in diameter. Sand is larger than silt and smaller than cobble or rubble.
Scour -- The erosive action of running water in streams, which excavates and carries away material from the bed and banks. Scour may occur in both earth and solid rock material.
Secchi Depth -- A relatively crude measurement of the turbidity (cloudiness) of surface water. The depth at which a Secchi Disc (Disk), which is about 10-12 inches in diameter and on which is a black and white pattern, can no longer be seen.
Secchi Disc -- A circular plate, generally about 10-12 inches (25.4-30.5 cm) in diameter, used to measure the transparency or clarity of water by noting the greatest depth at which it can be visually detected. Its primary use is in the study of lakes.
Sediment -- The organic material that is transported and deposited by wind and water.
Sedimentation -- Deposition of sediment.
Self-sustaining population -- "A population that perpetuates itself, in the absence of (or despite) human intervention, without chronic decline, in its natural ecosystem. A self-sustaining population maintains itself at a level above the threshold for listing under the Endangered Species Act. In this document, the terms ""self- sustaining"" and ""viable"" are used interchangeably."
Sensitive species -- Those species that (1) have appeared in the Federal Register as proposed for classification and are under consideration for official listing as endangered or threatened species or (2) are on an official state list or (3) are recognized by the U.S. Forest Service or other management agency as needing special management to prevent their being placed on federal or state lists.
Seral Stage: Refers to the age and type of vegetation that develops from the stage of bare ground to the climax stage.
Seral Stage - Early: The period from bare ground to initial crown closure (grass, shrubs, forbs, brush).

Seral Stage - Mid: The period of a forest stand from crown closure to marketability (young stand of trees from 25 to 100 years of age, includes hardwood stands).
Seral Stage - Late: The period of a forest stand from marketability to the culmination of the mean annual increment (mature stands of conifers and old-growth).
Shear Stress: The erosive energy associated with flowing water.
Silt -- Substrate particles smaller than sand and larger than clay.
Siltation -- The deposition or accumulation of fine soil particles.
Silviculture -- The science and practice of controlling the establishment, composition, and growth of the vegetation of forest stands.
Sinuosity -- The amount of bending, winding and curving in a stream or river.
Site Potential: Physical and biological conditions that are at maximum potential, taking into account local natural environmental constraints and conditions.
Slope -- The side of a hill or mountain, the inclined face of a cutting, canal or embankment or an inclination from the horizontal.
Slope stability -- The resistance of a natural or artificial slope or other inclined surface to failure by landsliding (mass movement).
Slough -- A shallow backwater inlet that is commonly exposed at low tide.
Sluiceway -- An open channel inside a dam designed to collect and divert ice and trash in the river (e.g., logs) before they get into the turbine units and cause damage. (On several of the Columbia River dams, ice and trash sluiceways are being used as, or converted into, fish bypass systems.)
Smolt -- Refers to the salmonid or trout developmental life stage between parr and adult, when the juvenile is at least one year old and has adapted to the marine environment.
Snag -- Any standing dead, partially dead, or defective (cull) tree at least 10 inches in diameter at breast height and at least 6 feet tall.
Soft Water -- Water that contains low concentrations of metal ions such as calcium and magnesium. This type of water does not precipitate soaps and detergents. Compare to Hard Water.
Soil Compaction: Activities/processes, vibration, loading, pressure, that decrease the porosity of soils by increasing the soil bulk density

$$\left(\frac{\text{Weight}}{\text{UnitVolume}}\right).$$

Spawn -- The act of reproduction of fishes. The mixing of the sperm of a male fish and the eggs of a female fish.
Spawning surveys -- Spawning surveys utilize counts of redds and fish carcasses to estimate spawner escapement and identify habitat being used by spawning fish. Annual surveys can be used to compare the relative magnitude of spawning activity between years.
Species -- A group of closely related individuals that can interbreed and produce fertile offspring.
Spill -- Releasing water through the spillway rather than through the turbine units.
Spillway -- "The channel or passageway around or over a dam through which excess water is released or ""spilled"" past the dam without going through the turbines. A spillway is a safety valve for a dam and, as such, must be capable of discharging major floods without damaging the dam, while maintaining the reservoir level below some predetermined maximum level."
Standard Deviation (σ): The measure of how widely values are dispersed from the mean (μ).

$$\sigma = \sqrt{\frac{n \cdot \sum x^2 - \left(\sum x\right)^2}{n \cdot (n-1)}}.$$

Standardization -- The procedure of maintaining methods and equipment as constant as possible.
State water management agencies -- State government agencies that regulate water resources. They include the Idaho Department of Water Resources; the Montana Department of Natural Resources and Conservation; the Oregon Water Resources Department; and the Washington Department of Ecology.
Steelhead -- The anadromous form of the species Oncorhynchus mykiss. Anadromous fish spend their early life history in fresh water, then migrate to salt water, where they may spend up to several years before returning to fresh water to spawn. Rainbow trout is the nonanadromous form of Oncorhynchus mykiss.
Stock -- A specific population of fish spawning in a particular stream during a particular season.
Stock status -- The current condition of a stock, which may be based on escapement, run size, survival, or fitness level.
Stone -- Rock fragments larger than 25.4 cm (10 inches) but less than 60.4 cm (24 inches).
Stream -- A general term for a body of flowing water; natural water course containing water at least part of the year. In Hydrology, the term is generally applied to the water flowing in a natural channel as distinct from a canal. More generally, as in the term Stream Gaging, it is applied to the water flowing in any channel, natural or artificial.
Stream Bank Erosion: Detachment, entrainment, and transport of stream bank soil particles via fluvial processes (i.e. local water velocity and shear stress).
Stream Bank Failure: Gravity related collapse of the stream bank by mass movement.
Stream Bank Retreat: The net loss of stream bank material and a corresponding widening of the stream channel that accompanies stream bank erosion and/or stream bank failure.
Stream Bank Stability: Measure of detachment, entrainment, and transport of stream bank soil particles by local water velocity and shear stress.

Stream Channel -- The bed where a natural stream of water runs or may run; the long narrow depression shaped by the concentrated flow of a stream and covered continuously or periodically by water.
Stream gradient -- A general slope or rate of change in vertical elevation per unit of horizontal distance of the water surface of a flowing stream.
Stream morphology -- The form and structure of streams.
Stream order -- A hydrologic system of stream classification. Each small unbranched tributary is a first order stream. Two first order streams join to make a second order stream. A third order stream has only first and second order tributaries, and so forth.
Stream reach -- An individual first order stream or a segment of another stream that has beginning and ending points at a stream confluence. Reach end points are normally designated where a tributary confluence changes the channel character or order.
Stream type -- Stream-type chinook salmon populations emigrate to the ocean as one- and two-year-old smolts. As juveniles, stream-type fish exhibit behavioral and morphological characteristics consistent with establishing and maintaining territories in freshwater systems (aggressive behavior, and larger, more colorful, fins). Little is known about the oceanic migration patterns of stream-type chinook salmon.
Streambank erosion -- The wearing away of streambanks by flowing water.
Streambank stabilization -- Natural geological tendency for a stream to mold its banks to conform with the channel of least resistance to flow. Also the lining of streambanks with riprap, matting, etc., to control erosion.
Streambed -- The channel through which a natural stream of water runs or used to run, as a dry streambed.
Streamflow -- The rate at which water passes a given point in a stream or river, usually expressed in cubic feet per second (cfs).
Sub-Lethal Limit: Temperature levels that cause decreased or lack of metabolic energy for feeding, growth or reproductive behavior, encourage increased exposure to pathogens, decreased food supplies, and increased competition from warm water tolerant species.
Subbasin -- Major tributaries to and segments of the Columbia and Snake rivers.
Subdrainage -- A land area (basin) bounded by ridges or similar topographic features, encompassing only part of a watershed, and enclosing on the order of 5,000 acres; smaller than, and part of, a watershed.
Substrate -- The composition of a streambed, including either mineral or organic materials.
Succession -- A series of dynamic changes by which one group of organisms succeeds another through stages leading to potential natural community or climax.
Surface erosion -- The detachment and transport of soil particles by wind, water, or gravity. Or a groups of processes whereby soil materials are removed by running water, waves and currents, moving ice, or wind.
Surface Water -- All waters whose surface is naturally exposed to the atmosphere, for example, rivers, lakes, reservoirs, ponds, streams, impoundments, seas, estuaries, etc., and all springs, wells, or other collectors directly influenced by surface water.
Surrogate Measures (Load Allocation): A term referenced in the Clean Water Act that refers to "other appropriate measures" that can be allocated to meet an established and accepted pollutant loading capacity.
Survival Rate -- Number of fish alive after a specified time interval, divided by the initial number. Usually on a yearly basis.
Suspended sediment -- Sediment suspended in a fluid by the upward components of turbulent currents, moving ice, or wind.

T

Take -- Under the Endangered Species Act, take means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect an animal, or to attempt to engage in any such conduct.
Temperature Limited Waterbody: Refers to a stream or river that has been placed on the §303(d) list for violating water quality numeric criteria based on measured data.
Tempertaure Statistic: The maximum seasonal seven (7) day moving average of the daily maximum stream tempertaures.
Thalweg -- (1) The lowest thread along the axial part of a valley or stream channel. (2) A subsurface, ground-water stream percolating beneath and in the general direction of a surface stream course or valley. (3) The middle, chief, or deepest part of a navigable channel or waterway.
Thermocline -- That layer of water in a lake in which the temperature changes 10C with each meter increase in depth.
Threatened Species: Species that are likely to become endangered through their normal range within the foreseeable future.
Threatened waterbody: Any waterbody of the United States that currently attains water quality standards (designated uses, numeric and narrative criteria and antidegradation requirements defined at 40 CFR 131), but for which existing and readily available data and information on adverse declining trends or anticipated load measures indicate that water quality standards will likely be exceeded by the time the next list is required to be submitted to EPA.
Total Maximum Daily Load (TMDL): TMDLs are written plans and analyses established to ensure

that the waterbody will attain and maintain water quality standards. The OAR definition is “The sum of the individual WLAs for point sources and LAs for non-point sources and background. If a receiving water has only one point source discharger, the TMDL is the sum of that point source WLA plus the LAs for any non-point sources of pollution and natural background sources, tributaries, or adjacent segments. TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure. If Best Management Practices (BMPs) or other non-point source pollution controls make more stringent load allocations practicable, then wasteload allocations can be made less stringent. Thus, the TMDL process provides for non-point source control tradeoffs” (340-04l-006(21))
Torrent -- (1) A turbulent, swift-flowing stream. (2) A heavy downpour; a deluge.
Toxic Materials -- Any liquid, gaseous, or solid substance or substances in a concentration which, when applied to, discharged to, or deposited in water or another medium may exert a poisonous effect detrimental to people or to the propagation, cultivation, or conservation of animals, or other aquatic life.
Travel corridors -- Paths animals use during their migrations.
Trend -- (1) A statistical term referring to the direction or rate of increase or decrease in magnitude of the individual members of a time series of data when random fluctuations of individual members are disregarded. (2) A unidirectional increasing or decreasing change in the average value of a variable.
Tributary -- A stream that flows into another stream, river, or lake.
Turbidity -- "The term ""turbid"" is applied to waters containing suspended matter that interferes with the passage of light through the water or in which visual depth is restricted."

U

Urban runoff -- Storm water from city streets and gutters that usually contains a great deal of litter and organic and bacterial wastes into the sewer systems and receiving waters.

V

Velocity -- In this concept, the speed of water flowing in a watercourse, such as a river.
Viscosity -- A measure of the resistance of a fluid to flow. For liquids, viscosity increases with decreasing temperature.

W

Warmwater fish -- A broad classification on non-salmonid fish that generally have at least one spiny ray, have pelvic and pectoral fins located behind the gills, and are usually suited for water that consistently exceeds 70 degrees F.
Wash -- (1) To carry, erode, remove, or destroy by the action of moving water. To be carried away, removed, or drawn by the action of water. Removal or erosion of soil by the action of moving water. (2) A deposit of recently eroded debris. (3) Low or marshy ground washed by tidal waters. A stretch of shallow water. (4) (Western United States) The dry bed of a stream, articularly a watercourse associated with an alluvial fan, stream, or river channel. Washes are often associated with arid environments and are characterized by large, high energy discharges with high bed-material load transport. Washes are often intermittent and their beds sparsely vegetated. (5) Turbulence in air or water caused by the motion or action of an oar, propeller, jet, or airfoil.
Washout -- (1) Erosion of a relatively soft surface, such as a roadbed, by a sudden gush of water, as from a downpour or floods. (2) A channel produced by such erosion.
Wasteload Allocation (WLA): A term referenced in the Clean Water Act that refers to point source rates of pollutant delivery that can be specifically linked to an established and accepted pollutant loading capacity.
Wasteway -- An open ditch or canal that discharges excess irrigation water or power plant effluent into the river channel.
Water Conservation -- The physical control, protection, management, and use of water resources in such a way as to maintain crop, grazing, and forest lands, vegetative cover, wildlife, and wildlife habitat for maximum sustained benefits to people, agriculture, industry, commerce, and other segments of the national economy.
Water Pollution -- Generally, the presence in water of enough harmful or objectionable material to damage the water's quality.
Water quality -- A term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose.
Water Quality Limited: Can mean one of the following categories: (a) A receiving stream which does not meet in-stream water quality standards during the entire year or defined season even after the implementation of standard technology; (b) A receiving stream which achieves and is expected to continue to achieve in-stream water quality standard but utilizes higher than standard technology to protect beneficial uses; (c) A receiving stream for which there is insufficient information to determine if water quality standards are being met with higher than standard treatment technology or where through professional judgment the receiving stream would not be expected to meet water quality standards during the entire year or defined season without higher than standard technology. (OAR 340-04l-006(30))
Water Resources -- The supply of groundwater and surface water in a given area.

Water rights -- "Priority claims to water. In western States, water rights are based on the principle ""first in time, first in right,"" meaning older claims take precedence over newer ones."
Water yield -- The quantity of water derived from a unit area of watershed.
Waterfall -- A sudden, nearly vertical drop in a stream, as it flows over rock.
Watershed restoration -- Improving current conditions of watersheds to restore degraded fish habitat and provide long-term protection to aquatic and riparian resources.
Watt -- A measure of the rate at which energy is produced, exchanged, or consumed.
Wet meadow -- Areas where grass predominate. Normally waterlogged within a few inches of the ground surface.
Width:Depth Ratio: The width of bankfull divided by the average depth in the survey reach of a stream.
Wildfall -- Trees or parts of trees felled by high winds.
Windthrow -- A tree or trees uprooted or felled by the wind.
Woody debris -- Referring to wood in streams.

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Acronym List

AWQM	Agriculture Water Quality Management (program or Act)
AWQMA	Agricultural Water Quality Management Area (plan)
BMP	Best Management Practice
CAFO	Confined Animal Feeding Operations
CCMP	Comprehensive Conservation Management Plan
CWA	Clean Water Act
DLCD	Department of Land Conservation and Development (state)
DMR	Discharge Monitoring Report
DO	Dissolved Oxygen
DOGAMI	Department of Geology and Mineral Industries (state)
DSL	Division of State Lands (state)
EIS	Environmental Impact Statement (federal)
LAC	Local Advisory Committee
LWD	Large Woody Debris
MAO	Mutual Agreement and Order
MOU	Memorandum of Understanding
NMFS	National Marine Fisheries Service (federal)
NOAA	National Oceanic and Atmospheric Administration (federal)
NPS	Nonpoint Source
NRCS	Natural Resource Conservation Service (federal)
ODOT	Oregon Department of Transportation (state)
OEDD	Oregon Economic Development Department (state)
OPSW	Oregon Plan for Salmon and Watersheds (state plan)
OSMB	Oregon State Marine Board (state)
OSP	Oregon State Police
OWEB	Oregon Watershed Enhancement Board
PLFN	Private Lands Forest Network
RHCAs	Riparian Habitat Conservation Areas
RMO	Riparian Management Objective
SWCD	Soil and Water Conservation District
TBNEP	Tillamook Bay National Estuary Project
TCPP	Tillamook County Performance Partnerships
TCWRC	Tillamook County Watershed resource Center
TCSWCD	Tillamook County Soil & Water Conservation District
TCCA	Tillamook County Creamery Association
USACOE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
WPCF	Water Pollution Control Facility (permit)
WQL	Water Quality Limited
WQS	Water Quality Standards

APPENDICES

APPENDIX A : TEMPERATURE TECHNICAL ANALYSIS

Stream Heating Processes – Background Information

Riparian vegetation, stream morphology, hydrology, climate, and geographic location influence stream temperature. While climate and geographic location are outside of human control, riparian condition, channel morphology and hydrology are affected by land use activities. Specifically, the elevated summertime stream temperatures attributed to anthropogenic sources in the Nestucca Bay Watershed result from the following:

- ✓ Riparian vegetation disturbance reduces stream surface shading via decreased riparian vegetation height, width and/or density, thus increasing the amount of solar radiation reaching the stream surface; and
- ✓ Localized near-stream disturbance zone (NSDZ) widening decreases potential shading effectiveness of shade-producing near-stream vegetation.
- ✓ Localized channel widening (increased wetted width to depth ratios) increases the stream surface area exposed to energy processes, namely solar radiation; and
- ✓ Point source discharges.

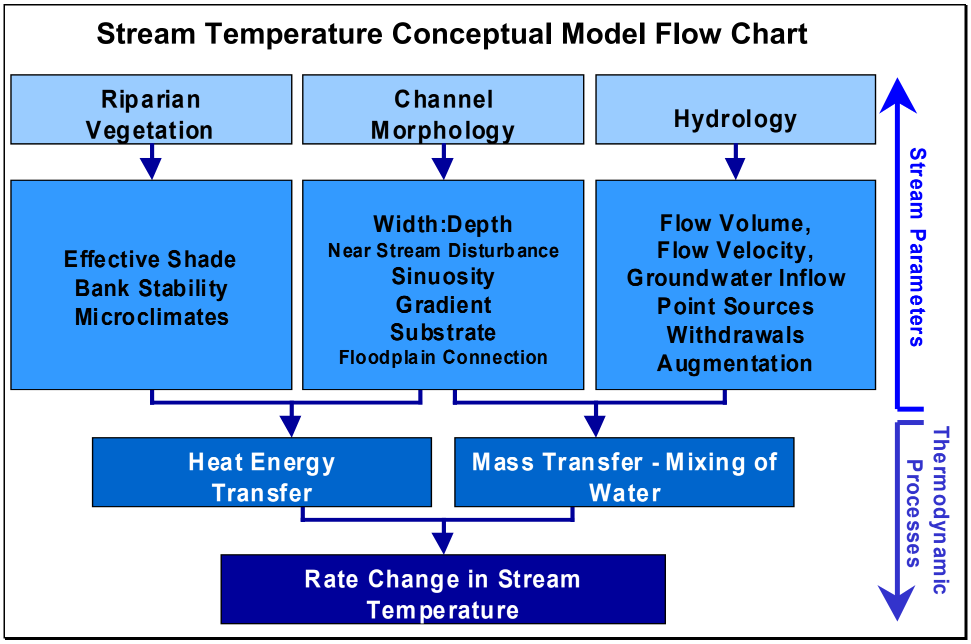
Human activities that contribute to degraded water quality conditions in the Nestucca Bay Watershed include timber harvest, agriculture activities, road location, and rural/urban residential development related riparian disturbances.

Direct analysis of temperature data and mathematical modeling were used to assess current and potential conditions in the Nestucca Bay Watershed. Temperature data was collected in two years. The data was continuous (hourly data) over the course of the summer (critical) period and was geographically distributed over the entire basin. Each of the five rivers was characterized for temperature, vegetational structure, channel morphology, hydrology, and geographical shading geometry. Each of these classes of features was measured directly in the field, and all except temperature were measured further with automated means through GIS. The resulting descriptive dataset described the basin in great detail and generally matched the field measurements. These data were used to model temperature accumulation rates in each of the five rivers. The model was calibrated with field measurements and provided a rich view of the watershed as a whole, and of stream heating in particular. Once developed, the model allowed the comparison of the current condition with respect to riparian vegetation, channel morphology, and hydrology, to potential conditions of the same features given management of streams and riparian areas for providing shade.

This appendix describes the current conditions of the watershed in the context each physical or biological characteristic and the importance to heating of surface waters. The information is both general, in discussing heating processes, and specific, in discussing the analysis of data collected within the Tillamook Bay Watershed. Wherever possible, data collected from the basin has been used in analysis and modeling.

Overview of Stream Heating Processes

At any particular instant of time, a defined stream reach is capable of sustaining a particular water column temperature. Stream temperature change that results within a defined reach is explained rather simply. The temperature of a parcel of water traversing a stream/river reach enters the reach with a given temperature. If that temperature is greater than the energy balance is capable of supporting, the temperature will decrease. If that temperature is less than energy balance is capable of supporting, the temperature will increase. Stream temperature change within a defined reach, is induced by the energy balance between the parcel of water and the surrounding environment and transport of the parcel through the reach. The general relationships between stream parameters, thermodynamic processes (heat and mass transfer) and stream temperature change is outlined in the model flow chart.



It takes time for the water parcel to traverse the longitudinal distance of the defined reach, during which the energy processes drive stream temperature change. At any particular instant of time, water that enters the upstream portion of the reach is never exactly the temperature that is supported by the defined reach. And, as the water is transferred downstream, heat energy and hydraulic process that are variable with time and space interact with the water parcel and induce water temperature change. Further, heat energy is stored within this parcel of water and temperatures may be a result of the heat energy processes many miles upstream. This is commonly referred to as a cumulative temperature effect, where conditions at a site contribute to heating of an already heated parcel of stream water. The described modeling scenario is a simplification; however, understanding the basic processes in which stream temperatures change occurs over the course of a defined reach and period of time is essential.

Stream Parameters that Control Temperature Change

Riparian vegetation, stream morphology, hydrology, point source discharge, climate, and geographic location influence stream temperature. While climate and geographic location are outside of human control, riparian condition, channel morphology, hydrology and point source discharges are affected by human activities.

Specifically, the elevated summertime stream temperatures attributed to anthropogenic sources result from the following:

- ✓ ***Riparian vegetation disturbance reduces stream surface shading via decreased riparian vegetation height, width and/or density, thus increasing the amount of solar radiation reaching the stream surface;***
- ✓ ***Localized channel widening (increased wetted width to depth ratios) increases the stream surface area exposed to energy processes, namely solar radiation;***
- ✓ ***Localized near-stream disturbance zone* (NSDZ) widening decreases potential shading effectiveness of shade-producing near-stream vegetation; and***
- ✓ ***Point source discharge that directly increases instream temperatures via mass transfer.***

* The term "near-stream disturbance zone" is defined for the purposes of the TMDL as a GIS estimate of bankfull width.

Stream Surface Shade - Defined

Stream surface shade is a function of several landscape and stream geometric relationships. Some of the factors that influence shade are listed in **Table 24**. Geometric relationships important for understanding the mechanics of shade are displayed in **Figure 35**. In the Northern Hemisphere, the earth tilts on its axis toward the sun during summertime months allowing longer day length and higher solar altitude, both of which are functions of solar declination (i.e. a measure of the earth's tilt toward the sun). Geographic position (i.e. latitude and longitude) fixes the stream to a position on the globe, while aspect provides the stream/riparian orientation. Riparian height, width and density describe the physical barriers between the stream and sun that can attenuate and scatter incoming solar radiation (i.e. produce shade). The solar position has a vertical component (i.e. altitude) and a horizontal component (i.e. azimuth) that are both functions of time/date (i.e. solar declination) and the earth's rotation (i.e. hour angle). While the interaction of these shade variables may seem complex, the math that describes them is relatively straightforward geometry.

Table 24. Factors that Influence Stream Surface Shade

Description	*Measure*
Season/Time	Date/Time
Stream Characteristics	Aspect, Near-Stream Disturbance Zone Width
Geographic Position	Latitude, Longitude
Vegetative Characteristics	Buffer Height, Buffer Width, Buffer Density
Solar Position	Solar Altitude, Solar Azimuth

Solar Altitude and **Solar Azimuth** are two basic measurements of the sun's position. When a stream's orientation, geographic position, riparian condition and solar position are known, shading characteristics can be simulated.

Solar Altitude measures the vertical component of the sun's position
Solar Azimuth measures the horizontal component of the sun's position

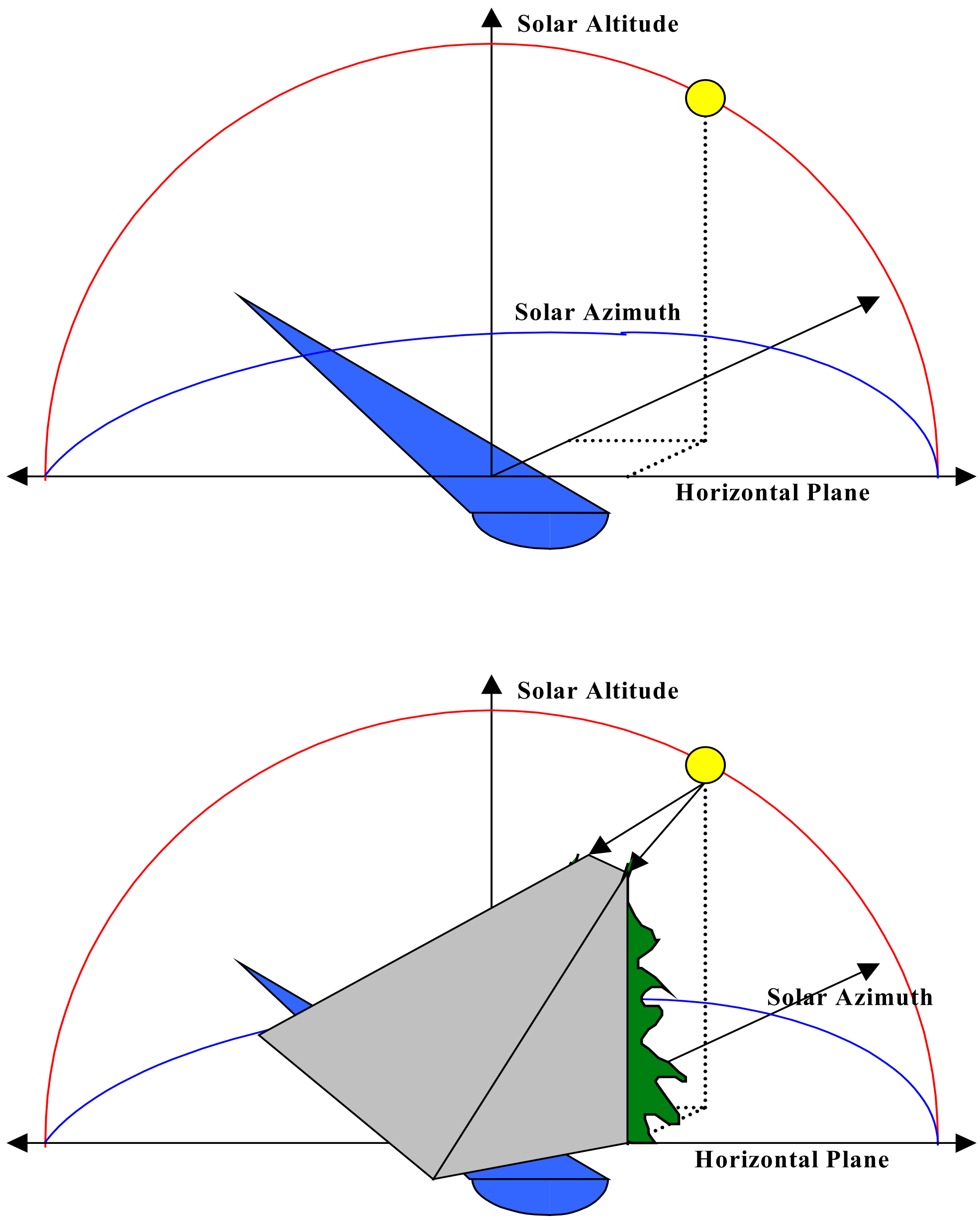


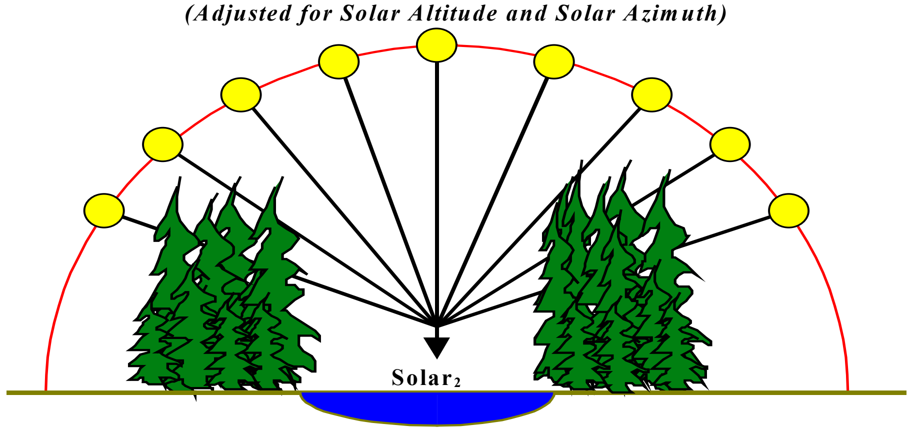
Figure 34. Geometric Relationships that Affect Stream Surface Shade

Percent effective shade is among the most straightforward stream parameters to monitor/calculate and is easily translated into quantifiable water quality management and Geometric Relationships that Affect Stream Surface Shade recovery objectives. **Figure 36** demonstrates how effective shade is monitored/calculated. Using solar tables or mathematical simulations, the *potential daily solar load* can be quantified. The *measured solar load* at the stream surface can easily be measured with a Solar Pathfinder© or estimated using mathematical shade simulation computer programs (Boyd, 1996 and Park, 1993).

Figure 35. Effective Shade - Defined

$Solar_1$ – Potential Daily Solar Radiation Load

(Adjusted for Solar Altitude and Solar Azimuth)



Effective Shade Defined:

$$\text{Effective Shade} = \frac{(Solar_1 - Solar_2)}{Solar_1}$$

Where,

$Solar_1$: Potential Daily Solar Radiation Load

$Solar_2$: Measured Daily Solar Radiation Load at Stream Surface

System Potential Shade - Defined

Primary factors that affect shade are near stream vegetation height and channel width (i.e. bankfull width). The maximum level of shade practical at a particular site is termed the "system potential" effective shade level."

Thermal Role of Riparian Vegetation

Riparian vegetation plays an important role in controlling stream temperature change. Near stream vegetation height, width and density combine to produce shadows that when cast across the stream reduces solar radiant loading. Bank stability is largely a function of riparian vegetation. Riparian corridors often produce a microclimate that surrounds the stream where cooler air temperatures, higher relative humidity and lower wind speeds are characteristic.

Longitudinal heating is a natural process. However, rates of heating can be dramatically reduced when high levels of shade exist and solar radiation loading is minimal. The overriding justification for a reduction in solar radiation loading is to minimize longitudinal heating. A limiting factor in reducing longitudinal stream heating is that there is a natural maximum level of shade that a given stream is capable of attaining.

Riparian Vegetation

Current Condition

The following are some excerpts from *Tillamook Bay Environmental Characterization* (Tillamook Bay National Estuary Project, 1997). Riparian vegetation conditions within the Nestucca and Little Nestucca sub-basins are similar to that discussed below for the Tillamook Bay and is illustrated in the GAP analysis (**Figure 37**).

> *The spruce zone covers the lower regions of the Watershed and normally occurs at elevations below 450 feet (150 meters).*
>
> *Dense, tall stands of Sitka spruce, western hemlock, western red cedar (Thuja plicata), Douglas fir (Psuedotsuga menziesii), and grand fir (Abies grandis) dominate the spruce zone…hardwood species occurring in the zone include red alder (Alnus rubra), bigleaf maple (Acer macrophyllum), and occasional California bay (Umbrellularia californica) with red alder dominating recently disturbed sites and some riparian areas.*
>
> *Successional patterns in the spruce zone following fire or logging are often dominated by a dense shrub community composed of salmonberry (Rubus spectabilis), sword fern, elderberry, and huckleberry, with relative dominance varying with the site conditions. The shrub community can persist for quite some time due to the excellent growing conditions, but at some point it yields to one of two types of seral forest stands. The conifer type is a mixture of spruce, hemlock, and Douglas fir and the hardwood type is a monotypic, dense stand of red alder.*

The hemlock zone normally extends in elevation between 450 feet (150 meters) and the subalpine zone of the Coast Range.

In the hemlock zone, the dominant vegetation is dense conifer forest. Forest stands are dominated by Douglas fir, western hemlock and western red cedar, with other conifers mixed in, such as grand fir, Sitka spruce, and Pacific yew (Taxus brevifolia). Hardwood species occurring in the hemlock zone include red alder, bigleaf maple, black cottonwood (Populus trichocarpa) and Oregon ash (Fraxinus latifolia).

Successional patterns in the hemlock zone following fire or clearcut logging bring the first year residual species and invading herbaceous species from the genera Senecio and Epilobium. This community is replaced during years two to five by one dominated by fireweed (Epilobium angustifolium), thistle (Cirsium vulgare) and bracken fern (Pteridium aquilinum). The next community is dominated by shrubs such as vine maple, Oregon grape, rhododendron, salal and blackberry species (Rubus spp.). Eventually the shrubs are overtopped by conifers such as Douglas fir.

- Tillamook Bay National Estuary Project, 1997

Sampling/Measuring Riparian Vegetation

Basin-wide vegetative conditions can be observed using Western Oregon Digital Imaging Project (WODIP) satellite images. WODIP is a vegetation mapping project using Thematic Mapper Satellite data collected in 1993, existing field inventory data, and advanced computer technology to produce a forest vegetation map of western Oregon. Its intended use is for watershed analysis, habitat analysis, and other environmental assessment projects. WODIP satellite data has a pixel size of 25 meters, meaning that the sensor on board the satellite records energy reflected from an area on the ground measuring 25 meters by 25 meters. The WODIP coverage for the Nestucca and Little Nestucca watersheds (**Figure 38**) illustrates vegetation fragmentation on a watershed-wide scale, with a portion of the lower watershed cultivated for agriculture, urban areas in the lower watershed, and timber harvests dotting the upper basin.

Figure 36. Dominant Vegetation and Land Cover in the Nestucca and Little Nestucca Watersheds[4] *(Oregon GAP Analysis Program, 1992)*

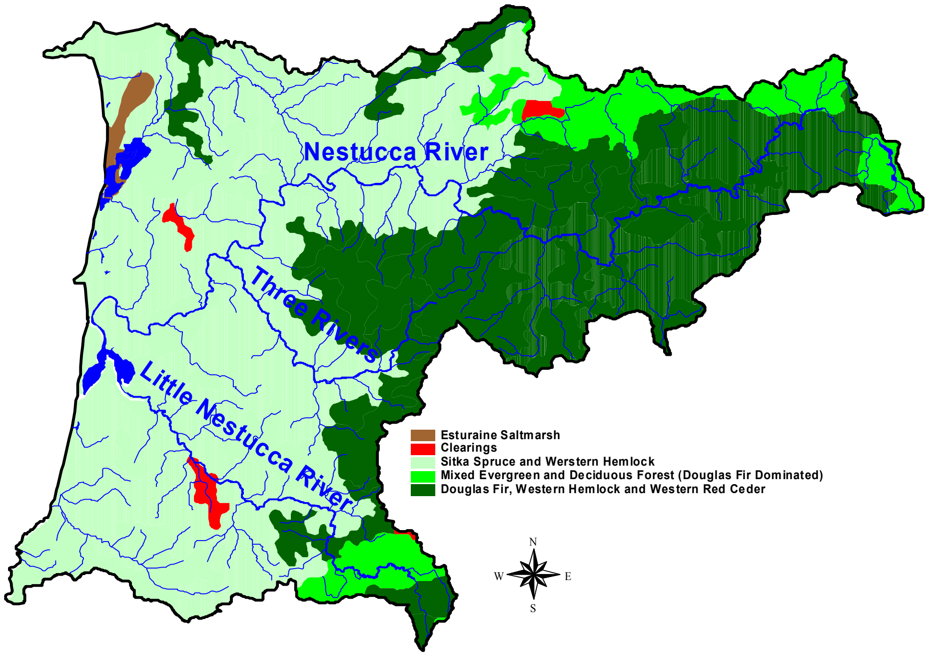
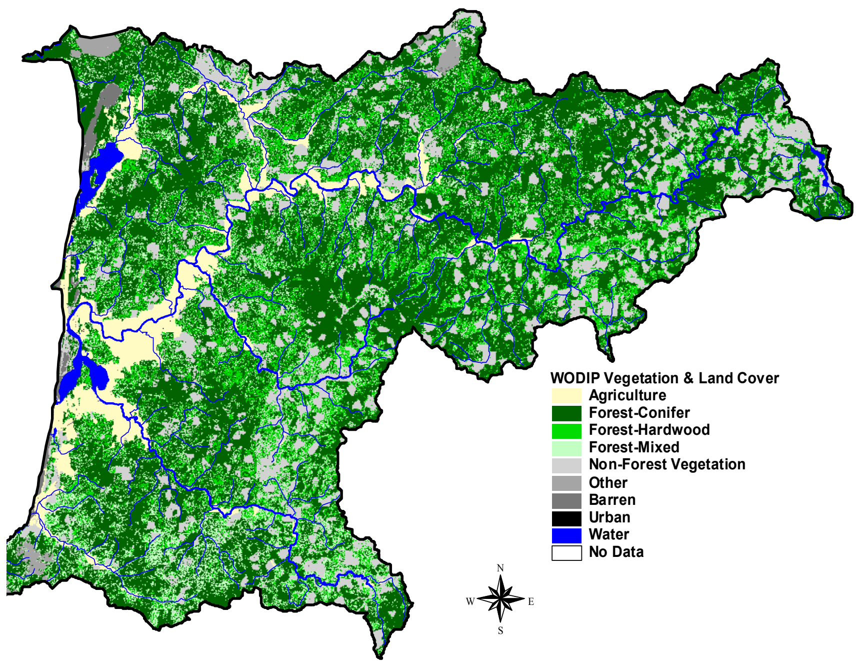


Figure 37. WODIP Satellite coverage of the Nestucca and Little Nestucca (BLM, 1999)



[4] GAP vegetation and land cover data was not used for analytical purposes in the TMDL. However, it does provide a coarse distribution of dominant vegetation types.

Riparian vegetation can be effectively mapped at a 25-meter pixel scale when vegetation characteristics (vegetation type) exceed sampling resolution. However, in many areas of the Nestucca and Little Nestucca watersheds riparian characteristics are more variable and require a higher resolution than that sampled by Landsat/WODIP. To increase the resolution of riparian vegetation characterizations, digital orthophoto quads where used to refine both the polygons and the classifications in the near stream area (300 feet on either side of the stream channel). Ground level measurements were collected throughout the Nestucca and Little Nestucca watersheds to assist in vegetation classifications. **Figure 39** displays vegetation and land cover polygons derived from orthophotos at 1:5,000 and validated with ground level measurements. Stream reaches within the Nestucca and Little Nestucca sub-basins that riparian vegetation was characterized is illustrated to the right.

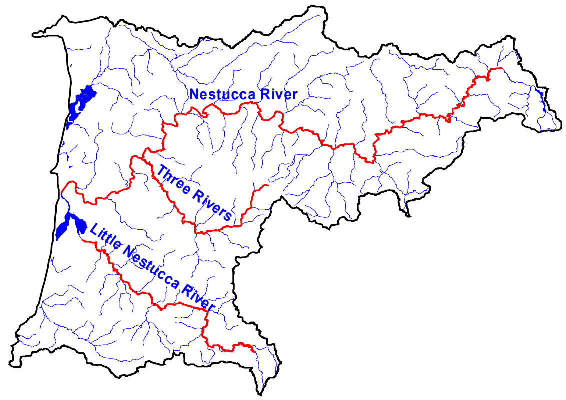
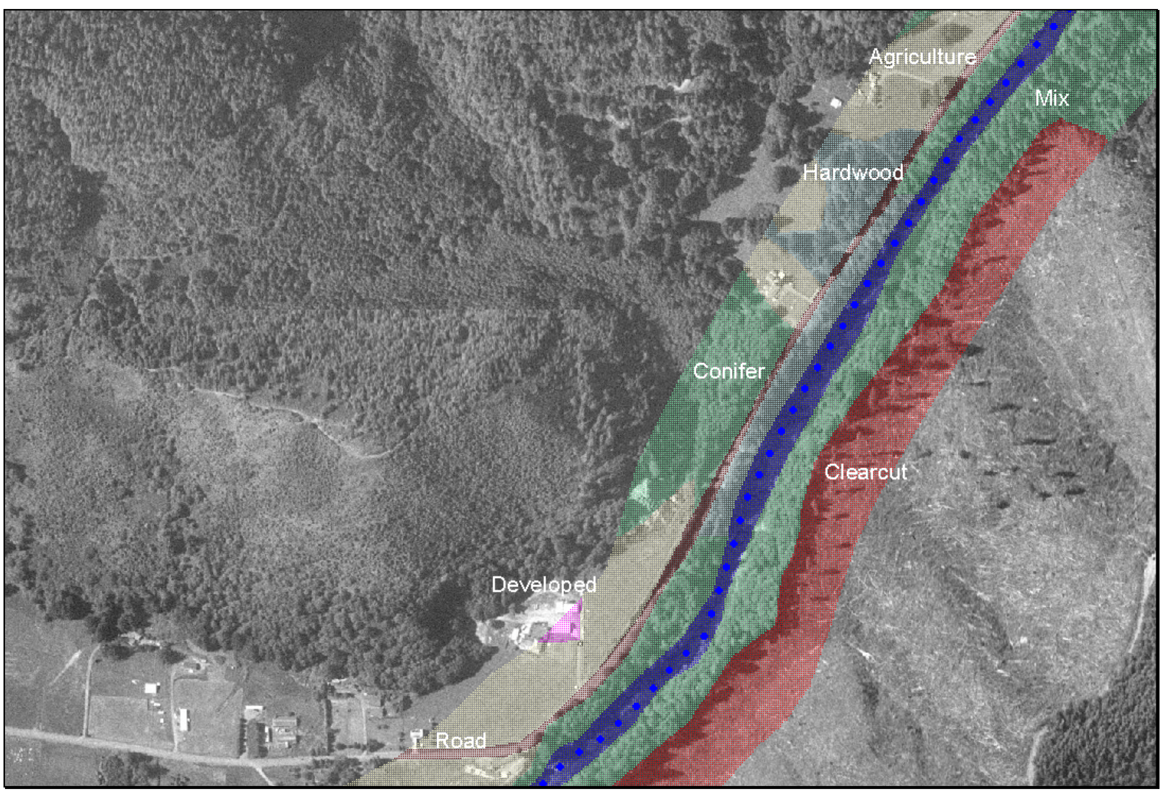


Figure 38. Vegetation Mapping from Digital Orthopohoto Quad (1:5,000)



Near stream vegetation classifications were determined from infrared satellite data (WODIP LandSat), digital orthophoto quads and ground level data. All classifications identified dominant species type, canopy density, and stand size and used ground truthing. Additionally, the Oregon DEQ collected riparian species, height, and density data at several sites in the Nestucca and Little Nestucca watersheds during the summer of 1999. Every near-stream vegetation code was quality checked against aerial photographs (digital orthophoto quads) by DEQ.

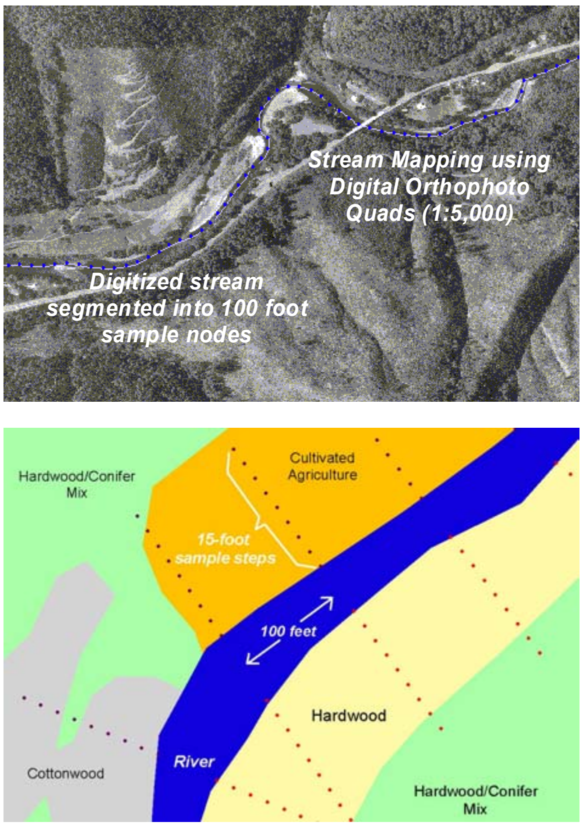
All near stream vegetation data is coded for species type, canopy density, and size/structure. Species type is coded according to the dominant existing over-story species. Canopy density is presented as the percentage of ground that is covered by over-story vegetation when viewed from directly above or measured by a densiometer at ground level. LandSat size/structure classes are divided by diameter at breast height (DBH) for woody vegetation. The LandSat size/structure class denotes whether the stand is single or multiple story.

Non Forest – If the total tree crown closure is <10%, then the site is labeled with the appropriate Non Forest class.

Canopy Layer – Single-storied if over 85% of the total tree crown closure is present in one canopy layer, otherwise is multi-storied.

Stream reaches were digitized from orthophoto quads at less than 1:5,000. These stream layers were then segmented into data sampling locations (points) at a 100-foot interval. These point data layers form the basis for automated sampling performed using Ttools[5]. At every distance node (i.e. every 100 feet) along the stream, longitudinally vegetation was sampled out to 120 feet from the channel edge at 15-foot intervals for both stream banks. A total of 18 vegetation samples are taken at each stream distance node (**Figure 40**). Example of TTools Automated Vegetation Sampling Methodology.

Figure 39. Example of TTools Automated Vegetation Sampling Methodology.



[5] Ttools is a automated sampling tool that was developed by DEQ to sample the following spatial data: stream aspect, channel width, FLIR derived temperatures, near stream vegetation and topographic shade angles. Sampling resolution is user defined and was set at 100 foot intervals longitudinally (i.e. along the stream) and 15 feet in the transverse direction (i.e. perpendicular to the stream).

Riparian Vegetation Composition

Automated sampling of the near stream areas classified vegetation types at a vector perpendicular to the stream aspect, starting the stream channel edge and extending to a distance of 120 feet (**Figure 41**). The sampling rate was set to 15-foot intervals. Automated near stream vegetation sampling was completed for 69.9 miles of mainstem reaches in the Nestucca and Little Nestucca watersheds. Given that 240 feet of near stream area (120 feet of each side of the stream) was sampled, a total of 3.2 square miles (2034 acres) of near stream vegetation was classified and analyzed. Near stream vegetation was grouped as one of the following: conifer forests, mixed (conifer and deciduous) forests, deciduous forests, scrub/shrub (woody vegetation less than 20 feet in height), agriculture/pasturelands, timber harvest, roads and developed lands (both urban and rural residential). Forestlands were the most prevalent land cover type found in the near stream area (within 120 feet from the stream channel). Specifically, forestlands were broken down into conifer (21.5%), mixed forests (22.3%), deciduous forests (27.5%), scrub/shrub (7.5%) and timber harvested areas (1.8%). Agriculture or Pasture comprise 13.1% of the sampled near stream areas. Roads occupied 4.7% of the near stream area and 1.5% of the near stream lands were developed as urban or rural residential.

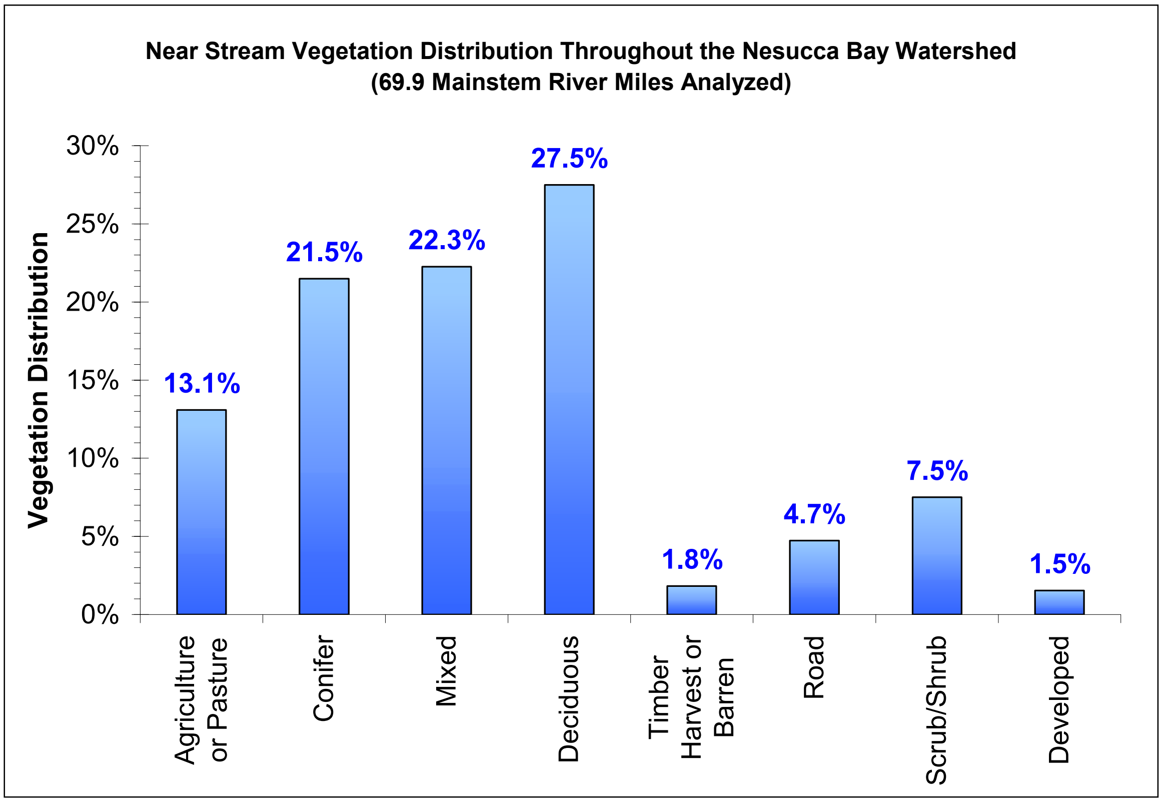


Figure 40. Frequency of vegetational types within the Nestucca Bay Watershed.

