# PREFACE

This document was generated from an assessment conducted by a local grassroots partnership. As a result, the organization of this document has been confusing to some. The information below is provided to help clarify.

The Lower Rogue Watershed Council worked with Lincoln Timber LLC as managed by The Campbell Group and the Siskiyou National Forest to assess current riparian and channel conditions and to collect temperature and flow data. These local interests sought to assess watershed conditions in order to better plan, prioritize, and maximize future restoration and enhancement efforts. The Lobster Creek Partnership a long standing and strong one.

This document houses this locally generated assessment and action plan in Chapter 2, Appendix C. Information has been extracted from this document and utilized to support development of Chapter 1 (Total Maximum Daily Load, TMDL) and Chapter 2 (Water Quality Management Plan, WQMP). Because of this, as you read Chapter 1 and 2 you will be asked to reference Chapter 2, Appendix C often. By organizing the document in this way, local efforts are recognized, emphasized, and integrated into TMDL development and implementation.

Chapter 2 (Water Quality Management Plan) focuses on institutional components and processes and identifies overarching DMA structures. For example, Chapter 2 identifies the Oregon Department of Forestry as the DMA for private timber lands. Chapter 2 Appendix C discusses not only assessment components but also localized and voluntary enhancement efforts currently occurring in the watershed.

The Department of Environmental Quality appreciates having this opportunity to work closely with local partnerships interested in assessing water quality impairments and causes, and with those implementing solutions, some of which are above those required through current DMA's management structures. EPA also recognized the value this working partnership in the comment below.

*"The Lobster Creek WQMP is unusual in that the first sections….are "cookie cutter" framework documents, identifying DMAs and programs, and laying out a pathway for more detailed planning and tracking. As such, they have only general, conceptual ties to the TMDL load allocations. The exceptions are the pieces from and the references to Chapter 2 Appendix C which is a collaborative, more detailed and focused plan that is related specifically to the load allocations for Lobster Creek and its tributaries. The Siskiyou National Forest, Lincoln Timber Company, The Campbell Group, Lower Rogue Watershed Council, and DEQ are to be commended for taking a proactive approach in using the TMDL analyses to craft specific goals and actions that apply to the relevant situation and landscape. It is refreshing to see collaborative watershed work done across land ownership boundaries that incorporates good data and scientific principles. Overall, the Lobster Creek WQMP is quite good, particularly regarding the engagement of local land managers, and the willingness to use data and sound scientific principles to guide land management decisions. We expect to learn valuable things from the good work being done here." EPA January 14, 2002.*

Detailed Table of Contents are provided both at the beginning of Chapter 1 (TMDL) and Chapter 2 (WQMP). An overview of document organization is provided below.

# Overview of Document Organization - Lobster Creek Watershed TMDL

## Executive Summary

**Chapter 1 TMDL Summary** - This TMDL Summary seeks to clearly address elements required by EPA to meet the requirements for Total Maximum Daily Load (TMDL) development. These elements are predominately addressed in the accompanying Water Quality Management Plan (WQMP). This Summary will help guide the reviewer to elements contained within the WQMP and provide additional supporting information.

*Chapter 1 TMDL Summary Appendices*

A. Lobster Creek Watershed Heat Source Predictive Temperature Modeling

**Chapter 2 Water Quality Management Plan** – This WQMP follows the DEQ Template and describes TMDL Implementation and Monitoring Efforts

*Chapter 2 WQMP Appendices*

B. Department Of Forestry – Implementation Plan for Non federal Forest Lands

C. Jointly Develop Water Quality Management Plan

This WQMP was prepared in partnership by Lincoln Timber LLC, The Campbell Group, the Lower Rogue Watershed Council, United States Forest Service, and the Oregon Department of Environmental Quality (DEQ).

The document follows the Guidance for WQMP Development provided by DEQ. It provides existing and future condition riparian and channel assessments and management related planning to address water quality limited parameters. Appendices 1-4 below are part of this document.

*Jointly Developed WQMP Appendices*

C-1. Maps and Figures
C-2. Riparian Shade Assessment Documentation
C-3. Calculation of TMDL for Solar Loading
C-4. Stream Shade Curves

D. DEQ 0700 NPDES PERMIT – RECREATIONAL MINING

# LOBSTER CREEK WATERSHED TMDL EXECUTIVE SUMMARY

This documentation package seeks to clearly address elements required by EPA to meet the requirements for Total Maximum Daily Load (TMDL) development. These elements are addressed in both the accompanying TMDL document and the Water Quality Management Plan (WQMP). The United States Forest Service, Lincoln Timber LLC, The Campbell Group, and the Lower Rogue Watershed council worked together in partnership with the Department of Environmental Quality (DEQ) to development this TMDL and WQMP.

The geographic scope of this TMDL focuses on the Lobster Creek Watershed, a major tributary to the Lower mainstem of the Rogue River. The watershed comprises an area managed by the United States Forest Service (USFS) and private timber interests.

Tributaries to the Lower Rogue represent high quality fishery habitat and are the primary source of salmonid production in the Lower Rogue. The Lower Rogue mainstem serves primarily as a migration corridor. Mainstem tributaries provide important spawning and rearing habitat and provide thermal refugia in the already heated mainstem. Working from headwaters downstream in these important tributaries represents a valid approach to TMDL assessment and to fishery enhancement efforts.

This approach has resulted in the early production of the Lobster Creek Watershed TMDL. DEQ plans to package the remainder of the Lower Rogue Subbasin under a separate TMDL package. The assessment of this important $5^{th}$ field tributary better supports ongoing $7^{th}$ field restoration and enhancement planning. The subsequent Lower Rogue Subbasin TMDL assessment will focus on the Rogue River mainstem and other smaller but significant tributaries.

The Lobster Creek Watershed is located in Curry County, Oregon. The watershed has 69 square miles or 44,253 acres with 64% in federal ownership, 1% in state and county ownership, and 35% in private ownership. The majority of the land in private ownership is held by Lincoln Timber LLC and is managed on contract by The Campbell Group. Private forested lands management activities are conducted under the Oregon Forest Practices Act (FPA).

Lobster Creek Watershed is home to productive forested lands and has the distinction of containing streams with historically abundant salmonid populations. Lobster Creek Watershed supports a variety of resident and anadromous fish species. These include coho and chinook salmon, steelhead, searun and resident cutthroat trout, and resident Rainbow trout. A biological assessment conducted in 1995 by DEQ ranked the Lobster Creek Watershed as healthy.

Valuable contributions from forestry, fisheries, and local watershed organizations in the Lower Rogue watershed have prompted extensive data collection and study of the interaction between land use and water quality. The knowledge derived from these data collection efforts and academic study, have been used by land managers to design protective and enhancement strategies that are actively being applied to address water quality issues.

Local watershed councils worked with private land managers and with the Siskiyou National Forest to assess current riparian and channel condition and to collect temperature and flow data used in this TMDL assessment. The components of this TMDL and WQMP provide improved assessment information from which local interests will plan and prioritize future restoration and enhancement efforts.

This TMDL builds upon the protection/restoration measures prescribed by the Northwest Forest Plan and the Forest Practices Act (FPA). The area covered by the TMDL and WQMP includes land managed primarily by the USFS with private timber ownership in the lower portions of the watershed.

Presently, small scale suction dredging occurs over a small area in the basin but has been determined to result in little damage to riparian shade or channel form. Recreational mining is concentrated in the mainstem of the Lobster Creek Watershed. Current State law limits suction dredges to a maximum 4-inch diameter nozzle size. Recreational mining is conducted under a general permit issued by DEQ and is considered a point source activity. It is the only point source activity present in the assessment area.

Riparian area and channel morphology disturbances have resulted from timber management, road building, and mining activities in addition to natural disturbances like disease, fire, and flood. These activities have primarily affected the water quality parameter (temperature) through increased solar loading by:

(1) Increasing stream surface solar radiation loading.
(2) Increasing stream surface area exposed to solar radiation loading.

Disturbance of the riparian area and stream channel from disease, wild fires and storms are considered natural processes. The gain or loss of riparian vegetation by these natural processes can fluctuate and has not been quantified within the scope of this assessment. Wildfire suppression policies of the past 100 years have likely reduced the influence of fire as a natural event on riparian shade quality.

