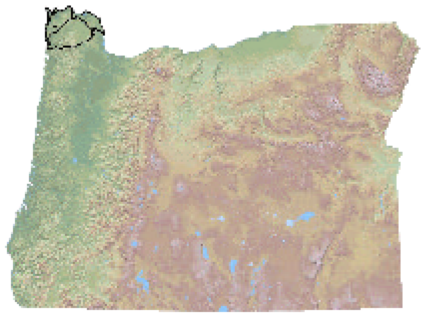
North Coast Subbasins
Total Maximum Daily Load (TMDL)



Prepared by, DEQ State of Oregon Department of Environmental Quality *June 2003*

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EXECUTIVE SUMMARY

WATER QUALITY SUMMARY

Section 303(d) of the federal Clean Water Act (CWA) requires that a list be developed of all impaired or threatened waters within each state. The Oregon Department of Environmental Quality (DEQ) is responsible for assessing data, compiling the 303(d) list and submitting the 303(d) list to the Environmental Protection Agency (EPA) for federal approval. Section 303(d) also requires that the state establish a Total Maximum Daily Load (TMDL) for any waterbody designated as water quality limited (with a few exceptions, such as in cases where violations are due to natural causes or pollutants cannot be defined). TMDLs define the amount of a pollutant that a water body can accommodate without violating water quality standards. The loads allocated within a TMDL should be sufficient that, along with a margin of safety and consideration of future growth, their achievement will result in water quality standards being met.

The portion of the North Coast Basin considered in this document includes four fourth-field hydrologic units: the Nehalem River, the Necanicum River, the Lower Columbia/Young's River, and the Lower Columbia/ Clatskanie River Subbasins. These Subbasins have stream segments and lakes listed on the 1998 and 2002 Oregon 303(d)[1] lists for: temperature, bacteria, dissolved oxygen (DO), biocriteria, and aquatic weeds or algae. A fifth Subbasin (Wilson-Trask-Nestucca – HUC 17100203), which makes up the remainder of the North Coast Basin, was addressed in earlier TMDLs approved by EPA.

The current document includes TMDLs for temperature and bacteria. Dissolved oxygen will be treated separately as DEQ determines the full scope of dissolved oxygen limitations throughout the basin. Most listed areas are within tidally influenced transition zones between fresh and seawater, which exhibit complex chemistry. Work has begun on collecting data from DO-listed waterbodies, but an appropriate model has not been chosen for these complex situations.

Habitat and flow modification concerns (identified under biological criteria standard exceedance) will be addressed in management plans to be developed by designated management agencies (DMAs). As they are not pollutants, TMDLs will not be developed for habitat and flow modification. Noxious aquatic vegetation listings occur in lakes along the coast, and will be treated separately as appropriate lake studies are completed.

TMDL Summaries

Following are brief descriptions of the TMDLs included in this document. A summary of the allocations and waste load allocations developed in these TMDLs are listed in table form at the beginning of each TMDL chapter.

Stream Temperature TMDL (Chapter II)

Compliance with the temperature standard is determined by comparison to numeric and narrative criteria designed to minimize detrimental impacts to salmonid fishes. The standard specifies that "no measurable surface water temperature increase resulting from anthropogenic activities is allowed" where the temperature exceeds migration and rearing or spawning and incubation criteria, where threatened cold water salmonids reside, where dissolved oxygen concentrations are limited, and in other situations. The stream temperature standard applies when one or more of these numeric and narrative triggers occur. The current TMDLs address the migration and rearing (64°F), spawning (55°F) and the Threatened and Endangered Species criteria of the temperature standard. The critical period for these TMDLs is summer through early fall, when low flows coincide with maximum heat loading, resulting in high instream temperatures.

[1] The 303(d) list contains stream segments that do not meet water quality standards.

The stream temperature TMDL targets heat from human sources as the thermal pollutant. There are two sources of this heat loading generally occurring in the North Coast Basin: increased solar radiation due to riparian alterations, and heat from warm water point source discharges. The loading capacity is the total allowable daily heat loading. Load allocations were developed for anthropogenic and background nonpoint sources of heat. Waste load allocations are developed for all point sources. There is no explicit numeric margin of safety provided in the temperature TMDL; rather, the margin of safety has been maintained through conservative assumptions in analysis and modeling of allocations.

Although only the Nehalem River Subbasin was included on the 1998 303(d) list of water quality limited streams for temperature, further study has demonstrated that the remaining Subbasins also include a significant number of streams that are water quality limited. Sophisticated modeling of the Nehalem River Subbasin, along with analysis of temperature data in the remaining Subbasins were used to develop allocations appropriate to all of the Subbasins. These allocations apply throughout all Subbasins covered by this document.

Percent effective shade and channel morphology targets are used as a surrogate measure for nonpoint source pollutant loading since it offers a straightforward parameter to monitor and measure. It is also easily translated into quantifiable water management objectives. Site specific effective shade surrogates averaged over a river reach can be used to assess TMDL nonpoint source allocation attainment. Attainment of surrogate measures ensures attainment of the nonpoint source allocations.

Bacteria TMDL (Chapter III)

A variety of sources contribute Bacterial loading to the Nehalem, Necanicum and Clatskanie Subbasins. Both the Nehalem and Necanicum Subbasins drain through estuaries to the Pacific Ocean, while the Clatskanie River Subbasin discharges to the Columbia River. The estuarine Subbasins (Nehalem and Necanicum) both must meet stringent water quality criteria to protect shellfish harvest for human consumption. Nehalem Bay is listed as impaired due to concentrations that exceed this criterion. The Necanicum and Clatskanie Rivers are listed as water quality limited for recreational contact, though the former also discharges through an area where shellfish are harvested recreationally for human consumption.

The Bacteria TMDL determined loads that point sources and various nonpoint source land uses may discharge to streams without violating water quality standards. Measured bacterial concentrations and flow rates were used to develop physically based mathematical models used to assess sources, determine loading capacities, and allocate loads for each of the subbasins with listed waterbodies (Nehalem, Necanicum, Lower Columbia, and Clatskanie Subbasins). Nonpoint sources were allocated loads based on land-use type. The analysis indicated that point source discharges did not produce significant loads at current permit limits. This analysis and modeling demonstrated that the most significant sources of bacteria were in the lower portions of each of these Subbasins. As a result of this outcome, separate allocations were developed for the Upper and Lower Nehalem Subbasin. Load allocations in the upper Subbasin were designed to meet water contact criteria, while lower Subbasin allocations were designed to meet shellfish criteria in the bay. The loading rates determined in each of the listed subbasins were applied as load allocations for landuses.

Biocriteria

Biocriteria were listed as a water quality limiting feature in one water body (South Fork Goble Creek) in the Lower Columbia and Clatskanie Subbasin. In general, biological community impairments are integrating indicators of a variety of physical and chemical limitations. Biological communities can only be improved through restoration of these impaired physical and biological limitations. This TMDL does not directly allocate biocriteria, though the allocations developed for temperature; such as riparian shade, and streambank and channel restoration should restore the condition of biological communities throughout the basin.

Water Quality Limitation	Load Allocations				Waste Load Allocations		
	Quantity	Geographic Areas	Season	Responsibility	Quantity	Point of Compliance	Season
Temperature	Allowable solar heat based on land cover type/condition and channel morphology	Perennial Streams of the North Coast Subbasins	July to September Annual Peak Temperatures	Land uses: Agriculture Forestry Urban Transportation	Allowable heat input during critical period	Edge of defined mixing zone	April 15 to November 1
Bacteria	Runoff Concentrations of E.coli bacteria	All streams and adjacent lands in the Nehalem, Necanicum, and Lower Columbia - Clatskanie Subbasins	Year Around	Land uses: Pasturelands CAFOs Urban Rural-Residential	Allowable effluent concentrations of E. coli	End of Pipe	Year Around
Biocriteria	Based on improving conditions resulting from implementation of temperature TMDL allocations						

CHAPTER I

OVERVIEW AND BACKGROUND

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1.1 INTRODUCTION

The North Coast Basin includes five fouth-field subbasins in the Northwest corner of Oregon. One of these Subbasins, the Wilson Trask-Nestucca has been considered in previous sets of TMDLs. The remaining four Subbasins in the basin are the subject of this document.

The North Coast Subbasins have several important characteristics:

- The Columbia River runs along the northern borders of the Lower Columbia/Young's River and Lower Columbia/Clatskanie River Subbasins;
- The Nehalem and Necanicum River Subbasins drain into the Pacific Ocean.
- The largest area of land use is forestlands;
- The water quality concerns are predominantly distributed nonpoint sources of pollution instead of discrete point source pollution;
- The North Coast Subbasins are home to productive agricultural and forestlands and contain streams with historically viable trout and anadromous salmonids.

The North Coast Subbasins have a combined area of 1,600 square miles and are located in the northwestern corner of Oregon (**Figure 1**). Four fourth-field hydrologic units comprise the North Coast Subbasins. These are: 1) the Nehalem River Subbasin, 2) the Necanicum River Subbasin, 3) the Lower Columbia/Young's Bay Subbasin, and 4) the Lower Columbia/Clatskanie River Subbasin. These Subbasins are in portions of Clatsop, Tillamook, Columbia, and Washington Counties.

Landuse in the area is dominated by forest lands, with some agricultural, rural residential, and urban lands predominantly at lower elevations. The Oregon Coast Range runs through the North Coast Subbasins, and includes parts of the Tillamook and Clatsop State Forests. Of the forestlands in the Subbasins, the majority are privately owned and managed.

The North Coast Subbasins TMDLs establish water quality goals for streams within the four North Coast Subbasins. In fulfilling Oregon's commitment to comply with State and Federal water quality laws, the State has promoted a path that progresses towards compliance with water quality standards adopted to protect the beneficial uses of waters of the State. The data review and analysis contained in this document summarizes the varied data collection and study that has recently occurred in the Nehalem, Necanicum, Lower Columbia/Young's Bay, and Lower Columbia/Clatskanie River Subbasins. These data were the basis of modeling and other analytical efforts resulting in the allocations in the TMDLs. These allocations will be used directly in setting limits on point source discharges, and should become elements in other plans that address water quality protection and restoration. A Water Quality Management Plan (WQMP) that describes existing regulations, programs, and plans is being submitted along with these TMDLs. This TMDL will also be used as a benchmark of water quality, instream physical parameters and landscape conditions that currently exist, and for assessing future trends and the effectiveness of planned water quality improvement efforts.

The report is organized as follows:

- The main text summarizes eight elements required for each of the TMDL parameters: temperature and bacteria.
- Appendices and attachments contain a more detailed description of the studies, computer modeling, references, and data analyses that were done to develop TMDLs or to address other parameters of concern.
- A Water Quality Management Plan is also presented as an appendix to this document.

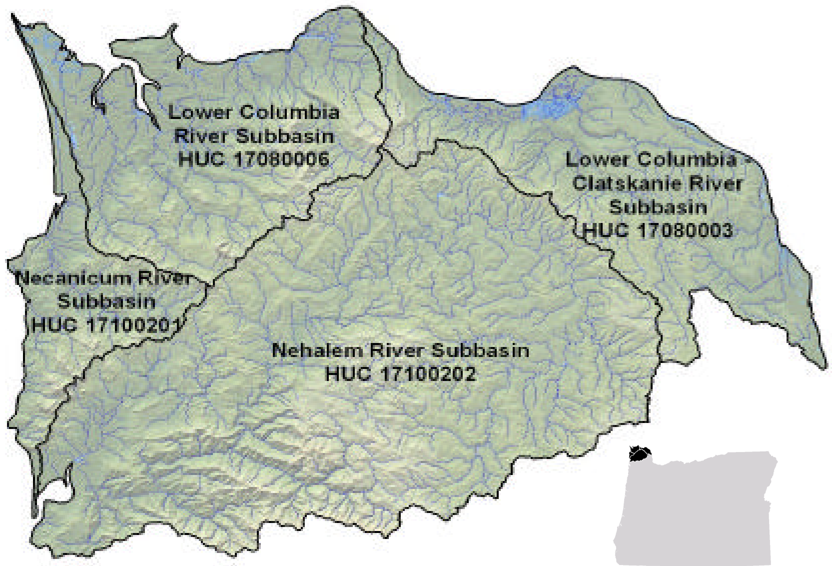


Figure 1. The North Coast Subbasins covered by this document include four 4th field hydrologic units: Nehalem River, Necanicum River, Lower Columbia/Young's River, and Lower Columbia/Clatskanie River Subbasins.

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) as well as other state, federal, and local organization and groups. 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, nonpoint, 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 nonpoint sources, such as urban, agriculture, transportation, or forestry activities.

Allocations can also be set aside in reserve for future uses. *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 nonpoint 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 nonpoint 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 TMDL relies on a watershed approach and addresses two parameters, temperature and bacteria, which are best addressed on a landscape scale. Allocations in the TMDL are applicable throughout the subbasin where they were developed.

Waterbodies have been listed as water quality limited for temperature, bacteria, dissolved oxygen, biological criteria, and aquatic weeds and algae (**Table 1**). This report contains TMDLs for the following parameters :

- **Temperature** – based on the 303(d) listing of the Nehalem River. Further assessment demonstrated widespread violations of the temperature standard in each of the 4 Subbasins. Therefore this TMDL has been expanded to cover all of the Subbasins;

- **Bacteria** – based on the 303(d) listing of Nehalem Bay and the Necanicum River, violations of the criteria for shellfish harvest (Bay), and the Clatskanie River, due to violations of the recreational contact criterion.

- **Biological Criteria** – Based on the 303(d) listing of the South Fork of Goble Creek in the Clatskanie River Subbasin. Listing resulted from a poor score in multivariate analysis for one visit to a site on SF Goble Creek. The poor score is the likely result of habitat modification in this reach.

Dissolved Oxygen violations in lower tributaries of selected streams and aquatic weeds and algae in three listed lakes will be addressed in a future TMDL.

Table 1. Water bodies in the NorthCoast Subbasins listed under section 303(d) of CWA as water quality limited due to temperature, bacteria or biocriteria (DEQ 2003)

Waterbody	River Mile	Parameter	Season	Criterion	Year Listed
Lower Columbia/Clatskanie Subbasin					
Beaver Creek	0 to 14	Temperature	Summer	Rearing: 17.8 C	2002
Clatskanie River	0 to 1.9	Fecal Coliform	Summer	Mean of 200 MPN	1998
Clatskanie River	0 to 1.9	Temperature	Summer	Rearing: 17.8 C	2002
Clatskanie River	1.9 to 25.5	Temperature	Summer	Rearing: 17.8 C	2002
Clatskanie River	1.9 to 25.5	Temperature	September 15	Spawning: 12.8 C	2002
Little Clatskanie River	0 to 6.2	Temperature	Summer	Rearing: 17.8 C	2002
South Fork Goble Cr.	0 to 3.9	Bio Criteria	Year Round	Waters of the stat	1998
Tide Creek	0 to 16.1	Temperature	September 15	Spawning: 12.8 C	2002
Lower Columbia/Young's Subbasin					
Bear Creek	2.5 to 9	Temperature	Summer	Rearing: 17.8 C	2002
Bear Creek	2.5 to 9	Temperature	September 15	Spawning: 12.8 C	2002
Gnat Creek	0 to 9.8	Temperature	September 15	Spawning: 12.8 C	2002
Lewis And Clark River	8.6 to 10.8	Temperature	Summer	Rearing: 17.8 C	2002
Youngs River	9 to 23.2	Temperature	Summer	Rearing: 17.8 C	2002
Necanicum Subbasin					
Necanicum River	0 to 5.9	E Coli	Summer	Mean of 126 MPN	2002
Necanicum River	0 to 20.6	Temperature	September 15	Spawning: 12.8 C	2002
Necanicum River	0 to 15	Temperature	Summer	Rearing: 17.8 C	2002
Pacific Ocean	26 to 30	Fecal Coliform	Year Around	Median 14 MPN	2002
Nehalem Subbasin					
Beneke Creek	0 to 10.1	Temperature	Summer	Rearing: 17.8 C	2002
Buster Creek	0 to 9.1	Temperature	September 15	Spawning: 12.8 C	2002
Cook Creek	0 to 9.3	Temperature	September 15	Spawning: 12.8 C	2002
Cronin Creek	0 to 1.8	Temperature	September 15	Spawning: 12.8 C	2002
East Fork Nehalem R.	0 to 9.8	Temperature	Summer	Rearing: 17.8 C	2002
East Humbug Creek	0 to 4.5	Temperature	September 15	Spawning: 12.8 C	2002
Fishhawk Creek	0 to 11.9	Temperature	Summer	Rearing: 17.8 C	2002
Fishhawk Creek	0 to 11.9	Temperature	September 15	Spawning: 12.8 C	2002
Fishhawk Creek	0 to 7.8	Temperature	Summer	Rearing: 17.8 C	2002
Fishhawk Creek	0 to 7.8	Temperature	September 15	Spawning: 12.8 C	2002
Foley Creek	0 to 3.7	Temperature	Summer	Rearing: 17.8 C	2002
Gods Valley Creek	0 to 4.8	Temperature	September 15	Spawning: 12.8 C	2002
Humbug Creek	0 to 6.5	Temperature	Summer	Rearing: 17.8 C	2002
Humbug Creek	0 to 6.5	Temperature	September 15	Rearing: 17.8 C	2002
Nehalem River	0 to 14.7	Temperature	Summer	Rearing: 17.8 C	1998
Nehalem River	14.7 to 92.	Temperature	Summer	Rearing: 17.8 C	1998
Nehalem River	14.7 to 92.	Temperature	September 15	Spawning: 12.8 C	2002
Nehalem River	92.4 to 108	Temperature	Summer	Rearing: 17.8 C	2002
Nehalem River	92.4 to 108	Temperature	September 15	Spawning: 12.8 C	2002
Nehalem River	108 to 120	Temperature	September 15	Spawning: 12.8 C	2002
North Fork Nehalem R.	10.5 to 23.	Temperature	Summer	Rearing: 17.8 C	2002
North Fork Nehalem R.	10.5 to 23.	Temperature	September 15	Spawning: 12.8 C	2002
Northrup Creek	0 to 7.5	Temperature	Summer	Rearing: 17.8 C	2002
Northrup Creek	0 to 7.5	Temperature	September 15	Spawning: 12.8 C	2002
Oak Ranch Creek	0 to 9.3	Temperature	Summer	Rearing: 17.8 C	2002
Oak Ranch Creek	0 to 9.3	Temperature	September 15	Spawning: 12.8 C	2002

Waterbody	River Mile	Parameter	Season	Criterion	Year Listed
Pebble Creek	0 to 9.8	Temperature	Summer	Rearing: 17.8 C	2002
Pebble Creek	0 to 9.8	Temperature	Fall-Winter-Spring	Spawning: 12.8 C	2002
Rock Creek	0 to 11	Temperature	Summer	Rearing: 17.8 C	2002
Rock Creek	0 to 11	Temperature	Fall-Winter-Spring	Spawning: 12.8 C	2002
Salmonberry River	0 to 5	Temperature	Summer	Rearing: 17.8 C	2002
Salmonberry River	0 to 5	Temperature	Fall-Winter-Spring	Spawning: 12.8 C	2002
Soapstone Creek	0 to 3.9	Temperature	Summer	Rearing: 17.8 C	2002
Walker Creek	0 to 10	Temperature	Summer	Rearing: 17.8 C	2002
Walker Creek	0 to 10	Temperature	Fall-Winter-Spring	Spawning: 12.8 C	2002
West Humbug Creek	0 to 5.1	Temperature	Fall-Winter-Spring	Spawning: 12.8 C	2002
Wolf Creek	0 to 7.8	Temperature	Fall-Winter-Spring	Spawning: 12.8 C	2002
Nehalem Bay	0 to 2.1	Fecal Coliform	Year Round	Median >14 MPN	1998
Nehalem Bay	0 to 4.1	Fecal Coliform	Year Round	10 percent >43 MPN	1998

Table 1 (continued). Water bodies in the NorthCoast Subbasins listed under section 303(d) of CWA as water quality limited due to temperature, bacteria or biocriteria (DEQ 2003)

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 will 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 North Coast Basin. 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.

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.

In addition to the FPA, the Tillamook State Forest (TSF) and Clatsop State Forests have adopted the Western Oregon State Forest Management Plan. TSF is also 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 as 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. The expanded protections provided by the State Forest Management Plans and HCP will only be required on State Forest lands, which account for approximately 25% of the area in the North Coast Subbasins area. Compliance by any private landowners will be on a voluntary basis.

Senate Bill 1010 – Agricultural Water Quality Management Area Plans

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 nonpoint source discharges from municipalities, industries, and construction activities that result in runoff directly or as a result of stormwater management. DEQ will incorporate Wasteload Allocations into NPDES permits in the next renewal for each facility.

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 Nonpoint Pollution Control Programs, the Northwest Forest Plan, Oregon's Forest Practices Act, Oregon's Senate Bill 1010 and Oregon's TMDL Program.

Northwest Forest Plan

There is very little federal forest land in the area covered by this set of TMDLs. However, the Northwest Forest Plan defines forest practices on federal lands. 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.

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 nonpoint 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 nonpoint source pollution. In addition, DEQ recognizes that technology for controlling nonpoint 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 nonpoint source that is covered by this TMDL complies with its DEQ-approved WQMP, it will be considered in compliance with the TMDL. Water Quality Management Plans have been approved for major Designated Management Agencies in the basin. Each of these plans has provisions for updating specific practices or measures when existing approaches are found inadequate. The plans approved for state agencies that are:

- Forest Practice Rules for non-federal forestry (ODF);
- North Coast Basin Agricultural Water Quality Management Area Plan for agriculture (ODA); and
- Department of Transportation Clean Water Plan for roads (ODOT).

DEQ intends to regularly review the 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 is 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 re-opening the TMDL should new information become available indicating that the TMDL or its associated surrogates should be modified.

CHAPTER II

NORTH COAST SUBBASINS OVERVIEW

2.1 GEOGRAPHY

The North Coast Subbasins headwaters predominately occur in the coniferous forests of the Coast Range mountains (the highest point in the Subbasins is 3,690 feet in elevation). The Nehalem River is over 118 miles long, originating on the eastern side of the Coast Range and eventually making its way westward to the Pacific Ocean. Shaded relief topography is depicted in **Figure 1**. Rivers in the North Coast Subbasins typically begin in steep mountainous terrain, with cobble and boulder stream beds and coniferous forests. In the lower elevations, rivers are often surrounded by wetlands, agriculture, or development.

The drainage area for the North Coast Subbasins is about 1,600 square miles. The Nehalem River Subbasin covers half of the study area (800 square miles). The Nehalem River and Necanicum River Subbasins drain into the Pacific Ocean. The Lower Columbia/Young's River and Lower Columbia/Clatskanie River Subbasins drain into the Columbia River.

2.2 CLIMATE

The climate of the North Coast Subbasins is generally characterized by mild summers and wetter winters with moderately low temperatures. Due to its location near the Pacific Ocean coast line, it is in the path of storms originating in the North Pacific Ocean. Winter precipitation is derived from these storms traversing in an easterly direction. The Coast Range Mountains are the primary cause for the relatively large annual precipitation events. Annual precipitation (**Figure 2, Table 2**) in the North Coast Subbasins ranges from about 50 inches on the eastern side of the Coast Range to up to 200 inches within the Coast Range mountains.

Table 2. Average Monthly Climate Data.

Astoria, Oregon - *Source: Oregon Climate Service, Period of record: 1961-1990*

Parameter	Jan	Feb	Mar	April	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Year
Air Temperature (°F)													
Mean	42.4	44.4	45.7	48.2	52.5	56.9	60.2	60.9	58.5	52.6	47.0	42.7	51.0
Maximum	48.3	51.3	53.3	56.0	60.2	64.1	67.6	68.9	67.7	61.1	53.6	48.5	58.4
Minimum	36.4	37.5	38.0	40.3	44.8	49.6	52.7	52.9	49.4	44.1	40.4	37.0	43.6
Precipitation (inches)													
Mean	10.0	7.6	7.1	4.6	3.0	2.4	1.2	1.3	2.9	5.7	10.1	10.6	66.4

Seaside, Oregon - *Source: Oregon Climate Service, Period of record: 1961-1990*

Parameter	Jan	Feb	Mar	April	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Year
Air Temperature (°F)													
Mean	43.9	46.0	46.7	49.0	53.1	57.0	59.8	60.4	59.2	54.2	48.2	44.2	51.7
Maximum	51.0	53.8	55.2	57.6	61.5	65.1	67.9	68.9	69.5	63.8	55.9	51.3	60.0
Minimum	36.7	38.2	38.4	40.5	44.7	48.9	51.6	52.0	49.0	44.6	40.6	37.2	43.6
Precipitation (inches)													
Mean	10.9	9.1	8.1	5.2	3.6	2.8	1.6	1.5	3.0	6.2	10.8	11.5	73.8

Clatskanie, Oregon - *Source: Oregon Climate Service, Period of record: 1961-1990*

Parameter	Jan	Feb	Mar	April	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Year
Air Temperature (°F)													
Mean	39.3	42.5	45.6	48.7	54.0	58.9	62.9	64.0	60.4	52.5	44.5	39.3	51.0
Maximum	44.2	49.4	53.9	58.0	63.6	68.4	73.0	74.2	70.8	61.3	50.4	44.1	59.2
Minimum	34.1	35.6	37.3	39.5	44.4	49.5	52.8	53.7	49.9	43.7	38.6	34.4	42.8
Precipitation (inches)													
Mean	9.1	6.6	6.3	3.7	2.5	1.7	0.8	1.2	2.4	4.4	8.6	9.4	56.9

Table 2. Average Monthly Climate Data – Continued.
Vernonia, Oregon - Source: Oregon Climate Service, Period of record: 1961-1990

Parameter	Jan	Feb	Mar	April	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Year
Air Temperature (°F)													
Mean	36.6	40.0	43.6	46.7	51.9	57.2	61.2	61.7	57.3	49.8	42.3	37.1	48.8
Maximum	44.2	49.1	53.8	57.9	64.0	69.8	75.3	76.7	72.2	62.5	50.8	44.1	60.0
Minimum	29.1	30.8	33.3	35.4	39.8	44.8	47.0	46.7	42.6	37.0	33.7	30.2	37.5
Precipitation (inches)													
Mean	7.5	5.7	5.3	3.3	2.3	1.6	0.6	1.0	2.3	3.8	7.0	8.0	48.8

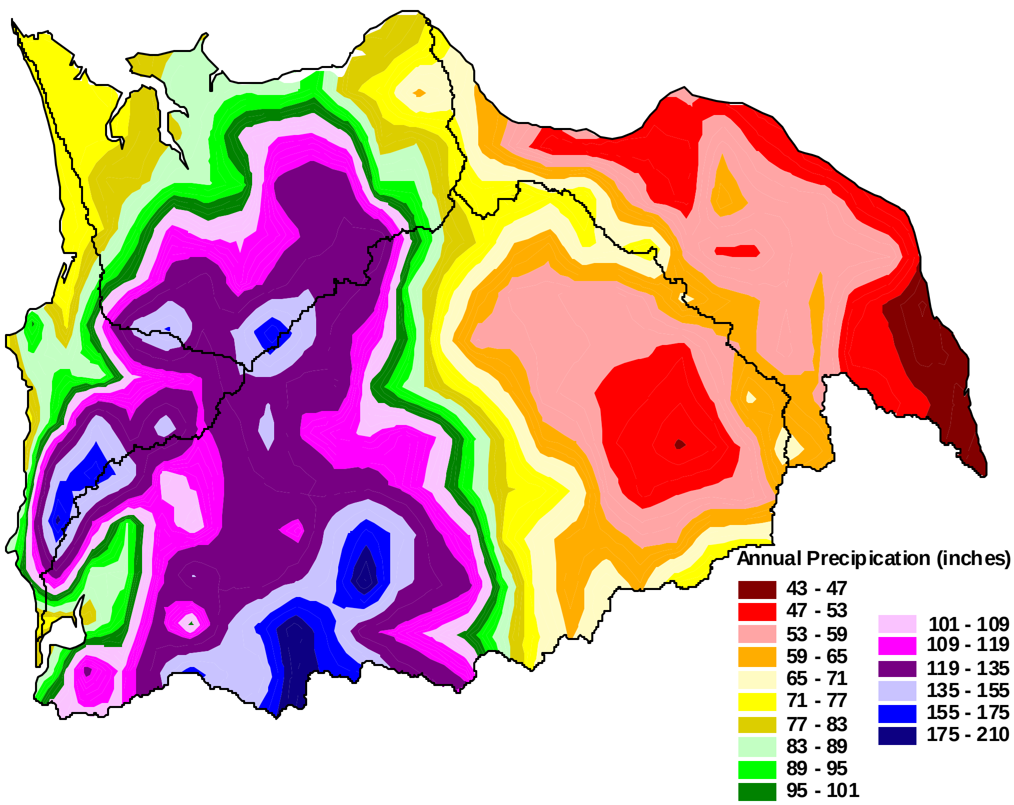
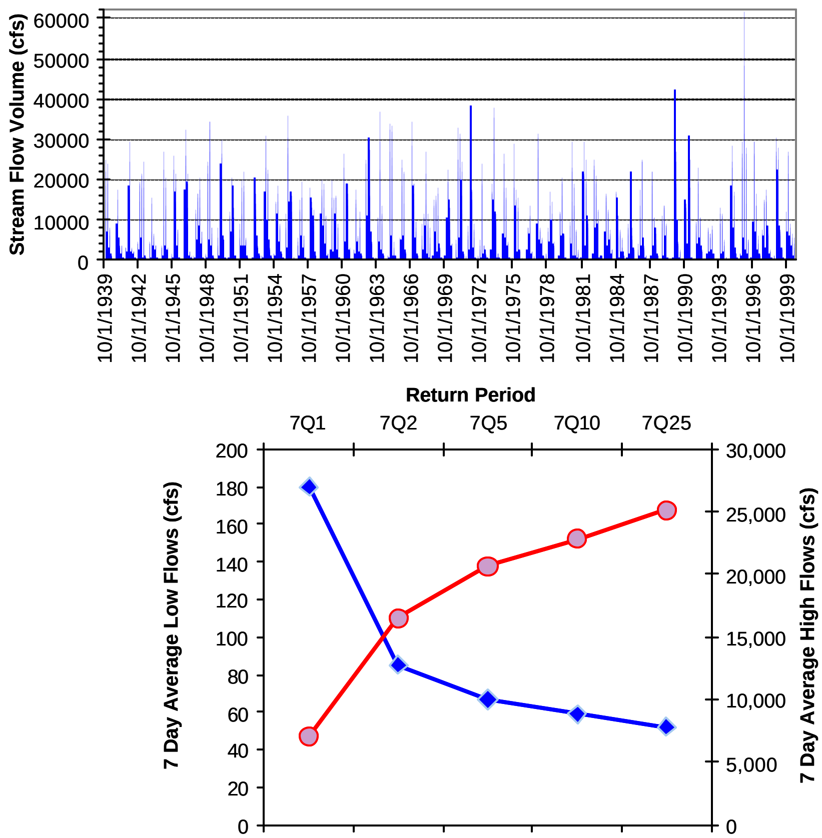


Figure 2. North Coast Subbasins Precipitation (Oregon SSCGIS).

2.3 STREAM FLOW

Low flows generally occur during the end of the summer months (July to October) due to decreased precipitation. It is possible that 7Q10 low flows[2] in the lower portions of the drainages are decreased by upstream diversions. Other than the Nehalem River, little historical flow data exists for the North Coast Subbasins. Although there are diversions of water in each of the subbasins, the cumulative diversion in the Nehalem River was not a significant factor determining stream temperature (see Section 3.6.1 of Appendix A – Temperature Technical Analysis). Nehalem River historical flow data is presented in **Figure 3**.



7 Day Ave. Low Flows	179.9	85.1	66.7	59.1	52.2
7 Day Ave. High Flows	7109.7	16498.3	20655.1	22852.5	25149.5

Figure 3.

Nehalem River at Foss Gage (USGS) Historical Stream Flow Statistics.

[2] 7Q10 refers to a seven day averaged low flow condition that occurs on a ten-year return period. Mathematically, this low flow condition has a 10% probability of occurring every year. A Log Pearson Type III distribution was used to calculate the return period.

2.4 LAND USE AND OWNERSHIP

Land ownership is predominantly private and State owned in the North Coast Subbasins, accounting for 73.7% and 25.6% of the land area, respectively. Spatial distributions of land ownership are displayed in **Figure 4**.

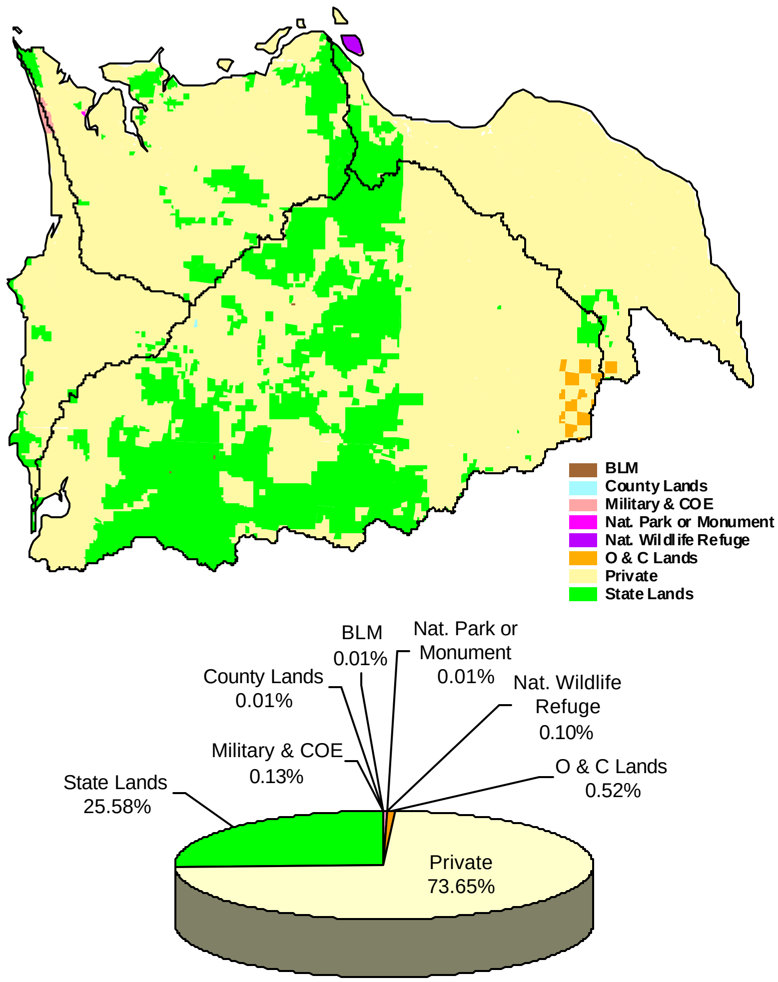


Figure 4. Land Ownership/Management Spatial Distributions.

Land use in the North Coast Subbasins is predominantly forested (90.0%). Agriculture (farming and grazing) occur on 3.0% of the Subbasins. 4.2% of the land area is classified as clearcut or barren.

Figure 5 shows the spatial distribution of major land use types.

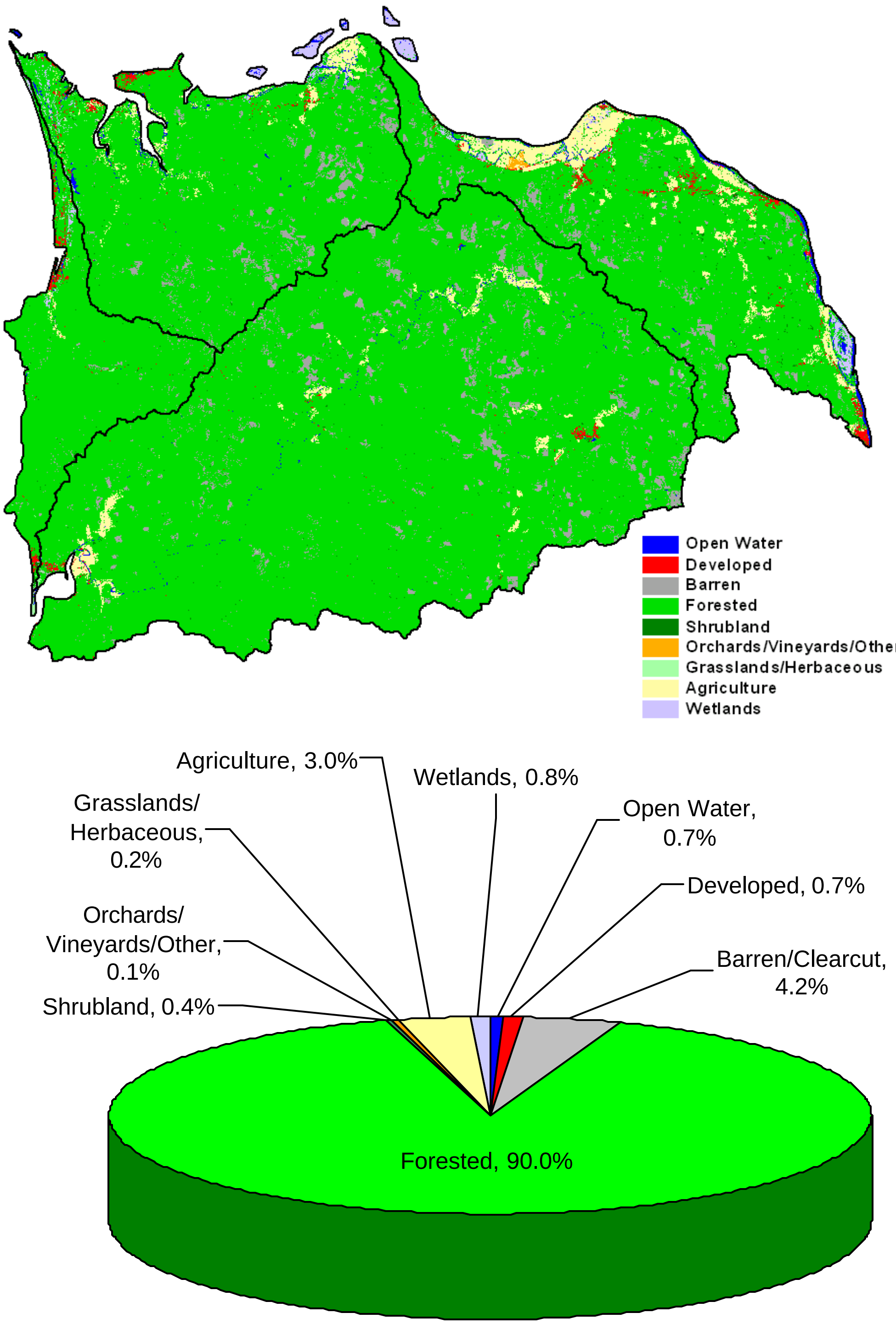


Figure 5. Land Use Spatial Distributions

2.5 FISHERIES

Fisheries are important beneficial uses throughout the North Coast Basin and are the most sensitive beneficial uses for applying temperature and, in some places, bacteria standards. Salmonid fish (salmon and trout) migration, rearing, spawning and incubation are all dependent upon availability of cold water to varying degrees. Shellfish harvesting, both commercial and recreational, are dependent on waters that are relatively free of fecal bacteria.

Salmonids

There are seven stocks of salmonid fish species in the North Coast Subbasins that are designated as threatened or that are candidates for threatened status under the federal Endangered Species Act **(Table 3)**. The North Coast Subbasins fall within several Evolutionarily Significant Units (ESU's). ESU maps are available at the NOAA Fisheries website: http://www.nwr.noaa.gov/1salmon/salmesa/.

Table 3. Summary of the listing status of various salmon species.

Fish Species	ESU[3]	
	Oregon Coast	**Lower Columbia**
Summer and Fall Chinook (*Oncorhynchus tshawytscha*)	Not Warranted	Threatened
Coho Salmon (*Oncorhynchus kisutch*)	Threatened	Candidate
Chum Salmon (*Oncorhynchus keta*)	Not Warranted	Threatened
Steelhead Trout (*Oncorhynchus mykiss)*	Candidate	Threatened
Cutthroat Trout (*Oncorhynchus clarki clarki*)	Candidate	Not Warranted

Temperature and dissolved oxygen criteria have been adopted in water quality standards to protect all of these species during migration, rearing and spawning in rivers and estuaries. Water quality criteria that protect the most sensitive beneficial uses are applied to a water body. Criteria are more restrictive when species are listed as *Threatened or Endangered* under the Federal Endangered Species Act as no measurable anthropogenic temperature increase is allowed. Other fish species have been listed as "sensitive" and will also benefit from improved water quality conditions. In the North Coast Basin, the most sensitive beneficial use is salmonid fish migration, rearing, and spawning. Migration and rearing criteria are applied year around while spawning criteria are applied only during times when spawning, incubation and fry emergence are presumed to occur based on ODFW District biologists information. Distribution of habitat use for each of the salmonid species listed in Table 7 (ODFW fish distribution maps).

Shellfish

Shellfish include a wide range of different types of organisms, but the chief concern with applying bacterial standards is harvest of bivalve mollusks (oysters, clams, etc) for human consumption. Nehalem Bay currently has no oyster leases, but clams are harvested in the Bay for sale within Oregon (see management plan – Appendix E) and recreationally for personal consumption. Commercial and recreational shellfish harvest also occurs at Clatsop Beach from Seaside, where the Necanicum River enters the ocean, up to the mouth of the Columbia River. Water in areas supporting shellfish harvest in these areas must meet the marine and estuarine shellfish harvest criterion for fecal coliform bacteria. Other coastal areas within the basin may also support recreational shellfish harvest, but these are generally on open beaches where there is no indication of bacterial contamination. The remainder of areas within the basin must meet the less stringent water contact numeric criteria.

[3] An Evolutionarily Significant Unit or "ESU" is a distinctive group of Pacific salmon, steelhead, or sea-run cutthroat trout. The National Marine Fisheries Service, Northwest Region is responsible for conducting Endangered Species Act (ESA) status reviews for marine and anadromous fishes, including 5 species of salmon - Chinook, Chum, Coho, Pink, Sockeye - and Steelhead (trout). More information can be obtained from http://www.nwr.noaa.gov/

CHAPTER III

TOTAL MAXIMUM DAILY LOADS

3.0 INTRODUCTION TO TMDLS

Total Maximum Daily Loads have been developed for stream temperature and for fecal bacteria in streams and bays. These TMDLs provide allocations for all known sources of temperature and bacteria throughout basins where there are known violations of the water quality standards for these parameters.

3.1 TEMPERATURE TMDL

Summary of Temperature TMDL Development and Approach

Why Is Temperature Important?