Riparian Vegetation Height

Existing tree heights were either calculated from the specified LandSat DBH using species-specific growth curves (Hann, 1997 and Richards 1959) (**Table 25**) or derived from ground level data. LandSat classifications provide DBH in ranges allowing calculation of vegetation height based on “growth curve” information developed for forestry practices. DEQ applied the middle (average) value of the range for each size/structure class. Below is the Chapman-Richards Asymptotic Nonlinear Regression Module equation that is used to determine heights based on known DBH values (Richards, 1959).

Tree height as a function of DBH **(Figure 42)** using the Chapman-Richards Asymptotic Nonlinear Regression Module (**Equation 1**) and the coefficients presented in **Table 26**. The Nestucca Bay watershed in home to tall growing conifers such as: douglas fir, western hemlock, sitka spruce, noble fir and western red cedar. Predominant deciduous trees include red alder and big leaf maple.

Equation 1. Chapman-Richards Asymptotic Nonlinear Regression Module (Hann, 1997 and Richards 1959),

$$H = 1.37 + \left(b_o\left[1 - \exp(b_1 \cdot DBH)\right]^{b_2}\right)$$

Where,
H = Height of Tree, b_0 = regression variable, b_1 = regression variable, b_2 = regression variable, DBH = Diameter at Breast Height

Table 25. Mean vegetation DBH and Height for North Coastal Tree Species (Hann, 1997 and Richards 1959)

Species	Mean DBH (inches)	Mean Height (feet)	Sample Size N
Bigleaf Maple	11.3	62.6	627
Douglas Fir	19.1	100.7	8332
Noble Fir	17.1	71.8	68
Red Alder	9.2	57.4	1641
Sitka Spruce	40.0	147.3	423
Western Hemlock	14.9	97.7	3152
Western Red Cedar	18.9	72.8	582

Figure 41. Tree Height as a Function of Diameter Breast Height (DBH) (Hann, 1997 and Richards 1959)

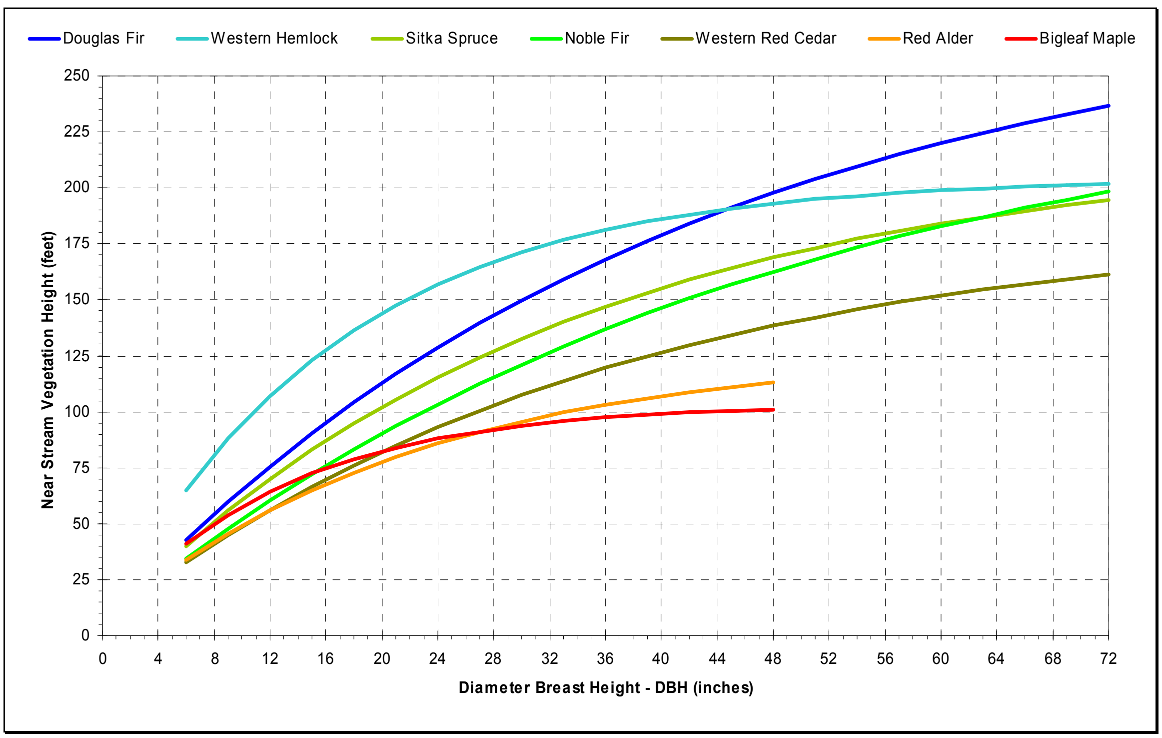


Table 26. Chapman-Richards Asymptotic Nonlinear Regression Module Coefficients (Hann, 1997 and Richards 1959)

Species	b_0	b_1	b_2	R^2
Bigleaf Maple	30.17141	-0.03738	0.81291	0.69
Douglas Fir	85.60765	-0.01023	0.93495	0.92
Noble Fir	75.47281	-0.00861	0.97062	0.94
Red Alder	37.36855	-0.02340	0.76164	0.75
Sitka Spruce	65.27757	-0.01236	0.96792	0.71
Western Hemlock	60.87614	-0.02195	1.07827	0.86
Western Red Cedar	55.19896	-0.01211	0.91076	0.91

Potential Riparian Vegetation Characteristics

System potential vegetation was determined based on information from the United States Forest Service (John Johansen, USFS Hebo Ranger District) and DEQ staff. USFS developed average height of mature trees[6] for the species listed in **Table 27**. Potential tree height was derived for forestlands, cropland/pasture and urban land (**Figure 43**). Tree height targets developed with information from USFS closely compare to targets with tree heights listed in **Figure 42** (Tree Height as a function of DBH), **Figure 44** (Expected Tree Height as a Function of Age), and **Figure 45** (Tree Height for various species). Potential vegetation density is assumed to be 90% for all tree species.

Current riparian conditions measured for the Nestucca River, Three Rivers, and Little Nestucca River are presented in **Figures 46, 47,** and **48**, respectively. In addition, system potential vegetation conditions for these rivers are illustrated in these images.

[6] Mature tree height estimates were based on growth rates for an "average" site indexes 1 (best) and 2 (good) and were set at 100 years.

Table 27. Potential Tree Heights (personal communications with John Johanssen, USFS)

Species	Average Height	Age
Douglas Fir	185 feet	100 years
Western Hemlock	180 feet	
Western Red Cedar	180 feet	
Sitka Spruce	180 feet	
Noble Fir	172 feet	
Red Alder	110 feet	
Big Leaf Maple[7]	100 feet	
Land Use Area	**Dominant Tree Species and Mature Tree Height**	**Targeted Height**
Forestlands	Douglas Fir - 185 feet	185 feet
Cropland, Pasture and Urban Lands	50% Douglas Fir – 185 feet Western Hemlock – 180 feet Western Red Cedar – 180 feet Sitka Spruce – 180 feet Noble Fir – 172 feet	142 feet
	50% Red Alder – 110 feet Big leaf Maple – 100 feet	

[7] Mature vegetation height associated with Big leaf Maple was obtained from ODF, Wayne Auble, for the Tillamook bay watersheds and represent the expected tree height at 80 years.

Figure 42. Land Use Used in Determination of Potential Dominant Tree Species and Mature Tree Heights (USGS, 1979)

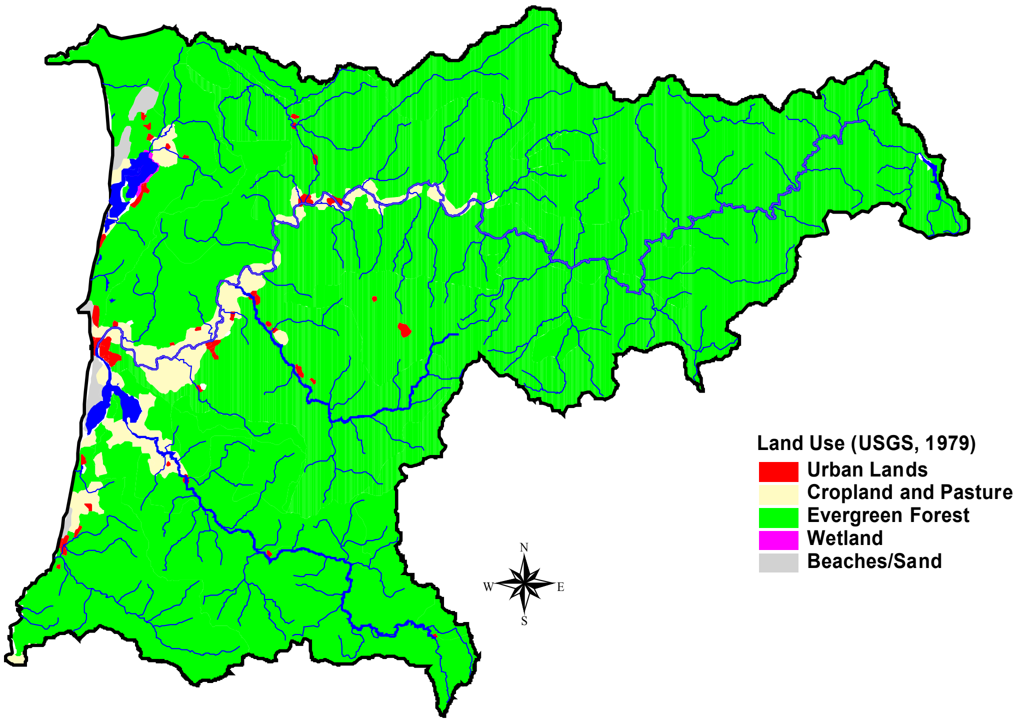


Figure 43. Expected Tree Height for Douglas Fir as a Function of Stand Age – Site Quality I (McArdle and Meyer, 1961)

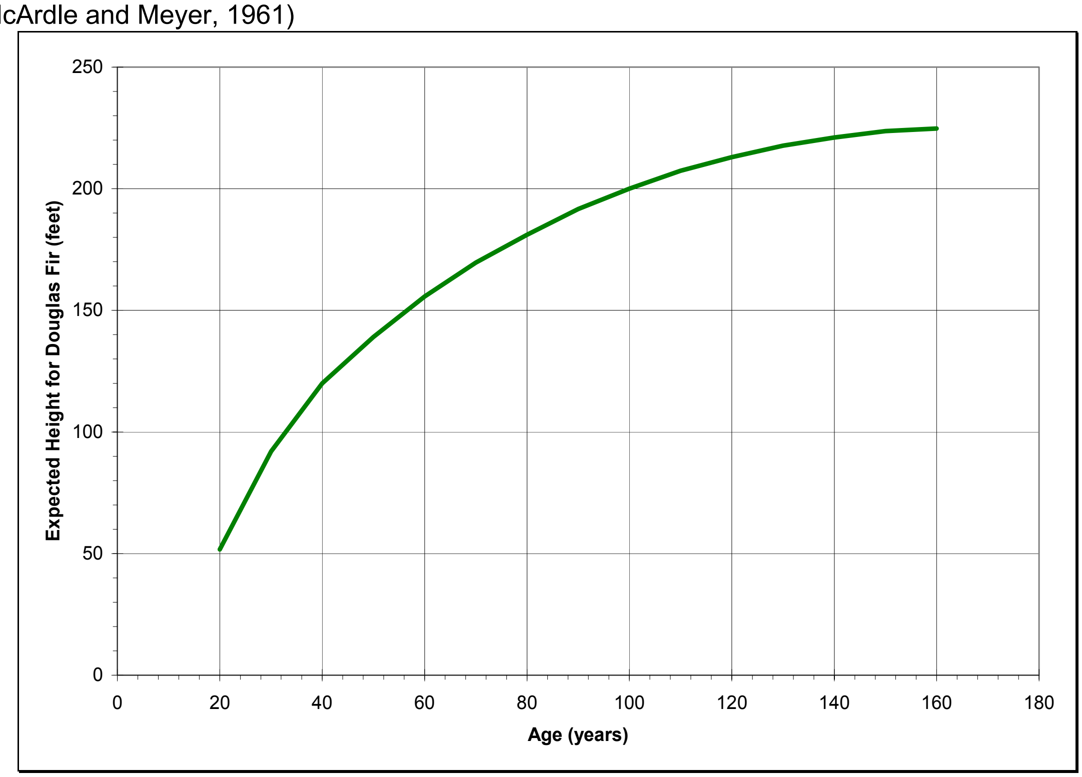


Figure 44. Tree Heights for Dominant Tree Species in the Tillamook Basin
(Whitney, 1997)

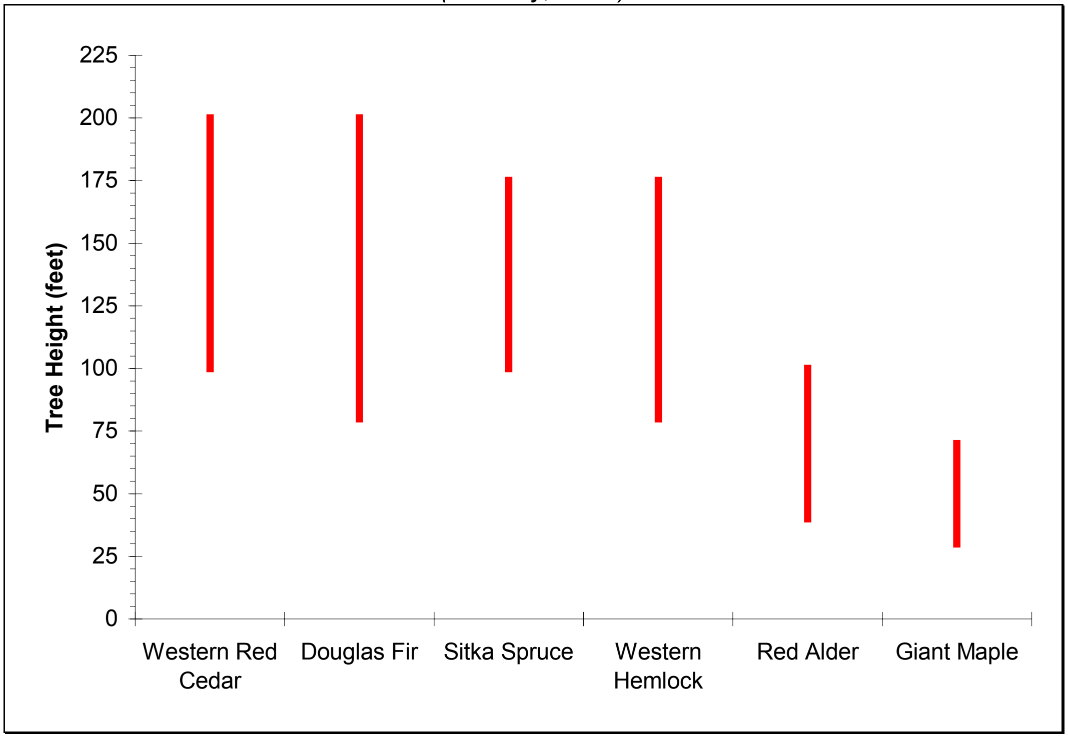
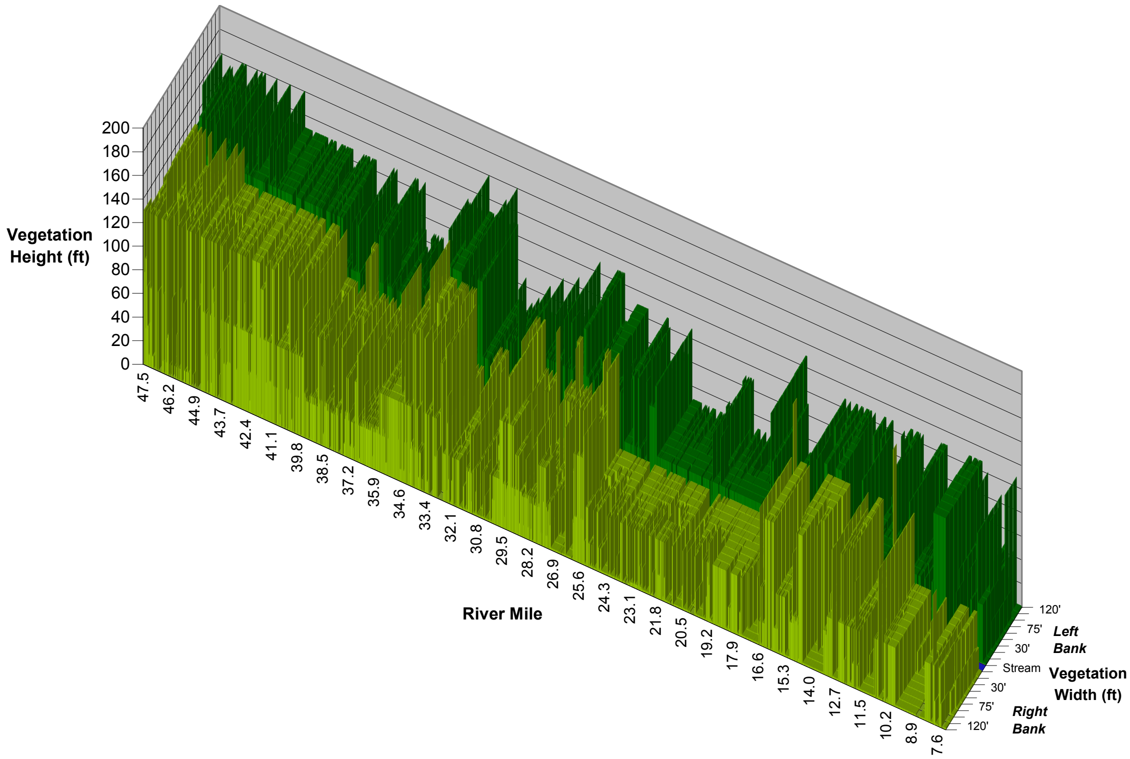


Figure 45. Nestucca River Vegetation Distribution, Current Height and Potential Height (River Mile 7.2 to 47.4)

Current Conditions



Potential Conditions

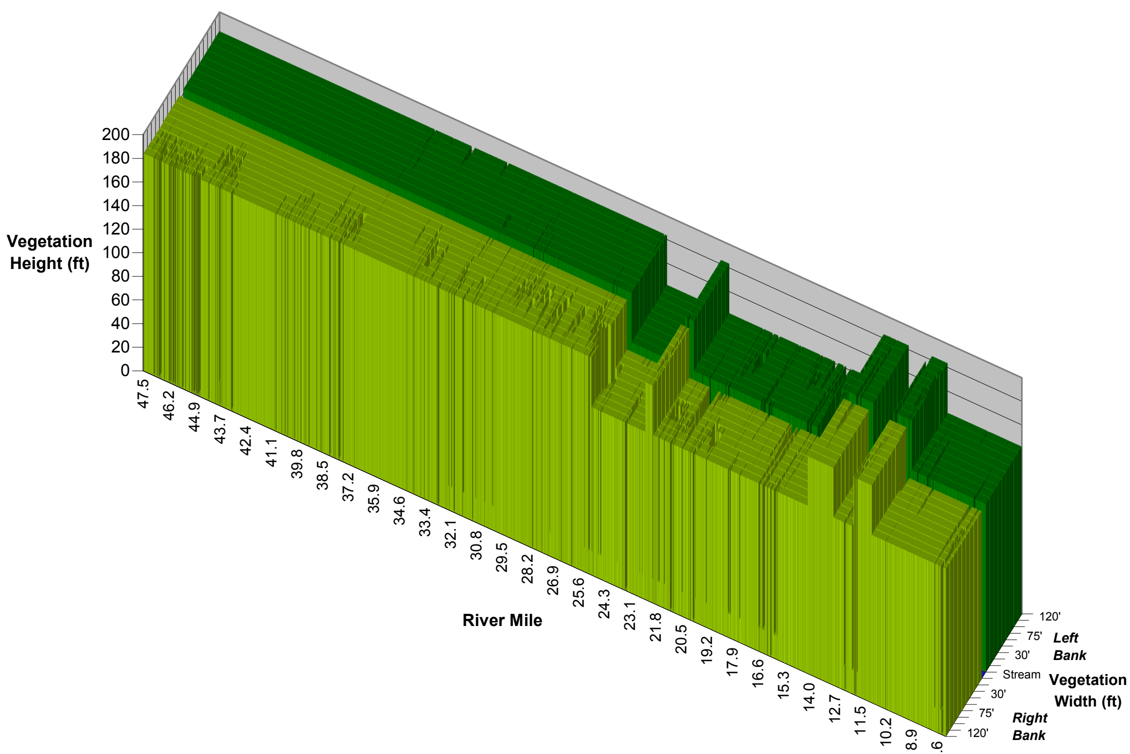
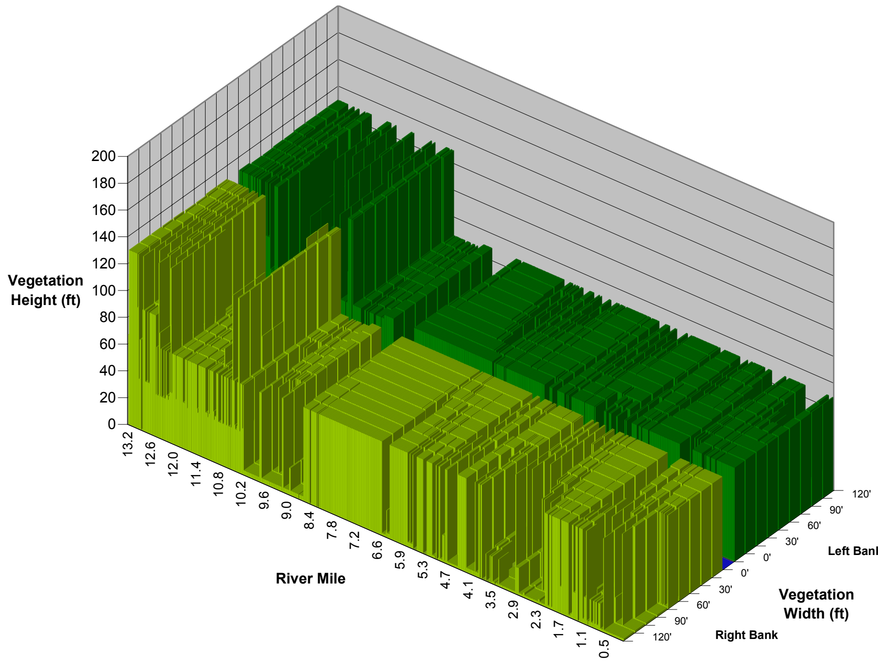


Figure 46. Three River Vegetation Distribution, Current Height and Potential Height (River Mile 0.0 to 13.2)

Current Conditions



System Potential

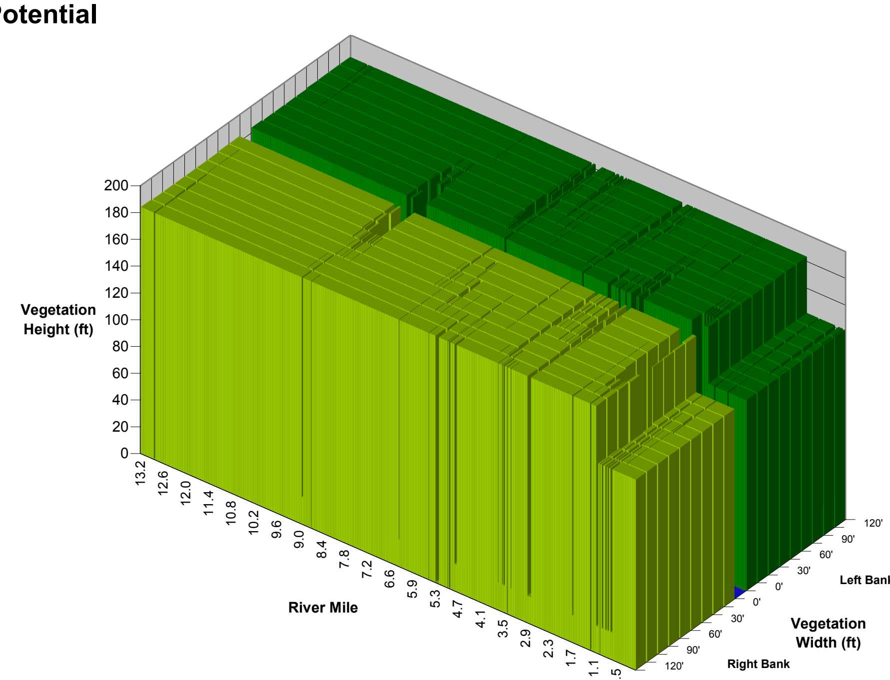
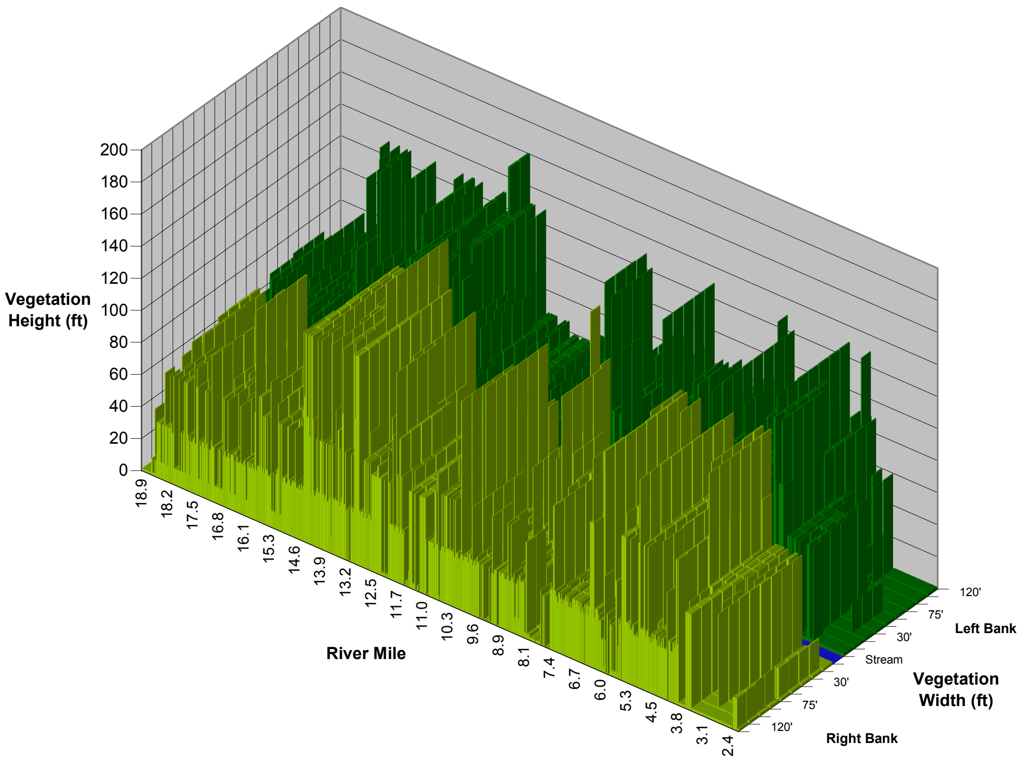
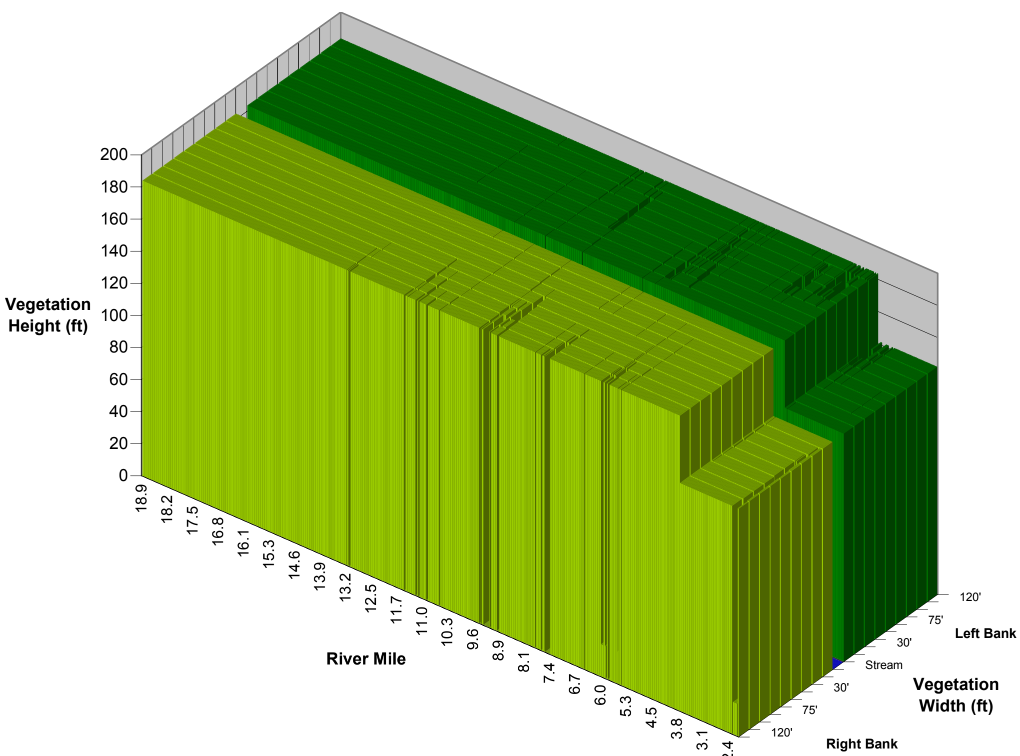


Figure 47. Little Nestucca Vegetation Distribution, Current Height and Potential Height (River Mile 2.4 to 18.9)

Current Conditions



System Potential

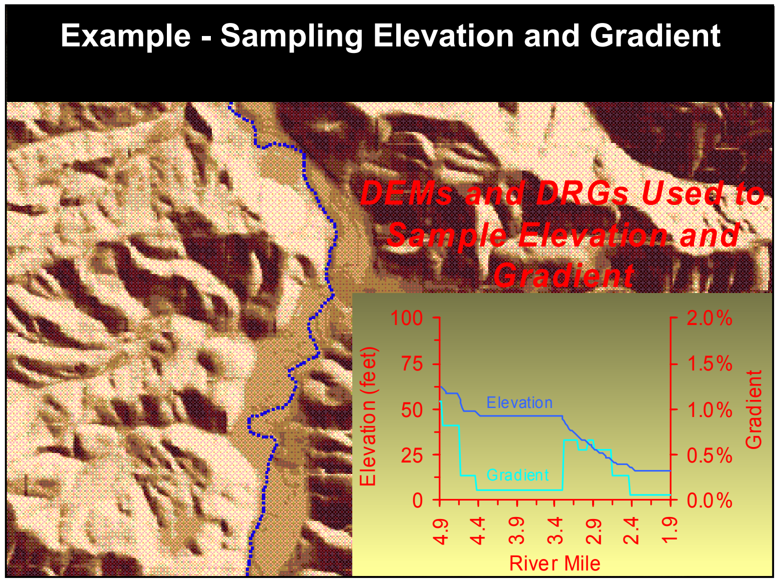


Thermal Role of Local Geography

The local geographic features control various constituents of stream warming. Stream elevation and gradient control velocity, while aspect and topographic shade partly determine the effectiveness of vegetation in providing shade to the stream surface.

Stream Elevation and Gradient

Stream elevation and gradient were sampled from 10-meter digital elevation models (DEMs) and checked against digital raster graphics (DRGs) at each model data node. Both sampled elevation and gradient data are plotted for the aerial extent displayed (**Figure 32**). In this fashion, stream elevation and gradient was derived for all stream reaches analyzed. Stream elevation data is used for calculating solar radiation loading and solar position. Stream gradient data is used as input for calculating stream flow velocity, average wetted depth and wetted width via the Manning equation.



Stream Aspect

Stream aspect is a determinant of the effectiveness of shade from both topography and vegetation, and was sampled at every stream data node (every 100 feet) (**Figure 33**). Stream surface shading is influenced by stream aspect in terms of timing and shadow length relative to the stream. Stream aspect is used in this analysis for positioning the stream and near stream vegetation relative to direct beam solar radiation.

Topography and Topographic Shade

Topographic features produce shade to the stream system that controls the local sunrise and sunset. Such features include distant mountain ranges, canyons or other near stream relief. At each stream data node (every 100 feet), the topographic shade angle was sampled from 10-meter digital elevation models (DEMs) to the west, south and east. Calculated values are presented in **Figure 34**.

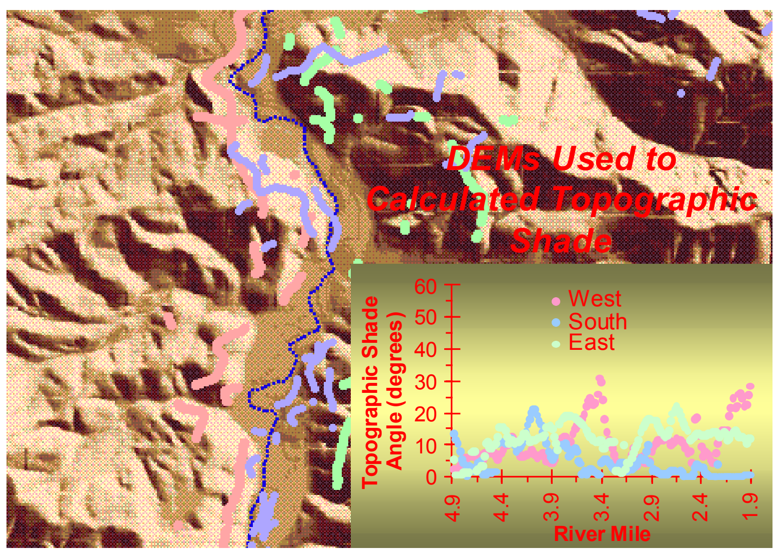


Figure 48. Stream Elevation and Gradient

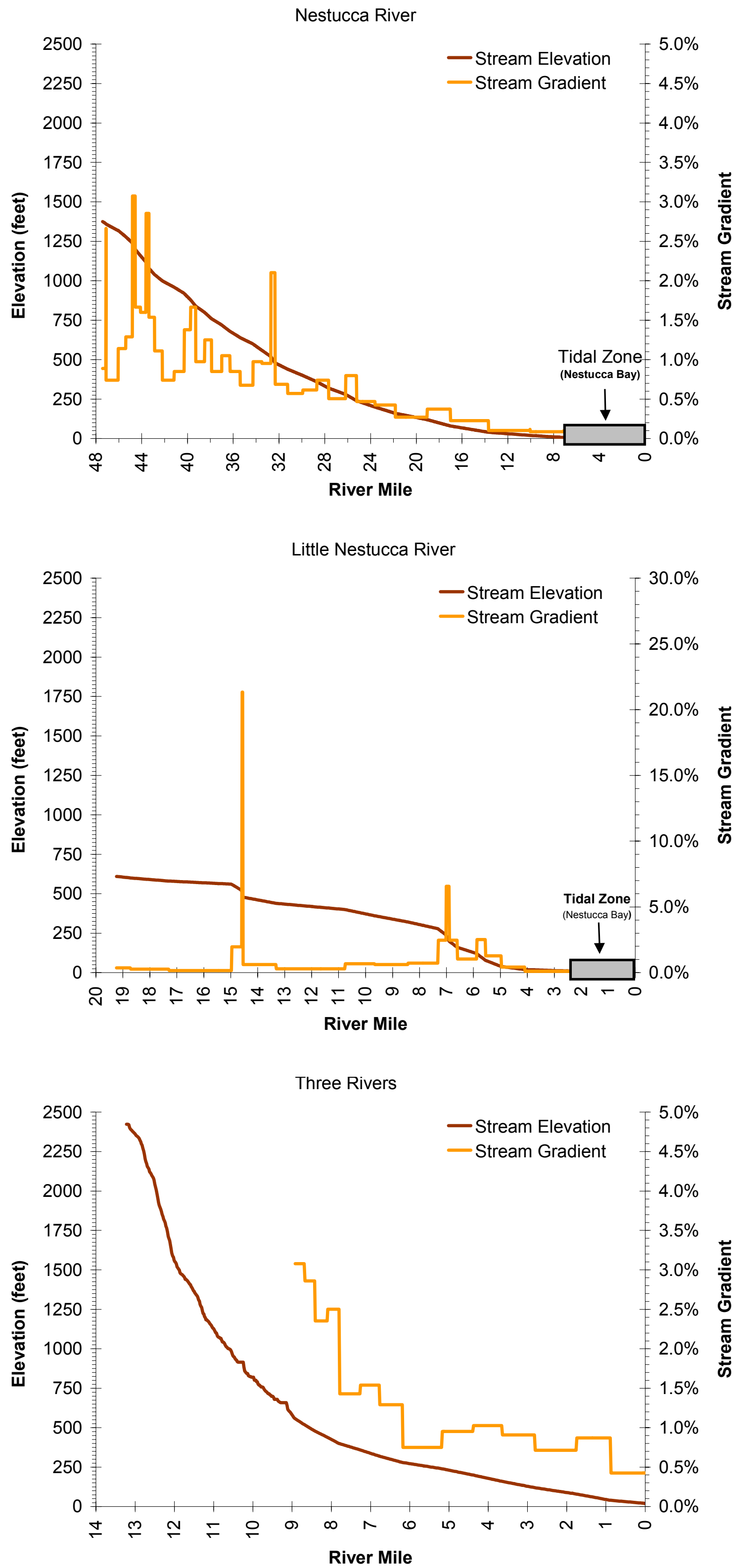


Figure 49. Stream Aspect

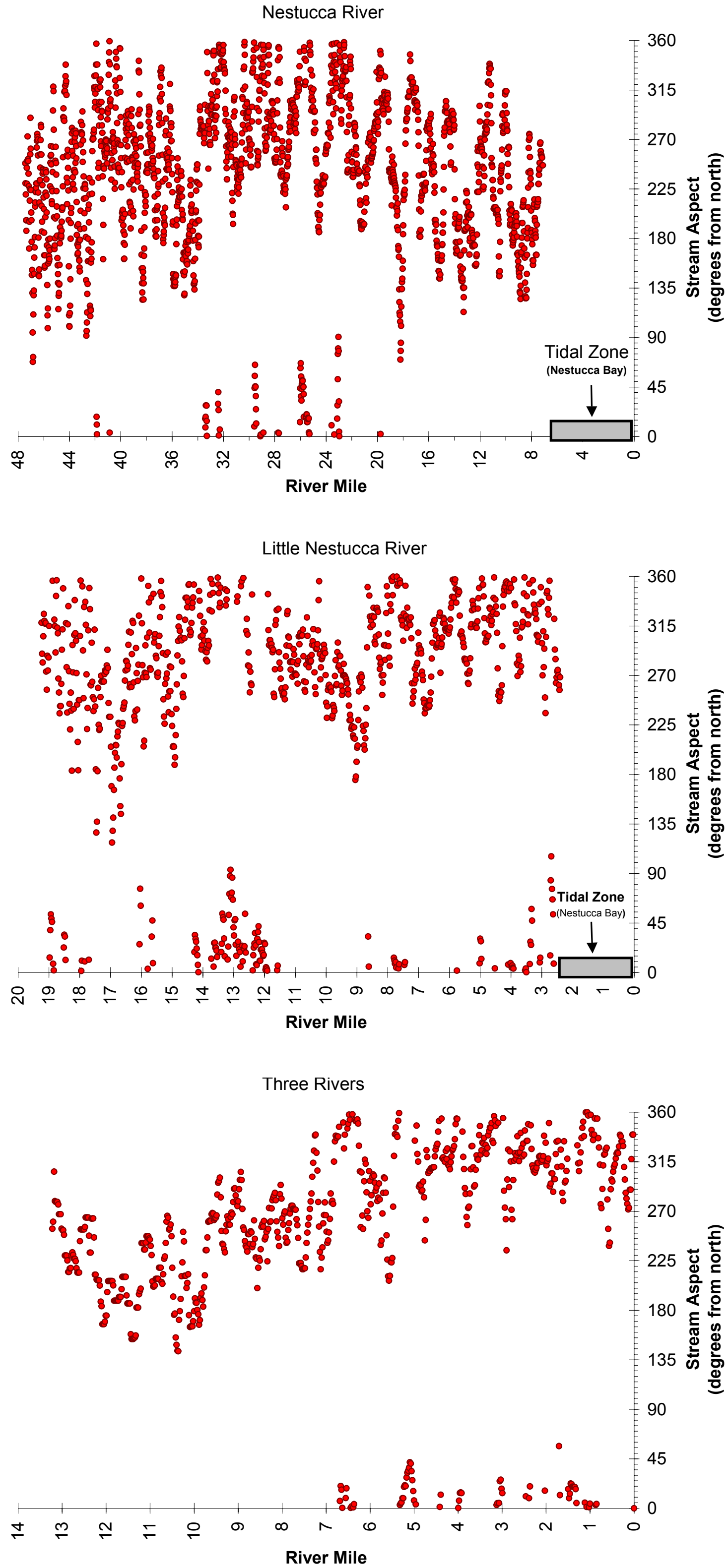
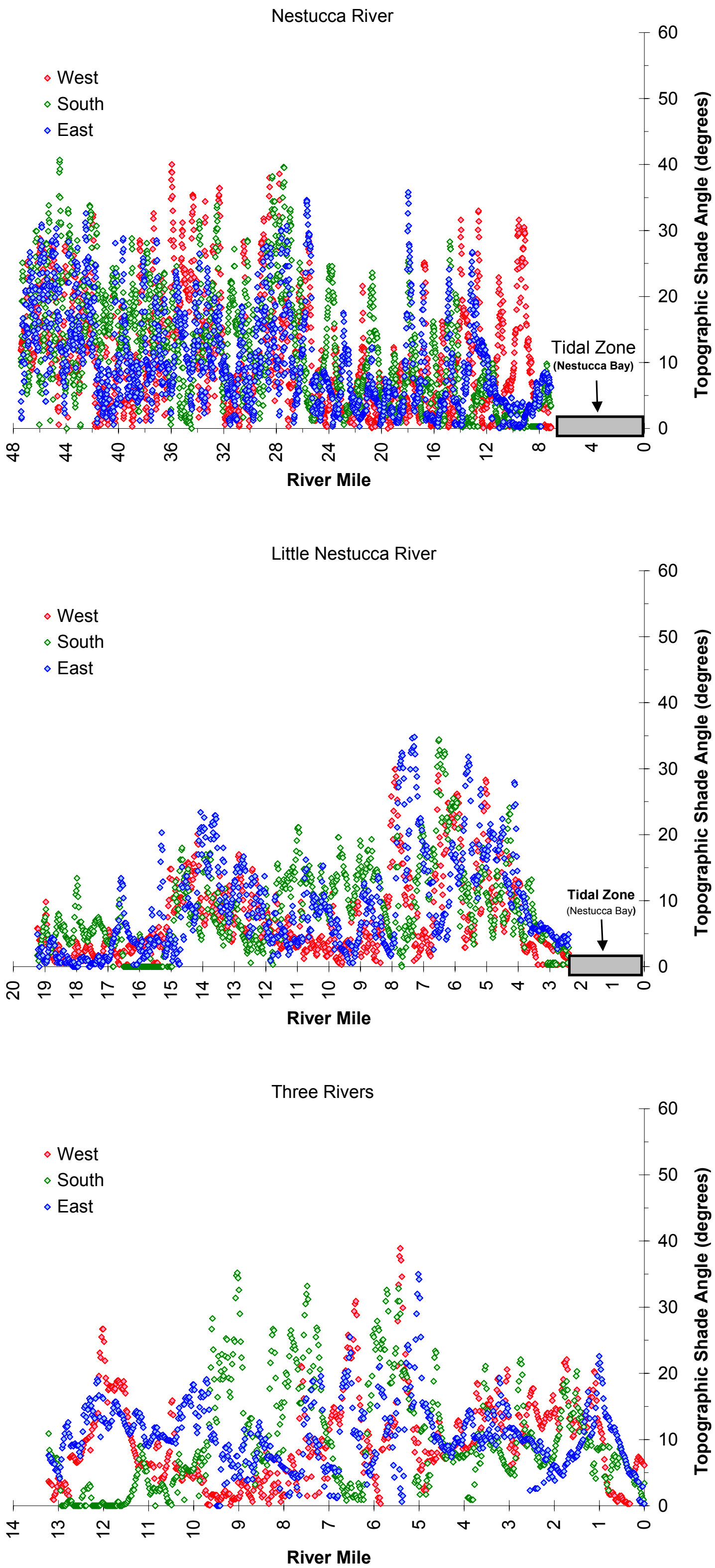


Figure 50. Topographic Shade Angles



Microclimate - Surrounding Thermal Environment

Riparian corridors often produce a microclimate that surrounds the stream where cooler air temperatures, higher relative humidity and lower wind speeds are characteristic. Riparian microclimates tend to moderate daily air temperatures. Relative humidity increases result from the evapotranspiration that is occurring by riparian plant communities. Wind speed is reduced simply by the physical blockage produced by riparian vegetation. Dong et al. (1998) analyzed microclimate data along 20 small streams in western Washington and found that riparian vegetation removal via timber harvests increased near stream air temperatures by up to 8^{o}F. Chen et al. (1995) detected that edge effects (i.e. atmospheric conditions outside of the near stream buffer) penetrated to distances greater than 600 feet into a well-vegetated area. Riparian buffers commonly occur on both side of the stream, compounding the edge influence on the microclimate.

Brosofske et al. (1997) reported that a minimum stream buffer width of 150 feet was required to maintain soil temperatures that reflect those of a normal microclimate. Ground temperatures can be a source of heat energy to the stream. When the ground is warmer than the stream, heat will transfer from the stream bank to the water column. In fact, ground surfaces can conduct heat to the stream hundreds of times faster than that of the air column surrounding the stream. Solids (ground surfaces) have conductivities on the order of 500 to 3,500 times greater than gases (air) (Halliday and Resnick, 1988). Impoverished riparian areas that allow excessive stream bank warming will introduce heat into the stream faster than cooler, highly vegetated stream banks. Riparian condition is again implicated as a controlling factor in stream temperature dynamics in part because ground/soil temperatures are a function of the shading.

Air affects stream temperatures at a slower *rate.* Nevertheless, this should not be interpretted to mean that air temperatures do not affect stream temperature. Air can deliver heat to a stream via the convection/conduction pathway, which is the slowest of the water energy transfer processes (Bowen, 1926; Beschta and Weatherred, 1984; Boyd, 1996; Chen, 1996). However, prolonged exposure to air temperatures warmer than the stream can induce gradual stream heating. Thus, a cooler microclimate will induce less stream warming.