This TMDL and WQMP focus on areas within the watershed where management disturbances have increased solar loading and affected water quality. Although timber harvest and mining continue in the Lobster Creek Watershed, management practices that comply with load allocations presented in this document are intended to ameliorate pollutant delivery.

As a result of water quality standards (WQS) exceedances for temperature, three 303d listed stream segments are included on Oregon's 1998 §303(d) list of water quality limited waterbodies. Monitoring has shown that water quality in the Lobster Creek Watershed does not meet State water quality standards all of the time. Existing data shows that the narrative and numeric standards for *temperature* are not achieved in the mainstem and tributary reaches. The following table lists the §303(d) listed reaches, the applicable criterion that is exceeded, and listed stream miles. In addition, this TMDL addresses potential water quality impairment for several tributary streams within the Lobster Creek Watershed not currently on Oregon's 1998 §303(d) list. A watershed approach was applied during assessment, seeking to address watershed health rather than exclusively focusing assessment activities on 303d listed segments.

| **USFS and Private Timber Managed Lands 303(d) listed Segments, Applicable Water Quality Standards, Stream Miles 303d Listed, and Stream Miles Assessed.** | | | |
|---|---|---|---|
| Mainstem – Mouth to Headwaters | 303d Temperature | *OAR 340-041-O365(2)(b)(A)[(i),(ii),and(v)*<br>*OAR 340-041-0006(54)* | 9.5 Miles |
| No Fork Lobster Ck Mouth to RM3 | 303d Temperature | *OAR 340-041-O365(2)(b)(A)[(i),(ii),and(v)*<br>*OAR 340-041-0006(54)* | 3 Miles |
| So. Fork Lobster Ck Mouth to Iron Ck | 303d Temperature | *OAR 340-041-O365(2)(b)(A)[(i),(ii),and(v)*<br>*OAR 340-041-0006(54)* | 3.7 Miles |
| Significant mainstem tributaries not specifically identified by name on 303 list | | *OAR 340-041-O365(2)(b)(A)[(i),(ii),and(v)*<br>*OAR 340-041-0006(54)* | 31 Miles |
| Others significant tributaries not specifically identified by name on 303 list | | *OAR 340-041-O365(2)(b)(A)[(i),(ii),and(v)*<br>*OAR 340-041-0006(54)* | 76 Miles |
| **Total stream miles Assessed** | | | **123 Miles** |
| **WQL 303d listed segments** | | | **16.2 Miles** |

This document contains the required watershed condition assessment and problem statement. It provides a water quality management plan (WQMP) identifying water quality goals and objectives. It therein designates responsible parties, a management plan, a measure of assurance that the plan will actually be implemented, and a monitoring feedback loop.

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. It then requires that a *Total Maximum Daily Load* (TMDL) will be developed and implemented to restore water quality.

**This document fully meets the requirements of Section 303(d) and is submitted as the TMDL for the Lobster Creek Watershed.**

# Chapter 1
# LOBSTER CREEK WATERSHED TOTAL MAXIMUM DAILY LOAD (TMDL)

**APRIL 2002**

State of Oregon
Department of Environmental Quality

TMDL SUMMARY
Lobster Creek Watershed
Prepared by
***Oregon Dept. of Environmental Quality***
***With submissions by***
***Siskiyou National Forest, Lincoln Timber LLC, The Campbell Group,***
***and the Lower Rogue Watershed Council***

**TABLE OF CONTENTS**

| **Table 1**. Lobster Creek Watershed TMDL Components | |
|---|---|
| State/Tribe: Oregon<br>Waterbody Name(s): Perennial streams within the 5th field HUC (hydrologic unit code) 1710031007– Lobster Creek Watershed.<br>Point Source TMDL: X Nonpoint Source TMDL: X (check one or both)<br>Date: April 2002 | |
| ***Component*** | ***Comments*** |
| **Pollutant Identification** | Stream temperature is an expression of *Heat Energy per Unit Volume* and is expressed in English Units as Btu per cubic feet.<br><br>*Pollutant:* Heat Energy<br>*Anthropogenic Contribution:* Solar Energy Input |
| **Target Identification** | *Applicable Water Quality Standards*<br>**Temperature: OAR 340-041-0365(2)(b)(A)[(i),(ii),&(v) and OAR 340-41-0006(54)**<br>No measurable surface water increase resulting from anthropogenic sources where the seven day moving average of the daily maximum exceeds the following values unless specifically allowed under a Department-approved temperature management plan:<br>**1.) 55°F (12.8°C)** during times and in waters that support salmonid spawning, egg incubation, and fry emergence from the egg and from the gravels.<br>**2.) 64°F (17.8°C)** during other times of the year in a basin for which salmonid fish rearing is a designated beneficial use. |
| **Existing Sources**<br><br><br>*CWA 303(d)(1)* | *Anthropogenic sources of thermal gain from riparian vegetation removal:*<br>• Forest and road management within riparian areas<br>*Anthropogenic sources of thermal gain from channel modifications:*<br>• Timber Harvest, Related silvicultural activities, Roads, Mining |
| **Seasonal Variation**<br><br><br><br><br><br>*CWA 303(d)(1)* | *Condition*: Based on USFS and WSC data (1994 to 2001)<br>*Flow*: Low flow associated with maximum stream temperatures<br><br>*Critical Conditions*: Increase desirable riparian vegetation to provide effective shade as determined by system potential (climax) conditions.<br><br>*Inputs*: Solar radiation increased by more exposed stream surface area as a result of decreased effective shade and increased channel width. |
| **TMDL Loading Capacities and Allocations**<br>*CWA 303(d)(1)*<br>*40 CFR 130.2(f)*<br>*40 CFR 130.2(g)*<br>*40 CFR 130.2(h)* | *Loading Capacities:* No more than 195 $Btu \cdot ft^{-2} \cdot day^{-1}$ solar loading as an average measured value over assessed perennial stream length, or attainment of effective shade resulting in system potential or climax solar radiation loading. *See Chapter 2 Appendix C-3 for calculation.*<br>*WLAs:* Zero waste load allocation for NPDES Permit 0700 J (recreational mining) activities.<br>*LAs:* Effective shade levels at system potential (climax shade conditions). 100 % natural condition, 0% anthropogenic (federal and private forest lands both receive 0% load allocations) |
| **Margins of Safety**<br>*CWA 303(d)(1)* | Margins of Safety demonstrated in critical condition assumptions regarding groundwater inflow and within shade and channel assessments. |
| **WQS Attainment Analysis**<br>*CWA 303(d)(1)* | • Statistical demonstration of temperature related to current shade conditions.<br>• Analytical assessment of simulated temperature change related to allocated solar loading. |
| **Public Participation**<br>*40 CFR 25* | See Chapter 2 and Appendix C Element 8, Public Involvement in addition to information contained within this TMDL summary on page 29. |

# 1. INTRODUCTION

This TMDL Summary seeks to clearly address elements required by Environmental Protection Agency (EPA) to meet the requirements for Total Maximum Daily Load (TMDL) development. These elements are predominately addressed in the accompanying Water Quality Management Plan (WQMP). This WQMP was prepared by local partners and the Oregon Department of Environmental Quality (DEQ). This Summary will both help guide the reviewer to these elements contained within the WQMP and provide additional supporting information.

## 1.1 OREGON'S TOTAL MAXIMUM DAILY LOAD PROGRAM (GENERALLY DEFINED)

The quality of Oregon's streams, lakes, estuaries and groundwaters is monitored by DEQ and a variety of other partners. This information is used to determine whether water quality standards are being violated and, consequently, whether the *beneficial uses* of the waters are being threatened. *Beneficial uses* include fisheries, aquatic life, drinking water, recreation, as well as other specific water uses. Specific State and Federal plans and regulations are used to determine if violations have occurred: these regulations include the *Federal Clean Water Act* of *1972* and its amendments 40 *Codified Federal Regulations* 131, and *Oregon's Administrative Rules* (**OAR Chapter 340**) and *Oregon's Revised Statutes* (**ORS Chapter 468**).