Excessive summer water temperatures in tributaries and mainstem reaches throughout the North Coast Subbasins 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 that contribute to surface water temperature increase include past forest and fishery 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. Point source discharges of warm water also contribute to stream heating in the lower Nehalem watershed. As a result of water quality standards (WQS) exceedances for temperature, waters in the North Coast Subbasins are on Oregon's 1998 303(d) list.

Scope

All lands (~1600 square miles) with intermittent or perennial streams that drain to the Pacific Ocean or Lower Columbia River within HUCs , 17100202 (Nehalem River), 17100201 (Necanicum River), 17080003 (Lower Columbia-Clatskanie River), and 17080006 (Lower Columbia-Young's Bay) are included in the temperature TMDL. All land uses and both point-sources and nonpoint sources of heat are included: lands managed by the State of Oregon, the Bureau of Land Management (BLM), private forestlands, agricultural lands, rural residences, military lands and urban areas.

Applying Oregon's Temperature Standard

Attainment of the temperature standard relies on simulating the thermal effects of "" riparian vegetation and channel morphology that reduce thermal patterns to those that minimize human caused increases in stream temperatures. In areas where the numeric criteria are being exceeded, DEQ considers attainment of conditions as measured by % effective shade to demonstrate compliance with the temperature standard. This is obtained through restoration/protection of riparian vegetation, channel morphology, and hydrologic processes.

Development of System Potential Conditions

System potential conditions are defined by riparian and channel morphology parameters. DEQ assessed potential vegetation, channel morphology, and flows with field measurements and existing information regarding vegetation distributions. Hydrology was characterized via the application of hydrologic principles, current and predicted flows, and distributions of current channel geometry. Heat accumulation through the Nehalem Subbasin was modeled based on direct long-term temperature monitoring and relatively instantaneous temperature measured remotely by Forward-Looking Infrared Radiometry (FLIR). DEQ calculated the thermal effects associated with achieving both riparian and channel morphology conditions. conditions were developed rigorously for the Nehalem Subbasin, and shade-heat load curves were applied throughout the four Subbasins.

Temperature TMDL Overview

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

3.1.1 Summary of Stream Temperature TMDL Development

Through field sampling, remote sensing, and modeling, this TMDL and allocations have been developed to ensure that water quality standard is met throughout the North Coast Subbasins geographic area (**Table 4**).

Table 4. North Coast Subbasins Temperature TMDL Components

Waterbodies	Perennial or fish bearing (as identified by ODFW, USFW or NFMS) streams within the 4th field HUCs (hydrologic unit codes) 17080003, 17080006, 17100201, and 17100202.
Pollutant Identification	*Pollutants:* Anthropogenic heat from (1) solar radiation loading from nonpoint sources and (2) warm water discharge to surface waters.
Water Quality Standard Identification (Applicable Water Quality Standards) *CWA §303(d)(1)*	OAR 340-041-0205(2)(b)(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); (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); (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 Subbasin;
Existing Sources *CWA §303(d)(1)*	Forestry, Agriculture, Transportation, Rural Residential, Urban, Industrial Discharge, Waste Water Treatment Facilities
Seasonal Variation *CWA §303(d)(1)*	Temperatures vary significantly among seasons, with elevated temperatures that exceed one or more criteria occurring during the period June through October.
TMDL Loading Capacity and Allocations *40 CFR 130.2(f)* *40 CFR 130.2(g)* *40 CFR 130.2(h)*	*Loading Capacity:* The water quality standard specifies a loading capacity based on the condition that meets the *no measurable surface water temperature increase resulting from anthropogenic activities.* Loading capacities in the North Coast Subbasins are the sum of (1) background solar radiation heat loading profiles for the mainstem rivers and major tributaries (expressed as kcal per day) based on potential near stream vegetation characteristics without anthropogenic disturbance and (2) allowable heat loads for NPDES permitted point sources based on the 0.25°F allowable temperature increase in the mixing zone. *Waste Load Allocations (Point Sources)*[4]: Maximum allowable heat loading based on system potential stream temperatures or numeric criteria and facility design flow for all permitted point sources discharging to temperature impaired waterbodies. *Load Allocations (Nonpoint Sources):* Maximum allowable heat loading associated with background solar radiation loading.
Surrogate Measures *40 CFR 130.2(i)*	Translates Nonpoint Source Load Allocations • Effective Shade targets translate the nonpoint source solar radiation loading capacity. • The allocation of "system potential effective shade" ensures that water temperatures will be as low as feasible throughout the year.
Margins of Safety *CWA §303(d)(1)*	*Margins of Safety* are demonstrated in critical condition assumptions and are inherent to methodology. No numeric margin of safety is developed.
Water Quality Standard Attainment Analysis *CWA §303(d)(1)*	• Analytical modeling of TMDL loading capacities demonstrates attainment of water quality standards • The Temperature Management Plan will consist of Implementation Plans, Water Quality Management Plan (WQMP) and Facility Operation Plans that contain measures to attain load / waste load allocations.

[4] Effluent temperatures and wasteload allocations (WLA) were based on calculating no measurable increase in temperature at the edge of a defined mixing zone using the flows, temperatures and equation in Section 3.1.8.1. As permits are renewed, WLAs may be recalculated if additional information demonstrates different flows, mixing zone dimensions, or effluent temperatures should be used. Therefore, the maximum temperature allowed in the permit may be different from the listed values and will be determined at the time of permit renewal to ensure no measurable increase outside of the mixing zone.

3.1.1.1 Summary of Stream Temperature Standard

Attributes of land and water that provide human benefits are defined as beneficial uses and are protected by water quality standards. Water quality standards are developed to protect the most sensitive beneficial use within a water body of the State. **The stream temperature standard applied in the North Coast Basins TMDL protects cold water fish (salmonids) rearing and spawning as the most sensitive beneficial use.**

Several numeric and qualitative trigger conditions invoke the temperature standard. Numeric triggers are based on temperatures that protect various salmonid life stages. Qualitative triggers specify conditions that deserve special attention, such as the presence of threatened and endangered cold water species, dissolved oxygen violations and/or discharge into natural lake systems. The occurrence of one or more of the trigger conditions invokes the temperature standard.

Once invoked, a water body is designated water quality limited. Waterbodies that are water quality limited due to temperature and that support populations of species listed as threatened or endangered are allowed "***…no measurable surface water temperature increase resulting from anthropogenic activities when numeric or qualitative criteria are exceeded"*** (OAR 340-41-0205(2)(b)(A)).

3.1.1.2 Summary of Stream Temperature TMDL Approach

Stream temperature TMDLs are generally scaled to a subbasin or basin and include all perennial surface waters with salmonid presence or that contribute to areas with salmonid presence. Since stream temperature results from cumulative interactions between upstream and local sources, the TMDL considers all surface waters that affect the temperatures of 303(d) listed water bodies. For example, the Nehalem River is water quality limited for temperature. To address this listing in the TMDL, the Nehalem River and all major tributaries are included in the TMDL analysis and TMDL targets apply throughout the entire stream network. This broad approach is necessary to address the cumulative nature of stream temperature dynamics. Work in the Nehalem Subbasin was the basis for temperature allocations for the other three Subbasins, though each Subbasin was characterized individually.

The temperature standard specifies that "***no measurable surface water temperature increase resulting from anthropogenic activities is allowed***". An important step in the TMDL is to examine the anthropogenic contributions to stream heating. The pollutant is heat. The TMDL establishes that the anthropogenic contributions of nonpoint source solar radiation heat loading results from varying levels of decreased stream surface shade throughout the sub-basin. Decreased levels of stream shade are caused by near stream land cover disturbance/removal and related channel morphology changes. Other anthropogenic sources of stream warming include stream flow reductions and warm surface water return flows.

System potential is defined in the TMDL as the combination of potential near stream land cover condition and potential channel morphology conditions. Potential near stream vegetation is that which can grow and reproduce on a site given: climate, elevation, soil properties, plant biology and hydrologic processes. Potential channel morphology is developed using an estimate of width to depth ratios appropriate for the Rosgen channel type regressed from regional curves (**see Appendix A**). does not consider management or land use as limiting factors. **In essence,System Potential is the design condition used for TMDL analysis that meets the temperature standard by minimizing human related warming.**

- System Potential <u>is</u> an estimate of the condition where anthropogenic activities that cause stream warming are minimized.
- System Potential <u>is not</u> an estimate of pre-settlement conditions. Although it is helpful to consider historic land cover patterns, channel conditions and hydrology, many areas have been altered to the point that the historic condition is no longer attainable given drastic changes in stream location and hydrology (channel armoring, wetland draining, urbanization, etc.).

All stream temperature TMDLs allocate heat loading. Nonpoint sources are expected to eliminate the anthropogenic portion of solar radiation heat loading. Point sources are limited to heat loading that results in less than 0.25^{o}F increase at the edge of a defined mixing zone. Allocated conditions are expressed as heat per unit time (kcal per day). The nonpoint source heat allocation is translated to effective shade surrogate measures that linearly translate the nonpoint source solar radiation load allocation. Effective shade surrogate measures provide site-specific targets for land managers, and attainment of the surrogate measures ensures compliance with the nonpoint source allocations. We expect that attainment of the surrogate will be reflected in reach-averaged levels of shade that meet the load allocation for a given channel width and orientation. Where these levels are not attained, even following apparently complete restoration, the model may provide an explanation for the ultimate condition.

Stream temperatures were modeled very rigorously in the Nehalem Subbasin with a combination of temperature data that was continuous in time but at fixed sites, and data that was continuous in space (along mainstem and all major tributaries) but short term (one day). The resulting load allocations from this basin, in terms of the surrogate measure "*shade*" were then applied to the other basins.

3.1.1.3 Summary of Stream Temperature TMDL Analytical Methods

Stream temperatures were modeled throughout the NorthCoast Subbasins with a combination of direct measurement, remote sensing, and derived landscape assessment. Temperatures were measured in major streams and tributaries throughout all four Subbasins with continuous temperature recorders deployed for months at a time to assess spring-summer-fall conditions. Temperature regimes in the mainstem and tributaries of the Nehalem basin were assessed through Forward-Looking Infrared Radiometry (FLIR). FLIR data is collected by flying a helicopter along streams and taking infrared (IR) and daylight video of the water surface. IR light is emitted by the water at different wavelengths depending on temperature. These different wavelengths are translated directly into temperature of the water surface and give and instantaneous measure of water temperature. In most cases water in the streams are well mixed, and the surface temperature represents the temperature of the entire water column. Stream temperature at individual stations is used to calibrate the FLIR and to track water temperature on an hourly basis throughout the season of study. This provides an assessment of long-term temperature patterns at each of the stations (with continuous temperature recorders), and a one-day assessment of stream heating on a very fine scale (from FLIR) throughout the basin.

Channel morphology and vegetative data is collected directly at each temperature monitoring station, and is also derived from aerial photographs (digital orthophoto quadrats or DOQs) on a fine scale (1:5000) throughout the watershed. Topography is determined on a fairly fine scale (10-meter precision) through the use of Digital Elevation Model (DEM) data for the basin. The data from ground stations are used to check the accuracy of the derived data. The derived data is used to establish the physical dimensions and the vegetative corridor of stream channels. Along with flow data collected through out the basins during the critical warming period, these data are combined in a mathematical model (HEATSOURCE v6.2) to characterize heat accumulation in the rivers from headwater areas, down to the mouths of the major rivers.

Thus a continuous (approximately 100-foot intervals) estimate of stream temperature is developed by modeling heat entering a channel of measured width and aspect, as modified by vegetative and topographic shade and a measured flow rate. Once heat accumulation can be modeled under current conditions, various elements of the waterbody (channel morphology, vegetative buffers, flow, etc.) can be manipulated in the model to predict possible future conditions. The details of these analyses are included Appendix A.

3.1.1.4 Limitations of Stream Temperature TMDL Approach

While the stream temperature data and analytical methods presented in TMDLs are comprehensive, there are limitations to the applicability of the results. Like any scientific investigation, loading analyses in a TMDL are limited to the current scientific understanding of the water quality parameter and data availability for other parameters that affect the water quality parameter. Physical, thermodynamic and biological relationships are well understood at very small spatial and temporal scales. However, at a large scale, such as a subbasin or basin, there are limits to the current analytical capabilities.

The state of scientific understanding of stream temperature has evolved, however, there are still areas of analytical uncertainty that introduce errors into the analysis. Three major limitations should be recognized:

- Current analysis is focused on a defined critical condition. This usually occurs in late July or early August when stream flows are low, radiant heating rates are high and ambient conditions are warm. However, there are several other important time periods where data and analysis are less explicit. For example, spawning periods have not received such a robust consideration.
- Current analytical methods fail to capture some upland, atmospheric and hydrologic processes. At a landscape scale these exclusions can lead to errors in analytical outputs. For example, methods do not currently exist to simulate riparian microclimates at a landscape scale.
- In some cases, there is not scientific consensus related to riparian, channel morphology and hydrologic potential conditions. This is especially true when confronted with highly disturbed sites, meadows and marshes, potential hyporheic/subsurface flows, and sites that have been altered to a state where potential conditions produce an environment that is not beneficial to stream thermal conditions (such as a dike).

3.1.2 Temperature Pollutant Identification

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.

3.1.3 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.

3.1.3.1 Salmonid Thermal Requirements

Salmonids, other cold water fish, and some amphibians are highly sensitive to temperature. 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^{o}F). Such warm temperature extremes are rare in the North Coast Subbasins.

More commonly observed within the North Coast Subbasins are temperatures in the mid-70^{o}F range (mid- to high-20^{o}C range). These temperatures cause death of cold-water fish species during exposure times lasting a few hours to one day. The 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 particular development life-stages. 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^{o}F to low-70^{o}F). **Table 5** summarizes the modes of cold water fish mortality.

Table 5. 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^{o}F > 32^{o}C	Instantaneous
Incipient Lethal Limit – Breakdown of physiological regulation of vital bodily processes, namely: respiration and circulation	70^{o}F - 77^{o}F 21^{o}C - 25^{o}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^{o}F - 74^{o}F 17.8^{o}C - 23^{o}C	Weeks to Months

3.1.3 Sensitive Beneficial Use Identification

Beneficial uses and the associated water quality standards are generally applicable subbasin-wide throughout each of the four North Coast Subbasins. Some uses require further delineation. At a minimum, uses are considered attainable wherever feasible or wherever attained historically. 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. Other sensitive uses (such as drinking water and water contact recreation) are applicable throughout the subbasins. Oregon Administrative Rules (OAR Chapter 340, Division 41, Section 202, Table 1) lists the "Beneficial Uses" occurring within the Lower Columbia – North Coast Basin (**Table 6**), which includes all four North Coast Subbasins addressed by this TMDL. 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 North Coast Subbasins.

Table 6. Beneficial uses occurring in the North Coast Subbasins
(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	

The generalized critical period for habitat use is based on the spatial distribution and the time of year that fish use areas, and the likelihood of elevated water temperatures. Distribution of habitat use and the periods of use by various species are presented in **Figure 6** and **Table 7**. These generalized use periods are constructed from the full range of use in the basin. Temperature criteria are applied at a given place depending on the time of use. There are differences in the onset of spawning among watersheds, and site-specific application of temperature criteria (e.g., for point source discharges) is determined by local information provided in **Appendix F**.

The migration and rearing criterion is applied year-around to all waters used by salmon, but the critical period is late summer when flows are minimal and temperatures are highest. The spawning criterion is applied to any waters indicated as spawning or incubation habitat by ODFW during times when spawning would be expected. For example, Fall Chinook spawn and incubate from mid September through February. Spring Chinook spawn and incubate from mid August through January. Since they use the same reaches of mainstem rivers for spawning however, their spawning periods are additive, extending the spawning period from August through February. Temperatures are low during much of this interval, and the critical period is during late summer or early fall when flows are low and temperatures are elevated, or late spring with the onset of seasonal warming trends.

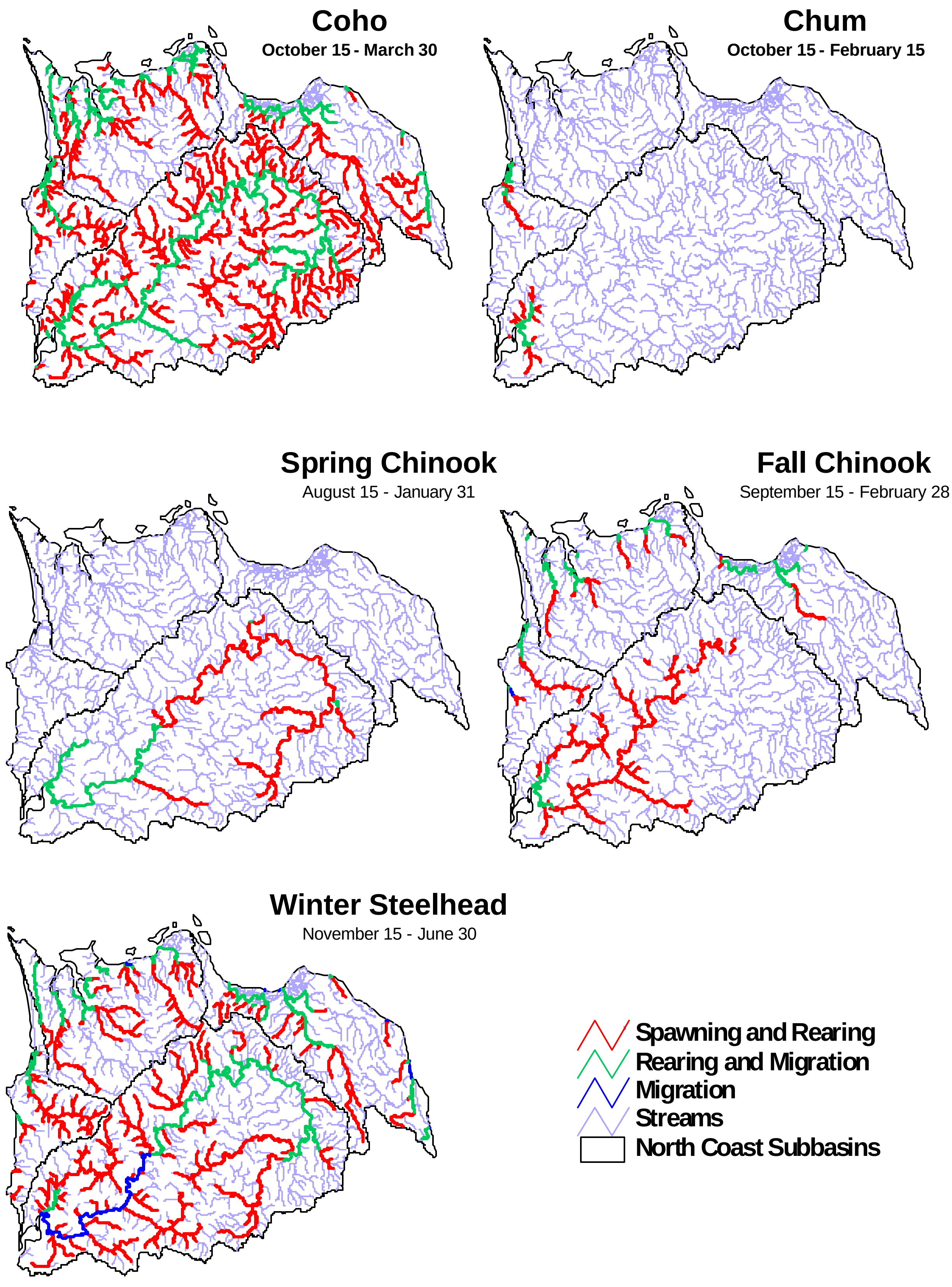


Figure 6. Habitat use by various salmon stock in the North Coast Basin. Dates represent the basinwide range of use for spawning through fry emergence for each stock (ODFW, 2002).

Table 7. North Coast Basin Habitat Use by Salmonid Species. Periods are based on extremes of habitat use from a composite of mainstem Nehalem, Necanicum, and Young's Rivers using professional judgement and observation (Provided by Joe Sheahan, ODFW). Additional information is included in Appendix F.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult Migration:												
Winter Steelhead	Entire Month	Entire Month	Entire Month	Entire Month						End of Month	Entire Month	Entire Month
Spring Chinook			Entire Month	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month			
Fall Chinook						End of Month	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month	Beginning of Month
Coho	Beginning of Month							End of Month	Entire Month	Entire Month	Entire Month	Entire Month
Chum										End of Month	Entire Month	Beginning of Month
Cutthroat	Entire Month	Entire Month					Entire Month	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month
Spawning:												
Winter Steelhead	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month						End of Month	Entire Month
Spring Chinook								End of Month	Entire Month	Beginning of Month		
Fall Chinook									End of Month	Entire Month	Entire Month	Beginning of Month
Coho	Beginning of Month									End of Month	Entire Month	Entire Month
Chum										End of Month	Entire Month	Entire Month
Cutthroat	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month						Entire Month	Entire Month
Egg Incubation Through Fry Emergence:												
Winter Steelhead	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month						Entire Month
Spring Chinook	Entire Month								End of Month	Entire Month	Entire Month	Entire Month
Fall Chinook	Entire Month	Entire Month									Entire Month	Entire Month
Coho	Entire Month	Entire Month	Entire Month								Entire Month	Entire Month
Chum	Entire Month	Beginning of Month									Entire Month	Entire Month
Cutthroat	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month						Entire Month	Entire Month
Rearing:												
Winter Steelhead	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month
Spring Chinook	Entire Month	Entire Month	Entire Month								End of Month	Entire Month
Fall Chinook		End of Month	Entire Month	Entire Month								
Coho	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month
Chum		Entire Month	Entire Month	Beginning of Month								
Cutthroat	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month	Entire Month
Downstream Juvenile Migration:												
Winter Steelhead		End of Month	Entire Month	Entire Month	Beginning of Month							
Spring Chinook		End of Month	Entire Month	Entire Month	Entire Month							
Fall Chinook		End of Month	Entire Month	Entire Month	Beginning of Month							
Coho		End of Month	Entire Month	Entire Month	Entire Month							
Chum		End of Month	Entire Month	Entire Month								
Cutthroat			Entire Month	Entire Month	Entire Month	Beginning of Month						

Period of Use

= Entire Month; = Beginning of Month; = End of Month

3.1.4 Water Quality Standard Identification

The temperature standard in the North Coast Subbasins is applied based on the most sensitive beneficial use, that being cold water salmonid fish.

3.1.4.1 Stream Temperature Standard

OAR 340-041-0205(2)(b)(A) To accomplish the goals identified in OAR 340-041-0120(11), 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:

(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);

(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);

(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 subbasin;

3.1.4.3 Deviation from Water Quality Standard

Section 303(d) of the Federal Clean Water Act (1972) requires that water bodies that violate water quality standards, thereby failing to fully protect *beneficial uses*, be identified and placed on a 303(d) list. The North Coast Subbasins have 50 stream segments on the 2002 303(d) list for water temperature violations (**Table 8** and **Figure 7**). Segments were listed based upon the 64^{o}F migration and rearing criterion or the 55^{o}F spawning criteria. Temperature assessments throughout the North Coast Subbasins demonstrated the migration and rearing criterion was commonly exceeded in summer (**Figure 8**). For specific information regarding Oregon's 303(d) listing procedures, and to obtain more information regarding the North Coast Subbasins 303(d) listed streams, visit the Department of Environmental Quality's web page at **http://www.deq.state.or.us/**.

Table 8. North Coast Subbasins Stream Segments on the 1998 303(d) List for Temperature.

Waterbody	River Mile	Parameter	Season	Criterion	Year Listed
Lower Columbia/Clatskanie Subbasin					
Beaver Creek	0 to 14	Temperature	Summer	Rearing: 17.8 C	2002
Clatskanie River	0 to 1.9	Temperature	Summer	Rearing: 17.8 C	2002
Clatskanie River	1.9 to 25.5	Temperature	Summer	Rearing: 17.8 C	2002
Clatskanie River	1.9 to 25.5	Temperature	September 15	Spawning: 12.8 C	2002
Little Clatskanie River	0 to 6.2	Temperature	Summer	Rearing: 17.8 C	2002
Tide Creek	0 to 16.1	Temperature	September 15	Spawning: 12.8 C	2002
Lower Columbia/Young's Subbasin					
Bear Creek	2.5 to 9	Temperature	Summer	Rearing: 17.8 C	2002
Bear Creek	2.5 to 9	Temperature	September 15	Spawning: 12.8 C	2002
Gnat Creek	0 to 9.8	Temperature	September 15	Spawning: 12.8 C	2002
Lewis And Clark River	8.6 to 10.8	Temperature	Summer	Rearing: 17.8 C	2002
Youngs River	9 to 23.2	Temperature	Summer	Rearing: 17.8 C	2002
Necanicum Subbasin					
Necanicum River	0 to 20.6	Temperature	September 15	Spawning: 12.8 C	2002
Necanicum River	0 to 15	Temperature	Summer	Rearing: 17.8 C	2002

Waterbody	River Mile	Parameter	Season	Criterion	Year Listed
Nehalem Subbasin					
Beneke Creek	0 to 10.1	Temperature	Summer	Rearing: 17.8 C	2002
Buster Creek	0 to 9.1	Temperature	September 15	Spawning: 12.8 C	2002
Cook Creek	0 to 9.3	Temperature	September 15	Spawning: 12.8 C	2002
Cronin Creek	0 to 1.8	Temperature	September 15	Spawning: 12.8 C	2002
East Fork Nehalem R.	0 to 9.8	Temperature	Summer	Rearing: 17.8 C	2002
East Humbug Creek	0 to 4.5	Temperature	September 15	Spawning: 12.8 C	2002
Fishhawk Creek	0 to 11.9	Temperature	Summer	Rearing: 17.8 C	2002
Fishhawk Creek	0 to 11.9	Temperature	September 15	Spawning: 12.8 C	2002
Fishhawk Creek	0 to 7.8	Temperature	Summer	Rearing: 17.8 C	2002
Fishhawk Creek	0 to 7.8	Temperature	September 15	Spawning: 12.8 C	2002
Foley Creek	0 to 3.7	Temperature	Summer	Rearing: 17.8 C	2002
Gods Valley Creek	0 to 4.8	Temperature	September 15	Spawning: 12.8 C	2002
Humbug Creek	0 to 6.5	Temperature	Summer	Rearing: 17.8 C	2002
Humbug Creek	0 to 6.5	Temperature	September 15	Rearing: 17.8 C	2002
Nehalem River	0 to 14.7	Temperature	Summer	Rearing: 17.8 C	1998
Nehalem River	14.7 to 92.	Temperature	Summer	Rearing: 17.8 C	1998
Nehalem River	14.7 to 92.	Temperature	September 15	Spawning: 12.8 C	2002
Nehalem River	92.4 to 108	Temperature	Summer	Rearing: 17.8 C	2002
Nehalem River	92.4 to 108	Temperature	September 15	Spawning: 12.8 C	2002
Nehalem River	108 to 120	Temperature	September 15	Spawning: 12.8 C	2002
North Fork Nehalem R.	10.5 to 23.	Temperature	Summer	Rearing: 17.8 C	2002
North Fork Nehalem R.	10.5 to 23.	Temperature	September 15	Spawning: 12.8 C	2002
Northrup Creek	0 to 7.5	Temperature	Summer	Rearing: 17.8 C	2002
Northrup Creek	0 to 7.5	Temperature	September 15	Spawning: 12.8 C	2002
Oak Ranch Creek	0 to 9.3	Temperature	Summer	Rearing: 17.8 C	2002
Oak Ranch Creek	0 to 9.3	Temperature	September 15	Spawning: 12.8 C	2002
Pebble Creek	0 to 9.8	Temperature	Summer	Rearing: 17.8 C	2002
Pebble Creek	0 to 9.8	Temperature	September 15	Spawning: 12.8 C	2002
Rock Creek	0 to 11	Temperature	Summer	Rearing: 17.8 C	2002
Rock Creek	0 to 11	Temperature	September 15	Spawning: 12.8 C	2002
Salmonberry River	0 to 5	Temperature	Summer	Rearing: 17.8 C	2002
Salmonberry River	0 to 5	Temperature	September 15	Spawning: 12.8 C	2002
Soapstone Creek	0 to 3.9	Temperature	Summer	Rearing: 17.8 C	2002
Walker Creek	0 to 10	Temperature	Summer	Rearing: 17.8 C	2002
Walker Creek	0 to 10	Temperature	September 15	Spawning: 12.8 C	2002
West Humbug Creek	0 to 5.1	Temperature	September 15	Spawning: 12.8 C	2002
Wolf Creek	0 to 7.8	Temperature	September 15	Spawning: 12.8 C	2002

Table 8 (Cont.): North Coast Subbasins Stream Segments on the 303(d) List for Temperature.

Waterbodies submitted for listing as water quality limited under Section 303(d) for the 2002 list were approved by EPA on March 24, 2003. These listings are based on data collected during the year 2000 sampling season at stations presented in the following table. Many of these proposed listings are due to 7-day average daily maximum temperatures in excess of the spawning criterion (55°F) during the general critical period for spawning of Sept 15 through May 31. Although the TMDL is being developed based on the summer critical period for migration and rearing of salmonid fish and the migration and rearing criterion (64°F), allocations of *system potential* temperature for entire subbasins will result in the lowest feasible temperatures throughout the basin and during both critical periods.

Table 9. Continuous Temperature Data from 95 stations throughout the North Coast Subbasins. Statistic is the 7-day average of daily maximum temperature. Shaded cells exceed the numeric criterion (64ºF) for protection of salmonid migration and rearing.

Site Name	River Mile (OWRD)	Date	7-Day Statistic (ºF)
Nehalem River Subbasin			
Nehalem R. u/s SF Nehalem R.	116.7	8/3/2000	57.4
South Fork Nehalem R. at Cochran Rd.	0.1	8/2/2000	55.2
Nehalem R. at Cochran Rd. (Brdg. 1393)	112.7	8/1/2000	61.5
Lousignont Cr. at Mouth	0.1	7/29/2000	62.8
Nehalem R. u/s Wolf Cr. at Timber Rd. Br.	106.8	8/1/2000	66.4
Wolf Cr. at Mouth	0.1	8/2/2000	63.7
Nehalem River u/s Beaver Cr.	92.9	7/30/2000	70.5
Beaver Cr. At Mouth	0.1	7/30/2000	63.7
Nehalem R. u/s Rock Cr.	90.8	8/1/2000	73.0
South Fork Rock Cr. near Mouth	0.3	8/1/2000	56.7
Rock Cr. At Hwy 26 u/s SF Rock Cr.	25.9	8/1/2000	61.2
Rock Cr. at Rock Cr. Rd. (Keasey)	12.1	8/2/2000	65.7
Rock Cr. at Mouth	0.1	8/1/2000	70.5
Pebble Cr. at Mouth	0.1	8/1/2000	68.2
Nehalem R. u/s EF Nehalem R.	84.1	8/3/2000	73.4
East Fork Nehalem R. at Scappoose-Vernonia Rd.	6	7/31/2000	65.3
East Fork Nehalem R. at Hwy 47	0.1	8/1/2000	66.7
Oak Ranch Cr. at Mouth (Hwy 47)	0.1	8/1/2000	64.2
Nehalem R. at Burris Rd.	76.3	8/1/2000	74.7
Nehalem R. at Fishhawk Rd.	66.5	8/1/2000	76.3
Fishhawk Cr. at Mouth (Nehalem RM 65.7)	0.1	8/1/2000	71.4
Nehalem R. at Hwy 202 (Vesper)	61.8	8/2/2000	73.6
Northrup Cr. at Mouth	0.1	8/1/2000	64.6
Nehalem R. at Hwy 202 (Jewell)	47.3	8/2/2000	72.5
Beneke Cr. at Hwy 202 (Mouth)	0.1	8/1/2000	65.8
Fishhawk Cr. at Mouth	0.1	8/1/2000	68.5
West Humbug Cr. at Mouth	0.1	7/31/2000	62.8
East Humbug Cr. at Mouth	0.1	7/31/2000	64.2
Humbug Cr. at Mouth	0.1	8/1/2000	68.4
Nehalem R. d/s Humbug Cr.	34.7	8/7/2000	74.1
Cronin Cr. at Mouth	0.1	8/5/2000	62.6
Nehalem R. u/s of Salmonberry R.	22.4	8/2/2000	74.5
North Fork Salmonberry R. at Mouth	0.1	7/31/2000	60.8
South Fork Salmonberry R. at Mouth	0.1	8/1/2000	56.5
Salmonberry R. at Wheeler (Cochran) Rd.	16	8/1/2000	57.9
Salmonberry R. u/s NF Salmonberry R.	8.2	8/1/2000	61.5
Salmonberry R. u/s of SF Salmonberry R.	6.9	8/1/2000	63.7
Salmonberry R. at Mouth	0.1	8/1/2000	68.2
Nehalem R. at Foss USGS Gage	13.5	8/2/2000	72.9
South Fork Cook Cr at EF Rd. (Mouth)	0.1	7/30/2000	55.8
Foley Cr. at Mouth	0.3	8/1/2000	64.4
Cook Cr. u/s SF Cook Cr.	4.6	8/1/2000	61.7
Cook Cr. at Clammer Rd.	2.2	7/31/2000	62.8
Cook Cr. at Cook Cr. Rd.	3.7	8/2/2000	60.1
Cook Cr. at Mouth	0.1	7/31/2000	61.3
Nehalem R. at Hwy 53 (Mohler)	5.7	8/2/2000	72.3

Nehalem River Subbasin -- Continued			
Site Name	**River Mile (OWRD)**	**Date**	**7-Day Statistic (°F)**
Little NF Nehalem R. at Mouth	0.1	7/31/2000	63.9
North Fork Nehalem R. u/s Little NF Nehalem R.	20.5	7/31/2000	64.6
North Fork Nehalem R. at Hwy 53	10.6	8/1/2000	65.5
North Fork Nehalem R. u/s Hatchery	10.3	8/1/2000	64.4
Coal Cr. at Mouth	0.1	7/31/2000	60.1
Gods Valley Cr. at Mouth	0.1	7/31/2000	63.5
Soapstone Cr. at Mouth	0.1	8/7/2000	63.7
North Fork Nehalem R. at Mouth	0.1	8/2/2000	71.4
Necanicum River Subbasin			
Necanicum R. at Highway 26	18.6	7/29/2000	62.6
Necanicum R. at Hwy 53	17.8	7/29/2000	62.6
Bergsvik Cr. at Mouth	0.1	8/21/2000	59.0
Necanicum R. u/s NF Necanicum R.	15.3	7/29/2000	65.7
North Fork Necanicum R. at Hwy 26	0.2	7/30/2000	61.2
Necanicum R. u/s SF Necanicum R.	12.9	7/29/2000	64.8
South Fork Necanicum R. at MP 5	0.4	7/29/2000	61.7
South Fork Necanicum R. Near Mouth	0.1	7/29/2000	61.9
Necanicum R. at Klootchie Cr. Rd.	9.6	7/30/2000	67.3
Necanicum R. at Highway 101	5.9	7/30/2000	67.1
Necanicum R. at U Street	2.9	8/22/2000	66.2
Lower Columbia/Young's Subbasin			
Lewis & Clark R. at Saddle Mt. Rd.	24.3	8/8/2001	59.7
Lewis & Clark R. (0.8 Miles South of Melville)	7.5	8/6/2001	67.1
Youngs R. at Youngs R. Loop Rd.	8.7	8/7/2001	63.0
North Fork Klaskanine R. at Green Mt. Rd.	0.5	8/7/2001	63.0
North Fork Klaskanine R. u/s NF of NF	1.5	8/7/2001	65.8
South Fork, South Fork Klaskanine R. at Hwy 202	0.1	8/7/2001	58.6
Bear Cr. d/s Astoria Reservoir	3.8	7/6/2001	68.2
Gnat Cr. at Weir	2.5	8/7/2001	61.0
Big Cr. at Old Highway 30	1.2	8/8/2001	63.5
Lower Columbia/Clatskanie Subbasin			
Clatskanie R. at Pittsburgh-Schaffer Rd.	25	7/29/2000	59.5
Clatskanie R. at Schaffer Rd. 2 mi. d/s Pittsburgh Rd.	23	7/31/2000	61.5
Clatskanie R. at Schaffer Rd.	21	7/30/2000	63.5
Clatskanie R. at Private Bridge (Nichols)	20	7/30/2000	64.2
Clatskanie R. u/s Little Clatskanie R.	16.2	7/29/2000	65.1
Clatskanie R. u/s Carcus Ck.	11.5	7/29/2000	66.9
Clatskanie R. at Swedetown Rd.	9.4	7/29/2000	66.7
Clatskanie R. at Highway 30	1.5	7/30/2000	70.9
Little Clatskanie R. at Apiary Rd.	0.1	7/29/2000	65.1
Carcus Cr. at Mouth	0.1	7/30/2000	63.1
Tide Creek at Highway 30	3	8/9/2001	67.8
Tide Creek at Anliker Road	9.9	8/7/2001	66.2
Goble Creek at Holbrook Road	2.7	7/6/2001	67.5
Goble Creek at Bishop Road	1.4	8/7/2001	67.6
Beaver Creek at Parkdale Road	14	8/7/2001	74.1
Beaver Creek at Beaver Springs Road	17.5	8/25/2001	62.4
Lost Creek at Highway 30	0.3	8/7/2001	66.4
SF Beaver Creek at Old Rainier Road	0.1	8/7/2001	67.6
Plympton Creek at Highway 30	0.3	8/8/2001	60.4

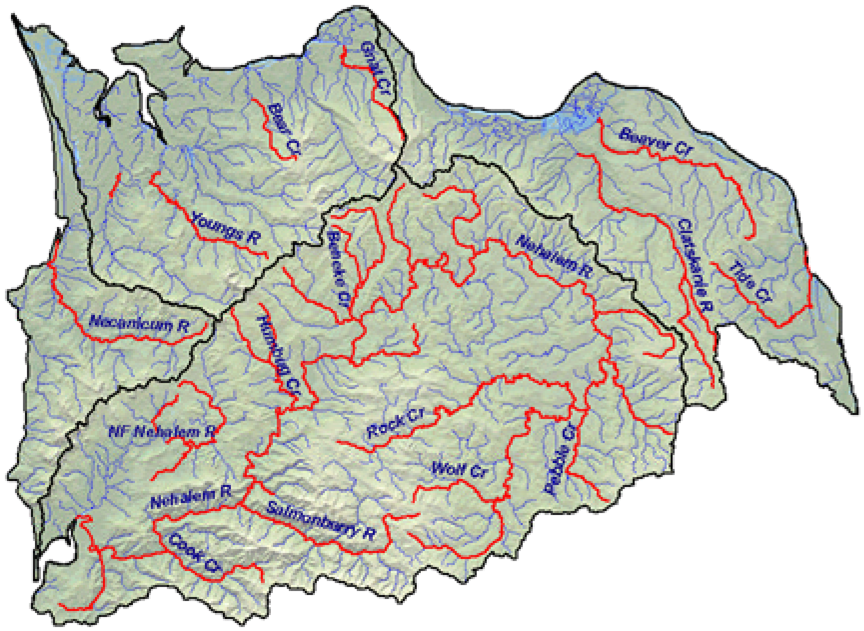


Figure 7. Temperature limited waterbodies (Red Lines) on the 303(d) list (DEQ 2003)

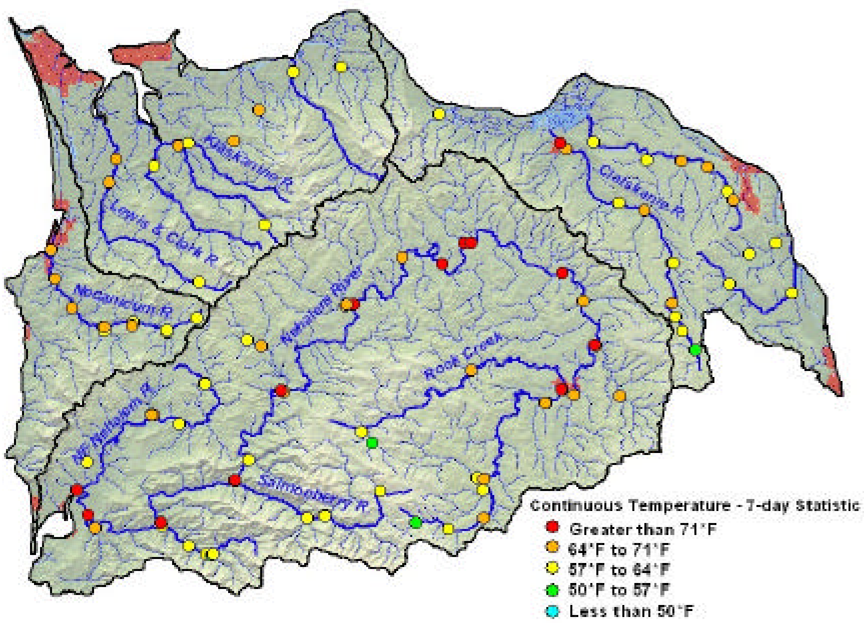


Figure 8. Continuous stream temperature measurement locations – Ninety-five instream continuous temperature measurements were collected in 2000 and 2001. Maximum seven-day moving average daily maximums (7-day statistic) suggest that temperatures commonly exceed the numeric criterion throughout the North Coast Subbasins, but are spatially highly variable (DEQ and Watershed Council Data).

3.1.5 Existing Heat Sources - CWA §303(d)(1)

Anthropogenic nonpoint source heat loading accounts for approximately one half of the total solar heat load basin-wide. The remaining portion of the solar heat load is attributed to background.

Heat loading was calculated for both nonpoint and point sources. The critical condition for heat loading was defined as the approximate date of highest water temperature during the summer months. This critical period represents highest water temperatures and low flows and occurred on approximately August 10, 2000. Of the total heat loading that occurred during the summertime critical condition in the modeled waterbodies, 48.3% is attributed to natural background and 51.7% is from anthropogenic nonpoint sources (**Figure 9**). The amount of heat loading and the proportion derived from nonpoint sources varies considerably among water bodies (**Figure 10**).

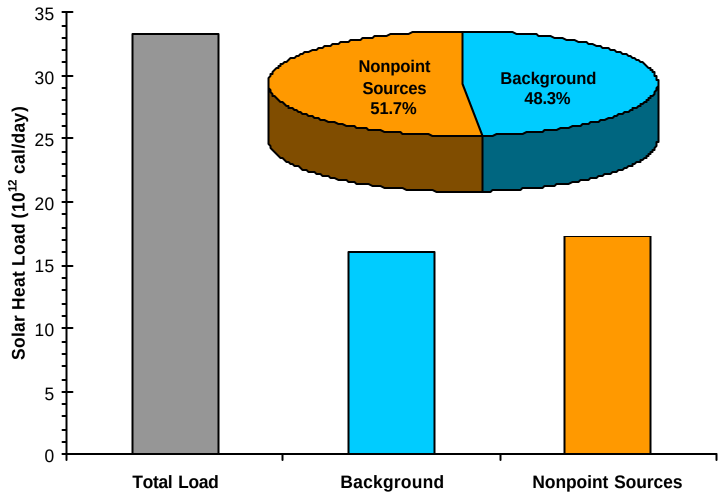


Figure 9.