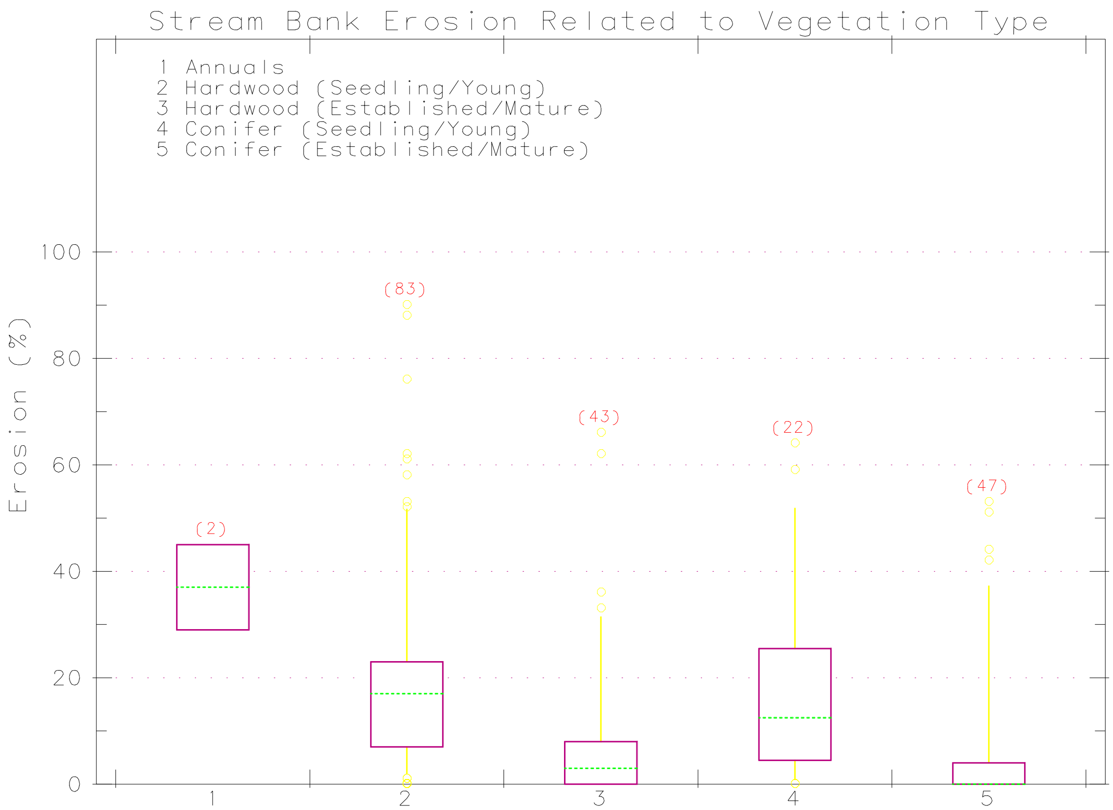
Thermal Role of Channel Morphology

Changes in channel morphology, namely channel widening, impacts stream temperatures. As a stream widens, the surface area exposed to radiant sources and ambient air temperature increases, resulting in increased energy exchange between the stream and its environment (Boyd, 1996). Further, wide channels are likely to have decreased levels of shade due to the increased distance created between vegetation and the wetted channel and the increased surface area to shade. Conversely, narrow channels are more likely to experience higher levels of shade. An additional benefit inherent to narrower/deeper channel morphology is a higher frequency of pools that contribute to aquatic habitat.

Channel widening is often related to degraded riparian conditions that allow increased stream bank erosion and sedimentation of the streambed, both of which correlate strongly with riparian vegetation type and condition (Rosgen 1994). Riparian vegetation contributes to rooting strength and flood plain/stream bank roughness that dissipates erosive energies associated with flowing water. Established/Mature woody riparian vegetation adds the highest rooting strengths and flood plain/stream bank roughness. Annual (grassy) riparian vegetation communities offer less rooting strength and flood plain/stream bank roughness.

Stream bank erosion relationships were analyzed using ODFW survey data for data collected in the Tillamook sub-basin (USGS HUC #17100203). **Figure 35** displays the range of active erosion rates that correspond to riparian vegetation types: annuals, hardwood (seedling/young), hardwood (established/mature), conifer (seedling/young) and conifer (established/mature). High rates of active stream bank erosion (greater than 22.5% of stream banks actively eroding) correlate with annual (grass dominated) riparian vegetation types. Low rates of active stream bank erosion (less than 7.5% of stream banks actively eroding) almost exclusively occur in areas where riparian vegetation communities comprised of established mature hardwoods or conifers. It should be noted that the lowest active stream bank erosion rates occurred in mature conifer riparian vegetation communities, where the median active stream bank erosion rate is zero (i.e. no active stream bank erosion is observed).

Figure 51. Active Stream Bank Erosion Related to Various Riparian Vegetation Types



Channel morphology is not solely dependent on riparian conditions. Sedimentation can deposit material in the channel, fill pools and agrade the streambed, reducing channel depth and increasing channel width. Flow events play a major role in shaping the stream channel. Channel modification usually occurs during high flow events. Naturally, land uses that affect the magnitude and timing of high flow events may negatively impact channel width and depth. Riparian vegetation conditions will affect the resilience of the stream banks/flood plain during periods of sediment introduction and high flow. Disturbance processes may have drastically differing results depending on the ability of riparian vegetation to shape and protect channels.

Channel morphology is related to riparian vegetation composition and condition by:

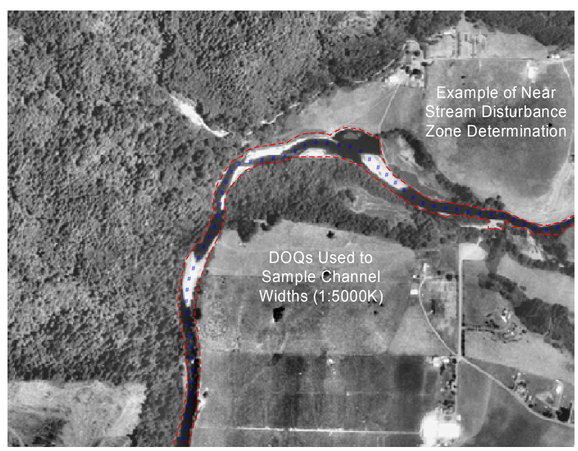
- ✓ ***Building stream banks:*** *Trap suspended sediments, encourage deposition of sediment in the flood plain and reduce incoming sources of sediment.*
- ✓ ***Maintaining stable stream banks:*** *High rooting strength and high stream bank and flood plain roughness prevent stream bank erosion.*
- ✓ ***Reducing flow velocity (erosive kinetic energy):*** *Supplying large woody debris to the active channel, high pool:riffle ratios and adding channel complexity that reduces shear stress exposure to stream bank soil particles.*

Channel Width and Near-Stream Disturbance Zone

Two channel parameters were sampled/measured: the near stream disturbance zone width and the wetted channel width. The near stream disturbance zone (NSDZ) is defined for purposes of the TMDL as the width between shade-producing near-stream vegetation. This dimension was measured from Digital Orthophoto Quad (DOQ) images and ground level measurements. Where near-stream vegetation was absent, the near-stream boundary was used, defined as armored stream banks or where the near-stream zone is unsuitable for vegetation growth due to external factors (i.e., roads railways, buildings, etc.). The near stream disturbance zone width serves as a estimate of the bankfull width. This parameter is used to determine the distance of the near stream vegetation to the wetted channel. In essence, the near stream disturbance zone allows for positioning of the near stream vegetation relative to the stream channel.

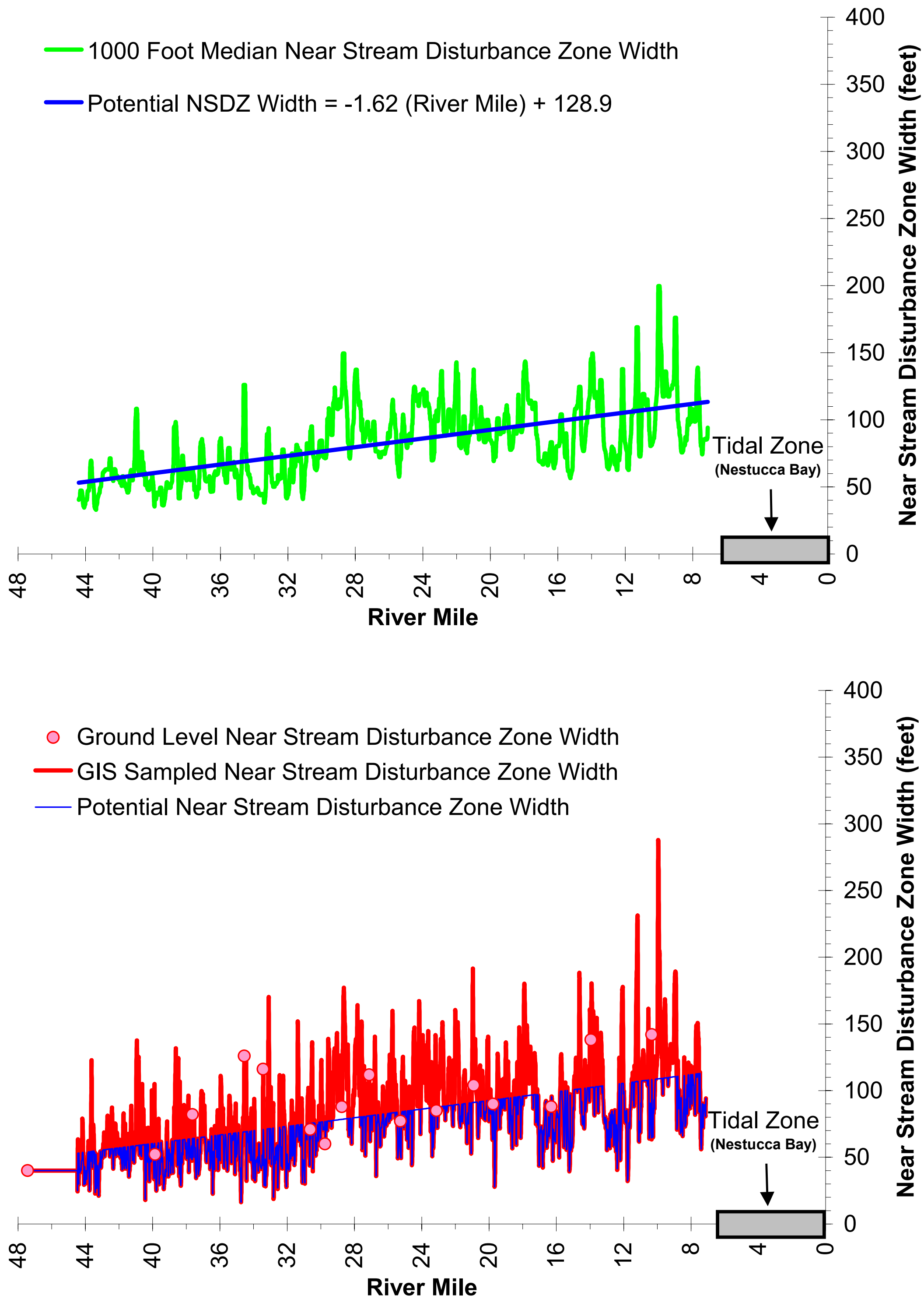
Near stream disturbance zone width data from each river were analyzed to assess the pattern of widening from headwaters to mouth and to estimate the effects of narrowing as a result of future passive restoration expected resulting from near stream vegetation protection/restoration. Widths were quite variable in each of the rivers, though there was generally an overall tendency toward increasing width with distance downstream. Given that the streams were narrower at some places downstream of very wide places, it follows that these narrow places were sufficiently wide to accommodate high flow volumes. Further, channel width reductions do not target a single width, but instead provide an upper limit as a function of distance along the stream channels.

The moving median[8] width value was calculated along 1000-foot stream segments (n=10 per segment). These values were calculated sequentially from the headwaters to the mouth of each river. The pattern of median widths still indicated considerable variability throughout each watershed, though peaks were less pronounced. A best-fit line and associated slope equation were fitted to the data set of each river. This line was used to determine an upper limit on the near stream disturbance zone width for the Nestucca River (**Figure 53**). Field measurements of channel widths for Three Rivers and Little Nestucca River did not vary greatly and where too narrow to measure utilizing the remote sampling methodology presented above.



[8] The median is the middle value within a group, with half of the values lower and half that are higher than other samples within the group.

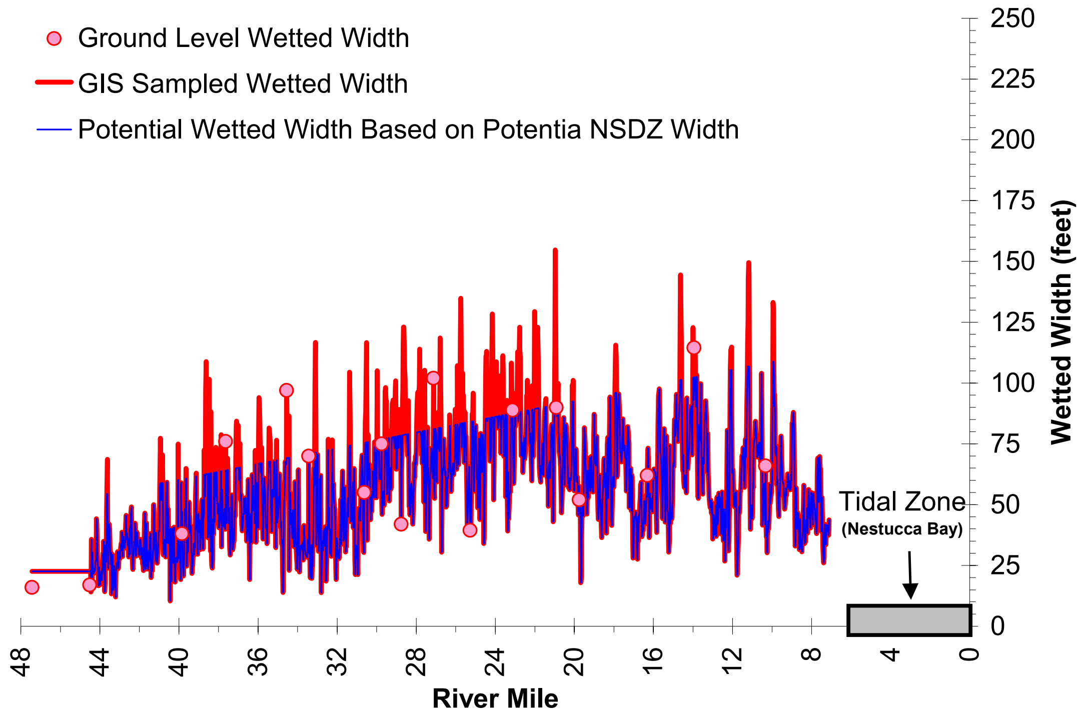
Figure 52. Nestucca River current Condition and Potential Near Stream Disturbance Zone Widths



The potential near stream disturbance zone width was derived from these regression lines fitted to the moving median channel width. Where the existing width at a given point was less than the upper limit derived for near stream disturbance zone width, the existing width was retained and deemed at potential. Where the existing width was wider than the calculated width, the calculated width replaced the existing to become the potential near stream disturbance zone width. This composite data set was used to model the effects of decreased near stream disturbance zone width on stream temperature. Using the regression of median width and distance is a conservative approach, since there are narrower existing widths than the calculated width downstream of virtually any point on the line.

Wetted widths are used to calculate other hydrologic parameters: flow velocity and average wetted depth (**Figure 54**). Further, the area exposed to surface thermodynamic processes is controlled by the wetted width. Therefore, wetted width data is used for multiple calculations in this analysis. Where near stream disturbance zone width reductions impinged upon wetted widths (i.e. NSDZ width became less than wetted widths), the wetted width was also reduced to that of the potential near stream disturbance zone width. In this fashion, wetted widths were evaluated and reduced locally. Since wetted depth is a function of wetted width, areas with reductions in wetted width had wetted depth adjustments (see **Average Wetted Depth**).

Figure 53. Nestucca River current Condition and Potential Wetted Widths



Average Wetted Depth

The wetted dimensions of the channel are interrelated. If it is assumed that stream channels are rectangular in shape, average wetted depth can be estimated when wetted width, flow volume and flow velocity is known.

Flow is calculated as,

$$Q = V \cdot A = V \cdot W \cdot D$$

Which can be rearranged to,

$$D = \frac{Q}{V \cdot W}$$

where,

Q: Stream flow volume (ft^3/s)
V: Stream velocity (ft/s)
A: Wetted cross-sectional area (ft^2)
W: Wetted width (ft)
D: Average wetted depth (ft)

If flow is unchanged, a narrowing of the stream channel will result in deeper wetted depth and perhaps a slightly altered stream velocity. Therefore, wetted depth increases when wetted stream width is reduced. Potential stream width was narrowed in localized stream reaches for the Nestucca River. In all of these cases, Manning's equation and the calculated wetted depth equation allow for the deepening of the average wetted depths, a reduction in stream surface area and less exposure to surface thermodynamic processes. **Figure 38** displays the wetted depths used in this analysis for the Nestucca River Mainstem. **Figure 39** illustrates observed Wetted Widths and Depths and NSDZ widths for the Little Nestucca River and Three Rivers.

Figure 54. Current Condition and Potential Average Wetted Depth

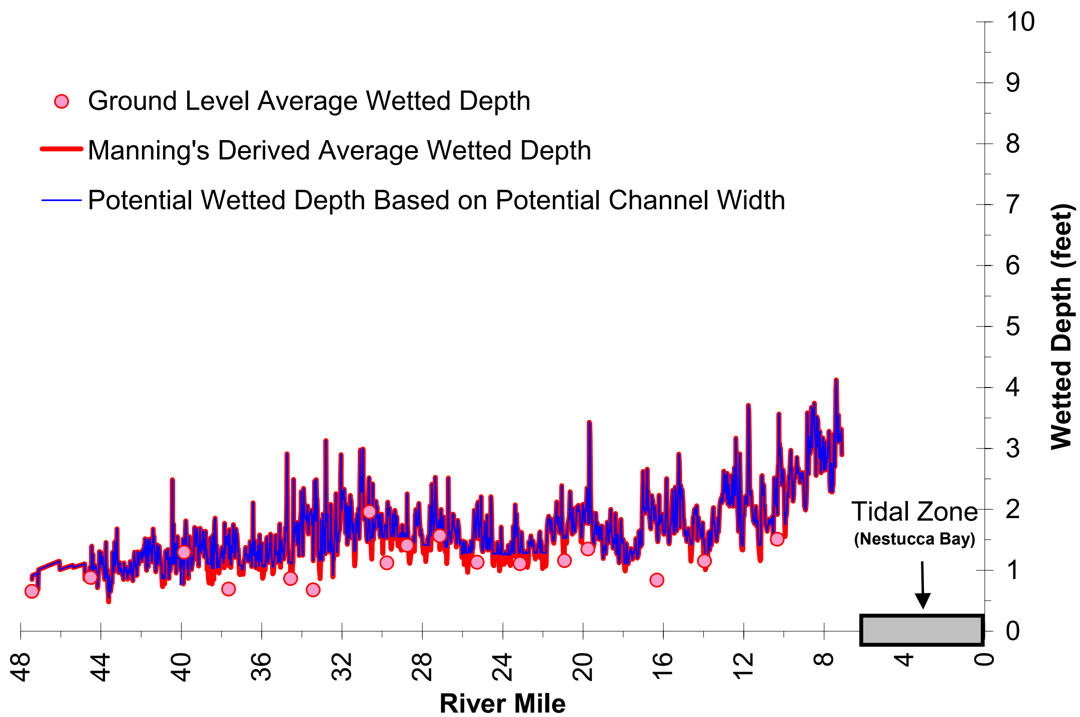
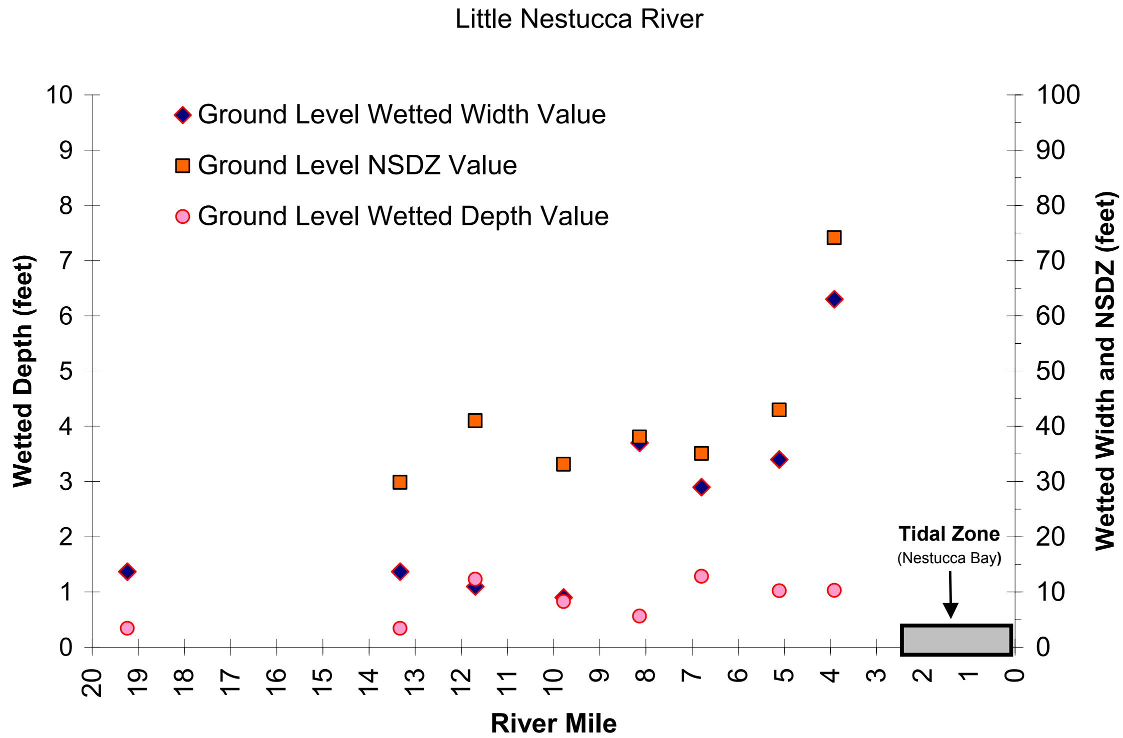
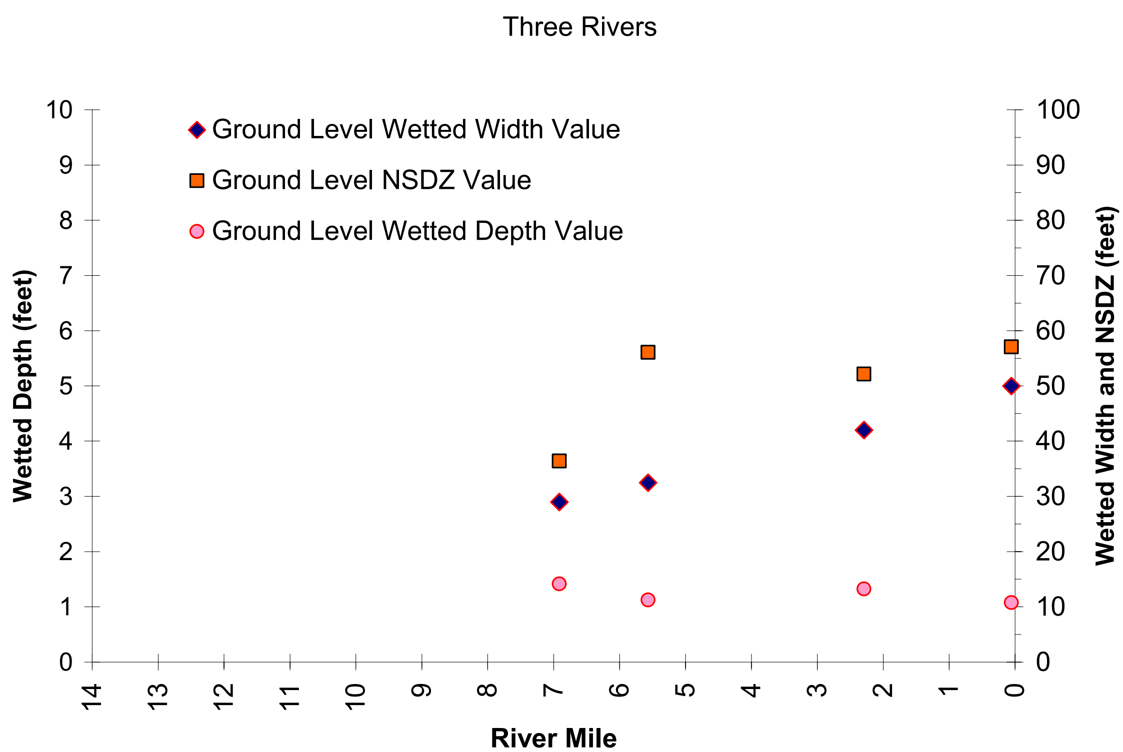


Figure 55. Observed Wetted Width and Depth and NSDZ in Three Rivers and Little Nestucca River

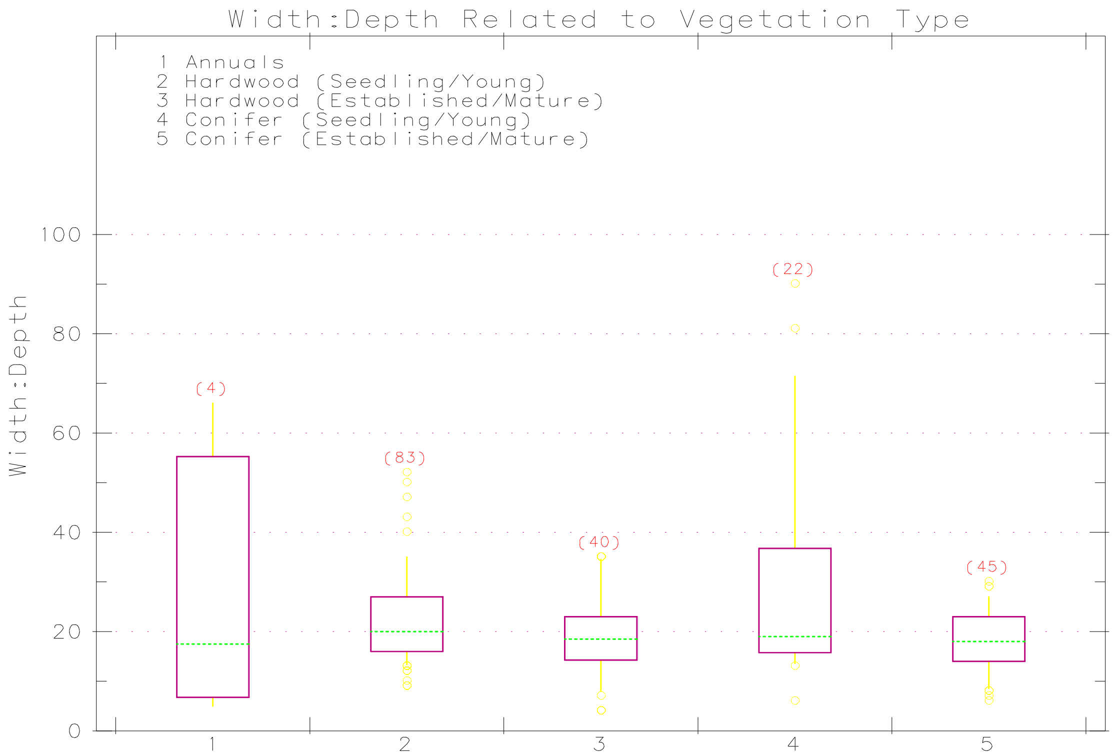




Width to Depth Ratio

The width to depth ratio is a common measure of channel morphology. A stream that has a naturally occurring (i.e. unarmored stream banks) low width to depth ratio would not be expected to have low stream bank erosion rates caused by mature near stream vegetation (i.e. increased rooting strength and floodplain roughness). ODFW stream survey data demonstrate the relationship between near stream vegetation and channel width. **Figure 40** displays various width:depth ratios related to various riparian vegetation types. Annual, hardwood and conifer width to depth ratio comparisons have similar median values (18.0 to 20.0). However, the variability represented in the data sets is markedly different. Annual (grassy) riparian vegetation communities have high width to depth ratio variability (7.0 to 57.0), indicating annual riparian vegetation types provide insufficient rooting strengths and/or flood plain roughness to prevent channel widening. Woody vegetaion correlates to less width:depth variability. Established/Mature hardwood and conifer riparian communities have the lowest variability

Figure 56. Width to Depth Ratios Related to Various Riparian Vegetation Types



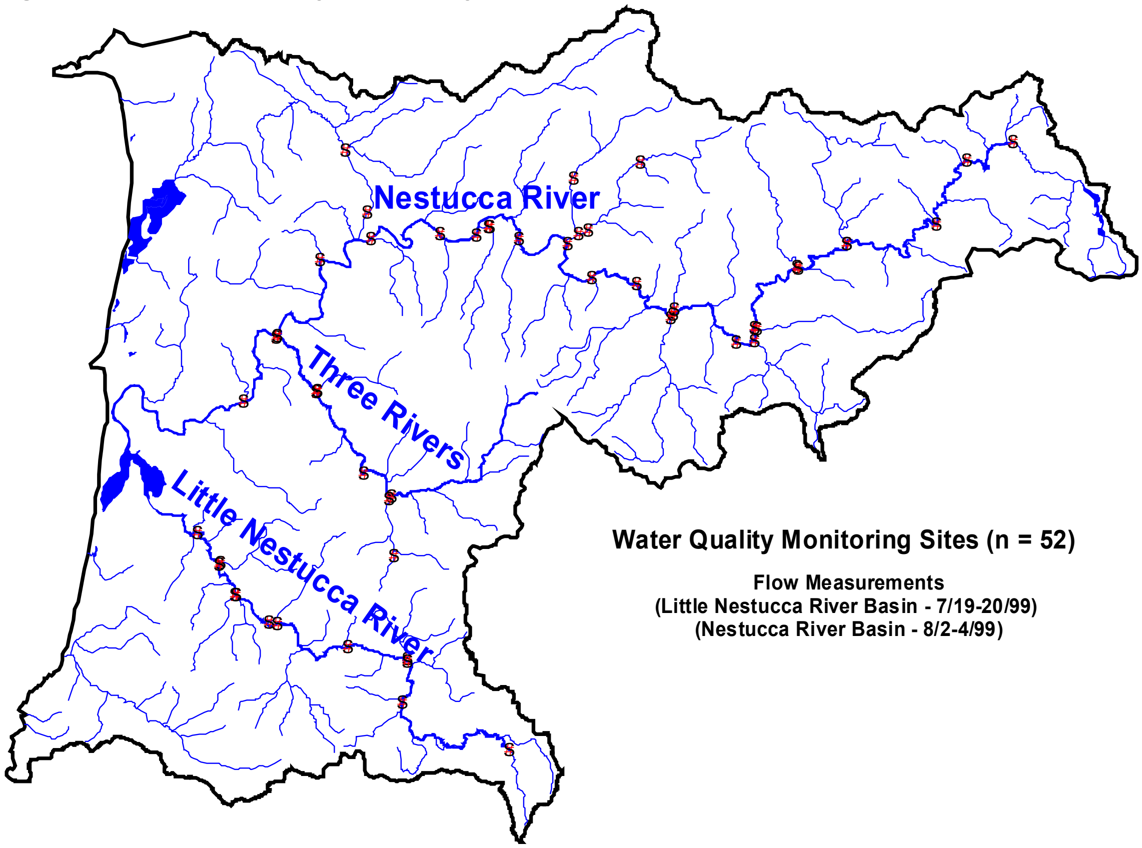
Thermal Role of Hydrology

Hydrological features of the rivers determine stream temperature. Flow volume and velocity directly limit the loading capacity of surface waters. Groundwater flow both augments volume and generally is of lower temperature than surface waters.

Flow Volume and Velocity

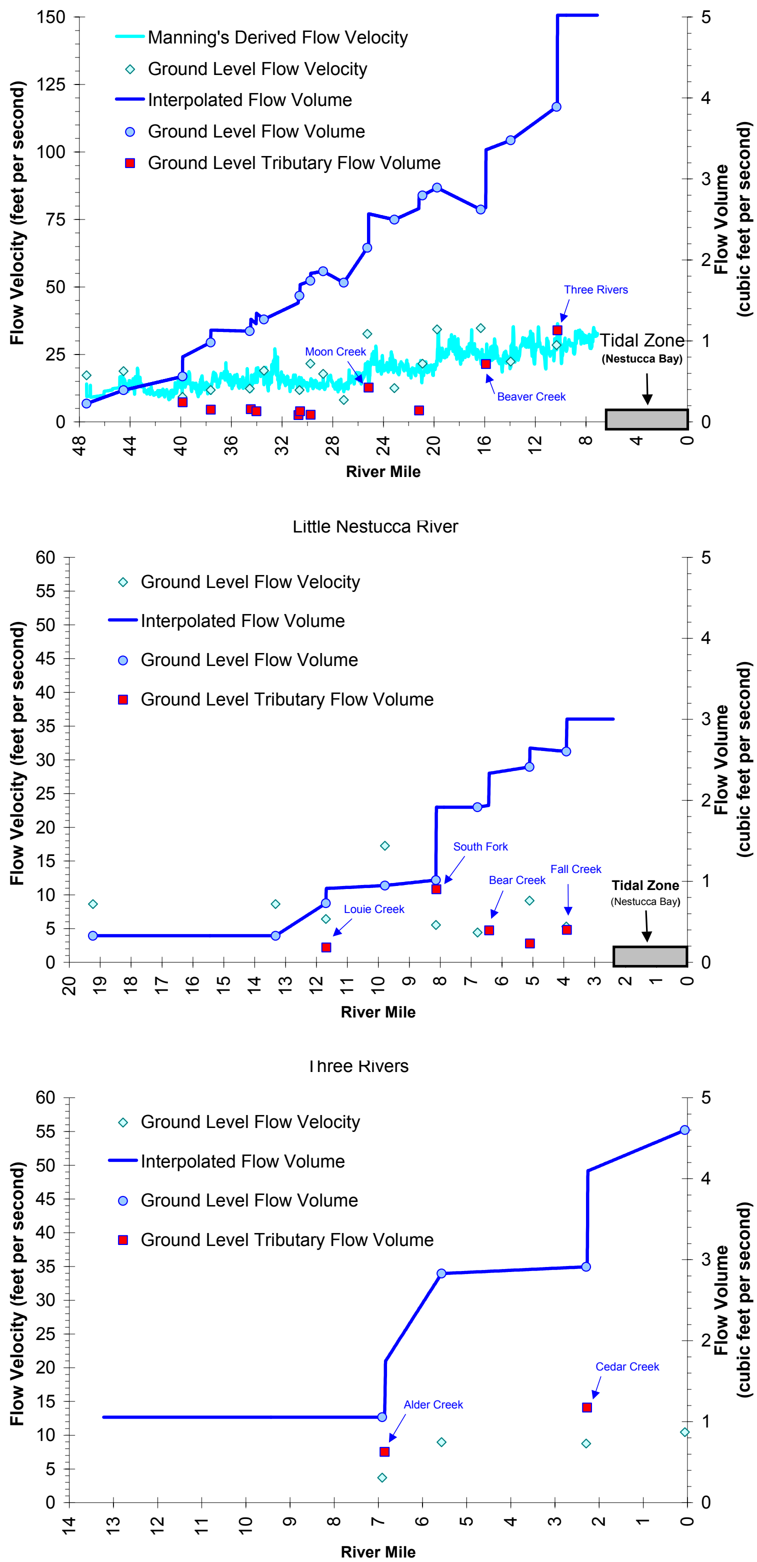
Stream temperature change is generally inversely related to flow volume. As flows decrease, stream temperature tends to increase if energy processes remain unchanged (Boyd, 1996). Runoff in the Nestucca Bay watersheds is primarily derived from rainfall precipitation, with peaks runoff typically occurring in the winter. Late summer low flows are common for many streams in the watershed due to low summer precipitation. 7Q10[9] low flows were calculated for the two gaged locations on the Nestucca River: Nestucca River near Fairdale (RM 48.5) 0.7 cfs and Nestucca River near Beaver (RM 13.6) 48.9 cfs. In addition, stream flow was sampled throughout the Nestucca and Little Nestucca watersheds during the summer of 1999 by DEQ staff (**Figure 34**). Flow profiles derived from these measurements are displayed in **Figure 35** and values are presented in **Appendix A**.

Figure 57. Flow Monitoring Sites during the summer of 1999.



[9] 7Q10 low flow is the average seven day interval with a return period of 10 years. This condition has a 10% probability of occurring during any one year.

Figure 58. Stream Flow Volume and Velocity



Stream flow is used extensively in this analysis for calculating Manning's equation for stream velocity and average wetted depth.

Manning's Equation,

$$Q = A \cdot V = 1.49 \cdot A \cdot \frac{1}{n} \cdot R_h^{\frac{2}{3}} \cdot S^{\frac{1}{2}}$$

which can be rearranged to calculate velocity,

$$V = 1.49 \cdot \frac{1}{n} \cdot R_h^{\frac{2}{3}} \cdot S^{\frac{1}{2}}$$

where,

- Q: Stream flow volume (ft^3/s)
- V: STREAM VELOCITY (FT/S)
- A: Wetted cross-sectional area (ft^2)
- R_h: Hydraulic radius (ft)
- S: Stream gradient
- n: Mannings's n

In addition to affecting wetted channel dimensions, stream velocity is used in the hydraulic routing of water downstream. Advection, the movement of water, is the primary means of mass transfer of water in the downstream direction. Travel times are largely a function of stream velocity. Therefore the effect of stream velocity is considerable in the temperature response of a stream system. Not only does stream velocity help shape the wetted channel (and the surface areas exposed to thermodynamic processes), but exposure times are also largely controlled by the rate of advective transfer of water downstream.

Groundwater Mixing

Groundwater inflow has a cooling effect on summertime stream temperatures. Subsurface water is insulated from surface heating processes. Groundwater temperatures fluctuate little and are cool (45^oF to 55^oF). Many land use activities that disturb riparian vegetation and associated flood plain areas may affect the surface water connectivity to groundwater sources. Groundwater inflow not only cools summertime stream temperatures, but also augments summertime flows. Reductions or elimination of groundwater inflow will have a compounding warming effect. The ability of riparian soils to capture, store and slowly release groundwater is largely a function of floodplain/riparian area health.

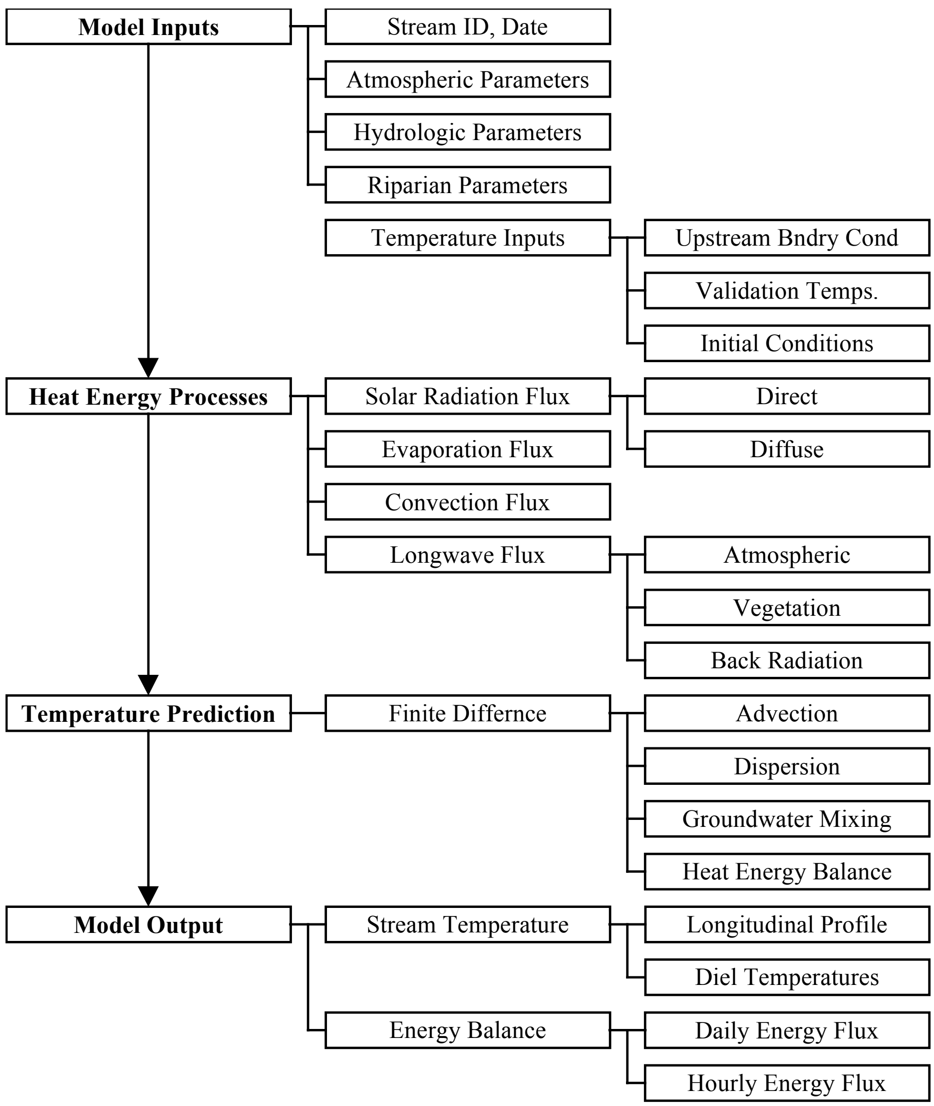
The effects of groundwater were not analyzed in the TMDL effort. The data required to assess the thermal effects of groundwater have not been collected in Nestucca Bay watershed. Forward-looking infrared radiometry collected via remote sensing provides the best tool to identify and analyze groundwater and surface stream temperature interactions. DEQ recommends such data collection for future groundwater/stream analysis.

Analytical Framework

Conceptual Model

At any particular instant of time, a defined stream reach is capable of sustaining a particular water column temperature. Stream temperature change that results within a defined reach is explained rather simply. The temperature of a parcel of water traversing a stream/river reach enters the reach with a given temperature. If that temperature is greater than the energy balance is capable of supporting, the temperature will decrease. If that temperature is less than energy balance is capable of supporting, the temperature will increase. Stream temperature change within a defined reach, is induced by the energy balance between the parcel of water and the surrounding environment and transport of the parcel through the reach. The general progression of the model is outlined in the model flow chart, **Figure 51**.

Figure 59. Temperature Model Flow Chart



It takes time for the water parcel to traverse the longitudinal distance of the defined reach, during which the energy processes drive stream temperature change. At any particular instant of time, water that enters the upstream portion of the reach is never exactly the temperature that is supported by the defined reach. And, as the water is transferred downstream, heat energy and hydraulic process that are variable with time and space interact with the water parcel and induce water temperature change. The described modeling scenario is a simplification; however, understanding the basic processes in which stream temperatures change occurs over the course of a defined reach and period of time is essential.

Governing Equations

Heat Energy Processes

Water temperature change is a function of the total heat energy transfer in a discrete volume and may be described in terms of energy per unit volume. It follows that large volume streams are less responsive to temperature change, and conversely, low flow streams will exhibit greater temperature sensitivity.

Equation A-1. Heat Energy per Unit Volume,

$$\Delta T_w \propto \frac{\Delta Heat \quad Energy}{Volume}$$

Water has a relatively high heat capacity ($c_w = 10^3$ cal kg^{-1} K^{-1}) (Satterlund and Adams 1992). Conceptually, water is a heat sink. Heat energy that is gained by the stream is retained and only slowly released back to the surrounding environment, represented by the cooling flux ($\Phi_{cooling}$). Heating periods occur when the net energy flux (Φ_{total}) is positive: ($\Phi_{heating} > \Phi_{cooling}$).

Equation A-2. Heat Energy Continuity,

$$\Phi_{total} = \Phi_{heating} - \Phi_{cooling}$$

In general, the net energy flux experienced by all stream/river systems follows two cycles: a seasonal cycle and a diurnal cycle. In the Pacific Northwest, the seasonal net energy cycle experiences a maximum positive flux during summer months (July and August), while the minimum seasonal flux occurs in winter months (December and January). The diurnal net energy cycle experiences a daily maximum flux that occurs at or near the sun's zenith angle, while the daily minimum flux often occurs during the late night or the early morning. It should be noted, however, that meteorological conditions are variable. Cloud cover and precipitation seriously alter the energy relationship between the stream and its environment.

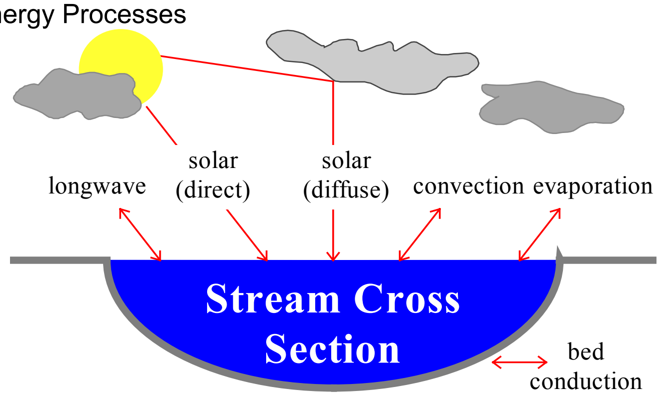
The net heat energy flux (Φ_{total}) consists of several individual thermodynamic energy flux components, namely: solar radiation (Φ_{solar}), long-wave radiation ($\Phi_{longwave}$), conduction ($\Phi_{conduction}$), groundwater exchange ($\Phi_{groundwater}$) and evaporation ($\Phi_{evaporation}$).

Equation A-3. Net Heat Energy Continuity,

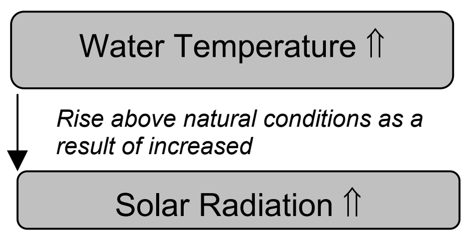
$$\Phi_{total} = \Phi_{solar} + \Phi_{longwave} + \Phi_{convection} + \Phi_{evaporation} + \Phi_{streambed} + \Phi_{groundwater}$$

Stream temperature is an expression of heat energy per unit volume, which in turn is an indication of the rate of heat exchange between a stream and its environment. The heat transfer processes that control stream temperature include solar radiation, longwave radiation, convection, evaporation and bed conduction (Wunderlich, 1972; Jobson and Keefer, 1979; Beschta and Weatherred, 1984; Sinokrot and Stefan, 1993; Boyd, 1996). With the exception of solar radiation, which only delivers heat energy, these processes are capable of both introducing and removing heat from a stream. **Figure A-21** displays heat energy processes that solely control heat energy transfer to/from a stream.

Figure 60. Heat Energy Processes



When a stream surface is exposed to midday solar radiation, large quantities of heat will be delivered to the stream system (Brown 1969, Beschta et al. 1987). Some of the incoming solar radiation will reflect off the stream surface, depending on the elevation of the sun. All solar radiation outside the visible spectrum (0.36µ to 0.76µ) is absorbed in the first meter below the stream surface and only visible light penetrates to greater depths (Wunderlich, 1972). Sellers (1965) reported that 50% of solar energy passing through the stream surface is absorbed in the first 10 cm of the water column. Removal of riparian vegetation, and the shade it provides, contributes to elevated stream temperatures (Rishel et al., 1982; Brown, 1983; Beschta et al., 1987). The principal source of heat energy delivered to the water column is solar energy striking the stream surface directly (Brown 1970). Exposure to direct solar radiation will often cause a dramatic increase in stream temperatures. The ability of riparian vegetation to shade the stream throughout the day depends on vegetation height, width, density and position relative to the stream, as well as stream aspect.



Both the atmosphere and vegetation along stream banks emit longwave radiation that can heat the stream surface. Water is nearly opaque to longwave radiation and complete absorption of all wavelengths greater than 1.2µ occurs in the first 5 cm below the surface (Wunderlich, 1972). Longwave radiation has a cooling influence when emitted from the stream surface. The net transfer of heat via longwave radiation usually balances so that the amount of heat entering is similar to the rate of heat leaving the stream (Beschta and Weatherred, 1984; Boyd, 1996).

Evaporation occurs in response to internal energy of the stream (molecular motion) that randomly expels water molecules into the overlying air mass. Evaporation is the most effective method of dissipating heat from water (Parker and Krenkel, 1969). As stream temperatures increase, so does the rate of evaporation. Air movement (wind) and low vapor pressures increase the rate of evaporation and accelerate stream cooling (Harbeck and Meyers, 1970).

Convection transfers heat between the stream and the air via molecular and turbulent conduction (Beschta and Weatherred, 1984). Heat is transferred in the direction of warmer to cooler. Air can have a warming influence on the stream when the stream is cooler. The opposite is also true. The amount of convective heat transfer between the stream and air is low (Parker and Krenkel, 1969; Brown, 1983). Nevertheless, this should not be interpretted to mean that air temperatures do not affect stream temperature.

Depending on streambed composition, shallow streams (less than 20 cm) may allow solar radiation to warm the streambed (Brown, 1969). Large cobble (> 25 cm diameter) dominated streambeds in shallow streams may store and conduct heat as long as the bed is warmer than the stream. Bed conduction may cause maximum stream temperatures to occur later in the day, possibly into the evening hours.

The instantaneous heat transfer rate experienced by the stream is the summation of the individual processes:

$$\Phi_{Total} = \Phi_{Solar} + \Phi_{Longwave} + \Phi_{Evaporation} + \Phi_{Convection} + \Phi_{Conduction}.$$

Solar Radiation (Φ_{Solar}) is a function of the solar angle, solar azimuth, atmosphere, topography, location and riparian vegetation. Simulation is based on methodologies developed by Ibqal (1983) and Beschta and Weatherred (1984). *Longwave Radiation* ($\Phi_{Longwave}$) is derived by the Stefan-Boltzmann Law and is a function of the emissivity of the body, the Stefan-Boltzmann constant and the temperature of the body (Wunderlich, 1972). *Evaporation* ($\Phi_{Evaporation}$) relies on a Dalton-type equation that utilizes an exchange coefficient, the latent heat of vaporization, wind speed, saturation vapor pressure and vapor pressure (Wunderlich, 1972). *Convection* ($\Phi_{Convection}$) is a function of the Bowen Ratio and terms include atmospheric pressure, and water and air temperatures. *Bed Conduction* ($\Phi_{Conduction}$) simulates the theoretical relationship ($\Phi_{Conduction} = K \cdot dT_b / dz$), where calculations are a function of thermal conductivity of the bed (K) and the temperature gradient of the bed (dT_b/dz) (Sinokrot and Stefan, 1993). Bed conduction is solved with empirical equations developed by Beschta and Weatherred (1984).