The term *water quality limited* is applied to streams and lakes 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 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. *Wasteload Allocations* are portions of the total load that are allotted to point sources of pollution, such as sewage treatment plants or industries. The *Wasteload Allocations* are used to establish effluent limits in discharge permits. *Load Allocations* are portions of the *TMDL* that are attributed to either natural background sources, such as soils, or from nonpoint sources, such as agriculture or forestry activities. *Allocations* can also be set aside in reserve for future uses. Simply stated, *allocations* are quantified measures that assure water quality standard compliance. The *TMDL* is the integration of all developed *allocations*.

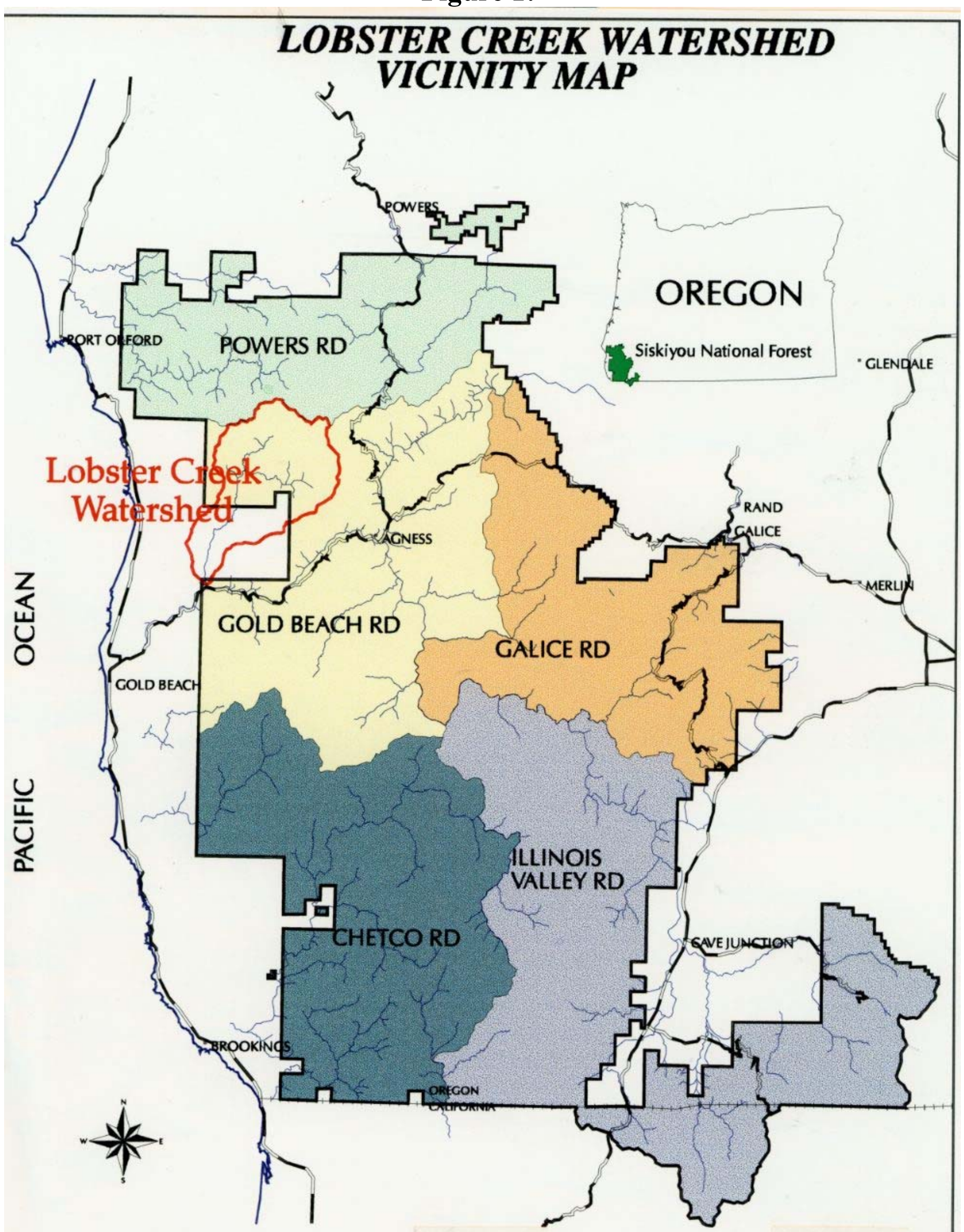
Recently several agencies have been mandated to take proactive roles in developing management strategies in the Lower Rogue subbasin. Water quality management plans for forested, agricultural, and urban lands that address both nonpoint and point sources of pollution basin wide are currently under development. It is imperative that these plans consider the relatively robust data that describe water quality, instream physical parameters and landscape features. These management efforts will require stakeholders, land managers, public servants and the general public to become knowledgeable of water quality issues in the Lower Rogue subbasin.

# 2. GEOGRAPHIC DESCRIPTION AND SCOPE

***(See Appendix C, Element 1, page 5-17)***

A TMDL has been developed to address fisheries concerns for the Lobster Creek Watershed and all its significant perennial tributaries. A vicinity map from Appendix C-1 is shown below in Figure 1. The TMDL builds upon management activities defined within the Oregon's Forest Practices Act (FPA) and the Northwest Forest Plan and Forest Ecosystem Management Assessment Team (FEMAT) protection/restoration measures.

**Figure 1:**




The decision was made to approach the Lower Rogue Subbasin TMDL assessment in two discrete segments. It was determined that tributaries to the Lower Rogue represent high quality fishery habitat. Mainstem tributaries are the primary source of Salmonid production in the Lower Rogue. They provide important spawning and rearing habitat and provide thermal refugia in a heated mainstem. Working from headwaters downstream in these important tributaries represents a valid approach to TMDL assessment and to fishery enhancement efforts. This decision has resulted in the early production of the Lobster Creek Watershed TMDL and plans to package the remainder of the Lower Rogue Subbasin under a separate TMDL package. The assessment of this important tributary at the 5$^{th}$ field level better supports 7$^{th}$ field planning for restoration and enhancement activities. Subsequent Lower Rogue Subbasin TMDL assessment will focus on the Rogue River mainstem and two other significant tributaries.

This approach is in no way intended to undermine the concept that a stream is a continuum where one part of the system relies on others to function correctly. Management plans will recognize this connectivity and reflect basin wide concerns and corresponding management needs. DEQ will continue to develop its TMDL's and WQMP's based on the basin connectivity philosophy.

The Lobster Creek Watershed, a 5$^{th}$ field watershed located in the Lower Rogue Subbasin, is home to productive forested lands and has the distinction of containing streams with historically abundant Salmonid populations. Valuable contributions from forestry, fisheries, and local watershed organizations in the Lower Rogue watershed have prompted extensive data collection and study of the interaction between land use and water quality. The knowledge derived from these data collection efforts and academic study, have been used by land managers to design protective and enhancement strategies that are actively being applied to address water quality issues. The development of this TMDL and WQMP provides improved assessment information from which to plan restoration and enhancement efforts.

The data review contained in this TMDL document summarizes the varied, yet extensive, data collection and studies that have occurred through many years in the Lobster Creek Watershed. Regional water quality programs are already utilizing this information to develop and/or alter water quality management efforts. In addition, this TMDL should be used to track water quality, instream physical parameters, and landscape conditions that currently exist. In the future, it will be important to determine the adequacy of planned water quality improvement efforts. Looking back at this TMDL, it will be possible to track the changes that have occurred in water quality, instream, and landscape parameters that affect fish, as well as people, in the Lobster Creek Watershed.

This TMDL builds upon the protection/restoration measures prescribed by the Northwest Forest Plan and the Forest Practices Act (FPA). The area covered by the TMDL and WQMP includes land managed primarily by the USFS with private timber ownership. An ownership map, taken from Appendix C-1, is shown here in Figure-2. Of the 44,253 acres within the watershed, 26,862 are managed by USFS, 13,300 by Lincoln Timber LLC and the remaining 4,100 acres are managed by other the State of Oregon, BLM, and private timber interests. The USFS, Lincoln Timber LLC, The Campbell Group, and the Lower Rogue Watershed Council worked closely together to develop this high quality riparian and channel condition assessment and WQMP.

Recreational mining is conducted within the watershed and is considered a point source activity. It is the only point source activity present in the assessment area.