Distribution of Current Condition Nonpoint Source Heat Loading.

Total daily solar heat load was derived as the sum of the products of the daily solar heat flux and channel surface area. For the purposes of this analysis the total heat load is calculated from the simulated current condition. The background condition is the daily solar flux reaching the water surface with system potential vegetation and channel morphology calculated from the channel width and land cover condition simulations. The nonpoint source load is the difference between the current total daily solar load and the background total daily solar heat load.

3.1.5.1 Nonpoint Sources of Heat

Elevated summertime stream temperatures attributed to nonpoint sources result from increased solar radiation heat loading. Near stream vegetation disturbance/removal and channel morphology disturbances have reduced levels of stream shading and exposed streams to higher levels of solar radiation (i.e., reduction in stream surface shading via decreased riparian vegetation height, width and/or density increases the amount of solar radiation reaching the stream surface). Anthropogenic nonpoint source contributions accounted for 51.7% of the total heat loading. The heat loading analysis is discussed in detail in ***Appendix A (Stream Temperature Analysis)***

Settlement of the North Coast Subbasins in the mid-1800s brought about changes in the near stream vegetation and hydrologic characteristics of the streams. Historically, agricultural and logging practices, and urban development have altered stream morphology and hydrology and decreased the amount of riparian vegetation in the Subbasins. These drainages include urban, agricultural, and forested lands. Due to agricultural practices, many streams in the lower watershed have undergone extensive channelization for drainage and flood control. Channel straightening, while providing relief from local flooding, may increase downstream velocity that may result in the destruction of riparian vegetation, increased channel erosion and flooding.

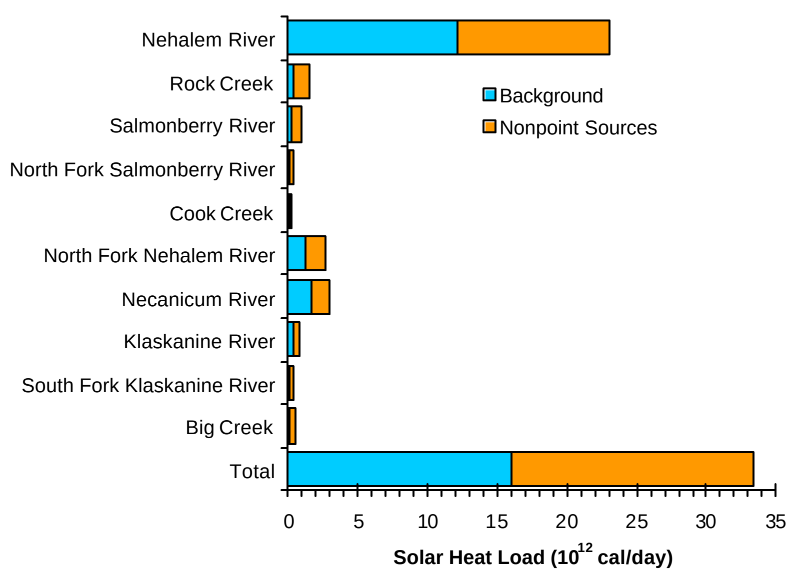


Figure 10. A Anthropogenic Nonpoint Source and Background Solar Heat Loading

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. Low summertime flows decrease the thermal assimilative capacity of streams. Pollutant (solar radiation) loading causes larger temperature increases in stream segments where flows are reduced.

The total nonpoint source solar radiation heat load was derived for the Nehalem River, Rock Creek, Salmonberry River, North Fork Salmonberry River, Cook Creek, North Fork Nehalem River, Necanicum River, Klaskanine River, South Fork Klaskanine River, and Big Creek (**Table 10**). Current solar radiation loading was calculated by simulating current stream and vegetation conditions (the methodology is presented in detail in the **North Coast Subbasins Stream Temperature Analysis – Appendix A**). Background loading was calculated by simulating the solar radiation heat loading that resulted with system potential near stream vegetation and channel morphology. This background condition, based on *system potential*, reflects an estimate of nonpoint source heat load that would occur while meeting the temperature standard (i.e., "*no measurable surface water increase resulting from anthropogenic activities is allowed…"*). The relationships below were used to determine solar radiation heat loads for the current condition, anthropogenic contributions and loading capacity derivations based on *system potential.*

Figure 11 contrasts the longitudinal profile of the current solar radiation heat loading with the solar radiation heat loading that occurs with *system potential* land cover and channel morphology. The solar radiation heat load calculated for system potential near stream vegetation and channel morphology is considered the background condition with anthropogenic sources removed. The anthropogenic portion of the total current condition solar radiation heat load for the modeled streams is given in **Table 10**. The relationship between nonpoint source heat loads, background heat loads and the total load of heat from solar radiation is provided below. Background heat loading is that portion of total solar heating that would reach the stream despite shade provided by *system potential* channel morphology and vegetation. The nonpoint source loading is the difference between total current loading and background loading.

Total Solar Radiation Heat Load from All Nonpoint Sources,

$$H_{Total\ NPS} = H_{SP\ NPS} + H_{Anthro\ NPS} = \Phi_{Total\ Solar} \cdot A$$

Solar Radiation Heat Load from Background Nonpoint Sources (*System Potential*),

$$H_{SP\ NPS} = \Phi_{SP\ Solar} \cdot A$$

Solar Radiation Heat Load from Anthropogenic Nonpoint Sources,

$$H_{Anthro\ NPS} = H_{Total\ NPS} - H_{SP\ NPS}$$

**All solar radiation loads are the clear sky received loads that account for Julian time, elevation, atmospheric attenuation and scattering, stream aspect, topographic shading, near stream vegetation stream surface reflection, water column absorption and stream bed absorption.*

where,

$H_{Total\ NPS}$: Total Nonpoint Source Heat Load (kcal/day)
$H_{SP\ NPS}$: Background Nonpoint Source Heat Load based on *System Potential* (kcal/day)
$H_{Anthro\ NPS}$: Anthropogenic Nonpoint Source Heat Load (kcal/day)
$\Phi_{Total\ Solar}$: Total Daily Solar Radiation Load (ly/day)
$\Phi_{SP\ Solar}$: Background Daily Solar Radiation Load based on *System Potential* (ly/day)
$\Phi_{Anthro\ Solar}$: Anthropogenic Daily Solar Radiation Load (ly/day)
A: Stream Surface Area - calculated at each 100 foot stream segment node (cm^2)

Table 10. Nonpoint Source Solar Radiation Heat Loading - Current Condition with Background (Loading Capacity) and Anthropogenic Contributions

Stream	$H_{Total\ NPS}$	$H_{SP\ NPS}$ **Loading Capacity**	$H_{Anthro\ NPS}$	$\frac{H_{Anthro\ -Subbasin}}{H_{Anthro\ -total}}$
	Current Condition Solar Radiation Heat Loading (10^{12} cal/day)	**Background** *System Potential* Solar Radiation Heat Loading[5] (10^{12} cal/day)	**Anthropogenic** Nonpoint Source Solar Radiation Heat Loading (10^{12} cal/day)	Portion of Current Basinwide Solar Radiation Load from Anthropogenic Nonpoint Sources
Nehalem River	23.1	12.1	11.0	63.6%
Rock Creek	1.5	0.3	1.2	6.8%
Salmonberry River	0.9	0.2	0.7	4.3%
NF Salmonberry River	0.3	0.1	0.2	1.3%
Cook Creek	0.2	0.1	0.2	1.0%
NF Nehalem River	2.7	1.2	1.5	8.8%
Necanicum River	3.0	1.6	1.4	8.1%
Klaskanine River	0.8	0.4	0.4	2.5%
SF Klaskanine River	0.3	0.1	0.2	1.3%
Big Creek	0.5	0.1	0.4	2.3%
Totals	33.3	16.1	17.2	100.0%

[5] Background solar radiation heat loading is based on effective shade resulting from *system potential* near stream vegetation.

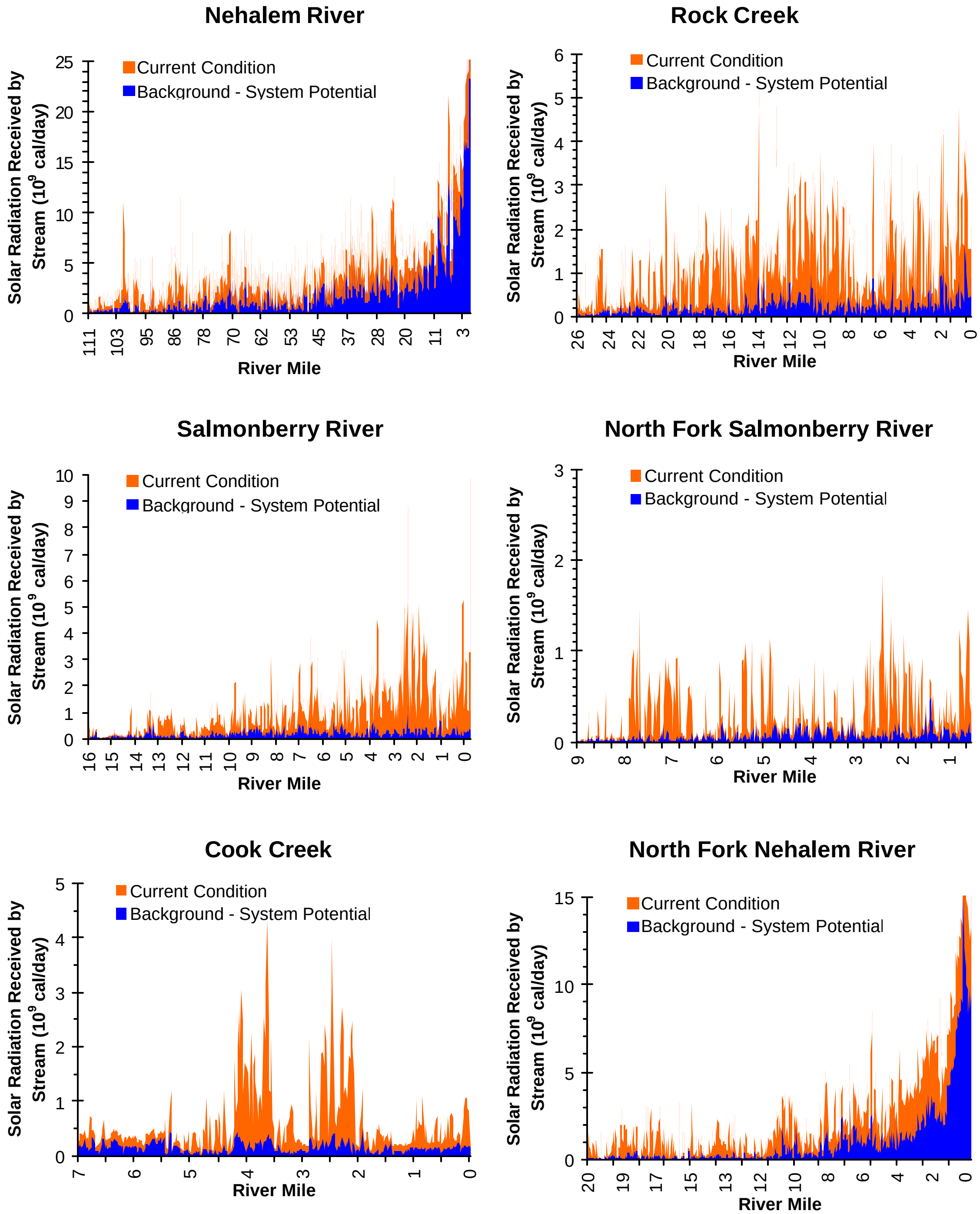


Figure 11. Solar Radiation Loading - Current Condition and Background - *System Potential*

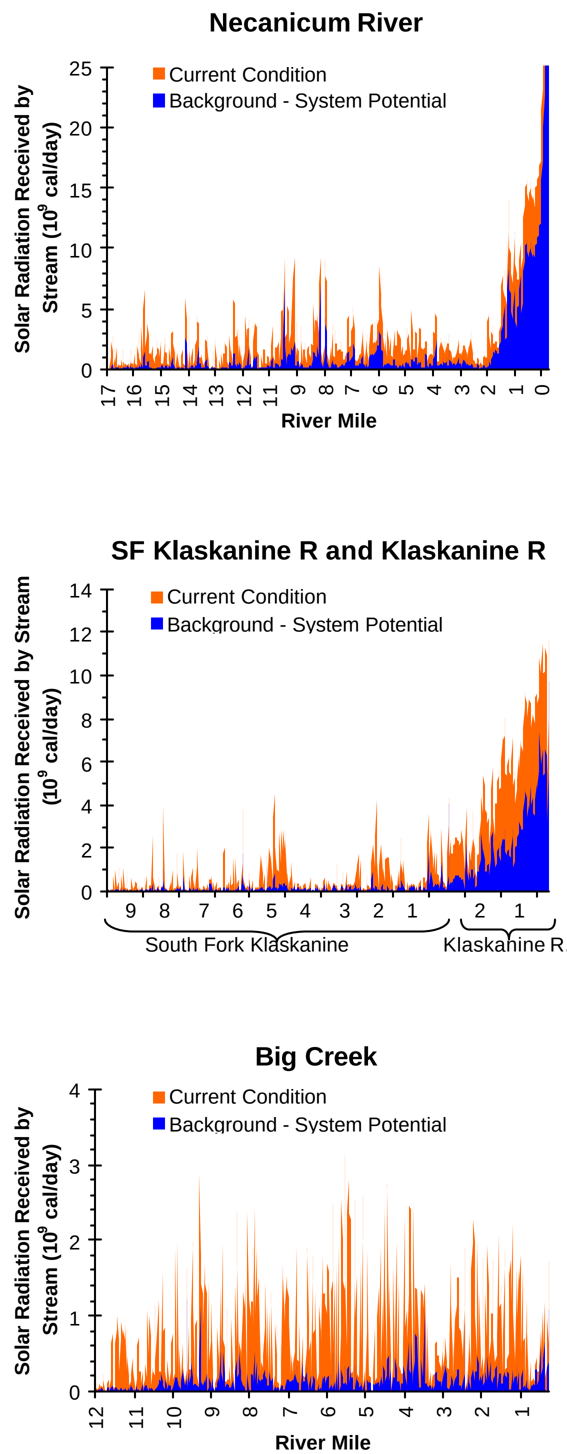


Figure 11 (continued). Solar Radiation Loading - Current Condition and Background

3.1.5.2 Point Sources of Heat

The Oregon Department of Environmental Quality maintains a database for point source information. This data was used to identify point sources within the North Coast Subbasins. Eleven thermal point sources discharge to waters within the North Coast Subbasins (**Figure 12**).

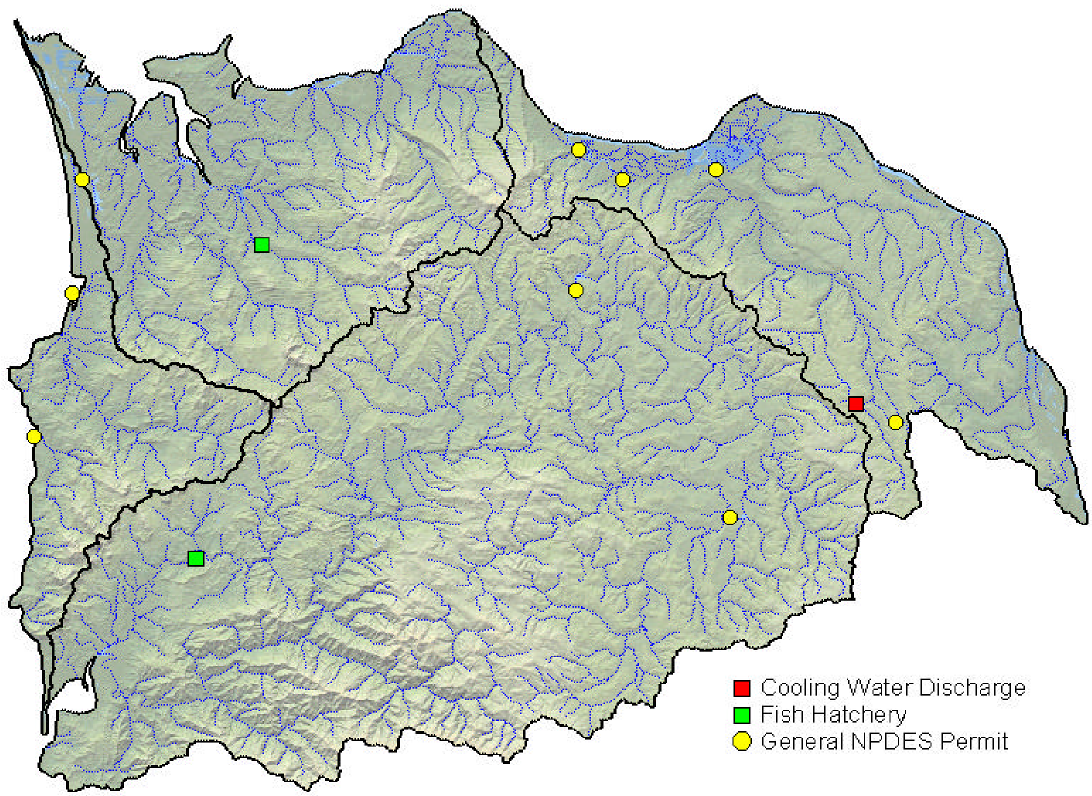


Figure 12. Point sources of heat

Waste load allocations must be developed for point sources that discharge to temperature impaired waterbodies or discharge into waterbodies that drain to temperature impaired waterbodies**.** Wasteload allocations are developed to ensure that temperature increases at the edge of a defined mixing zone (e.g. 25% of the volume of the stream's 7Q10 low flow, or as described through a mixing zone study) are no more than 0.25°F. Where data are available, simulated *system potential* stream temperatures during the critical condition in August were estimated by simulating removal of anthropogenic sources of heat throughout the North Coast Subbasins. These *system potential* temperatures are developed using computer modeling (see the **North Coast Subbasins Stream Temperature Analysis - Attachment 1**) and used to assign the wasteload allocations to the point sources. Where *system potential* temperature estimates are not available, numeric criteria from the temperature standard (64°F for migration and rearing; 55°F for spawning) are used as endpoints.

Many of the point sources in the North Coast Basins discharge to estuarine waters that have a different water quality standard ("No significant increase above natural background temperature shall be allowed."), and generally are not listed as water quality limited for temperature. These sources will have permit limits that require them to ensure that they meet this estuarine criterion.

Stream temperatures were simulated in the Nehalem River Subbasin for early August, 2000 (see **Attachment 1 – North Coast Subbasins Stream Temperature Analysis** for more information). The North Fork Nehalem River Hatchery was discharging a reported 12.6 cfs in August of 2000. FLIR imagery recorded the rearing pond surface temperatures. This data was incorporated into the North Fork

Nehalem River stream temperature model during the calibration process. Once calibrated to instream temperature monitors and continuous longitudinal (FLIR) surface temperatures, the effect of hatchery effluent was removed, and the model re-run. Results indicate that the North Fork Nehalem River hatchery is increasing maximum stream temperatures approximately one degree Fahrenheit (**Figure 13**). (Note that stream temperature was modeled down to the point of tidal influence at river mile 5.)

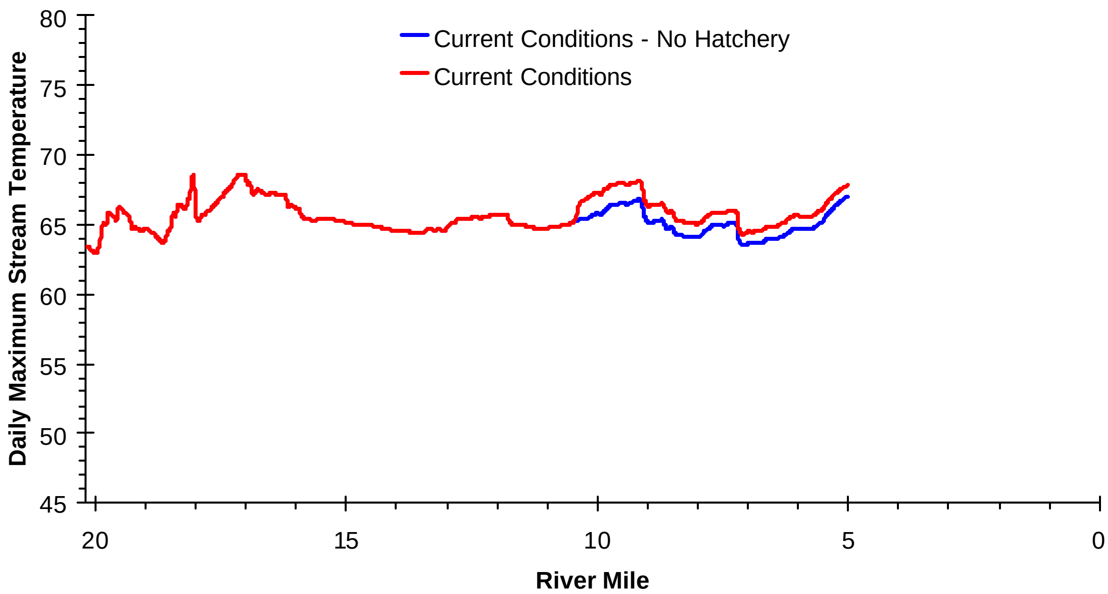


Figure 13. Comparison of North Fork Nehalem River daily maximum temperatures under current conditions (with hatchery) and current conditions without hatchery. Stream temperature modeling indicates that the hatchery is increasing stream temperatures approximately 1 degree Fahrenheit.

3.1.6 Seasonal Variation - CWA §303(d)(1)

Maximum temperatures typically occur in July and August (**Figure 14).** The TMDL focuses the analysis during the August period as a critical condition as identified by year 2000 temperature data. Data were collected by DEQ, and the Upper and Lower Nehalem Watershed Council.

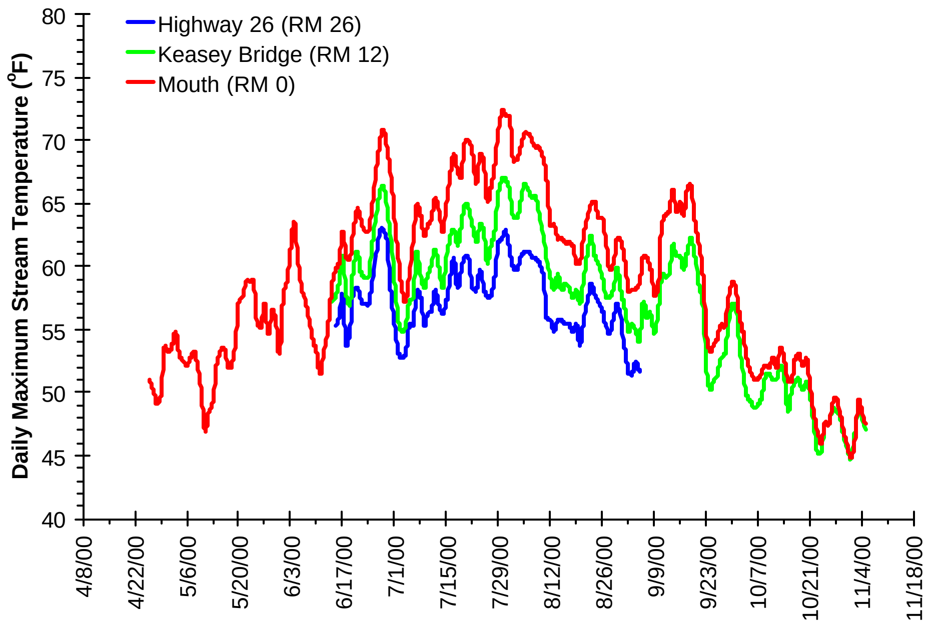


Figure 14. 2000 Observed Stream Temperatures – Rock Creek.

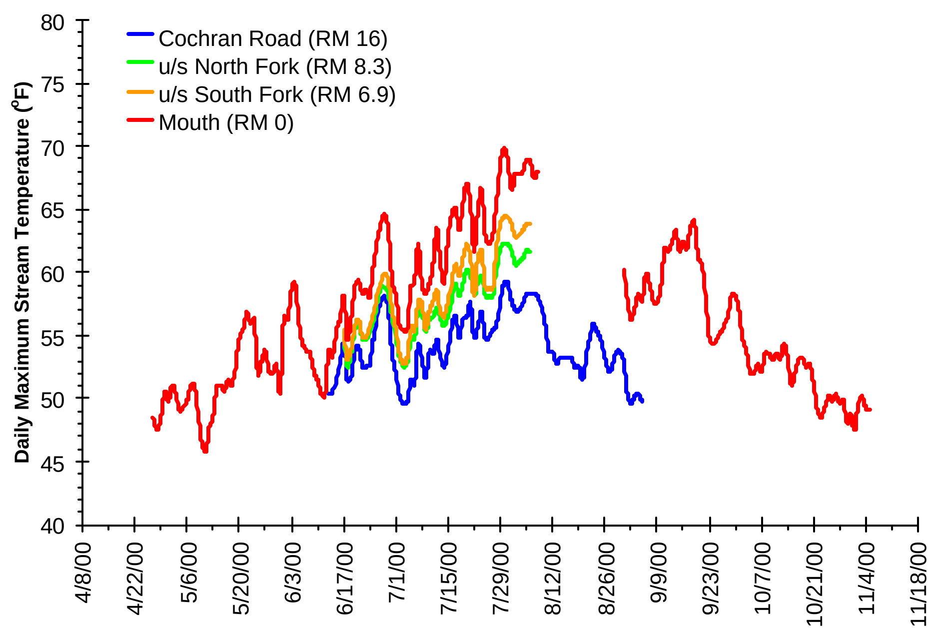


Figure 14 (continued). 2000 Observed Stream Temperatures – Salmonberry River

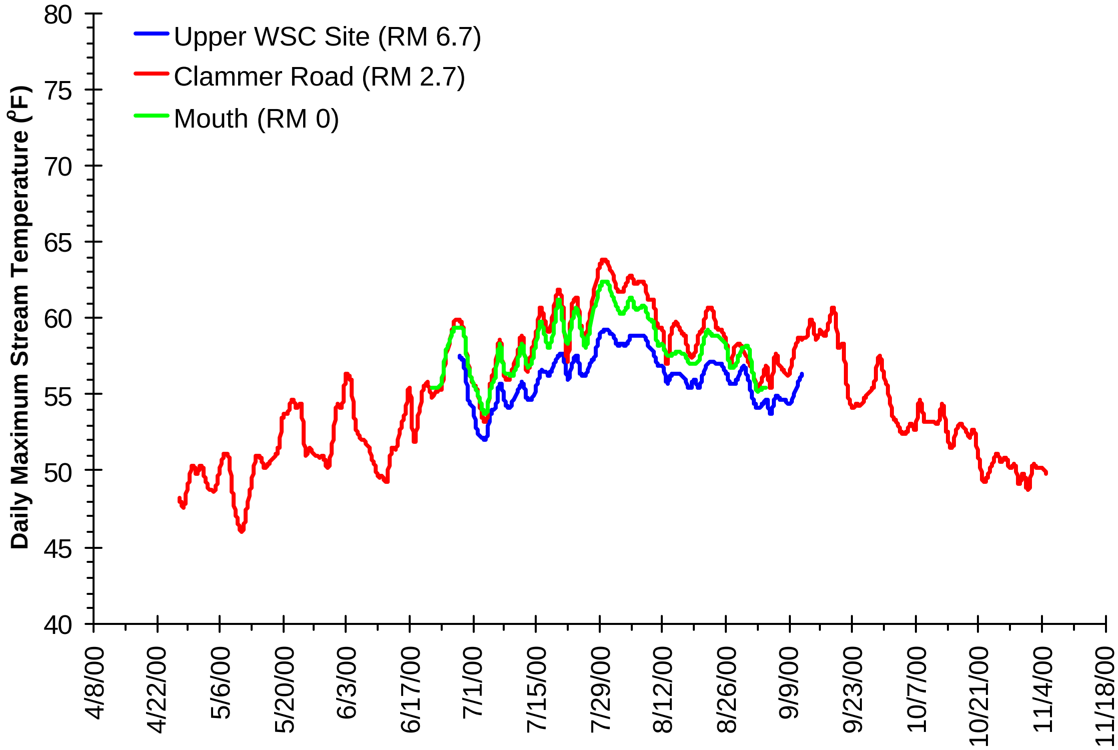


Figure 14 (continued). 2000 Observed Stream Temperatures – Cook Creek

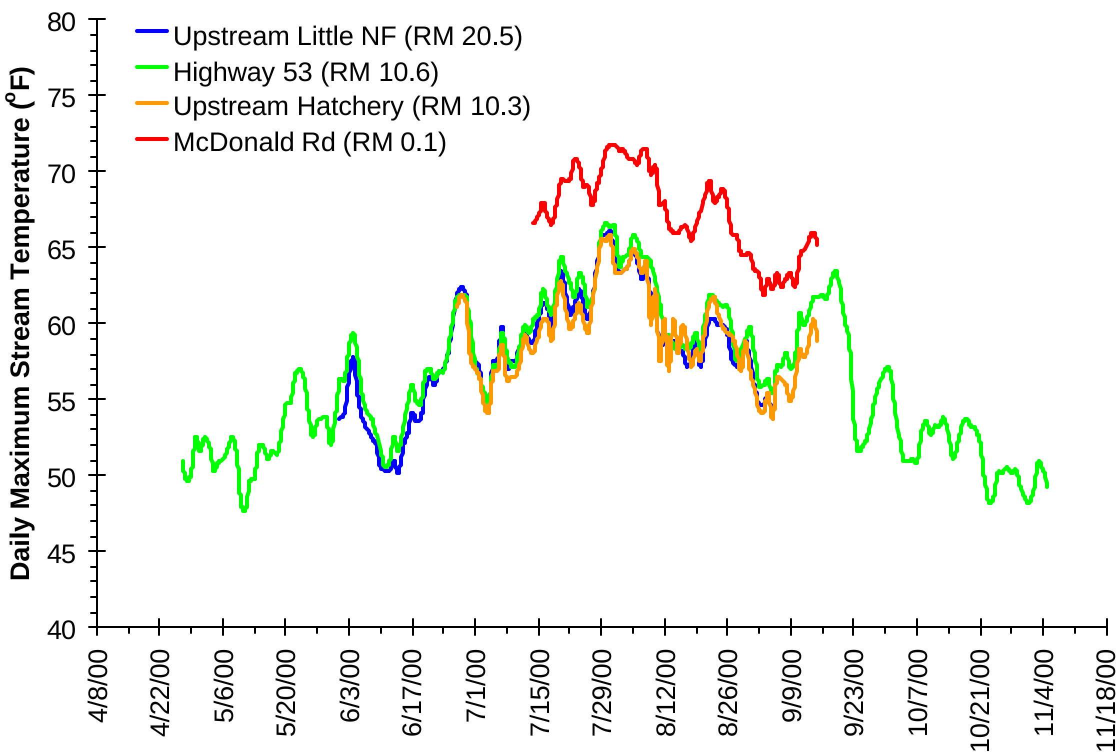


Figure 14 (continued). 2000 Observed Stream Temperatures – North Fork Nehalem River

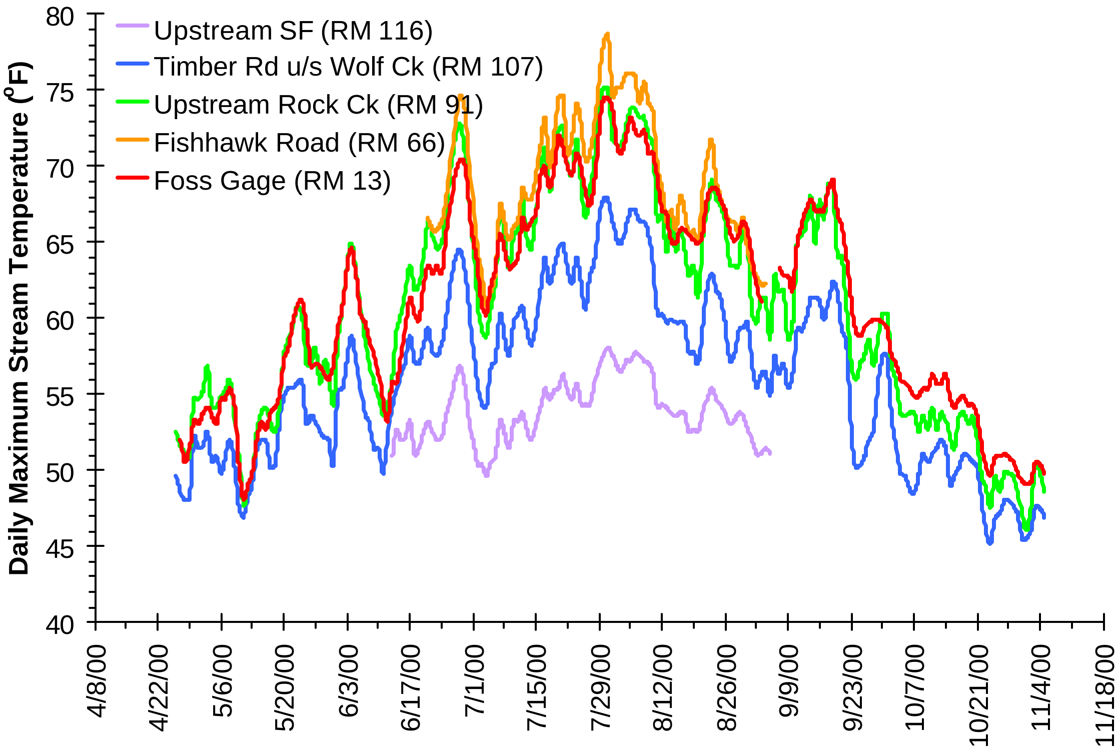


Figure 14 (continued). *2000 Observed Stream Temperatures – Nehalem River*

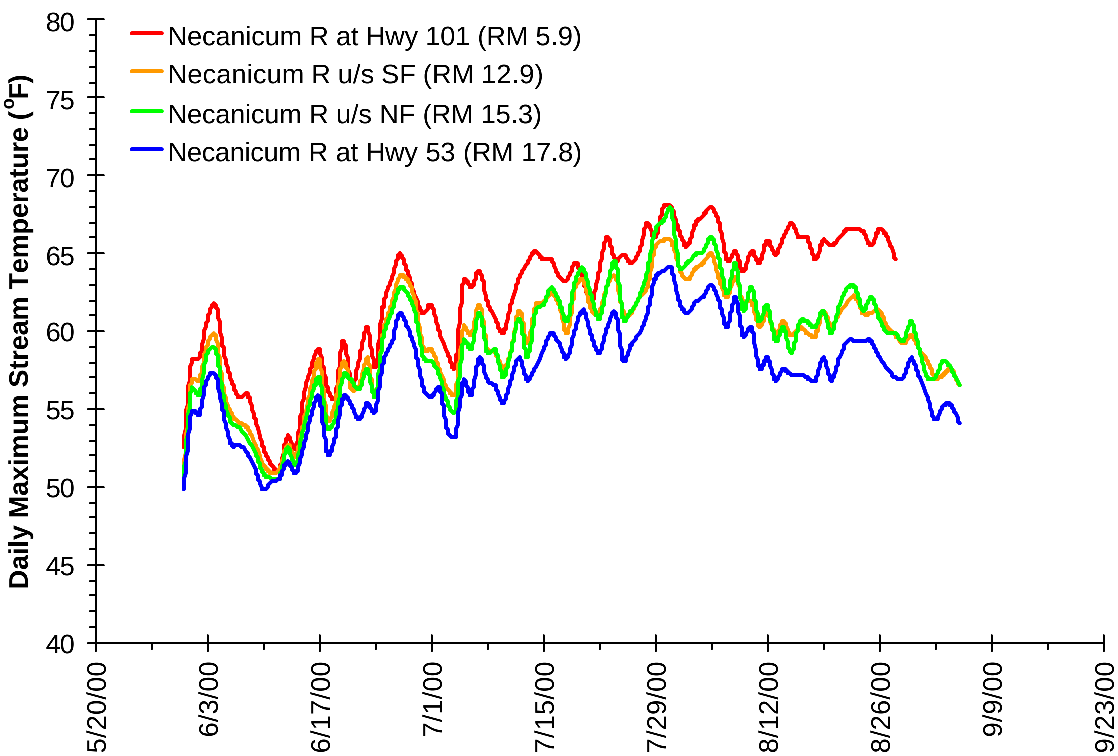


Figure 14 (continued). *2000 Observed Stream Temperatures – Necanicum River*

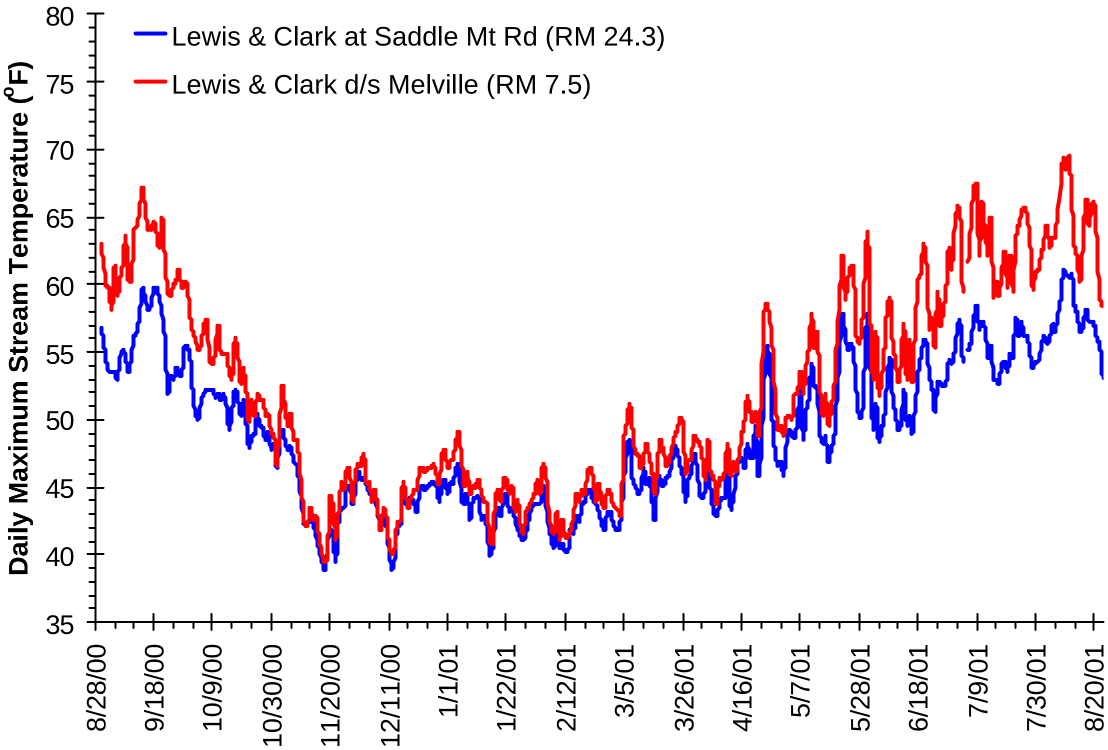


Figure 14 (continued). *2000/2001 Observed Stream Temperatures – Lewis and Clark River*

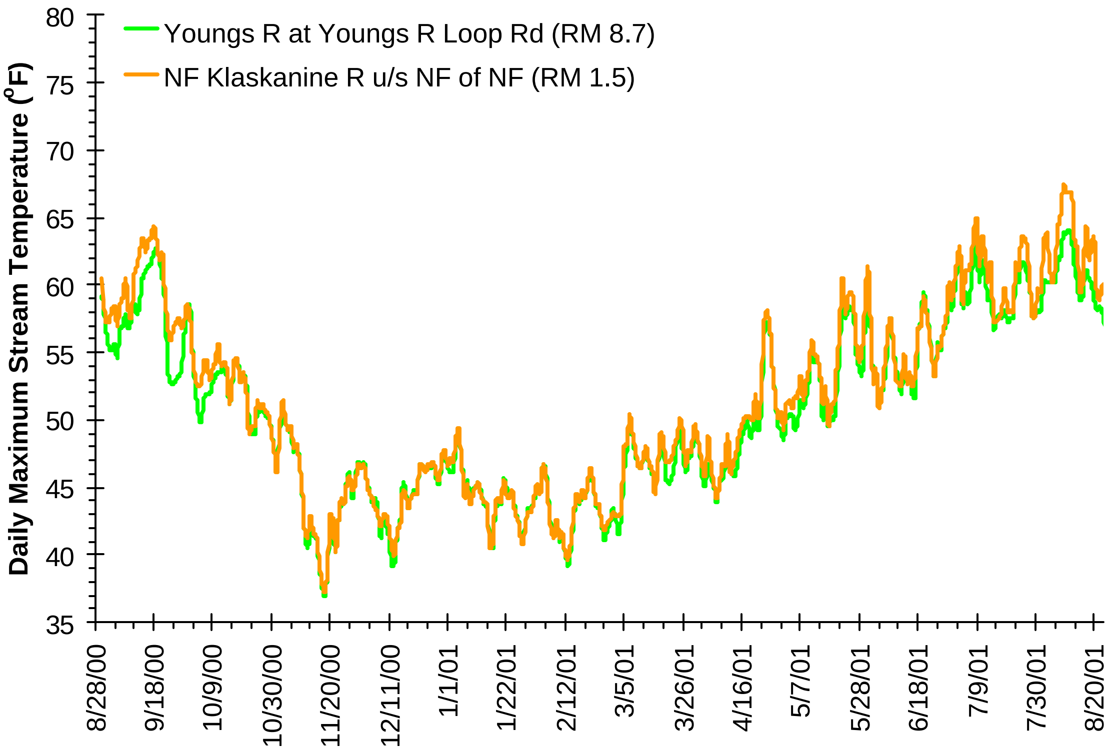


Figure 14 (continued). *2000/2001 Observed Stream Temperatures – Youngs River and NF Klaskanine River*

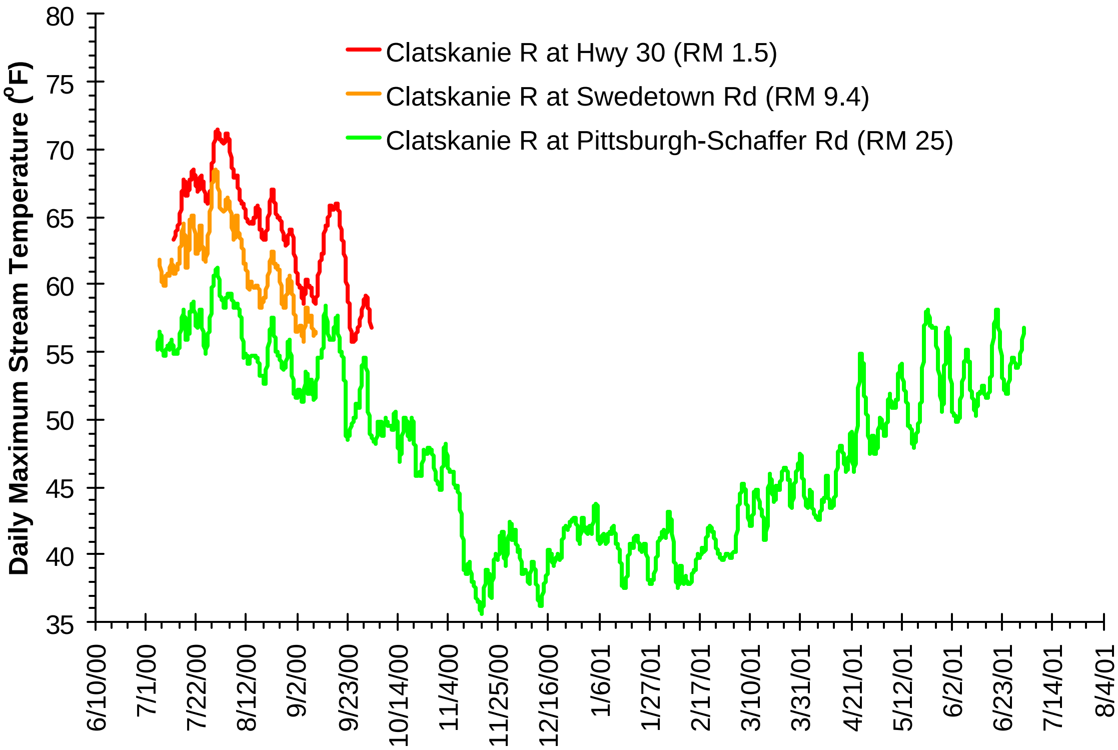


Figure 14 (continued). *2000/2001 Observed Stream Temperatures – Clatskanie River*

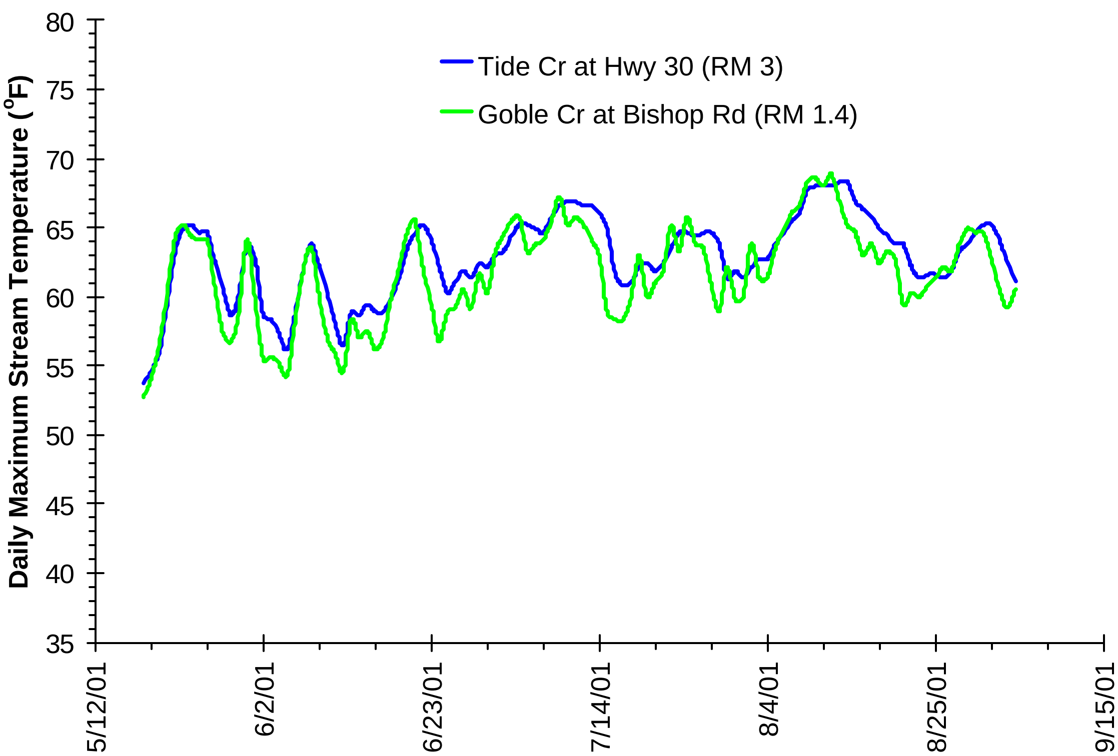


Figure 14 (continued). *2001 Observed Stream Temperatures – Tide Creek and Goble Creek*

The data above were also used to propose the listing of waterbodies in the basin as water quality limited in the 2002 303(d) list (DEQ 2002) under the spawning criterion of the temperature standard. Spawning by several salmonid species occurs in most parts of the Subbasins. This spawning habitat is partitioned among the various species in both space and time, though there is some overlap (**Figure 6 and Table 7**). Although the temperature modeling that follows is based on characterizing heat accumulation on the warmest day of the summer, this process will be roughly similar in other periods of the summer season. This ensures that allocations that produce the lowest feasible temperatures on the warmest day of the summer will also produce the lowest feasible temperatures on any given day.