The ultimate source of heat energy is solar radiation both diffuse and direct. Secondary sources of heat energy include long-wave radiation, from the atmosphere and streamside vegetation, streambed conduction and in some cases, groundwater exchange at the water-stream bed interface. Several processes dissipate heat energy at the air-water interface, namely: evaporation, convection and back radiation. Heat energy is acquired by the stream system when the flux of heat energy entering the stream is greater than the flux of heat energy leaving. The net energy flux provides the rate at which energy is gained or lost per unit area and is represented as the instantaneous summation of all heat energy components.

Non-Uniform Heat Energy Transfer Equation

The rate change in stream temperature is driven by the heat energy flux (Φ_i). It is easily shown that a defined volume of water will attain a predictable rate change in temperature, provided an accurate prediction of the heat energy flux. The rate change in stream temperature (T) is calculated as shown in **Equation A-4**.

Equation A-4. Rate Change in Temperature Caused by Heat Energy Thermodynamics,

$$\frac{\partial T}{\partial t} = \left(\frac{Ax_i \cdot \Phi_i}{\rho \cdot c_p \cdot V_i} \right),$$

Which reduces to,

$$\frac{\partial T}{\partial t} = \left(\frac{\Phi_i}{\rho \cdot c_p \cdot D_i} \right).$$

Where,

Ax_i:	cross-sectional area (m^2)
C_p:	specific heat of water ($cal\ kg^{-1} \cdot {}^oC^{-1}$)

D_i:	average stream depth (m)
t:	time (s)
T:	Temperature (^oC)
V_i:	volume (m^3)
Φ_i:	total heat energy flux (cal $m^{-2} \cdot s^{-1}$)
ρ:	density of water (kg/m^3)

Advection (U_x) redistributes heat energy in the positive longitudinal direction. No heat energy is lost or gained by the system during advection, and instead, heat energy is transferred downstream as a function of flow velocity. In the case where flow is uniform, the rate change in temperature due to advection is expressed in the first order partial differential equation below.

Equation A-5. Rate Change in Temperature Caused by Advection,

$$\frac{\partial T}{\partial t} = -U_x \cdot \frac{\partial T}{\partial x}$$

Dispersion processes occur in both the upstream and downstream direction along the longitudinal axis. Heat energy contained in the system is conserved throughout dispersion, and similar to advection, heat energy is simply moved throughout the system. The rate change in temperature due to dispersion is expressed in the second order partial differential equation below.

Equation A-6. Rate Change in Temperature Caused by Dispersion,

$$\frac{\partial T}{\partial t} = D_L \cdot \frac{\partial^2 T}{\partial x^2}$$

The dispersion coefficient (D_L) may be calculated by stream dimensions, roughness and flow. In streams that exhibit high flow velocities and low longitudinal temperature gradients, it may be assumed that the system is advection dominated and the dispersion coefficient may be set to zero (Sinokrot and Stefan 1993). In the event that dispersion effects are considered significant, the appropriate value for the dispersion coefficient can be estimated with a practical approach developed and employed in the QUAL 2e model (Brown and Barnwell 1987). An advantage to this approach is that each parameter is easily measured, or in the case of Manning's coefficient (n) and the dispersion constant (K_d), estimated.

Equation A-7. Physical Dispersion Coefficient,

$$D_L = C \cdot K_d \cdot n \cdot U_x \cdot D^{\frac{5}{6}}$$

Where,

C:	Unit conversion C = 3.82 for English units C = 1.00 for Metric units
D:	Average stream depth (m)
D_L:	Dispersion coefficient (m^2/s)
K_d:	Dispersion constant
n:	Manning's coefficient
U_x:	Average flow velocity (m/s)

The simultaneous non-uniform one-dimensional transfer of heat energy is the summation of the rate change in temperature due to heat energy thermodynamics, advection and dispersion. Given that the stream is subject to steady flow conditions and is well mixed, transverse temperature gradients are negligible (Sinokrot and Stefan 1993). An assumption of non-uniform flow implies that cross-sectional area and flow velocity vary with respect to longitudinal position. The following second ordered parabolic partial differential equation describes the rate change in temperature for non-uniform flow.

Equation A-8. Non-Uniform One-dimensional Heat Energy Transfer,

$$\frac{\partial T}{\partial t} = -U_x \cdot \frac{\partial T}{\partial x} + D_L \cdot \frac{\partial^2 T}{\partial x^2} + \frac{\Phi}{c_p \cdot \rho \cdot D_i}$$

Steady Flow: $\frac{\partial U_x}{\partial t} = 0$

Non-Uniform Flow: $\frac{\partial U_x}{\partial x} \neq 0$

The solution to the *one-dimensional heat energy transfer equation* is essentially the summation of thermodynamic heat energy exchange between the stream system and the surrounding environment and physical processes that redistribute heat energy within the stream system. It is important to note that all heat energy introduced into the stream is conserved, with the net heat energy value reflected as stream temperature magnitude. Further, heat energy is transient within the stream system, due to longitudinal transfer of heat energy (i.e., advection and dispersion). The net heat energy flux (□) is calculated at every distance step and time step based on physical and empirical formulations developed for each significant energy component. The dispersion coefficient (D_L) is assumed to equal zero.

Boundary Conditions and Initial Values

The temperatures at the upstream boundary (i_o) for all time steps (t_o ,$t_{1,}$..., t_{M-1}, t_M) are supplied by the upstream temperature inputs. At the downstream boundary temperature at longitudinal position i_{n+1} is assumed to equals that of i_n with respect to time t. Initial values of the temperatures at each distance node (i_o ,$i_{1,}$..., i_{N-1}, i_N) occurring at the starting time (t_o) can be input by the model user or assumed to equal the boundary condition at time t_o.

Spatial and Temporal Scale

The lengths of the defined reaches are 100 feet. The temperature model is designed to analyze and predict stream temperature for one day and is primarily concerned with daily prediction of the diurnal energy flux and resulting temperatures on August 12, 1998. Prediction time steps are limited by stability considerations for the finite difference solution method.

Input Parameters

Data collected during this TMDL effort has allowed the development of temperature simulation methodology that is both spatially continuous and spans full day lengths (diurnal). Detailed spatial data sets have been developed for the following parameters:

- ✓ River and Tributary Digital Mapping at 1:5,000 scale,
- ✓ Riparian Vegetation Species, Size and Density Digital Mapping at 1:3,000 scale,
- ✓ West, East and South Topographic Shade Angles calculations at 1:5,000 scale (**Figure 34**),
- ✓ Stream Elevation and Gradient at 1:5,000 scale,
- ✓ Hydrology Developed from Field Data - Spatially Continuous Flow, Wetted Width, Velocity and Depth Profiles.

All input data is longitudinally referenced in the model allowing spatial and/or continuous inputs to apply to certain zones or specific river segments.

Spatial Input Parameters

Longitudinal Distance (meters): Defines the modeled reaches for which spatial input parameters reference. Model reaches are 100 feet each, are derived from DOQ 1:5000 river layer digitized from Digital Orthophoto Quarter Quads (DOQQs), and are measured in the downstream direction.

Elevation (meters): Sampled for each model reach either from Digital Raster Graphic (DRG) or Digital Elevation Model (DEM).

Gradient (%): Is the difference between the upstream and downstream elevations divided by the reach length.

Bedrock (%): The percent of streambed material that has a diameter of 25 cm or greater. Values are derived from stream survey data or assumed where data is limited.

Aspect (decimal degrees from North): Calculated for each reach break (**see Figure 33**) and represents the direction of stream flow.

Flow Volume (cubic meters per second): Measured by DEQ with standard USGS protocols with interpolation between flow measurement sites, while taking into account known water withdrawals and inputs.

Flow Velocity (meters per second): Derived from Manning's equation and Leopold power functions calibrated to measured flow velocity data.

Wetted Width (meters): Derived from Manning's equation and Leopold power functions calibrated to measured wetted width data.

Average Depth (meters): Derived from Manning's equation and Leopold power functions calibrated to measured average depth data. Calculated based on assuming rectangular channel.

Near-Stream Disturbance Zone Width (meters): Based upon ODEQ field measurements and USGS reported values.

Channel Incision (meters): Depth of the active channel below riparian terrace or floodplain. Measured by ODEQ and reported by USGS.

Riparian Height (meters): Obtained from WODIP satellite vegetation coverage and ODEQ field observations.

Canopy Density (%): Obtained from WODIP vegetation coverage and aerial photograph (DOQ) interpretation.

Riparian Overhang (meters): Distance of riparian vegetation intrusion over Near-Stream Disturbance Zone. Based on ODEQ field observations.

Topographic Shade Angle (decimal degrees): The angle made between the stream surface and the highest topographic features to the west, east and south as calculated from DEM at each stream reach (**Figure 34**).

Continuous Input Parameters

Wind Speed (meters per second): Hourly values.

Relative Humidity (%): Hourly values.

Air Temperature (^oC): Hourly values measured.

Stream Temperature (^oC): Hourly values measured by ODEQ.

Tributary Temperature (^oC): Hourly values measured by ODEQ.

Tributary/Flow Volume (cubic meters per second): Measured flow volumes for all major tributaries.

Data Source Descriptions

Existing Vegetation:

1. WODIP satellite vegetation coverage that has been delineated into polygons according to vegetation species, size, and canopy density (BLM, 1999). The pixel size of this data is 25 meters. Tree sizes were presented as diameter at breast height (DBH) ranges. The mid-range DBH was used to calculate approximate heights for each species. All coverage was verified using Digital Orthophoto Quarter Quads (DOQQs) or Digital Orthophoto Quads (DOQs). (**Figure A-25**)
2. In agricultural areas, WODIP overlooked narrow riparian buffers. In these areas, ODEQ digitized the vegetation from DOQQs at a 1:3000 scale (**Figure A-22**). Canopy densities were assigned according to aerial photograph (DOQQ) interpretation, while heights were assigned based upon field measurements. Additionally, roads were digitized from the DOQQs for all areas.

<u>Digital Elevation Models (DEM)</u>: 30-meter DEMs are available for the entire state of Oregon. These DEMs have a 30-meter pixels, each of which have an elevation associated with it.

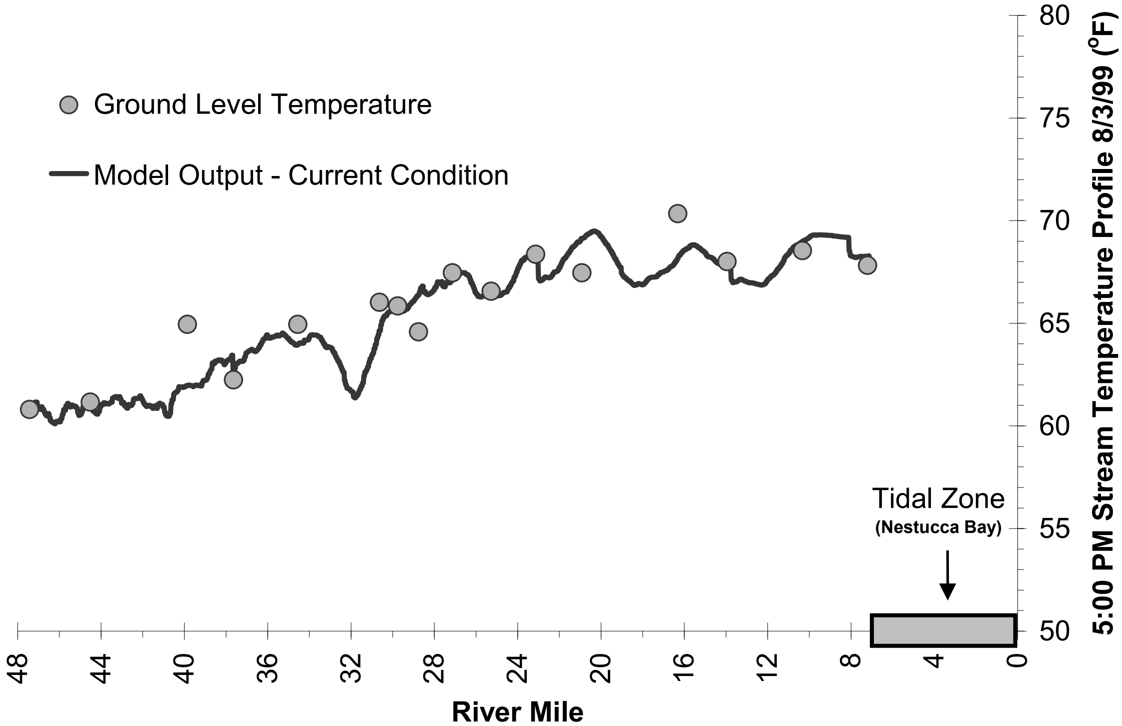
<u>Digital Orthophoto Quarter Quads (DOQQs)</u>: DOQQs for the Nestucca Bay Watershed are available from the United States Geologic Survey (the aerial photos were taken in 1995). USGS DOQQs correspond to the topographic map quarter quadrants.

Stream Temperature Simulation Results

Current Condition Simulation

Stream temperature was simulated for 40.2 miles in mainstem of the Nestucca River. The longitudinal profiles of calibrated and measured stream temperature are presented in **Figure 45**. Model performance statistics are presented in **Figure 46**.

Figure 61. Nestucca River Calibrated Longitudinal Model Output Compared to Ground Level Temperature Data



System Potential Simulation

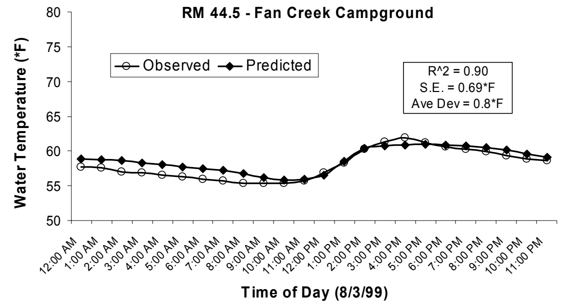
Simulations were performed by increasing near stream vegetation to potential height, width and density as described in **Vegetation** and adjusting channel morphology as described in **Channel Width and Near Stream Disturbance Zone**, above. Simulations are presented in **Figures 47** and **48**. Significant reductions in daily maximum stream temperature resulted from system potential conditions. Diurnal temperature fluctuations were also moderated. Daily minimum stream temperatures were reduced slightly.

Individual near stream vegetation and channel morphology simulations were performed. Results from these single parameter simulations confirm the importance of both riparian vegetation and channel morphology as stream parameters that influence stream heating processes in the Nestucca River mainstem.

Figure 62. Calibration Statistics for the mainstem Nestucca temperature model.

OVERALL SUMMARY

- CALIBRATION SAMPLES (N) =360 HOURLY TEMPERATURE SAMPLES
- CORRELATION COEFFICIENT (R^2) = 0.89
- STANDARD ERROR = 1.1°F
- AVERAGE DEVIATION = 1.0°F



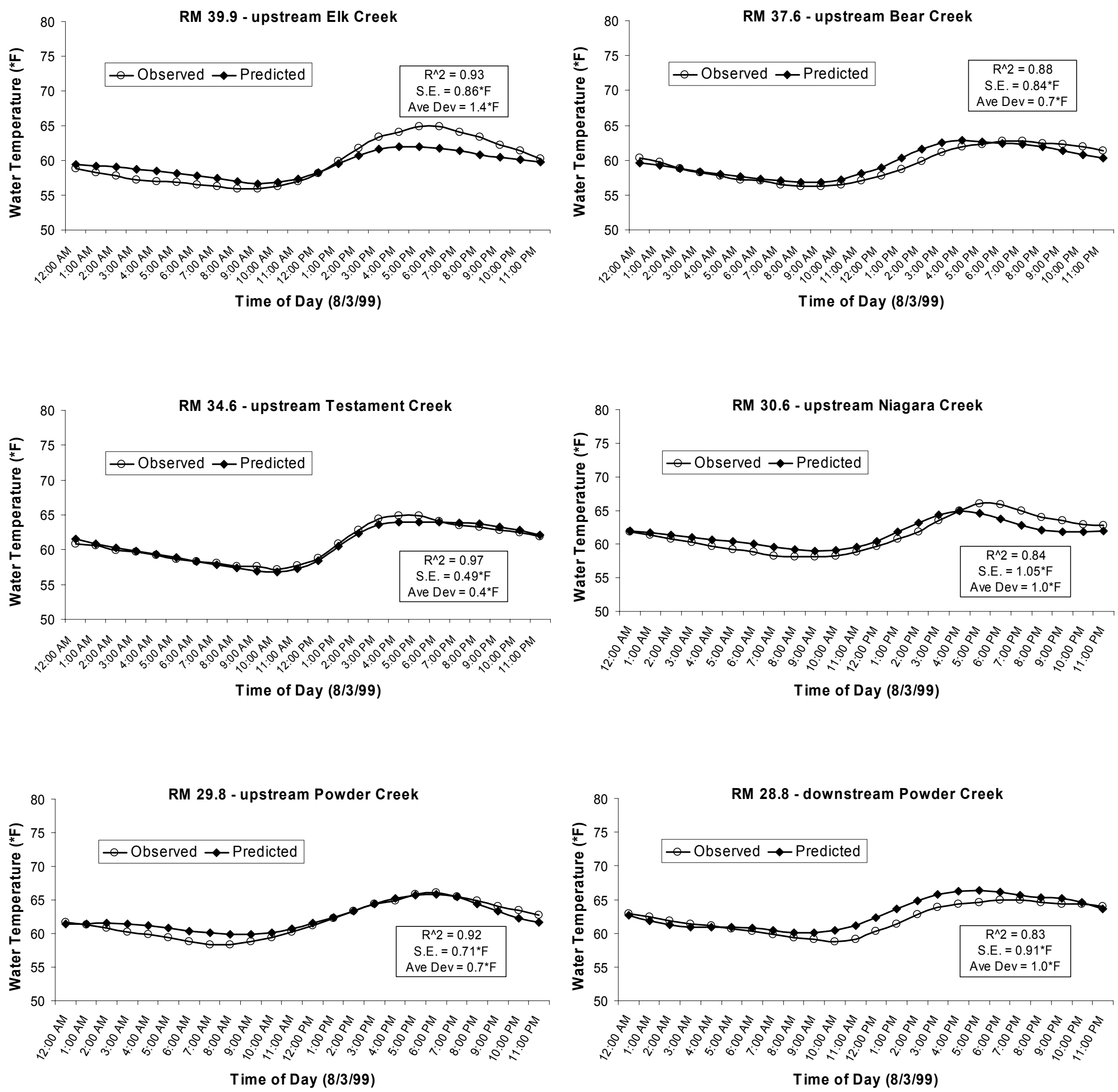


Figure 46 (continued). Calibration Statistics for the mainstem Nestucca temperature model.

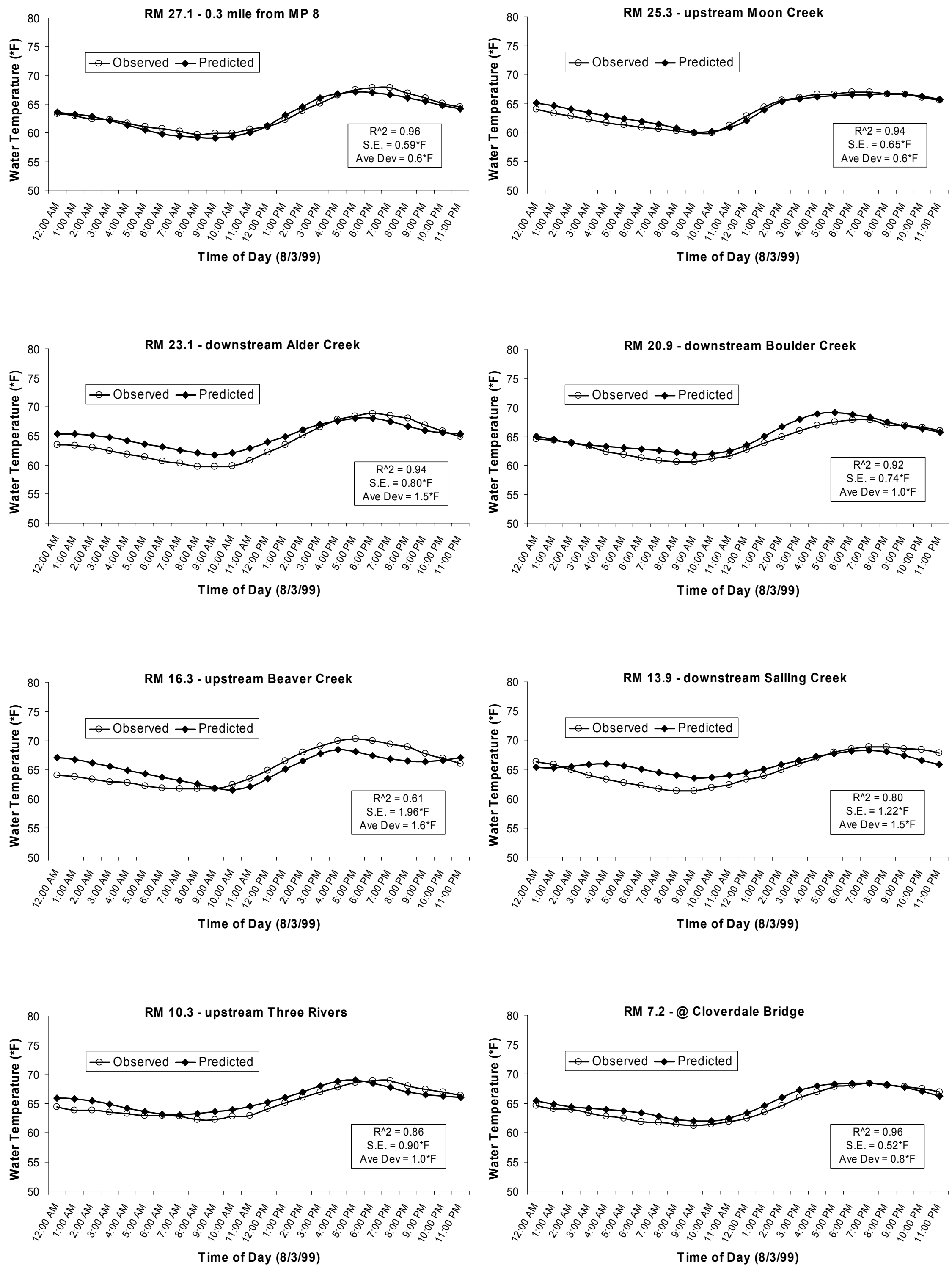


Figure 63. Nestucca River Model Output for Potential Near Stream Vegetation and Potential Channel Morphology(August 3, 1999 - 5:00 PM)

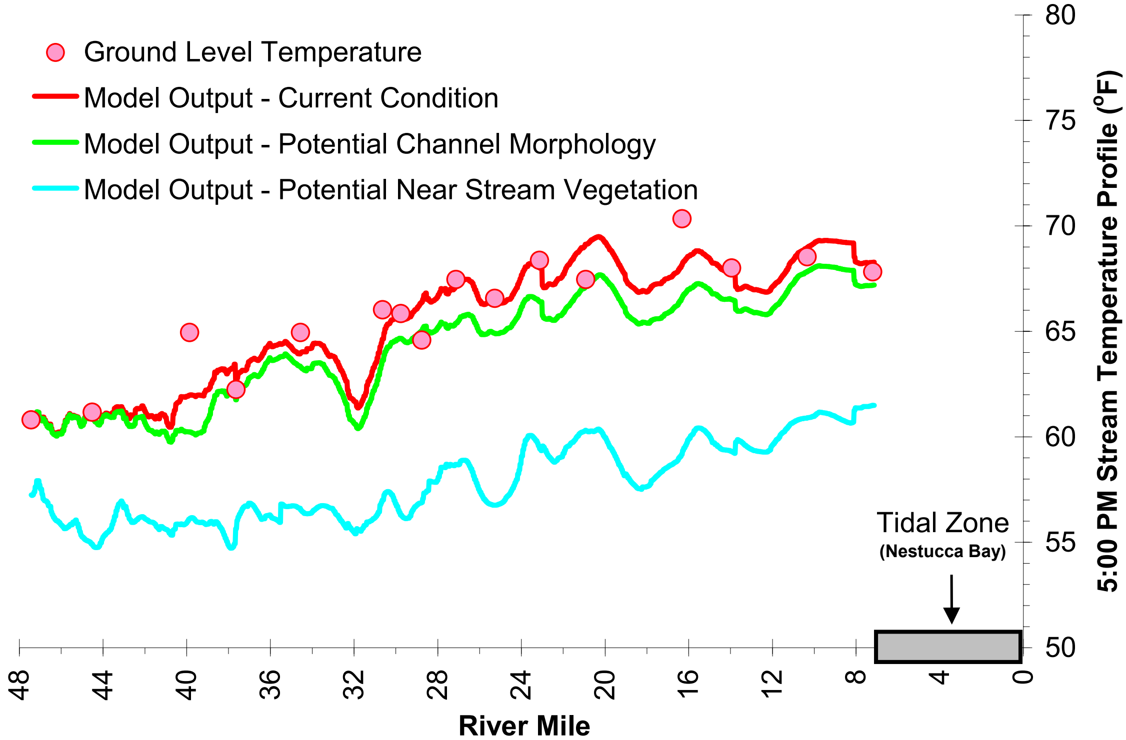
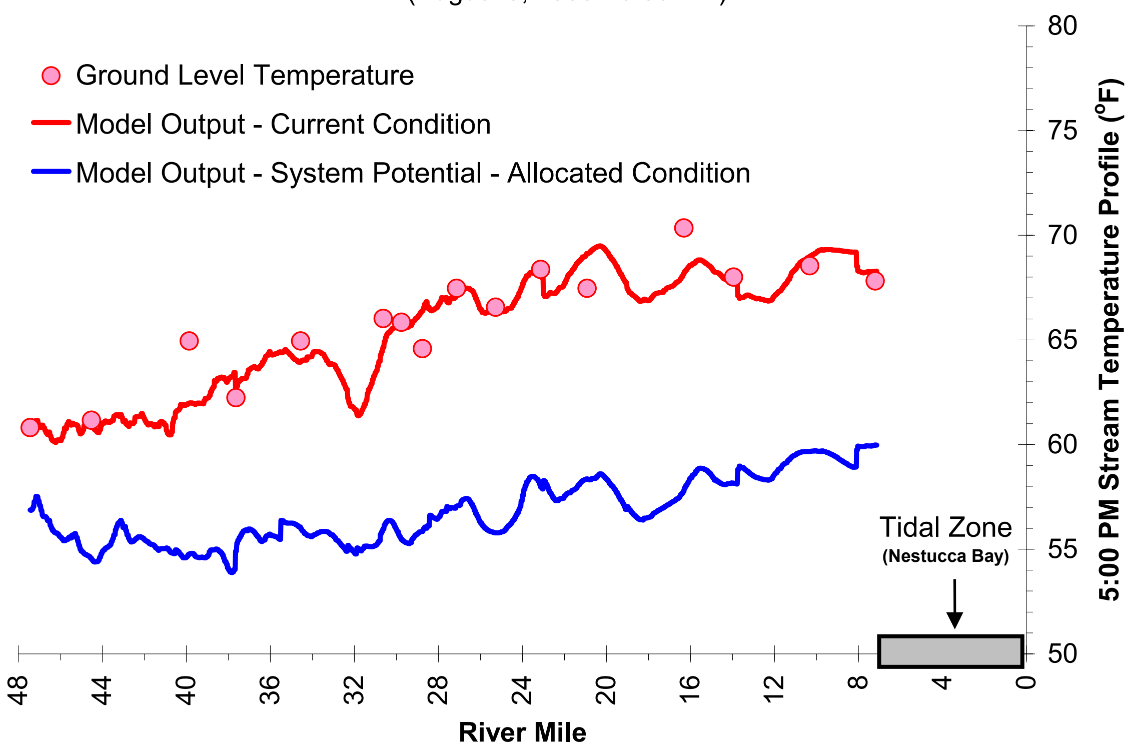


Figure 64. Nestucca River System Potential Longitudinal Maximum Temperatures (August 3, 1999 - 5:00 PM)



APPENDIX B: BACTERIA

Bacteria Model Description

DEQ used an event based, unit load model to evaluate bacteria loading in the Nestucca Bay Watershed. The model uses estimated storm volume, runoff concentrations for various land uses, and bacteria decay rates to predict total bacteria concentration and loads in the streams. Five major geographic databases were used in this project: soils, land use, precipitation pattern, watersheds, and distance from the stream. These five databases were overlaid in ArcView to create a composite GIS database. This composite data set was used for estimating storm volume, travel time of overland flow in the watershed, the bacteria decay rate as function of the travel time, and bacteria load. These parameters were modeled for all locations in the watershed.

Estimates of flow and ultimate instream bacterial concentrations were calibrated to measured flows and bacteria from a storm survey in February 2000. Stations sampled during this storm were distributed throughout the Nestucca Bay Watershed, with special emphasis on the mainstem of the Nestucca River.

Loading capacity was determined through an estimate of the dilution ratio provided by mixing of river water with seawater that is practically free of bacteria. The allocations of runoff concentration to each of the land uses considered was determined by adjusting runoff concentrations until the resultant concentration at the mouth of each river met the limit set by application of the shellfish harvesting criterion adjusted by the dilution ration. Each of these parameters is discussed below.

Storm Volume

Runoff volume was estimated using the Soil Conservation Service Curve Number (SCS CN) approach (Novotny and Olem, 1994). The curve number calculations are as follows:

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

Where:
Q= the runoff volume (ft^3)
P= precipitation (inches)
S= storage (inches)

Storage is calculated as follows:

$$S = \frac{1000}{CN} - 10$$

The curve numbers (CN) are read from SCS tables and vary by land use, hydrologic soil group, percent ground cover and antecedent moisture conditions (AMC). **Table14** summarizes CNs for various land uses under average moisture conditions with good vegetation cover (McCuen 1998).

Table 28. Curve Number Summary

	Curve Numbers for Hydrologic Soil Group			
Land Use	**A**	**B**	**C**	**D**
Open spaces	39	61	74	80
Streets and Roads	83	89	92	93
Commercial	89	92	94	95
Residential	51	68	79	84
Pasture	39	61	74	80
Forest	32	58	72	79

The curve numbers can be adjusted for the level of moisture in the soil or the antecedent moisture condition (AMC). The AMC is determined by examination of precipitation records for the basin and are described in **Table 15** (McCuen 1998):

Condition **I**: Soils dry but not to wilting point; satisfactory cultivation has taken place
Condition **II**: Average conditions
Condition **III**: Heavy rainfall, or light rainfall and low temperatures have occurred within the last five days; saturated soil

Table 29. Definitions of Antecedent Moisture Conditions

	Total 5 day antecedent rainfall (inches)	
AMC	Dormant Season	Growing Season
I	Less than 0.5	Less than 1.4
II	0.5 - 1.1	1.4 -2.1
III	Over 1.1	Over 2.1

The CN for average conditions is adjusted for the AMC according to the following equations:

$$CN(I) = \frac{4.2CN(II)}{10 - 0.058CN(II)}$$

$$CN(III) = \frac{23CN(II)}{10 + 0.13CN(II)}$$

Flow Calibration

The rainfall distribution was estimated using spatial patterns of precipitation in the watershed from long term precipitation maps generated by the PRISM model (Daly, et al. 1994, digital maps are available for Oregon). During the February 2000 storm event, stream flow was measured twice at multiple locations in the watershed. To convert this flow, measured as cubic feet per second (cfs), to a storm volume, the flow is multiplied by the storm length as follows:

$$Volume(ft^3) = \frac{ft^3}{\sec} * 60 * \frac{\sec}{\min} * 60 * \frac{\min}{hour} * 24 * \frac{hour}{day} * 3days$$

Table 30. Summary of Flow Volume Results

5th Field Watershed	**6th Field Watershed**	**Average storm flow (cfs)**	**Storm length (days)**	**Storm volume (ft^3)**
Three Rivers	Hebo	294	3	76204800
Little Nestucca	Nesco Bridge	364	3	94348800
Beaver Creek	Beaver at HWY 101	133	3	34473600

Because the measured flow includes baseflow and storm flow, an estimate of baseflow was added to the storm volume generated by the model. Estimates of baseflow were obtained from the record of daily average stream flow for the gage on the Nestucca River near Beaver (WRD Gage: 14303600, using data from 1/90-9/95). The unit hydrograph method of separation was applied to separate the storm hydrographs into baseflow and storm runoff (Dunne and Leopold, 1978). The average of the winter storm baseflow was added to the modeled storm volume for the February 2000 storm calibration.

Table 31. Summer and Winter Baseflow Estimates

Season	Baseflow (ft^3/sec)
Summer	163
Winter	579

The modeled storm volume (baseflow and storm runoff) was compared to the measured average storm volume for the sampling period. Agreement was calculated using a measure of the relative percent difference (RPD) and the % error. Runoff coefficients were adjusted until the volumes with the lowest measures of error were attained. The error calculations are as follows:

% error $=\sum (F_O - F_S)/F_O$;

$$RPD_{total} = \left(\frac{(F_O - F_S)}{(F_O + F_S / 2}\right)$$

where F_o is the observed flow, F_s is the simulated flow

Table 32. Summary of Flow Error Calculations for February 2000 storm event

6th Field watershed	Soil condition	Rainfall (in)	Measured volume (ft^3)	Modeled volume (ft^3)	Relative Percent Difference	Percent Error
Hebo	dry, forest +40%	1.72	76204800	78382812	-0.0282	-0.029
Nesco Bridge	dry, forest +40%	1.72	94348800	82478306	0.134	0.126
Beaver at Hwy 101	dry, forest +40%	1.72	34473600	51284580	-0.392	-0.488

Land Use and Point Source Concentration

Table 33. *E coli* concentrations for sources

Forest Land Use: The forest land use concentration was based on samples collected from forest runoff in the Nestucca bay basin. The flow weighted average runoff concentration for a forested site was 10 MPN/100 mL. The forest land use concentration was also adjusted in the model to approximate the average instream concentration of 10 MPN/100 mL measured at the forested site.

Residential Land Use: No residential outfalls were identified in the Nestucca Bay basin. The runoff concentration of 1400 MPN/100 mL was based on samples collected from an urban storm water outfall at Cloverdale Bridge collected during the February 2000 storm event.

Urban Land Use: The runoff concentration of 1400 MPN/100 mL was based on samples collected from an urban storm water outfall at Cloverdale bridge collected during the February 2000 storm event.

Pasture Land Use: Pasture land use was assumed to include animal grazing. The runoff concentration was based on the range of values from samples collected from agricultural operations in the Nestucca Bay basin during the February 2000 storm event. Flow weighted averages from 3 outfalls ranged from 3400 MPN/100 mL to 14000 MPN/100 mL.

CAFOs: CAFO locations and number of adult animals were provided by Oregon Department of Agriculture. Bacteria contributions from CAFOs were assumed to include manure application on fields. Manure was assumed to be spread on 1/2 acre per adult animal (Dean Moburg, NRCS, personal communication). Runoff concentrations were based on the range of runoff concentrations recorded in the Nestucca Bay basin.

Point Sources: E coli concentrations and flow from the waste water treatment plants were taken from Discharge Monitoring Reports covering (approximately) the period of January 1999 to July 2000.

Septic Systems: No sanitary survey information was available for the Nestucca Bay basin. According to the county sanitarian, the area around the town of Beaver is most likely to have failing septic systems due to the age of the systems (Wes Greenwood, personal communication). Using data from “ODEQ Final Report Oregon On site Experimental Systems Program, December 1982”, the flow and concentration of septic tank effluent was estimated. It was assumed that 100% of the effluent flowed overland. The resulting load is calculated by the following equation:

(200 gallons/day)(3.7854 L/gallon)(1000ml/1 L)(20000 counts/100 ml) = 1.51×10^8 counts/day

Bacteria Decay

Overland Decay

The bacterial decay rate during overland flow was estimated based on the travel time of the water to the major streams. The travel time of water (hydrologic time of concentration) was estimated using a kinematic wave equation (Chow ET al, 1988):

Travel Time (minutes) = $T = (6.93L^{0.6}n^{0.6})/(i^{0.4} S^{0..3})$

Where:

L = Slope length (meters)
n = Manning's n
i = Rainfall Intensity (mm/hr)
S = Slope (m/m)

The generalized slopes derived from STATSGO were adjusted using the 30 meter Digital Elevation Model *(citation).* The Manning's n values were based on land uses (Chow ET al, 1988). To estimate the slope length, values within the GIS database were grouped together into concentric zones. The slope length was then the distance to major streams for each zone.

Decay is based on the first order decay equation. According to Moore (1982) there is a lack of data in the literature on correlation of other decay models to decay in soil and water systems.

First order decay (Moore, 1982):

$$\frac{N_t}{N_o} = 10^{-kt}$$

Where:

- N_t = number of bacteria at time t
- N_o = number of bacteria at time zero
- t = time in days
- k = first order decay rate constant

The first order decay rates can be adjusted in the model, but an overland decay rate of 0.6 per day was used in the Nestucca Bay basin. This value is the median decay rate for *E coli* in manure (Moore, 1988).

Instream Decay

An additional decay rate was incorporated into the stream to account for loss during travel time from each watershed. The instream bacteria decay rate was adjusted for temperature using the following equation (Tchobanoglous, 1985).:

$$(K)_T = (K)_{20}(\Theta)^{T-20}$$

Where:

Θ is the temperature coefficient

K_T = decay rate at temperature T

K_{20} = decay rate at 20°C

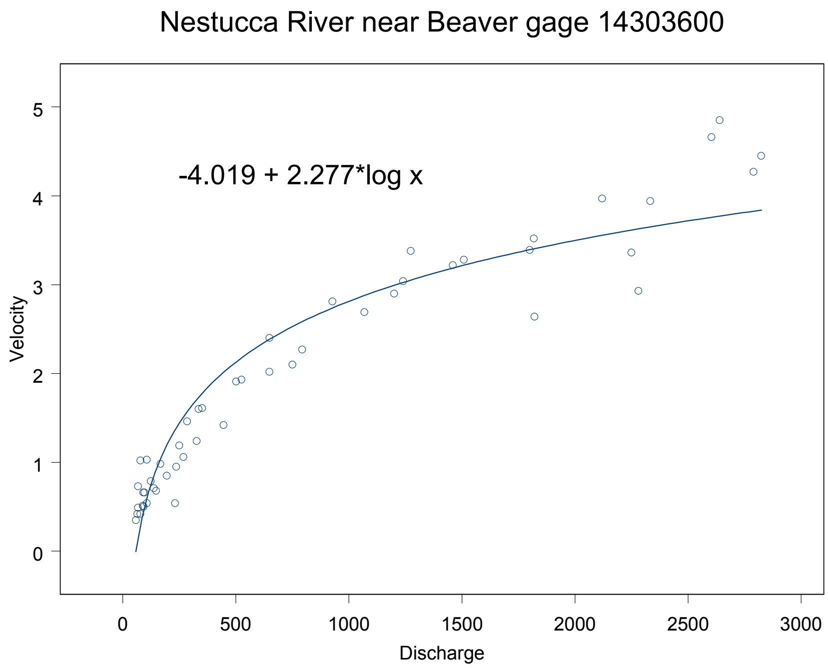
Using laboratory data (Moore 1982), the average Θ was 1.1. Theta (Θ) was then applied to a field determined K (from Moore 1982) using temperatures measured instream. Using a Θ value of 1.1 and a temperature of 9°C, a decay rate (K) of 3 was calculated for the February 2000 storm event. This decay rate of 3 was used for storms occurring in the period of October through May. For June through September storms, the decay rates were based on the same value of theta and temperature estimates developed in the temperature modeling in this document TMDL. Ultimate temperatures were based on expected system potential conditions as indicated in **Table 20**.

Table 34. Decay Rates Adjusted for Temperature

Basin	Winter Temperature (°C)	Winter Decay Rates	Summer Temperature Allocation (°C)	Summer Decay Rate
Three Rivers	9	3	15.6	8
Nestucca River	9	3	15.6	8
Little Nestucca River	9	3	17.2	10

The instream travel time was estimated for each storm. A regression of velocity and flow was developed for the Nestucca River based on data from the WRD gage at Beaver (Gage: 14303600) to apply velocities for the various flow rates **(Figure 49)** and determine time of travel to the river mouth from the discharge.

Figure 65. Nestucca River Flow and Velocity Regression



Bacteria Calibration Results

The total bacteria load was estimated by the product of: the flow, the source concentrations and the decay rate. The bacteria loads for all the polygons in a watershed were summed and divided by the flow volume to obtain an instream bacteria concentration. Model parameters were altered slightly until the modeled concentrations were similar to the instream concentrations measured during the February 2000 storm event. Similarity was based on the lowest values of error overall based on estimates of Relative Percent Difference and Percent Error as defined above in **Flow Calibration**. The differences between modeled and measured concentrations were compared to samples collected in the February 2000 storm event **(Table 8)**.

Table 35. Model versus measured concentration error estimates for February 2000 storm event

Landuse Bacterial Runoff Concentrations (MPN/100 ml)			
Pasture	**Impervious (cts/100mL)**	**CAFOS**	**Other Uses Forestry**
4000	1400	10000	10

Watershed	**Measured Geomean**	**Modeled Instream Conc (cts/100ml)**	**Calculated Error**	
			Relative Percent Difference (RPD)	**Percent ERROR**
Alder Glen	**4**	9	0.732	-1.153
Beaver (nestucca)	**65**	19	1.11	0.714
Beaver (Beaver)	**44**	17	0.870	0.606
Mouth Three Rivers	**13**	34	0.886	-1.59
Cloverdale	**56**	87	0.433	-0.553
Woods	**163**	101	0.469	0.380
Mouth (Little Nestucca)	**14**	34	0.841	-1.45

TMDL Calculations

Loading Capacity:

The loading capacity is set to meet the shellfish consumption criterion in Nestucca Bay. The criterion is a median concentration of 14 counts/100 ml, with no more than 10% of the samples exceeding 43 counts/100 ml. The concentration at the mouth of the Nestucca River and the Little Nestucca River to meet the bay concentration of 14 was calculated.

Dilution Ratio

In order to calculate the dilution in Nestucca Bay basin due to freshwater inputs, a conservative tracer was used. Solving a mass balance using salinity as the tracer yields:

Equation 1

$$Q_f C_f + Q_s C_s = C_b (Q_f + Q_s)$$

Where:

Q_f = freshwater flow

C_f = freshwater salinity = 0

Q_s = seawater flow

C_s = seawatersalinity(35 ppt)

C_b = bay salinity

$$Q_s C_s = C_b (Q_f + Q_s) - Q_f C_f$$

$$C_s = \frac{C_b (Q_f + Q_s) - Q_f C_f}{Q_s}$$

$$C_s = \frac{C_b Q_f}{Q_s} + \frac{C_b Q_s}{Q_s} - \frac{Q_f C_f}{Q_s}$$

$$C_S = C_b \frac{Q_f}{Q_s} + C_b - \frac{Q_f}{Q_s} C_f$$

$$C_s = C_b + \frac{Q_f}{Q_s}(C_b - C_f)$$

$$\frac{C_s - C_b}{C_b - C_f} = \frac{Q_f}{Q_s}$$

Where: $C_f = 0$

$$\frac{C_s - C_b}{C_b} = \frac{Q_f}{Q_s}$$

Equation 2

$$\frac{C_b}{C_s - C_b} = \frac{Q_s}{Q_f} = \frac{\text{bay salinity}}{\text{seawater salinity - bay salinity}}$$

Solving a mass balance for bacteria in the Bay and assuming seawater has no bacteria:
Equation 3

$$\frac{C_f Q_f + C_s Q_s}{Q_s + Q_f} = C_b$$

Where:

Q_f = freshwater flow

C_f = concentration of bacteria in freshwater

C_s = concentration of bacteria in seawater = 0

Q_s = seawater flow

C_b = concentration of bacteria in the bay = 14 CFU/100ml

$$\frac{C_f Q_f}{Q_s + Q_f} = C_b$$

$$C_f = C_b \frac{(Q_s + Q_f)}{Q_f}$$

$$\frac{C_f}{C_b} = \frac{Q_s + Q_f}{Q_f}$$

$$\frac{C_f}{C_b} = \frac{Q_s}{Q_f} + \frac{Q_f}{Q_f}$$

$$\frac{C_f}{C_b} = \frac{Q_s}{Q_f} + 1$$

$$C_f = \left\{ \left(\frac{Q_s}{Q_f} \right) + 1 \right\} * C_b$$

Substituting the dilution from equation 2:

Equation 4

$$C_f = \left\{ \frac{\text{bay salin.}}{\text{seawater salin. - bay salin.}} + 1 \right\} * C_b$$

As stated previously, the criteria concentration for bacteria in the bay is 14 counts/100 ml, expressed as a median. The average salinity of the bay was calculated for one site in each of the lobes of Nestucca Bay. The salinity of seawater was taken from Snoeyink and Jenkins (1980) and Tchobanoglous (1985). The results of this calculation are summarized in **Tables 23 and 24**.

Table 36. Dilution ratios for stations within Nestucca Bay calculated from samples collected during dry-weather and wet-weather conditions.

Dilution Ratios For Stations within Nestucca Bay	**August 1999**		**February 2000**	
Site	**Average Salinity**	**Dilution Factor**	**Average Salinity**	**Dilution factor**
Little Nestucca River at Hwy 101	18	2.0		
Nestucca Bay 0.5 mile d/s Fischer Landing	23	3.0	9	1
Nestucca Bay East Lobe at Mouth	26	3.9		
Nestucca Bay East Lobe at West Channel	25	3.4	18	2
Nestucca Bay Near Mouth	31	9.0	23	3
Nestucca Bay West Lobe at East Channel (Mid Bay)	29	6.0	22	3

Table 37. Dilution Factors at River Mouths

Station Description	**Waterbody**	**Dilution +1**	**Fecal Coliform Target at Mouth**	***E. coli* Target at Mouth**[1]
Nestucca Bay West Lobe at East Channel	Nestucca River	3	42	28
Nestucca Bay East Lobe at West Channel	Little Nestucca River	2	28	18

1 = Based on regression between analyses of split sample. See Appendix B.

Using equation 4, the average allowable fecal coliform bacteria concentration is 28 counts/100ml at the mouth of the Little Nestucca River and 42 at the mouth of the Nestucca River. These values are set as the loading capacity at the mouths of each of the rivers.

E. coli versus Fecal Coliform Concentrations

While the bay criterion is expressed as fecal coliform, the fresh water criterion is expressed as *E coli*. Moreover, modeling in the rivers used E. coli data and produced allocation values in terms of E. coli. To determine the allowable fecal coliform concentration within the rivers, regressions between *E coli* and fecal coliform were calculated and applied to the allocations (Cude 2001). Ultimate allocations that had been modeled with E. coli data were reduced to fecal coliform concentrations by application of the regression equation:

$$(E.\ coli) = 0.530855 * (\text{fecal coliform})^{1.05652}$$

This regression was based on paired fecal coliform and E. coli samples collected simultaneously from the same waterbodies throughout the state **(Figure 50)**. Stratification into different basins did not improve the regression, although removal of estimated concentrations did. Although the regression is significant (r^2=0.754 and p<0.001), predictions of individual values of fecal coliform concentration from the equation will result in appreciable error.