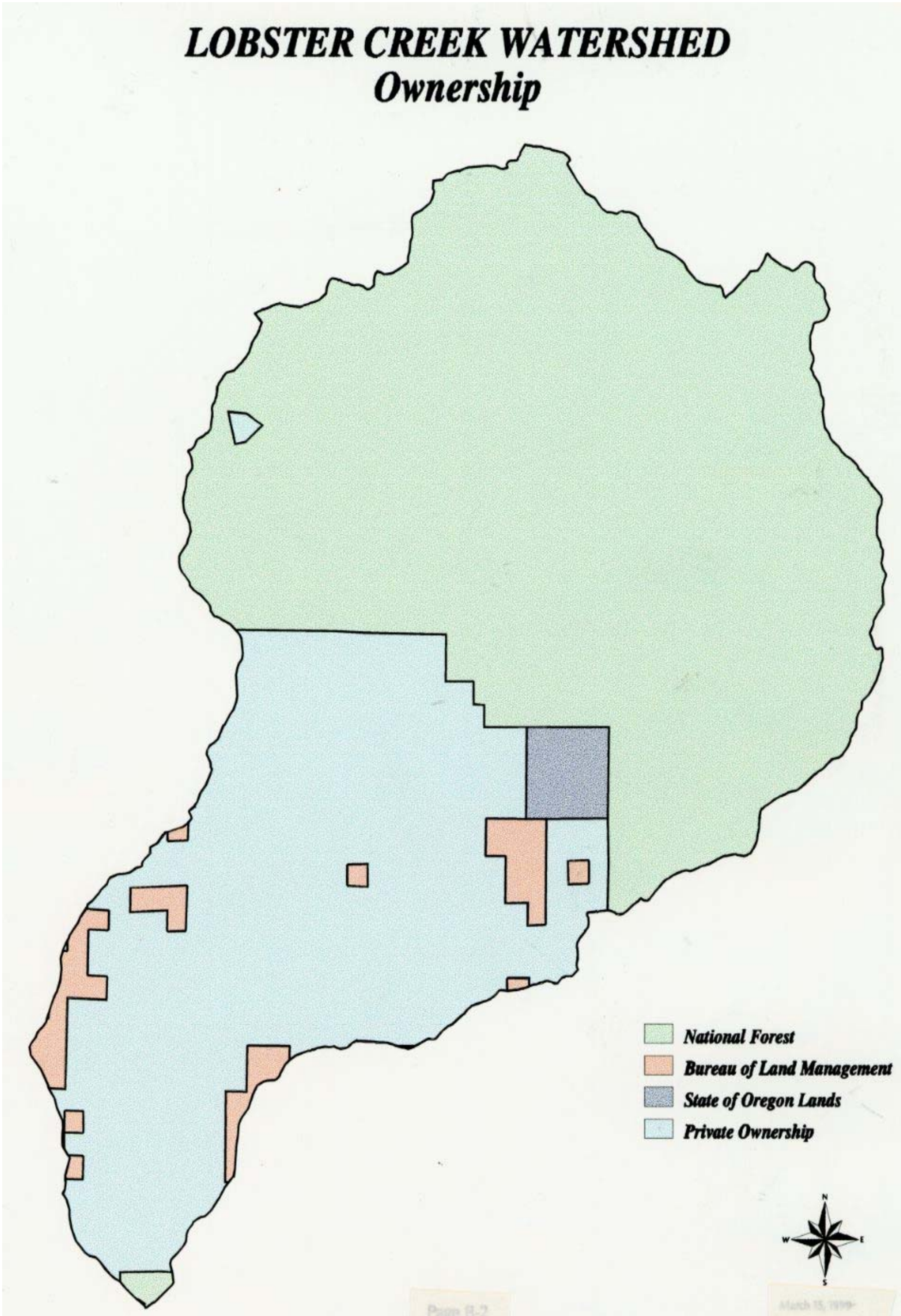
# 3. APPLICABLE WATER QUALITY STANDARDS

## 3.1 TEMPERATURE STANDARD

The Oregon Environmental Quality Commission (EQC) has adopted numeric and narrative water quality standards to protect designated *beneficial uses*.

A seven-day moving average of daily maximums (7-day statistic) was adopted as the statistical numeric measure of the stream temperature standard. Absolute numeric criteria are deemed action levels and can determine water quality standard compliance (Table 2). The numeric criteria adopted in Oregon's water temperature standard rely on the biological temperature limitations considering sensitive designated beneficial uses. An extensive analysis of water temperature related to aquatic life and supporting documentation for the temperature standard can be found in the *1992-1994 Water Quality Standards Review Final Issue Papers (DEQ, 1995)*.

**Figure 2:**


LOBSTER CREEK WATERSHED
Ownership
National Forest
Bureau of Land Management
State of Oregon Lands
Private Ownership
N
W
E
S
Page B-2

| **Table 2**. Applicable Water Temperature Criteria<br>*OAR 340-41-0365(2)(b)(A)(i),(ii),(iii),and(v), OAR 340-0006* | |
|---|---|
| **Water Temperature Standard** | **7-Day Statistic** |
| ***Basic Absolute Criterion*** – Applies year long in all streams in the basin, with the exception of those that qualify for the *Salmonid spawning, egg incubation and fry emergence criterion* -or- *bull trout criterion*. | ≤64°F (17.8°C) |
| ***Salmonid Spawning, Egg Incubation and Fry Emergence Criterion*** – Applies to stream segments designated as supporting native Salmonid spawning, egg incubation and fry emergence for the specific times of the year when these uses occur. | ≤55°F (12.8°C) |
| ***No Measurable Increase*** - Unless specifically allowed under a Department-approved surface water temperature management plan, no measurable surface water temperature increase resulting from anthropogenic activities is allowed where the above stated numeric criteria are exceeded | No Measurable Increase |

In practice, water quality standards have been set at a level to protect the most sensitive uses and seasonal standards may be applied for uses that do not occur year round. Cold-water aquatic life such as salmonids and trout are the most sensitive *beneficial uses* in the Lobster Creek Watershed. In this forested watershed, water quality data review identified stream temperatures in exceedance of the numeric portion of the temperature standard. This data review initiated development of this TMDL.

Implementation Program Applicable to All Basins (340-41-120) states:

- 11(a) It is the policy of the Environmental Quality Commission (EQC) to protect aquatic ecosystems from adverse surface water warming caused by anthropogenic activities. The intent of the EQC is to minimize the risk to cold-water aquatic ecosystems from anthropogenic warming of surface waters, to encourage the restoration of critical aquatic habitat, to reverse surface water warming trends, to cool the waters of the State, and to control extremes in temperature fluctuations due to anthropogenic activities:

- 11(A) The first element of this policy is to encourage the proactive development and implementation of best management practices or other measures and available temperature control technologies for nonpoint and point source activities to prevent thermal pollution of surface waters.

- 11(c) The temperature criteria in the basin standards establish numeric and narrative criteria to protect designated beneficial uses and to initiate actions to control anthropogenic sources that adversely increase or decrease stream temperatures. Natural surface water temperatures at times exceed the numeric criteria due to naturally high ambient air temperatures, naturally heated discharges, naturally low stream flows or other natural conditions. These exceedances are not water quality standards violations when the natural conditions themselves cause water temperatures to exceed the numeric criteria. In these situations the natural surface water temperatures become the numeric criteria. In surface waters where both natural and anthropogenic factors cause exceedances of the numeric criteria, each anthropogenic source will be responsible for controlling, through implementation of a management plan, only that portion of temperature increase caused by the anthropogenic source.

## 3.2 LOBSTER CREEK WATERSHED WATER QUALITY IMPAIRMENTS

As a result of water quality standards (WQS) exceedances for temperature, three stream segments are included on Oregon's 1998 §303(d) list. Monitoring has shown that water quality in the Lobster Creek Watershed often does not meet State water quality standards all of the time. The narrative and numeric standards for temperature are not achieved in the mainstem reaches of the North and South Forks as well as in the mainstem. These listing were based upon available data. Some tributary monitoring indicates that areas of the watershed do achieve WQ criteria even during peak loading periods. Please refer to Table 12, in the Seasonal Variability section to view the data summary for the period of record. Table 3, 4, and 5 below provide temperature statistics for 1999.