Temperatures at the ends of the critical periods are also highly dependent on flow. Although the critical period for spawning is perceived to begin on a particular date in the TMDL, this varies from year to year and may be dependent in part on the decline and onset of seasonal rainfall. When temperatures rise above, or decline below the spawning criterion is dependent not only on sources of heat, but also on the vagaries of seasonal weather patterns.

Interannual variation is also relevant to the development of appropriate allocations. Temperature modeling based on data from an unrepresentative year would result in allocations that were either too restrictive or too liberal. Temperature has been monitored for several years at a number of stations within the Nehalem Subbasin by the Nehalem Watershed Council. Seasonal temperature patterns at Northup Creek (**Figure 15**), though variable among years, were not abnormally high or low in 2000 when the data used for modeling heat loading in the Subbasin were collected
.

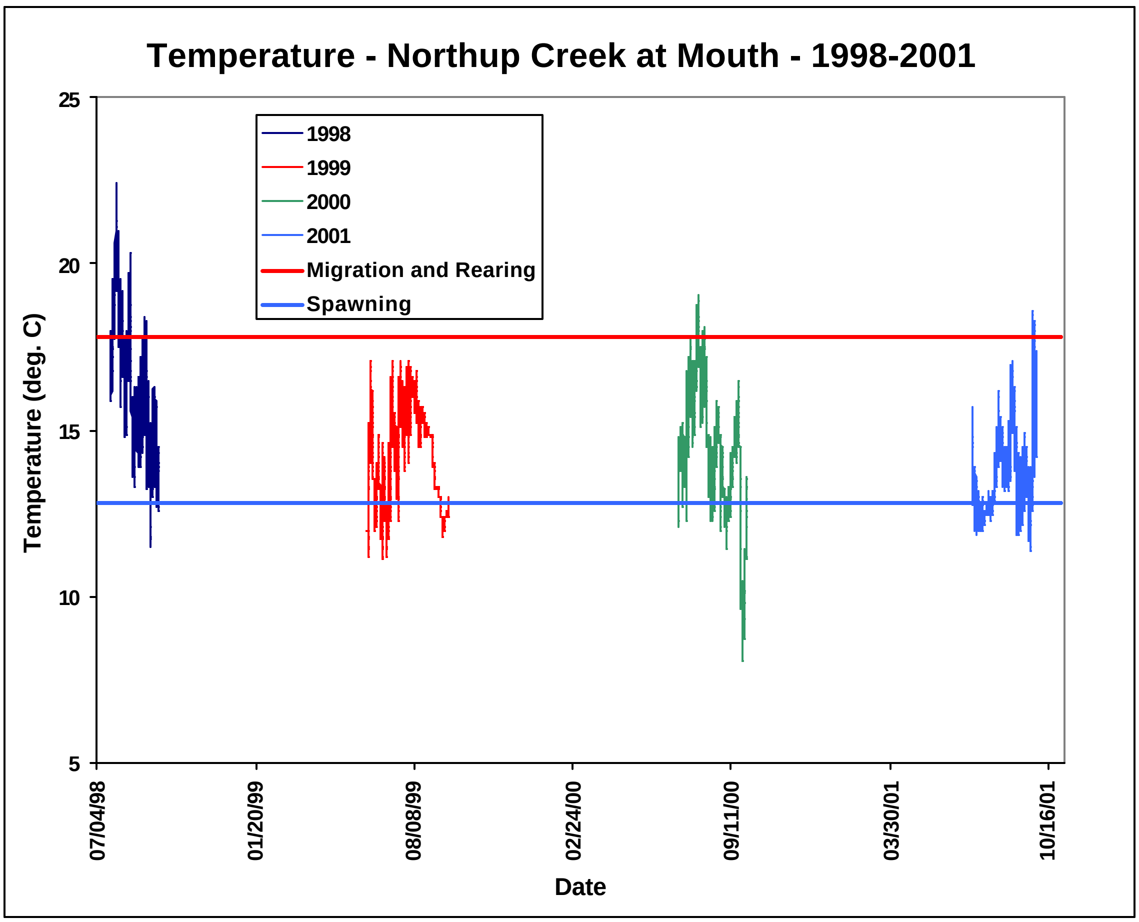


Figure 15. Seasonal temperature patterns at Northup Creek, Nehalem Subbasin, from 1998 through 2001.

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 is presented in Section 3.1.4.1. Loading capacity is based on the following:

- The water quality standard states that ***no measurable surface water temperature increase resulting from anthropogenic activities*** is allowed in the North Coast Subbasins under specified conditions (OAR 340-41-0205(2)(b)(A));
- The pollutants are anthropogenic increases in solar radiation loading (nonpoint sources) and heat loading from warm water discharge (point sources);
- **Loading capacities** in the North Coast Subbasins are the sum of (1) background solar radiation heat loading profiles (expressed as kcal per day) based on potential land cover characteristics and channel morphology and (2) allowable heat loads for NPDES permitted point sources based on no measurable (< 0.25^oF) temperature increase beyond the zone of dilution.;
- The generalized critical period for Migration and Rearing is during the summer months, while for the spawning it is from September 15 through May 31;
- Critical periods for spawning and incubation vary among watersheds depending on local fish behavior;
- The loading capacity on the warmest day of the summer will be protective of the remainder of the year in both critical periods;
- The North Coast Subbasins Stream Temperature Analysis (**Appendix A**) describes the modeling results that lead to the development of *system potential* river temperatures.

The Heat Loading Capacity (H_{LC} = 1.6079 $x10^{10}$ kcal/day) is the sum of nonpoint source background based on *system potential* (H_{LA} = 1.6075 $x10^{10}$ kcal/day), allowable point source heat (H_{WLA} = 3.72 $x10^6$ kcal/day) for all sources combined, heat included in a margin of safety (H_{MOS} = 0 kcal/day) and heat held as a reserve capacity (H_{RC} = 0 kcal/day). Future growth that required expansion of existing discharges or new discharges would be required to meet the requirement of no measurable increase (< 0.25^oF) beyond the edge of the mixing zone.

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

Allocations have been developed to ensure the minimization of anthropogenic sources of heat to the system and to ensure that point sources do not cause a measurable temperature increase outside a defined mixing zone. These allocations together will ensure development of a *system potential* thermal regime with all allowed heat loading derived from natural sources. Although the *system potential* temperature regime was developed with the migration and rearing criterion as a partial endpoint, allocations were developed to ensure no increase in temperature due to anthropogenic heat inputs. As a result the allocations will result in the lowest feasible temperature throughout the Subbasins, and are protective of all temperature criteria.

Load Allocations (Nonpoint Sources) *- The* ***temperature standard*** *targets (i.e., no measurable temperature increases from anthropogenic sources). To meet this requirement the solar radiation heat load (*1.6075 $x10^{10}$ *kcal/day) is allocated to background nonpoint sources.*

Wasteload Allocations (Point Sources) *- Surface water discharges into North Coast Subbasins receiving waters have been given a heat load based on the* 0.25^oF *allowable increase in the zone of dilution as specified in the temperature standard. Heat loads have been converted to allowable effluent temperatures as well. The wasteload allocation is the point source heat load (3.72* $x10^6$ *kcal/day) and not the calculated maximum effluent temperatures. There are several options for meeting the allocated heat loads (i.e., passive effluent temperature reductions, changes in facility discharge operation, purchasing instream flows, pollutant trading, etc.).*

3.1.8.1 Nonpoint Source Allocations

Load Allocations are portions of the loading capacity divided between natural, human and future nonpoint pollutant sources. **Table 11** lists load allocations (i.e., distributions of the loading capacity) for the North Coast Subbasins. Each DMA's portion of the WQMP will address only the lands and activities within each identified stream segment to the extent of the DMA's authority. A *Waste Load Allocation* (WLA) is the amount of pollutant that a point source can contribute to the stream without violating water quality criteria.

Table 11. Heat Load Allocation Summary

Nonpoint Sources	
Source	**Loading Allocation**[2] **Allowable Nonpoint Source Solar Radiation Heat Load (kcal/day)**
Natural Background Solar Radiation	1.6075×10^{10}
Combined Loading for all Point Sources (see Table 11)	3.72×10^{6}
Anthropogenic Nonpoint Source Loading	0
Reserve Capacity[1]	0
Margin of Safety	0
Total Allowable Heat Loading (Loading Capacity)	1.6079×10^{10}

1 = Expansion of existing point sources and future point sources will be allowed no measurable (<0.25°F) temperature increase beyond the edge of the mixing zone.
2 – Significant figures on heat load were extended to illustrate difference between natural and total loading.

3.1.8.2 Point Source Heat Loading and Effluent Temperature Calculations

Heat Loading and Effluent Temperature were calculated (**Equation 1**) using standard mass loading equations taking into account river flow and temperature, and effluent flow and temperature, These calculations are defined to ensure that a given effluent will not cause a measureable temperature increase outside of a defined mixing zone for each of the discharges receiving allocations (**Table 12**).

Equation 1:

$$T_{WLA} = \frac{\left[(Q_{PS} + Q_{ZOD}) \cdot (T_R + \text{Max}\Delta T_{ZOD})\right] - (Q_{ZOD} \cdot T_R)}{Q_{PS}}$$

T_R: Upstream potential river temperature (^oF)
T_{WLA}: Maximum allowable point source effluent temperature (^oF)
? T_{ZOD}: Change in river temperature at edge of zone of dilution - 0.25^{o}F allowable (^oF)
Max? T_{ZOD}: Maximum Allowable Change in river temperature at edge of zone of dilution (^oF)

- If zone of dilution temperature change is greater than 0.25^{o}F then maximum allowable zone of dilution temperature change is 0.25^{o}F, or
- If zone of dilution temperature change is less than 0.25^{o}F, then maximum allowable zone of dilution temperature change is the current zone of dilution temperature change.

Q_{ZOD}: Upstream river flow through zone of dilution - Calculated as 1/4 7Q10 low flow statistic (cfs)
Q_{PS}: Point source effluent discharge (cfs)
H_{PS}: Heat from point source effluent received by river (kcal/day)
H_{WLA}: Allowable heat from point source effluent received by river (kcal/day)
c: Specific heat of water (1 kcal/kg ^{o}C)

Table 12. Allocations for Point sources that discharge to freshwater. These sources are allocated specific effluent temperatures that ensure they do not violate water quality criteria.

Legal Name (Common Name)	River Flow Rate	Facility Flow (cfs)	Critical Effluent Temp.	Criterion	Period	Numeric Criterion or System Potential	Load Allocation kcal/day	Allowable Effluent Temp.
Fishhawk Lake Recreation Club, INC.	5	0.15	71°F	M&R	Year round	64°F	4.25 x10^5	66.3
				Spawn	Oct 15-May 31	55°F		57.3
City of Vernonia [6] No Discharge May 1-Oct 31	14	0	NA	SP	NA	58°F	0 No Discharge	NA No Discharge
November 1 – April 30	43	0.87	71°F	Spawn	Aug 15-May 31	55°F	3.66 x10^6	58.4
ODFW – NF Nehalem Fish Hatchery	30.6[7]	20.0[8]	69.8[9]	SP	Year round	57.4	2.60 x10^6	57.7
				Spawn	Oct 1-May 31	55°F		55.3
Shoreline Sanitary District	2.5	0.077	71°F	M&R	Year round	64°FF	2.13 x10^5	66.3
ODFW – Klaskanine Fish Hatchery	ND	ND	ND	M&R	Year round	64°F	ND	64.25
				Spawn	Sept 15-Jun 30	55°F		55.25
City of Clatskanie STP	5.6	0.77	71°F	M&R	Year round	64°F	4.77 x10^5	64.7

SP= *System potential* based on modeling of temperature in the subbasin with anthropogenic heating minimized.
M&R= Migration and Rearing Criterion;
Spawn= Spawning Criterion
NA= Not Applicable; ND= No Data

Heat load limits to streams were calculated for each discharge to freshwater. For computational purposes, DEQ has defined the zone of dilution as 1/4 of the 7Q10 low flow. The design condition for point sources is the heat from effluent that produces a 0.25^{o}F increase (or less) in the zone of dilution. The equations for calculating the heat load from point sources are provided in Equation 1, above.

The indicated effluent temperatures and WLAs for point sources were based on calculating no measurable increase above *system potential* using the flows and temperatures in **Table 12** and using the equations in Section 3.1.5.1 to calculate loadings and effluent temperatures under a defined set of conditions. However as the permits are renewed, WLAs may be recalculated using the equations if flow rates or effluent temperatures differ. Therefore, the maximum temperature allowed in the permit may be different from the values expressed here and will be determined at the time of permit renewal to determine no measurable increase above *system potential* using **Equation 1**. Expansion of existing point sources and future point sources will also be limited to ensure no measurable (<0.25°F) temperature increase beyond the edge of the mixing zone.

Facilities that discharge into estuarine waters are required to meet a different standard for temperature. These facilities discharge to waterbodies that are not listed as water quality limited, and do not receive an allocation in this TMDL (**Table 13**).

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[6] City of Vernonia does not discharge effluent from May 1 through October 31.

[7] Due to lack of data, 7Q10 low flows are not available for the North Fork Nehalem River. The figure presented is the measured flow volume on August 8, 2000. Actual 7Q10 low flow values may vary.

[8] Permitted water right rate (Certificate #41085, Permit #S31450).

[9] This effluent temperature is estimated by DEQ from FLIR data. The WLA may be re-calculated during the permitting process if effluent temperature data differs from this TMDL.

Table 13. Point sources that discharge to estuarine waters. These sources are regulated under a standard requiring no significant increase over natural background temperature.

Facility ID	Legal Name (Common Name)	River Flow Rate	Facility Flow (cfs)	Critical Condition Effluent Temp.	Numeric Criterion	Allowable Temp. Increase	Load Allocation Allowable Effluent Temp.
3300/A	Arch Cape Service District No Discharge May 1-Oct 31 November - April	NA	0.23	71°F	64°F 55°F	0.25	NSI
13729/A	City of Cannon Beach	NA	0.45	71°F	64°F 55°F	0.25	NSI
79929/A	City of Seaside	NA	3.48	71°F	64°F 55°F	0.25	NSI
88436/B	Henke, Harry III (River Point Homeowners)	NA	0.96	71°F	64°F 55°F	0.25	NSI
61787/A	Nehalem Bay Wastewater Agency	NA	1.1	71°F	64°F 55°F	0.25	NSI

NSI = No significant increase over natural background temperatures (OAR 340-041-0205(2)(b)(D).

3.1.9 Surrogate Measures – 40 CFR 130.2(i)

The North Coast Subbasins 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. kilocalories 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."*

Water temperature warms as a result of increased solar radiation loads. 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.

Since factors that affect water temperature are interrelated, the surrogate measure (percent effective shade) relies on restoring/protecting riparian vegetation to increase stream surface shade levels, reducing stream bank erosion, stabilizing channels, reducing the near-stream disturbance zone width and reducing the surface area of the stream exposed to radiant processes. 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).

Surrogates used in this TMDL include:

- Site-specific shade targets;
- Shade curves for areas that were not specifically modeled;
- Channel widths.

Reduced channel widths significantly influenced the effectiveness of vegetation by decreasing the width of water surface to be shaded. Though Flow is discussed in the following loading analysis, potential flow did not have a significant influence on instream temperature of modeled reaches.

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 solar radiation load delivered to the water surface. Thus, the role of effective shade in this TMDL is to translate solar radiation loading into a measurable surrogate that can express direct reductions in heating.

3.1.9.1 Site Specific Effective Shade Surrogate Measures

Site specific effective shade surrogates are developed to help translate the nonpoint source solar radiation heat loading allocations. Attainment of the effective shade surrogate measures is equivalent to attainment of the nonpoint source load allocations.

As mentioned above, a loading capacity of heat per day is not very useful in guiding nonpoint 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. **Figures 16** displays the percent effective shade values that correspond to the loading capacities throughout the North Coast Subbasins. It is important to note that the percent effective shade surrogate measures rely upon both the *system potential* land cover (near stream vegetation) and potential channel morphology (near stream disturbance zone widths). **Appendix A** contains detailed descriptions of the methodology used to develop the temperature TMDL.

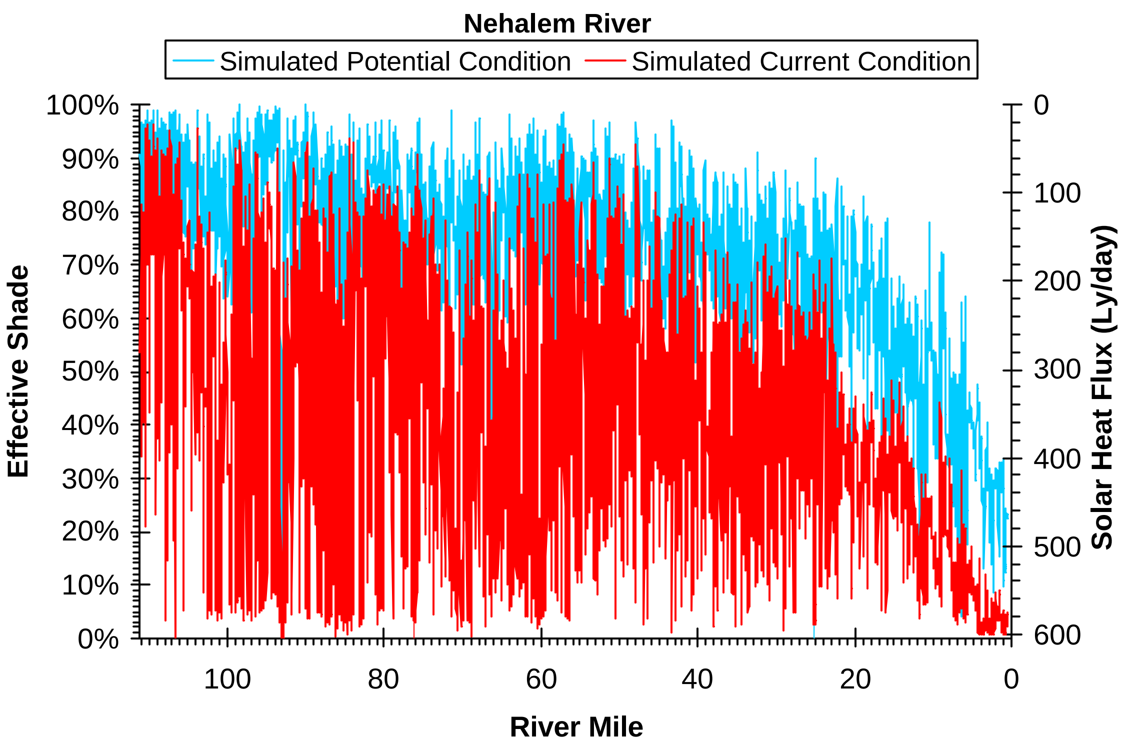


Figure 16. Percent Effective Shade Surrogate Measures – Nehalem River

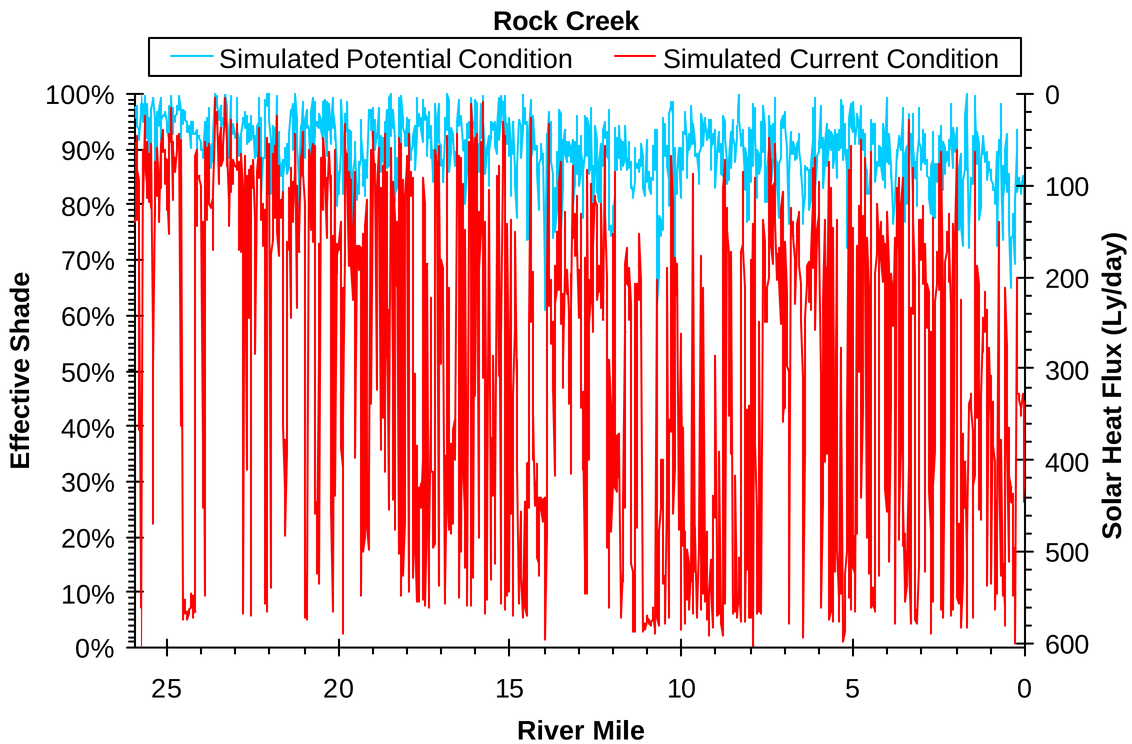
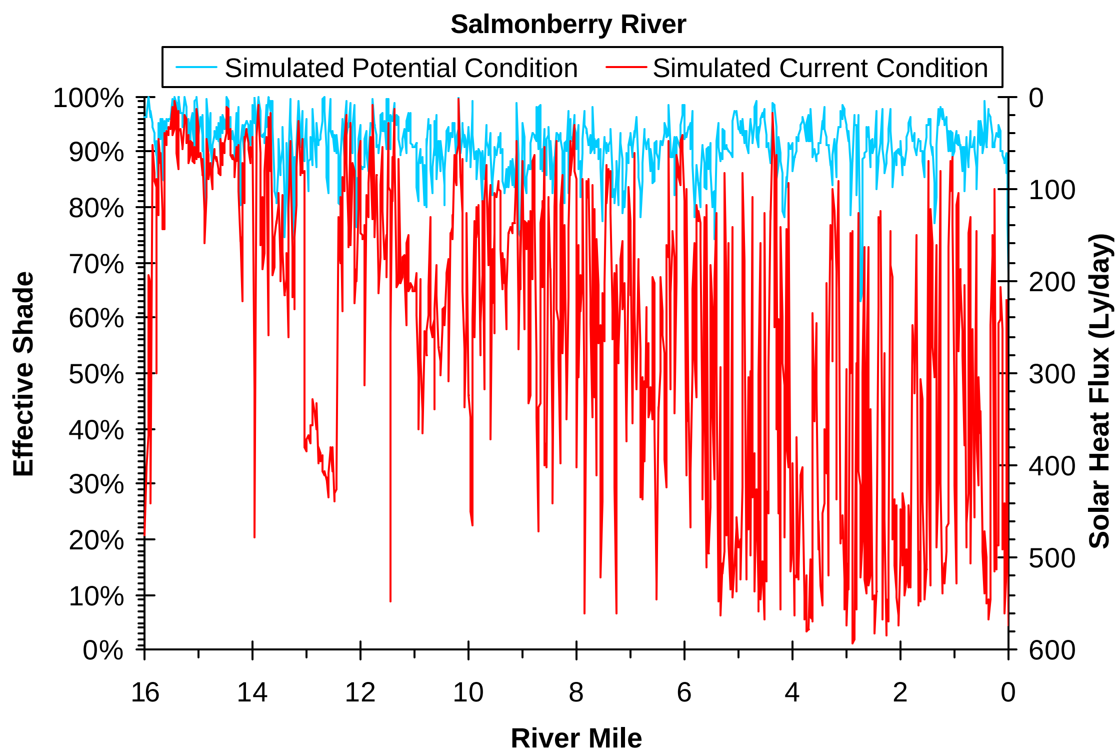


Figure 16 (Continued): Percent Effective Shade Surrogate Measures – Rock



Creek

Figure 16 (Continued): Percent Effective Shade Surrogate Measures – Salmonberry River

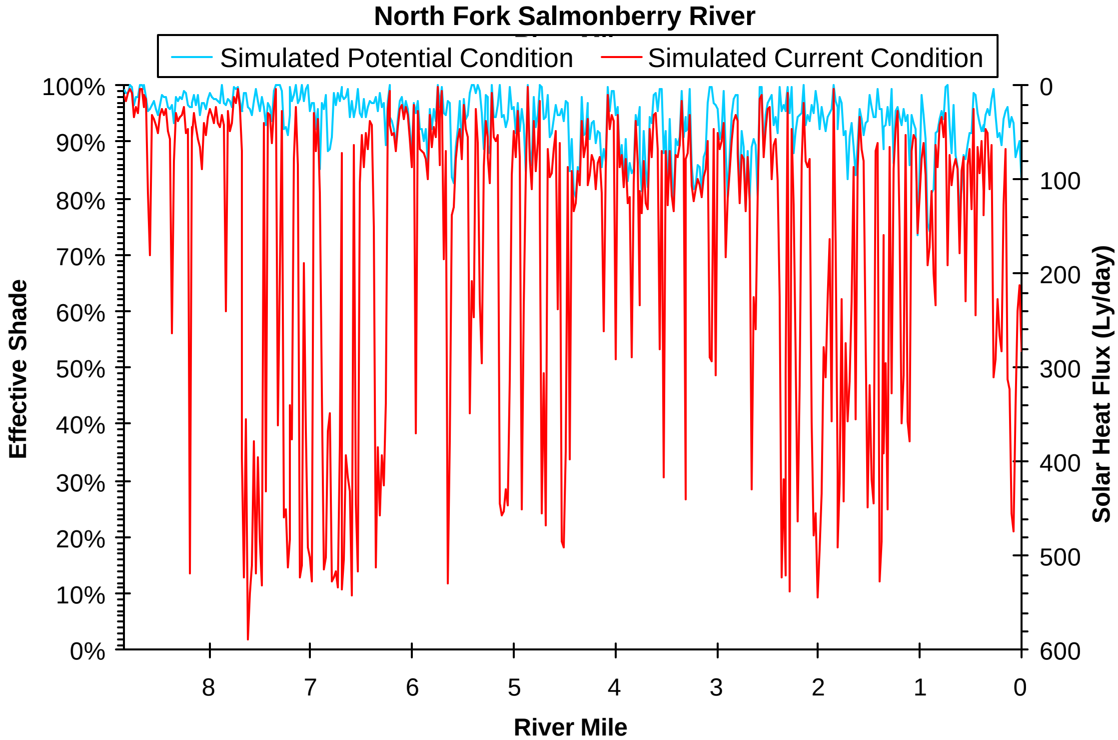


Figure 16 (Continued): Percent Effective Shade Surrogate Measures – North Fork Salmonberry River

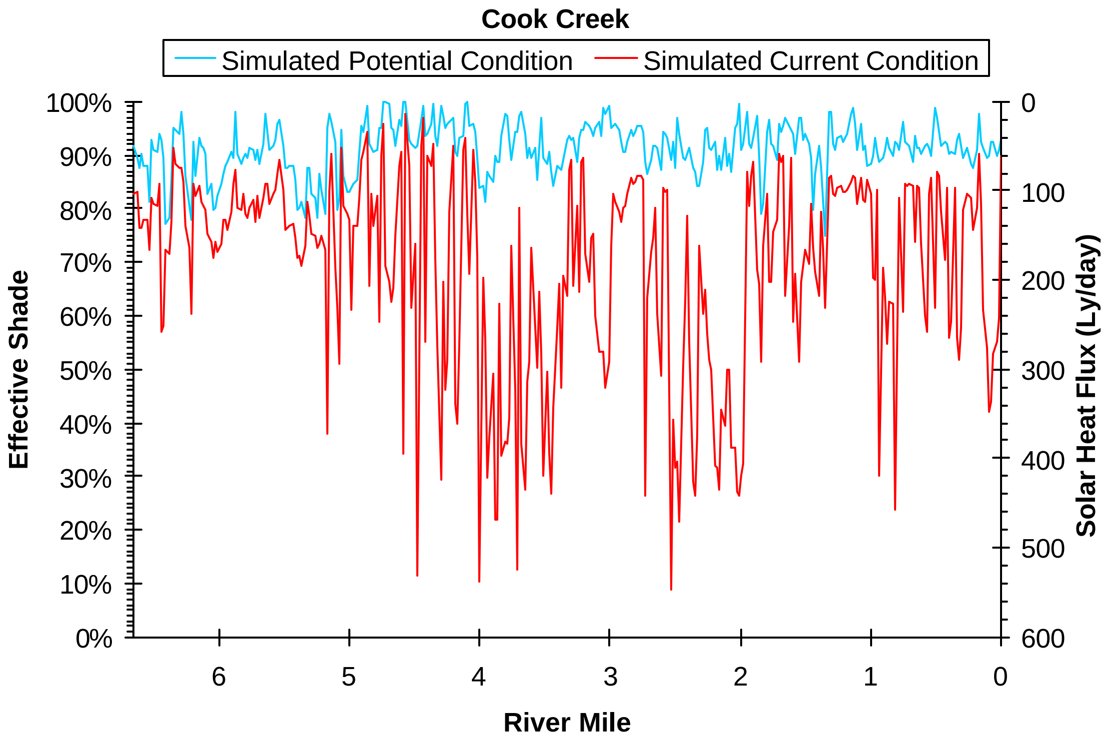


Figure 16 (Continued): Percent Effective Shade Surrogate Measures – Cook Creek

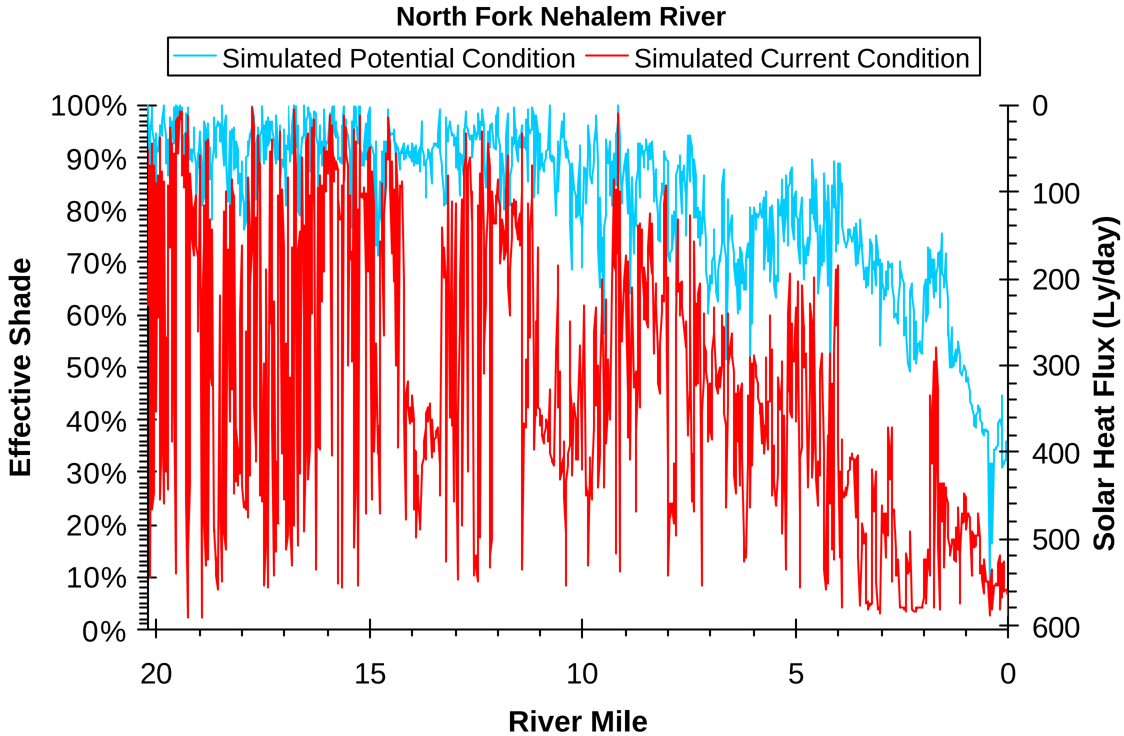


Figure 16 (Continued): Percent Effective Shade Surrogate Measures – North Fork Nehalem River

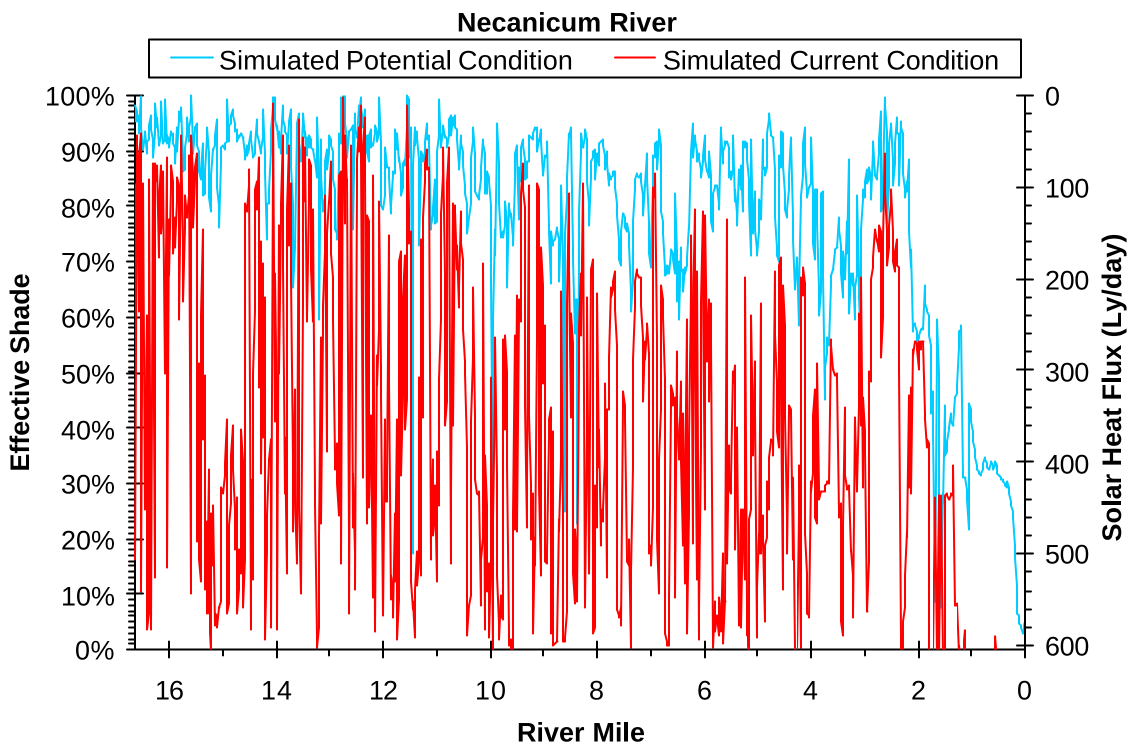


Figure 16 (Continued): Percent Effective Shade Surrogate Measures – Necanicum River

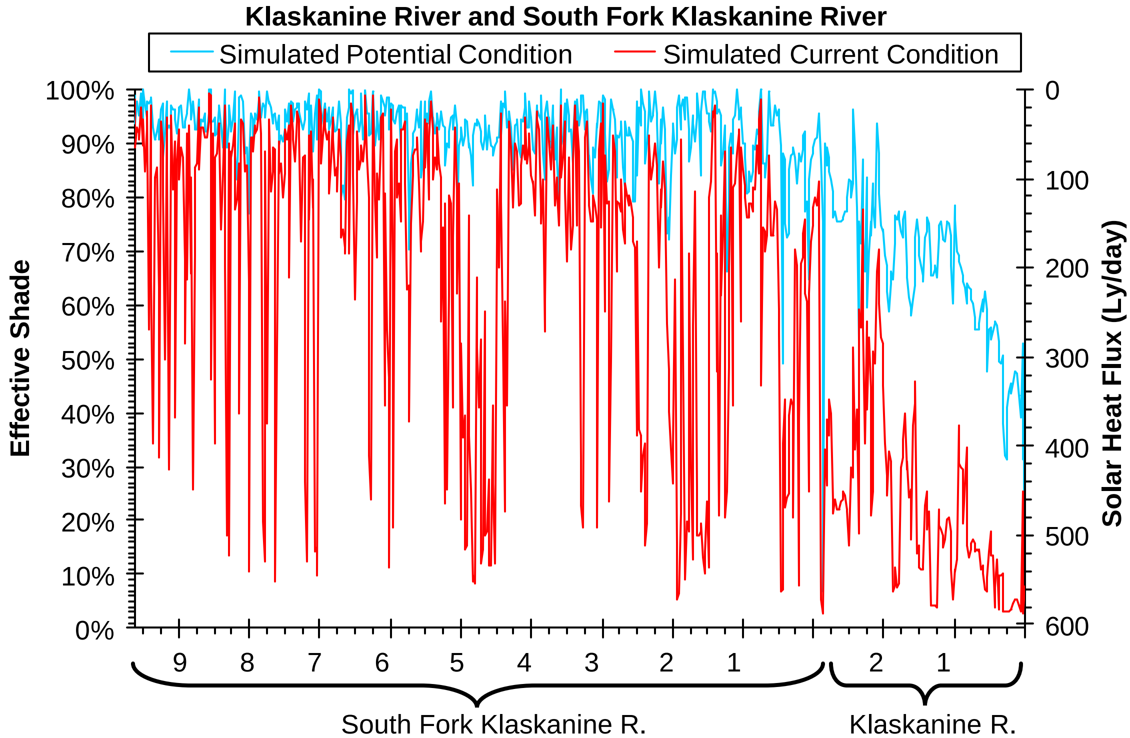


Figure 16 (Continued): Percent Effective Shade Surrogate Measures – Klaskanine River and SF Klaskanine River.