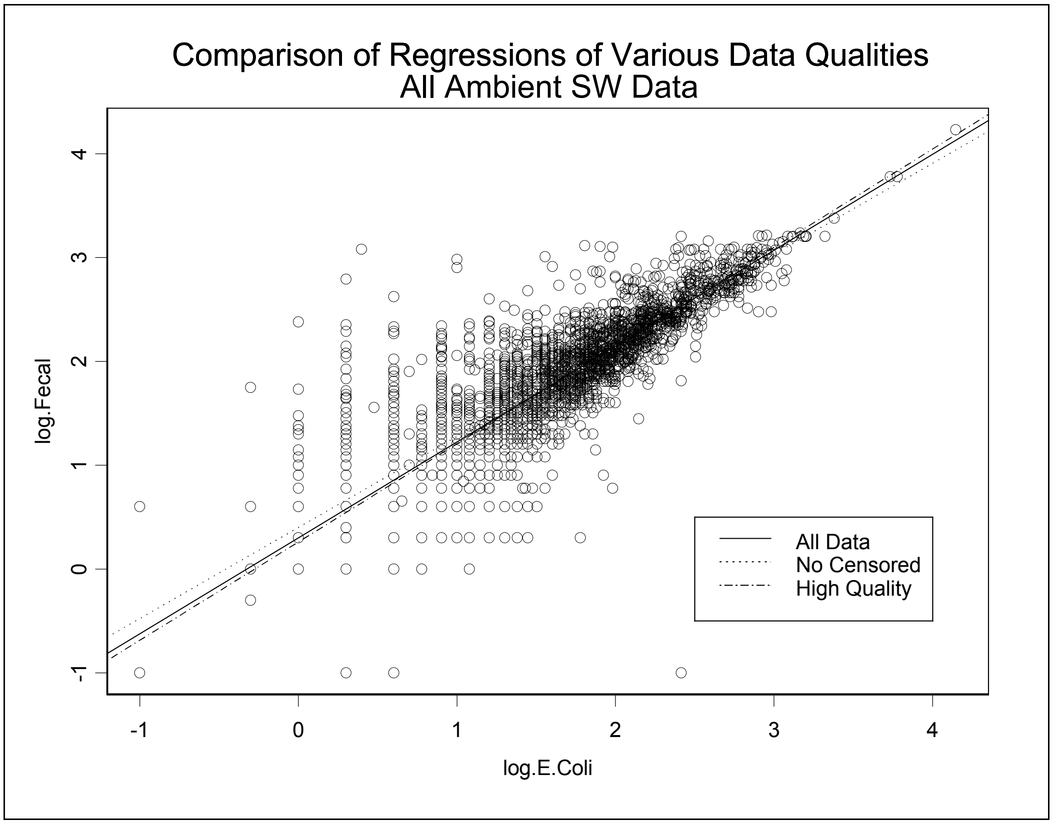


Figure 66. Regression of E. coli concentration as a function of fecal coliform concentration. The regression included 878 pairs of samples from the ODEQ ambient monitoring program. The coefficient of determination (r^2) was 0.754.

Point Source Allocations and Instream Decay

Estimates of instream decay were also applied to point source allocations based on the same decay coefficients and temperature estimates as used for nonpoint sources **(Table 24)**. Decay was applied to each point source by estimating travel time for the distance from the mouth of the river to the discharge, and the river's velocity for the period being considered (i.e., summer, or fall-winter-spring). An allocation was based on the concentration that would decay to the target at the mouth of the river given the time of travel and temperature of the water. Targets were adjusted to reflect *E. coli* concnetrations. Where the resultant concentration was above the recreational criterion, the criterion became the allocation.

Table 38. Decay rates and discharge limits for Sewage Treatment Plants in the Nestucca River.

Flow Regime[1]	Flow	Velocity fps
Winter 90th%	4023	4.19
Winter 50th%	1370	3.12
Summer 90th%	643	2.38
Summer 50th%	183	1.14

STP	Distance From Mile 0
Hebo	10.21
Cloverdale	6.99
Pacific City	1.97

Hebo	**Three Rivers**	**RM 0.68**	**Nestucca River**	**RM 10.21**	**t**
	Velocity fps	distance ft	seconds	hours	days
	4.19	53908.8	12866	3.57	0.15
	3.12	53908.8	17278	4.80	0.20
	2.38	53908.8	22651	6.29	0.26
	1.14	53908.8	47288	13.14	0.55
		k	Decay Rate	Effluent Limit	
			10^(-kt)	28/10^kt	90/10^(-kt)
Winter	High Flow	3	0.36	78.3	251.8
	Low Flow	3	0.25	111.5	358.3
Summer	High Flow	8	0.01	3503.1	11259.9
	Low Flow	8	0.00	669446.0	2151790.6
Cloverdale	**Nestucca River**		**RM 6.99**		**t**
	Velocity fps	distance ft	seconds	hours	days
	4.19	36907.2	8808	2.45	0.10
	3.12	36907.2	11829	3.29	0.14
	2.38	36907.2	15507	4.31	0.18
	1.14	36907.2	32375	8.99	0.37
		k	Decay Rate	Effluent Limit	
			10^(-kt)	28/10^kt	90/10^(-kt)
Winter	High Flow	3	0.49	56.6	182.0
	Low Flow	3	0.39	72.1	231.7
Summer	High Flow	8	0.04	763.9	2455.3
	Low Flow	8	0.00	27849.6	89516.5
Pacific City	**Nestucca River**	**RM 1.97**			**t**
	Velocity fps	distance ft	seconds	hours	days
	4.19	10401.6	2482	0.69	0.03
	3.12	10401.6	3334	0.93	0.04
	2.38	10401.6	4370	1.21	0.05
	1.14	10401.6	9124	2.53	0.11
		k	Decay Rate	Effluent Limit	
			10^(-kt)	28/10^kt	90/10^(-kt)
Winter	High Flow	3	0.82	34.1	109.8
	Low Flow	3	0.77	36.6	117.5
Summer	High Flow	8	0.39	71.1	228.5
	Low Flow	8	0.14	195.9	629.6

APPENDIX C: OREGON ADMINISTRATIVE RULES

[SELECTED] DEFINITIONS

340-04l-0006

(5) "Estuarine Waters" means all mixed fresh and oceanic waters in estuaries or bays from the point of oceanic water intrusion inland to a line connecting the outermost points of the headlands or protective jetties.

7) "Marine Waters" means all oceanic, offshore waters outside of estuaries or bays and within the territorial limits of the State of Oregon.

(9) "Pollution" means such contamination or other alteration of the physical, chemical, or biological properties of any waters of the state, including change in temperature, taste, color, turbidity, silt, or odor of the waters, or such radioactive or other substance into any waters of the state which either by itself or in connection with any other substance present, will or can reasonably be expected to create a public nuisance or render such waters harmful, detrimental, or injurious to public health, safety, or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses or to livestock, wildlife, fish or other aquatic life, or the habitat thereof.

(11) "Sewage" means the water-carried human or animal waste from residences, buildings, industrial establishments, or other places together with such groundwater infiltration and surface water as may be present. The admixture with sewage as herein defined of industrial wastes or wastes, as defined in sections (6) and (l3) of this rule, shall also be considered "sewage" within the meaning of this division.

14) "Waters of the State" include lakes, bays, ponds, impounding reservoirs, springs, wells, rivers, streams, creeks, estuaries, marshes, inlets, canals, the Pacific Ocean within the territorial limits of the State of Oregon, and all other bodies of surface or underground waters, natural or artificial, inland or coastal, fresh or salt, public or private (except those private waters which do not combine or effect a junction with natural surface or underground waters), which are wholly or partially within or bordering the state or within its jurisdiction.

(15) "Low Flow Period" means the flows in a stream resulting from primarily groundwater discharge or baseflows augmented from lakes and storage projects during the driest period of the year. The dry weather period varies across the state according to climate and topography. Wherever the low flow period is indicated in the Water Quality Management Plans, this period has been approximated by the inclusive months. Where applicable in a waste discharge permit, the low flow period may be further defined.

(17) "Non-point Sources" refers to diffuse or unconfined sources of pollution where wastes can either enter into -- or be conveyed by the movement of water to -- public waters.

(18) "Loading Capacity (LC)" -- The greatest amount of loading that a water can receive without violating water quality standards.

(19) "Load Allocation (LA)" -- The portion of a receiving water's loading capacity that is attributed either to one of its existing or future non-point sources of pollution or to natural background sources. Load allocations are best estimates of the loading which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting loading. Whenever possible, natural and non-point source loads should be distinguished.

(20) "Wasteload Allocation (WLA)" -- The portion of a receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution. WLAs constitute a type of water quality-based effluent limitation.

(21) "Total Maximum Daily Load (TMDL)" -- The sum of the individual WLAs for point sources and LAs for non-point sources and background. If a receiving water has only one point source discharger, the TMDL is the sum of that point source WLA plus the LAs for any non-point sources of pollution and natural background sources, tributaries, or adjacent segments. TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure. If Best Management Practices (BMPs) or other non-point source pollution controls make more stringent load allocations practicable, then wasteload allocations can be made less stringent. Thus, the TMDL process provides for non-point source control tradeoffs.

30) "Water Quality Limited" can mean one of the following categories:
(a) A receiving stream which does not meet instream water quality standards during the entire year or defined season even after the implementation of standard technology;
(b) A receiving stream which achieves and is expected to continue to achieve instream water quality standard but utilizes higher than standard technology to protect beneficial uses;
(c) A receiving stream for which there is insufficient information to determine if water quality standards are being met with higher than standard treatment technology or where through professional judgment the receiving stream would not be expected to meet water quality standards during the entire year or defined season without higher than standard technology.
(31) "Reserve Capacity" means that portion of a receiving stream's loading capacity which has not been allocated to point sources or non-point sources and natural background as waste load allocations or load allocations, respectively. The reserve capacity includes that loading capacity which has been set aside for a safety margin and is otherwise unallocated.

40) "Critical Habitat" means those areas which support rare, threatened or endangered species, or serve as sensitive spawning and rearing areas for aquatic life.

(51) "Cold-Water Aquatic Life" -- The aquatic communities that are physiologically restricted to cold water, composed of one or more species sensitive to reduced oxygen levels. Including but not limited to *Salmonidae* and cold-water invertebrates.

54) "Numeric Temperature Criteria" are measured as the seven-day moving average of the daily maximum temperatures. If there is insufficient data to establish a seven-day average of maximum temperatures, the numeric criteria shall be applied as an instantaneous maximum. The measurements shall be made using a sampling protocol appropriate to indicate impact to the beneficial uses;
(55) "Measurable Temperature Increase" means an increase in stream temperature of more than 0.25°F;
(56) "Anthropogenic", when used to describe "sources" or "warming", means that which results from human activity;

[SELECTED] POLICIES AND GUIDELINES GENERALLY APPLICABLE TO ALL BASINS

340-04l-0026
Temperature
340-041-0026(3)(a)
(D) Effective July 1, 1996, in any waterbody identified by the Department as exceeding the relevant numeric temperature criteria specified for each individual water quality management basin identified in OAR 340-041-0205, OAR-340-041-0245, OAR-340-041-0285, OAR-340-041-0325, OAR-340-041-0365, OAR-340-041-0445, OAR-340-041-0485, OAR-340-041-0525, OAR-340-041-0565, OAR-340-041-0605, OAR-340-041-0645, OAR-340-041-0685, OAR-340-041-0725, OAR-340-041-0765, OAR-340-041-0805, OAR-340-041-0845, OAR-340-041-0885, OAR-340-041-0925, OAR-340-041-0965, and designated as water quality limited under Section 303(d) of the Clean Water Act, the following requirements shall apply to appropriate watersheds or stream segments in accordance with priorities established by the Department. The Department may determine that a plan is not necessary for a particular stream segment or segments within a water-quality limited basin based on the contribution of the segment(s) to the temperature problem:

(i) Anthropogenic sources are required to develop and implement a surface water temperature management plan which describes the best management practices, measures, and/or control technologies which will be used to reverse the warming trend of the basin, watershed, or stream segment identified as water quality limited for temperature;

(ii) Sources shall continue to maintain and improve, if necessary, the surface water temperature management plan in order to maintain the cooling trend until the numeric criterion is achieved or until the Department, in consultation with the Designated Management Agencies (DMAs), has determined that all feasible steps have been taken to meet the criterion and that the designated beneficial uses are not being adversely impacted. In this latter situation, the temperature achieved after all feasible steps have been taken will be the temperature criterion for the surface waters covered by the applicable management plan. The determination that all feasible steps have been taken will be based on, but not limited to, a site-specific balance of the following criteria: protection of beneficial uses; appropriateness to local conditions; use of best treatment technologies or management practices or measures; and cost of compliance;

(iii) Once the numeric criterion is achieved or the Department has determined that all feasible steps have been taken, sources shall continue to implement the practices or measures described in the surface water temperature management plan in order to continually achieve the temperature criterion;

(iv) For point sources, the surface water temperature management plan will be part of their National Pollutant Discharge Elimination System Permit (NPDES);

(v) For nonpoint sources, the surface water temperature management plan will be developed by designated management agencies (DMAs) which will identify the appropriate BMPs or measures;

(vi) A source (including but not limited to permitted point sources, individual landowners and land managers) in compliance with the Department or DMA (as appropriate) approved surface water temperature management plan shall not be deemed to be causing or contributing to a violation of the numeric criterion if the surface water temperature exceeds the criterion;

(E) Waters of the state exceeding the temperature criteria will be identified in the Clean Water Act (CWA), Section 303(d) list developed by the Department according to the schedule required by the Clean Water Act. This list will be prioritized in consul-tation with the DMAs to identify the order in which those waters will be addressed by the Department and the DMAs;

(
F) In basins determined by the Department to be exceeding the numeric temperature criteria, and which are required to develop surface water temperature management plans, new or increased discharge loads from point sources which require an NPDES permit under Section 402 of the Clean Water Act or hydro-power projects which require certification under Section 401 of the Clean Water Act are allowed a 1.0°F total cumulative increase in surface water temperatures as the surface water temperature management plan is being developed and implemented for the water quality limited basin if:

(i) In the best professional judgment of the Department, the new or increased discharge load, even with the resulting 1.0°F cumulative increase, will not conflict with or impair the ability of a surface water temperature management plan to achieve the numeric temperature criteria; and

(ii) A new or expanding source must demonstrate that it fits within the 1.0°F increase and that its activities will not result in a measurable impact on beneficial uses. This latter showing must be made by demonstrating to the Department that the temperature change due to its activities will be less than or equal to 0.25°F under a conservative approach or by demonstrating the same to the EQC with appropriate modeling.

(G) Any source may petition the Department for an exception to paragraph (F) of this subsection, provided:

(i) The discharge will result in less than 1.0°F increase at the edge of the mixing zone, and subparagraph
(ii) (ii) or (iii) of this paragraph applies;

(ii) The source provides the necessary scientific information to describe how the designated beneficial uses would not be adversely impacted; or

(iii) The source demonstrates that:

(I) It is implementing all reasonable management practices;

(II) Its activity will not significantly affect the beneficial uses; and

(III) The environmental cost of treating the parameter to the level necessary to assure full protection would outweigh the risk to the resource.

(H) Any source or DMA may petition the Commission for an exception to paragraph (F) of this subsection, provided:

(i) The source or DMA provides the necessary scientific information to describe how the designated beneficial uses would not be adversely impacted; or

(ii) The source or DMA demonstrates that:

(I) It is implementing all reasonable management practices;

(II) Its activity will not significantly affect the beneficial uses; and

(III) The environmental cost of treating the parameter to the level necessary to assure full protection would outweigh the risk to the resource.

Bacteria
340-041-0026(3)(a)(I)
(I) In waterbodies designated by the Department as water-quality limited for bacteria, and in accordance with priorities established by the Department, development and implementation of a bacteria management plan shall be required of those sources that the Department determines to be contributing to the problem. The Department may determine that a plan is not necessary for a particular stream segment or segments within a water-quality limited basin based on the contribution of the segment(s) to the problem. The bacteria management plans will identify the technologies, BMPs and/or measures and approaches to be implemented by point and nonpoint sources to limit bacterial contamination. For point sources, their National Pollutant Discharge Elimination System permit is their bacteria management plan. For nonpoint sources, the bacteria management plan will be developed by designated management agencies (DMAs) which will identify the appropriate BMPs or measures and approaches.

OREGON ADMINISTRATIVE RULES – NORTH COAST BASIN

340-041-0205

Water Quality Standards Not to be Exceeded (To be Adopted Pursuant to ORS 468.735 and Enforceable Pursuant to ORS 468.720, 468.990 and 468.992)

(1) Notwithstanding the water quality standards contained below, the highest and best practicable treatment and/or control of wastes, activities, and flows shall in every case be provided so as to maintain dissolved oxygen and overall water quality at the highest possible levels and water temperatures, coliform bacteria concentrations, dissolved chemical substances, toxic materials, radioactivity, turbidities, color, odor, and other deleterious factors at the lowest possible levels.

(2) No wastes shall be discharged and no activities shall be conducted which either alone or in combination with other wastes or activities will cause violation of the following standards in the waters of the North Coast -- Lower Columbia River Basin:
b) Temperature: The changes adopted by the Commission on January 11, 1996, become effective July 1, 1996. Until that time, the requirements of this rule that were in effect on January 10, 1996, apply. The method for measuring the numeric temperature criteria specified in this rule is defined in OAR 340-041-0006(54):
(A) To accomplish the goals identified in OAR 340-041-0120(11), unless specifically allowed under a Department-approved surface water temperature management plan as required under OAR 340-041-0026(3)(a)(D), no measurable surface water temperature increase resulting from anthropogenic activities is allowed:
(i) In a basin for which salmonid fish rearing is a designated beneficial use, and in which surface water temperatures exceed 64.0°F (17.8°C);
(ii) In the Columbia River or its associated sloughs and channels from the mouth to river mile 309 when surface water temperatures exceed 68.0°F (20.0°C);
(iii) In waters and periods of the year determined by the Department to support native salmonid spawning, egg incubation, and fry emergence from the egg and from the gravels in a basin which exceeds 55.0°F (12.8°C);
(iv) In waters determined by the Department to support or to be necessary to maintain the viability of native Oregon bull trout, when surface water temperatures exceed 50.0°F (10.0°C);
(v) In waters determined by the Department to be ecologically significant cold-water refugia;
(vi) In stream segments containing federally listed Threatened and Endangered species if the increase would impair the biological integrity of the Threatened and Endangered population;
(vii) In Oregon waters when the dissolved oxygen (DO) levels are within 0.5 mg/l or 10 percent saturation of the water column or intergravel DO criterion for a given stream reach or sub-basin;
(viii) In natural lakes.
(B) An exceedance of the numeric criteria identified in subparagraphs (A)(i) through (iv) of this subsection will not be deemed a temperature standard violation if it occurs when the air temperature during the warmest seven-day period of the year exceeds the 90th percentile of the seven-day average daily maximum air temperature calculated in a yearly series over the historic record. However, during such periods, the anthropogenic sources must still continue to comply with their surface water temperature management plans developed under OAR 340-041-0026(3)(a)(D);
(C) Any source may petition the Commission for an exception to subparagraphs (A)(i) through (viii) of this subsection for discharge above the identified criteria if:
(i) The source provides the necessary scientific information to describe how the designated beneficial uses would not be adversely impacted; or
(ii) A source is implementing all reasonable management practices or measures; its activity will not significantly affect the beneficial uses; and the environmental cost of treating the parameter to the level necessary to assure full protection would outweigh the risk to the resource.

(D) Marine and estuarine waters: No significant increase above natural background temperatures shall be allowed, and water temperatures shall not be altered to a degree which creates or can reasonably be expected to create an adverse effect on fish or other aquatic life.

340-041-0205(2)

(e) Bacteria standards:
(A) Numeric Criteria: Organisms of the coliform group commonly associated with fecal sources (MPN or equivalent membrane filtration using a representative number of samples) shall not exceed the criteria described in subparagraphs (i) and (ii) of this paragraph:
(i) Freshwaters and Estuarine Waters Other than Shellfish Growing Waters:
(I) A 30-day log mean of 126 *E. coli* organisms per 100 ml, based on a minimum of five (5) samples;
(II) No single sample shall exceed 406 *E. coli* organisms per 100 ml.
(ii) Marine Waters and Estuarine Shellfish Growing Waters: A fecal coliform median concentration of 14 organisms per 100 milliliters, with not more than ten percent of the samples exceeding 43 organisms per 100 ml.
(B) Raw Sewage Prohibition: No sewage shall be discharged into or in any other manner be allowed to enter the waters of the State unless such sewage has been treated in a manner approved by the Department or otherwise allowed by these rules;
(C) Animal Waste: Runoff contaminated with domesticated animal wastes shall be minimized and treated to the maximum extent practicable before it is allowed to enter waters of the State;
(D) Effluent Limitations and Water Quality Limited Waterbodies: Effluent limitations to implement the criteria in this rule are found in OAR 340-041-0120(12) through (16). Implementation of the criteria in this rule in water quality limited waterbodies is described in OAR 340-041-0026(3)(a)(I) and OAR 340-041-0120(17).
(f) Bacterial pollution or other conditions deleterious to waters used for domestic purposes, livestock watering, irrigation, bathing, or shellfish propagation, or otherwise injurious to public health shall not be allowed;

Implementation Program Applicable to All Basins
340-041-0120
(1) No waste treatment and disposal facilities shall be constructed or operated and no wastes shall be discharged to public waters without obtaining a permit from the Department as required by ORS 468.740.
(2) Plans for all sewage and industrial waste treatment, control, and disposal facilities shall be submitted to the Department for review and approval prior to construction as required by ORS 468.742.
(3) Minimum design criteria for waste treatment and control facilities prescribed under this plan and such other waste treatment and controls as may be necessary to insure compliance with the water quality standards contained in this plan shall be provided in accordance with specific permit conditions for those sources or activities for which permits are required and the following implementation program:
(a) For new or expanded waste loads or activities, fully approved treatment or control facilities, or both shall be provided prior to discharge of any wastes from the new or expanded facilities or conduct of the new or expanded activity;
(b) For existing waste loads or activities, additional treatment or control facilities necessary to correct specific unacceptable water quality conditions shall be provided in accordance with a specific program and timetable incorporated into the waste discharge permit for the individual discharger or activity. In developing treatment requirements and implementation schedules for existing installations or activities, consideration shall be given to the impact upon the overall environmental quality including air, water, land use, and aesthetics;
(c) Wherever minimum design criteria for waste treatment and control facilities set forth in this plan are more stringent than applicable federal standards and treatment levels currently being provided, upgrading to the more stringent requirements will be deferred until it is necessary to expand or otherwise modify or replace the existing treatment facilities. Such deferral will be acknowledged in the permit for the source;
(d) Where planning or design or construction of new or modified waste treatment and controls to meet prior applicable state or federal requirements is underway at the time this plan is adopted, such plans, design, or construction may be completed under the requirements in effect when the project was initiated. Timing for upgrading to meet more stringent future requirements will be as provided in section (3) of this rule.
(4) Confined animal feeding operations shall be regulated pursuant to OAR 340-041-0005 through 340-051-0080 in order to minimize potential adverse effect on water quality.
(5) Programs for control of pollution from nonpoint sources when developed by the Department, or by other agencies pursuant to Section 208 of Public Law 92-500 and approved by the Department, shall as applicable, be incorporated into this plan by amendment via the same process used to adopt the plan unless other procedures are established by law.
(6) Where minimum requirements of federal law or enforceable regulations are more stringent than specific provisions of this plan, the federal requirements shall prevail.
(7) Within framework of state-wide priority and available resources, the Department will monitor water quality within the basin for the purposes of evaluating conformance with the plan and developing information for future additions or updating.
(8) The EQC recognizes that the potential exists for conflicts between water quality management plans and the land use plans and resource management plans which local governments and other agencies must develop pursuant to law. In the event any such conflicts develop, it is the intent of the Department to meet with the local government or responsible agency to formulate proposed revisions to one or both so as to resolve the conflict. Revisions will be presented for adoption via the same process used to adopt the plan unless other specific procedures are established by law.
(9) The Department shall calculate and include effluent limits specified in pounds per day, which shall be the mass load limits for biochemical oxygen demand or carbonaceous biochemical oxygen demand and total suspended solids in National Pollutant Discharge Elimination System permits issued to all sewage treatment facilities. These limits shall be calculated as follows:
(a) Except as noted in paragraph (H) of this subsection, for existing facilities and for facilities receiving engineering plans and specifications approval from the Department for new treatment

facilities or treatment facilities expanding the average dry weather treatment capacity, prior to June 30, 1992:
(A) During periods of low stream flows (approximately May 1 through October 31), the monthly average mass load expressed as pounds per day shall not exceed the applicable monthly concentration effluent limit times the design average dry weather flow expressed in million gallons per day times 8.34 pounds per gallons. The weekly average mass load expressed as pounds per day shall not exceed the monthly average mass load times 1.5. The daily mass load expressed in pounds per day shall not exceed the monthly average mass load times 2.0;
(B) During the period of high stream flows (approximately November 1 through April 30), the monthly average mass load expressed as pounds per day shall not exceed the monthly concentration effluent limit times the design average wet weather flow expressed in million gallons per day times 8.34 pounds per gallon. The weekly average mass load expressed as pounds per day shall not exceed the monthly average mass load times 1.5. The daily mass load expressed in pounds per day shall not exceed the monthly average mass load times 2.0;
(C) On any day that the daily flow to a sewage treatment facility exceeds the lesser hydraulic capacity of the secondary treatment portion of the facility or twice the design average dry weather flow, the daily mass load limit shall not apply. The permittee shall operate the treatment facility at highest and best practicable treatment and control;
(D) The design average wet weather flow used in calculating mass loads shall be approved by the Department in accordance with prudent engineering practice and shall be based on a facility plan approved by the Department, engineering plans and specifications approved by the Department, or an engineering evaluation. The permittee shall submit documentation describing and supporting the design average wet weather flow with the permit application, application for permit renewal, or modification request, or upon request by the Department. The design average wet weather flow is defined as the average flow between November 1 and April 30 when the sewage treatment facility is projected to be at design capacity for that portion of the year;
(E) Mass loads assigned as described in paragraphs (B) and (C) of this subsection will not be subject to OAR 340-041-0026(3);
(F) Mass loads as described in this rule will be included in permits upon renewal, or upon permit modification request;
(G) Within 180 days after permit renewal or modification, permittees receiving higher mass loads under this rule and having a separate sanitary sewer system shall submit to the Department for review and approval a proposed program and time schedule for identifying and reducing inflow. The program shall consist of the following:
(i) Identification of all overflow points and verification that sewer system overflows are not occurring up to a 24-hour, five-year storm event or equivalent;
(ii) Monitoring of all pump station overflow points; and
(iii) A program for identifying and removing all inflow sources into the permittees sewer system over which the permittee has legal control; and
(iv) For those permittees not having the necessary legal authority for all portions of the sewer system discharging into the permittee's sewer system or treatment facility, a program and schedule for gaining legal authority to require inflow reduction and a program and schedule for removing inflow sources.
(H) Within one year after the Department's approval of the program, the permittee shall begin implementation of the program.
(I) Paragraphs (A) through (G) of this subsection shall not apply to the cities of Athena, Elgin, Adair Village, Halsey, Harrisburg, Independence, Carlton and Sweet Home. Mass load limits have been individually assigned to these facilities.
(b) For new sewage treatment facilities or treatment facilities expanding the average dry weather treatment capacity, and receiving engineering plans and specifications approval from the Department after June 30, 1992, the mass load limits shall be calculated by the Department based on the proposed treatment facility capabilities and the highest and best practicable treatment to minimize the discharge of pollutants;
(c) Mass load limits as defined in this rule may be replaced by more stringent limits if required by waste load allocations established in accordance with a TMDL for treatment facilities discharging

to water quality limited streams, or if required to prevent or eliminate violations of water quality standards;
(d) In the event that the design average wet weather flow or the hydraulic secondary treatment capacity is not known or has not been approved by the Department at the time of permit issuance, the permit shall include as interim mass load limits the mass load limits in the previous permit issued to the permittee for the treatment facility. The permit shall also include a requirement that the permittee shall submit to the Department the design average wet weather flow and hydraulic secondary treatment capacity within 12 months after permit issuance. Upon review and approval of the design flow information, the Department will modify the permit and include mass load limits as described in subsection (a) of this section;
(e) Each permittee with existing sewage treatment facilities otherwise subject to subsection (a) of this section may choose mass load limits calculated as follows:
(A) The monthly average mass load expressed as pounds per day shall not exceed the applicable monthly concentration effluent limit times the design average dry weather flow expressed in million gallons per day times 8.34 pounds per gallon;
(B) The weekly average mass load expressed as pounds per day shall not exceed the monthly average mass load times 1.5;
(C) The daily mass load expressed in pounds per day shall not exceed the monthly average mass load times 2.0. In the event that existing mass load limits are retained by the permittee, the terms and requirements of subsection (a) of this section shall not apply.
(f) The Commission may grant exceptions to subsection (a) of this section. In allowing increased discharged loads, the Commission shall make the findings specified in OAR 340-041-0026(3) for waste loads, and in addition shall make the following findings:
(A) That mass loads as calculated in subsection (a) of this section cannot be achieved with the existing treatment facilities operated at maximum efficiency at projected design flows; and
(B) That there are no practicable alternatives to achieving the mass loads as calculated in subsection (a) of this section.
(10) Agricultural water quality management plans to reduce agricultural non-point source pollution shall be developed and implemented by the Oregon Department of Agriculture (ODA) through a cooperative agreement with the Department of Environmental Quality (DEQ) to implement applicable provisions of ORS 568.900–933 and ORS 561.191. If DEQ has reason to believe that agricultural discharges or activities are contributing to water quality problems resulting in water quality standards violations, DEQ shall hold a consultation with the ODA. If water quality impacts are likely from agricultural sources, and DEQ determines that a water quality management plan is necessary, the Director of DEQ shall write a letter to the Director of the ODA requesting that such a management plan be prepared and implemented to reduce pollutant loads and achieve the water quality criteria.
(11) EQC policy on surface water temperature (as regulated in the basin standards found in OAR 340-041-0205, OAR-340-041-0245, OAR-340-041-0285, OAR-340-041-0325, OAR-340-041-0365, OAR-340-041-0445, OAR-340-041-0485, OAR-340-041-0525, OAR-340-041-0565, OAR-340-041-0605, OAR-340-041-0645, OAR-340-041-0685, OAR-340-041-0725, OAR-340-041-0765, OAR-340-041-0805, OAR-340-041-0845, OAR-340-041-0885, OAR-340-041-0925, OAR-340-041-0965:
(a) It is the policy of the Environmental Quality Commission (EQC) to protect aquatic ecosystems from adverse surface water warming caused by anthropogenic activities. The intent of the EQC is to minimize the risk to cold-water aquatic ecosystems from anthropogenic warming of surface waters, to encourage the restoration of critical aquatic habitat, to reverse surface water warming trends, to cool the waters of the State, and to control extremes in temperature fluctuations due to anthropogenic activities:
(A) The first element of this policy is to encourage the proactive development and implementation of best management practices or other measures and available temperature control technologies for non-point and point source activities to prevent thermal pollution of surface waters;
(B) The second element of this policy is to require the development and implementation of surface water temperature management plans for those basins exceeding the numeric temperature criteria identified in the basin standards. The surface water temperature management plans will identify the best management practices (BMPs) or measures and

approaches to be taken by non-point sources, and technologies to be implemented by point sources to limit or eliminate adverse anthropogenic warming of surface waters.
(b) Surface water temperatures in general are warming throughout the State. These water temperatures are influenced by natural physical factors including, but not limited to solar radiation, stream-side shade, ambient air temperatures, heated water discharges, cold-water discharges, channel morphology, and stream flow. Surface water temperatures may also be affected by anthropogenic activities that discharge heated water, widen streams, or reduce stream shading, flows, and depth. These anthropogenic activities, as well as others, increase water temperatures. Anthropogenic activities may also result in the discharge of cold water that decreases water temperatures and affects biological cycles of aquatic species;
(c) The temperature criteria in the basin standards establish numeric and narrative criteria to protect designated beneficial uses and to initiate actions to control anthropogenic sources that adversely increase or decrease stream temperatures. Natural surface water temperatures at times exceed the numeric criteria due to naturally high ambient air temperatures, naturally heated discharges, naturally low stream flows or other natural conditions. These exceedances are not water quality standards violations when the natural conditions themselves cause water temperatures to exceed the numeric criteria. In these situations, the natural surface water temperatures become the numeric criteria. In surface waters where both natural and anthropogenic factors cause exceedances of the numeric criteria, each anthropogenic source will be responsible for controlling, through implementation of a management plan, only that portion of the temperature increase caused by that anthropogenic source;
(d) The purpose of the numeric criteria in the basin standards is to protect designated beneficial uses; this includes specific life cycle stages during the time periods they are present in a surface water of the state. Surface water temperature measurements taken to determine compliance with the identified criteria will be taken using a sampling protocol appropriate to indicate impact to the beneficial use. The EQC, in establishing these criteria, recognizes that new information is constantly being developed on water temperatures and how water temperatures affect different beneficial uses. Therefore, continued reevaluation of temperature information is needed to refine and revise numeric criteria in the basin standards over time. The EQC also recognizes that the development and implementation of control technologies and best management practices or measures to reduce anthropogenic warming is evolving and the achievement of the numeric criteria will be an iterative process;
(e) Surface water temperature management plans will be required according to OAR 340-041-0026(3)(a)(D) when the relevant numeric temperature criteria are exceeded and the waterbody is designated as water-quality limited under Section 303(d) of the Clean Water Act. The plans will identify those steps, measures, technologies, and/or practices to be implemented by those sources determined by the Department to be contributing to the problem. The plan may be for an entire basin, a single watershed, a segment of a stream, single or multiple non-point source categories, single or multiple point sources or any combination of these, as deemed appropriate by the Department, to address the identified temperature problem:
(A) In the case of state and private forest lands, the practices identified in rules adopted pursuant to the State Forest Practices Act (FPA) will constitute the surface water temperature management plan for the activities covered by the act. Consequently, in those basins, watersheds or stream segments exceeding the relevant temperature criterion, and for those activities covered by the Forest Practices Act, the forestry component of the temperature management plan will be the practices required under the FPA. If the mandated practices need to be improved in specific basins, watersheds or stream segments to fully protect identified beneficial uses, the Departments of Forestry and Environmental Quality will follow the process described in ORS 527.765 to establish, implement, and improve practices in order to reduce thermal loads to achieve and maintain the surface water temperature criteria. Federal forest management agencies are required by the federal Clean Water Act to meet or exceed the substantive requirements of the state forestry non-point source program. The Department currently has Memoranda of Understanding with the U.S. Forest Service and Bureau of Land Management to implement this aspect of the Clean Water Act. These memoranda will be used to identify the temperature management plan requirements for federal forest lands;

(B) The temperature management plan for agricultural non-point sources shall be developed and implemented in the manner described in section (10) of this rule;
(C) The Department will be responsible for determining the appropriate surface water temperature management plan for individual and general NPDES permitted sources. The requirement for a surface water temperature management plan and the content of the plan will be appropriate to the contribution the permitted source makes to the temperature problem, the technologies and practices available to reduce thermal loads, and the potential for trading or mitigating thermal loads;
(D) In urban areas, the Department will work with appropriate state, county, municipal, and special district agencies to develop surface water temperature management plans that reduce thermal loads in basins, watersheds, or stream segments associated with the temperature violations so that the surface water temperature criteria are achieved.
(f) The EQC encourages the release of stored water from reservoirs to cool surface water in order to achieve the identified numeric criteria in the basin standards as long as there is no significant adverse impact to downstream designated beneficial uses from the cooler water temperatures. If the Department determines that a significant adverse impact is resulting from the cold-water release, the Department shall, at its discretion, require the development of a management plan to address the adverse impact created by the cold-water release;
(g) Maintaining low stream temperatures to the maximum extent practicable in basins where surface water temperatures are below the specific criteria identified in this rule shall be accomplished by implementing technology based permits, best management practices or other measures. Any measurable increase in surface water temperature resulting from anthropogenic activities in these basins shall be in accordance with the antidegradation policy contained in OAR 340-041-0026.
(12) Effluent Limitations for Bacteria: Except as allowed in subsection (c) of this section, upon NPDES permit renewal or issuance, or upon request for a permit modification by the permittee at an earlier date, effluent discharges to freshwaters, and estuarine waters other than shellfish growing waters shall not exceed a monthly log mean of 126 E. coli organisms per 100 ml. No single sample shall exceed 406 E. coli organisms per 100 ml. However, no violation will be found, for an exceedance if the permittee takes at least five consecutive re-samples at four-hour intervals beginning as soon as practicable (preferably within 28 hours) after the original sample was taken and the log mean of the five re-samples is less than or equal to 126 E. coli. The following conditions apply:
(a) If the Department finds that re-sampling within the timeframe outlined in this section would pose an undue hardship on a treatment facility, a more convenient schedule may be negotiated in the permit, provided that the permittee demonstrates that the sampling delay will result in no increase in the risk to water contact recreation in waters affected by the discharge;
(b) The in-stream criterion for chlorine listed in **Table 20** shall be met at all times outside the assigned mixing zone;
(c) For sewage treatment plants that are authorized to use reclaimed water pursuant to OAR Chapter 340, Division 55, and which also use a storage pond as a means to dechlorinate their effluent prior to discharge to public waters, effluent limitations for bacteria shall, upon request by the permittee, be based upon appropriate total coliform, limits as required by OAR Chapter 340, Division 55: For Level II limitations, no two consecutive samples shall exceed 240 total coliform per 100 ml and for Level III and Level IV limitations, no single sample shall exceeds 23 total coliform per 100 ml. However, no violation will be found for an exceedance under this paragraph if the permittee takes at least five consecutive re-samples at four hour intervals beginning as soon as practicable (preferably within 28 hours) after the original sample(s) were taken; and in the case of Level II effluent, the log mean of the five re-samples is less than or equal to 23 total coliform per 100 ml or, in the case of Level III and IV effluent, if the log mean of the five re-samples is less than or equal to 2.2 total coliform per 100 ml.
(13) Sewer Overflows in Winter: Domestic waste collection and treatment facilities are prohibited from discharging raw sewage to waters of the State during the period of November 1 through May 21, except during a storm event greater than the one-in-five-year, 24-hour duration storm. However, the following exceptions apply:

(a) The Commission may on a case-by-case basis approve a bacteria control management plan to be prepared by the permittee, for a basin or specified geographic area which describes hydrologic conditions under which the numeric bacteria criteria would be waived. These plans will identify the specific hydrologic conditions, identify the public notification and education processes that will be followed to inform the public about an event and the plan, describe the water quality assessment conducted to determine bacteria sources and loads associated with the specified hydrologic conditions, and describe the bacteria control program that is being implemented in the basin or specified geographic area for the identified sources;
(b) Facilities with separate sanitary and storm sewers existing on January 10, 1996, and which currently experience sanitary sewer overflows due to inflow and infiltration problems, shall submit an acceptable plan to the Department at the first permit renewal, which describes actions that will be taken to assure compliance with the discharge prohibition by January 1, 2010. Where discharges occur to a receiving stream with sensitive beneficial uses, the Department may negotiate a more aggressive schedule for discharge elimination;
(c) On a case-by-case basis, the beginning of winter may be defined as October 15 if the permittee so requests and demonstrates to the Department's satisfaction that the risk to beneficial uses, including water contact recreation, will not be increased due to the date change.
(14) Sewer Overflows in Summer: Domestic waste collection and treatment facilities are prohibited from discharging raw sewage to waters of the State during the period of May 22 through October 31, except during a storm event greater than the one-in-ten-year, 24-hour duration storm. The following exceptions apply:
(a) For facilities with combined sanitary and storm sewers, the Commission may on a case-by-case basis approve a bacteria control management plan such as that described in subsection (13)(a) of this rule;
(b) On a case-by-case basis, the beginning of summer may be defined as June 1 if the permittee so requests and demonstrates to the Department's satisfaction that the risk to beneficial uses, including water contact recreation, will not be increased due to the date change;
(c) For discharge sources whose permit identifies the beginning of summer as any date from May 22 through May 31: If the permittee demonstrates to the Department's satisfaction that an exceedance occurred between May 21 and June 1 because of a sewer overflow, and that no increase in risk to beneficial uses, including water contact recreation, occurred because of the exceedance, no violation shall be triggered if the storm associated with the overflow was greater than the one-in-five-year, 24-hour duration storm.
(15) Storm Sewers Systems Subject to Municipal NPDES Storm Water Permits: Best management practices shall be implemented for permitted storm sewers to control bacteria to the maximum extent practicable. In addition, a collection-system evaluation shall be performed prior to permit issuance or renewal so that illicit and cross connections are identified. Such connections shall be removed upon identification. A collection system evaluation is not required where the Department determines that illicit and cross connections are unlikely to exist.
(16) Storm Sewers Systems Not Subject to Municipal NPDES Storm Water Permits: A collection system evaluation shall be performed of non-permitted storm sewers by January 1, 2005, unless the Department determines that an evaluation is not necessary because illicit and cross connections are unlikely to exist. Illicit and cross-connections shall be removed upon identification.
(17) Water Quality Limited for Bacteria: In those waterbodies, or segments of waterbodies identified by the Department as exceeding the relevant numeric criteria for bacteria in the basin standards and designated as water-quality limited under Section 303(d) of the Clean Water Act, the requirements specified in OAR 340-041-0026(3)(a)(I) and in section (10) of this rule shall apply.
[ED. NOTE: The Table(s) referenced in this rule is not printed in the OAR Compilation. Copies are available from the agency.]
Stat. Auth.: ORS 468B.030 & ORS 468B.048
Stats. Implemented: ORS 468B.048
Hist.: DEQ 128, f. & ef. 1-21-77; DEQ 16-1992, f. & cert. ef. 8-7-92; DEQ 5-1996, f. & cert. ef. 3-7-96; DEQ 11-1997, f. & cert. ef. 6-11-97

OREGON ADMINISTRATIVE RULES

OREGON DEPARTMENT OF AGRICULTURE

CHAPTER 603, DIVISION 95

AGRICULTURAL WATER QUALITY MANAGEMENT PROGRAM

North Coast Basin

603-095-0800
Purpose

(1) These rules have been developed to effectuate a water quality management area plan for the North Coast Basin pursuant to authorities vested in the department through ORS 561.190-561.191 and 568.900-568.933. Development of this plan is due to a determination by the Environmental Quality Commission to establish Total Maximum Daily Loads (TMDL) and allocate loads to agricultural water pollution sources. This plan also contributes to the state's program to restore and protect coastal waters in response to the federal Coastal Zone Management Act. The area plan is known as the North Coast Basin Agricultural Water Quality Management Area Plan.

(2) The purpose of these rules is to outline requirements for landowners in the North Coast Basin Agricultural Water Quality Management Area for the prevention and control of water pollution from agricultural activities and soil erosion. Compliance with these rules is expected to aid in the achievement of applicable water quality standards in the North Coast Basin.

(a) Failure to comply with any provisions of the North Coast Basin Agricultural Water Quality Management Area Plan:

(A) does not constitute a violation of OAR 603-090-0000 to 603-090-0120, or of OAR 603-095-0010 to OAR 635-095-0860;

(B) is not intended by the department to be evidence of a violation of any federal, state, or local law by any person.

(b) Nothing in the North Coast Basin Agricultural Water Quality Management Area Plan shall be:

(A) construed as an effluent limitation or standard under the federal Water Pollution Control Act, 33 USC §§ 1251-1376;

(B) used to interpret any requirement of OAR 603-095-0800 through 603-095-0860.

Statutory Authority: ORS 561.190-561.191 and ORS 568.909

Stats. Implemented: ORS 568.900-568.933

603-095-0820
Geographic and Programmatic Scope

(1) The physical boundaries of North Coast Basin subject to these rules are indicated on the map included as Appendix A of these rules.

(2) Operational boundaries for the land base under the purview of these rules include all lands within the North Coast Basin in agricultural use, agricultural and rural lands which are lying idle or on which management has been deferred, and forested lands with agricultural activities, with the exception of public lands managed by federal agencies and activities which are subject to the Oregon Forest Practices Act.

(3) Current productive agricultural use is not required for the provisions of these rules to apply. For example, highly erodible lands with no present active use are within the purview of these rules.

(4) The provisions and requirements outlined in these rules may be adopted by reference by Designated Management Agencies with appropriate authority and responsibilities in other geographic areas of the North Coast Basin.

(5) For lands in agricultural use within other Designated Management Agencies or state agency jurisdictions, the department and the appropriate Local Management Agency shall work with these Designated Management Agencies to assure that provisions of these rules apply, and to assure that duplication of any services provided or fees assessed does not occur.

Statutory Authority: ORS 568.909
Stats. Implemented: ORS 568.900-568.933

603-095-0840
Required and Prohibited Conditions

(1) All landowners or operators conducting activities on lands in agricultural use shall be in compliance with the following criteria. A landowner or operator shall be responsible for only those required and prohibited conditions caused by activities conducted on land managed by the landowner or operator. Criteria do not apply to conditions resulting from unusual weather events or other exceptional circumstances that could not have been reasonably anticipated.

(2) Healthy Riparian Streambank Condition. Effective upon rule adoption.

(a) Allow the natural and managed regeneration and growth of riparian vegetation -- trees, shrubs, grasses, and sedges -- along natural waterways (as defined in OAR 141-085-0010(27)) to provide shade to moderate water temperatures and bank stability to maintain erosion near background levels.

(b) The technical criteria to determine compliance with OAR 603-095-0840(2)(a) are:

(A) Ongoing renewal of riparian vegetation that depends on natural processes (including processes such as seed fall, seed bank in soil, or sprouting from roots, rhizomes, or dormant crowns) is evident.

(B) Ongoing growth of riparian vegetation that has a high probability of remaining or becoming vigorous and healthy is evident.

(C) Management activities minimize the degradation of established native vegetation while allowing for the presence of nonnative vegetation.

(D) Management activities maintain at least 50% of each year's new growth of woody vegetation -- both trees and shrubs.

(E) Management activities are conducted in a manner so as to maintain streambank integrity through 25-year storm events.

(c) Exemptions:

(A) Levees and dikes are exempt from the Healthy Riparian Streambank Condition OAR 603-095-0840(2)(a) and (b), except for areas on the river-side of these structures that are not part of the structures and which can be vegetated without violating U.S. Army Corps of Engineers vegetation standards.

(B) Drainage areas where the only connection to other waterbodies are through pumps shall be exempt from the Healthy Riparian Streambank Condition OAR 603-095-0840(2)(a) and (b).

(C) Access to natural waterways for livestock watering and stream crossings are allowed such that livestock use is limited to only the amount of time necessary for watering and crossing the waterway.

(D) Drainage and irrigation ditches managed in compliance with OAR 603-095-0840(3) are exempt from the Healthy Riparian Streambank Condition OAR 603-095-0840(2)(a) and (b).

(3) Drainage and irrigation ditches (channels legally constructed). Effective upon rule adoption.

(a) Construction, maintenance, and use of surface drainage ditches shall not result in sediment delivery to waters of the state from soil erosion caused by excessive channel slope, unstable channel cross section, or placement of disposed soils.

(b) Ditch bank vegetation shall be present to stabilize earthen ditch banks.

(c) Technical criteria to determine compliance with OAR 603-095-0840(3)(a) and (b) are:

(A) Construction and maintenance of drainage and irrigation ditches utilize ditch slope and ditch cross section that are appropriate to the site.

(B) Disposed soils from construction and maintenance of drainage and irrigation ditches are placed such that sediment delivery to waters of the state from the placement of these soils is consistent with natural background sediment delivery from these sites.

(d) Exemptions:

(A) Bank vegetation damaged and soils exposed during maintenance (as defined in OAR 141-085-0010(22)) and construction, in accordance with Division of State Lands rules. Bank vegetation must be reestablished as soon as practicable after construction and maintenance are completed. However, sediment delivery to waters of the state shall not result from inappropriate ditch slope and cross section or from placement of disposed soils.

(4) Tide Gates. Effective upon rule adoption.

(a) Tide gates shall open and close as designed.

(5) Erosion and Sediment Control. Effective upon rule adoption.

(a) No cropland erosion in excess of the soil loss tolerance factor (T) for the subject field, as determined by the Revised Universal Soil Loss Equation (RUSLE) for soil loss, will occur.

(A) Exceptions: The department shall establish an alternate erosion control standard for croplands which the department determines cannot practically or economically achieve the soil loss tolerance factor. Any alternate erosion control standard for croplands established by the department shall assure that delivery of sediment to adjacent water sources is reduced to the maximum extent practicable.

(b) Private roads that traverse rural lands or private roads used for agricultural activities shall be constructed and maintained such that road surfaces, fill and associated structures are designed and maintained to limit contributing sediment to waters of the state. All private roads on agricultural lands not subject to the Oregon Forest Practices Act are subject to this regulation.

(A) Exceptions: Roads subject to the Oregon Forest Practices Act.

(c) Agricultural lands shall be managed to prevent and control runoff of sediment to public road drainage systems.

(d) Except for operations governed by the Oregon Forest Practices Act, no activities related to the conversion of woodland to non-woodland agricultural uses that require removal of the majority of woody material from a parcel of land, such that the land no longer meets the definition of woodland, shall be conducted in a manner which results in the placement of soil, the delivery of sediment or the sloughing of soil into waters of the state, the initiation or aggravation of streambank erosion, or the loss of a healthy riparian streambank condition as defined in OAR 603 095-0840(2).

(6) Manure, Nutrients, and Other Waste. Effective upon rule adoption.

(a) No person conducting agricultural land management shall cause pollution of any waters of the state or place or cause to be placed any wastes in a location where such wastes are likely to escape or be carried into the waters of the state by any means.

(b) No person conducting agricultural land management shall discharge any wastes into the waters of the state if the discharge reduces the quality of such waters below the water quality standards established by rule for such waters by the Environmental Quality Commission.

(c) No person shall violate the conditions of any waste discharge permit issued under ORS 468B.050.

(d) Exceptions:

(A) Access to natural waterways for livestock watering and stream crossings are allowed such that livestock use is limited to only the amount of time necessary for watering and crossing the waterway.

Statutory Authority: ORS 568.909

Stats. Implemented: ORS 568.900-568.933

603-095-0860

Complaints and Investigations

(1) When the department receives notice of an alleged occurrence of agricultural pollution through a written complaint, its own observation, through notification by another agency, or by any other means, the department may conduct an investigation. The department may, at its discretion, coordinate inspection activities with the appropriate Local Management Agency.

(2) Each notice of an alleged occurrence of agricultural pollution shall be evaluated in accordance with the criteria in ORS 568.900 to 568.933 or any rules adopted thereunder to determine whether an investigation is warranted.