## Table 3 – Lobster Watershed Temperature Statistics

| Site Name | Start | Stop | Seasonal Max. | | Seasonal Min. | |
|---|---|---|---|---|---|---|
| | Date | Date | Date | Value | Date | Value |
| MS abv Lost Valley | 07/16/99 | 08/26/99 | 08/26/99 | 67.2 | 07/21/99 | 55.4 |
| MS Lobster @ Remap | 07/09/99 | 09/08/99 | 08/26/99 | 69.0 | 09/01/99 | 54.7 |
| MS Lobster d/s Deadline | 07/09/99 | 09/08/99 | 08/26/99 | 68.7 | 09/01/99 | 54.7 |
| Lobster MS at Gorge | 07/19/99 | 08/26/99 | 08/26/99 | 66.3 | 07/21/99 | 57.6 |
| Lobster @ Mouth | 07/01/99 | 09/02/99 | 08/26/99 | 67.4 | 07/04/99 | 55.1 |
| Deadline Creek @ Mouth | 07/16/99 | 08/26/99 | 08/26/99 | 62.4 | 07/25/99 | 54.1 |
| Fall Creek @ Mouth | 07/16/99 | 08/26/99 | 08/26/99 | 62.7 | 07/25/99 | 54.1 |
| Lost Valley Creek @ Mouth | 07/16/99 | 08/26/99 | 08/26/99 | 61.4 | 07/22/99 | 53.0 |
| (* MS = mainstem) | | | | | | |

## Table 4– Lobster Watershed Temperature Statistics

| Site Name | Seasonal Max DT | | 7-Day averages | | | |
|---|---|---|---|---|---|---|
| | Date | Value | Date | Max. | Min. | D T |
| Mainstem abv Lost Valley | 07/18/99 | 9.0 | 08/23/99 | 65.4 | 59.0 | 6.4 |
| Mainstem Lobster @ Remap | 07/11/99 | 8.6 | 08/25/99 | 67.5 | 61.6 | 5.9 |
| Mainstem Lobster Below Deadline | 07/11/99 | 8.6 | 08/25/99 | 67.3 | 61.2 | 6.1 |
| Lobster Mainstem at Gorge | 07/25/99 | 4.6 | 08/23/99 | 64.7 | 61.8 | 3.0 |
| Lobster @ Mouth | 09/02/99 | 5.4 | 08/25/99 | 66.3 | 62.6 | 3.8 |
| Deadline Creek @ Mouth | 07/18/99 | 6.5 | 08/23/99 | 61.4 | 57.2 | 4.2 |
| Fall Creek @ Mouth | 07/18/99 | 5.9 | 08/23/99 | 61.3 | 57.0 | 4.3 |
| Lost Valley Creek @ Mouth | 07/18/99 | 4.3 | 08/23/99 | 59.6 | 56.6 | 3.0 |

## Table 5– Lobster Watershed Temperature Statistics

| Site Name | Days >55 F | Days >64 F | Days >70 F | Hours >55 F | Hours >64 F | Hours >70 F | Warmest day of 7-day max. | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Date | Max. | Min. |
| Mainstem abv Lost Valley | 42 | 22 | 0 | 1007.5 | 77.5 | 0.0 | 08/26/99 | 67.2 | 60.8 |
| Mainstem Lobster @ Remap | 62 | 43 | 0 | 1486.5 | 349.5 | 0.0 | 08/26/99 | 69.0 | 62.1 |
| Mainstem Lobster Below Deadline | 62 | 40 | 0 | 1486.5 | 272.5 | 0.0 | 08/26/99 | 68.7 | 61.8 |
| Lobster Mainstem at Gorge | 39 | 10 | 0 | 935.5 | 60.5 | 0.0 | 08/26/99 | 66.3 | 63.0 |
| Lobster @ Mouth | 64 | 18 | 0 | 1535.5 | 134.0 | 0.0 | 08/26/99 | 67.4 | 63.0 |
| Deadline Creek @ Mouth | 42 | 0 | 0 | 981.0 | 0.0 | 0.0 | 08/26/99 | 62.4 | 58.1 |
| Fall Creek @ Mouth | 42 | 0 | 0 | 971.0 | 0.0 | 0.0 | 08/26/99 | 62.7 | 58.1 |
| Lost Valley Creek @ Mouth | 42 | 0 | 0 | 793.0 | 0.0 | 0.0 | 08/26/99 | 61.4 | 58.4 |

Note that the system attains the 7 day maximum average numeric standard. Little time is spent above 64°F and no time was spent above 70°F. The temperature regime is favorable for salmonids and other cool water fish species.

A watershed approach was applied during the assessment. This TMDL addresses potential water quality impairment for seven significant tributary streams within the Lobster Creek Watershed that are not currently identified on Oregon's 1998 §303(d) list by name. These tributary streams were selected for assessment because they were determined to provide one or more of the following;

- Support a resident fishery
- Provide juvenile salmonid summer rearing habitat

- Where flows were determined to be of significant size to impact a 303d listed receiving waterbody

This TMDL and subsequent load allocations apply to assessed stream segments. Other, smaller perennial streams and/or springs may provide important habitat and/or refugia for sensitive salmonids. Protection of these small cool water sources should be addressed by DMA's on an individual basis prior to management activities that may result in shade reduction and/or sediment delivery to sensitive receiving channels.

Table 6 identifies stream reaches that are §303(d) listed for temperature, the applicable criterion that is exceeded, and listed stream miles.

**Table 6: USFS and Private Timber Managed Lands 303(d) listed Segments, Applicable Water Quality Standards, Stream Miles 303d Listed, and stream miles assessed.**

| | | | |
|---|---|---|---|
| Lobster Creek Mainstem – Mouth to Headwaters | Temperature 303d listed | *OAR 340-041-O365(2)(b)(A)[(i),(ii),and(v)*<br>*OAR 340-041-0006(54)* | 9.5 Miles |
| No Fork Lobster Ck Mouth to RM3 | Temperature 303d listed | *OAR 340-041-O365(2)(b)(A)[(i),(ii),and(v)*<br>*OAR 340-041-0006(54)* | 3 Miles |
| So. Fork Lobster Ck Mouth to Iron Ck | Temperature 303d listed | *OAR 340-041-O365(2)(b)(A)[(i),(ii),and(v)*<br>*OAR 340-041-0006(54)* | 3.7 Miles |
| Significant mainstem tributaries not specifically identified by name on 303d list | | | 31 Miles |
| Others significant tributaries not specifically identified by name on 303d list | | | 76 Miles |
| **Total stream miles assessed** | | | **123 Miles** |
| **Water Quality Limited 303d listed segments** | | | **16.2 miles** |

Elevated summer water temperatures in the Lobster Creek mainstem and tributaries are reducing the quality of rearing habitat for chinook and coho salmon, as well as steelhead and searun cutthroat trout. Primary watershed disturbance activities examined within this TMDL include forest management within riparian areas, sediment delivery, road management, and instream mining practices.

Some data was available for use in determining system compliance with temperature criteria designed to be applied at times and in waters that support salmonid spawning, egg incubation and fry emergence from the egg and from the gravel. These periods of the salmonid life cycle vary according to species, weather, and stream flow regimes. Spawning, egg incubation, and fry emergence can occur in the Lobster Creek Watershed beginning in October and continue through July. Meeting the salmonid spawning criteria is an objective of this TMDL. Achieving surrogate targets identified in this TMDL will result in the attainment of optimum temperature regimes for spawning, egg incubation, and fry emergence as well as juvenile rearing that the area is capable of producing. System potential conditions should result in maximum shading and more natural temperature patterns during most of the year. Available data indicates that temperature spawning criteria are currently not being met for portions of October and July in most years.

These allocations will lead to the attainment of applicable temperature criteria in all significantly sized perennial streams in the watershed. As this TMDL addresses attainment of the temperature criteria for salmonid spawning as well as the rearing, no additional waterbodies will need to be listed under 303(d).

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. Following further assessment, a TMDL will be developed and implemented to restore water quality. In addition to watershed condition assessment and problem statements, a WQMP requires identification of water quality goals and objectives, designation of responsible parties, implementation of the TMDL, some measure of assurance that the TMDL will actually be implemented, and a monitoring feedback loop (DEQ WQMP guidance 1997). **This document fully meets the requirements of Section 303(d) is submitted as the TMDL for the Lobster Creek Watershed.**

## 3.3 BENEFICIAL USES

Oregon Administration Rules (**OAR 340-41-0362 Table 5)** lists the designated beneficial uses for tributaries to Rogue River. The specific beneficial uses *occurring* in the Lobster Creek Watershed are presented below in **Table 7**.