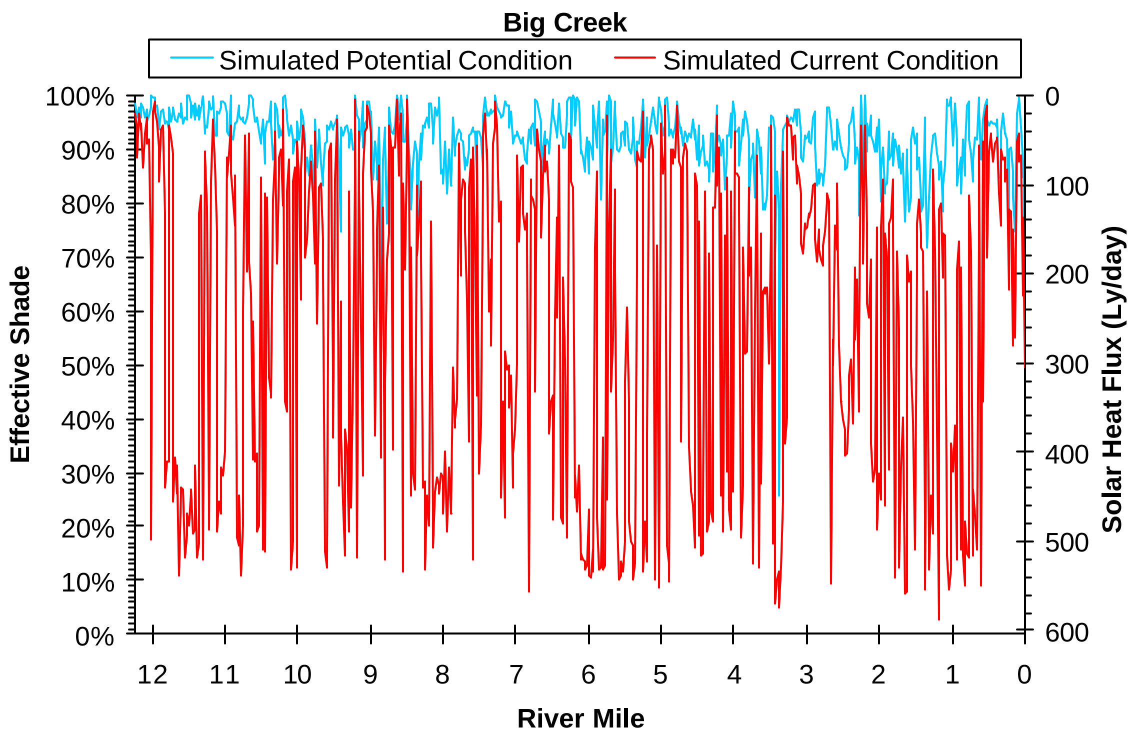


Figure 16 (Continued): Percent Effective Shade Surrogate Measures – Big Creek

3.1.9.2 Channel Morphology - Surrogate Measures

Channel morphology, the measures of width, depth, pattern, and profile of a stream are a function of the amount of water a channel must carry, the gradient, valley type, and many other factors. A river will reach a relatively stable conformation through time given normal volumes of water and sediment. Alterations to channel form can result from increased or decreased flows or sediment volumes.

Channel width can increase as a result of removal of riparian vegetation, destabilizing streambanks, or excessive sedimentation, which aggrades the channel (raises its elevation) causing water to cut away at stream banks. Increased sediment volumes are often related to land uses that disturb upland or riparian areas. This disturbance has been widespread throughout the North Coast Basin resulting from agricultural practices, forestry, development and other forms of disturbance, but is not constant in time or space.

Channel width is an important component in stream heat transfer and mass transfer processes. Effective shade, stream surface area, wetted perimeter, stream depth and stream hydraulics are all highly sensitive to channel width. Accurate measurement of channel width across the stream network, coupled with other derived data, allows a comprehensive analytical methodology for assessing channel morphology. The steps for channel width assessment are listed below.

Step 1. **Stream channel edges are digitized from Digital Orthophoto Quadrates (DOQs) at 1:5,000 or less**. These channel boundaries establish the near stream disturbance zone (NSDZ), which is defined for purposes of the TMDL, as the perpendicular distance across the stream between shade-producing near-stream vegetation. Where near-stream vegetation is absent, the near-stream boundary is used, defined as downcut stream banks or where the near-stream zone is unsuitable for vegetation growth due to external factors (i.e., roads, railways, buildings, etc.).

Step 2. **Sample near stream disturbance zone width at each stream data node using GIS (Arcview) and the geomeasurement application, TTools**. The sampling algorithm measures the near stream disturbance zone width in the transverse direction relative to the stream aspect.

Step 3. **Compare sampled near stream disturbance zone width and ground level measurements**. Establish statistical limitations for near stream disturbance zone width values when sampled from aerial photograph (DOQ) analysis.

Step 4. **Perform Rosgen Level 1 channel classification**. As previously discussed, Rosgen Level 1 channel classifications were derived for selected streams in the Nehalem River Subbasin. This analysis was performed using aerial photographic (DOQ) analysis and the 10-meter digital elevation model (DEM).

Step 5. **Compute drainage areas.** The 10-meter DEM was used to compute the drainage areas of each stream, every 100 feet longitudinally.

Step 6. **Relate sampled NSDZ widths to drainage area and Rosgen Level 1 channel classification.** The channel morphology analysis was performed on Rock Creek, Salmonberry River, Cook Creek, North Fork Nehalem River, and the mainstem Nehalem River. Data for all five streams was combined into a single database. The data was then sorted according to Rosgen channel type. Sampled NSDZ widths and drainage areas were then plotted on opposing axes for each Rosgen channel type.

Step 7. A linear regression was applied to each data set. **The upper 75% confidence limit of the regression then became the targeted maximum NSDZ**. The upper 75% confidence limit was chosen as the target because it most accurately identified stream reaches where channel disturbance was apparent in the aerial photographs (DOQs) and ground level observations. Concurrently, the upper 75% confidence limit is not an overly restrictive target (i.e., most stream reaches have channels that are in fair condition or are already at their potential minimum NSDZ width).

Step 8 **NSDZ width targets are then incorporated into stream temperature modeling.** Maximum NSDZ width targets are then applied to each stream reach, based on drainage area and potential Rosgen channel type. Locations where the current NSDZ width exceeds the target have their

NSDZ widths reduced to the target. Locations where the current NSDZ widths are at or below the target are unchanged.

Potential versus Current channel widths are presented in **Figure 17** for the Nehalem Subbasin. In each graph, the blue area is the potential site-specific channel width based on the 75th percent confidence interval of the regression as described above. The red area, where it is visible represents current channel widths in excess of the calculated potential width. The details of the channel morphology analysis and it's use in modeling temperature is contained in Section 3.4.4 of the Stream Temperature Analysis – Appendix A of this document.

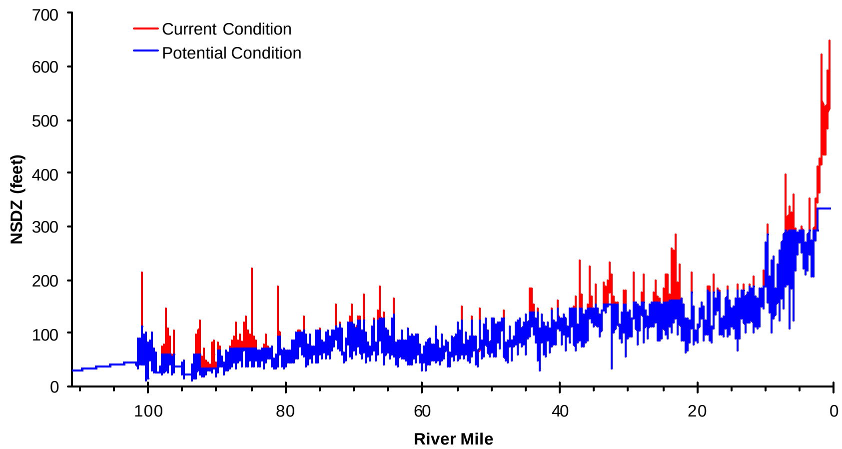


Figure 17. Potential Channel Width Targets for the Nehalem River

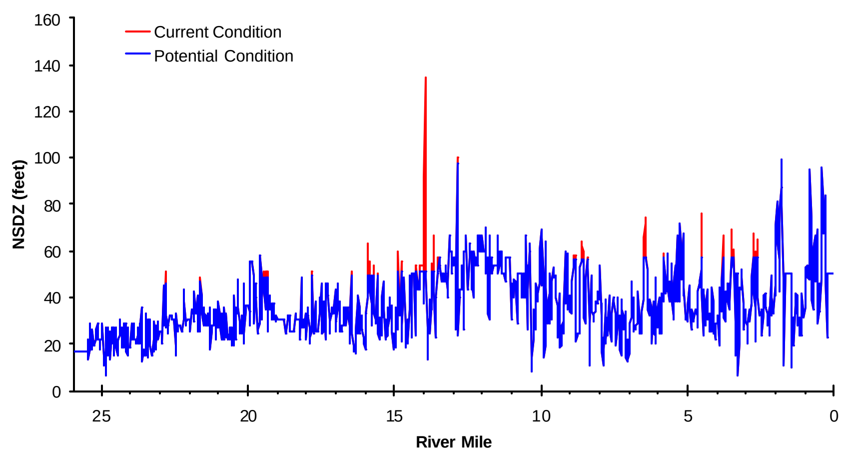


Figure 17 (Continued): Potential Channel Width Targets for the Rock Creek

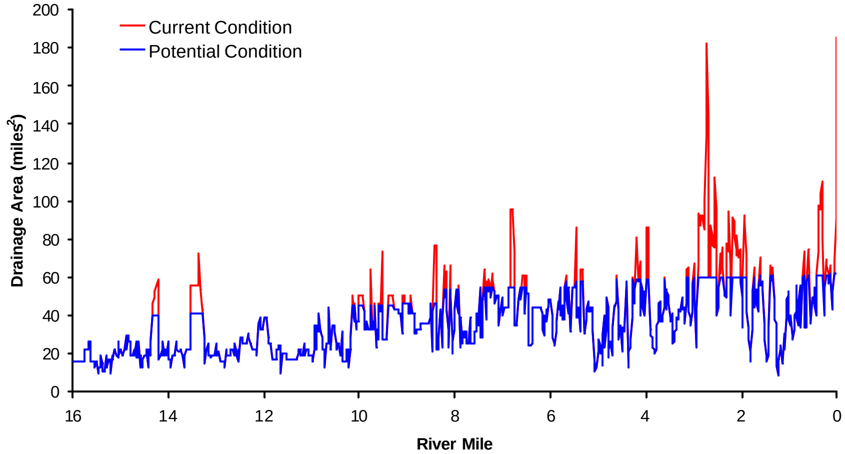


Figure 17 (Continued): Potential Channel Width Targets for the Salmonberry River

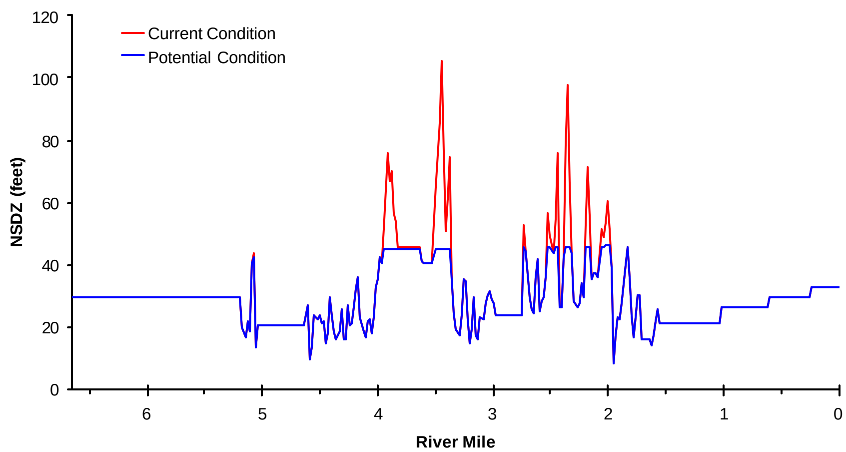


Figure 17 (Continued): Potential Channel Width Targets for the Cook Creek

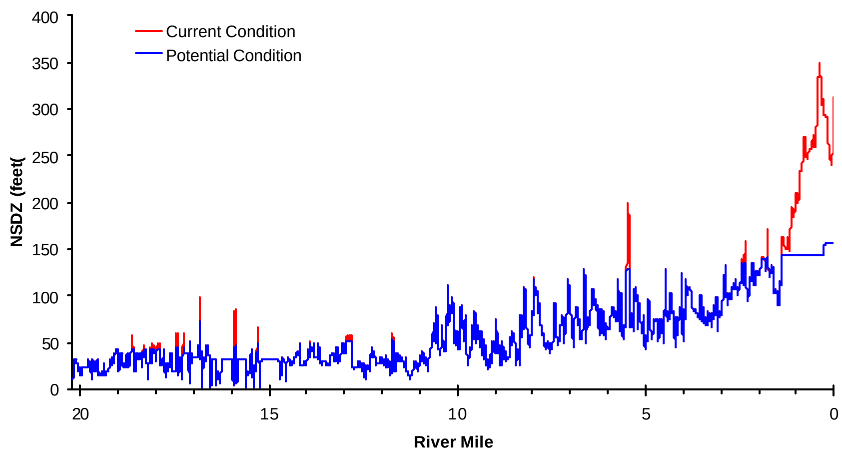


Figure 17 (Continued): Potential Channel Width Targets for the North Fork Nehalem River

Part of the effective shade curve methodology relies on channel width estimates (i.e., near stream disturbance zone width). The near stream disturbance zone (NSDZ) width is defined, for purposes of the TMDL, as the width between shade-producing near-stream vegetation. This dimension was measured from georeferenced aerial photographs and, where near-stream vegetation was absent, the near-stream boundary 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.). **Figure 18** illustrates the near stream disturbance zone.

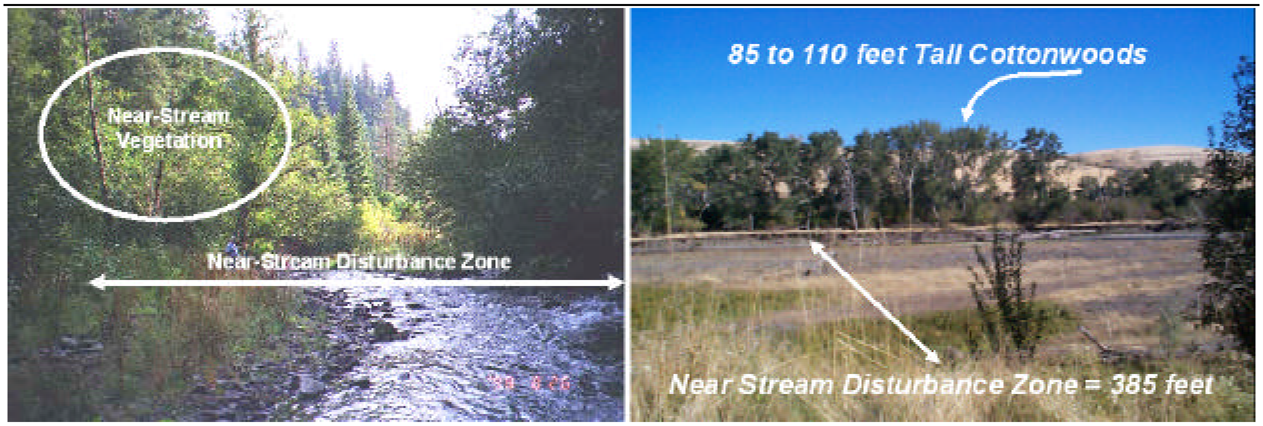


Figure 18. Near stream disturbance zone width

When compared to ground NSDZ width data, aerial photograph derived NSDZ width samples have a correlation coefficient of 0.96, a standard error or 8.5 feet and an average absolute deviation of 6.5 feet (calculated from ground level sites in the Nehalem River Subbasin). Sources of error include scale limitations from aerial photo resolution, plan view line of sight to the stream channel boundaries and the clarity of the channel edge (i.e. there must be a visibly defined channel boundary). There is an obvious bias to the methodology towards features visible in plan view. Vertical features (i.e., channel incisions, cut banks, flood plain relief, etc.) can be difficult to distinguish for aerial photos.

2.1.9.3 Effective Shade Curves - Surrogate Measures

The previous figures (**Figures 16 and 17**) present site-specific system potential shade and channel widths resulting from analysis of the Nehalem Subbasin. The site-specific values presented in the graphics are available from DEQ upon request. In practice, the calculated channel width and potential shade at the modeled points along the rivers could be used as a benchmark for restoration activities. Allocations are intended to be interpreted as a reach average of system potential effective shade. Therefore, rather than meeting the exact values presented, the average system potential shade and near-stream disturbance zone width for a given reach is the anticipated target. Where specific effective shade levels are not specified in **Figures 16** and **17**, effective shade for the appropriate potential land cover type (described in detail in **Appendix A**) and near stream disturbance zone width are provided in **Figures 19** to **21.** Again, these shade targets are intended to be applied as a reach averaged value.

Effective shade curves are provided for three landscape schemes based upon the type of riparian vegetation that would be expected. These schemes determine tree heights used in modeling and are largely correlated to elevation. Conifer dominated, and mixed conifer-deciduous riparian areas are predominantly in the upland or higher elevation areas of the watersheds. Deciduous dominated areas are most common in lower elevation and low gradient areas. The type of tree controls the potential height of the riparian canopy which largely controls the amount of shade that can be provided (**Table 14**).

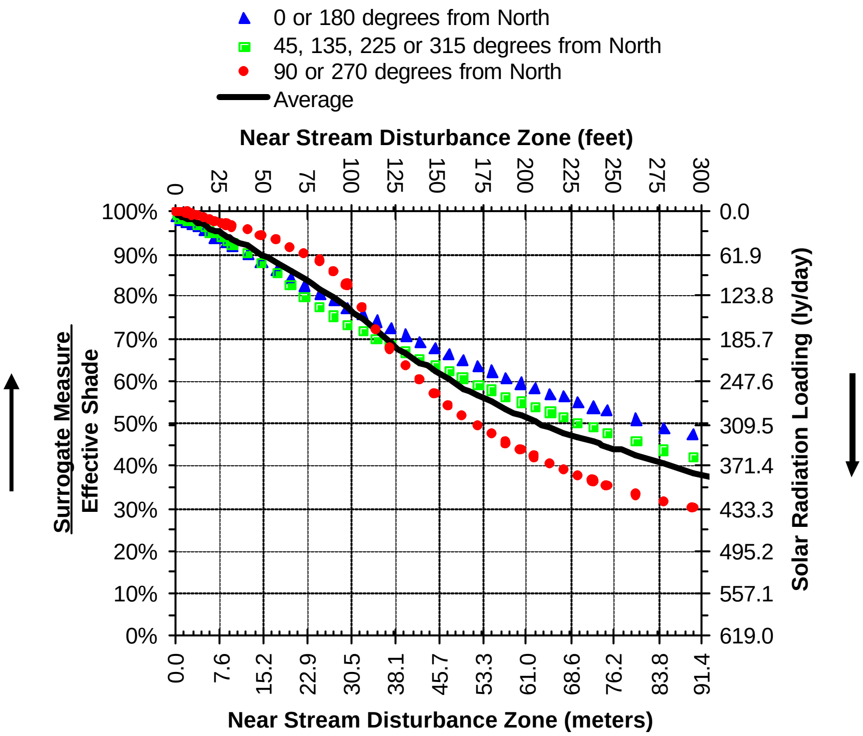


Figure 19. Effective shade curves for the conifer land cover type - 175 feet tall and 90% density.

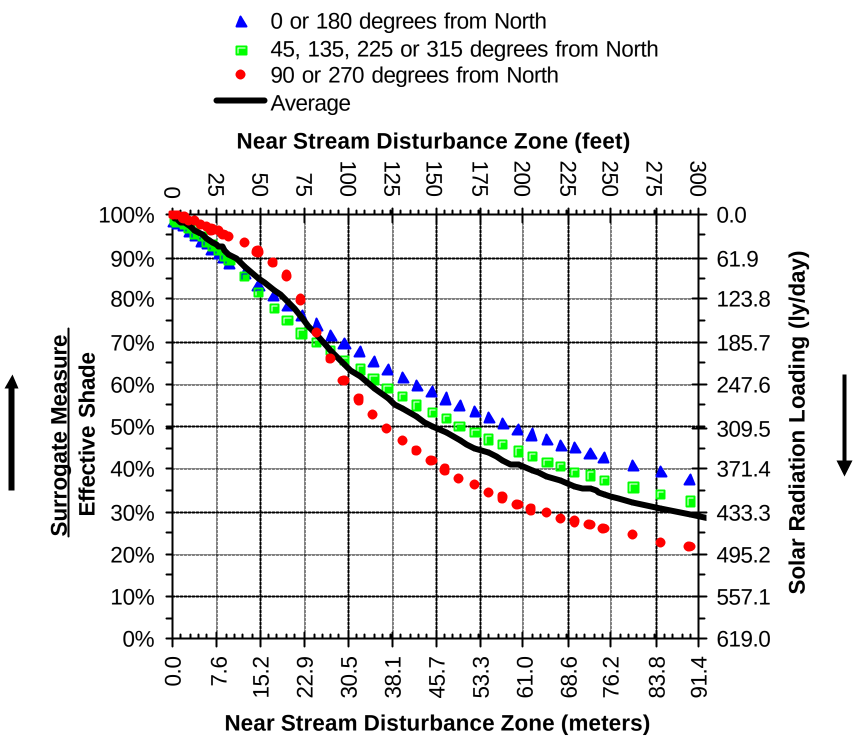


Figure 20. Effective shade curves for the deciduous/conifer mix land cover type – 125 feet tall and 90% density.

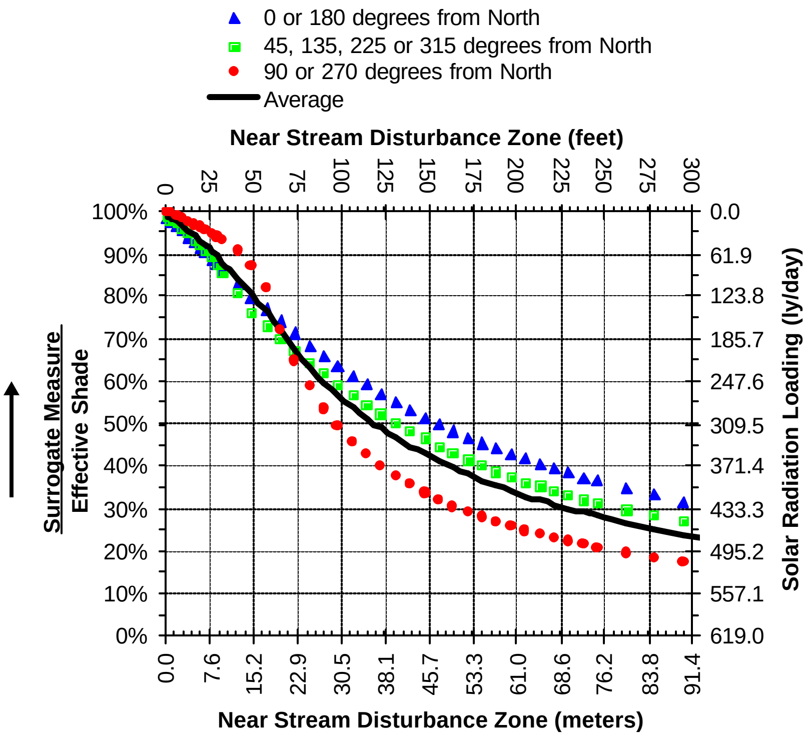


Figure 21. Effective shade curves for the deciduous land cover type – 100 feet tall and 90% density.

Table 14. Potential near stream land cover characteristics that were applied, based on the existing near stream land cover characteristics.

Potential Tree Heights		
Species	**Average Height**	**Age**
Douglas Fir	160 to 180 feet	80 years
Western Hemlock	140 feet	
Western Red Cedar	120 to 140 feet	
Sitka Spruce	140 feet	
Red Alder	100 feet	
Bigleaf Maple	100 feet	

Land Cover Type	Dominant Tree Species and Mature Tree Height	*Targeted Height*
Coniferous	Douglas Fir - 175 feet	*175 feet*
Mixed Deciduous and Conifer	50% Douglas Fir – 175 feet Western Hemlock – 140 feet Western Red Cedar – 140 feet Sitka Spruce – 140 feet	*125 feet*
	50% Red Alder - 100 feet Bigleaf Maple - 100 feet	
Deciduous	Red Alder - 100 feet Bigleaf Maple - 100 feet	*100 feet*

Potential tree heights were determined through a combination of literature references and professional judgment of local foresters. Potential heights were defined as the height of a mature stand of a given type of tree at maturity (or, the age and height at which growth rates typically decline significantly). Growth curves for commonly occurring tree species (Richards 1959, McArdle and Meyer 1961, Hann 1997, and Whitney 1997) were used to determine height and age at maturity. A professional forester at the Tillamook State Forest (Wayne Auble, personal communication) also provided estimates of approximate heights at mature stand ages. These estimates corroborated well and were used directly in defining *system potential* vegetation conditions.

DEQ acknowledges that load allocations of system potential effective shade will take many years to develop in areas where there is little or no existing vegetation. While restoration efforts have begun throughout the North Coast Basin, vegetative growth is a naturally slow process. Despite the long time frame expected for full development of system potential shade and channel morphology, we expect steady improvement in instream temperatures as effective shade increases. This slow accrual of benefit should be observed on small streams first and then on increasingly large streams with additional time.

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

*The temperature TMDL and the temperature water quality standards are achieved when (1) nonpoint source solar radiation loading is representative of a riparian vegetation condition without human disturbance and potential channel morphology and (2) point source discharges cause no measurable temperature increases (as defined in the temperature standard) in surface waters. Stream temperatures (displayed in **Figures 22** to **26**) that result from the conditions represent attainment of the temperature standard **(no measurable surface water temperature increase resulting from anthropogenic activities)**.*

Simulations were performed to calculate the temperatures that result with the allocated measures (potential channel morphology and land cover) that represent the *system potential* condition with ***no measurable surface water temperature increase resulting from anthropogenic activities***. The resulting simulated temperatures represent attainment of *system potential*, and therefore, attainment of the temperature standard.

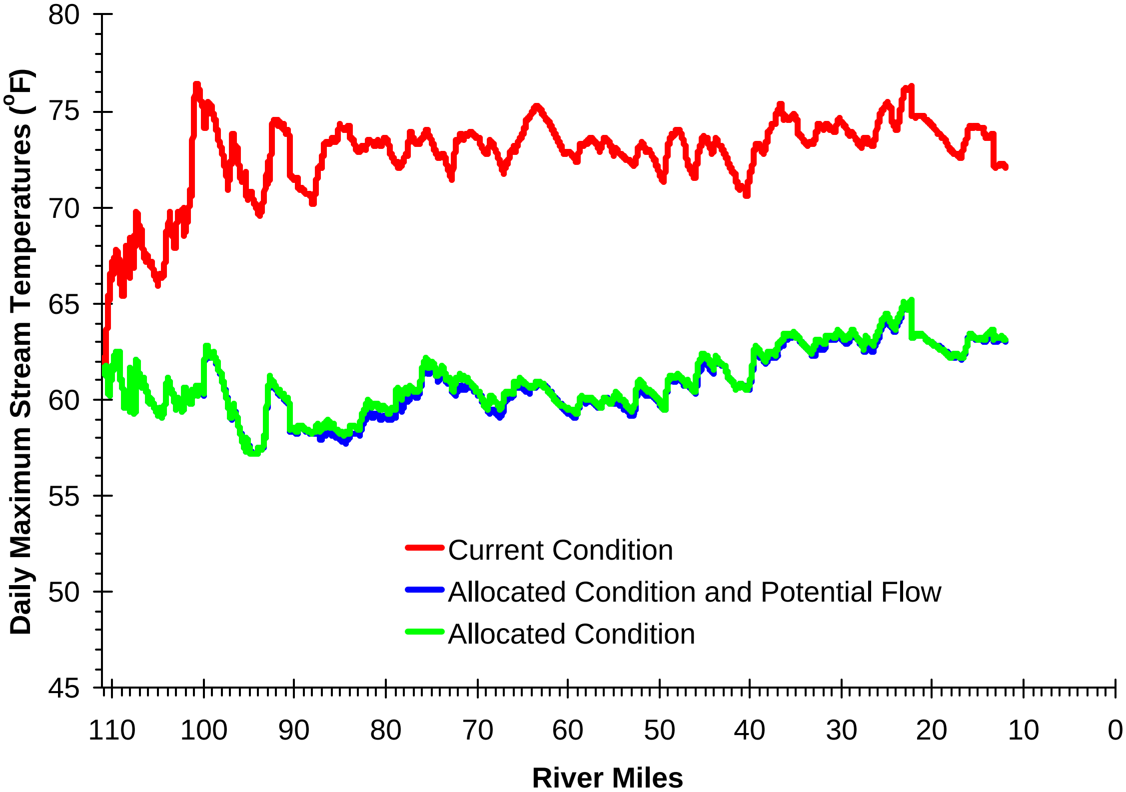
Figures 22 to **26** display the stream temperatures that result from *system potential* conditions for each stream that was modeled. Although flow is not allocated in this TMDL, stream temperatures that result from *system potential* flow conditions are included in the charts for informational purposes. Simulating flow regimes with no diversions for human use did not influence temperatures in the Nehalem Subbasin. The stream temperatures that result from the potential channel width and land cover are the allocated condition.

A total of 168 river miles in the Nehalem River, Rock Creek, Salmonberry River, Cook Creek, and North Fork Nehalem River were analyzed and simulated during the critical period (August 4 to August 8, 2000).

Maximum daily stream temperature distributions in the Nehalem Subbasin are presented in **Figure 27**. Currently 82% of the sampled stream segments (138 river miles) in the Nehalem River Subbasin exceed 64^{o}F. Under potential land cover and channel width (allocated condition), only 2% of the simulated stream segments exceed 64^{o}F. Furthermore, results indicate that 45% of the stream length can achieve maximum daily stream temperatures less than 59.5^{o}F under allocated conditions (*system potential* conditions).

An overriding emphasis of the temperature TMDL is the focus on spatial distributions of stream temperatures in the North Coast Subbasins. Comparisons of stream temperature distributions capture the variability that naturally exists in stream thermodynamics. Spatial variability is observed in all of the stream segments sampled and analyzed. The advent of new sampling technologies and analytical tools that include landscape scaled data and computational methodologies used in this TMDL have improved our understanding of stream temperature dynamics (Boyd, 1996, Faux et al. (in review), Torgersen et al., 1999, Torgersen et al., 2001, DEQ 2000a, DEQ 2001a, DEQ 2001b, DEQ 2001c). This understanding suggests spatial and temporal variability that results in departures from biologically derived temperature thresholds.

Further, simple conceptual models that focus on a single stream, landscape or atmospheric parameter will fail to capture the interactions of a multitude of parameters that are interrelated. These parameters combine to have complex thermal effects. As an example, temperature simulations demonstrate at a network scale that stream temperature is relatively insensitive to potential land cover conditions. However, when coupled with potential channel width, stream temperatures are highly sensitive to potential land cover. The results of this analytical effort clearly demonstrate that a comprehensive restoration approach should be developed that focuses on the protection and recovery of land cover and channel morphology.



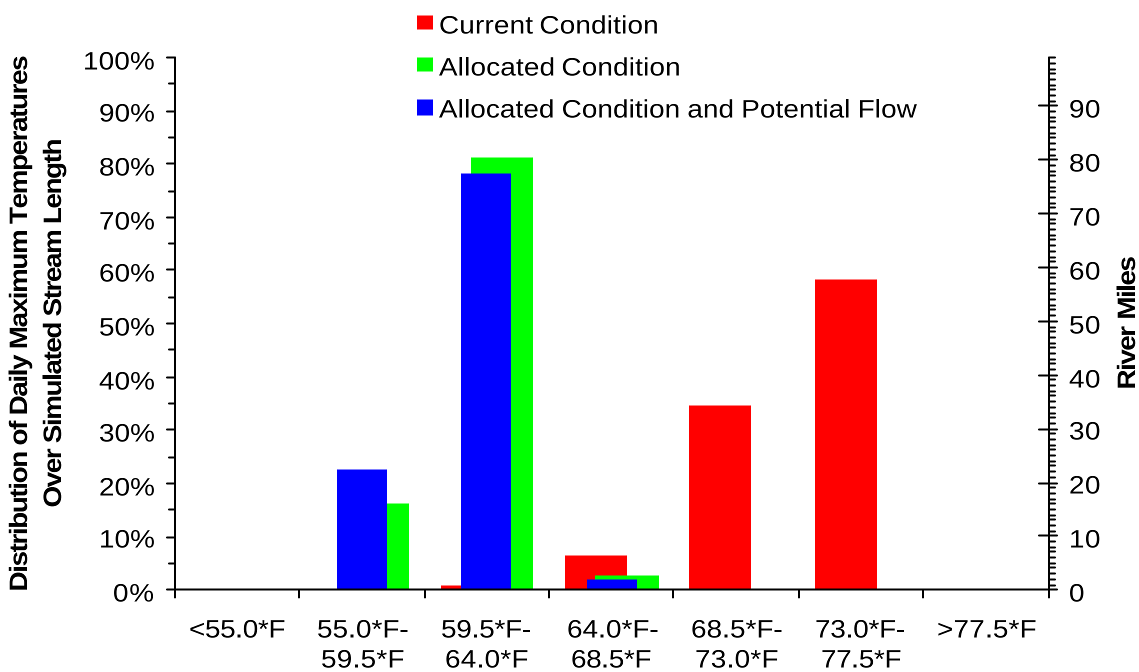


Figure 22. Nehalem River summary of maximum daily simulated potential stream temperatures – August 5, 2000. Upper chart displays the longitudinal profile of maximum daily stream temperatures. The lower chart is a histogram that shows the distribution of simulated maximum daily stream temperatures for the current condition compared to potential channel width, land cover and flow rate.

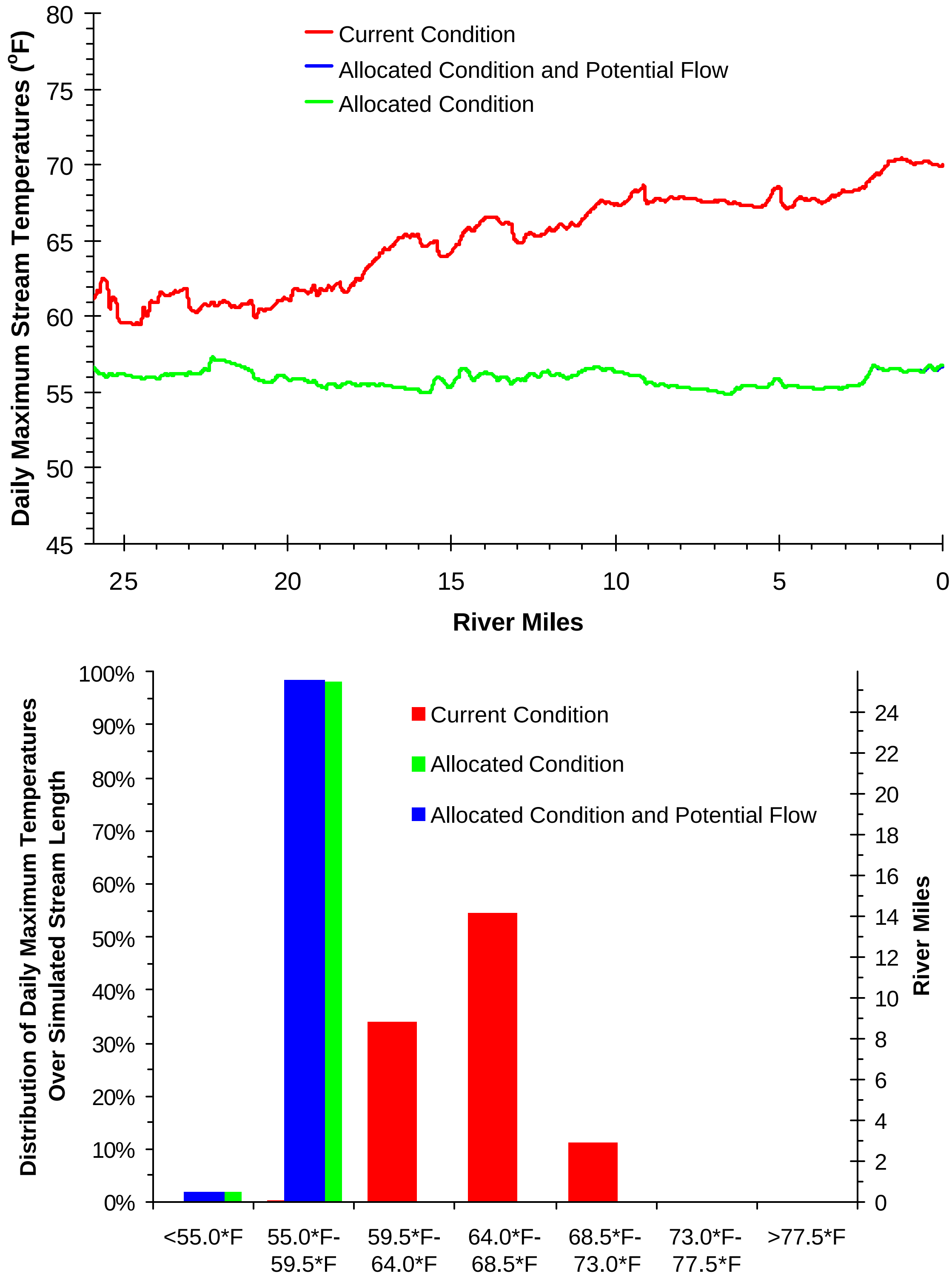


Figure 23. Rock Creek summary of maximum daily simulated potential stream temperatures – August 6, 2000. Upper chart displays the longitudinal profile of maximum daily stream temperatures. The lower chart shows the distribution of simulated maximum daily stream temperatures for the current condition compared to potential channel width, land cover and flow rate.

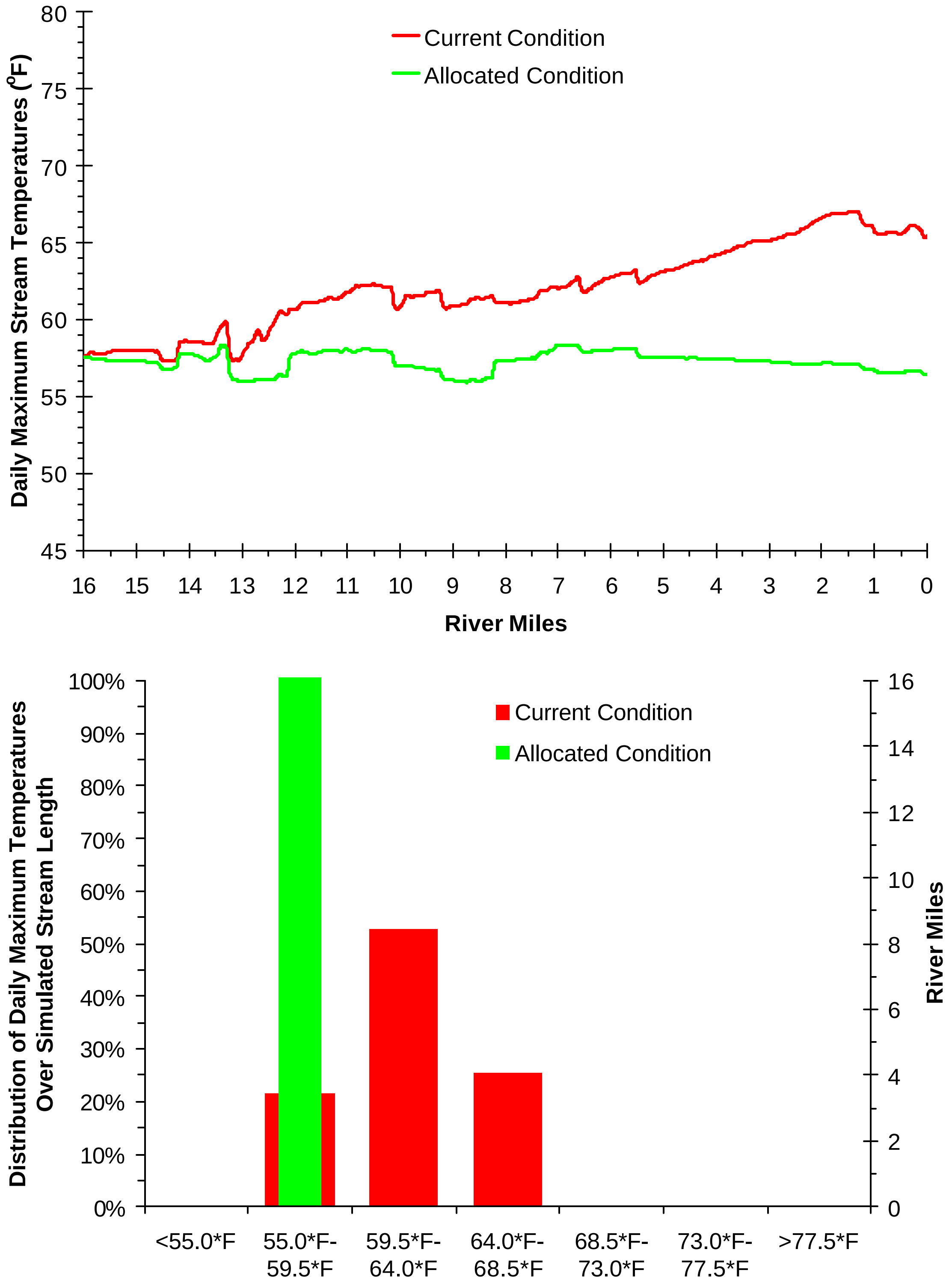
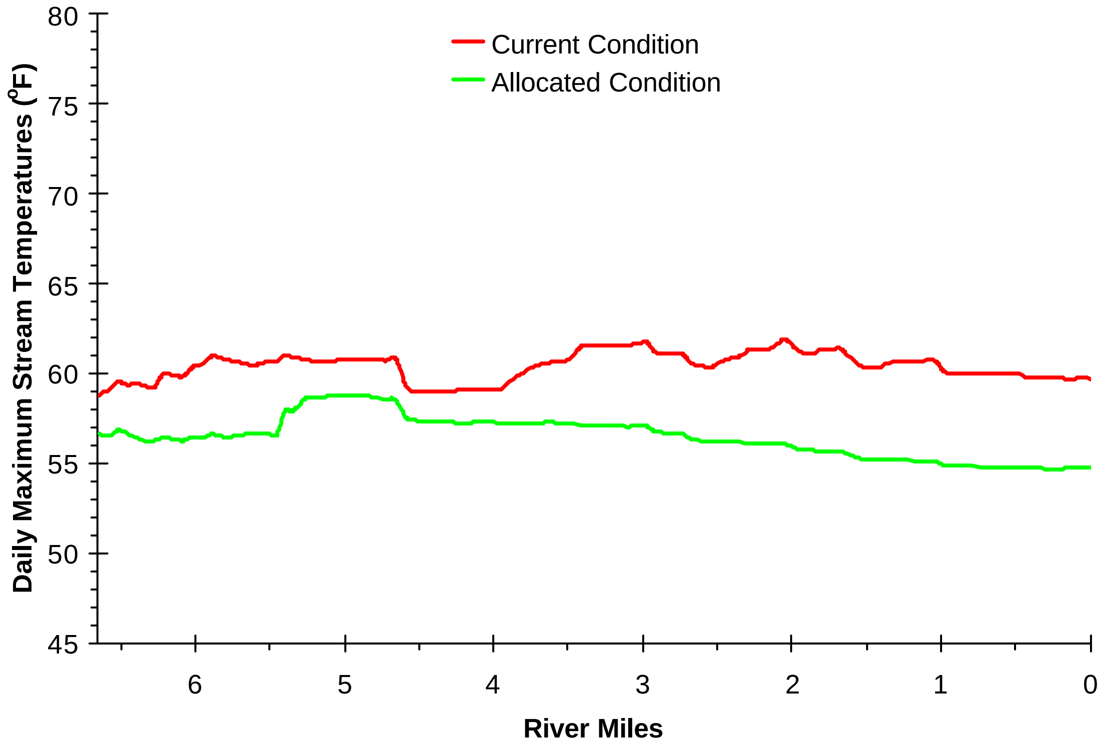


Figure 24. Salmonberry River summary of maximum daily simulated potential stream temperatures – August 4, 2000. Upper chart displays the longitudinal profile of maximum daily stream temperatures. The lower chart is a histogram that shows the distribution of simulated maximum daily stream temperatures for the current condition compared to potential channel width, land cover and flow rate.