(3) Any person allegedly being damaged or otherwise adversely affected by agricultural pollution or alleging any violation of ORS 568.900 to 568.933 or any rules adopted thereunder may file a complaint with the department.

(4) The department will evaluate or investigate a complaint filed by a person under section OAR 603-095-0860(3) if the complaint is in writing, signed and dated by the complainant and indicates the location and description of:

(a) The property and waters of the state allegedly being damaged or impacted; and

(b) The property allegedly being managed under conditions violating criteria described in ORS 568.900 to 568.933 or any rules adopted thereunder.

(5) As used in section OAR 603-095-0860, "person" does not include any local, state or federal agency.

(6) Notwithstanding OAR 603-095-0860, the department may investigate at any time any complaint if the department determines that the violation alleged in the complaint may present an immediate threat to the public health or safety.

(7) Actions based on investigation findings:

(a) If the department determines that a violation of ORS 568.900 to 568.933 or any rules adopted thereunder has occurred and an Approved Voluntary Water Quality Farm Plan exists and the landowner or occupier is making a reasonable effort to comply with the plan:

(A) The department shall inform the landowner of the non-compliance with ORS 568.900 to 568.933 or any rules adopted thereunder; and

(B) The department may acknowledge the existence of the Approved Voluntary Water Quality Farm Plan and direct the landowner to seek appropriate technical assistance and revise the plan and its implementation in a manner necessary to eliminate the violation.

(b) The landowner may be subject to the enforcement procedures of the department outlined in OARs 603-090-0060 through 603-090-0120 if:

(A) The department determines that a violation of ORS 568.900 to 568.933 or any rules adopted thereunder has occurred and an Approved Voluntary Water Quality Farm Plan does not exist; or

(B) The department determines that a violation of ORS 568.900 to 568.933 or any rules adopted thereunder has occurred and an Approved Voluntary Water Quality Farm Plan exists and the landowner or occupier is not making a reasonable effort to comply with the plan; or

(C) The department determines that a landowner or occupier has not revised a plan per OAR 603-095-0860(7)(a)(B) within the time specified by the department.

Statutory Authority: ORS 568.915, 568.918, and 568.933

Stats. Implemented: ORS 568.900 - 568.933

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SELECTED OREGON REVISED STATUTES

Available on the internet at: http://landru.leg.state.or.us/ors/468b.html

468B.005.

[Selected] Definitions for water pollution control laws

(3) "Pollution" or "water pollution" means such alteration of the physical, chemical or biological properties of any waters of the state, including change in temperature, taste, color, turbidity, silt or odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive or other substance into any waters of the state, which will or tends to, either by itself or in connection with any other substance, create a public nuisance or which will or tends to render such waters harmful, detrimental or injurious to public health, safety or welfare, or to domestic, commercial, industrial, agricultural, recreational or other legitimate beneficial uses or to livestock, wildlife, fish or other aquatic life or the habitat thereof.

….

(7) "Wastes" means sewage, industrial wastes, and all other liquid, gaseous, solid, radioactive or other substances which will or may cause pollution or tend to cause pollution of any waters of the state.

(8) "Water" or "the waters of the state" include lakes, bays, ponds, impounding reservoirs, springs, wells, rivers, streams, creeks, estuaries, marshes, inlets, canals, the Pacific Ocean within

the territorial limits of the State of Oregon and all other bodies of surface or underground waters, natural or artificial, inland or coastal, fresh or salt, public or private (except those private waters which do not combine or effect a junction with natural surface or underground waters), which are wholly or partially within or bordering the state or within its jurisdiction. [Formerly 449.075 and then 468.700]

468B.015.
Policy
Whereas pollution of the waters of the state constitutes a menace to public health and welfare, creates public nuisances, is harmful to wildlife, fish and aquatic life and impairs domestic, agricultural, industrial, recreational and other legitimate beneficial uses of water, and whereas the problem of water pollution in this state is closely related to the problem of water pollution in adjoining states, it is hereby declared to be the public policy of the state:
(1) To conserve the waters of the state;
(2) To protect, maintain and improve the quality of the waters of the state for public water supplies, for the propagation of wildlife, fish and aquatic life and for domestic, agricultural, industrial, municipal, recreational and other legitimate beneficial uses;
(3) To provide that no waste be discharged into any waters of this state without first receiving the necessary treatment or other corrective action to protect the legitimate beneficial uses of such waters;
(4) To provide for the prevention, abatement and control of new or existing water pollution; and
(5) To cooperate with other agencies of the state, agencies of other states and the Federal Government in carrying out these objectives. [Formerly 449.077 and then 468.710]

468B.020
Prevention of pollution.
(1) Pollution of any of the waters of the state is declared to be not a reasonable or natural use of such waters and to be contrary to the public policy of the State of Oregon, as set forth in ORS 468B.015.
(2) In order to carry out the public policy set forth in ORS 468B.015, the Department of Environmental Quality shall take such action as is necessary for the prevention of new pollution and the abatement of existing pollution by:
(a) Fostering and encouraging the cooperation of the people, industry, cities and counties, in order to prevent, control and reduce pollution of the waters of the state; and
(b) Requiring the use of all available and reasonable methods necessary to achieve the purposes of ORS 468B.015 and to conform to the standards of water quality and purity established under ORS 468B.048. [Formerly 449.095 and then 468.715]

468B.025
Prohibited activities.
(1) Except as provided in ORS 468B.050 or 468B.053, no person shall:
(a) Cause pollution of any waters of the state or place or cause to be placed any wastes in a location where such wastes are likely to escape or be carried into the waters of the state by any means.
(b) Discharge any wastes into the waters of the state if the discharge reduces the quality of such waters below the water quality standards established by rule for such waters by the Environmental Quality Commission.
(2) No person shall violate the conditions of any waste discharge permit issued under ORS 468B.050.
(3) Violation of subsection (1) or (2) of this section is a public nuisance. [Formerly 449.079 and then 468.720; 1997 c.286 s.5]

APPENDIX D

NESTUCCA BAY WATERSHED TMDL WATER QUALITY MANAGEMENT PLAN

TABLE OF CONTENTS

INTRODUCTION

Clean Water Act, 303(d) List, TMDLs, and Implementation Strategy

Section 303(d) of the 1972 federal Clean Water Act (CWA) as amended requires states to develop a list of rivers, streams and lakes that cannot meet water quality standards without application of additional pollution controls beyond the existing requirements on industrial sources and sewage treatment plants. Waters that need this additional help are referred to as "water quality limited". Water Quality Limited waterbodies must be identified by the Environmental Protection Agency (EPA) or by a state agency which has been delegated this responsibility by the EPA. In Oregon, this responsibility rests with the Oregon Department of Environmental Quality (DEQ). The DEQ updates the list of water quality limited waters every two years. The list is referred to as the 303(d) list. Section 303 of the CWA further requires that Total Maximum Daily Loads (TMDLs) be developed for all waters on the 303(d) list. A TMDL defines the amount of a pollutant that can be present in the waterbody without causing water quality standards to be violated. The total amount of allowable pollutants is then allocated among the background sources, point sources, nonpoint sources and the amount needed as a measure of safety. The point sources are given wasteload allocations (WLAs) and the nonpoint sources as well as background are given load allocations (LAs).

Along with a TMDL, a water quality management plan (WQMP) is developed that describes a strategy to meet the allocations detailed in the TMDL. This strategy must include actions that will result in reductions in contributions from nonpoint sources to the level of the load allocations (LAs) and for reducing discharges from point sources to the level of the waste load allocations (WLAs) prescribed in the TMDL. The WQMP/Implementation Plan must include specific information to meet both State of Oregon statutes/rules and federal requirements.

TMDL Implementation Strategy Guidance

DEQ has entered into an agreement with the EPA regarding implementation of Section 303(d) of the Federal Clean Water Act. Terms of that agreement include submission of water quality management plans along with The elements of these WQMPs are:

1. Condition Assessment
2. Goals and Objectives
3. Management Measures
4. Timeline for Implementation
5. Identification of Responsible Participants
6. Reasonable Assurance of Implementation
7. Monitoring and Evaluation
8. Public Involvement
9. Maintenance of Efforts over time
10. Costs and Funding
11. Legal Authorities to be Used
12. Estimate of the Time It Will Take to Meet Water Quality Standards
13. Milestones for Measuring Progress
14. Plans for Revising the TMDL if Progress is Not Being made

ELEMENT 1: CONDITION ASSESSMENT AND PROBLEM DESCRIPTION

Geographic Region of Interest

The Nestucca and Little Nestucca River watersheds are located in northwest Oregon occupying approximately 371 square miles. The hydrologic unit (HUC) containing the Nestucca and Little Nestucca, classified accordingly as a 'sub-basin' or 4th field watershed, is 17100203 (USGS, 1989). It is important to note that additional watersheds are located within this HUC (i.e., Miami, Kilchis, Trask, Wilson, and Tillamook Rivers). These systems are located within the Tillamook Bay Watershed. This document only covers information pertaining to the rivers draining into the Nestucca Bay.

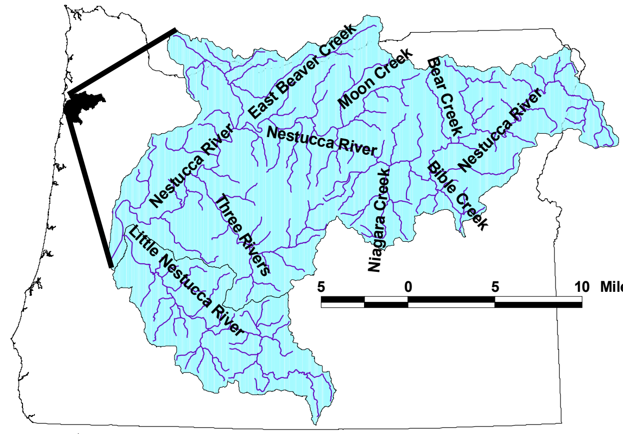

Figure 1. Location of Nestucca Bay Watershed.

The Nestucca Bay Watershed (**Figure 1**) is part of a coastal , temperate rainforest ecosystem west of Portland on the western slope of the Coast Range of Oregon. A typical year brings almost 80 inches (203 cm) of rainfall in the lower basin and up to 180 inches (460 cm) at higher elevations. The mean annual temperature is 50.4 °F (10.2 °C), with yearly mean maximum and mean minimum temperatures of 60 ° F (15.55 °C) and 43 °F (6.1 °C), respectively (NNWC, 1998). The soils are loamy, well drained, with moderate permeability. Sand dunes, beach sands, and alluvial deposits make up the youngest geologic materials in the lower river basin. Alluvial deposits, consisting of gravel, sand, and silt, are most extensive along the Nestucca River and its major tributaries. Along Nestucca Bay, the deposits consist mainly of mud, silt, and sand (USFS and BLM 1994). The Nestucca and Little Nestucca Rivers flow into Nestucca Bay draining a 371 square mile (217,085 acre) watershed.

The upper watershed originates in the high, steep ridges of the Coast Range at elevations reaching 3,133 feet (approximately 1000 m). The uplands support coniferous forests of douglas fir, true fir, spruce, cedar, and hemlock, and covering approximately 82% of the total area. Hardwood species such as alder and maple also grow throughout the region, especially as second growth in riparian areas. Understory vegetation is generally composed of a dense growth of shrubs, herbs, ferns, and cryptogams.

The lower watershed is composed of rich alluvial plains used primarily for dairy agriculture, rural residential, and urban uses. The basin includes approximately 35,663 acres of lowlands in which approximately 3,945 acres support approximately 7,000 dairy cattle (USDA, 1992). Once characterized by meandering rivers and networks of small channels that provided fish habitat, woody debris, and organic matter, the lowlands have been modified by dikes, levees, channels, tide gates, and riprap.

Nestucca Bay is a small, shallow estuary covering approximately 1,000 acres (405 hectares). Tidelands, the area between mean low water (MLW) and mean high water MHW), represents approximately 578 acres (233 hectares), or 58 percent (DSL 1973). The mean tidal range at the entrance to the Nestucca Estuary is 5.8 feet, (1.77 meters), and the spring tidal range is 7.6 feet (2.32 meters), (NOAA 1977). The mean tidal range multiplied by the mean surface area between MHW and MLW produces a tidal prism of 170-million cubic feet. From values reported by Johnson (1972) and computations from the tide tables, it is apparent that the Nestucca Estuary has considerably less salt water exchange than most other Oregon estuaries (ODFW 1979). Although there are no published data on tidal dynamics, some crude estimates of mixing characteristics can be obtained by the flow ratio method discussed by Simmons (1966). The flow ratio is the volume of fresh water which enters an estuary during a tidal cycle divided by the tidal prism. Results of the flow ratio analysis indicate that the estuary is well mixed in the spring, summer, and fall and partially mixed in winter (ODFW 1979).

The Bay receives fresh water input from two rivers and exchanges ocean water through a single channel in the Southwest corner. Tidal effects extend various distances up the rivers, ranging from 7 miles (11.26 kilometers) for the Nestucca River (USFS,BLM 1994), to 2.5 miles (11 kilometers) for the Little Nestucca River (USFS 1998). The Nestucca River discharges an average of 750,000 acre-feet of water annually. The Little Nestucca River flow is estimated to be one-forth of that figure (OSWRB 1961). Mean monthly river discharge from the Nestucca River is approximately 2000 cfs from November through March. It falls below 250 cfs during the period July – September (ODFW 1979). Only a few random estuarine water temperatures have been recorded (Giger 1972a; Giger 1972b, ODEQ 1978). The data suggests that the relative amounts of river and ocean water combined with the seasonal mixing characteristics greatly influence water temperatures. Water temperatures will be higher in shallow areas, during low tide (except in winter), and in summer (ODFW 1979).

Giger (1972b) and the ODEQ (1978) provide a few salinity measurements for the Nestucca River. Giger (1972b) observed higher salinities during high tide, near the mouth of the estuary, on the bottom, and during low stream flow. Salinities decreased upstream from the mouth, but decreased more slowly on the bottom. The limit of saline intrusion occurred between RM 4 and RM 5 in the summer and between RM 1.5 and RM 2.5 in the winter (Giger 1972b).

A number of other chemical parameters have been monitored including dissolved oxygen, pH, turbidity, orthophosphates, nitrates, and pathogens (DEQ 1978).

The estuary provides habitat for numerous fish, shellfish, crabs, birds, seals, sea lions, and sea grasses USFS 1998). Five species of anadromous salmonids use the estuary at some point in their life cycle (Wick 1970). A rich benthic community includes clam beds, ghost shrimp, and areas of eelgrass (Gaumer and Holstead 1976). Dungeness crabs and clams provide an important recreational opportunity. Marine mammals also use the bay for resting, feeding, and pupping. The basin also supports a wide variety of water contact recreation that includes swimming, wading, fishing and boating. Both water contact recreation and shellfish harvesting are compromised by bacterial contamination of water.

Current Conditions

The largest landowner in the Nestucca Bay Watershed is the United states Forest Service (36.4% of the surface area). Private lands account for 128 square miles (34.5% of the surface area) that occures throughout the watershed. The Bureau of Land management manages 19 square miles within these watersheds (5.0% of the surface area) and State Forests cover approximately 5.1% of the surface area. Other smaller land ownership designations include Oregon and California lands (10.8% of the surface area), Bankhead and Jones (8.3% of the surface area).

There are six assessment studies either completed or underway within the Nestucca Bay Basin. These are: Nestucca Estuary Inventory Project (ODFW 1978-1979); Nestucca Watershed Analysis, (USFS and BLM 1994); Watershed Plan and Environmental Assessment, (USDA-SCS 1986); Nestucca River Basin Water Quality Study (USDA 1992); Nestucca/Neskowin Watershed Assessment, (NNWC 1998); and the Draft Nestucca Bay Watershed Total Maximum Daily Load for temperature, sedimentation and bacteria (ODEQ 2001). The basin is commonly considered in three distinct zones; Upland, Lowland, and Estuarine habitats.

Figure 67. Land Use within the Nestucca Bay Watershed (USGS, 1979)

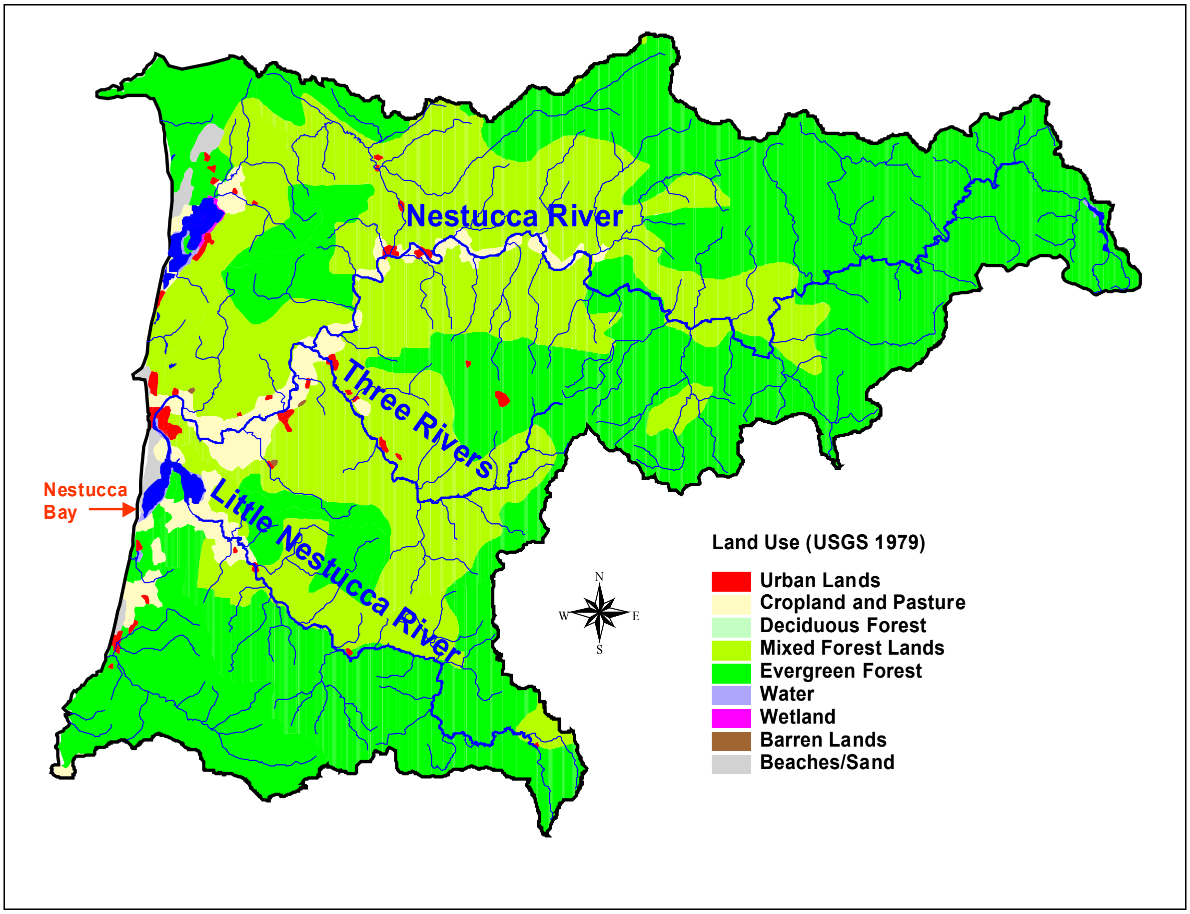

Figure 2 shows the land uses within the Nestucca and Little Nestucca watersheds identified by USGS (1979). Forested land uses predominate in the watersheds, with 93.6% of the watershed area mapped as conifer and mixed forests. Crop and pasture land uses are confined to low gradient areas near tidally influence areas and comprise 4.2% of the watershed area. Urban areas comprise less than one percent of the surface area (0.7%).

Upper Watershed Habitat

Tillamook County's forestlands have provided timber for wood products industries since the 1880s. By 1894, the timber industry was the most important industry in the County (Levesque 1985). Fires in 1845 and 1890 burned much of the Little Nestucca Watershed (USFS 1998). Repeated fires in 1910,1934, and 1939, burned additional portions of the Nestucca Watershed (USFS 1992).

The loss of forest cover and exposure of mineral soil probably resulted in increased landsliding and sedimentation to streams, as well as increased runoff and elevated stream temperatures (Baker 1986). Massive salvage logging after the Tillamook Burn left a legacy of poor quality logging roads and skid trails. Many of these legacy roads have poorly designed culverts and road crossings, blocking fish passage (Mills 1997).

Although logging in the Nestucca Watershed began in the late 1880s and increased somewhat after the aforementioned burns, significant logging did not occur until the period 1960 – 1990. Currently little logging is occuring on federal lands, however, logging on private timber lands has increased in the past decade.

Lowland/floodplain Habitat

Agriculture and urban development in the lowland floodplains altered riparian and instream habitats vital to salmon and other aquatic species. Historically, bottomland forest and open grasslands covered a rich alluvial plain that regularly flooded in winter. Off-channel sloughs, oxbows, and wetlands in these lowland floodplain's provided ample habitat for rearing fish. A forest of mixed hardwoods and conifers supplied organic matter and insects to feed fish and support the aquatic food chain. Large log-jams in the main rivers led to frequent seasonal flooding in floodplains, regularly depositing sediments to lowland areas and providing large areas of salmon habitat. Large wood deposition also created scour pools in the mainstream channels.

Early settlers cut down riparian trees to expedite log drives and cleared logjams in the main rivers to reduce flooding and improve navigation. In the early 1900s, loggers used splash dams to move logs downstream and subsequently damaged instream and riparian habitat in several river reaches. Prior to the early 1980s, ODFW policy was to clear streams and rivers of large wood to enhance fish passage. Such activities, as well as urban development, expansion of impervious surfaces, and other land changes, has caused changes in the hydrograph, sediment routing and disposition, and channel complexity.

The basin has lost most of its floodplain and lowland wetlands. Much of the landscape has been diked, ditched, filled, drained, and cleared, with poorly designed tide gates and culverts cutting off fish access to the remaining wetland habitat. Instream habitats have been channelized, straightened, riprapped, and mined for gravel. Most lowland riparian areas have been cleared of vegetation, except brush and grass. Livestock have direct access to streambanks and streams in some locations, resulting in crumbling streambanks, trampled vegetation, and disturbed streambeds. Livestock in and adjacent to streams also pollute the water with bacteria.

Estuarine Habitat

The Nestucca Estuary can be divided into a marine, a bay, and two riverine subsystems, based on sediment size, habitats, and geographic location. Although the subsystems do not function independently, a separate discussion of each is useful.

The marine subsystem is located in the lower portion of the estuary and extends from the mouth to RM 1.8 on the Nestucca River. The diurnal salinity changes and the overwash of the spit in February 1978 indicate it is an area where ocean waters have a strong influence (Komar 1978). Depths in the marine subsystem are greater then in the bay subsystem. Approximately 70% of this subsystem is intertidal habitat with primarily a sand substrate. Gaumer and Halstead (1976) reported some shrimp and a few softshell and baltic clams were found. Dungeness and other crabs species also occupy the sand habitats (Gaumer et al. 1973). Adult and juvenile anadromous fish pass through the marine subsystem. Juvenile fall chinook may rear in this subsystem before entering the sea. In some estuaries juvenile fall chinook spend the entire summer in shallow water in the lower estuary prior to seaward migration (Reimers 1970). A comprehensive inventory of fish habitats in the Nestucca and Little Nestucca River Estuaries is lacking, but research in other estuaries suggests that the cobble shore and subtidal habitats on the eastern margin of the marine subsystem may provide food and shelter for many species. Surveys also show dense accumulations of algae and eelgrass attached to the cobble substrate in the Nestucca Estuary (Gaumer and Halstead 1976).

The bay subsystem is located between the marine subsystem and the Nestucca and Little Nestucca river subsystem. It encompasses most of the major marshes and contains extensive flats where most of the fine, river-born sediments are deposited. It is a transition zone between salt and fresh waters and is shallower than either the marine or riverine subsystems. Habitats in the bay subsystem range from lower intertidal to extreme high water elevations. Eelgrass beds correspondingly graduate into algal beds, flats, low marshes, and high marshes. Intertidal marshes, flats, and aquatic beds account for approximately 83% of the surface area of the estuary (ODFW 1979). Softshell clams, baltic clams, and shrimp were observed on the flats of the bay by Gaumer and Halstead (1976). Data are scarce concerning the occurrence of other species in the bay subsystem. Perch, flounder, salmon, and cutthroat trout have been caught by anglers (Gaumer et al. 1973). Migratory waterfowl and shore birds rest and feed in large numbers in this subsystem.

The Nestucca River subsystem extends from the boat ramp at approximately RM 2.4 to the head of the tide at the Cloverdale Bridge (RM 9.0). The water is deeper and narrower in this subsystem than the bay subsystem. Available salinity data indicate that this subsystem is composed of brackish water during summer and fresh water during winter (Giger 1972b; ODEQ 1978). Downstream from the town of Woods, altered and unaltered intertidal habitats occur with low sedge marshes interspersed among riprap and pilings. Small patches of algal beds and high marsh are also found. Riverine habitats upstream of Woods are primarily subtidal. The Nestucca River subsystem is heavily used by recreational anglers (Heckeroth 1970). Cutthroat trout, winter steelhead, and fall chinook are caught as they migrate upstream. Mammals such as beaver, river otter, mink, muskrat, and meadow mouse are residents of the riparian habitats (Batterson 1971). Much of the shoreline in the Nestucca River subsystem has been altered by docks, bulkheads, pilings, and riprap.

Existing Sources of Water Pollutants

Parts of the Nestucca River, Nestucca Bay and several tributaries are currently listed as water quality limited under section 303(d) of the Clean Water Act, resulting from excessive stream temperatures, sedimentation, or elevated concentrations of bacteria. Status of a waterbody is judged based on standards set to ensure beneficial uses (**Table 1**) are protected.

Table 39. Beneficial uses occurring in the Nestucca Bay Watershed

(OAR 340 – 41 – 202)

Beneficial Use	Occurring	Beneficial Use	Occurring
Public Domestic Water Supply	✓	Anadromous Fish Passage	✓
Private Domestic Water Supply	✓	Salmonid Fish Spawning	✓
Industrial Water Supply	✓	Salmonid Fish Rearing	✓
Irrigation	✓	Resident Fish and Aquatic Life	✓
Livestock Watering	✓	Wildlife and Hunting	✓
Boating	✓	Fishing	✓
Aesthetic Quality	✓	Water Contact Recreation	✓
Commercial Navigation & Trans.		Hydro Power	

Temperature

In the rivers, the migration, rearing and spawning of salmonid (salmon and trout) fish are put at risk by high water temperatures (those that exceed 64°F for migration and rearing, or 55°F for spawning) in the summer. In the Nestucca Bay Watershed, 41.5 miles of surface waters were listed as water quality limited for temperature. These water bodies included Powder Creek, Niagara River, and Nestucca River downstream of Powder Creek. Sources of temperature in these streams are primarily from solar radiation that hits the surface of the water due to the widespread removal of riparian vegetation. Although there are three wastewater treatment plants in the watershed, flows from these facilities have a relatively small impact on water temperature.

Sedimentation

The upper reaches of the Nestucca River (above Powder Creek) and East Beaver Creek (a total of 34.3 miles of streams) are listed as impaired due to excessive sedimentation. Excessive sedimentation can result in streambeds that are unsuitable for spawning of salmonid fishes. There is not a numeric criterion defining excessive sedimentation, although the State of Oregon does have a narrative standard barring accumulation of deposits that would make the streambed unsuitable for support of beneficial uses. Excessive sedimentation is principally from poorly constructed or maintained forest roads, natural slides, and streambank erosion in areas where riparian vegetation has been removed. Road-building techniques and forest management practices have been improved in the last decade with the implementation of new rules under the Northwest Forest Plan (federal lands) and the Forest Practices Act (non-federal forestlands). Natural slides can be expected to continue at historical though variable rates. Streambanks in lower gradient reaches of the watershed are currently a continuing source of sedimentation. Stablization of these areas with riparian vegetation will result in decreased sedimentation, narrower channels, and better habitat for fish.

Bacteria

Shellfish harvesting in Nestucca Bay is dependent on waters with minimal concentrations of fecal bacteria. Fecal coliform bacteria in concentrations exceeding a log mean of 14 MPN/100 ml ("most probable number per 100 ml of sample") or when more than 10% of samples have concentrations exceeding 43 MPN/100 ml) cause excessive risk for consumption of shellfish by humans. Bacteria in the rivers are the primary source of the impairment of Bay waters, which support recreational shellfish harvesting. These elevated bacterial concentrations also indicate that recreational contact is not supported at all times in the rivers. The principal sources of fecal bacteria in the watershed are runoff from livestock operations, urban runoff, rural residential runoff, an undetermined number of failing septic systems in the watershed, and wastewater treatment plant discharges. Due to the relative area under livestock management, this use has a larger impact on water quality. Wildlife in the watershed probably provide a relatively low contribution to fecal bacterial loads except in areas surrounding the Bay itself, where concentrations of waterfowl may have a significant effect.

Water Quality Standard Identification

Water quality standards are currently not being met for three parameters; temperature, sedimentation, and fecal bacteria. These standards and criteria are described below. Listed reaches are presented in **Table 2**.

Temperature

A seven-day moving average of daily maximums (7-day statistic) was adopted as the statistical measure of the stream temperature standard. Absolute numeric criteria are deemed action levels and indicators of water quality standard compliance. Unless specifically allowed under a DEQ-approved surface water temperature management plan as required under Oregon Administrative Rules (OAR) 340-041-0026(3)(a)(D), no measurable surface water temperature increase resulting from anthropogenic activities is allowed in State of Oregon Waters determined out of compliance with the temperature standard. A much more extensive analysis of water temperature related to aquatic life and supporting documentation for the water temperature standard can be found in the 1992-1994 Water Quality Standards Review Final Issue Paper (ODEQ, 1995). The standard itself is in the OAR 340-041-202(2)(b)(A).

Sedimentation

The Environmental Protection Agency (EPA) and the State of Oregon do not have numeric water quality standards for streambed fines. Excessive fine sediment is addressed through application of state narrative criteria which restricts "the formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to fish or other…" beneficial uses. For listing purposes, a target of 20% streambed fines was used as an indicator of fine sediment impairment to salmonids (the most sensitive "resident biological community"). This target is based on documentation that formed the basis for interim guidance (PACFISH) for managing federal lands, ODFW habitat benchmarks (Foster, etal 2001), and other studies of sediments in salmonid habitats. Final PACFISH documentation (USFS/BLM 1995) did not include riparian management objectives based on area fines because it was inappropriate to set standards that would be applied over a large region (much of 4 western states) that included variable geology and a wide range of environments (Mike Lohrey, personal communication).

The ODFW benchmarks are specific to streams based on gradient and differing parent sediment sources. Oregon Department of Fish and Wildlife habitat benchmarks indicate a range of substrate fines thresholds above which conditions were "undesirable." The midpoint of these limits was 20% area fines for streams with sedimentary parent materials, as are found in the streambanks of the lower elevation portions of the watershed., though desirable conditions ranged from 8% to 12% fines depending on slope and parent material. This indicator is specific to riffle and glide reaches where currents continually move fine sediments through and salmonids preferentially spawn. Other features (e.g., pools) may be storage areas for fine sediments between large flushing events.

A variety of other sources support the target as appropriate for use as an allocation. A composite of studies of fry emergence related to fine sediments in substrates demonstrated substantial declines in emergence at proportions greater than 20% fines by surface area (Phillips, etal 1975; Hausle and Cobel 1976; and McCuddin 1977; all in Bjornn and Reiser 1991). Results of some studies (Bjornn and Reiser 1991) indicated embryo sensitivity to fines varied among species, but several salmonids (cutthroat and rainbow trout, kokanee, and chinook salmon) showed sensitivity beginning at approximately 20% fines.

Management plans for the Snake River basin have also indicated 20% fines as a threshold for protecting salmoinid habitat (Rhodes, 1995). Anderson, etal (1992 in Rhodes, 1995) recommend maintaining "surface fines and fines by depth in channel substrate at less than 20% in salmon spawning habitat. Where conditions are lower than standards, maintain them." Rhodes, etal (1994 in Rhodes, 1995) recommend "average surface fine sediment <20% in spawning areas with no increase allowed when surface fine sediment is <20%."

For these reasons, the Department has decided, the target for the TMDL should be based on percent fine sediment as indicated above. The loading capacity for sedimentation will be defined as:

- **20 percent streambed area fines in riffle and glide reaches.**

Long-term monitoring and the adaptive management nature of this TMDL will be used to evaluate this goal over time.

> *Sedimentation* [OAR 340-41-205(2)(j)] - "The formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to fish or other aquatic life or injurious to public health, recreation, or industry shall not be allowed."
>
> *Biological criteria* (OAR 340-41-027) - "Waters of the State shall be of sufficient quality to support aquatic species without detrimental changes in the resident biological communities."

Bacteria

The water quality standard for shellfish harvest is a 30-day log mean of 14 fecal coliform organisms per 100 milliliters (mL) with no more than 10 percent of samples exceeding 43 fecal coliform per 100 mL. These criteria have been exceeded in Nestucca Bay. The standard to protect for water contact recreation is a 30-day log-mean of 126 *E. coli* organisms per 100 mL with no single sample exceeding 406 *E. coli* organisms per 100 mL. These criteria are usually met in the watershed, but meeting the criteria for shellfish harvesting will ensure compliance with this recreational contact standard.

Table 40. Water bodies in the Nestucca Bay Watershed listed as water quality limited under section 303(d) of Clean Water Act (DEQ 1998).

Waterbody Name	Boundaries	Parameter	Criteria	Season
Niagara Creek	Mouth to Headwaters	Temperature	Rearing 64 F (17.8 C)	Summer
Powder Creek	Mouth to Headwaters	Temperature	Rearing 64 F (17.8 C)	Summer
Nestucca River	Mouth to Powder Creek	Temperature	Rearing 64 F (17.8 C)	Summer
Nestucca Bay	Bay	Bacteria (fecal coliform)	Marine and shellfish growing area	Year Around
Beaver Creek, East Fork	Mouth to Headwaters	Sedimentation	Narrative	Year Around
Nestucca River	Powder Creek to Headwaters	Sedimentation	Narrative	Year Around
Beaver Creek, East Fork	Mouth to Headwaters	Habitat Modification	Narrative	Year Around
Nestucca River	Powder Creek to Headwaters	Habitat Modification	Narrative	Year Around
Nestucca River	Mouth to Powder Creek	Flow Modification	Narrative	Year Around

ELEMENT 2: GOALS AND OBJECTIVES

The overall goal of the TMDL Implementation plan is to achieve compliance with water quality standards for each of the 303(d) listed parameters and streams in the Nestucca Bay Watershed. The specific goal of this Water Quality Management Plan (WQMP) is to describe a strategy for reducing discharges from nonpoint sources to the level of the load allocations (LAs) and for reducing discharges from point sources to the level of the waste load allocations (WLAs) prescribed in the TMDL. This WQMP is designed to be adaptive as more information and knowledge is gained regarding the pollutants, allocations, management measures, and other related areas.

The overarching goals of this WQMP are to:

Goal 1: Promote Beneficial Uses of the Bay and Rivers;

Goal 2: Reduce Instream Temperatures to Meet Salmonid Requirements;

Goal 3: Reduce Instream Streambed Area Fine Sediment to Meet Salmonid Requirements;

Goal 4 Reduce Instream Fecal Bacteria Concentrations to Meet Shellfish Harvesting and Recreational Contact Standards.

All recovery goals and plans are strongly linked to the philosophy of maintaining those components of the ecosystem that are believed to be currently functioning, and to improving those sites that show the greatest potential for improvement in the shortest time frame. This philosophy maximizes recovery while minimizing expensive, extensive, and risky restoration treatments . The goals and actions described are directly related to the Nestucca-Neskowin Watershed Council Management and Action Plan (1999), Nestucca Estuary Inventory Project (ODFW 1978-1979), Nestucca Watershed Analysis (USFS 1994), and the Nestucca River Basin Water Quality Study (USFS 1992). Many of the identified actions are common to the Nestucca Neskowin Watershed Council Action Plan and the Coordinated Conservation and Management Plan developed by the Tillamook Bay National Estuary project. Actions that will be implemented countywide have been blended from these sources.

ELEMENT 3: MANAGEMENT MEASURES

Management measures described here are those that will result in meeting the stated goals presented in Element 2. Some measures are mandatory and required as a condition of permits (e.g., wastewater discharges) or other legal requirements (e.g., Forest Practices Act). Others are measures that groups of Stakeholders in the Nestucca Bay Watershed and Tillamook County have indicated are appropriate and feasible.

A variety of state and federal laws and rules have been identified as critical in controlling discharge of pollutants to waters of the state and of the United States. These are:

- Clean Water Act section 303(d) as administered by the EPA/DEQ sets load allocations;
- NPDES and WPCF permit programs as administered by the DEQ addresses point source discharges;
- SB 1010 as administered by the ODA addresses agriculture practices;
- Oregon Forest Protection Act as administered by the ODF addresses forest practices;
- The Northwest Forest Plan as administered by the US Forest Service and the Bureau of Land Management, and;
- Local zoning and ordinances to address urban and rural residential activities.

Point Sources

Point sources of bacteria and heat originate with a variety of land uses, but are mostly associated with treated wastewater discharges operated by municipalities or industries, and with urban stormwater runoff. There are 8 permitted facilities in the Watershed. Each of these facilities has one or more general permits covering the specific activity (**Table 3**). These include wastewater discharges, stormwater from facilities, gravel-mining operations, fish hatcheries, and seafood processing. There is some monitoring associated with these permits, which may be revised when the permits are renewed.

Table 41. Wastewater Discharge Permits in the Nestucca Bay Watershed (does not include construction permits).

Facility ID	River Mile	Common Name	City	Category	Type
104818/A	0.3	Nestucca River Trailer Court	Beaver	Domestic	WPCF
110326/A	0.1	Riverhouse Food Products (ABN)	Cloverdale	Domestic	GEN54
102774/A	0.1	Wi-Ne-Ma Christian Camp	Cloverdale	Domestic	WPCF
109796/A	5.7	Tri-Agg, Inc.	Cloverdale	Indiv.	GEN12A
17318/A	7	Cloverdale Sanitary District	Cloverdale	Domestic	NPDES
100058/B	0.75[1]	Hebo Joint Water-Sanitary Auth.	Hebo	Domestic	NPDES
64440/A	2.2	Cedar Creek Hatchery	Hebo	Agricult.	GEN03
66100/A	4	Pacific City Joint Water-Sanitary Auth.	Pacific City	Domestic	NPDES

1 = Discharges to Three Rivers, tributary to the Nestucca River

The Department will work with the County, municipal and special district agencies to develop surface water temperature management plans and to complete a storm sewer system evaluation by January 1, 2005. In addition, it will explore requiring municipalities that discharge urban runoff to rivers or the Bay to obtain permits. Although stormwater is diffuse in origin, it becomes a point source when it is conveyed and discharged to receiving streams. These permits may be for individual city and county facilities, or a regional permit may be issued if the individual governments can develop the necessary agreements on overall management strategies. General NPDES permits for stormwater require development of specific stormwater management plans. These plans must specify management practices that will be used to control the discharge of pollutants to the rivers and bay and meet the Wasteload Allocations of the TMDL.

There are three NPDES-permitted wastewater discharges in the Nestucca Bay Watershed. The Cloverdale Sanitary District Wastewater Treatment Plant discharges to the Nestucca River at RM 7.0. The Hebo Joint Water and Sanitary Authority Wastewater Treatment Plant discharges to Three Rivers at RM 0.75. Pacific City Joint Water and Sanitary Authority Wastewater Treatment Plant discharges into the Nestucca River, within the tidally influenced and salty portion of the estuary, at RM 1.5. Bacterial contamination from these discharges will continue to be controlled through the conditions of the dischargers' permits. Depending on Wasteload Allocations and the likelihood of the receiving waters meeting water quality standards once best management practices are implemented, these permits may become more stringent upon renewal.

Table 42. Individual NPDES Permits and current Permit Limits.

Facility Name	**Discharge Point**	**Permit Limits**
Hebo Joint Water and Sewer Authority STP	Three Rivers at RM 0.75 To Nestucca River at RM	Monthly geometric mean of 126 /100 ml No sample exceeding 406 /100 ml
Cloverdale Sanitary District STP	Nestucca River at RM 7	Monthly geometric mean of 126 /100 ml No sample exceeding 406 /100 ml
Pacific City Joint Water and Sewer Authority STP	Nestucca River at RM 1	Monthly geometric mean of 126 /100 ml No sample exceeding 406 /100 ml

Specific Management Measures

Additional management measures were developed by the Nestucca-Neskowin Watershed Council, county and local governments, and state and federal management agencies.

Point Source Management Measures -- Bacteria

Ensure adequate urban runoff treatment and retention

- Effectively enforce laws and regulations
- Expand sewer network
- Develop system to ensure detection and elimination of illegal discharge activities
- Ensure that runoff from construction sites is contained
- Ensure that runoff from general road maintenance is contained

Point Source Management Measures -- Temperature

- Permit compliance will be the method of ensuring point sources meet Wasteload Allocations.

Non-Point Sources

Non-Point Sources of bacterial contamination and heating (temperature) are associated with large-scale land management practices. The sources include urban, rural residential , agricultural, and forestry uses. Elevated levels of bacteria are found in the Bay, all of the rivers flowing into the Bay, and many tributary streams throughout the basin. Major sources include dairy and other livestock operations, onsite septic systems for rural residential homes, runoff from industrial and municipal facilities, urban runoff, and both domestic and wild animals.

Temperature is associated with changes to riparian shade and channel morphology resulting from all of these land uses as well as forestry practices.

Agriculture

Many of the improvements in water quality are expected to occur as a result of implementation of the SB1010 Agricultural Water Quality Management Area Plan (AWQMAP) for the North Coast Basin (Oregon Department of Agriculture 1999), which includes the Nestucca and Neskowin Bay Watersheds. Generally the issues associated with agriculture are diffuse, or non-point sources rather than point-sources. This plan defines conditions that agricultural practices are not allowed to cause, and includes enforceable rules to ensure progress can be made. The rules are stated in the context of “Pollution Prevention and Control Measures” that were developed by a Local Advisory Committee with a variety of interests. The plan addresses riparian and streambank conditions, livestock access to surface waters, manure and nutrient management, among other issues.

Pollution Prevention and Control Measures for Agriculture (SB1010 – AWQMAP ; ODA 1999)

BACTERIA --

- Healthy Riparian and Streambank Condition
- Livestock and Grazing Management
- Manure and Nutrient Management

TEMPERATURE

- Healthy Riparian and Streambank Condition
- Tidegates
- Livestock and Grazing Management

Though not enforceable, the AWQMAP also included suggested management measures that would control pollutants at their source. While not all practices would be appropriate for any one farm, the list provides choices that may be included in management on a farm-specific basis. These practices are listed below.

Erosion and Sediment Control
Management
- Conservation tillage
- Contour farming
- Contour strip cropping
- Delayed seed bed preparation

Vegetative
- Cover crops
- Critical area planting (including wetland and riparian zone protection)
- Filter strip/field border
- Grassed waterway

Structural
- Streambank stabilization
- Clean water diversion
- Grade stabilization structure
- Sediment basin/retention pond
- Terrace

Confined Animal Facility Management (Wastewater Runoff Management)
Management
• Agronomic application of manure, composted manure or wastewater to agricultural land
Vegetative
• Heavy use area protection (e.g., cover crops)
• Grassed Waterway
Structural
• Heavy use area protection (e.g., concrete)
• Roof runoff management (e.g., gutters & downspouts)
• Dikes
• Clean water diversion
• Terrace
• Waste storage pond/structure
• Waste treatment lagoon
• Constructed wetland
Nutrient Control
Management
• Overall nutrient management planning (e.g., nutrient budgeting)
- Soil testing
- Manure, sludge, and compost testing
- Proper timing, formulation, and application methods of nutrients for maximum crop utilization
- Plant tissue testing
Vegetative
• Cover crops
• Filter Strip/field border
Pesticides
Management
• Use of Integrated Pest Management (IPM) strategies and systems
- Biological controls, pheromones, crop rotations, cover crops, economic thresholds, etc.
- Maintain inventory of current and historical pest problems, cropping patterns, and use of pesticides for each field
- Consider the persistence, toxicity, and runoff and leaching potential of products, and current label requirements in making a selection when a choice of pesticide materials exists
• Recalibrate spray equipment each spray season
• Use of anti-backflow devices on hoses used for filling tank mixtures
Structural
• Protect against leaching and runoff potential in loading, mixing, and storage areas
Grazing
Management
• Planned grazing systems
    - deferred grazing & pasture rotation
• Pasture management
    - pasture renovation, cross-fencing, brush/weed management, prescribed burning
Structural
• Alternate water supply practices (off-stream water sources)
    - placement of water and salt supplement facilities away from streams
• Limit livestock access to waterways
    - fencing, livestock exclusion, stream crossing
Irrigation
Management
• Sprinkler calibration
• Irrigation scheduling practices
    - irrigation water management; utilization of water measuring devices and soil & crop

water use data
- evaporation monitoring

Vegetative
- Cover crops and straw mulch
- Filter strip/field border

Structural
- Irrigation water application methods
    - drip or trickle irrigation, sprinkler irrigation, microjet irrigation
- Drainage water management
    - ditch and canal lining, subsurface drainage
- Surface and subsurface irrigation systems
    - furrows, borders, contour levees/ditches
- Irrigation land leveling
- Tailwater recovery/recycling systems
- Sediment basin/retention pond
- Rip hardpans and compacted soil layers to improve infiltration rates

Irrigation and Drainage Ditches

Management
- During maintenance, remove only sand silt; avoid removing gravel important for native fish
- Conduct excavation operations with land-based equipment from one side of the channel
- Properly dispose of dredged sediments away from the channel, either on uplands or spread in a thin layer (3 inches or less) on farmed wetland or wet pasture in a manner that does not convert the wetland to upland
- Conduct maintenace and excavation only during the time period specified in the "Oregon Guidelines for Timing of In-Water Work to Protect Fish and Wildlife Resources" prepared by the Oregon Department of Fish and Wildlife

Vegetative
- Promote and maintain woody vegetation along ditches and channelized streams in a manner that provides shade and shelter for fish, yet allows regular maintenace and cleaning
- Plant channel banks and work areas with grass and/or trees and shrubs after maintenance in order to minimize erosion as much as possible

Structural
- Construct and maintain ditches utilizing ditch slope and ditch cross section that are appropriate to the site and prevent ditch bank sloughing

Riparian Areas and Vegetation

Management
- Exclude livestock from riparian areas
- Create riparian pasture and manage to protect riparian vegetation and streambank stability
- Avoid manure, fertilizer, and chemical applications in the riparian area or where the riparian area could be affected
- Control noxious weeds
- Limit in-stream livestock access and crossings to the absolute minimum

Vegetative
- Riparian forest buffer
- Riparian herbaceous cover
- Vegetative buffers

Structural
- Fencing riparian areas to limit or exclude livestock access
    - electric "New Zealand" style high tensile wire fences are low cost and flood resistant
- Install off-stream water sources for livestock
- Development of appropriately sized bridges and culverts for livestock crossings
- Biotechnical barbs for streambank stability

One of the key elements of this planning process is the assumption that individual Voluntary Farm Plans will be developed by a large percentage of the landowners in the basin in concert with local

agency (e.g., NRCS, SWCD personel). These farm plans would define the range of practices that individual landowners would use to ensure that their operations do not result in prohibited conditions. Through development of the plans, landowners would use their personal experience along with judgment of professionals in determining what practices will be most effective in limiting pollutant effects from their land.
In addition to Those provided by the AWQMAP for the North Coast Basin, there are other management measures that were developed through the Tillamook Bay National Estuary Project and published in the Comprehensive Conservation and Management Plan (TBNEP/TBPP 1999). Though this planning document was developed for the Tillamook Bay Watershed, many of the management measures and actions are intended to be implemented county-wide. Some of these that are relevant to temperature, sedimentation, and bacterial management are listed below.

Other Management Measures Identified for Temperature and Bacteria (CCMP – Appendix A)

- Define, Implement, and Enforce Pollution Prevention and Control Measures on Agriculture Lands.
- Implement Voluntary Farm Management Plans.
- Implement Revised Confined Animal Feeding Operation (CAFO) Inspection Procedure
- Use Farm-Specific Agronomic Rates for Nutrient Management
- Provide Farm/Livestock Management Training Programs
- Identify Stream Segments Where Heating Occurs
- Assess and Map Riparian and Wetland Habitat
- Characterize riparian and Instream Habitat
- Increase Incentive Program Payments
- Encourage Protection and Enhancement on Private Lands
- Control Livestock Access to Streams
- Prioritize Floodplain/Lowland Protection and Enhancement Sites
- Protect and Enhance Lowland Riparian Areas
- Protect and Enhance Freshwater Wetland Habitat
- Revise Local Ordinances to Increase Protection of Riparian Areas,
- Protect and Enhance Wetlands, and Instream Habitat
- Remove or Modify Ineffective Tide Gates and Culverts
- Reconnect Sloughs and Rivers to Improve Water Flow

Forestry

Forestry practices on state and private lands are governed by the State of Oregon's Forest Practices Act (FPA). The FPA defines specific measures for protecting water quality and habitat during forestry operations. These measures include leaving trees within certain distances of streambanks depending on the type of stream and occurrence of fish. These trees and understory vegetation are intended to provide a buffer between logged areas and the stream, providing shade, woody debris, filtration of sediments from overland flow, and erosion control. The FPA is the governing law on all state forest and private land.