**Table 7. Designated beneficial uses and those currently occurring in the Lobster Creek Watershed.**

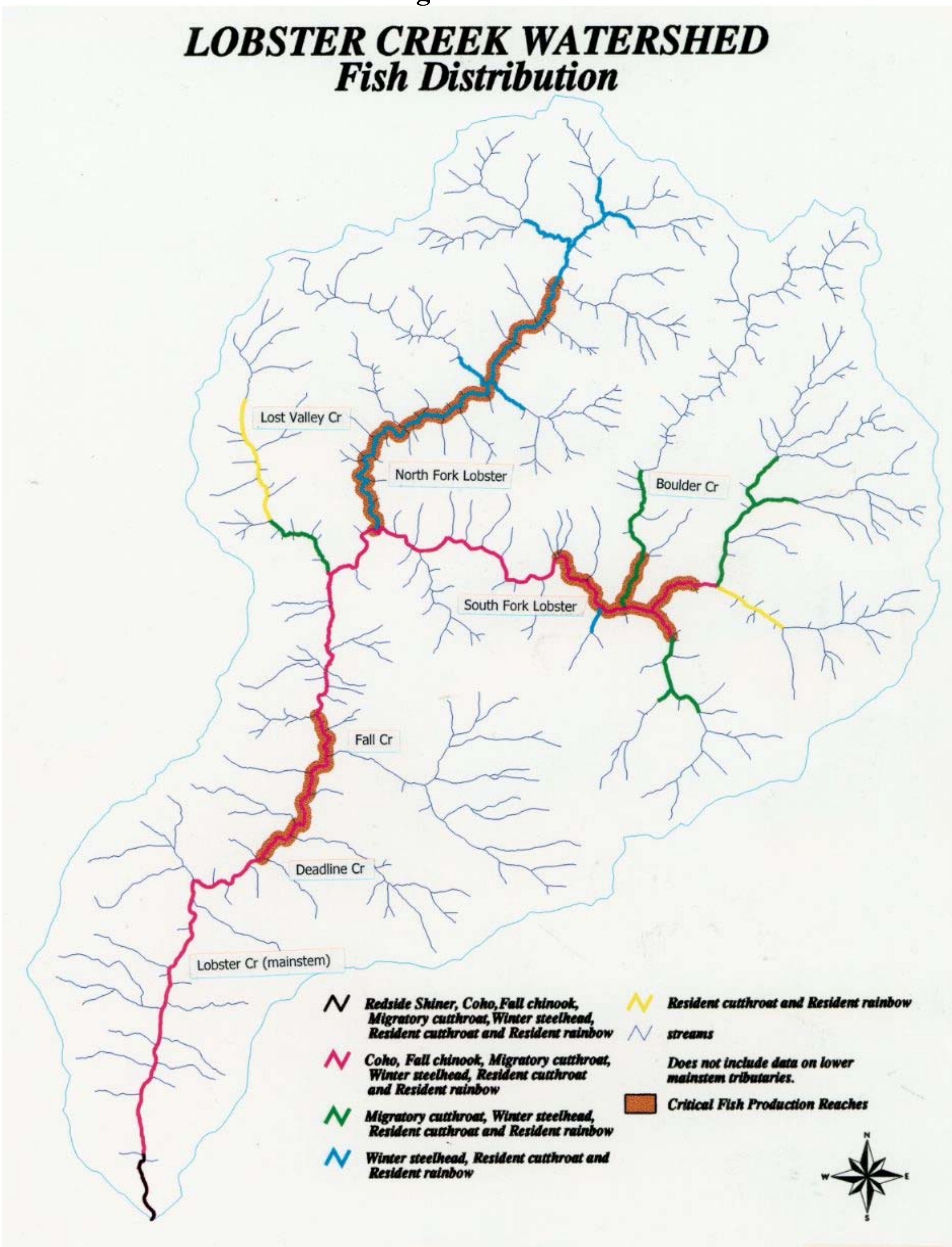
| *Beneficial Use* | *Occurring* | *Beneficial Use* | *Occurring* |
|---|---|---|---|
| Public Domestic Water Supply | | Anadromous Fish Passage | ✓ |
| Private Domestic Water Supply | | Salmonid Fish Spawning | ✓ |
| Industrial Water Supply | | Salmonid Fish Rearing | ✓ |
| Irrigation (Fire Suppression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

Numeric and narrative water quality standards are designed to protect the most sensitive *beneficial uses*. In the Lobster Creek Watershed, resident fish, aquatic life, and salmonid spawning and rearing are the most sensitive designated *beneficial uses*.

Figure 3 identifies fish distribution in the Lobster Creek Watershed. Salmonid fishes, often referred to as cold water fish, and some amphibians appear to be highly sensitive to temperature. In particular, Coho salmon and migratory cutthroat and steelhead trout are among the most temperature sensitive of the cold water fish species during the juvenile rearing time period. It is not the intent of this TMDL to manage conditions within this watershed for only one group of species. Resident cutthroat and rainbow trout likely maximize refugia during summer warm periods and in general populations would likely benefit from improved cool water habitat conditions.

Coho salmon have been allotted protection (are listed) under the Endangered Species Act (ESA) as a threatened species in the Lobster Creek Watershed. Fall Chinook are more sensitive to late summer and early fall spawning period stream flows and temperatures. Chinook are currently at candidate species status under the ESA.

**Figure 3**




* Fall and Deadline Creeks have been identified as fish bearing streams. ODFW is in the process of generating updated fish distribution maps in digital format.

Oregon's water temperature standard employs logic that relies on using these ***indicator species**,* which are the most sensitive of the designated ***beneficial uses***. If temperatures are protective of *these indicator species*, other beneficial uses will share in this level of protection.

Thermally induced stresses can result in fish mortality. This can be 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 stress, termed indirect or *sub-lethal*, is more delayed, and occurs weeks to months after the onset of elevated temperatures.

# 4. PROBLEM ASSESSMENT - STREAM TEMPERATURE

## 4.1 BACKGROUND

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

Anthropogenic or management related increases in heat energy are derived from assessing solar radiation. As increased levels of sunlight reach the stream surface water temperature raises. Stream warming as water moves downstream under vegetative site potential conditions would likely reflect some level of longitudinal warming. Increases in heat energy (solar heat energy) that can be attributed to land management related activities are considered a pollutant. These management related sources of stream temperature increase are addressed by surrogate conditions targeted in this TMDL.

Riparian vegetation, stream morphology, hydrology, climate, and geographic location influence stream temperature. While climate and geographic location are outside human control, the condition of the riparian area, channel morphology, and hydrology can be affected by land use activities. This does not take into account long term climate changes that may occur as a result of the Global Warming Theory. Assessment of summertime stream temperatures regimes and their relationship to legacy and current land management activities in the Lobster Creek Watershed included the evaluation of the following parameters that can affect the water quality parameter (temperature) through increased solar loading:

1. *Management related riparian vegetation disturbance. Management related changes in riparian vegetation height and density (measured as percent effective shade).*
   - Decreased percent effective shade levels available to reduce sunlight (e.g. solar energy from incoming solar radiation).
   - Increasing stream surface solar radiation loading by changing riparian composition and/or seral stage.
2. *Channel widening (increased width to depth ratios) that increases the stream surface area exposed to heat transfer energy processes (solar radiation).*
   - Sediment loading above that resulting from "natural background conditions" can potentially impact channel morphology.
   - Sediment loading has occurred as a result of legacy road building, road design, road maintenance, and management related landslides.

- Historic instream mining activities have also adversely affect channel morphology.