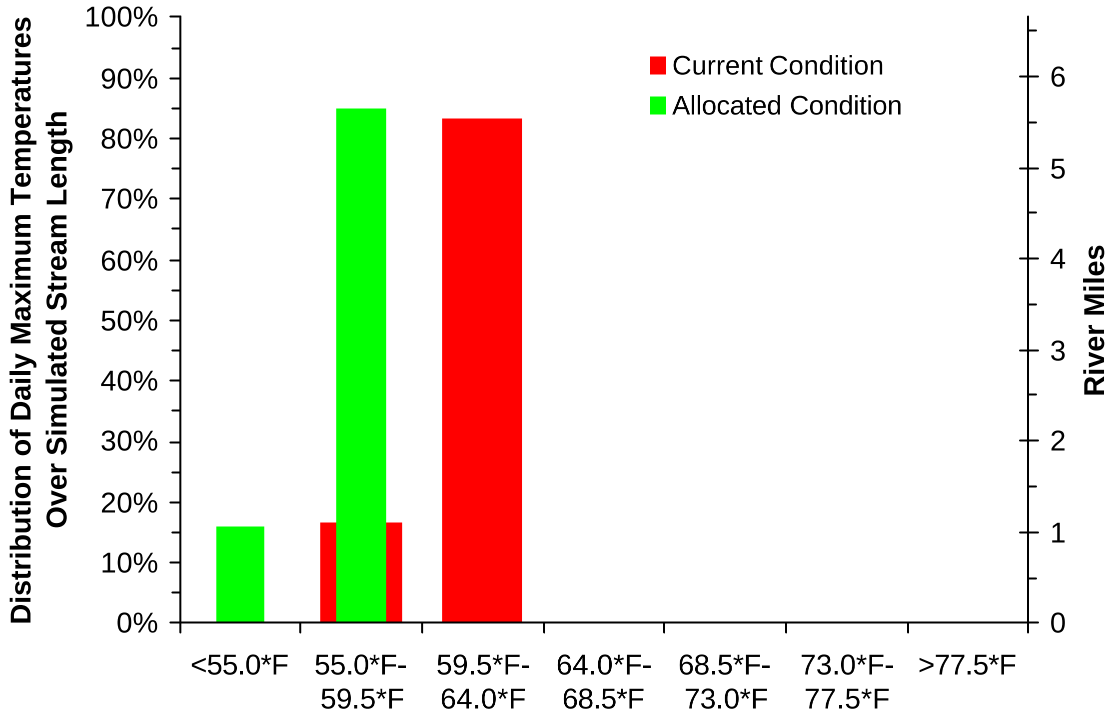
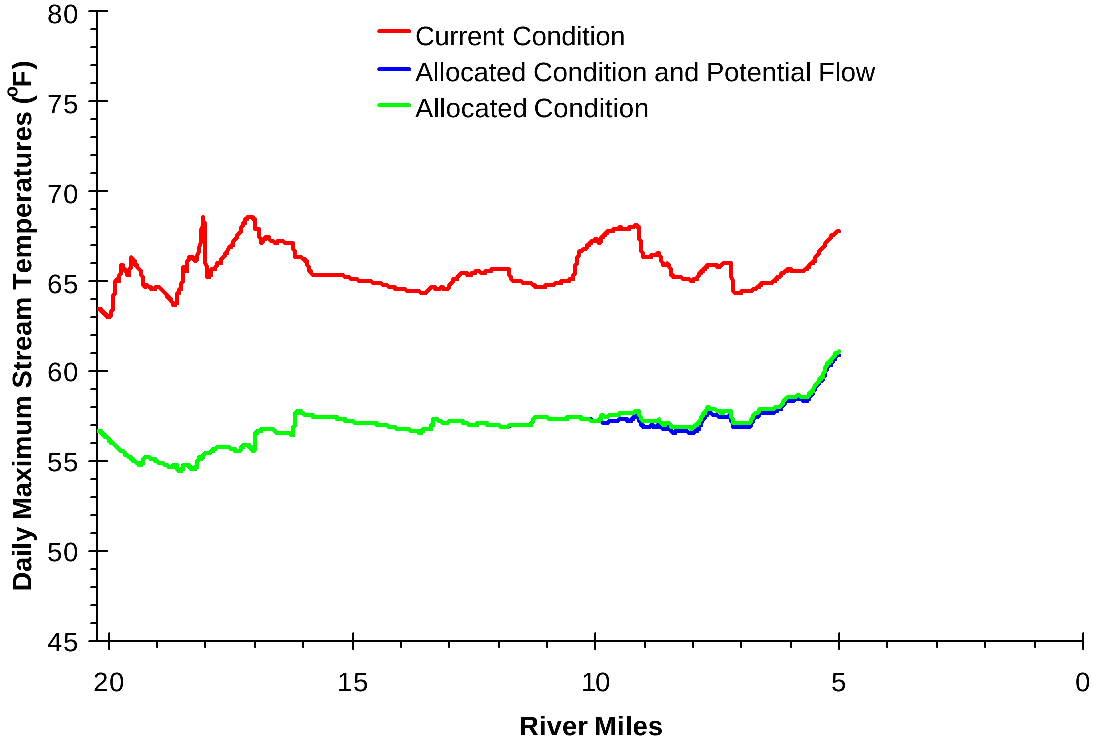


Figure 25. Cook Creek summary of maximum daily simulated potential stream temperatures – August 6, 2000. Upper chart displays the longitudinal profile of maximum daily stream temperatures. The lower chart is a histogram that shows the distribution of simulated maximum daily stream temperatures for the current condition compared to potential channel width, land cover and flow rate.



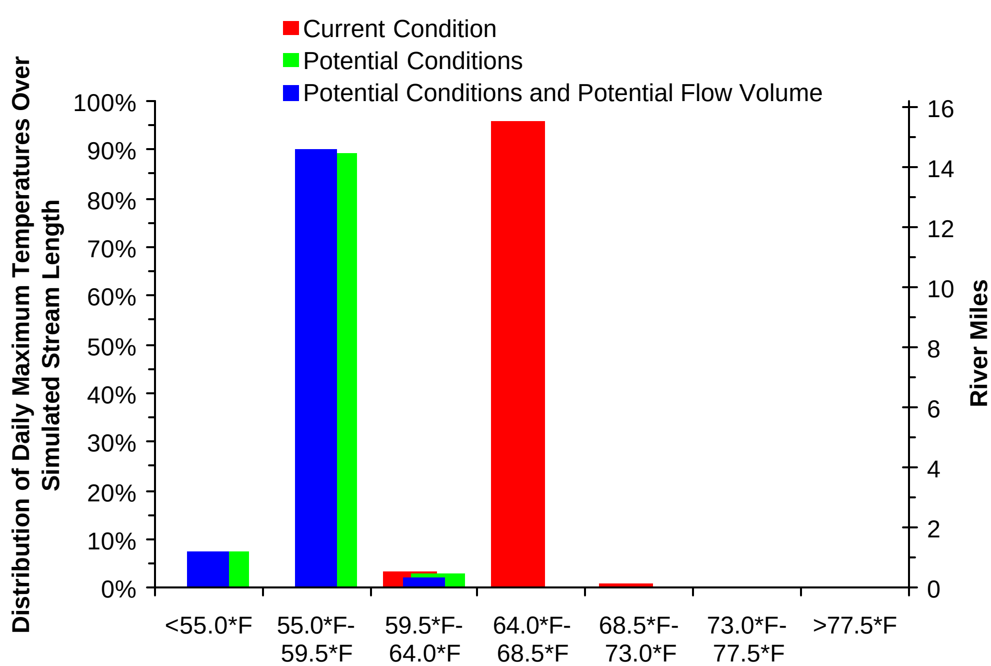


Figure 26. North Fork Nehalem River summary of maximum daily simulated potential stream temperatures – August 8, 2000. Upper chart displays the longitudinal profile of maximum daily stream temperatures. The lower chart is a histogram that shows the distribution of simulated maximum daily stream temperatures for the current condition compared to potential channel width, land cover and flow rate.

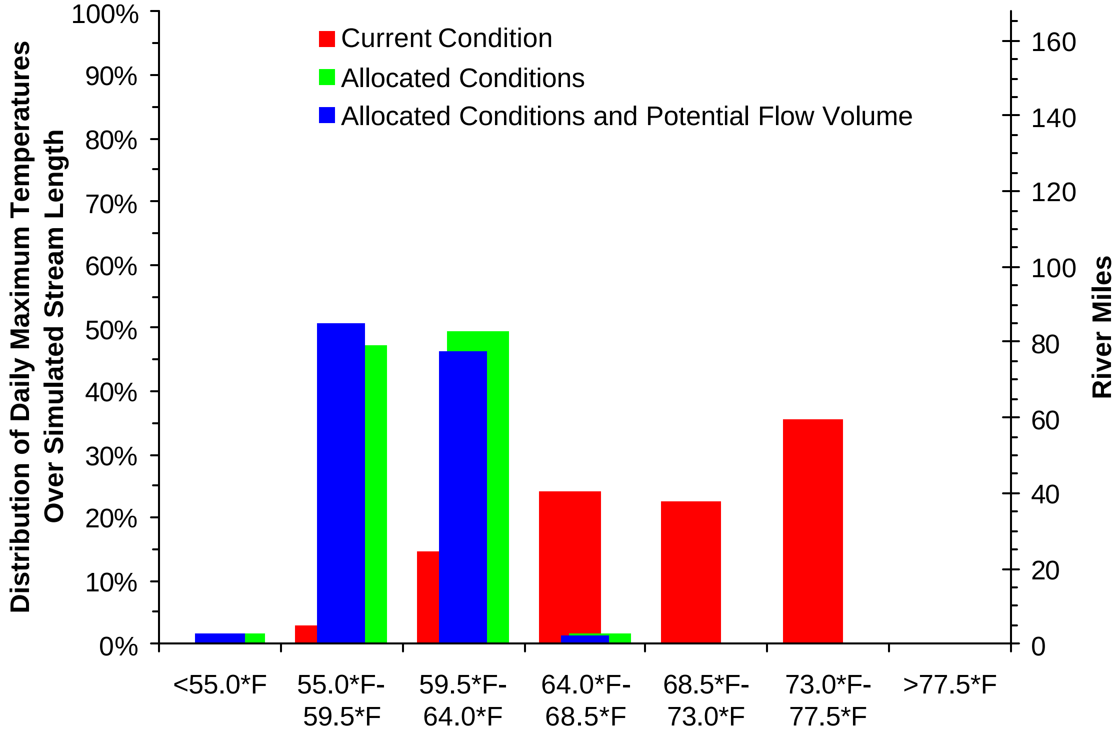


Figure 27. Distributions of maximum daily stream temperatures in the Nehalem River Subbasin stream network (168 river miles) for current and potential conditions.

3.2 BACTERIA TMDL

The North Coast Subbasins considered in this document include waterbodies that have been listed as water quality limited due to excessive concentrations of fecal bacteria. These bacteria affect surface waters for a suite of beneficial uses including water contact recreation and shellfish harvest. The Nehalem Bay, Necanicum River, and Clatskanie River have all had significant numbers of water quality standards violations in the past, and are considered water quality limited. The sources of these violations may include residential septic systems, sewage treatment plants, livestock waste, and urban runoff. In general, sources appear to be dominated by nonpoint sources. Allocations have been developed for all known sources of fecal bacteria in the basin, and are expected to result in water quality standards being met.

3.2.1 Summary of Bacteria TMDL Development and Approach

The TMDL includes descriptions of watersheds, the pollutants responsible for impairments, standards being applied, sources of the pollutants, a description of data collected, Loading capacity and allocations of loads for various direct loads and landuses, and a margin of safety. These features are summarized in **Table 15**.

Table 15. North Coast Subbasins Bacteria TMDL Components.

Waterbodies	Streams providing recreational contact or shellfish harvesting beneficial uses as defined in OAR 340-41-205 within the 4th field HUCs (hydrologic unit codes) 17080003, 17100201, and 17100202.
Pollutant Identification	*Pollutants:* Fecal bacteria from various sources. Particularly *E. coli* as an indicator of human pathogens for recreational contact and fecal coliform bacteria as an indicator of human pathogens for shellfish harvest in estuarine areas..
Target Identification (Applicable Water Quality Standards) *CWA §303(d)(1)*	OAR 340-041-0205(2)(b)(A) To ensure the protection of beneficial uses of water contact recreation and shellfish harvesting in estuarine areas: Geometric mean *E. coli* concentrations shall not exceed 126 MPN/100 ml and no single sample shall exceed 406 MPN/100 ml in waters providing primary recreational contact; Geometric mean fecal coliform concentrations shall not exceed 14 MPN/100 ml and no more than 10% of samples may exceed 43 MPN/100 ml in waters providing shellfish harvest for human consumption.
Existing Sources *CWA §303(d)(1)*	Urban runoff, livestock, Rural Residential development, Waste Water Treatment Facilities
Seasonal Variation *CWA §303(d)(1)*	Concentrations tend to be highest during fall and winter during runoff events (storms). Other periods of the year are also considered.
TMDL Loading Capacity and Allocations *40 CFR 130.2(f)* *40 CFR 130.2(g)* *40 CFR 130.2(h)*	*Loading Capacity:* The loading capacity in each basin considered is based on accumulation of bacteria in runoff during storm events. The loading capacity is expressed as the total load of bacteria that can accumulate in a basin in a median storm event and not cause violations of the water quality criteria in the waterbodies providing specified beneficial uses. *Waste Load Allocations (Point Sources)*: Concentrations of bacteria in effluent from point sources are sufficiently low at permitted limits that they do not impact water quality. *Load Allocations (Nonpoint Sources):* Concentrations of *E. coli* in runoff from several sources of bacterial contamination were determined through modeling of water flow throughout the Nehalem, Necanicum, and Clatskanie River Watersheds. Load allocations are expressed as concentrations in runoff from the various landuse types that in combination do not exceed the loading capacity. These concentrations are also expressed as percentage reductions compared to current conditions. Allocations in the Nehalem Basin were divided between upper and lower watershed units. .
Surrogate Measures *40 CFR 130.2(i)*	Translates Nonpoint Source Load Allocations Allocations are in terms of concentrations of bacteria in runoff from a variety of landuses. This translates load allocations into directly applicable measures of performance.
Margins of Safety *CWA §303(d)(1)*	*Margins of Safety* are applied as conservative assumptions in modeling and are inherent to methodology. No numeric margin of safety is developed.

3.2.1.1 Data Collection and Analysis

Concentrations of fecal bacteria in the subbasins have been determined by several entities over the years. DEQ has collected samples at ambient monitoring stations in each of the subbasins as well as at other places during special studies. These data have been used for purposes of listing under section 303(d), and for determining sources of contamination. Some data have been collected by the Lower Nehalem Watershed Council, the Clatskanie Watershed Council, and bay data in the Nehalem and Necanicum estuary have been collected by DEQ and the Oregon Department of Agriculture.

In general, violations of bacterial standards have occurred in the lower reaches of major rivers and in estuaries and bays. Elevated concentrations in all three of these Subbasins result in occasional violations of the water contact recreation criterion in the lower reaches, but this also results in violations of the shellfish harvesting criterion in Nehalem Bay and the Necanicum estuary. This distribution of bacterial concentration data largely guided the data collection and characterization phase of TMDL development.

Data were collected on three scales for characterization and modeling. Long-term monitoring data have been collected since the 1960s for some areas of the subbasins. These data were analyzed for range of concentrations and spatial and temporal trends in rivers, bays, and estuaries. Data have been collected by DEQ, ODA, the Lower Nehalem Watershed Council (since 1998), and the Clatskanie River Watershed Council (since 1998). Data were collected during a one-week dry-weather summer period to estimate concentrations during non-runoff events in the Nehalem and Necanicum Subbasins. Data were also collected weekly in the Nehalem and Necanicum Subbasins from October 2000 through March 2001. An intended week-long storm monitoring study in 2000-01 never materialized due to a lack of storms that winter, but was eventually conducted in October 2001. These data are presented fully in later sections.

3.2.1.2 Modeling Approach

The TMDL for the Nehalem and Necanicum Rivers was developed through the surveys described above and modeling. The surveys were conducted over the fall and winter of 2000-2001, with samples collected weekly during a variety of weather conditions and special short-term studies of wet and dry weather. These data were used to characterize bacterial concentrations at various points along the rivers, followed by modeling of the accumulation of bacteria from headwaters to mouth and ultimate concentrations at the mouth.

Current loading rates and possible loading rates with allocated reductions were determined with a mathematical model. The model combined aspects of landuse, hydrology (rainfall and river flow), bacterial decay, and dilution. The bacteria model operates on a daily time step and has three basic components: watershed hydrology, watershed pollutant balance, and estuary pollutant balance. These components were combined to mathematically describe the accumulation and decay of bacteria throughout the subbasins under current conditions. This allowed the model to estimate potential concentrations under different conditions with reduced bacterial runoff concentrations, but all other variables held constant.

The hydrology governs the transport of bacteria within the watershed, delivering loads to the bay. Basin hydrology is modeled using the physically based, Soil and Water Assessment Tool (SWAT), developed by the United States Department of Agriculture (USDA) Agricultural Research Service (ARS). Input variables for the model include are listed in **Table 16.**

The loading capacity is defined as the maximum predicted 90-day median and 90th percentile loads after load allocations using the mathematical model described in Appendix B. The model is based on flow and pollutant accumulations from small spatial subunits distributed throughout the subbasins. The maximum load for each landuse was determined by reducing storm runoff concentrations and direct loading until the shellfish criteria were not exceeded for the model period of September 1995 through March 2002. The model used a daily time step, but a 90-day moving window to calculate the median and 90th percentile statistics.

Bacteria enter the river network from three categories of potential sources: through storm generated overland flow (e.g., urban, residential, and rural stormwater), through constant direct input (e.g., septic systems), and through wastewater treatment plants (WWTPs). The bacteria loads are routed within the river network dependent on flow rate while experiencing first-order decay. The concentration of bacteria in the bay is determined from the upland loading and empirically determined, flow dependent dilution. Bacterial concentration input data were generally from direct measurements in the subbasin being modeled. The hydrologically calibrated model was then calibrated to field measurements of bacterial concentrations under a variety of flow conditions over a five-year period. . The model was then re-run, iteratively reducing loading rates until there were no violations of the water quality criteria for shellfish harvest in Nehalem Bay and Necanicum Estuary, and for water contact recreation at the Clatskanie River mouth over the same 5-year period. Details are included in **Appendix B**.

Table 16. SWAT Model Input Parameter Values

Parameter	Value	Explanation
Precipitation Lapse Rate	10.5 mm / km	Adjusts daily rainfall accumulations based elevations
Deep aquifer percolation fraction	1.0	Controls volume of groundwater which percolates into the deep aquifer
Manning's n – Main Channel	0.050	Roughness coefficient
Manning's n – Tributaries	0.035	Roughness coefficient
Muskingum: coefficient 1	0.0	Governs the storage in reach at low flows
Muskingum: coefficient 2	2.0	Governs the storage in reach at high flows
Muskingum: X (weighting factor)	0.2	Governs the shape of the hydrograph
Landuse Runoff factors	Vary by basin and landuse	Concentration of bacteria in runoff from various land uses
Direct Inputs	Vary by category	Concentrations and flow rates from direct inputs such as septic systems, wastewater treatment plants, etc.
First Order Decay Rate	0.8/day	Describes decay of bacteria with time in water.

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. 1) 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. 2) 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 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 bays and estuaries. The TMDL targets river concentrations that will limit the loading and result in low concentrations in shellfish harvesting beds of Nehalem Bay and the Necanicum estuary. 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 the general class of 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 North Coast Subbasins are defined in the Oregon Administrative Rules **(***OAR 340 – 41 – 202;* **Table 17)**. The key beneficial uses affected by elevated concentrations of fecal bacteria are body contact recreation in rivers, and shellfish harvesting (classified as a fishing beneficial use) in bays and estuaries. There are recreational shellfisheries, although the neither Nehalem Bay nor the Necanicum estuary currently include 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 either of these waterbodies.

Table 17. Beneficial uses occurring in the North Coast Basin
(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 18 and Appendix C of this document)**. The beneficial uses affected by elevated bacteria levels are primary contact recreation (swimming) and shellfish harvesting (fishing). The criteria for "bacteria in shellfish waters" apply to Nehalem Bay and Necanicum Estuary and beaches where shellfish are harvested commercially or recreationally for human consumption. The criteria for "recreational contact in water" apply to all other waters in the watershed. 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.

Table 18. 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.

3.2.5 Pollutant Identification

The pollutant causing impairment of 303(d) listed waters is fecal bacteria. Standards violations have occurred due to both fecal coliform and *E. coli* bacteria (a subset of 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, bays, and estuaries.

The majority of data analysed for development of this TMDL was of *E. coli* concentrations, though fecal coliform data are still collected for estuarine waters to assess the potential health threat of consuming harvested shellfish. The methods of bacterial analysis have 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 (for fecal coliform) were not of any practical significance mainly because of the inherently low degree of reproducibility of the MPN estimates." Regardless of the analytical technique, all available fecal coliform data have been combined for this report. E. coli data derived from various analytical techniques have also been combined.

3.2.6 Deviation from standards and Existing Bacterial Sources - CWA §303(D)(1)

Bacterial concentrations are most commonly elevated in the lower reaches of the Nehalem, Necanicum and Clatskanie Rivers. In general, instream concentrations in higher elevations only rarely exceed standards, if at all. Analysis of bacterial concentrations is based on data available in DEQ's LAboratory Storage And Retrieval System (LASAR). Data from all available stations (**Table 19, Figure 28**) were analyzed over the entire period of record in subsets of more recent data and are presented in box plot format (**Figure 36**). Where available, watershed council data have also been reviewed. Overall, violations of water quality standards were rare at river and stream stations. Bay and estuarine samples were much more likely to exceed the more restrictive shellfish standards.

Table 19. Monitoring sites

Code (see Fig. 1)	LASAR ID	Name
1	11226	Necanicum River At 12Th Ave (Seaside)
2	23551	Necanicum River at U Street
3		Neacoxie Creek at "G" Street
4	24326	Neawanna Creek at Hwy 101 Bridge
5		Neawanna Creek at Stanley Lake fork
6	10521	Necanicum River At Riverside Lake Camp (Seaside)
7	23552	Necanicum River at Klootchie Creek Road
8	23555	North Fork Necanicum River at Hwy 26 (Necanicum RM15.2)
9	23558	Necanicum River at Hwy 53 (u/s of Bergsvik Creek)
10	23871	Necanicum River at Hwy 26 Bridge, RM 18.8
11	13298	Nehalem Bay At Jetty Fisheries
12	13297	Nehalem Bay At Brighton
13	13446	Nehalem Bay At Nehalem Bay St Park Boat Ramp
14	18886	Nehalem Bay At Green Marker #17
15	13296	Nehalem Bay At Paradise Cove Dock
16	13295	Nehalem Bay At Wheeler
17	24388	Gallagher Slough at Hwy 101 (Nehalem)
18	13640	Nehalem River At Hwy 101 (County Boat Ramp)
19	13639	Nehalem River At Nehalem City Dock (West Chan)
20	12866	Nehalem River North Fork At Mcdonald Road Bridge
21	24297	Nehalem River at RM 3.5
22	11428	North Fork Nehalem River At Aldervale
23	18802	North Fork Nehalem R At Highway 53
24	20440	Foley Creek @ Lommen Road
25	11856	Nehalem River At Foley Rd (Roy Creek Campground)
26	23292	Cook Creek at Mouth (Nehalem)
27	13368	Nehalem River At River Mile 15.0
28		Salmonberry River at Mouth
29	23509	Nehalem River d/s Humbug Creek at Lower Nehalem Rd.
30	23287	Nehalem River at Hwy 202 (Jewell)
31	23873	Nehalem River at Hwy 202 Bridge in Vesper
32	24300	Nehalem River at Hwy 47 Bridge in Pittsburg (RM 84.7)
33	11787	Rock Creek 200 Ft U/S Of Mouth
34	24299	Nehalem River at Hwy 47 Bridge u/s of Vernonia (RM 92.1)
35	23273	Nehalem River at Cochran Rd. Bridge 1393

Table 20. Wastewater treatment plants

Code (see Fig. 28)	Facility ID	Name
A	61787/A	Nehalem Bay Wastewater Agency
B	92773/A	City of Vernonia
C	29850/A	Fishhawk Lake Recreation Club, Inc.
D	79929/A	City of Seaside

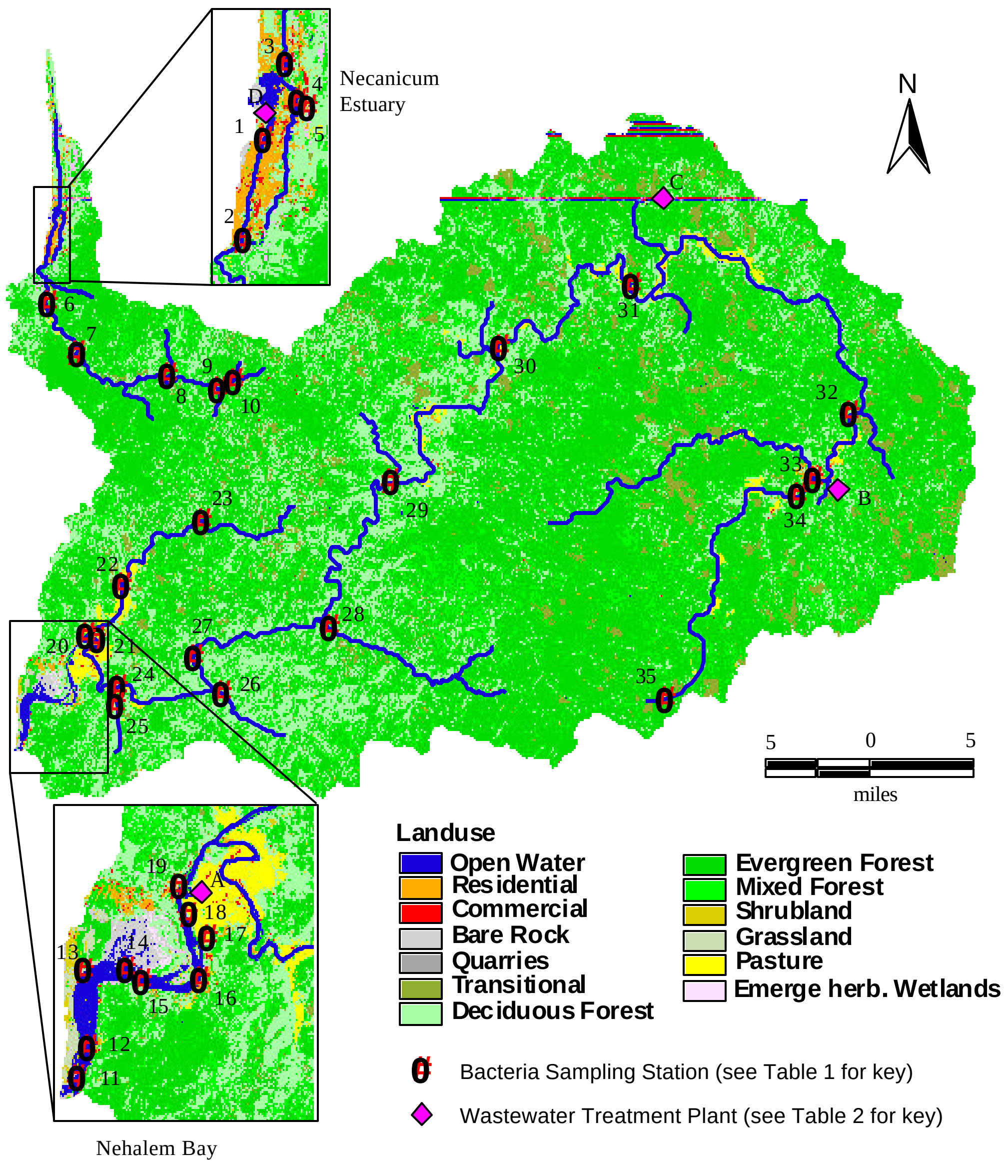


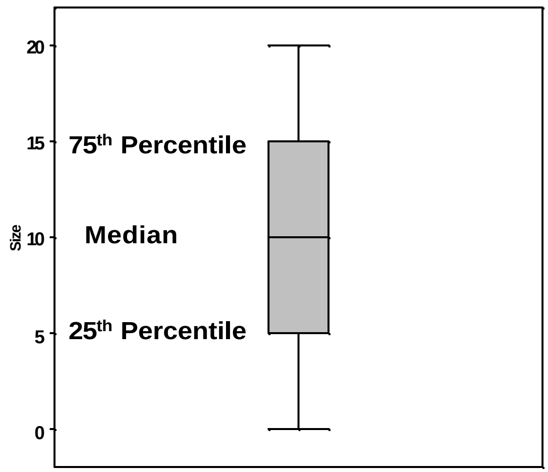
Figure 28. Landscape types within the model study area for bacteria. Sample stations are identified in Table 19 and Wastewater Treatment Plants are identified in Table 20.

Bacterial Distributions

Discussions of bacterial concentrations that follow present distributions of sample data and use median values as approximations of geometric means. This would not be appropriate for determinations of violations of water quality criteria based on geometric means, but is reasonable as a method of discussing distributions of sample concentrations. The distributions are presented in box and whisker plots, as described in **Figure 29**.

Figure 29. **Box Plots are used to illustrate the distribution of samples through time or among places. The percentile indicates the percentage of sample values less than the value at that point in the distribution. In example 1 (top), 75 percent of sample values are lower than 15 and 25 percent are lower than 5. By definition, the median is the 50th percentile, with 50 percent of values lower and 50 percent of values higher than the median.**

Box and Whisker Plot Example 1

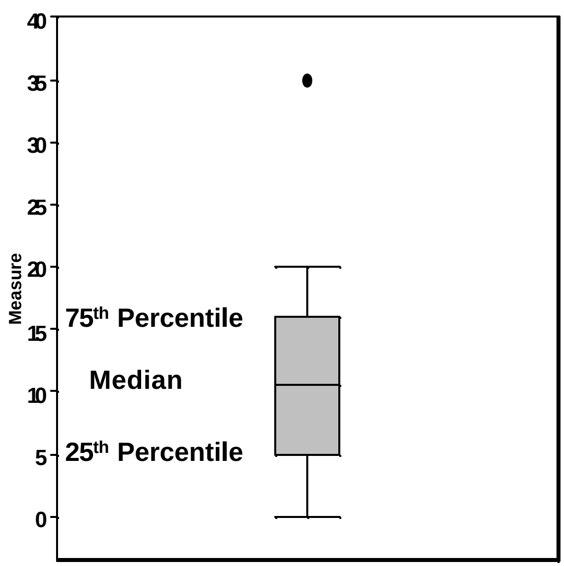


In the Box Plot at left, the numbers 0 through 20 are plotted based on their distribution as a percent of the total.

The median = 10
75th Percentile = 15
25th Percentile = 5

Ends of the "whiskers" are the extreme values in the data excluding "outliers"

Box and Whisker Plot Example 2



In the Box Plot at left, the numbers 0 through 20 are plotted based on their distribution as a percent of the total. An additional number,35, is plotted as an "outlier"

Outliers are greater than 1.5 times the range between the 25th and 75th Percentiles

3.2.6.1 Nehalem River Subbasin

<u>3.2.6.1.1 Rivers</u>

Nehalem River bacterial concentrations were measured by DEQ and the Lower Nehalem Watershed Council. The DEQ data covered a period from 1966 through 2001. Watershed council data was restricted to 2000 and 2001 data because earlier samples did not meet DEQ-defined quality assurance criteria. Concentrations were most often below criteria for protection of recreational contact in all datasets. Median *E. coli* concentrations were less than 126 MPN/100 ml at all stations. Single sample concentrations were occasionally greater than the “not-to-exceed” value of 406 MPN/100 ml, but were more likely to exceed this criterion on the North Fork of the Nehalem than on the Nehalem River itself.

When viewed on a monthly basis, the data indicate the same pattern. Median *E. coli* concentrations were generally below the recreational criterion in all months, though individual samples exceeded the maximum criterion on occasion. Concentrations overall were higher and more likely to exceed the single-sample criterion in fall months than other times of the year (**Figure 30**). This is a typical pattern apparently associated with the onset of large storms in September through January. First-flush events typically contain higher concentrations of bacteria. As observed in the station data, concentrations were more likely to exceed the single-sample criterion in the North Fork of the Nehalem than in the Nehalem River itself. The highest values on the North Fork were not apparently associated with storms.

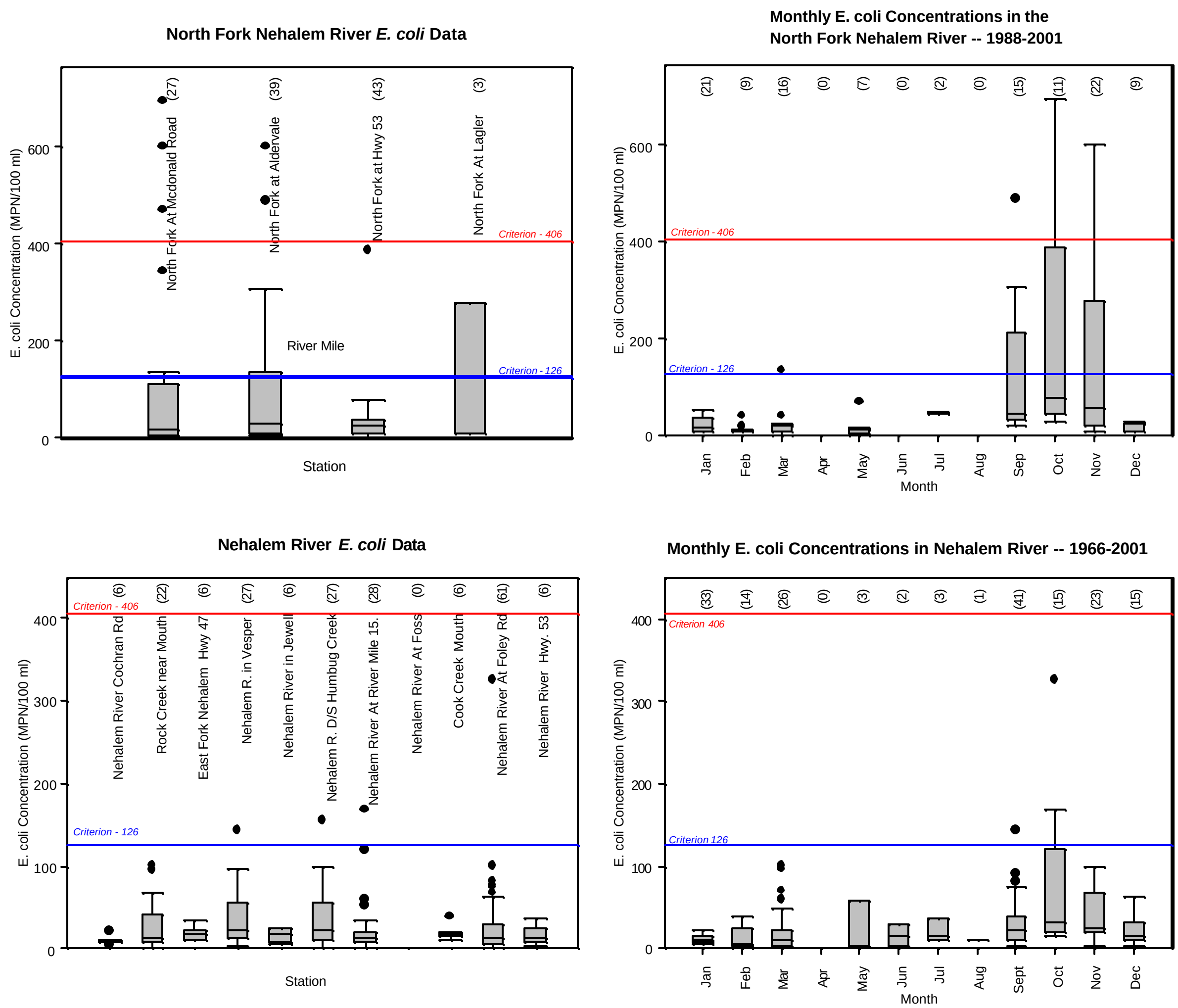


Figure 30. Concentrations of E, coli in DEQ samples among stations and monthly in the North Fork Nehalem (top row) and Nehalem Rivers (bottom row).

E. coli concentrations in Watershed Council data cover a more discrete period of time than the data collected by DEQ. Data were collected monthly at 14 sites in the Nehalem and North Fork Nehalem sub-watersheds (**Figure 31**). These data indicate the same patterns as the DEQ data in that concentrations were often higher in the North Fork Nehalem than in the Mainstem Nehalem, and that fall and winter concentrations tended to be higher than during drier months.

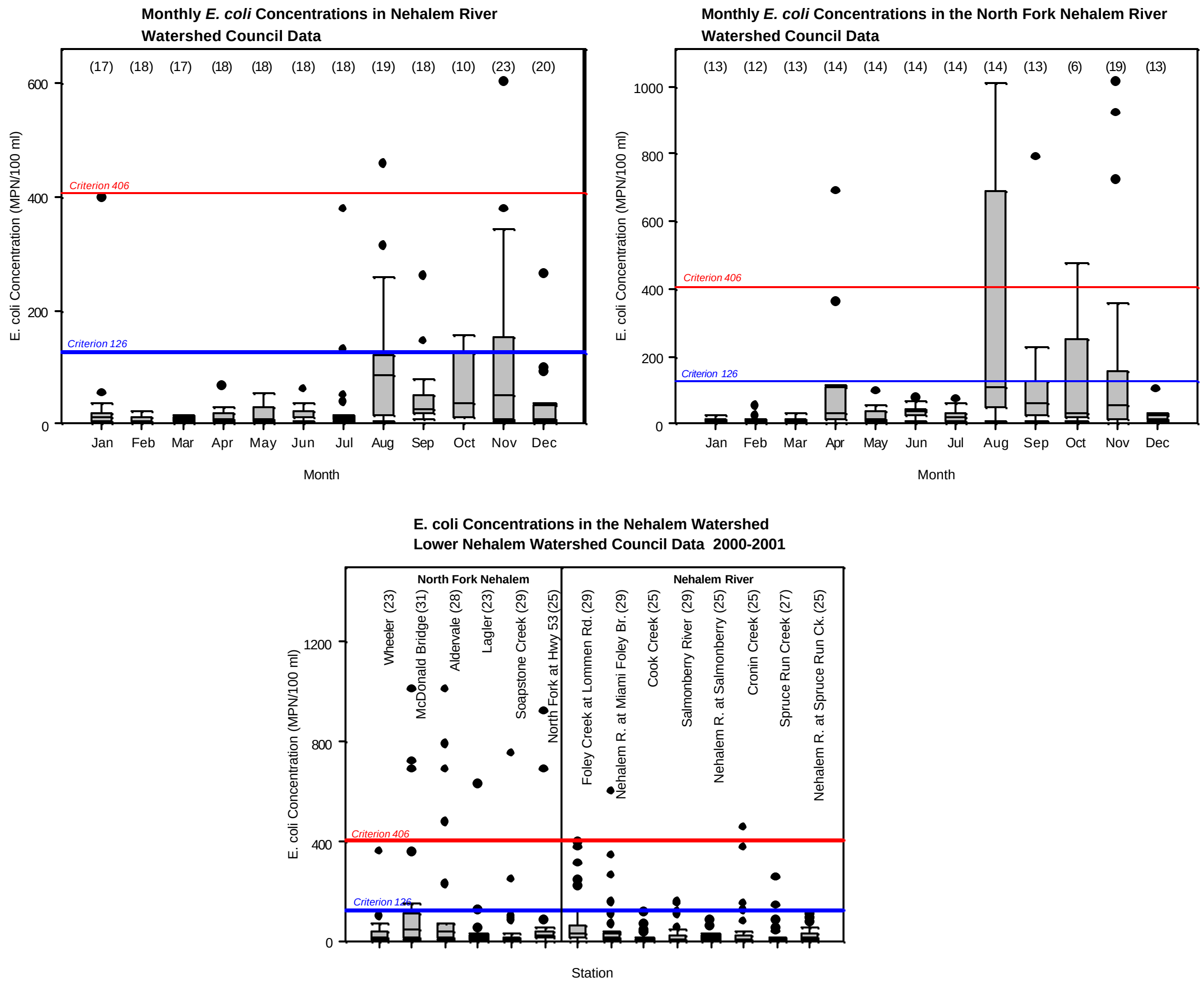
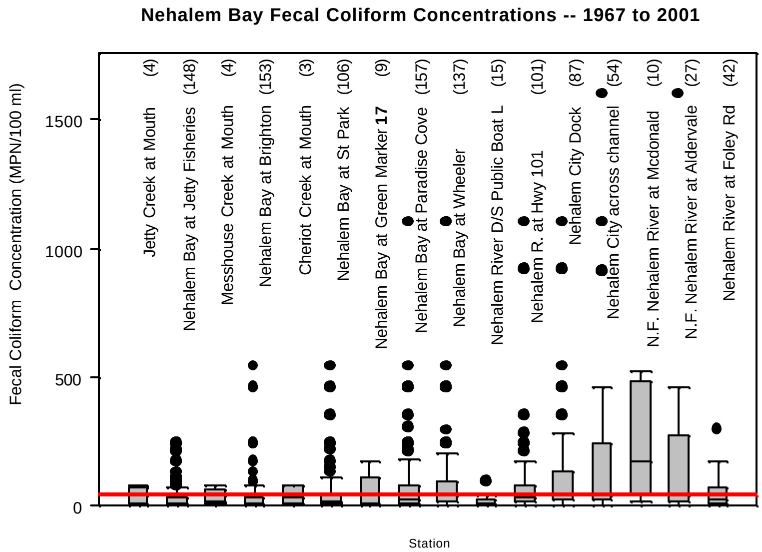


Figure 31. Concentrations of E.coil in watershed council samples during 2000-01. Samples are plotted by month with all stations combined (top row) and among stations (bottom).