In addition to the FPA, the Tillamook State Forest (TSF) has adopted the Western Oregon State Forest Management Plan, and is developing a Habitat Conservation Plan (HCP) for management of its forests. Both of these plans have more protective management standards than the FPA. The HCP is required by the federal government as protection of a variety of rare, threatened and endangered species that live in or on State Forest land. Although the HCP is being developed to protect habitat for endangered species, there will be direct benefits to water quality if it is implemented. Some of the principal improvements of the HCP relative to FPA regulations are:

- Increased widths of Streambank Zones from 20 to 25 feet;
- Addition of an outer Riparian Management Zone for a total of 170 feet of restricted harvest compared with 100 feet under FPA;
- No harvest in inner Riparian Management Areas where Mature Forest Condition exists;
- Increased density of trees within the Riparian Management Zones; and
- Increased Protection on non-fish-bearing streams as well as fish-bearing streams.

All of these measures will be effective in moderating temperature in forested areas where they are applied. These measures will only be required on State Forest lands, which account for relatively little (approximately 5%) area in the Nestucca Bay Watershed. Compliance by any private landowners will be on a voluntary basis.

Federal forest lands are managed by the US Forest Service (USFS) and the Bureau of Land Management (BLM). The Siuslaw National Forest manages approximately 44% of the watershed. This land area is managed under the guidelines of the Northwest Forest Plan and its Aquatic Conservation Strategy, and the Siuslaw National Forest Land and Resource Management Plan. The Standards and Guidelines for the Aquatic Conservation Strategy contain four components: riparian reserves; key watersheds; watershed analysis; and watershed restoration. Each part is expected to play an important role in improving the health of the region's aquatic ecosystems. The Siuslaw National Forest is part of the Northern Coast Range Adaptive Management Area. The management goals of the Northern Coast Range Adaptive Management Area are restoration and maintenance of late-successional forest and the conservation of fisheries habitat and biological diversity.

The Bureau of Land Management administers approximately 17% of the land in the watershed. This land area is managed under the guidelines of the Northwest Forest Plan and its Aquatic Conservation Strategy, and it is part of the Northern Coast Range Adaptive Management Area. The Standards and Guidelines for the Aquatic Conservation Strategy contain four components: riparian reserves; key watersheds; watershed analysis; and watershed restoration. Each part is expected to play an important role in improving the health of the region's aquatic ecosystems. The management goals of the Northern Coast Range Adaptive Management Area are restoration and maintenance of late-successional forests and the conservation of fisheries habitat and biological diversity. BLM lands are managed according to provisions of the Salem District Record of Decision and Resource Management Plan, as amended by the Northwest Forest Plan.

Pursuant to the *Nestucca Watershed Analysis* (1994), the most important components of the Bureau of Land Management's watershed restoration program are control and prevention of road-related run-off and sediment production, restoration of the condition of riparian vegetation, and restoration of in-stream habitat complexity. Timelines for addressing these issues will be dependent on availability of funding.

In 2000 the Bureau completed an environmental assessment of its transportation system and issued a decision to repair storm damaged roads in ten locations and to stabilize or decommission over 80 miles of Bureau controlled roads in a five to ten year time period. The road treatments include actions such as constructing retaining walls, establishing waterbars, removing sidecast material, removing or replacing culverts, subsoiling the road surface to restore infiltration, constructing earth barricades to block roads, and revegetating disturbed areas with native or sterile species.

In January 2001 the Bureau issued a decision to enhance salmonid spawning and rearing habitat on approximately 10 miles of stream in a three to five year time period. This decision was based upon an environmental assessment conducted on the stream reaches located on lands managed by the Bureau in the upper portion of the watershed. The specific activities include the replacement and/or modification of culverts, maintenance of existing stream structures (log), and placement of new stream structures (log and boulder).

Other management actions that the Bureau intends to continue implementing within the watershed include riparian planting and site-specific silvicultural treatments (e.g., variable-spaced thinnings, snag and down wood creation) in the upland habitat to hasten the development of older forest characteristics and uneven-aged stands.

The Bureau is interested in and intends to pursue collaboration with other land owners and stakeholders in the watershed to strategize and coordinate our collective restoration efforts.

Land use Planning and County RoleOrdinances

Tillamook County is responsible for the development of local ordinances designed to control NPS water quality pollution in urban and rural residential areas. Oregon cities and counties have authority to regulate land use activities through local comprehensive plans and related development regulations. This authority begins with a broad charge given to them by the Oregon constitution and the Oregon legislature to protect the public's health, safety, and general welfare.

Every city and county is required to have a comprehensive plan and accompanying development ordinance to be in compliance with state land use planning goals. While the comprehensive plan must serve to implement the statewide planning goals mandated by state law, cities and counties have a wide degree of local control over how resource protection is addressed in their community.

The Oregon land use planning system provides a unique opportunity for local jurisdictions to address water quality protection and enhancement. Many of the goals have a direct connection to water quality, particularly Goals 5 (Open Spaces, Scenic and Historic Areas, and Natural Resources) and 6 (Air, Water and Land Resources Quality). Tillamook County is currently conducting a periodic review of its Comprehensive Plan. Among the expected changes to this plan will be revised ordinances for the protection of riparian areas. We expect these revised ordinances to be sufficient to meet the allocations in the TMDL."
Specific ordinances identified to date are:

- Riparian protection ordinance (currently under review by Tillamook County);
- Freshwater wetlands protection ordinance;
- Intertidal wetlands protection ordinance; and
- Stormwater abatement ordinance.

ELEMENT 4: TIMELINE FOR IMPLEMENTATION

The timeline for implementation of the allocations in the TMDLs relies on efforts by Designated Management Agencies (DMAs) as well as local groups and private citizens. Many of the requirements of the DMAs are mandated by existing regulations or plans. Examples of these would be the Northwest Forest Plan for the USDA Forest Service (USFS), or the Agricultural Water Quality Management Area Plan for the Oregon Department of Agriculture (ODA). These plans have their own timelines for compliance with management measures and achievement of goals. Tillamook County has existing ordinances that affect compliance with the allocations, but which may need to be modified to achieve compliance. The Nestucca-Neskowin Watershed Council has developed an Action Plan that addresses many of the rural non-point sources of temperature, sediment and bacteria. Many of these actions will require the watershed council to secure funding from outside sources (e.g., Oregon Watershed Enhancement Board, DEQ 319 funding).

The table below lists the actions from a variety of sources to be completed and the approximate completion date. Many actions are ongoing. They do not have completion dates but will continue to be implemented throughout the life of the plan. Some actions were developed as part of the

Coordinated Conservation and Management Plan for the Tillamook Bay National Estuary Project, but are expected to be implemented countywide. County ordinances that are being reviewed to meet needs of the CCMP would also be implemented in the Nestucca Bay Watershed.

Table 43. Actions generally identified by various planning documents. Timelines are based on TBNEP Comprehensive Conservation and Management Plan (TBNEP 1999)

Action	**Year of Completion**										
Non-Point Sources	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Action 1: Define implement, Enforce pollution control measures on Agricultural land	■	■	■	■	■	■	■	■	■	■	■
Action 2: Implement Voluntary Farm Management Plans	■	■	■	■	■	■	■	■	■	■	■
Action 3: Implement Revised CAFO Inspection procedures.	**Accomplished in 2000**										
Action 4:Provide Farm Management Training.	■	■	■	■	■	■	■	■	■	■	■
Action 5: Control Livestock Access to stream	■	■	■	■	■	■	■	■	■	■	■
Action 6: Encourage Protection /Enhancement on Private Lands.	■	■									
Action 7: Revise Local Ordinances to Increase Protection of Riparian and Wetland Habitat.	■	■									
Action 8: Reconnect Sloughs and Rivers to Improve Water Flow.	■	■	■	■	■	■	■	■	■	■	■
Action 9: Ensure Minimum Streamflows.	■	■	■	■	■	■	■	■	■	■	■
Action 10: Assess and Map Riparian Habitat	■	■	■								
Action 11: Prioritize Upland Riparian Protection/Enhancement Sites	■	■	■								
Action 12: Protect/Enhance Upland Riparian Areas	■	■	■	■	■	■	■	■	■	■	■
Action 13: Protect/Enhance Lowland Riparian Areas	■	■	■	■	■	■	■	■	■	■	■
Action 1: Develop NPDES discharge permits with effluent limits that meet TMDL allocations.	■	■	■	■	■	■	■	■	■	■	■
Action 2: Ensure Adequate Urban Runoff Treatment and Retention.	■	■	■	■	■	■	■	■	■	■	■
Action 3: Ensure Properly Functioning On-Site Sewage Disposal Systems.	■	■	■	■	■	■	■	■	■	■	■

ELEMENT 5: IDENTIFICATION OF RESPONSIBLE PARTICIPANTS

This element identifies the agencies and organizations responsible for the implementation strategy and to list the major responsibilities of each organization. Parties that are Designated Management Agencies with legal responsibilities for enforcement of land management or water quality rules are indicated with a DMA. Others may provide assistance on a voluntary basis or under the terms of grant funding, or may be sources of funding and/or technical assistance. Various implementation aspects will be addressed based on priority as specific plans are developed or implemented, and as funding is available.

Unincorporated Communities (DMA)

- Upgrade Sewer Networks;
- Ensure Adequate Urban Runoff Treatment and Retention;

Tillamook County: (DMA)

- Review/Revise/Adopt Relevant Ordinances;
- Encourage Protection/Enhancement On Private Lands;
- Assess and Map Riparian and Wetland Habitat;
- Prioritize Floodplain/Lowland Protection/Enhancement Sites;
- Reconnect Sloughs and Rivers to Improve Water Flow;
- Expand Sewer Network;
- Ensure Adequate Urban Runoff Treatment and Retention;
- Ensure Properly Functioning On-Site Sewage Disposal Systems;
- Provide Technical Assistance;
- Provide Funding for Habitat Protection/Enhancement Projects.

Oregon Department of Agriculture: (DMA)

- Implement SB 1010 Agriculture Water Quality Management Plan.
- Implement CAFO Implementation/Enforcement.
- Nutrient Management Plans
- Livestock Management Training.
- Encourage Protection/Enhancement On Private Lands
- Prioritize Floodplain/Lowland Protection/Enhancement Sites.
- Protect and Enhance Freshwater Habitat.
- Effectively Enforce Laws and Regulations;
- Provide technical Assistance;
- Provide Funding for Habitat Protection/Restoration Projects;

Oregon Department of Environmental Quality: (DMA)

- Characterize Riparian and Wetland Habitat;
- Prioritize Floodplain/Lowland Protection/Enhancement Sites;
- Protect and Enhance Freshwater Riparian and Wetland Habitat;
- Characterize Estuarine and Tidal habitat
- Prioritize Tidal Habitat Protection/Enhancement Sites
- Protect and Enhance Tidal Marsh;
- Reconnect Sloughs and Rivers to Improve Water Flow;
- Ensure Properly Functioning On-Site Sewage Disposal Systems;
- Identify Stream Segments Where Rapid Heating Occurs;
- Analyze Instream Flows;
- Prioritize Upland Riparian Protection/Enhancement Sites;
- Effectively Enforce Laws and Regulations;
- NPDES Permitting and Enforcement

- WPCF Permitting and Enforcement
- Provide Technical Assistance;
- Provide 319 Funding For Habitat Protection/Enhancement Projects

Oregon Department of Forestry: (DMA)
- Characterize Riparian and Instream Habitat;
- Prioritize Upland Riparian Protection/Enhancement Sites;
- Protect and Enhance Upland Riparian Sites
- Effectively Enforce Laws and Regulations;
- Forest Practices Act Compliance
- Provide Technical Assistance;
- Provide Funding for Habitat Protection/Enhancement Projects;

U.S. Department of Agriculture – Forest Service (DMA)
- Provide Technical Assistance;
- Provide Funding for Habitat Protection/Enhancement Projects;
- Manage lands pursuant to Standards and Guidelines in the Northwest Forest Plan, Aquatic Conservation Strategy, Coast Range Adaptive Management Area Plan, and the Siuslaw National Forest Land and Resource Management Plan;
- Continue restoration activities as defined in long range plans.

U.S. Department of Interior – Bureau of Land Management: (DMA)
- Provide Technical Assistance;
- Provide Funding for Habitat Protection/Enhancement Projects;
- Manage lands based on the Salem District Record of Decision and Resource Management Plan, as amended by the Standards and Guidelines in the Northwest Forest Plan, Aquatic Conservation Strategy, and the Coast Range Adaptive Management Area Plan;
- Continue restoration activities as defined in long range plans.

Nestucca-Neskowin Watershed Council
- Encourage Protection/Enhancement On Private Lands;
- Characterize Riparian and Instream Habitat;
- Prioritize Floodplain/Lowland Habitat;
- Prioritize Floodplain/Lowland Protection/Enhancement Sites;
- Protect and Enhance Freshwater Wetland Habitat;
- Characterize Estuarine and Tidal Habitats;
- Prioritize Estuarine and Tidal Protection/Enhancement Sites;
- Protect and Enhance Tidal Habitat;
- Remove or Modify Ineffective Tide Gates and Culverts;
- Prioritize Upland Riparian Protection/Enhancement Sites;
- Protect and Enhance Upland Riparian Sites;
- Provide Technical Assistance;
- Provide Funding for Habitat protection/Enhancement Projects.

Tillamook County Soil & Water Conservation District:
- Nutrient Management Plans.
- Livestock Management Training.
- Exclude Livestock From Streams.
- Encourage Protection/Enhancement on Private Lands.
- Prioritize Floodplain/Lowland Protection/Enhancement Sites.
- Protect and Enhance Freshwater Habitat.
- Remove or Modify Ineffective Tide Gates and Culverts;
- Provide technical Assistance.

Oregon Department of Fish and Wildlife:
- Characterize Riparian and Instream Habitat;
- Prioritize Floodplain/Lowland Protection/Enhancement Sites;
- Protect and Enhance Freshwater Riparian and Wetland Habitat;
- Prioritize Tidal Habitat Protection/Enhancement Sites;
- Protect and Enhance Tidal Marsh
- Prioritize Upland Protection/Enhancement Sites
- Protect and Enhance Upland Riparian Sites;
- Effectively Enforce Laws and Regulations;
- Provide Technical Assistance;
- Provide Funding For Habitat Protection/Enhancement projects;

Oregon Division of State Lands:
- Assess and Map Riparian and Wetland Habitat;
- Characterize Riparian and Wetland Habitat;
- Reconnect Sloughs and Rivers to Improve Water Flow;
- Provide Technical Assistance;
- Effectively Enforce Laws and Regulations;

Oregon State University Extension Service:
- Nutrient Management Plans;
- Livestock Management Training;
- Provide technical Assistance;

Oregon State Police:
- Effectively Enforce Laws and Regulations;

Oregon Watershed Enhancement Board:
- Provide Funding for Habitat Protection/Enhancement Projects;

Oregon Wetlands Joint Venture:
- Prioritize Wetlands Protection/Enhancement Sites;
- Protect/Enhance Freshwater Wetlands Habitat;
- Prioritize Estuarine and tidal Habitats;
- Protect and Enhance Tidal Marsh;
- Provide technical Assistance;
- Provide Funding for Wetlands Protection/Enhancement Projects;

Oregon Water Resources Department:
- Analyze Instream Flows;
- Effectively Enforce Laws and Regulations;
- **Provide Technical Assistance;**

U.S. Army Corps of Engineers:
- Reconnect Sloughs and Rivers to Improve Water Flow;
- Provide Technical Assistance;
- Provide Funds for Habitat protection/Enhancement Projects;

U.S. Department of Agriculture Farm Service Agency:
- Provide Technical Assistance;
- Provide Funding for Habitat Protection/Enhancement Projects;

U.S. Environmental Protection Agency:
- Provide technical Assistance;
- Provide 319 Funding for Habitat Protection/Enhancement Projects;

U.S. Natural Resource Conservation Service:
- Develop Voluntary Farm Plans;
- Nutrient Management Plans;
- Increase Incentive Program Payments;
- Provide technical Assistance;
- Provide Funding for Habitat Protection/Enhancement Projects;

ELEMENT 6: REASONABLE ASSURANCE OF IMPLEMENTATION

The Oregon Plan

The Oregon Plan for Salmon and Watersheds is a partnership between Federal and State agencies, local groups and grassroots organizations, that recognizes the attributes of aquatic health and their connection to the health of salmon populations. The Oregon Plan considers the condition of salmon as a critical indicator of ecosystems (CSRI, 1997). The decline of salmon populations has been linked to impoverished ecosystem form and function. The Oregon Plan has committed the State of Oregon to the following obligations: an ecosystem approach that requires consideration of the full range of attributes of aquatic health; focuses on reversing factors for decline by meeting objectives that address these factors; develops adaptive management and a comprehensive monitoring strategy; and relies on citizens and constituent groups in all parts of the restoration process. The intent of the Oregon Plan is to conserve and restore functional elements of the ecosystem that supports fish, wildlife, and people. In essence, the Oregon Plan depends on sustaining a local-state-federal partnership. Specifically, the Oregon Plan is designed to build on existing State and Federal water quality programs, namely: Coastal Zone Non-Pollution Control Programs, the Northwest Forest Plan, Oregon Forest Practices Act, Oregon's Senate 1010 Agriculture Water Quality Management Plans, and Oregon's Total Maximum Daily Load Program. The Oregon plan is a major component of the demonstration of " reasonable assurance " that this TMDL Water Quality Management Plan will be implemented.

The Plan consists of four essential elements:

1. Coordinated Agency Programs:
Many state and federal agencies administer laws, policies, and management programs that have an impact on salmon and water quality. These agencies are responsible for fishery harvest management, production of hatchery fish, water quality, water quantity, and a wide variety of habitat protection, alteration, and restoration activities. Previously, agencies conducted business independently. Water quality and salmon suffered because they were affected by the actions of all the agencies, but no single agency was responsible for comprehensive, life-cycle management. Under the Oregon Plan, all government agencies that impact salmon are accountable for coordinated programs in a manner that is consistent with conservation and restoration efforts.

2. Community-Based Action:
Government, alone, cannot conserve and restore salmon across the landscape. The Oregon plan recognizes that actions to conserve and restore salmon must be worked out by communities and landowners, with local knowledge of problems and ownership in solutions. Watershed councils, soil and water conservation districts, and other grassroots efforts are vehicles for getting the work done. Government programs will provide regulatory and technical support to these

efforts, but local people will do the bulk of the work to conserve and restore watersheds. Education is a fundamental part of the community based action. People must understand the needs of salmon in order to make informed decisions about how to make changes to their way of life that will accommodate clean water and the needs of fish.

3. Monitoring:
The monitoring program combines an annual appraisal of work accomplished and results achieved. Work plans will be used to determine whether agencies meet their goals as promised. Biological and physical sampling will be conducted to determine whether water quality and salmon habitats and populations respond as expected to conservation and restoration efforts.

4. Appropriate Corrective Measures:
The Oregon Plan includes an explicit process for learning from experience, discussing alternative approaches, and making changes to current programs. The Plan emphasizes improving compliance with existing laws rather than arbitrarily establishing new protective laws. Compliance will be achieved through a combination of education and prioritized enforcement of laws that are expected to yield the greatest benefits for salmon.

Voluntary Measures

There are many voluntary, non-regulatory, watershed improvement programs (Actions) That are in place and are addressing water quality concerns in the Nestucca Bay Basin. Both technical expertise and partial funding are provided through these programs. Examples of actions promoted and accomplished through these programs include: planting of conifers, hardwoods, shrubs, grasses, and forbs along streams; fencing out livestock from riparian areas; protecting or enhancing wetlands; relocating and retiring legacy roads; and replacing tide gates and culverts. The programs addressing these problems include:

- **Nestucca-Neskowin Watershed Council (NNWC)**
- **Tillamook County Performance Partnerships (TCPP).**

The Nestucca-Neskowin Watershed council has been active in the Nestucca Basin since 1997. The Council has developed a Nestucca Basin Watershed Assessment (1998), and a Nestucca Basin Management and Action Plan (1999) in close cooperation with state and federal agencies. local governments, business, and landowners. The Council, in association with the Council Technical Advisory Committee has provided invaluable contributions toward the development of the Nestucca Basin TMDL. The Council has provided a forum for local citizens to meet, plan, discuss actions and alternatives, and select specific projects for completion. The Council will be the focal point for future TMDL implementation activities.

The Tillamook Bay National Estuary Project (TBNEP) worked in close association with state and federal agencies, local governments, businesses, watershed councils, and landowners to develop a Tillamook Bay Basin Comprehensive Conservation Management Plan (CCMP). The plan defines a litany of actions to be taken to protect or enhance water quality and fish habitat. Although the CCMP specifically address the Tillamook Bay, a part of the mission of the TBNEP was to develop information and processes for estuary/watershed evaluation that could be used in other estuaries coast-wide and particularly within Tillamook County. The Tillamook Bay CCMP process has been incorporated into the Nestucca Bay Watershed TMDL Water Quality Management Plan.

The TCPP was formed in 1999 upon the completion of the CCMP to oversee implementation of the Plan. The TCPP is a partnership among local residents, state and federal agencies, local governments, and public interest groups concerned with the management of the Tillamook Bay Basin. The TCPP also provides technical expertise to watershed councils involved in

estuary/watershed programs county-wide. The TCPP will be working closely with the NNWC toward the implementation of the Nestucca Basin WQMP.
The central strategy of the TCPP approach is based upon the belief that a locally based effort to improve coordination, integration and implementation of existing local, state, and federal programs can be effectively protect, enhance, and restore a regional watershed area. The TCPP coordinates efforts to: characterize riparian and wetland habitats; prioritize riparian and wetland sites for protection/enhancement; develop specific project plans and design; provide funding; project implementation; and project monitoring.

The EPA provides funding for TCPP staff and provides oversight to ensure that CCMP goals, objectives, and action items are implemented. A majority of Management Measures identified in this implementation strategy plan are identified as specific action items within the CCMP. This EPA oversight will add additional assurance of implementation.

2. Landowner Assistance Programs

A variety of grants and incentive programs are available to landowners in the Nestucca Bay Watershed. These incentive programs are aimed at improving the health of the watershed, particularly on private lands. They include technical and financial assistance, provided through a mix of state and federal funding. Local natural resource agencies administer this assistance, including the ODF, ODA, ODFW, ODEQ, OWEB, WRD, and NRCS.

Field staff from the administrative agencies provide technical assistance and advice to individual landowners, watershed councils, local governments, and organizations interested in enhancing the Watershed. These services include on-site evaluations, technical project design, stewardship/conservation plans, and referrals for funding as appropriate. This assistance and funding is further assurance of implementation of the TMDL Water Quality Management Plan.

Regulatory/Structured Programs

There are a variety of structured programs that are either in place or will be put in place to help assure that this TMDL WQMP will be implemented. Some of these are traditional regulatory programs such as discharge permit programs for industry. In these cases, the pollutants of concern will be considered and the regulation will be carried out as required by federal, state, or local law. Other programs, while structured, are not strictly regulatory. In these cases, local implementing agencies agree to make a good faith effort to implement the program.

1. NPDES and WPCF Permit Programs

The DEQ administers two different types of wastewater permits in implementing Oregon Revised Statute (ORS) 468B.050. The National Pollutant Discharge Elimination System (NPDES) permits for waste discharge; and Water Pollution Control Facilities (WPCF) are granted by the State of Oregon for waste disposal. The NPDES permit is also a Federal permit, which is required under the Clean Water act for discharge of waste into waters of the United States. DEQ has been delegated authority to issue NPDES permits by the EPA. The WPCF permit is unique to the State of Oregon. As the permits are renewed they will be revised to insure that all 303(d) related issues are addressed in the permit. Hence, these permit activities assure that elements of the TMDL Implementation Strategy involving urban and industrial pollution problems will be implemented.

2. Countywide Regulatory Structure

Oregon cities and counties have authority to regulate land use activities through local comprehensive plans and related development regulations. This authority begins with a broad charge given to them by the Oregon constitution and the Oregon legislature to protect the public's health, safety, and general welfare.

Every city and county is required to have a comprehensive plan and accompanying development ordinances to be in compliance with state land use planning goals. While the comprehensive plan must serve to implement the statewide planning goals mandated by state law, cities and counties have a wide degree of local control over how resource protection is addressed in their community.

The Oregon land use planning system provides a unique opportunity for local jurisdictions to address water quality protection and enhancement. Many of the goals have a direct connection to water quality, particularly Goals 5 and 6. Tillamook County is currently conducting a periodic review of its Comprehensive Plan. Among the expected changes to this plan will be revised ordinances for the protection of riparian areas. We expect the county to adopt revised ordinances that will be sufficient to meet the allocations in the TMDL

3. **Forestry**

Northwest Forest Plan
In response to environmental concerns and litigation related to timber harvest and other operations on Federal Lands, the United States Forest Service (USFS) and the Bureau of Land Management (BLM) commissioned the Forest Ecosystem Management Assessment Team (FEMAT) to formulate and assess the consequences of management options. The assessment emphasizes producing management alternatives that comply with existing laws and maintaining the highest contribution of economic and social well being. The "backbone" of ecosystem management is recognized as constructing a network of late-successional forests and an interim and long-term scheme that protects aquatic and associated riparian habitats adequate to provide for threatened species and at risk species. Biological objectives of the Northwest Forest Plan include assuring adequate habitat on Federal lands to aid the "recovery" of late-successional forest habitat-associated species listed as threatened under the Endangered Species Act and preventing species from being listed under the Endangered Species Act.

The Northwest Forest Plan is a comprehensive ecosystem management strategy the core components of which include:

- A network of Late-Successional and other reserves distributed across the landscape in which management actions must protect or enhance late-successional forest conditions;

- An aquatic conservation strategy that delineates reserves (buffers) along rivers, streams and other riparian areas, and provides other measures to protect or improve aquatic and riparian habitats;

- A series of broadly stated standards and guidelines that provide guidance for management actions across the entire Northwest Forest Plan area; and

- A series of specific standards and guidelines for management actions outside of reserve areas.

Under the Northwest Forest Plan, strict limits are placed on management activities ranging from road building to harvest. These limits are generally more restrictive than existing state regulations and provide clear protection for riparian forest areas central to the allocations in the TMDLs. More than 2/3 of the Nestucca Bay watershed is managed by the USFS and BLM. Of the forests in this federal land, a large percentage is being managed as "Late Successional Reserve" or "Adaptive Management Area." Although no scheduled harvest is allowed in the reserves, certain thinning and salvage sales and other multiple use activities may be permitted, provided they maintain or improve the characteristics and purposes of the reserves.

Oregon Forest Practices Act
Oregon's Department of Forestry (ODF) has adopted Forest Practice Administrative Rules (1997) that define allowable actions on State, County and private forestlands. The Oregon Forest Practices Act (FPA, 1994) contains regulatory provisions that include objectives to: classify and protect water resources, reduce the impacts of clearcut harvesting, maintain soil and site productivitiy, ensure successful reforestation, reduce forest management impacts to anadromous fish, conserve and protect water quality and maintain fish and wildlife habitat, develop cooperative monitoring agreements, foster public participation, identify stream restoration projects, recognize the value of biodiversity and monitor/regulate the application of chemicals. Forest Practice Administrative Rules allow revisions and adjustments to the regulatory parameters it contains. Several revisions have been made in previous years and it is expected that the ODF, in conjunction with DEQ, will continue to monitor the success of the Forest Practice Administrative Rules and make appropriate revisions when necessary to address water quality concerns.

4. **Agriculture:**

Senate Bill 1010
Senate Bill 1010 allows the Oregon Department of Agriculture (ODA) to develop Water Quality Management Plans for agriculture lands where such actions are required by State or Federal Law, such as TMDL requirements. The Agriculture Water Quality Management Plan (AWQMP) should be crafted in such a way that landowners in the local area can prevent and control water pollution resulting from agriculture activities. Local stakeholders will be asked to take corrective action against identified problems such as soil erosion, nutrient transport to waterways and degraded riparian areas. It is the ODA's intent to establish AWQMPs on a voluntary basis. However, Senate Bill 1010 allows the ODA to use civil penalties when necessary to enforce against agriculture activity that is found to transgress parameters of an approved Agriculture Water Quality Management Plan. The ODA has expressed a desire to work with the local stakeholders and other State and federal agencies to formulate and enforce Agriculture Water Quality Management Plans.

5. **Oregon Plan**

The State of Oregon has formed a partnership between Federal and State agencies, local groups and grassroots organizations, that recognizes the attributes of aquatic health and their connection to the health of salmon populations. The Oregon Plan considers the condition of salmon as a critical indicator of ecosystems (CSRI, 1997). The decline of salmon populations has been linked to impoverished ecosystem form and function. Clearly stated, the Oregon Plan has committed the State of Oregon to the following obligations: an ecosystem approach that requires consideration of the full range of attributes of aquatic health, focused on reversing factors for decline by meeting objectives that address these factors, develops adaptive management and a comprehensive monitoring strategy, and relies on citizens and constituent groups in all parts od the restoration process. The intent of the Oregon Plan is to conserve and restore functional elements of the ecosystem that supports fish, wildlife, and people. In essence, the Oregon Plan is different from the traditional agency approach, and instead, depends on sustaining a local-state-federal partnership. Specifically, the Oregon Plan is designed to build on existing State and federal water quality programs, namely: Coastal Zone Non-point Pollution Control Programs, the Northwest Forest Plan, Oregon's Forest Practices Act, Oregon's Senate Bill 1010, and Oregon's Total Maximum Daily Load Program.

ELEMENT 7. MONITORING AND EVALUATION

Purpose

Monitoring will provide information on progress being made toward achieving water quality standards. The information generated by each of the agencies/entities gathering data in the Nestucca Bay Watershed will be pooled and used to determine whether management actions are having the desired effects or if changes in the management actions are needed. If progress is not occurring then the appropriate management agency (ODA,ODF, TCSWCD, Municipalities, and Tillamook County) will be contacted with a request for action.

The objective of these monitoring efforts are to demonstrate long-term recovery, better understand natural variability, track implementation of projects and BMPs, and track effectiveness of TMDL implementation. This monitoring and feedback mechanism is a major component of the " reasonable assurance of implementation" for this Plan.

Tracking Implementation of the Plan

Implementation of the Plan will be tracked by accounting for the numbers, types, and locations of projects, BMPs, education activities, or other actions taken to improve or protect water quality. This will be done on an annual basis.

Nestucca-Neskowin Watershed Council/Tillamook County Performance Partnerships

The NNWC in conjunction with the TCPP will take the lead in tracking the implementation of the WQMP. The Council, in cooperation with the TCPP and DEQ will host a Management Conference every two years. The Management Conference shall monitor the effectiveness of actions taken pursuant to the WQMP with the following primary goals:

- measure the effectiveness of the management actions and programs implemented under the WQMP; and
- provide essential information that can be used to redirect and refocus the WQMP during implementation.

Implementation Monitoring

Programmatic implementation monitoring will help keep managers informed regarding the implementation status of various programs and the degree to which programs are not achieving their intended outcomes. With this information, managers can modify the Plan or actions as needed to achieve the desired outcomes outlined in the Plan.

Implementation, or programmatic monitoring is designed to answer such questions as: "is the WQMP being implemented at the level of commitment specified in the WQMP goals, targets, and measures of success?" "Are the actions in the Plan having the desired effects?" " Does the Plan need to be changed?" Many actions in the WQMP lend themselves to this type of administrative monitoring. Implementation monitoring established accountability on the part of the designated lead organizations for specific actions outline in the WQMP.

EFFECTIVENESS MONITORING

Effectiveness monitoring answers broader ecological questions: "Is the ecological integrity of the Bay and watershed changing?" "Is water quality improving or getting worse, and by how much?

Effectiveness monitoring lends itself more toward an assessment of success in obtaining WQMP goals and objectives than to the implementation of specific actions. This type of monitoring requires a statistically sound analysis of environmental data of known quality and confidence. For each WQMP Objective, associated monitoring parameters provide a measurement of success. For example, to monitor the WQMP Objective " Achieve at least a 25% reduction in bacteria loads to rivers", fecal coliform and E. coli bacteria concentrations will be measured at numerous sites in the Basin.

The environmental monitoring component of the Nestucca Bay Monitoring Program (NBMP) is designed to provide data that can be directly compared to the quantifiable objectives in each action item. It builds upon recently conducted characterization studies and existing monitoring efforts. It seeks to promote cooperation among agencies and stakeholders by incorporating and coordinating efforts into an integrated monitoring plan, increasing the scope and resolution of existing efforts, improving the timeliness of data analysis, and making the results available to a diverse group of agencies and stakeholders in a timely manner. This will minimize duplication of effort among agencies, reduce the cost of monitoring, and provide integrated results to the scientific, regulatory, and stakeholder communities in an efficient and timely manner.

Standardized sampling, analytical methods, and quality control (QA/QC) protocols will be adopted to ensure that monitoring information collected by the various partners in this effort are of high quality and are directly comparable.

Monitoring Parameters

Monitoring will be done on a continuing basis for many characteristics in the watershed (NNWC 1999). Some of these will address temperature, sedimentation, bacterial contamination, and beneficial use attainment either directly or indirectly.

Monitoring Parameters:

- Bacteria Monitoring;
- Temperature Monitoring;
- Turbidity Monitoring;
- Riparian assessment;
- Stream Channel and Habitat Assessments;
- Forest Road Surveys; and
- Fish Monitoring (Rivers).

Water Quality and Related Parameter Improvements

Bacteria Monitoring

The purpose of the bacteria monitoring program is to determine long-term trends in bacteria loading and short-term variations in bacteria concentrations in relation to DEQ water quality standards.

Major monitoring questions are: Is the concentration (flow-weighted average concentration) of fecal coliform bacteria (FCB) in the lower reaches of the Nestucca, and Little Nestucca Rivers increasing or decreasing (and by how much) during typical storm events during the summer, fall, winter, and spring seasons over time scale of years to decades? Are the storm loads of FCB increasing or decreasing (and by how much) during typical seasonal storm events in the Nestucca, and Little Nestucca Rivers over a scale of years to decades? How often and for what length of time does each of the rivers violate DEQ's water quality criteria for E-coli bacteria? Are there trends in the frequency and/or duration of those water quality standard violations over time scales of years or decades?

The DEQ has monitored bacteria in the Nestucca Bay Watershed for many years. Major sampling efforts have included:

DEQ Ambient Water Quality Monitoring;
DEQ TMDL Development Sampling and Analysis;
Citizen Water Quality Compliance Monitoring;

Temperature Monitoring

The purposes of temperature monitoring are: to determine the daily maximum temperatures of the rivers during summer months. To document changes in the number of days per year that daily maximum temperatures in the rivers exceed water quality criteria; and to determine the spatial extent of water temperature exceedences during summer months in the rivers.

Major monitoring questions are: What is the frequency and duration of temperature excursions above threshold values (expressed as daily maxima) in the rivers and what is the spatial extent of such excursions? Are there trends (increasing or decreasing) in the frequency, duration or extent of temperature excursions above the threshold values in the rivers over time scales of years or decades?

Temperatures in the Nestucca River and numerous tributaries in the Nestucca Basin have been measured above 64°F, temperature conditions in the range of stressful to lethal for salmonid fish. The monitoring program will measure temperature to more precisely quantify the frequency, duration, and extent of temperature excursions above threshold values in each of the rivers. Temperature monitoring by DEQ, and ODF will continue with support from the Nestucca-Neskowin Watershed Council.

Quality Assurance/Quality Control/Data Management

The NNWC, TCSWCD, local, state, and federal agencies, and academic institutions all use data collected in the Nestucca Basin. Data quality must be known to insure that it is of sufficient quality for its intended use.

In general, data will be gathered and handled in accordance with the Oregon Plan for Salmon and Watersheds " Water Quality Monitoring Guide Book", Nestucca Basin Monitoring Program Guidelines, and standard DEQ field monitoring criteria. Special projects or other monitoring efforts will be done in accordance with specific quality assurance plans that identify the precision and accuracy of the data collected. Where this information is not available, the data will be identified as of unknown quality. For educational demonstrations, or screening efforts of lesser quality is sometime collected and still has value. Such data can be included in the data bases and data summaries but will be flagged and its quality identified.

Reporting/Revisions

The Tillamook Bay Watershed Resource Center (TBWRC), NNWC, and DEQ, will be responsible for collating and summarizing data and providing copies of data summaries to the other cooperators on an annual basis. The data will be maintained at the TBWRC and will be available to all interested parties. The NNWC and DEQ will convene a water quality advisory committee to discuss any needed revisions in monitoring strategies and coordinate the coming monitoring season activities.

On a biannual basis, the NNWC and DEQ will produce a report on the status of water quality in the Nestucca Basin. This report will be developed in cooperation with the water quality advisory committee. The agencies involved in implementing this Plan will use this report to adjust the

Water Quality Management Plan over time as appropriate based on trends in monitoring results. Copies of the final report will be made available to the participating agencies, local media, and the general public.

ELEMENT 8: PUBLIC INVOLVEMENT

To be successful at improving water quality a TMDL Implementation Strategy must include a process to involve interested and affected stakeholders in both the development and the implementation of the Plan., These aspects of the plan will largely be implemented by the NNWC and the TCPP In the Nestucca Bay Watershed. This public involvement element of the Plan first describes on-going NNWC public involvement efforts within the Basin. The second section describes on-going efforts with the development of Basin TMDLs. The third section of this element describes a strategy by which the affected agencies/organizations will continue to involve and educate the public during the implementation of the Nestucca Bay Basin Water Quality Management Plan.

On-going Public Involvement Activities

As explained earlier, the Nestucca-Neskowin Watershed Council (NNWC) is currently implementing the public involvement aspects of the Nestucca Basin Water Quality Management Plan (WQMP).

To meet the goals and objectives of the WQMP, the NNWC will continue to foster citizen stewardship through public outreach and education. The NNWC will continue to develop public outreach programs related to forestry, agriculture, and urban and rural residential development. NNWC will also continue work to strengthen K-12 school watershed education programs and improve opportunities for adult education.

On-going activities include:

- Public presentations;
- Fairs and exhibits;
- Issue forums;
- Signs and displays;
- NNWC web site;
- Videos;
- Newsletters.

TMDL Water Quality Management Plan Development

As a member of the NNWC Technical Advisory Committee, DEQ staff have periodically updated the partners on TMDL development efforts. The DEQ has also worked closely with NNWC and others to gather needed data. In May, 2001, DEQ requested that a NNWC Task Force be established to work with DEQ in the development of the final TMDL and the associated TMDL Water Quality Management Plan. The Task Force has met with DEQ TMDL staff and will continue to work closely with DEQ to finalize both the TMDL and WQMP.

Plan Implementation

As mentioned previously, public awareness and involvement will be crucial to the successful implementation of this plan and resulting improvements to water quality. Much of this will be done by the NNWC, though some other aspects will be done by the DMAs and TCPP for county-wide issues. The plan depends on voluntary implementation by landowners for many aspects of water quality protection and restoration. The following actions will take place during the implementation of this Plan:

Urban and Rural Residential

The primary message conveyed to citizens will be that everyone is a contributor to the water quality in the Basin and everyone needs to participate in the efforts to improve water quality. All citizens can participate by using less fertilizer and garden chemicals, washing vehicles on the lawn, keeping wastes of all kinds out of storm drains, drainage ditches, and similar measurers. Special emphasis will be given to protection of riparian vegetation, especially retention of trees along the rivers and urban streams. Additional efforts will be directed toward problems associated with new construction and development activities. Development should be designed to protect and retain vegetation, minimize impervious surfaces, and retain stormwater on-site to the extent possible.

Tillamook County and local municipalities will work with the NNWC and DEQ to develop programs and materials related to the WQMP action items that affect these areas. Actions that have been identified are:

City and County informational mailings;
Stormdrain stenciling;
Displays in public places;
Public service announcements;
Outreach to county planning departments; and
Outreach to city and county public works departments.

Forestry

The primary message conveyed to the forestry community will be that compliance with water quality standards and load allocations during commercial activities on non-federal forestlands will continue to be achieved through compliance with Best Management Practices (BMPs) established under the Forest Practices Act and forest practice rules. Consistent with the DEQ/ODF Memorandum of Understanding, the Act and BMPs may be modified in the future to better ensure water quality standard compliance. If and when such changes occur, forest landowners and operators will be expected to comply with those revised requirements as well.

The Oregon Department of Forestry in close association with the forest industry and small woodlot owners, will work with the NNWC and DEQ to accomplish the following objectives:

- To clearly explain and exchange information regarding the non-federal forestlands component of the Implementation Strategy in order to build understanding, acceptance, and support for the Plan;

- To clearly explain and exchange information on the other components of The Plan and how other users are affected.

- To exchange information and encourage cooperative monitoring efforts that can lead to further improvements in the non-federal forestland areas and/or the overall Plan in the future.

- To encourage forestry community involvement in future revisions of the non-federal forestland areas.

Agriculture

The primary message to agriculture landowners and operators will be that compliance with water quality standards and load allocations will be achieved through compliance with the provisions of the SB 1010 Agriculture Water Quality Management Plan and associated rules.

The Oregon Department of Agriculture (ODA) in association with the agriculture industry and landowners, will work with the NNWC to:

- Educate landowners and public about what SB 1010 is, and how it works;
- Raise awareness of what the prohibited conditions are;
- What the available solutions are; and
- Where financial and technical assistance is available.

Major public outreach efforts will include:

- Public meetings;
- Hearings;
- Direct mail;
- Newsletters;
- Newspaper articles;
- Workshops;
- Project tours;
- Public service announcements; and
- Presentations at community group meetings.

ELEMENT 9: MAINTENANCE OF EFFORT OVER TIME

The purpose of this element of the Implementation Strategy is to demonstrate efforts for maintaining the implementation of the Plan and resulting water quality improvements over the long-term.

To ensure the long-term implementation of the Plan, DEQ will work with the DMAs and the NNWC to oversee plan implementation, review plan priorities and practices, and encourage public education and involvement. The review group will be made up of private citizens and representatives of management agencies involved in the implementation of the Plan. At a minimum, the membership will include:

- Tillamook County government;
- Local Municipalities
- Nestucca-Neskowin Watershed Council;
- Tillamook County Soil & Water Conservation District;
- Oregon Department of Agriculture
- Oregon Department of Forestry;
- Oregon Department of Fish & Wildlife;
- Oregon Department of Environmental Quality;
- US Forest Service – Hebo Ranger District
- Bureau of Land Management – Tillamook Resource Area; and
- Private citizens.

The review group's major charge will be to periodically review the entire plan and revise as necessary. This will involve:

1. Review of the activities of the responsible agencies to determine if implementation is occurring as planned. If it is not, determine the reason and revise the plan timeline as necessary.

2. Promotion of ongoing communication and education among the public on the goals of the plan and on the availability of financial and technical assistance for implementing priority projects.

3. Continuing efforts to encourage adequate technical and financial assistance programs that are active in the Basin to help implement resource enhancement projects.

ELEMENT 10: COSTS AND FUNDING

The purpose of this element is to describe estimated costs and demonstrate there is sufficient funding available to begin implementation of the Implementation strategy. Another purpose is to identify potential future funding sources for project implementation. There are many natural resource enhancement efforts and projects occurring in the Basin which are relevant to the goals of the plan. These efforts, in addition to proposed future actions are described in the Management Measurers element of this Plan. The following table lists the action items described in the Management Measures Element and estimated costs.

Implementation Actions	**Approximate Cost**
Action 1: Define implement, Enforce pollution control measures on Agricultural land	$25,000/year
Action 2: Implement Voluntary Farm Management Plans	$250,000
Action 3: Implement Revised CAFO Inspection procedures.	Implemented 2000
Action 4:Provide Farm Management Training.	$10,000/yr
Action 5: Control Livestock Access to stream	$1,300,000
Action 6: Encourage Protection /Enhancement on Private Lands.	$10,000/yr
Action 7: Revise Local Ordinances to Increase Protection of Riparian and Wetland Habitat.	NA
Action 8: Reconnect Sloughs and Rivers to Improve Water Flow.	Variable by project
Action 9: Ensure Minimum Streamflows.	NA – Enforcement Issue
Action 10: Assess and Map Riparian Habitat	$30,000

Action 11: Prioritize Upland Riparian Protection/Enhancement Sites	$15,000
Action 12: Protect/Enhance Upland Riparian Areas	$500,000 (coordinated with Action 5)
Action 13: Protect/Enhance Lowland Riparian Areas	$800,000 (coordinated with Action 5)

Point Sources

Action 1: Develop NPDES discharge permits with effluent limits that meet TMDL allocations.	NA Enforce ment Issue
Action 2: Ensure Adequate Urban Runoff Treatment and Retention.	$200,000
Action 3: Ensure Properly Functioning On-Site Sewage Disposal Systems.	$30,000 (for survey)

Monitoring

The water quality monitoring effort described in Element 7 is comprise of key actions identified by the agencies for documenting and understanding the long-term water quality trends in the Nestucca Basin. This monitoring is already underway and is expected to continue at this level. Cost estimates are identified below.

Monitoring Parameter	Estimated Costs
Bacteria	$25,000/year (compliance monitoring
Temperature	$8,000 /year (staff & equipment)
Total Annual Anticipated Costs	$33,000

Potential Sources of Project Funding

Funding is essential to implementing projects associated with this Implementation Strategy. There are many sources of local, state, and federal funds. The following is a partial list of assistance programs available in the Nestucca Bay Watershed.

Program	Agency/Source
OREGON PLAN FOR SALMON AND WATERSHEDS	**OWEB**
Environmental Quality Incentives Program	USDA-NRCS
Wetland Reserve Program	USDA-NRCS
Conservation Reserve Enhancement Program	USDA-NRCS
Stewardship Incentive Program	ODF
Access and Habitat Program	ODFW
Partners for Wildlife Program	USDI-FSA
Conservation Implementation Grants	ODA
Water Projects	WRD
Nonpoint Source Water Quality Control (EPA 319)	ODEQ-EPA
Riparian Restoration	TCCA
Riparian Protection/Enhancement	COE
forestlands Protection/Enhancement	NFF
Wetlands/Riparian Enhancement	NFWF

ELEMENT 11: LEGAL AUTHORITIES TO BE USED

Clean Water Act Section 303(d)

Section 303(d) of the federal Clean Water Act (CWA) as amended, requires states to develop a list of rivers, streams, and lakes that cannot meet water quality standards without application of additional pollution controls beyond the existing requirements on industrial sources and sewage treatment plants. Waters that need this additional help are referred to as “water quality limited” (WQL). Water quality limited waterbodies must be identified by the Environmental Protection Agency (EPA) or by a delegated state agency. In Oregon, this responsibility rests with the Department of Environmental Quality. The DEQ updates the list of water quality limited waters every two years. The list is referred to as the 303(d) list. The CWA section 303 further requites that Total Daily Maximum Loads (TMDLs) be developed for all waters on the 303(d) list. A TMDL defines the amount of pollution that can be present in the waterbody without causing water quality standards to be violated. A TMDL Water Quality Management Plan is developed to describe a strategy for reducing water pollution to the level of the TMDL, which will restore the water quality and result in compliance with the water quality standards.

NPDES and WPCF Permit Programs

The Oregon Department of Environmental Quality (DEQ) administers two different types of wastewater permits in implementing Oregon Revised Statute (ORS) 468B.050. These are: the National Pollution Discharge Elimination System (NPDES) permits for waste discharge; and Water Pollution Control Facilities (WPCF) permits for waste disposal. The NPDES permit is also a Federal permit and is required under the Clean Water Act. The WPCF permit is a state program. As permits are renewed they will be revised to insure that all 303(d) related issues are addressed in the permit.

Oregon Administrative Rules

Specific rules and authority regarding water quality and its management in the State of Oregon are contained in the Oregon Administrative Rules. A complete collection of the administrative rules relevant to listed waters in the Nestucca Bay Watershed are in Appendix C. Selected rules of interest are:

- Bacteria in Shellfish Waters OAR 340-41-205(2)(e)(A)(ii)
- Recreational Contact in Waters OAR 340-41-205(2)(e)(A)(I)
- Water Temperature OAR 340-41-205(2)(b)
- Sedimentation OAR 340-41-205(2)(j)

Oregon Forest Practices Act

The Oregon Forest Practices Act (FPA, 1994) contains regulatory provisions that include the objectives to classify and protect water resources, reduce the impacts of clearcut harvesting, maintain soil and site productivity, ensure successful reforestation, reduce forest management impacts to anadromous fish and wildlife habitat, develop cooperative monitoring agreements, foster public participation, identify stream restoration projects, recognize the value of biodiversity, and monitor/regulate the application of chemicals. Oregon’s Department of Forestry (ODF) has adopted Forest Practice Administrative Rules (1997) that define allowable actions on State, County, and private forestlands. Forest Practice Administrative Rules allow revisions and adjustments to the regulatory parameters it contains. Several revisions have been made in previous years and it is expected that the ODF, in conjunction with DEQ, will continue to monitor the success of the Forest Practice Administrative Rules and make appropriate revisions when necessary to address water quality concerns.