3. *Consumptive water uses are **not** present within the watershed boundary and do not impact summertime base flows and are **not considered a significant contributor** to stream temperature increases.**

** Timber harvest has the potential to increase water yield by removing agents of evapotranspiration and may increase summer base flows. Road construction has the potential to concentrate water and increase storm flow events thereby reducing upland storage of groundwater. Because of this, road building can result in a decrease of water available for summer base flows. Sediment delivery to the stream can result in channel widening. These components are discussed under the Margin of Safety section.*

This assessment determined that riparian composition and channel morphology changes have resulted from timber management and mining activities conducted for decades. Management related potential impacts were assessed and quantified. Shade recovery predictions based on reach weighted averages range from 2-9%. The Lobster Creek Watershed is representative of a watershed in good biological condition. Improvements can be realized and that potential is recognized in this document.

Although timber harvest and mining continue in the Lobster Creek Watershed, adaptive management practices that comply with surrogate measures (allocations) presented in this document are intended to ameliorate pollutant delivery.

Recreational mining is conducted within the watershed and is considered a point source activity. It is the only point source activity present in the assessment area. As currently conducted, this activity is not effecting riparian and/or channel conditions. This activity is currently managed under the 0700J General NPDES Permit. A waste load allocation of zero has been established for this activity. If managed prudently point source influences should contribute no pollutant load to the system.

***See Chapter 2 and Appendix C, Element 1, Condition Assessment, for detailed information regarding the Problem Assessment.***

## 4.2 MECHANICS OF SHADE - RIPARIAN VEGETATION

Stream surface shade is a function of several landscape and stream geometric relationships. Some of the factors that influence shade are listed in **Table 8**. In the Northern Hemisphere, the earth tilts on its axis toward the sun during summertime months allowing longer day length and higher solar altitude, both of which are functions of solar declination (i.e. a measure of the earth's tilt toward the sun). Geographic position (i.e. latitude and longitude) fixes the stream to a position on the globe, while aspect provides the stream/riparian orientation. Riparian height, width and density describe the physical barriers between the stream and sun that can attenuate incoming solar radiation (i.e. produce shade). The solar position has a vertical component (i.e. altitude) and a horizontal component (i.e. azimuth) that are both functions of time/date (i.e. solar declination) and the earth's rotation (i.e. hour angle). While the interaction of these shade variables may seem complex, the math that describes them is relatively straightforward geometry, much of which was developed decades ago by the solar energy industry.

**Table 8.** Factors that Influence Stream Surface Shade

| Description | Measure |
|---|---|
| Season | Date |
| Stream Characteristics | Aspect, Bankfull Width |
| Geographic Position | Latitude, Longitude |
| Vegetative Characteristics | Buffer Height, Buffer Width, Buffer Density |
| Solar Position | Solar Altitude, Solar Azimuth |

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 prevent or reduce heating by solar radiation and serve as a linear translator to the solar loading capacities.

The percent effective shade is perhaps one of the easiest and straightforward stream parameters to monitor/calculate and is most helpful in directing water quality management and recovery efforts. Using solar tables or mathematical simulations, the *potential daily solar load* can be quantified. The *measured solar load at the streams surface* can easily be measured with a Solar Pathfinder© or estimated using mathematical shade simulation computer programs (Boyd, 1996 and USFS, 1993).

## 4.3 MECHANICS OF SHADE - CHANNEL WIDENING

The effects of sediment on channel form (and eventually temperature) were identified and analyzed with historic air photos and direct field measurement of width to depth ratios and pool depth by the USFS. The objective was to find areas where aggradation and channel widening have occurred and to assess the extent to which they are recovering.

The presence and activity level of many large, naturally occurring mass wasting features most often overshadow management related sediment inputs in this geomorphic province. Geologic factors are assessed as the primary cause of the heating reach on the South Fork of Lobster Creek, from Boulder Creek to its confluence with the North Fork. Several inner gorge landslides along this reach appear on the 1956 aerial photos, prior to harvest and roading. One is a reactivated slide that appeared to be healing on the 1940 photos. These were probably activated by the 1955 flood, which removed riparian vegetation, widened the canopy opening, and aggraded the channel. On the later photos taken through 1988, these conditions persist with little change along a mile of the segment below the largest slide. Additionally, timber was harvested nearly to the channel along half of this aggraded mile in 1964 and 1965. On the 1997 aerial photos, riparian vegetation has grown and is covering more of the channel than in 1986.

It is difficult to definitively say that management related sediment is the cause of any channel form issues in the Lobster Creek Watershed. The assumption made here is that management related sediment will potentially have an impact on the system, and that efforts to reduce management related inputs will be implemented.

Furniss et al. (1991), concluded that forest roads contributed more sediment than all other forest activities combined on a per unit area basis. Roads are primary sources of sediments to streams, both through chronic erosion and as trigger points of mass failures (Spence et al., 1996). To reduce potential channel plan and profile adjustments initiated by increased sediment loading, potential sources of management related sediment are being identified and treated.

It should be noted that most stream reaches within the Lobster Creek Watershed above the Forest Boundary have significant sediment transport capacity for sand and gravel sized materials. Consequently, the effects from these sediment sizes are likely seen lower in the system. Channels below the Forest Boundary are likely more vulnerable to potential impacts from sediment inputs.

This TMDL analysis has determined that anthropogenic sediment inputs (those resulting from land management practices) can have an impact on the channel width in the system. Low gradient reaches along the mainstem of Lobster Creek and the lower portion of Boulder Creek are especially vulnerable. These are reaches where some channel widening has occurred. Measurable solar radiation hits the water’s surface because shading does not reach the stream. In order to protect channel integrity, upland sediment abatement activities have and will continue to be implemented. Some areas of channel width to depth ratio reductions are predicted, the benefits of which are housed in *Margin of Safety* and as such were not utilized in modeling future conditions.

## 4.4 EXISTING CONDITION ASSESSMENT

Management activities can increase the amount of solar radiation entering a steam by the of riparian shade components (overhang and density). In addition, the introduction of management related sediment bedload can result in increases in the stream's surface area. The Lobster Creek Watershed Water Quality Management Plan was developed to address stream shade and changes in channel form, as these management factors may contribute to water temperature problems.

Effective shade and solar radiation loading were simulated for various channel widths (bankfull). System potential vegetation was determined to be late seral Douglas fir, with Hemlock and Port Orford cedar present. Coniferous and mixed hardwood stands are common based upon evaluation of reference sites in the watershed. This vegetative condition was utilized to define effective shade potential. System potential shading is utilized to predict solar loading without anthropogenic effects. System potential vegetation defines the solar load while effective shade is the surrogate target. Effective shade may well be achieved in given channel types without system potential vegetation.

In the Lobster Creek Watershed, undisturbed riparian areas generally progress towards late seral woody vegetation communities (mixed hardwood, but conifer dominated). Few, if any, riparian areas in the Lobster Creek Watershed are unable to support either late seral woody vegetation or tall growing herbaceous vegetation. Further, the climate and topography are well suited for growth and maintenance of large woody vegetative species in the riparian areas.

**Table 9 - Summary reach weighted percent existing shade and percent target shade values for the Lobster Creek Watershed.**

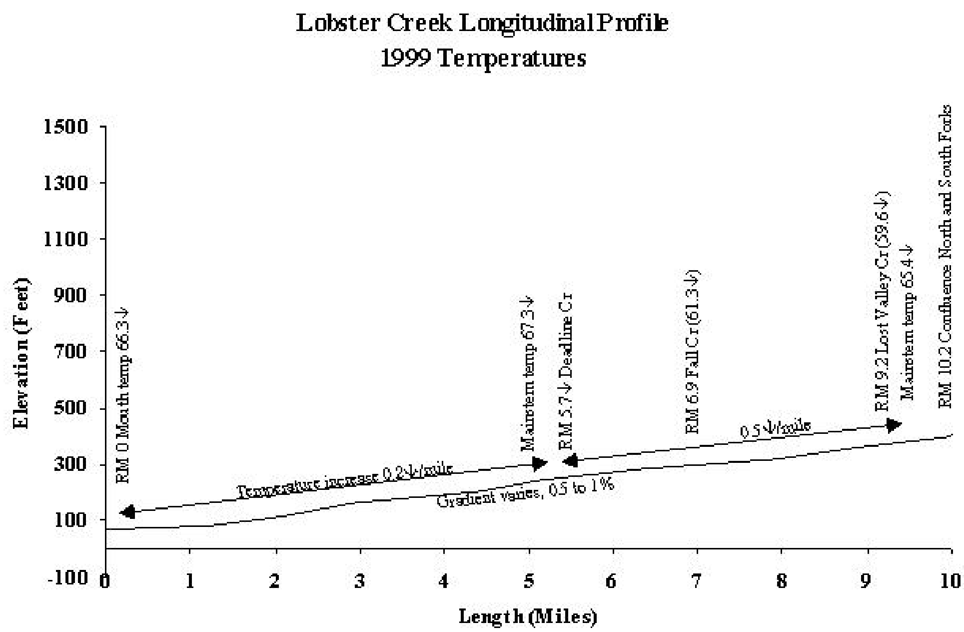
| Location | Existing Shade Percent | Potential Shade Percent | Predicted Shade Increase Percent |
|---|---|---|---|
| South Fork Lobster | 89 | 91 | 2 |
| North Fork Lobster | 94 | 96 | 2 |
| Boulder Cr. | 87 | 92 | 5 |
| Lost Valley | 93 | 96 | 3 |
| Fall Creek | 88 | 93 | 4 |
| Deadline Creek | 90 | 93 | 3 |
| Mainstem Lobster | 80 | 88 | 9 |