3.2.6.1.2 Concentrations in the Bay

Concentrations of fecal coliform bacteria in Nehalem Bay have regularly exceeded the criteria for the protection of marine and estuarine shellfish harvesting. Monthly median values of all samples over time were mostly greater than the 14 MPN/100 ml criterion. Historically, concentrations within the bay have had strong geographical and seasonal components. Seaward of the State Park dock, median concentrations generally have met the criterion during summer months, but violate during some winter months (**Figure 32**). Median concentrations near Wheeler generally violated both median and 90th percentile criteria throughout the year. Overall, there have been no appreciable changes in concentrations through time (**Figure 32**). Though distributions of sample concentrations appear to be lower and tighter around the median in recent years, this may be an artifact of the generally greater number of samples collected since the late 1980s.



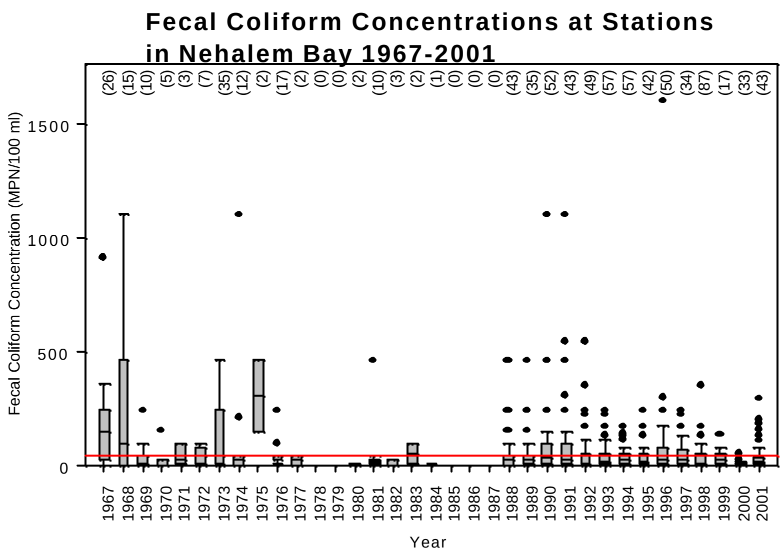


Figure 32. Fecal coliform concentrations by station (top) and by year (bottom). Red line indicates 90th percentile shellfish harvest criterion of 43 MPN/100 ml.

Seasonally, concentrations have been higher in the fall and early winter than the rest of the year (**Figure 33**). All stations in the bay have shown some violations of one or the other criterion at some time of the year, although the stations near the mouth of the bay generally violate less frequently and to a lesser degree. Although there are differences among stations in what month high concentrations occur, this is likely a result of the high variation in bacterial samples and the differences in when samples were collected.

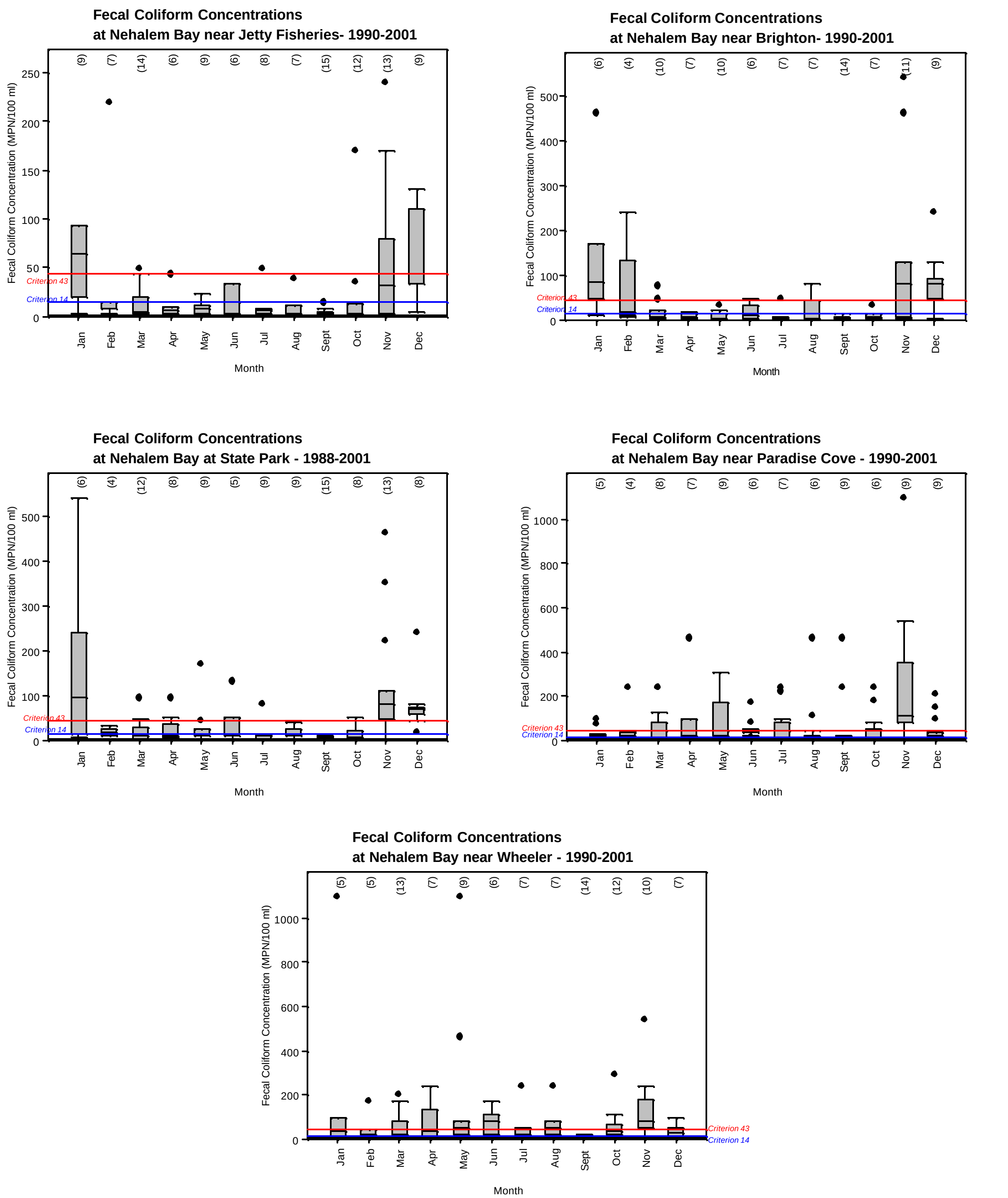


Figure 33. Fecal coliform concentrations by month at 5 stations; 1988-2001.

3.2.6.1.3 Dry Weather Data

A dry-weather survey of the entire watershed was conducted in September 2000. Data from the survey, which were collected over several days, indicated that concentrations in the rivers and bay generally met the various water quality criteria (**Figure 34**). Exceptions were at the Aldervale Bridge on the North Fork of the Nehalem, with a median concentration of 236 MPN/100 ml and a 90th percentile value of 398 MPN/100 ml, and the Nehalem River at Pittsburgh, where the median was 153 MPN/100 ml and the 90th percentile value was 300 MPN/100 ml. These were the only sites that violated water quality criteria during the survey. Although the concentrations at the Pittsburgh site violated the recreational contact criterion, it would not be expected to cause violations in the Bay. The violations at Aldervale Bridge would be more likely to impact the Bay.

Concentrations within Nehalem Bay were generally low during the dry-weather survey, despite elevated concentrations at the Aldervale Bridge station. Median concentrations ranged as high as 17 MPN/100 ml, but concentrations at all stations from Wheeler seaward were well below the criterion of 14 MPN/100 ml.

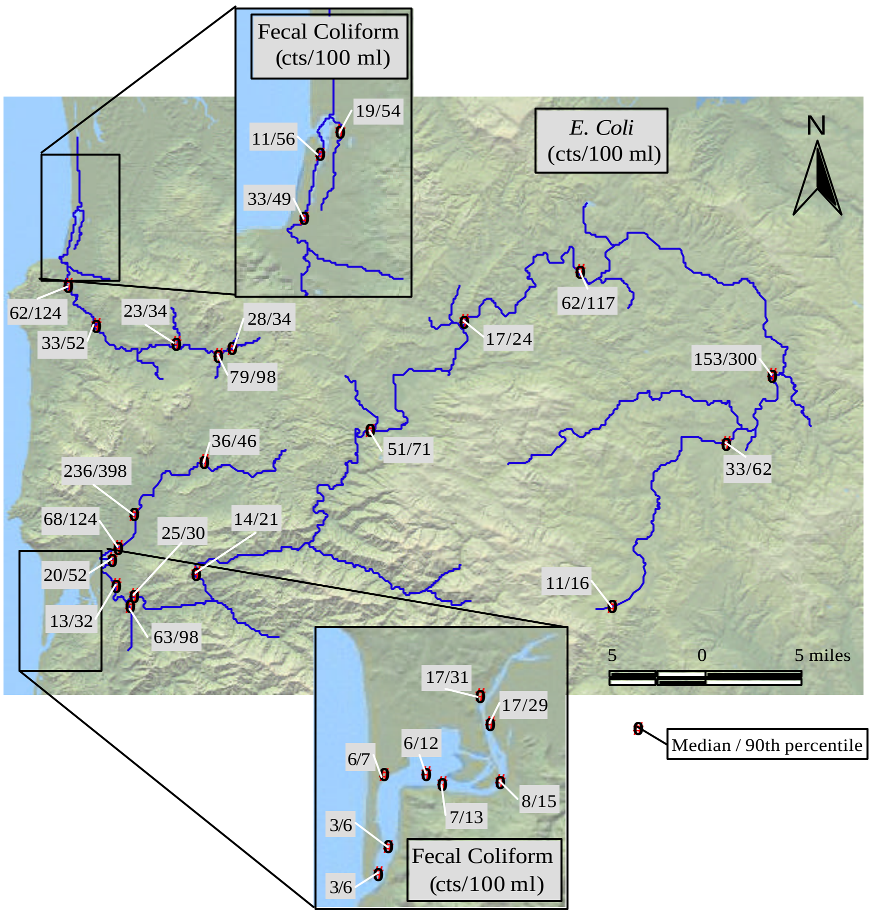


Figure 34. Concentrations of bacteria in bay and mainstem dry-weather survey of Nehalem and Necanicum Subbasins. Values at each station are median and 90th percentiles of *E. coli* in rivers and Fecal Coliform at Bay stations (exploded boxes).

3.2.6.1.4 Storm Data

Storm sampling could not be done in fall-winter of 2000 because there were few if any storms of sufficient size that year to provide representative instream and runoff concentrations. Sampling during a storm in October 2001 indicated generally higher concentrations throughout the basin than during the dry-weather survey, with especially high concentrations in lowlands of both the North Fork and Nehalem Mainstem near the bay (**Figure 35**). Concentrations from the outlet of Gallagher Slough near hwy 101 were especially high, peaking at over 12,000 MPN/100 ml.

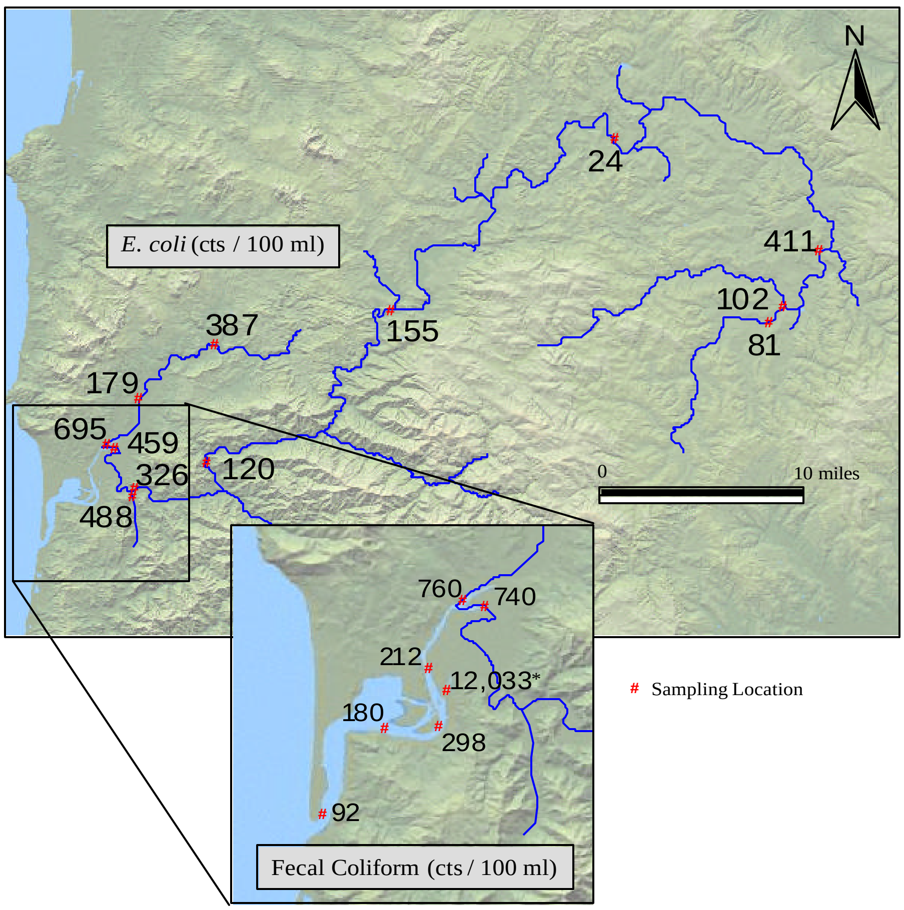


Figure 35. Maximum concentrations of E. coli in a wet-weather survey of the Nehalem Subbasin.

3.2.6.2 Necanicum River Subbasin

3.2.6.2.1 Necanicum River

Bacterial concentrations have been characterized in the Necanicum River through monitoring at DEQ's ambient monitoring site at river mile 5, through a dry-weather study, and through weekly sampling in the fall-winter of 2000 and 2001 (**Figure 36**). The river is listed as water quality limited under section 303(d) based on elevated concentrations of fecal coliform data collected over the years at the ambient monitoring station. More recent data indicates that concentrations above river mile 5 are generally lower, and generally meet the water contact recreation criterion of 126 MPN/100 ml as a geometric mean and concentrations never exceeded the "not-to-exceed" criterion of 406 MPN/100 ml. Concentrations at the ambient monitoring site occasionally exceeded both criteria, suggesting a source of bacteria between the ambient site and the next station upstream at Klootchie Creek. An analysis of paired samples (n=6) collected over a three-day period at these two sites indicated a significantly higher mean concentration at River Mile 5 than at Klootchie Creek (Wilcoxon Rank Test; z=2.25, p-value = 0.0245). A significant source of bacterial contamination appears to be entering the river between Klootchie Creek and river mile 5 (Riverside Lake Campground). We believe this source results from failing septic systems at the Riverside Lake Campground. Though some improvements have been made, this recreational camp has been a known site of failed septic systems and is currently under enforcement by DEQ. In fact, all of the values greater than the "not-to-exceed" criterion of 406 MPN/100 ml and much of the variation among monthly samples may be attributed to this site. Sample concentrations downstream of the site were generally low overall.

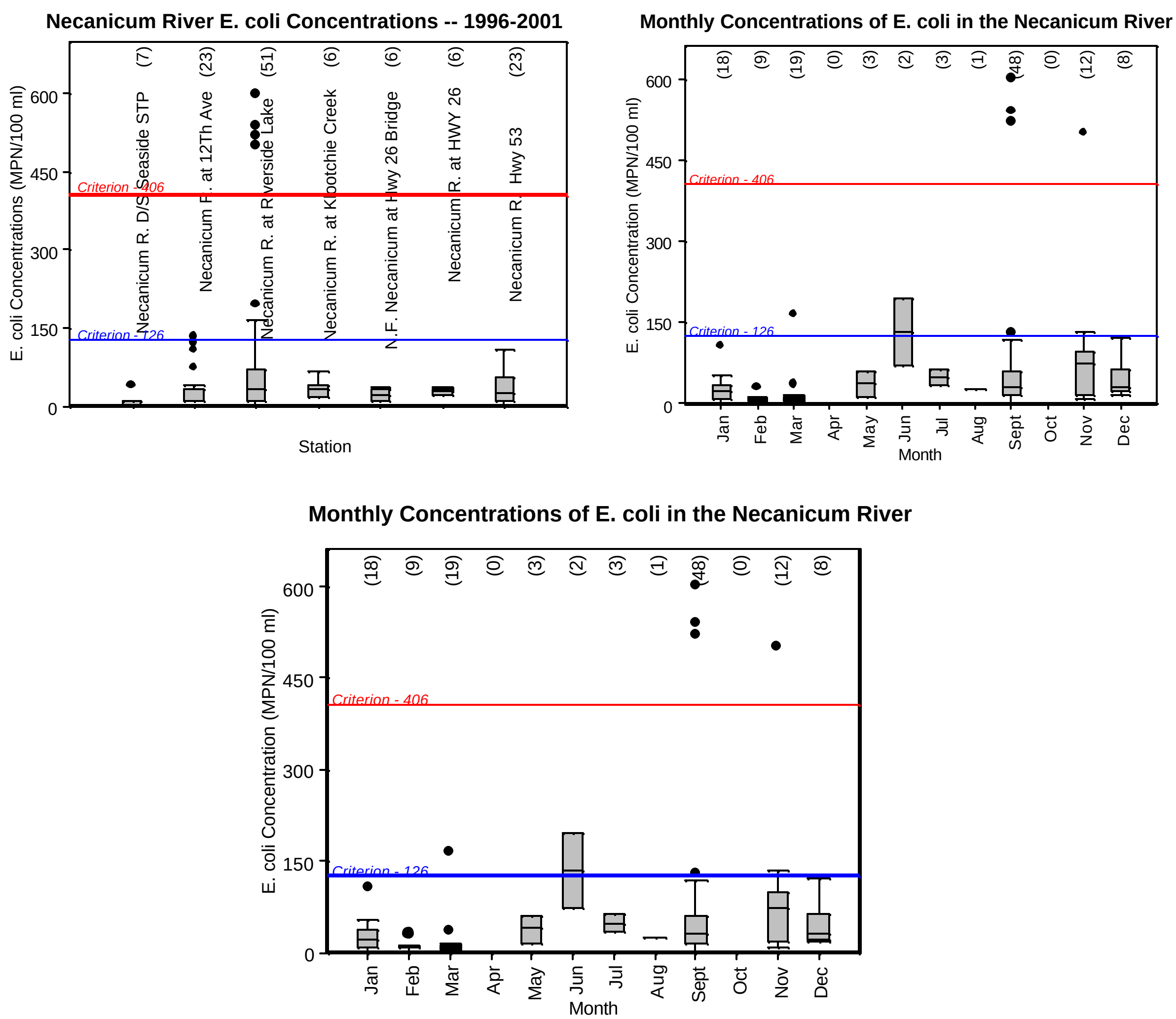


Figure 36. **E. coli concentrations by station and by month throughout the Necanicum River (top row) and monthly at Riverside Lake Campground (bottom).**

3.2.6.2.2 Necanicum Estuary

Bacterial concentrations in the Necanicum Estuary and adjacent beaches have been monitored through a combination of DEQ and Oregon Department of Agriculture (ODA) sampling (**Table 21**). These sites and others are routinely monitored by ODA to ensure the safety of shellfish harvest for human consumption. The beach stations must meet the marine and estuarine criterion of 14 MPN/100 ml fecal coliform as a median and 43 MPN/100 ml as a 90th percentile. Bacterial concentrations in the Necanicum Estuary are the result of inflows from several creeks as well as flow in the Necanicum River. The concentrations in the estuary itself are often elevated, though most beach sites are in compliance with the marine and estuarine water quality criteria. The exception along the oceanfront is at Seaside Beach at the Promenade during summer months. The Necanicum River at 12th Street generally meets the freshwater contact criteria of 126 MPN/100 ml *E. coli* as a geometric mean and a maximum value of 406 MPN/100 ml, though there have occasionally been values that exceeded the maximum criterion. From 1995 through 2001 there were 6 violations of this maximum criterion in 88 samples at this site.

Table 21. Concentrations of bacteria in Necanicum Estuary and beaches near the City of Seaside.

	Necanicum River at 12th St. [1]		Seaside [2] Beach at Promenade	Del Rey [2] Beach	Gearhart [2] Beach
Fall Winter Spring	**E. coli**	**Fecal Coliform**	**Fecal Coliform Concentrations**		
Geometric Mean	22.2	34	7	3	4
90th percentile	113.6	124	33	15	11
Median	20	33	7	2	2
n	17	44	41	59	47
Summer					
Geometric Mean	13.7	29	10	4	5
90th percentile	36	350	201	16	17
Median	9	33	6.5	2	2
n	6	44	44	62	41

1=Freshwater criterion based on *E. coli*: 126 MPN/100 ml geometric mean; maximum value of 406 MPN/100 ml.
2=Marine and estuarine shellfish criterion based on fecal coliform: 14 MPN/100 ml median; 90th percentile of 43 MPN/100 ml or less.

Concentrations are commonly elevated in creeks that flow into the estuary (**Table 22**). These waterbodies are largely dominated by nonpoint sources of bacteria, though failing septic systems may also be important contributors to this pollution. A recent survey of septic system permits indicate that, although many of the septic systems along Neacoxie Creek are relatively new, many have components that date to the 1970s.

Table 22. Samples from Inflows to Necanicum Estuary during January and February, 2002.

	Necanicum River at 12th St	Neawanna Crk at Highway 101	Neacoxie Crk at "G" Street	Neawanna Crk at Stanley Lake Fork
E. coli [1]				
Geometric Mean	99	172	195	101
90th Percentile	204	308	634	234
Median	121	218	173	96
Count (n)	6	5	7	5
Fecal Coliform				
Geometric Mean	128	142	232	86
90th Percentile	224	228	860	182
Median	150	147	152	73
Count (n)	5	4	5	4

1=Freshwater criterion based on *E. coli*: 126 MPN/100 ml geometric mean; maximum value of 406 MPN/100 ml.

3.2.6.3 Clatskanie River Subbasin

Bacterial concentrations in the Clatskanie River have been characterized through monitoring at DEQ's ambient monitoring station in the lower watershed, occasional sampling at several other stations, and through monthly E. coli monitoring conducted by the Clatskanie River Watershed Council. The Clatskanie River is listed as water quality limited in summer based on data collected at the ambient monitoring station and samples collected near the City's sewage treatment plant (STP) outfall. Some of these data exceed the criteria for protection of water contact recreation. In general, concentrations in the river meet water quality criteria, but there are occasional excursions above one or the other. The dataset is particularly affected by four samples collected within an hour of each other in the vicinity of the STP on a rainy summer day. These samples all exceeded the "not-to-exceed" criterion and are the basis for the listing.

Watershed Council data suffer from inadequate quality assurance measures, and so were not considered during 303(d) listing process. Despite the flaws in these data, we have analyzed them to assess the breadth and possible causes of water quality limitations. These data suggest that concentrations are within the criteria throughout the basin, except for occasional high values both near the Highway 30 bridge and upstream of Carcus Creek in the upper watershed. Unfortunately, the watershed council's analysis could only provide values lower than 200 MPN/100 ml, and estimated values above this concentration. This requires us to assume that any estimate of >200 MPN/100 ml also exceeds the criterion of 406 MPN/100 ml. Median and geometric mean (range = 3.9-63.4 MPN/100 ml) values were below the 126MPN/100 ml criterion at all stations.

The source of bacteria at the Highway 30 site is most likely urban runoff, the highest concentrations having occurred during a light summer rain event near this site. The source upstream of Carcus Creek is more likely to be small livestock operations or failing septic systems, respectively. Whatever the sources are, the concentrations observed suggest a relatively subtle bacterial load at these sites. There is no indication of elevated values downstream of Clatskanie near the confluence with Beaver Creek, and the sewage treatment plant has consistently demonstrated effective reduction of *E. coli* in its wastewater. The only sources upstream of Carcus Creek are rural residences that may have failing septic systems or small livestock operations.

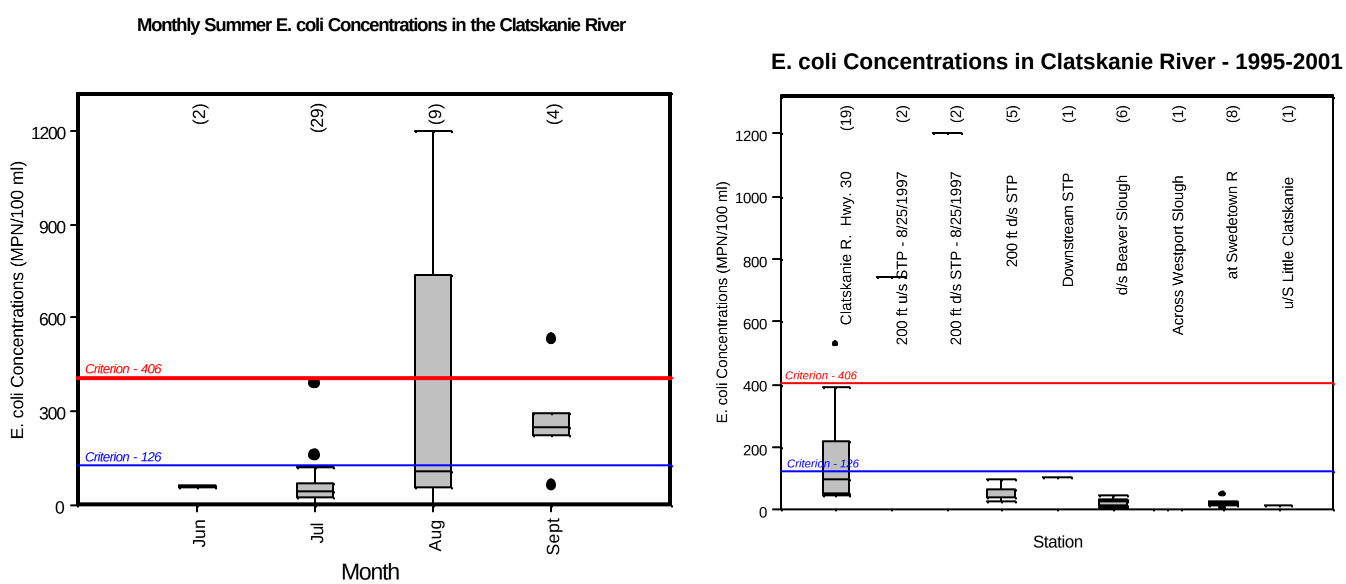


Figure 37. E. coli concentrations in DEQ samples collected from the Clatskanie River by station and by month.

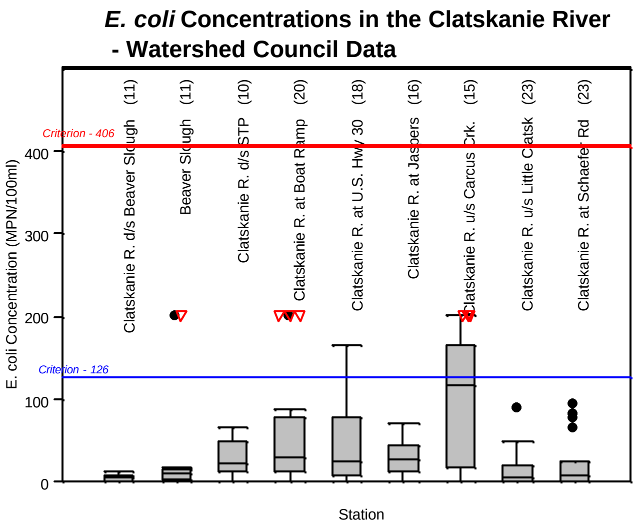


Figure 38. E. coli concentrations in watershed council data by station in the Clatskanie River. The data do not meet quality assurance criteria, but are included for illustration. Red triangles indicate samples with estimated values greater than 200 MPN/100 ml.

3.2.7 Identification of Sources of Bacteria

3.2.7.1 Nonpoint Sources

Bacteria reach surface waters from a variety of sources. Urban runoff, rural residential runoff and failing septic systems, pet wastes and livestock all produce fecal bacteria and are sources in each of the Subbasins covered by this document. Urban areas are largely restricted in the Subbasins receiving allocations to the Cities of Nehalem, Wheeler, Vernonia, Seaside, and Clatskanie. Rural residential areas are ubiquitous in all of the Subbasins, but are more common where flat land occurs near rivers and streams. Failing septic systems and pet wastes are associated with urban and rural residential uses.

There are confined animal feeding operations (CAFOs) in most of the Subbasins (**Table 23, Figure 46**). These facilities operate under a general National Pollutant Discharge Elimination System (NPDES) permit issued by DEQ and administered by the Oregon Department of Agriculture ODA). CAFO facilities are considered point sources, and under the terms of these permits, **no discharge is allowed from areas of animal confinement, or manure management and storage**. Pastures associated with these CAFOs that do not have manure spread on them for nutrient management are considered nonpoint sources of bacteria and other pollutants. These facilities are generally small and tend to be concentrated in lowland areas, particularly in the Nehalem Subbasin. Although the number of facilities is small, overall, there are many more animals than indicated on small acreages that do not qualify as CAFOs. Non point source load allocations were determined based on the number of head of livestock in each of the modeled subbasins.

Table 23. Number of CAFOs and Adult Animals by Subbasin (ODA).

Category	Nehalem	NF Nehalem	Lower Columbia Young's	Clatskanie[2]
Number of CAFOs	10	5	7	2
Number of Cattle	1291	880	799	80
Other			10300[1]	

1= Mink Breeding Farms 2= not on the Clatskanie River – see Figure 39
CAFO = Confined Animal Feeding Operation

The Waste Load Allocations to CAFOs include some pasture areas that have manure spread on them for management. The area of these pastures was estimated by assuming that the 0.5 acres was associated with each adult animal. Therefore, an estimated 650 acres in the Nehalem River Watershed and 440 acres in the North Fork Nehalem Watershed are part of CAFO facilities. There are no CAFOs in modeled rivers of the Necanicum and Clatskanie River Subbasins. For analyses and allocation purposes, pastureland associated with CAFOs is differentiated from pastureland not associated with CAFOs which receives Load Allocations.

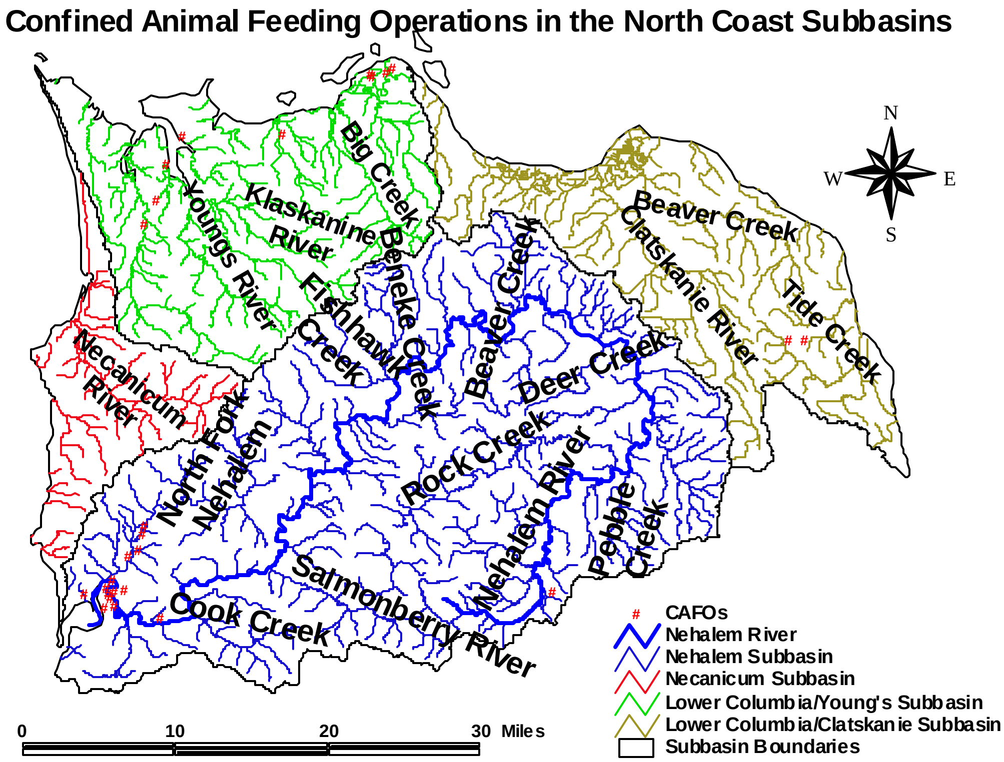


Figure 39. Distribution of Confined Animal Feeding Operations (CAFOs) in the North Coast Subbasins.

3.2.7.1.1 Nehalem Subbasin

Livestock management occurs in parts of the Nehalem Subbasin, with substantial numbers of animals in the lower watershed near the bay and fewer in discrete areas of the upper watershed. Urban areas are generally small and widely separated in the basin. Although the City of Vernonia is the largest urban area in the basin, it is located more than 90 miles up river and has a minor impact on bacterial concentrations in the Bay.

3.2.7.1.2 Necanicum and Clatskanie Subbasins

Neither the Necanicum nor Clatskanie River Subbasins have livestock use comparable to the Lower Nehalem River. Livestock operations are relatively modest operations and are scattered throughout these areas. Both Subbasins have urban areas in the lowlands near confluences with the Pacific Ocean (Necanicum River) and the Columbia River (Clatskanie River).

Failing septic systems may play a significant role in elevated bacterial concentrations in these small rivers. A history of system failures have been recorded at the Riverside Lake Campground, on the Necanicum River. DEQ has ongoing enforcement action against this site, and significant increases at this site relative to one a few miles upstream have been measured (see Storm Data, above). A motel in downtown Clatskanie was also a continuing source of bacteria due to a failing system until connection to the city sewer in 1998. The influence the removal of this source from the river is currently unknown, although there appears to have been an improvement in bacterial concentrations since that time.

3.2.7.2 Point Sources of Bacteria

Point sources occur in each of the Subbasins (**Table 24**), though they are generally small and most are located in the lower elevation areas of the Subbasins. Facilities that confine and feed animals for specified periods and manage accumulated manure also operate as point sources under CAFO (confined animal feeding operations) permits administered by the Oregon Department of Agriculture.

Table 24. Point source dischargers and likely pollutants discharged.

Facility ID	Legal Name (Common Name)	Permit Type	Nearest City	Receiving Waterbody	River Mile	Pollutants Possible
29850/A	Fishhawk Lake Recreation Club, INC.	NPDES	Birkenfeld	Fishhawk Creek (to Nehalem River)[1]	3.8 (66)	Temperature Bacteria
61787/A	Nehalem Bay Wastewater Agency	NPDES	Nehalem	Nehalem River (Bay)[1]	2	Temperature Bacteria
92773/A	City of Vernonia	NPDES	Vernonia	Nehalem River[1]	90.3	Temperature Bacteria
64485/A	ODFW – NF Nehalem Fish Hatchery	GEN03	Nehalem	North Fork Nehalem River[1]	10.5	Temperature
3300/A	Arch Cape Service District	NPDES	Arch Cape	Arch Cape Creek[2]	0.5	Temperature Bacteria
13729/A	City of Cannon Beach	NPDES	Cannon Beach	Ecola Creek[2]	0	Temperature Bacteria
79929/A	City of Seaside	NPDES	Seaside	Necanicum River[1]	0.2	Temperature Bacteria
88436/B	Henke, Harry III (River Point Homeowners)	NPDES	Astoria	Young's River (Bay)[2]	2	Temperature Bacteria
81118/A	Shoreline Sanitary District	NPDES	Warrenton	Skipanon River[2]	8	Temperature Bacteria
64485/A	ODFW – Klaskanine Fish Hatchery	GEN03	Astoria	Klaskanine River (to Young's River)[2]	4.6 (10.3)	Temperature
16872/A	City of Clatskanie	NPDES	Clatskanie	Clatskanie River[1]	1.1	Temperature Bacteria

[1]= listed for bacteria or flows to a listed reach.
[2]= not listed for bacteria and does not flow to a listed reach.

3.2.8 Seasonal Variation - CWA §303(D)(1)

Seasonal variation has been considered in both the analysis of current conditions and in developing loading allocations. In general, the violations of the shellfish criteria in Nehalem Bay occur in wet season months or during runoff events. Allocations are designed to reduce concentrations during runoff events, and will be protective of the beneficial use throughout the year.

3.2.9 Loading Capacity – 40 CFR 130.2(F)

Loading capacity was determined for the Nehalem Subbasin, the Necanicum Subbasin, and the Clatskanie Subbasin separately. The loading capacity is defined in terms of the maximum predicted 90-day median and 90th percentile loads that resulted in meeting the water quality criteria concentrations in the mathematical model described in **Appendix B**. Loading rates were determined by decreasing runoff loads until water quality criteria were met at the appropriate point in the watershed. These loading rates reflect the accumulation of bacteria from all sources, including pointsources, and urban, rural and natural runoff.

3.2.9.1 Nehalem Subbasin

Load capacity was developed for each of the two numeric criteria in the standard for protection of shellfish harvest. The median concentration of 14 MPN/100 ml would be met in Nehalem Bay at Wheeler if the loads from all sources in the basin were limited to a median daily load of $3.18x10^{12}$ counts per day. The 90th percentile criterion or 43 MPN/100 ml would be met if maximum daily load was limited to $9.06x10^{12}$ counts (**Table 25**).

Table 25. Load Capacity to meet individual criteria for bacteria standard

Subbasin	**Load to meet geometric mean of 14 MPN/100 ml**	**Load to meet 90th percentile value of 43 MPN/100 ml**
Nehalem River	$3.18x10^{12}$	$9.06x10^{12}$
Necanicum River	$5.36x10^{11}$	$1.65x10^{12}$
	Load to meet geometric mean of 126 MPN/100 ml	**Load to meet Not-to-Exceed criterion of 406 MPN/100 ml**
Clatskanie River	$1.78\ x10^{12}$	$5.74x10^{12}$

3.2.9.2 Necanicum Subbasin

Load capacity was also developed for each of the two fecal coliform numeric criteria in the standard for protection of shellfish harvest in Necanicum Estuary. The median concentration of 14 MPN/100 ml would be met in Nehalem Bay at Wheeler if the loads from all sources in the basin were limited to a median daily load of $5.36x10^{11}$ counts per day. The 90th percentile criterion or 43 MPN/100 ml would be met if maximum daily load was limited to $1.65x10^{12}$ counts (**Table 25**).

3.2.9.3 Clatskanie Subbasin

The Clatskanie River is listed as water quality limited relative to the freshwater criteria for contact. These criteria are much less stringent than those protecting shellfish harvest in estuarine areas. The loading capacity for this Subbasin was developed using the modeling in the Upper Nehalem watershed, being of a comparable size and with similar land uses. The Clatskanie Subbasin drains about 300 square miles and contains three fifth field watersheds Plympton Creek, Clatskanie River, and Beaver Creek. The area upstream of Vesper in the Nehalem is approximately the same size (approximately 350 square miles) as the Clatskanie Subbasin. Modeling was performed on the Clatskanie River and its immediate tributaries. The loading capacity that would ensure meeting the median E. coli concentration of 126 MPN/100 ml is $1.78\ x10^{12}$ (**Table 25**). The loading capacity that would ensure meeting the maximum allowable *E. coli* concentration of 406 MPN/100 ml is $5.74x10^{12.}$ Modeling of this watershed at the proposed load reductions over a 5-year period resulted in concentrations exceeding 406 MPN/100 ml about 0.1% of the time.

3.2.10 Allocations – 40 CFR 130.2(G) AND (H)

Allocations are derived from modeling that determines that amount of bacteria (E. coli) that may enter surface waters without causing a violation of water quality criteria. Allocations are organized by Subbasin and divided among point sources (wasteload allocations) and nonpoint sources (load allocations) in the following sections. Point sources include wastewater treatment plants, industrial discharges, stormwater, and Confined Animal Feeding Operations (CAFOs). CAFO wasteload allocations have been reduced to zero (0) to reflect the permit requirement that no discharge is allowed from the confinement and manure management areas. This is distinguished from pasture lands that are used by animals for grazing and are allocated a loading rate. Wasteload allocations are presented for each of the wastewater treatment plants. Load allocations are in terms of runoff concentrations for each land use in the basin.

3.2.10.1 Wasteload Allocations

Loads of *E.coli* in STP effluent were very small relative to total daily loads under either current conditions or following modeled reductions (**Table 25**). Reported STP loads (**Table 26)** were less than 1/10th of one percent of the total loads for the watersheds, were generally well below permitted limits (**Table 27**), and had no effect in the model in determining concentration in the Bay. Several scenarios were modeled to assess the impact of point sources on bacterial concentrations in the Bay. Point-source bacterial concentrations were modeled assuming:

- no bacteria load;
- the current loading as calculated from discharge monitoring reports, and;
- permitted loading based on permit limits and current effluent flow rates.