Northwest Forest Plan

In response to environmental concerns and litigation related to timber harvest and other operations on Federal Lands, the United States Forest Service (USFS) and the Bureau of Land

Management (BLM) commissioned the Forest Ecosystem Management Assessment Team (FEMAT) to formulate and assess the consequences of management options. The assessment emphasizes producing management alternatives that comply with existing laws and maintaining the highest contribution of economic and social well being. The "backbone" of ecosystem management is recognized as constructing a network of late-successional forests and an interim and long-term scheme that protects aquatic and associated riparian habitats adequate to provide for threatened species and at risk species. Biological objectives of the Northwest Forest Plan include assuring adequate habitat on Federal lands to aid the “recovery” of late-successional forest habitat-associated species listed as threatened under the Endangered Species Act and preventing species from being listed under the Endangered Species Act.

Senate Bill 1010

Senate Bill 1010 allows the Oregon Department of Agriculture (ODA) to develop Water Quality Management Plans for agriculture lands where such actions are required by State or Federal law, such as TMDL requirements. The Agriculture Water Quality Management Plan should be crafted in such a way that landowners in the local area can prevent and control water pollution resulting from agriculture activities. Local stakeholders will be asked to take corrective action against identified problems such as soil erosion, nutrient transport to waterways and degraded riparian areas. It is the ODA’s intent to establish Agriculture Water Quality Management Plans on a voluntary basis. However, Senate Bill 1010 allows the ODA to use civil penalties when necessary to enforce against agriculture activity that is found to transgress parameters of an approved Agriculture Water Quality Management Plan. The ODA has expressed a desire to work with local stakeholders and other State and federal agencies to formulate and enforce approved Agriculture Water Quality Management Plans.

Ordinances

Oregon cities and counties have authority to regulate land use activities through local comprehensive plans and related development regulations. This authority begins with a broad charge given to them by the Oregon constitution and the Oregon legislature to protect the public’s health, safety, and general welfare.

Every city and county is required to have a comprehensive plan and accompanying development ordinance to be in compliance with state land use planning goals. While the comprehensive plan must serve to implement the statewide planning goals mandated by state law, cities and counties have a wide degree of local control over how resource protection is addressed in their community.

The Oregon land use planning system provides a unique opportunity for local jurisdictions to address water quality protection and enhancement. Many of the goals have a direct connection to water quality, particularly Goals 5 and 6. Tillamook County is currently conducting a periodic review of its Comprehensive Plan. Among the expected changes to this plan will be revised ordinances for the protection of riparian areas. We expect the county to adopt revised ordinances that will be sufficient to meet the allocations in the TMDL

ELEMENT 12: ESTIMATE OF TIME TO MEET WATER QUALITY STANDARDS

Estimates of time for meeting standards and full protection of beneficial uses were made based on existing plans (bacteria) or estimates of vegetational growth (temperature and sedimentation). Bacteria estimates are based on the timeline in Element 4 of the WQMP. Temperature and sedimentation improvements are dependent on growth of riparian vegetation and other management actions. The longest-term treatment is restoration of riparian vegetation where needed to provide system potential shade. Vegetation should stabilize streambanks sooner than it will provide system potential shade. Time scales are approximate and implementation will occur as specific plans are implemented or developed, and as funding becomes available

Bacteria: Achieve water quality standards in the rivers and Bay by 2010.

Temperature: Achieve instream temperatures that meet salmonid requirements by 2050

Sedimentation: Achieve Streambed fines target throughout watershed by 2020

ELEMENT 13: MILESTONES FOR MEASURING PROGRESS

General action items are described in Element 3, Management Measures section. Greater detail is available in source documents, including the Nestucca Neskowin Watershed Council Management and Action Plan (Attached), and the Tillamook Bay National Estuary Project Comprehensive Conservation and Management Plan (TBNEP 1999).

The NNWC in cooperation with DEQ will convene a biannual Management Review Group. The Group will review the actions, study water quality trends, and identify adapt actions as necessary to ensure the WQMP is moving forward on schedule.

ELEMENT 14: PLANS FOR REVISING THE TMDL

The Department is committing to a watershed Process wherby the TMDL will be reviewed and, if needed modified or added to on a five-year schedule. This review will precede the renewal of discharge permits so that new information can be put to the task of setting effluent limits. It is anticipated that the next review of the TMDLs in the North Coast Basin will begin in 2005.

APPENDIX D-1
NESTUCCA NESKOWIN WATERSHED COUNCIL MANAGEMENT AND ACTION PLAN

Nestucca-Neskowin Watershed Council

Management & Action Plan

May 1999

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Nestucca/Neskowin Watershed Council
Resource Assistance for Rural Environments, University of Oregon
Governor's Watershed Enhancement Board

Cover photo: Watershed Council members conducting riparian planting on Neskowin Creek.

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CHAPTER 1: INTRODUCTION

The Nestucca-Neskowin Watershed Council

The Nestucca Watershed Council was formed in 1995. The Council was officially designated by the Tillamook County Commissioners in 1996 and became incorporated in 1997. The name was changed to the Nestucca-Neskowin Watershed Council in June 1997, to reflect the expansion of the Council to include the Neskowin Watershed. The Council is comprised of landowners, industry representatives, special district representatives, government agency representatives and interested private citizens. A Board of Directors is responsible for conducting business and organizing activities for the Council. Board meetings and Council meetings are open to the public and occur monthly.

The mission of the Nestucca-Neskowin Watershed Council is to provide a forum for public participation and education regarding decisions that can have significant effects on those who live, work and recreate in the Watershed, now and in the future.

The Technical Advisory Committee (TAC) was formed in 1995. The TAC is made up of representatives of all public agencies which own, manage, or have jurisdiction/regulatory responsibility in the Nestucca-Neskowin Watershed.

Overview of Nestucca-Neskowin Watershed

The Nestucca-Neskowin Watershed is located on the northern coast of Oregon (Map 1) and the watershed covers approximately 217,085 acres (340 square miles). The watershed is roughly 30 miles wide (west to east) and 20 miles long (north to south).

The Nestucca watershed is defined by all streams and tributaries that flow into the Nestucca Bay; thus, the Nestucca River, the Little Nestucca River and their tributaries. The Nestucca is 53 river miles long and the river flows in a west-southwest direction to Nestucca Bay. The Little Nestucca flows 18 river miles from it headwaters to Nestucca Bay.

The Neskowin Watershed is defined by all tributaries that flow into Neskowin Creek and Daley Lake. Neskowin Creek flows 10 miles from its headwaters and empties directly into the Pacific Ocean.

As can be seen in Map 2, much of the land in the Nestucca-Neskowin Watershed is managed by federal agencies: US Forest Service manages 95,4317.6 acres (43.8% of the watershed); The Bureau of Land Management manages 36,331.6 acres (16.7% of the watershed); and US Fish and Wildlife manages 260 acres as a wildlife refuge (0.01% of the watershed). Oregon Department of Forestry manages 4.1% of the watershed. Industrial private forest companies own 38,662.6 acres (17.7 % of the watershed). The remaining 16.4% of the watershed is owned by private landowners (agriculture, rural residential and small woodlot).

Purpose of the Management and Action Plan

The purpose of this Management and Action Plan is to help guide the Nestucca-Neskowin Watershed Council (Council) in accomplishing two **main goals**:

- ➔ providing opportunities for watershed-related education of the people who live, work, and recreate in the watershed
- ➔ protecting and enhancing the health of the watershed based on the findings of the Nestucca-Neskowin Watershed Assessment (May 1998) and ongoing monitoring and studies.

The Management and Action Plan is divided into two parts. The first part, presented in Chapter 2, is an overall management plan, watershed-level strategy, and list of criteria for priority projects. The second part, presented in Chapters 3, 4, and 5, consists of action plans for: (1) habitat protection and enhancement; (2) water quality monitoring; and (3) partnerships, public education and involvement.

Implementation of Management & Action Plan

The Management and Action Plan provides specific direction for activities of the Council over the next two years and the plan is a "living document" that can be updated and revised as new information is available. The Council plans to work with the Technical Advisory Team (TAC) to prioritize actions and set yearly work plans. In addition, the TAC will help the Council to develop milestones so that progress can be measured.

CHAPTER 2: MANAGEMENT PLAN

Taking a Watershed-Wide Approach to Management

The Management Plan provides the overall strategy that the Council will follow to protect and enhance the health of the watershed. In order to manage the health of the watershed on a watershed-wide basis, the watershed is divided into three landscape classes based on stream gradients. These landscape classes are described below and are based on similar definitions found in the Coquille Watershed Action Plan. See Map 2 for streams classified by landscape class.

Landscape Classes

- **Headwater Areas** are areas where streams originate, stream gradients are greater than 8%, and channels are narrowly confined. These areas are important sources of nutrients, water, sediments, and large woody debris that can be moved by natural stream transport to the Mid-slope and Lowland Areas. ***Headwater streams*** are described in the Oregon Watershed Assessment Manual (GWEB 1997, draft)-- Channel Habitat Type = VH, SV, BC.

- **Mid-slope Areas** are areas where stream gradients are between 4% and 8%, and channels are narrowly to moderately confined. These areas provide short term storage of sediments and woody debris and contain ***moderately steep narrow valleys*** or ***moderate-gradient constrained streams*** as described by the Oregon Watershed Assessment Manual (GWEB 1997, draft)-- Channel Habitat Type = MV, MC.

- **Lowland Areas** are areas where stream gradients are less than 4%, and channels are moderately confined or unconfined. Lowlands are where pools are formed, sediments are stored, and high quality, diverse habitat for fish can be found. Lowland Areas contain ***productive flats*** as described in the Nestucca-Neskowin Watershed Council Assessment (May 1998); they are referred to as ***floodplains*** and ***alluvial fans*** by the Oregon Watershed Assessment Manual (GWEB 1997, draft)-- Channel Habitat Type = FP1, FP2, FP3, AF.

Watershed Level Strategy

The Council has developed an overall strategy for protecting and enhancing each of the landscape classes discussed above. These strategies are based on the watershed issues and land ownership found in each landscape class.

Headwater Areas Strategy

The general issues facing the Headwater Areas are: sedimentation; fish passage barriers; inadequate riparian vegetation for shading streams; high water temperatures; lack of conifer trees to provide high quality large woody debris; lack of mature and old-growth forest habitat; lack of large contiguous forest habitat for wildlife species; and the spread of noxious and invasive weeds that reduce habitat quality.

The vast majority of Headwaters Area in the Nestucca-Neskowin Watershed is forest lands managed by the Bureau of Land Management (BLM) and the United States Forest Service (USFS). Oregon Department of Forestry (ODF) owns a very small percentage in the Headwater Areas of the watershed. Private industrial forest companies also own a small percentage. Other private ownership in this area (residential or agriculture) is minimal. Recreation occurs in this portion of the watershed in the form of hiking, hunting, fishing, camping, and off-highway vehicle use.

The management objectives and trends in resource conditions for federal and state agencies in the Headwater Areas indicate that the issues listed above are being addressed. The USFS and BLM are managing federal lands according to the Northern Coast Range Adaptive Management Area (AMA) guidelines in compliance with the Northwest Forest Plan, which are to restore and maintain late-successional forest and conserve of fisheries habitat and maintain biological diversity. Timber industry and state forest lands in the area are managed under the Forest Practices Act and the goals of the Northwest Region Long Range Plan, that promote timber growth and harvest while maintaining the integrity of the forest ecosystem.

The Council's strategy for the Headwater Areas is to engage in partnership building with federal, state, and private land managers, participate in the AMA process, and educate the public about activities and conditions in the Headwater Areas.

Mid-slope Areas Strategy

The general issues facing the Mid-slope Areas are fish passage barriers, inadequate conifer trees in riparian zones for large woody debris recruitment, sedimentation, and a lack of continuous riparian vegetation for shading streams.

The Mid-slope Areas are transitional between the forested Headwater Areas and the meadows of the Lowland Areas. The Mid-slope Area landowners include timber industry, small woodlot owners, some residential areas, and federal and state land management agencies.

The resource programs and management objectives of federal and state agencies in the Mid-slope Areas indicate that the issues listed above are being addressed. The USFS and BLM are managing federal lands according to the Northern Coast Range Adaptive Management Area (AMA) guidelines in compliance with the Northwest Forest Plan, which are to restore and maintain late-successional forest, and conserve fisheries habitat and maintain biological diversity. Timber industry, small woodlot, and state forest lands in the area are managed under the Forest Practices Act and the goals of the Northwest Region Long Range Plan , which promote timber growth and harvest while maintaining the integrity of the forest ecosystem.

The Council's strategy for the Mid-slope Areas is to conduct education and outreach activities with small woodlot owners, focusing on the topics of fish and wildlife habitat needs, promote reforestation projects, and provide information about technical and funding resources available for private landowners. The Council will also engage in partnership building with federal, state, and private partners.

Lowland Areas Strategy

The general issues facing the Lowland Areas are: sedimentation; inadequate riparian vegetation for shading streams; fish passage barriers; lack of rearing habitat for fish; lack of in-stream complexity for fish; fecal coliform contamination of some stream segments; decreased amounts of estuary and wetland habitats; spread of noxious and invasive weeds that reduce native habitat quality; lack of coniferous trees in riparian areas to provide high quality, long-term large woody debris; streambank erosion from livestock and human activities; and high water temperature.

The vast majority of Lowland Areas are owned by private landowners who engage in agricultural, small woodlot, and industrial timber activities. Continued residential development is occurring along streams, near the estuary, and along oceanfront areas. Recreation also occurs in the form of hiking, biking, fishing, and camping.

The Council's strategy for the Lowland Areas, most of which is privately owned, is to engage in public education and outreach about protection, enhancement, and monitoring projects on private lands, and to develop and implement these projects on private lands with willing landowners.

Council Criteria for Priority Projects

There is agreement among the members of the Council that Council-sponsored projects should focus on private lands since private landowners often lack the resources or information to develop and implement monitoring, protection, and enhancement projects on their own. Another goal important to Council members is that public education and involvement be included as a part of all projects during the next two years of Council activities. Better stewardship practices among the people of the watershed can be promoted by increasing their knowledge of watershed-related issues and increasing awareness of how activities throughout the watershed affect watershed health.

A project was considered a priority and was included in the Action Plan if it met all of the following criteria:

- provides an opportunity for public education and involvement
- addresses a resource issue concerning water quality, fish habitat, or wildlife habitat, as summarized in the Executive Summary of the Nestucca-Neskowin Watershed Assessment
- fulfills practical concerns such as landowner interest/cooperation and available funding
- involves private lands—OR—involves private lands in conjunction with state and federal lands
- provides partnership building opportunities with private, state, and federal agencies; landowners; local government; and/or schools

Priority Action Groups

The Council's Priority Actions are based on the Watershed Resource Issues, the management Strategy for each landscape class, and Council Criteria for Priority Projects. The Priority Actions have been allocated into three groups described in the following chapters:

- Chapter 3: Habitat Protection and Enhancement
- Chapter 4: Water Quality Monitoring
- Chapter 5: Public Education and Involvement

These priority action groups provide a framework for the development of specific Action Plans and projects on which the council will focus its activities over the next two years. Many projects will address the goals of more than one action group.

Priority Areas for Habitat Restoration

Riparian habitat restoration projects should be concentrated in areas that maximize the benefits to salmonid species. Priority stream segments are identified in Table 1 and Map 3.

Key to Table 1: Prioritized Stream Segments for Anadromous Fish Habitat Restoration

Fish present: salmonid species that may be present due to each species natural range of distribution

Habitat miles: miles of habitat for anadromous species on the stream

Productive flats/miles: 1 = unconfined with < 2% gradient, 2 = moderately confined with < 2% gradient, 3 = unconfined with 2-4% gradient, 4 = moderately confined with 2-4% gradient, 0 = no productive flat on stream. Followed by *miles* found in each category.

Riparian ownership: P = privately owned, T = timber industry, F = US Forest Service, B = Bureau of Land Management, S = Oregon (State) Department of Forestry and O = Other.

Upland and Other Issues: Fecal = stream impaired for fecal coliform contamination, Sediment = stream impaired for sediment levels, Temp = stream impaired for high water temperatures in summer, Habitat = stream impaired for habitat modification, Flow = stream impaired for flow modification, DT-MR = Debris torrent potential-moderate risk (Igneous Headlands), DT-HR = Debris torrent potential-high risk (Volcanic Uplands-High Relief)

Priority Class: High = stream with characteristics that provide the best potential to provide high quality, productive habitat and successful restoration projects for salmonids;
Medium = stream with characteristics that provide good potential to provide high quality, productive habitat and successful restoration projects for salmonids; Low = stream with characteristics that provide low potential to provide high quality, productive habitat and successful restoration projects for salmonids. Prioritization process described in detail in the Nestucca-Neskowin Watershed Council Assessment (May 1998).

Table 1. Prioritized Stream Segments for Anadromous Fish Habitat Restoration

ID Number	Stream	Restoration Priority Class	Fish Present	Habitat Miles	Productive Flats/ miles	Riparian Ownership	Upland & Other Issues
1	**Lower Nestucca River** (from Bay to confluence w/ Farmer Cr.)	**High**	Chinook Chum Coho Steelhead	11.7	1/ 9.0 3/ 2.5	P	Flow, Temp, Fecal
2	**Middle Nestucca River** (from confluence w/ Farmer Cr., to confluence with Alder Cr.)	**High**	Chinook Chum Coho Steelhead	10.7	1/ 9.7 3/ 1.0	P	Flow, Temp
3	**Upper Nestucca River** (from confluence with Alder Cr. to headwaters)	**High +**	Chinook Coho Steelhead	24.9	1/ 16.0 2/ 0.5 3/ 1.0 4/ 1.0	P, T, F, B, S, O	Flow, Temp, Sediment
4	**Horn Creek**	**High +**	Chum Coho Steelhead	4.0	1/ 1.3 3/ 2.3 4/ 0.5	P, T, F	Temp
5	**Clear Creek**	**High +**	Chinook Chum Coho Steelhead	3.4	1/ 1.0 3/ 0.75 4/ 0.4	P, T, F	Tidegates
6	**Lower Three Rivers** (from mouth to confluence w/ Pollard Cr.)	**High**	Chinook Chum Coho Steelhead	7.3	1/ 7.3	P, T, F	
7	**Middle Three Rivers** (from confluence w/ Pollard Cr. to confluence w/ Crazy Cr.)	**High**	Chinook Coho Steelhead	2.9	1/ 2.9	P, T, F	
8	**Alder (Three Rivers)**	**High**	Chinook Coho Steelhead	3.8	1/ 2.8 3/ 1.0	P, F	
9	**Lower Beaver Creek**	**High**	Chinook Coho Steelhead	4.2	1/ 4.2	P, T	
10	**North Beaver Creek**	**High**	Chinook Coho Steelhead	1.7	1/ 2.3 3/ 0.5	P, T	
11	**West Beaver Creek**	**High**	Chinook Coho Steelhead	5.1	1/ 1.2 3/ 2.0	P, T, F	
12	**West Creek**	**High**	Coho Steelhead Chinook	2.8	1/ 1.0 3/ 0.7	P, T, F	Temp
13	**Tiger Creek**	**High**	Chinook Coho Steelhead	3.4	1/ 4.2 3/ 1.0	P, T	
14	**East Beaver Creek**	**High**	Chinook Coho Steelhead	10.9	1/ 2.7 3/ 6.0 4/ 1.0	P, T, F	DT-HR, Habitat, Sediment
15	**Clarence Creek**	**Medium +**	Coho Steelhead Chinook	1.2	3/ 1.3	T, F, B	

ID Number	Stream	Restoration Priority Class	Fish Present	Habitat Miles	Productive Flats/ miles	Riparian Ownership	Upland & Other Issues
16	**Wolfe Creek**	**High**	Coho Steelhead	3.2	1/ 0.7 3/ 0.5 4/ 0.5	P, T, F	DT-HR
17	**East Creek**	**High +**	Chinook Coho Steelhead	6.2	1/ 0.7 2/ 0.5 3/ 1.3 4/ 0.5	P, T, F, B, S	DT-HR
18	**Bays Creek**	**High**	Chinook Coho Steelhead	4.1	1/ 1.5 3/ 0.3 4/ 0.3	T, F, S	DT-HR
19	**Moon Creek**	**High +**	Chinook Coho Steelhead	5.2	1/ 1.5 3/ 2.0	P, T, F, B, S	DT-HR
20	**Powder Creek**	**Medium +**	Chinook Coho Steelhead	2.6	3/ 2.0	F, P	Temp
21	**Niagara Creek**	**Medium +**	Chinook Coho Steelhead	4.7	3/ 3.5 4/ 0.8	P, T, F	Temp
22	**Pheasant Creek**	**Medium +**	Coho Steelhead	1.8	3/ 1.0	F	
23	**Buelah Creek**	**Medium +**	Coho Steelhead	0.6	3/ 0.5	F	
24	**Slick Rock Creek**	**Medium +**	Coho Steelhead Chinook	0.8	3/ 0.3 4/ 0.3	P, T, F	
25	**Elk Creek**	**Medium +**	Chinook Coho Steelhead	3.3	3/ 0.5 4/1.5	B, S	
26	**Bible Creek**	**High +**	Coho Steelhead	0.8	1/ 1.5	P, T, F, B, S	
27	**Bear Creek (Big Nestucca)**	**High +**	Chinook Coho Steelhead	3.2	2/ 0.5 3/ 0.2 4/ 2.0	T, B, S	
28	**Testament Creek**	**Medium +**	Coho Steelhead	4.0	4/ 0.7	P, T, F, B	
29	**Walker Creek**	**High**	Coho Steelhead	1.5	1/ 1.0 2/ 0.5 3/ 0.2	B, O	
30	**Lower Little Nestucca** (from Bay to confluence w/ Austin Cr.)	**High**	Chinook Chum Coho Steelhead	3.9	1/ 3.0 2/ 1.5	P, T, F	Temp
31	**Middle Little Nestucca** (from confluence w/ Austin Cr. to confluence w/ Hiack Cr.)	**High**	Chinook Chum Coho Steelhead	9.2	1/ 4.0 2/ 3.6 3/ 0.4	P, T, F	Temp
32	**Fall Creek (Little Nestucca)**	**Medium +**	Chinook Chum Coho Steelhea	1.1	3/ 0.4	P, T, F, S	

ID Number	Stream	Restoration Priority Class	Fish Present	Habitat Miles	Productive Flats/ miles	Riparian Ownership	Upland & Other Issues
33	**Austin Creek**	**Medium +**	Chinook Coho Steelhead	1.4	3/ 0.3 4/ 1.0	F	
34	**South Fork Little Nestucca**	**High**	Chinook Coho Steelhead	5.3	1/ 2.3 2/ 0.3 3 /0.3 4/ 2.7	T, F	
35	**Stillwell Creek**	**High**	Chinook Coho Steelhead	1.0	2/ 0.2 4/ 0.3	P, T, F	
36	**Baxter Creek**	**High**	Chinook Coho Steelhead	1.3	2/ 0.8	P, F	Culverts
37	**Sourgrass Creek**	**High**	Chinook Coho Steelhead	2.6	2/ 2.5 4/ 0.8	P, T, F	
38	**Bear Creek (Little Nestucca)**	**Medium +**	Chinook Chum Coho Steelhead	1.7	3/ 3.0 4/ 0.7	T, F	
39	**Bower Creek**	**High**	Chinook Chum Coho Steelhead	1.0	1/ 1.0 3/ 0.5 4/ 0.5	P, F	
40	**Kellow Creek**	**High +**	Coho Steelhead	1.9	1/ 0.3 3/ 0.3 4/ 0.3	T	
41	**Lower Neskowin Creek** (from mouth to confluence w/ Jim Cr.)	**High +**	Coho Steelhead	5.6	1/5.6	P	DT-MR
42	**Upper Neskowin Creek** (from confluence w/ Jim Cr. to headwaters)	**High**	Coho Steelhead	3.0	1/1.0 4/1.5	P, T, F	
43	**Lewis Creek**	**High**	Coho Steelhead	NYA	1/0.3	P, T, F	
44	**Hawk Creek**	**High**	Coho Steelhead	1.7	1/0.5 2/0.7 4/0.5	P, T	DT-MR
45	**Butte Creek**	**High**	Coho Steelhead	1.5	1/0.3 2/0.8	P, T	DT-MR

CHAPTER 3:
HABITAT PROTECTION & ENHANCEMENT ACTION PLAN

Background

Most of the anadromous species in the watershed have depressed populations. The following issues concerning fish and wildlife habitat were identified in the Nestucca-Neskowin Watershed Assessment (May 1998) as needing attention in the watershed:

- There is a lack of mature vegetation in streamside areas. Vegetation in riparian zones in general is not continuous, resulting in a lack of channel shade and elevated summertime water temperatures in many streams.
- Erosion and unstable streambanks are present in riparian zones.
- There is damage to streambanks and riparian vegetation caused by livestock grazing and trampling and human activities.
- There is a lack of large conifer trees in riparian zones. Much of the riparian area in the watershed lacks the large conifer trees that can provide high quality, long-term sources of large woody debris to streams. Such debris is important in developing stream habitat complexity for aquatic species.
- There is a lack of mature and old-growth forest in the watershed. Forty-two percent of the watershed is vegetated by trees, shrubs and grass that are less than 24 years old. Because there is so little remaining older forest, plant and animal species that rely on mature and old-growth forest find very little habitat, and the older stands that remain are highly fragmented.
- The spread of exotic noxious and invasive plants is causing displacement of native species and loss of habitat quality in the watershed.
- There is a loss of quality estuary habitat resulting from dikes, diversions, drainage, and tidegates.
- Barriers to fish passage such as improperly installed culverts and tidegates are present throughout the watershed.

Overall Goals

Work with federal, state, county and private partners to develop, encourage and implement habitat protection and enhancement for fish and wildlife. Promote education and cooperation in habitat restoration issues. Complete 13 specific actions and accomplish 4 objectives:

⇒ Reduce sources of sediment and turbidity in streams;
⇒ Increase stream shading to decrease water temperature;
⇒ Improve fish habitat; and
⇒ Protect and restore unique & limited habitats for native wildlife & plants.

<u>Objective 1:</u> Reduce sources of sediment and turbidity in streams

Habitat Action #1: Inventory Roads

Watershed Level Strategy:
- Headwaters Areas: Encourage road inventories and road stabilization projects.
- Mid-Slope: Encourage and assist in inventory of roads on private lands (industrial and small woodlot) and recommend areas needing stabilization.
- Lowland Areas: Encourage and assist in inventory of roads on private, state and county lands and recommend areas needing stabilization.

Specific Tasks for Implementation:
- Compile road inventory data
- Survey roads where needed
- Using partnerships, work with landowners to prioritize road stabilization
- Encourage restoration.

Education Component:
- One-on-one consultation with landowners
- Participate in federal or state organized workshop on road stabilization

Lead/Sponsor, Others: Council Board, Council Staff, BLM

Habitat Action #2: Conduct tree planting in riparian zones

Watershed Level Strategy:
- In Headwaters Areas: Encourage and support the implementation of stream buffers and riparian planting.
- In Mid-Slope: Assist in riparian planting through volunteer efforts or grant writing.
- Lowland Areas: Assist in riparian planting through volunteer efforts or grant writing.

Specific Tasks for Implementation:
- Review prioritized list of streams for possible sites.
- Contact landowners—determine interest and obtain permission to field check sites.
- Field check sites for need/type of plantings
- Design projects
- Obtain funding, materials, labor and volunteer labor (including schools)
- Conduct planting project

Education Component:
- One-on-one discussions with landowners
- Use completed projects as demonstration projects and tour sites
- Flyers and newspaper articles about relationship between healthy riparian areas and water quality

Lead/Sponsor, Others: Council Staff, Council Board, SWCD, Volunteer Coordinator.

Habitat Action #3: Encourage and implement fencing and offstream watering projects

Watershed Level Strategy:
- In Headwaters and Mid-Slope Areas: no action needed.
- Lowland Areas: Conduct projects where needed to protect streambanks and riparian vegetation.

Specific Tasks for Implementation:
- Review prioritized list of streams for possible sites.
- Contact landowners—determine interest and obtain permission to field check sites.
- Field check sites for type of protection and fencing needed
- Design projects
- Obtain funding, planting stock, labor and volunteer labor (including schools).
- Conduct projects

Education Component:
- One-on-one discussions with landowners
- Use completed projects as demonstration projects and tour sites
- Flyers and newspaper articles announcing prioritized streams

Lead/Sponsor, Others: Council Staff, Council Board, SWCD, Volunteer Coordinator.

Objective 2: Increase stream shading to decrease water temperature

Habitat Action #4: Conduct tree planting in riparian zones

Watershed Level Strategy:
- In Headwaters Areas: Encourage implementation of stream buffers and riparian planting.
- In Mid-Slope and Lowland Areas: Assist in riparian planting especially along fish-bearing streams through volunteer efforts or by obtaining grants.

Specific Tasks for Implementation:
- Review prioritized list of streams for possible sites.
- Contact landowners—determine interest and obtain permission to field check sites.
- Field check sites for need/type of plantings
- Design projects
- Obtain funding, materials, labor and volunteer labor (including schools)
- Conduct planting projects

Education Component:
- One-on-one discussions with landowners
- Use completed projects as demonstration projects and tour sites

- Flyers and newspaper articles announcing prioritized streams

Lead/Sponsor, Others: Council Staff, SWCD, Volunteer Coordinator, School Teachers

Habitat Action #5: Encourage and implement fencing and offstream watering projects

Watershed Level Strategy:
- In Headwaters and Mid-Slope Areas: no action needed.
- Lowland Areas: Conduct projects where needed to protect streambanks and riparian vegetation.

Specific Tasks for Implementation:
- Review prioritized list of streams for possible sites.
- Contact landowners—determine interest and obtain permission to field check sites.
- Field check sites for type of protection and fencing needed
- Design projects
- Obtain funding, planting stock, labor and volunteer labor
- Conduct projects

Education Component:
- One-on-one discussions with landowners
- Use completed projects as demonstration projects and tour sites
- Flyers and newspaper articles announcing prioritized streams

Lead/Sponsor, Others: Council Staff, Council Board, Volunteer Coordinator, SWCD.

Objective 3: Improve Fish Habitat

Habitat Action #6: Encourage and implement fish rearing habitat and stream complexity enhancement projects

Watershed Level Strategy:
- In Headwaters: No action needed (projects unlikely in 1st and 2nd order streams).
- Mid-Slope areas: Encourage and implement priority projects on private, state and federal lands.
- Lowland Areas: Encourage and implement priority projects on private, county, state and federal lands and in estuaries.

Specific Tasks for Implementation:
- Review prioritized list of streams for possible sites.
- Contact landowners—determine interest and obtain permission to field check sites.
- Field check sites for need and type of instream project
- Design project
- Obtain funding and volunteer labor
- Conduct project

Education Component:
- One-on-one discussions with landowners
- Use completed projects as demonstration projects and tour sites
- Flyers and newspaper articles announcing prioritized streams

Lead/Sponsor, Others: Council Staff, Council Board, SWCD, NRCS, ODFW

Habitat Action #7: Conduct fish carcass dispersal projects to enhance stream nutrient levels

Watershed Level Strategy: Action can occur throughout the watershed in fish bearing streams.

Specific Tasks for Implementation:
- Contact ODFW to communicate continued Council interest
- Generate a list of streams where fish carcasses could be dispersed and provide list to ODFW.
- Develop and maintain list of volunteers to participate in dispersal
- Contact schools to encourage and coordinate their participation
- Coordinate volunteers
- Write an update article for newspaper

Education Component:
- Newspaper article on project
- Volunteer training and education

Lead/Sponsor, Others: Volunteer Coordinator, Council staff, Chuck Fahrni, ODFW

Habitat Action #8: Survey and encourage the improvement of fish passage barriers such as culverts and tidegates

Watershed Level Strategy:

- In Headwaters: Support and review projects on federal lands.
- Mid-Slope areas: Inventory culverts where there are willing partners; encourage projects on private, state, and county lands.
- Lowland Areas: Inventory culverts and tidegates where there are willing partners; encourage and assist with improvement projects.

Specific Tasks for Implementation:

- Develop survey plan—volunteers, methods, equipment, etc.
- Work with ODFW to train volunteers to assess culverts
- Contact landowners—determine interest and obtain permission to field check sites.
- Field check sites for type of improvements, in any
- Design improvement projects
- Obtain funding and volunteer labor
- Conduct improvement projects

Education Component:

- One-on-one discussions with landowners
- Flyers and newspaper articles discussing need to address tidegate and culvert issues
- Use completed projects as demonstration projects and tour sites
- Possible high school project
- Forum on the upcoming survey, request for information from landowners, possible funding and technical help to address tidegate and culvert issues

Lead/Sponsor, Others: Council Staff, Performance Partnership, SWCD, ODFW, TCCA, cities

Objective 4: Protect and restore unique and limited habitats for native wildlife and plants.

Habitat Action #10: Encourage the removal of noxious and invasive weeds

Watershed Level Strategy:

- In Headwaters and Mid-Slope areas: Support and assist counties, ODA and other agencies in inventory and manual control of noxious and invasive weeds.
- Lowland Areas: Work with counties, ODA and other agencies to inventory and manually control spread of noxious and invasive weeds on farmlands and recreation areas.

Specific Tasks for Implementation:

- Locate sites needing attention for noxious and invasive weeds.
- Contact landowners and agencies—determine interest and obtain permission to field check sites.
- Build partnerships with agencies (such as Tillamook County Soil and Water Conservation District, Tillamook County and Yamhill County).
- Field check sites to determine need.
- Research options for control and eradication.
- Design/plan project.
- Obtain funding and volunteer labor.
- Conduct removal.

Education Component:

- One-on-one discussions with landowners
- Flyers and newspaper articles on the effects of noxious and invasive weeds.
- Develop a list of alternate native species land owners can plant (ODFW has nature-scapping information)

Lead/Sponsor, Others: Carol Bickford, Volunteer Coordinator, Council Staff, SWCD, ODA, counties

Habitat Action #11: Pursue protection and enhancement options for wetland and estuary habitat

Watershed Level Strategy:
- In Headwaters and Mid-Slope areas: No action needed.
- Lowland Areas: Work with county, state and federal agencies and willing landowners to protect and restore estuaries and wetlands.

Specific Tasks for Implementation:
- Research journals on wetlands and estuaries.
- Contact experts and arrange presentations to the Council
- Hold forum/workshop on wetlands and estuaries.
- Work with USFWS in estuary restoration and demonstration projects.
- Add wetlands and estuaries projects to Action Plan as information becomes available.

Education Component:
- Hold forum /workshop on wetland and estuary issues

Lead/Sponsor, Others: Carol Bickford, Council staff, Performance Partnership, Universities

Habitat Action #12: Work with small woodlot owners to complete projects that will supply forest connectivity from the headwaters to the lowland areas.

Watershed Level Strategy:
- In Headwaters: No action needed.
- Mid-Slope and Lowland Areas: Work with small woodlot owners to complete habitat improvement, protection and enhancement projects.

Specific Tasks for Implementation:
- Develop mailing list of small woodlot landowners.
- Distribute information to small woodlot owners regarding options for habitat improvement through forest management.
- Contact landowners— promote interest in habitat issues
- Organize a forum/workshop about small woodlot habitat enhancement through forest management.
- Visit landowners who request on-site consultation and to determine need for project.
- Set up demonstration project on reforestation/habitat enhancement on small woodlot in visible area.

Education Component:
- One-on-one discussions with landowners
- Distribution of informational materials
- Forum/workshop about small woodlot habitat enhancement
- Demonstration project educational value

Lead/Sponsor, Others: Kate Skinner, Council Staff, ODF Forester

Habitat Action #13: Participate in projects that restore and retain healthy forest systems with emphasis on Late-Seral Forests and Late-Successional Forest Habitats.

Watershed Level Strategy:

- In Headwaters and Mid-Slope areas: Work with federal, state and county management plans, particularly the Adaptive Management Area (AMA), BLM and USFS.
- Lowlands areas: Work with county and residential areas to retain forested areas.

Specific Tasks for Implementation:

- Designate Council Representative (and backup) to attend AMA meetings and report back to the rest of the Council.
- Play an active role in communicating public land management plans to the public through Council meetings.
- Assist in distributing technical information on subjects like Swiss Needle Cast and Bark Beetle.
- Provide a forum or article on late-seral forest and late-successional forest habitats including the importance of snags and down wood.

Education Component:

- Forum and articles about late-seral forest and late-successional forest habitats
- newspaper articles about Council/AMA activities

Lead/Sponsor, Others: Warren Tausch (BLM), USFS, Council Staff, Council Member

CHAPTER 4:
WATER QUALITY MONITORING ACTION PLAN

Background

The Oregon Department of Environmental Quality (DEQ) protects water quality by establishing standards to protect beneficial uses of water. Beneficial uses for water in the Nestucca-Neskowin Watershed include resident fish and aquatic life, salmonid fish spawning and rearing, anadromous fish passage, public and domestic water supply, irrigation, water contact recreation, aesthetics, fishing, wildlife, hunting boating and hydropower.

In addition to setting standards for water quality standards, DEQ is required to develop a list of waterbodies that do not meet the water quality standards. The waterbodies that do not meet the standards are referred to as *water quality limited.* DEQ's requirement to create a list of water quality limited waterbodies is part of the federal Clean Water Act and is described in section 303(d) of that act. For this reason, the list waterbodies that do not meet the standards is commonly called the "303(d) list."

The following water quality issues were identified in the Nestucca-Neskowin Watershed Assessment (May, 1998):

Sedimentation

Periodic pulses of sediment --including boulders, logs, and gravel-- are necessary to provide the basic ingredients for good spawning habitat. However, chronic input of fine sediments can reduce the quality of habitat for salmon. Fine sediments clog the spaces between spawning gravels, suffocating the eggs and pre-emergent fry. There are many sources of fine sediment inputs in the watershed, caused by both natural conditions and effects of human activity.

- Known sources of chronic fine sediment are located in the East Beaver Creek, Bear Creek (upper Nestucca), Moon Creek, Nestucca River (from Powder Creek to the Headwaters) and Upper Three Rivers Subwatersheds.
- The Nestucca River from the mouth to headwaters is on the DEQ's 303(d) list for sediment.

Fecal Coliform

Fecal coliform refers to the group of bacteria associated with the digestive system of warm blooded animals. The presence of coliform bacteria in water is an indicator of contamination by human or animal waste. Data indicate fecal coliform contamination is an issue for Nestucca Bay and Nestucca River at Cloverdale and Nestucca Bay is on the 303(d) list for fecal coliform. Fecal coliform sources in the watershed include septic systems, wastewater treatment plants, dairy farms, hobby farms, and wildlife populations.

Water Temperature

Water temperature has a profound effect on organisms that live or reproduce in the water and this is particularly true of Oregon's native 'cold-water' fish such as salmon and trout. When water temperature becomes too high, salmon and trout suffer a variety of ill effects ranging from decreased spawning success to death. Many of the watershed's tributaries have summer temperatures that exceed standards for resident fish, salmonid rearing and other aquatic life. Niagara Creek, Powder Creek, and parts of the

Nestucca River are on DEQ's 303(d) list for temperature. Other waterbodies of concern for temperature are: Horn Creek, West Creek, and the Little Nestucca River.

Streamflow

- Summer streamflow levels in the watershed during the dry season do not meet minimum habitat requirements for anadromous and resident fish and other aquatic life.
- Nestucca River from the mouth to Powder Creek on DEQ's 1994/1996 303(d) list as water quality impaired due to flow modifications.

Pesticides

Many pesticides are used in the Nestucca-Neskowin Watershed and may be affecting water quality. No known testing for the presence of pesticides in streams has been conducted.

Overall Goals

To develop and implement a water quality monitoring program to provide the specific data needed to locate sources of water quality problems in the watershed. To provide systematic water quality data that can be used to develop a plan of action to remedy water quality problems (inadequate summer streamflow levels, fecal coliform contamination, high sedimentation rates, and high water temperatures) so that waterbodies can eventually be removed from the 303(d) list.

Specific Actions

The following actions will help the Council reach the Overall Goal.

Water Quality Action #1: Develop and implement a temperature water quality monitoring program

Specific Tasks for Implementation:

- Develop monitoring plan for temperature with technical advice from DEQ and other agencies.
- Coordinate with other organizations
- Obtain landowner permission for access to sampling sites.
- Recruit and train volunteers to do sampling.
- Work with schools conducting water quality monitoring
- Follow up on water temperature data from summer 1998.

Education Component:

- Report to Council
- Volunteer training and education

Lead/Sponsor, Others: Andy Dufner, Council staff, DEQ, Agencies, County Departments, school teachers

Water Quality Action #2: Develop and implement a bacteria monitoring program

Specific Tasks for Implementation:

- Obtain funding for equipment and sample processing.
- Develop sampling plan with assistance from DEQ.
- Obtain landowner permission for access to sampling sites.
- Recruit and train volunteers to do sampling.
- Work with schools conducting water quality monitoring
- Assist County Development Department to do a sanitary survey.
- Council request to be added to the DEQ National Pollution Discharge Elimination System permit review list.

- Involve agriculture sector of community in this activity.

Education Component:
- Report to Council
- Volunteer training and education
- Once data has been collected present data to ag. Community and others

Lead/Sponsor, Others: Andy Dufner, Council staff, DEQ, ODA, County Departments, agencies

Water Quality Action #3: Develop and implement a turbidity monitoring program

Specific Tasks for Implementation:
- Develop sampling plan with assistance from DEQ.
- Obtain landowner permission for access to sampling sites.
- Recruit and train volunteers to do sampling.
- Work with schools conducting water quality monitoring

Education Component:
- Report to Council
- Volunteer training and education

Lead/Sponsor, Others: Andy Dufner, Council staff, Agencies, County Departments

Water Quality Action #4: Assist DEQ in preparation of Water Quality Management Plan and Total Maximum Daily Load Analysis

Specific Tasks for Implementation:
- Assist DEQ in landowner contact and data gathering.
- Obtain landowner permission for access to sampling sites.

Education Component:
- Report to Council
- Volunteer training and education

Lead/Sponsor, Others: Andy Dufner, Council staff, DEQ, Agencies, County Departments

Water Quality Action #5: Develop and implement a pesticide assessment

Specific Tasks for Implementation:
- Survey county department and agencies to update information on pesticides used, application rates, number of acres treated.
- Develop a preliminary plan for a pesticide characterization and monitoring program.
- Obtain funding for a pesticide characterization and monitoring program.

Education Component:
- Report to Council

Lead/Sponsor, Others: Andy Dufner, Council staff, Agencies, County Departments

Water Quality Action #6: Monitor McGuire Reservoir Expansion Project

Specific Tasks for Implementation:
- Verify summer and fall water release levels guaranteed by McMinnville.
- Verify instream flow requirements for fish during summer and fall.
- Research fish passage into Walker Creek.

- Work with the County to get public input into the expansion project and to keep people informed.

Education Component:

- Report to Council

Lead/Sponsor, Others: Vicki Goodman, Connie Gann, Andy Dufner, Tom Manning (Tillamook County).

CHAPTER 5: PUBLIC EDUCATION/INVOLVEMENT AND PARTNERSHIP ACTION PLAN

Background

The Council is working to protect and enhance the health of the watershed and the success of this goal is dependent, in a large part, on volunteer stewardship efforts of an educated populace. For this reason, the Council is also working to provide watershed-related education of the people who live, work, and recreate in the watershed.

The Council has been having monthly meetings since April of 1995. Attendance at meetings has included many stakeholders within the watershed as well as local, state and federal government agencies involved in the watershed. Continued education and outreach efforts are important to insure consistent participation in the Council and to broaden knowledge of watershed issues and increase involvement in the Council.

Overall Goals

To develop and maintain partnerships with schools and other organizations that are active in the watershed. To develop and implement a public education and involvement program for the people who live, work, and recreate in the watershed. To act as a forum for information sharing on watershed-related topics such as: water quality, land use, habitat enhancement, riparian planting, noxious weeds, and volunteer opportunities.

Specific Actions

The following actions will help the Council reach the Overall Goal.

Education/Involvement Action #1: Present educational forums on watershed-related topics at watershed council meetings

Specific Tasks for Implementation:

- Solicit ideas from the Council and create a list topics (e.g. Swiss needle cast)
- Determine appropriate person to present information for each topic
- Organize schedule for topics at meetings
- Publicize meetings: write articles for the paper, hang flyers, let interested parties know about the talks

Education Component:

- Action is educational

Lead/Sponsor, Others: Council Board, Joyce Cochran, Council staff

Education/Involvement Action #2: Organize a public speakers bureau

Specific Tasks for Implementation:

- Create a list of council members willing to speak at community meetings (such as PTA, Rotary, Lions, etc.) to inform people about Council activities.
- Contact host organizations to determine interest and arrange dates for Council member to give a presentation.

- Report to the Council about questions that were asked and feedback from local organizations.

Education Component:
- Action is educational

Lead/Sponsor, Others: Joyce Cochran, Council staff

Education/Involvement #2: Educate recreational users about the impact of their activities on the watershed

Specific Tasks for Implementation:
- Design/Produce/Install educational signs to place in recreation areas
- Plan forum/workshop on recreational impacts
- Hold form/workshop - if possible at a recreational users group meeting

Education Component:
- Action is educational

Lead/Sponsor, Others: Council staff , Joyce Cochran, Ed Armstong, BLM

Education/Involvement #3: Organize forum/workshop on MEAD project

Specific Tasks for Implementation:
- Contact speaker on MEAD benefits and progress
- Advertise forum/workshop with flyers and in newspaper
- Hold forum/workshop

Education Component:
- Informational meeting in community

Lead/Sponsor, Others: Vicki Goodman, ODA

Education/Involvement #4: Organize tours and develop educational material about demonstration projects

Specific Tasks for Implementation:
- Develop list of demonstration projects
- Determine specialist who could lead tours
- Organize, advertise and conduct tours
- Advertise projects through signboards, news articles, and radio announcements.

Education Component:
- Produce education fact sheets on projects and distribute them.
- Demonstration event at project site for hands-on education of participants.

Lead/Sponsor, Others: Joyce Cochran, Ed Armstrong, Vicki Goodman

Education/Involvement #5: Develop and Install Watershed Identification Signs

Specific Tasks for Implementation:
- Design and produce signs.
- Contact ODOT for installation requirements.
- Recruit volunteers to help install signs.
- Choose installation sites.
- Install signs.

Education Component:
- Produce education fact sheets on project and distribute
- Demonstration event at project site for hands-on education of participants

Lead/Sponsor, Others: Joyce Cochran, Vicki Goodman

Education/Involvement #6: Develop and Publish Watershed Council newsletter, fact sheets, and articles in school newsletters

Specific Tasks for Implementation:
- Maintain funding for publications.
- Recruit writers for articles in the newsletter
- Obtain artwork (photos and drawings) possible from school art classes
- Develop regular newsletter columns such as watershed 101 and volunteer opportunities
- Produce education fact sheets on projects and distribute
- Make information available on a webpage

Education Component:
- Educational fact sheets
- Newsletter will reach everyone in the watershed

Lead/Sponsor, Others: Joyce Cochran, Council Staff, Watershed Council Coordinator, Volunteer writers, schools, TCWRC

Education/Involvement #7: Create list of project ideas for high school seniors and other students

Specific Tasks for Implementation:
- Contact interested high school teachers.
- Suggest possible projects based on Action Plan.
- Go to schools and give presentations on Council activities and project ideas.
- Set up timeline and expectations for students.

Education Component:
- Student will report to Council on activities or findings

Lead/Sponsor, Others: Ed Armstrong, Council Staff, High School Teachers

Education/Involvement #8: Build partnerships between the Council and local schools for watershed related activities.

Specific Tasks for Implementation:
- Contact high school teachers to determine who is conducting projects.
- Go to schools and give presentations on Council activities and project ideas (such as water quality monitoring, macro invertebrate monitoring, Coast-Net, riparian planting etc.).
- Determine how the Council and teachers could work together on projects.
- Work with teachers to organize activities with Council members and students.

Education Component:
- Student and teachers will report to Council on activities or findings.

Lead/Sponsor, Others: Ed Armstrong, Council Staff, Teachers, School Districts

Education/Involvement #9: Build partnership between the Council and Tillamook Bay Community College (TBCC)

Specific Tasks for Implementation:
- Council members attend Watershed curriculum meetings sponsored by TBCC.
- Develop list of courses that Council members would be interested in attending.
- Help develop natural resources curriculum for TBCC.

Education Component:
- Student and teachers will report to Council on activities or findings.

Lead/Sponsor, Others: Ed Armstrong, Council Staff, TBCC

Education/Involvement #10: Participate in the Tillamook County Performance Partnership

Specific Tasks for Implementation:
- Designate a Council representative (and backup representative) to attend Performance Partnership meetings
- Present Council updates to the Performance Partnership
- Representative reports back to the Council

Education Component:
- Council meetings, monthly report

Lead/Sponsor, Others: Council member, Vicki Goodman, Council Staff, Performance Partnership

Education/Involvement #11: Participate in the Northern Coast Range Adaptive Management Area (AMA) planning

Specific Tasks for Implementation:
- Contact AMA coordinator (Warren Tausch, BLM) and express Council interest in active participation
- Designate a Council representative (and backup representative) to attend AMA meetings
- Representative reports back to the Council

Education Component:
- Council meetings, monthly report

Lead/Sponsor, Others: Warren Tausch (BLM), USFS, Council member