In general, none of these model scenarios resulted in a violation of the shellfish bacterial concentration criteria in the Bay regardless of contributions from other (nonpoint) sources. This indicates that the point source effluent flow rates at the time of violations, typically during runoff and elevated river flows, do not carry significant loads of bacteria to the Bay.

Table 26. Reported Daily Wasteloads by season for Wastewater Treatment Plants (WWTP) and Confined Animal Feeding Operations (CAFO). CAFO loads are limited by permit requirements.

	Nehalem WWTP	Vernonia WWTP	Fishhawk Lake WWTP	Seaside WWTP	Clatskanie WWTP	CAFOs
Facility ID	61787/A	92773/A	29850/A	79929/A	16872/A	Various
Jan - Mar	$1.43x10^9$	$6.05\ x10^7$	$2.59\ x10^7$	$6.77\ x10^8$	$5.45\ x10^7$	0
Apr - June	$1.96\ x10^8$	$7.20\ x10^6$	$1.01\ x10^7$	$4.44\ x10^8$	$3.19\ x10^7$	0
July - Sept	$1.41\ x10^8$	No Discharge	$5.41\ x10^7$	$2.88\ x10^8$	$2.66\ x10^7$	0
Oct – Dec.	$1.73\ x10^8$	$1.21\ x10^9$	$7.19\ x10^8$	$5.74\ x10^8$	$6.23\ x10^7$	0

Table 27. Permitted Daily Wasteloads by season for Wastewater Treatment Plants (WWTP) and Confined Animal Feeding Operations (CAFO). CAFO loads are limited by permit requirements.

	Nehalem WWTP	Vernonia WWTP	Fishhawk Lake WWTP	Seaside WWTP	Clatskanie WWTP	CAFOs
Facility ID	61787/A	92773/A	29850/A	79929/A	16872/A	Various
Jan - Mar	$6.44\ x10^9$	$1.27\ x10^9$	$8.16\ x10^8$	$4.90\ x10^9$	$2.01\ x10^9$	0
Apr - June	$1.54\ x10^9$	$9.07\ x10^8$	$4.54\ x10^8$	$4.63\ x10^9$	$9.64\ x10^9$	0
July - Sept	$2.54\ x10^9$	No Discharge	$1.81\ x10^8$	$5.35\ x10^9$	$7.81\ x10^8$	0
Oct – Dec.	$5.44\ x10^9$	$3.81\ x10^9$	$6.08\ x10^9$	$8.89\ x10^9$	$2.03\ x10^9$	0

A final model scenario assumed a doubling of the current permitted loads from point sources. This resulted in geometric means and 90th percentile concentrations below the shellfish harvesting standard criteria more than 99% of the time during runoff events. The 99th percentile values of the running geometric mean of fecal coliform concentrations met the shellfish harvesting criteria in both the Nehalem and Necanicum basins (**Table 28)**. Therefore, an allocation of two-times the currently permitted loads for all WWTPs in the Nehalem and Necanicum Subbasins violated the geometric mean criterion (14 MPN/100 ml) less than 1% of the time during runoff events, and never violated the 90th percentile criterion (43 MPN/100 ml) under modeled scenarios. Wasteload allocations were not dependent on reductions to load allocations for nonpoint source contributions.

Table 28. 90-day running 99th Percentile concentrations for the Nehalem and Necanicum subbasins modeled with 200% of current permitted loading from wastewater treatment plants. Numbers in parentheses are shellfish criteria for fecal coliform bacteria. Concentrations assume achieving load allocations from nonpoint sources.

Statistic Criterion	90 day Geometric Mean (14 MPN/100 ml)	90 day 90th Percentile (43 MPN/100 ml)
Nehalem	14	28
Necanicum	14	30

Wasteload allocations for wastewater treatment plants (WWTPs) are based on current permit limits and an allowance for future growth and development. WWTPs in the subbasins generally discharge at concentrations lower than their permits allow. Results of modeling are based on a 90-day running geometric mean and 90th-percentile concentrations calculated over a five year period. Conversions from *E. coli* to fecal coliform were incorporated into the model. Increases to 200% of the current permitted loading from the Nehalem Bay WWTP, Fishhawk Lake WWTP and Vernonia WWTP would result in fecal coliform concentrations of 14 MPN/100 ml and 90th percentile concentrations well below 43 MPN/100 ml in at Wheeler (**Table 28**). Increases to 200% of current permitted loading for the Seaside WWTP would also meet water quality criteria in Necanicum Estuary. Thus, doubling of current WWTP flows at the recreational contact criterion (126 MPN/100 ml) would not result in a violation of water quality standards. Given these results, the current permitted load is allocated to all sources in the Nehalem and Necanicum Subbasins. In addition, a load equal to the current permitted load is allocated for future growth and expansion (**Table 29**).

Table 29. Wasteload Allocations for Wastewater Treatment Plants (WWTP) and Confined Animal Feeding Operations (CAFO). CAFO loads are limited by permit requirements.

Facility ID	Legal Name (Common Name)	River Mile	Permit Limit MPN/100 ml *E. coli*	Allocated Wet Weather Load Fecal Coiform Counts/day	Allocated Wet Weather Load – Growth and Expansion	Total Allocation
29850/A	Fishhawk Lake Recreation Club, INC.	3.8 (66)	126	6.08×10^{9}	6.08×10^{9}	1.22×10^{10}
61787/A	Nehalem Bay Wastewater Agency	2	126	6.44×10^{9}	6.44×10^{9}	1.29×10^{10}
92773/A	City of Vernonia	90.3	126	3.81×10^{9}	3.81×10^{9}	7.62×10^{9}
79929/A	City of Seaside	0.2	126	8.89×10^{9}	8.89×10^{9}	1.78×10^{10}
16872/A	City of Clatskanie	1.1	126	9.64×10^{9}	9.64×10^{9}	1.93×10^{10}
NA	Confined Animal Feeding Operations (CAFO)	NA	0	0	0	0

Permit limits for the Nehalem Bay WWTP and City of Seaside WWTP of 126 MPN/100 ml as a geometric mean or 406 MPN/100 ml as a single sample maximum will be protective of shellfish harvest and water contact recreation. Discharge from the City of Vernonia and Fishhawk Lake Recreation Club WWTPs must also meet these freshwater contact recreation criteria, and discharges at these concentrations do not impact bacterial concentrations in Nehalem Bay. As such, there are no additional limitations to the existing wastewater treatment plants resulting from the loading model.

Expanded or new discharges will be required to meet the appropriate water quality criterion for the location of the discharge. Expanded or new discharges to the rivers upstream of shellfish harvesting may be allowed the *E. coli* recreational contact criteria (126 MPN/100 ml as a geometric mean or 406 MPN/100 ml as a single sample maximum) if they demonstrate they will not increase Bay/Estuary concentrations beyond those expected under allocated conditions. In Nehalem Bay or Necanicum Estuary, new or expanded discharges to shellfish harvesting waters will be limited to the shellfish criterion

(Fecal Coliform geometric mean of 14 MPN/100ml and no more than 10% of samples exceeding 43 MPN/100 ml). Permit limits for Fishhawk Lake Recreation Club WWTP, City of Vernonia WWTP, and City of Clatskanie WWTP will remain at the *E. coli* recreational contact criteria (126 MPN/100 ml as a geometric mean or 406 MPN/100 ml as a single sample maximum), and any expansion must ensure that effluent will meet these limits.

3.2.10.2 Load Allocations

3.2.10.2.1 Nehalem Subbasin

Load allocations are separated in the Nehalem Subbasin into upper and lower watershed allocations. Bacterial decay in the upper basin results in diminished concentrations that have no significant effect on concentrations in the Bay. Lower watershed allocations reflect the importance of local landuse on bacterial concentrations in the Bay. Allocations are presented by land use and geographic area (**Table 30**). CAFOs by definition receive a wasteload allocation of zero as a term of their NPDES permits.

Table 30. Nehalem watershed storm runoff concentrations

Source – Storm Runoff	Present *E. coli* (cts / 100 ml)	Reduced *E. Coli*. (cts / 100 ml)	Reduction (%)
Low Pasture	10,000	500	95
Upper Pasture	10,000	4500	55
Low Urban	1400	500	65
Upper Urban	1400	630	55
Non Anthropogenic	60	60	0

3.2.10.2.2 Necanicum Subbasin

Load allocations in the Necanicum Subbasin were developed for runoff conditions from the SWAT model and apply throughout the watershed. Greatest reductions are required in pasture lands, though all categories except non-anthropogenic must significantly reduce runoff concentrations (**Table 31**).

Table 31. Necanicum River Subbasin storm runoff concentrations

Source – Storm Runoff	Present *E. coli* (cts / 100 ml)	Reduced *E. coli* (cts / 100 ml)	Reduction (%)
Pasture	2500	304	88
Urban	420	96	77
Rural Residential	175	72	59
Non Anthropogenic	60	60	0

3.2.10.2.3 Lower Columbia Clatskanie Subbasin

Load allocations in the Clatskanie Subbasin were developed for runoff conditions from the SWAT model and apply throughout the watershed. Similar reductions are required among land uses, and all categories except non-anthropogenic must significantly reduce runoff concentrations (**Table 32**).

Table 32. Table 7. Clatskanie River Subbasin storm runoff concentrations

Source – Storm Runoff	Present *E. coli* (cts / 100 ml)	Reduced *E. Coli*. (cts / 100 ml)	Reduction (%)
Pasture	10,000	7,000	30
Urban	1,400	980	30
Rural Residential	1,400	980	30
Non Anthropogenic	60	60	0

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

3.2.11.1 Nehalem River and Bay

Concentrations of E. coli in the Nehalem River with allocated reductions of bacterial concentrations in runoff will meet water quality criteria throughout the Subbasin. Modeled concentrations are slightly higher in the upper watershed, due to relatively low flow rates, but did not exceed the criteria for water contact. Concentrations at Wheeler will meet both the median (14 MPN/100 ml) and 90th percentile (43 MPN/100 ml) criteria for protection of shellfish harvest. Estimates of maximum values of the median and 90th percentile were predicted throughout the subbasin by the bacteria model at all historical flows between 1995 and 2001 (**Figure 47)**.

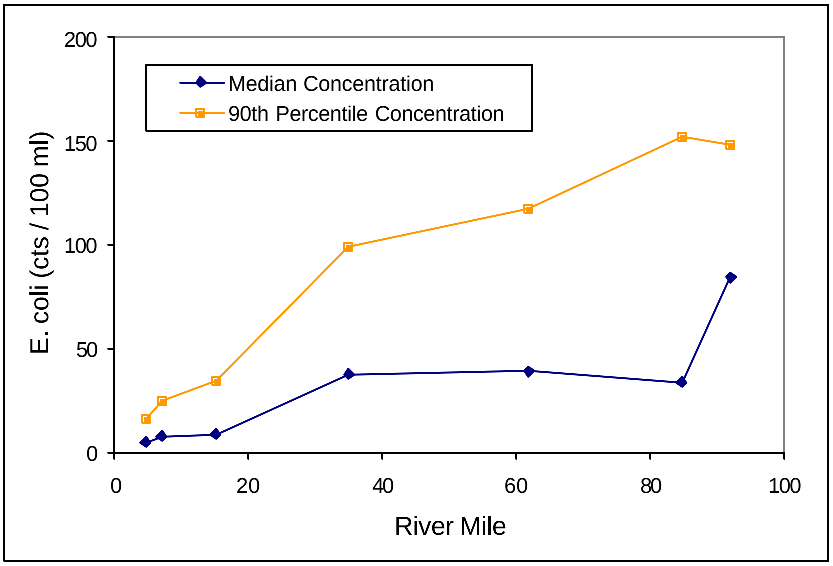


Figure 40. Profile of predicted median and 90th percentile *E. coli* concentration along the Nehalem River after allocated reductions. The site near the mouth is at Wheeler.

3.2.11.2 Necanicum River and Estuary

Concentrations of E. coli in the Necanicum River with allocated reductions of bacterial concentrations in runoff will meet water quality criteria throughout the Subbasin. Modeled concentrations will meet recreational contact criteria throughout the Subbasin, and will meet both the median (14 MPN/100 ml) and 90th percentile (43 MPN/100 ml) criteria for protection of shellfish harvest. Estimates of maximum values of the median and 90th percentile were predicted throughout the subbasin by the bacteria model at all historical flows between 1995 and 2001 (**Figure 48)**.

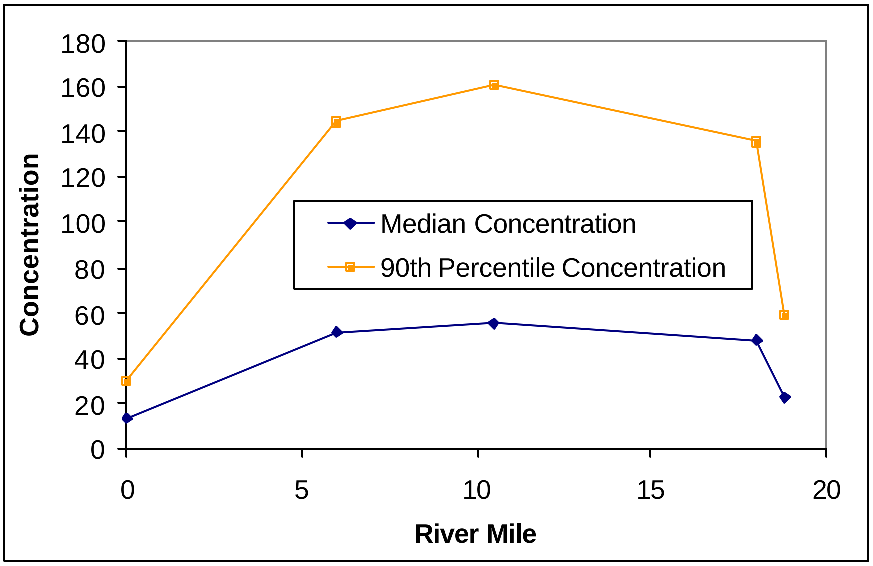


Figure 41. Profile of predicted median and 90th percentile *E. coli* concentration along the Necanicum River after allocated reductions.

3.2.11.3 Clatskanie River

Concentrations of E. coli in the Clatskanie River with allocated reductions of bacterial concentrations in runoff will meet recreational contact water quality criteria (geometric mean of 126 MPN/100 ml and single sample maximum of 406 MPN/100 ml) throughout the Subbasin (**Figure 49**).

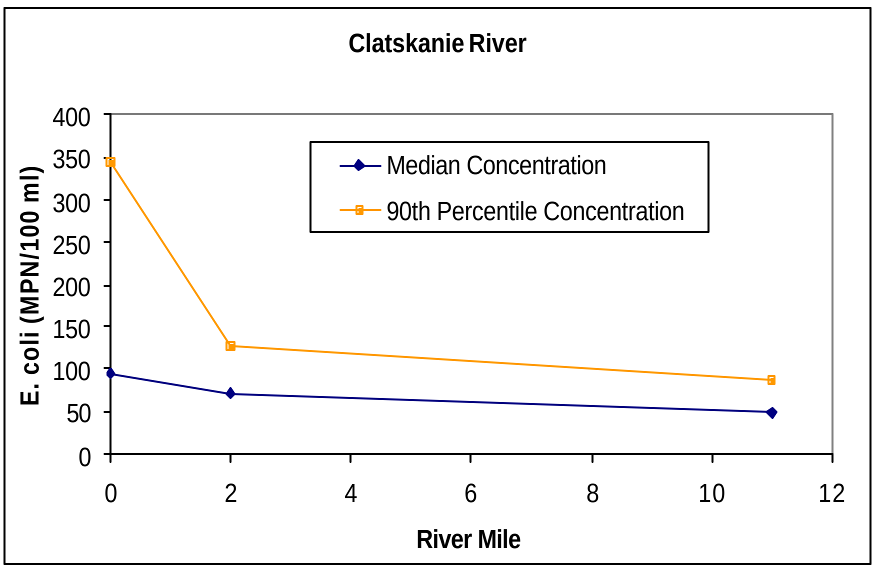


Figure 42. Profile of predicted median and 90th percentile *E. coli* concentration along the Clatskanie River after allocated reductions.

3.3 BIOCRITERIA TMDL

The South Fork of Goble Creek is listed under section 303(d) as water quality limited due to an impaired biological community. This is referred to as a biocriteria listing. The South Fork is in the Lower Columbia/Clatskanie subbasin as defined in the beginning of this TMDL.

This site was listed based on a comparison of macroinvertebrate taxa (i.e., species, genera, or families) observed at the station relative to what would be expected based on a large number of reference stations in the basin. This analysis was done using EPA biomonitoring protocols and a model developed by DEQ (BORIS, see DEQ 1999). To score well, a sample must contain a high proportion of the predicted taxa. Values at the South Fork of Goble Creek station varied among visits, but the site scored a community metric rating of 46% in the late summer of 1995. This score indicated the station condition was "poor" relative to reference stations in the basin. Sites are considered severely impaired with a score of 45% or less.

Biological communities reflect the history of environmental conditions in the stream during their development and maintenance. This makes determination of individual factors that effect community structure very difficult. Several features were quite variable among site visits to the listed reach, indicating either sample variance or a changing physical environment. The cause of the limitation could potentially be related to several landscape level factors including substratum quality, woody debris availability, dissolved oxygen concentrations, nutrient concentrations, and channel morphology. Overall, improvements to the physical environment that will result from allocations in the two other TMDLs (temperature and bacteria) are expected to improve conditions in the South Fork of Goble Creek.

There are no specific allocations to biocriteria. Allocations of other parameters/pollutants that are expected to improve biological conditions throughout the North Coast Subbasins area will result in improved conditions in the South Fork of Goble Creek. *System potential* shade and channel morphology allocated subbasin-wide in the Temperature TMDL, and bacterial runoff concentrations that limit runoff of nutrients as well will collectively improve conditions throughout the Goble Creek Watershed.

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 30** presents six approaches for incorporating a MOS into TMDLs.

Table 33. 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 North Coast Subbasins TMDLs

A MOS has been incorporated into the temperature and bacteria assessment methodologies. The MOS for temperature and bacteria in the North Coast Subbasins 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. Groundwater directly cools stream temperatures via mass transfer/mixing. Wind speed is a controlling factor for evaporation, a cooling heat energy process, and higher windspeeds cause increased cooling of surface waters. 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.

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 Oregon Department of Agriculture collects fecal coliform samples under adverse conditions such as outgoing tides. The model was calibrated to these concentrations, treating them as a daily mean when in fact they likely are higher than the daily mean value. Therefore, load allocations will likely result in lower than the predicted, post-reduction median and 90^{th} percentile values.

Third, the empirically derived flow-salinity relationship is based on samples collected approximately 1 meter below the water surface. Field surveys indicated that the Nehalem Bay can act as a partly-mixed or a two-layered system (Percy et. al., 1974). The concentration of fecal coliform will likely be greater nearer the surface because the ratio of fresh and seawater will be the largest. Depth averaged dilution is likely greater than that measured. Therefore, the depth averaged concentration is likely less than measured and using the measured surface values is a conservative assumption.

3.5 REASONABLE ASSURANCE

This section of the WQMP is intended to provide reasonable assurance that the WQMP (along with the associated DMA-specific Implementation Plans) will be implemented and that the TMDL and associated allocations will be met.

There are several programs that are either already in place or will be put in place to help assure that this TMDL and accompanying WQMP will be implemented. Some of these are traditional regulatory programs such as specific requirements under NPDES discharge permits. Other programs address nonpoint sources under the auspices of state law (for forested and agricultural lands) and voluntary efforts.

3.5.1 Point Sources

Reasonable assurance that implementation of the point source wasteload allocations will occur through the issuance or revision of NPDES and WPCF permits.

3.5.1.1 NPDES and WPCF Permit Programs

The DEQ administers two different types of wastewater permits in implementing Oregon Revised Statute (ORS) 468B.050. These are: the National Pollutant Discharge Elimination System (NPDES) permits for surface water discharge; and Water Pollution Control Facilities (WPCF) permits for onsite (land) 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. These permit activities assure that elements of the TMDL WQMP involving urban and industrial pollution problems will be implemented.

For point sources, provisions to address the appropriate waste load allocations (WLAs) will be incorporated into NPDES permits when permits are renewed by DEQ, typically within 1 year after the EPA approves the TMDL. It is likely each point source will be given a reasonable time to upgrade, if necessary, to meet its new permit limits. A schedule for meeting the requirements will be incorporated into the permit. Adherence to permit conditions is required by State and Federal Law and DEQ has the responsibility to ensure compliance.

The NPDES permits for the 8 wastewater treatment plants with wasteload allocations, will be revised to address the WLAs. All general and minor NPDES permits within the subbasin will also be revised to address the appropriate WLAs.

3.5.2 Nonpoint Sources

3.5.2.1 Non Federal Forest Lands

The Oregon Department of Forestry (ODF) is the designated management agency for regulation of water quality on non-federal forestlands. The Oregon Board of Forestry (BOF), in consultation with the Environmental Quality Commission (EQC), establish best management practices (BMPs) and other rules to ensure that, to the maximum extent practicable, nonpoint source pollution resulting from forest operations does not impair the attainment of water quality standards. The Board of Forestry has adopted water protection rules, including but not limited to OAR Chapter 629, Divisions 635-660, which describe BMPs for forest operations. These rules are implemented and enforced by ODF and monitored to assure their effectiveness.

By statute, forest operators conducting operations in accordance with the BMPs are considered to be in compliance with Oregon's water quality standards. ODF provides on the ground field administration of the Forest Practices Act (FPA). For each administrative rule, guidance is provided to field administrators to insure proper, uniform and consistent application of the Statutes and Rules. The FPA requires penalties, both civil and criminal, for violation of Statutes and Rules. Additionally, whenever a violation occurs, the responsible party is obligated to repair the damage. For more information, refer to the Management Measures element of this Plan.

ODF and DEQ are involved in several statewide efforts to analyze the existing FPA measures and to better define the relationship between the TMDL load allocations and the FPA measures designed to protect water quality. How water quality parameters are affected, as established through the TMDL process, as well as other monitoring data, will be an important part of the body of information used in determining the adequacy of the FPA.

As the DMA for water quality management on nonfederal forestlands, the ODF has recently completed working with the DEQ through a memorandum of understanding (MOU) signed in April of 1998. This MOU was designed to improve the coordination between the ODF and the DEQ in evaluating and proposing possible changes to the forest practice rules as part of the Total Maximum Daily Load process. The purpose of the MOU was also to guide coordination between the ODF and DEQ regarding water quality limited streams on the 303d list. An evaluation of rule adequacy has been conducted (also referred to as the "Sufficiency Analysis") through the analysis of water quality parameters that can potentially be affected by forest practices . This statewide demonstration of forest practices rule effectiveness in the protection of water quality addressed the following specific parameters:

1) Temperature
2) Sediment
3) Turbidity
4) Aquatic habitat modification
5) Bio-criteria

The Sufficiency Analysis final report has been externally reviewed by peers and other interested parties. The report was designed, in part, to provide background information and assessments of BMP effectiveness in meeting water quality standards. The report demonstrates overall FPA adequacy at the statewide scale with due consideration to regional and local variation in effects. Achieving the goals and objectives of the FPA will ensure the achievement and maintenance of water quality goals. The report offers recommendations to highlight general areas where current practices could be improved in order to better meet the FPA goals and objectives and in turn provide added assurance of meeting water quality standards. The Board of Forestry will consider these recommendations, along with the FPAC recommendations, in their on-going review of the FPA in order to determine whether revisions and/or additional voluntary approaches are necessary, consistent with ORS 527.710 and ORS 527.714.

ODF and DEQ statutes and rules include provisions for adaptive management that provide for revisions to FPA practices where necessary to meet water quality standards. These provisions are described in ORS 527.710, ORS 527.765, ORS 183.310, OAR 340-041-0026, OAR 629-635-110, and OAR 340-041-0120. For a more detailed description of current adaptive management efforts and the roles of the BOF and EQC in developing BMPs that will achieve water quality standards see Appendix 1 (detailed description of the management of non-federal forest lands portion under the Forest Practices Act).

The final Sufficiency Analysis is available for viewing at:
http://www.deq.state.or.us/wq/nonpoint/nonpoint.htm

ODF has plans specific to the management of state forests. The Northwest Oregon State Forests Management Plan was approved in January 2001, and covers management of about 615,000 acres of mostly young forests in western Oregon. In the North Coast Basin, the plan guides activities on the Tillamook and Clatsop state forests, as well as scattered forestlands in many western Oregon counties. In general, these plans have more restrictive harvest management requirements than the FPA.

3.5.2.2 Federal Forest Lands

Federal forest lands are managed by the US Forest Service (USFS) and the Bureau of Land Management (BLM). Very little of the area covered by this WQMP are managed by federal agencies. All management activities on federal lands managed by the U.S. Forest Service (USFS) and the Bureau of Land Management must follow Aquatic Conservation Strategy standards and guidelines (S&Gs) as listed in the respective Land Use and Management Plans (LRMPs), as amended, for the specific land management units. 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 forest and the conservation of fisheries habitat and biological diversity.

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.

3.5.2.3 Agriculture

It is the Oregon Department of Agriculture's (ODA) statutory responsibility to develop agricultural water quality management (AWQM) plans and enforce rules that address water quality issues on agricultural lands. The AWQM Act directs ODA to work with local farmers and ranchers to develop water quality management area plans for specific watersheds that have been identified as violating water quality standards and having agriculture water pollution contributions. The agriculture water quality management area plans are expected to identify problems in the watershed that need to be addressed and outline ways to correct those problems. These water quality management plans are developed at a local level, reviewed by the State Board of Agriculture, and then adopted into the Oregon Administrative Rules. It is the intent that these plans focus on education, technical assistance, and flexibility in addressing agriculture water quality issues. These plans and rules will be developed or modified to achieve water quality standards and will address the load allocations identified in the TMDL. In those cases when an operator refuses to take action, the law allows ODA to take enforcement action. DEQ will work with ODA to ensure that rules and plans meet load allocations.

Recognizing the adopted rules need to be quantitatively evaluated in terms of load allocations in the TMDL and pursuant to the June 1998 Memorandum of Agreement between ODA and DEQ, the agencies will evaluate the AWQMAP to assure attainment of DEQ's load allocations for agriculture. The agencies will establish the relationship between the plan and its implementing rules and the load allocations in the TMDL to determine if the rules provide reasonable assurance that the TMDLs will be achieved. The AWQMA Local Advisory Committee (LAC) will be apprised and consulted during this evaluation. This adaptive management process provides for review of the AWQMA plan to determine if any changes are needed to the current AWQMA rules specific to the North Coast Subbasins.

3.5.2.4 Oregon Department of Transportation

The Oregon Department of Transportation (ODOT) has been issued an NPDES MS4 waste discharge permit. Included with ODOT's application for the permit was a surface water management plan which has been approved by DEQ and which addresses the requirements of a Total Maximum Daily Load

(TMDL) allocation for pollutants associated with the ODOT system. Both ODOT and DEQ agree that the provisions of the permit and the surface water management plan will apply to ODOT's statewide system. This statewide approach for an ODOT TMDL watershed management plan addresses specific pollutants, but not specific watersheds. Instead, this plan demonstrates how ODOT will incorporate water quality protection into project development, construction, and operations and maintenance of the state and federal transportation system that is managed by ODOT, thereby meeting the elements of the National Pollutant Discharge Elimination System (NPDES) program, and the TMDL requirements.
The MS4 permit and the plan:

- Streamlines the evaluation and approval process for the watershed management plans
- Provides consistency to the ODOT highway management practices in all TMDL watersheds.
- Eliminates duplicative paperwork and staff time developing and participating in the numerous TMDL management plans.

Temperature and sediment are the primary concerns for pollutants associated with ODOT systems that impair the waters of the state. DEQ is still in the process of developing the TMDL water bodies and determining pollutant levels that limit their beneficial uses. As TMDL allocations are established by watershed, rather than by pollutants, ODOT is aware that individual watersheds may have pollutants that may require additional consideration as part of the ODOT watershed management plan. When these circumstances arise, ODOT will work with DEQ to incorporate these concerns into the statewide plan.

3.5.2.5 Urban and Rural Sources

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. Columbia County has published a final draft of Proposed Amendments to the Comprehensive Plan for Goal 5, and Clatsop and Tillamook Counties are also currently in the process of conducting Periodic Reviews of their comprehensive plans. Among the expected changes to these plans will be revised ordinances for the protection of riparian areas. We expect the counties to adopt revised ordinances that will be sufficient to meet the allocations in the TMDL.

3.5.3 All Responsible Parties

Responsible participants for implementing DMA specific water quality management plans for urban and rural sources were identified in Chapter 5 of this Water Quality Management Plan. Upon approval of the North Coast Subbasin TMDLs, it is DEQ's expectation that identified, responsible participants will develop, submit to DEQ, and implement individual water quality management plans that will achieve the load allocations established by the TMDLs. These activities will be accomplished by the responsible participants in accordance with the Schedule in Chapter 7 of this Water Quality Management Plan. The DMA specific water quality management plans must address the following items:

1) Proposed management measures tied to attainment of the load allocations and/or established surrogates of the TMDLs, such as vegetative site potential for example.
2) Timeline for implementation.
3) Timeline for attainment of load allocations.

4) Identification of responsible participants demonstrating who is responsible for implementing the various measures.
5) Reasonable assurance of implementation.
6) Monitoring and evaluation, including identification of participants responsible for implementation of monitoring, and a plan and schedule for revision of implementation plan.
7) Public involvement.
8) Maintenance effort over time.
9) Discussion of cost and funding.
10) Citation of legal authority under which the implementation will be conducted.

Several of the DMAs have existing implementation plans that will suffice for implementing the WQMP. Should any responsible participant fail to comply with their obligations under this WQMP, the Department will take all necessary action to seek compliance. Such action will first include negotiation, but could evolve to issuance of Department or Commission Orders and other enforcement mechanisms.

3.5.3.1 The Oregon Plan

The Oregon Plan for Salmon and Watersheds represents a major effort, unique to Oregon, to improve watersheds and restore endangered fish species. The Oregon Plan is a major component of the demonstration of " reasonable assurance " that this TMDL WQMP will be implemented.

The Plan consists of four essential elements:

3.5.3.1.1 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.

3.5.3.1.2 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.

3.5.3.1.3 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.

3.5.3.1.4 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 North Coast Subbasin. Both technical expertise and partial funding are provided through these programs. Examples of activities promoted and accomplished through these programs include: planting of conifers, hardwoods, shrubs, grasses and forbs along streams; relocating legacy roads that may be detrimental to water quality; replacing problem culverts with adequately sized structures, and improvement/ maintenance of legacy roads known to cause water quality problems. These activities have been and are being implemented to improve watersheds and enhance water quality. Many of these efforts are helping resolve water quality related legacy issues.

Landowner Assistance Programs

A variety of grants and incentive programs are available to landowners in the North Coast Subbasin. 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 Oregon Department of Forestry, the Oregon Department of Fish and Wildlife, DEQ, and the National Resources Conservation Service.

Field staff from the administrative agencies provide technical assistance and advice to individual landowners, watershed councils, local governments, and organizations interested in enhancing the subbasin. 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 WQMP.

Financial assistance is provided through a mix of cost-share, tax credit, and grant funded incentive programs designed to improve on-the-ground watershed conditions. Some of these programs, due to source of funds, have specific qualifying factors and priorities. Cost share programs include the Forestry Incentive Program (FIP), Stewardship Incentive Program (SIP), Environmental Quality Incentives Program (EQIP), and the Wildlife Habitat Incentive Program (WHIP).

3.5.3.2 Lower Columbia River Estuary Partnership (modified from LCREP Website)

The Lower Columbia River became part of the National Estuary Program in 1995. The Lower Columbia River Estuary Partnership is a two-state, public-private initiative. It is implementing a comprehensive management plan for the 146 miles of the lower Columbia River and estuary. It has a strong record of bringing diverse interests together to reach consensus in the best interests of this complex river system. Using a watershed approach, the Estuary Partnership cuts across political boundaries, integrating 28 cities, 9 counties, and the states of Oregon and Washington.

The Comprehensive Conservation and Management Plan (CCMP) serves as the strategic plan for the Lower Columbia River Estuary Partnership. It guides all program activities and annual work tasks for the Partnership. Developing and implementing a Comprehensive Conservation and Management Plan is the primary task of a National Estuary Program. Although many of the actions listed in the plan address issues other than temperature and bacteria, its unified approach to restoration and protection will help address these parameters as well.

The Management Plan embodies the efforts of many committed citizens who represent environmental groups, local governments, state and federal agencies, ports, tribal governments, industry, labor, agriculture, recreational users, commercial fishing, the regional Northwest Power Planning Council, and citizens-at-large. In keeping with the Estuary Program's emphasis on a collaborative local decision-making process, extensive public outreach and involvement opportunities have been used in developing the Management Plan.

A Policy Committee and Management Committee led the effort to develop the Management Plan for the Lower Columbia River. The Management Committee itself represented broad and diverse issues and perspectives. They worked to identify priority issues, then specify actions to address the priority issues, and finally, define how to implement those actions. The Comprehensive Conservation and Management Plan is the result of this 3-year effort to define what the river needed. A innovative tool used by the Management Committee to define actions was the comparative risk ranking. It integrated science and public concern and helped define specific actions.

3.5.3.2.1 Management Plan Goals

- Increase habitat and habitat functions
- Prevent toxic and conventional pollution
- Improve land use practices to protect ecosystems
- Monitor the river for long term and evaluate impact of actions
- Strengthen coordination between the states in water quality and species issues
- Enhance education opportunities about the lower river and estuary to build stewardship among all citizens: individual, municipal, corporate

3.5.3.2.2 Management Plan Actions

On-The-Ground Improvements for Habitat and Land Use

- Restore16,000 acres of wetlands in the study area
- Inventory and classify habitat and identify critical habitat for protection
- Change land use practices to ensure that development is environmentally sensitive
- Limit non-water dependent development in the floodway
- Maintain natural buffers on riparian corridors
- Reduce the quantity of stormwater runoff and improving its quality
- Use best management practices to control runoff and limit conventional or toxic pollutants

Twelve actions address habitat loss and modification and the impacts of land use activities. In the comparative risk ranking conducted in 1997, all three participating groups (technical experts, focus groups, and the general public) ranked loss of habitat and wetlands as the number one risk to public health, ecological health, and quality of life in the lower river and estuary. The Estuary Partnership will initiate these activities and assist others as well.

3.5.3.2.3 Heightened Education and Information and Government Coordination

- Initiate and sustain long term monitoring that builds on existing agency monitoring activities
- Centralized comprehensive data to measure effectiveness of actions taken
- Define a common purpose and establish a commitment to that purpose among all interests to advance regional well-being
- Provide education and information to all citizens, including opportunities to experience the river and its connections to our behaviors
- Improve coordination among government agencies
- Administer grant Partnership
- Coordinate volunteer monitoring and involvement
- Help local governments implement federal, state, and local environmental and land use laws

Over 160 agencies of government currently has some management or regulatory role on the lower Columbia River. The Management Plan also recognizes that accurate, objective information for all ages is key to fostering stewardship for the river among all citizens. Fifteen actions call for increased education and improved consistency and coordination among government agencies with responsibility for the lower river and estuary. These actions are seen as paramount for fostering public stewardship and effectively protecting the resource. Long term monitoring is a key component of the education efforts. The Estuary Partnership will take the lead in implementing these actions.

3.5.3.2.4 Reduction of Toxic and Conventional Pollutants

- Eliminate persistent bioaccumulative toxics
- Establish maximum daily loads for streams that do not meet water quality standards
- Reduce PAHs and heavy metal discharges associated with petroleum powered vehicles and equipment
- Reduce bacterial contamination

The sixteen actions that address conventional and toxic pollutants involve the regulatory authority of a variety of local, state, and federal agencies. Some actions reflect existing activities, some call for increased activity. The Estuary Partnership's primary role will be to monitor the progress of the responsible entities to ensure the actions are implemented and the goals are met. Implementation of the plan is on-going. Some actions are one time activities; most require a long term sustained effort.

ACRONYM LIST

BLM – Bureau of Land Management

CFR - Code of Federal Regulations

cfs - cubic feet per second

CWA - Clean Water Act

DEM - Digital Elevation Model

DEQ - Department of Environmental Quality (Oregon)

DOQ - Digital Orthophoto Quad

DOQQ - Digital Orthophoto Quarter Quad

EPA - (United States) Environmental Protection Agency

FLIR - Forward Looking Infrared Radiometry

HUC - Hydrologic Unit Code

LA - Load Allocation

LC - Loading Capacity

NSDZ - Near-Stream Disturbance Zone

OAR - Oregon Administrative Rules

ODA - Oregon Department of Agriculture

DEQ - Oregon Department of Environmental Quality

ODF - Oregon Department of Forestry

ODFW - Oregon Department of Fish and Wildlife

OWRD - Oregon Water Resources Department

R^2 – Correlation coefficient

RM - River Mile

SE - Standard Error

TMDL - Total Maximum Daily Load

USBR (US BOR) - United States Bureau of Reclamation

US COE - United States Army Corps of Engineers

USDA - United States Department of Agriculture

USFS - United States Forest Service

USGS - United States Geological Survey

W:D - Width to Depth (ratio)

WLA - Waste Load Allocation

WQS - Water Quality Standard

WWTP - Waste Water Treatment Plant

BIBLIOGRAPHY

Bell, M.C. 1986. Fisheries handbook of engineering requirements and biological criteria. Fish Passage Development and Evaluation Program, U. S. Army Corps of Engineers, North Pacific Division. Portland, Oregon, 290 pp.

Beschta, R.L, R.E. Bilby, G.W. Brown, L.B. Holtby, and T.D. Hofstra. 1987. Stream temperature and aquatic habitat: Fisheries and Forestry Interactions. Pp. 191-232. *In*: E.O. Salo and T.W. Cundy (eds), Streamside Management: Forestry and Fishery Interactions. University of Washington, Institute of Forest Resources, Contribution No. 57. 471 pp.

Boyd, M.S. 1996. Heat Source: stream temperature prediction. Master's Thesis. Departments of Civil and Bioresource Engineering, Oregon State University, Corvallis, Oregon.

Brett, J.R. 1952. Temperature Tolerance in Young Pacific Salmon, Genus *Oncorhynchus*. *J. Fish. Res. Bd. Can.*, 9(6):265-323.

Brown, G.W. 1969. Predicting temperatures of small streams. *Water Resour. Res.* 5(1):68-75.

CSRI (Coastal Salmon Recovery Initiative). 1997. State Agency Measures.

Cude, C. G., 2001. Draft Prediction of Fecal Coliform from *Escherichia Coli* for the Oregon Water Quality Index (OWQI).

Faux, R. N., P. Maus, C. Torgersen, and M. Boyd. (In review). Airborne Thermal Infrared (TIR) Remote Sensing Application to USDA USFS Stream Temperature Monitoring Programs: New Approaches for monitoring thermal variability. USFS Remote Sensing Applications Center, Salt Lake City, Utah.

Heath A.G. and G.M. Hughes. 1973. Cardiovascular and respiratory changes during heat stress in rainbow trout *(Salmo gairneri). J. Exp. Biol*., 59:323-338.

Hogan, J.W. 1970. Water temperature as a source of variation in specific activity of brain acetylcholinesterase of bluegills. *Bull. Environment. Contam. Toxicol*., 5:347-353.

Hokanson, K.E.F., C.F. Kleiner and T.W. Thorslund. 1977. Effects of Constant Temperatures and Diel Temperature Fluctuations on Specific Growth and Mortality Rates and Yield of Juvenile Rainbow Trout, Salmo gairdneri. J. Fish. Res. Bd. Can., 34:639-648.

Holaday, S.A. 1992. Summertime water temperature trends in Steamboat Cr. Basin, Umpqua National Forest. Master's Thesis. Department of Forest Engineering, Oregon State University, Corvallis, Oregon.

Huber, W.C 1993. Contaminant transport in Surface Water, in Handbook of Hydrology, McGraw Hill, NY.

Li, H.W., G.L. Lamberti, T.N. Pearsons, C.K. Tait, J.L. Li, and J.C. Buckhouse. 1994. Cumulative effects of riparian disturbance along high desert trout streams of the John Day Basin, Oregon. *Am. Fish Soc.* 123:627-640.

Neitsch, S.L., J.G. Arnold, J.R. Kiniry and J.R. Williams. 2001. Soil and Water Assessment Tool Theoretical Documentation.

Oregon Department of Environmental Quality. 1999. Oregon Coast Range Macorinvertebrate Analysis and Monitoring Status: 1991-1997. Technical Report BIO99-005.

Oregon Department of Environmental Quality. 2000. Upper Grande Ronde River Subbasin Total Maximum Daily Load.

Oregon Department of Environmental Quality. 2001a. Umatilla River Subbasin Total Maximum Daily Load.

Oregon Department of Environmental Quality. 2001b. Tualatin River Subbasin Total Maximum Daily Load.

Oregon Department of Environmental Quality. 2001c. Tillamook Bay Watershed Total Maximum Daily Load.

Oregon Department of Environmental Quality. 2002. Nestucca Bay Watershed Total Maximum Daily Load.

Oregon Department of Environmental Quality. 2003. List of water quality limited waterbodies in Oregon under Section 303(d) of the Clean Water Act. Approved by EPA on March 24, 2003.

Percy, K.L., C. Sutterlin, D. A. Bella, and P.C. Klingeman. 1974. Descriptions and Information Sources for Oregon Estuaries, Sea Grant College Program, Oregon State University.

Pipes, W.O. 1982. Bacterial indicators of pollution. CRC Press, Boca Raton, Florida, USA.

Sherer, B.M., J.R. Miner, J.A. Moore, and J.C. Buckhouse. 1988. Resuspending Organisms From a Rangeland Stream Bottom, American Society of Agricultural Engineers, Vol. 31, No. 2, pp 1217-1222.

Swann, C. 2001. The Influence of Septic Systems at the Watershed Level in Urban Lake Management, Bulletin on Urban Watershed Restoration and Protection Tools, Vol. 3, No. 4, December.

Thomann and Mueller. 1987. Principles of Surface Water Quality Modeling and Control, Harper & Row, New York.

Torgersen, C. E., D. M. Price, H. W. Li, and B. A. McIntosh. 1999. Multiscale thermal refugia and stream habitat associations of chinook salmon in northeastern Oregon. *Ecological Applications* 9: 301-319.

Torgersen, C.E., R. Faux, B.A. McIntosh, N. Poage, and D.J. Norton. 2001. Airborne thermal remote sensing for water temperature assessment in rivers and streams. *Remote Sensing of Environment* 76(3): 386-398.

U.S. Environmental Protection Agency. 2001, Protocol for Developing Pathogen TMDLs, First Edition, EPA 841-R-00-002.