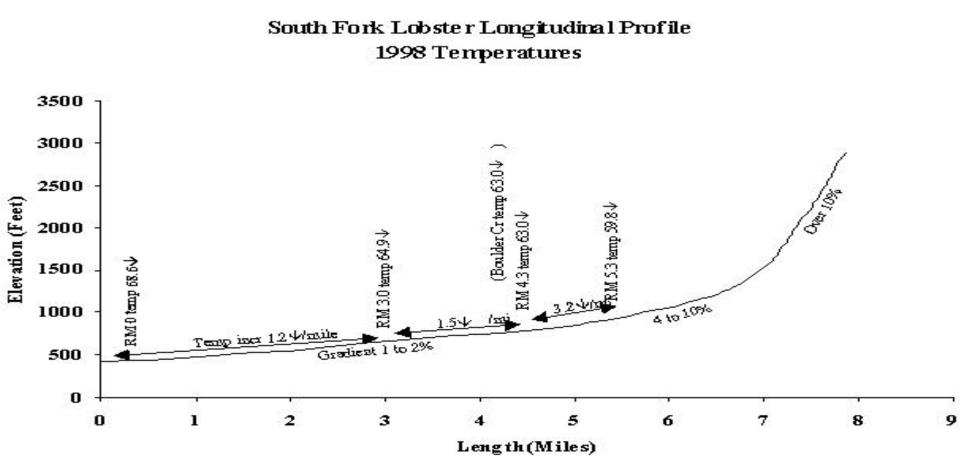
## 4.5 OBSERVED LONGITUDINAL STREAM HEATING

Generally, stream temperatures follow a longitudinal (downstream) heating pattern. Lobster Creek 7 day seasonal maximum average temperature regimes are influenced by cooler groundwater and small tributary inputs. These inputs have a cooling influence on the Lobster Creek mainstem. Summer of 1999 seven-day maximum average temperatures in upper Lobster Creek above Lost Valley Creek occurred in August and reached 65.4°F. Data indicate that longitudinal heating occurs in the mainstem until the cooling influence of flows from Deadline Creek. Lobster Creek mainstem then cools 2.6°F as it moves through the gorge area. This cooling likely occurs due to channel narrowing, topographical shade increases, and cooler groundwater and tributary inputs. Lobster Creek mainstem then heats 0.8°F, as measured at the confluence with the Rogue River. The mainstem warms only 0.9°F over the nearly 10 miles of stream length. Important cool water inputs from relatively small tributaries have large effects on longitudinal heating in this watershed.

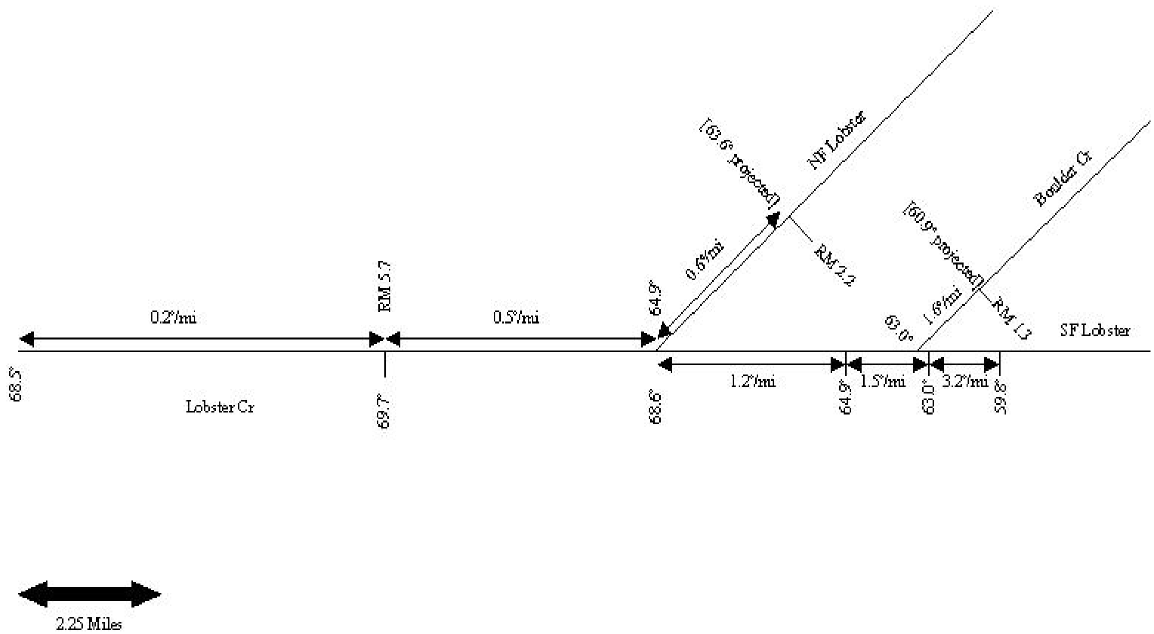
***Figures 4, 5, and 6 were taken from the Appendix C and are provided here for your convenience. They display stream profiles and stream heating as a function of measured perennial stream distance from headwaters based upon data collected in 1998 and 1999.***

# Figures 4, 5, 6 – Longitudinal Profiles



Temperature Increase Schematic
(Distances are to Scale)
1998 Temperatures




## 4.6 SHADE RELATED TO OBSERVED LONGITUDINAL STREAM HEATING

Longitudinal heating is a natural process and downstream temperatures can, at some point, reach a natural equilibrium with local ambient conditions. However, rates of heating are dramatically reduced when high levels of shade exist and solar radiation loading is minimal. The overriding justification for the solar loading reduction (loading capacity) is to minimize longitudinal heating. A limiting factor in reducing longitudinal stream heating is the existing effective shade level and tributary inputs.

Effective shade at system vegetative potential modeling was conducted utilizing the Shadow model (USFS, 1993). Riparian shade assessment documentation can be found in Chapter 2 Appendix C-2. The Shadow model determines shading on August 1 of any given year. August was selected for this exercise because it is a peak solar loading month for this region. The Heat Source model (Boyd, 1996) was utilized as a predicitve tool to determine what the longitudinal temperature profile would look like with system potential vegetation present. Heat Source modeling results can be found in Appendix A. Heat Source modeling was based upon conditions for July 22, 1999, a date close to the peak solar loading period and the date of flow data collection.

Based upon predicted future shading potential conditions the predicted longitudinal stream temperature profile indicates that the system will attain the temperature standard in most years. No thermal loads are available for allocation to anthropogenic sources in this system because the watershed does not currently attain numeric water quality criteria. In addition, current temperature conditions in the Lower Rogue receiving waterbody also exceed numeric temperature criteria. The Lobster Creek Watershed provides high quality cool water for rearing juvenile salmonids. Predicted shade improvements are not dramatic but should result in improvement of the temperature regime and improvements in water and habitat quality.

Some data was available for use in determining system compliance with temperature criteria designed to be applied at times and in waters that support Salmonid spawning, egg incubation and fry emergence from the egg and from the gravel. These periods of the Salmonid life cycle vary according to species, weather, and stream flow regimes. Spawning, egg incubation, and fry emergence can occur in the Lobster Creek Watershed beginning in October and continue through July. DEQ is committed to improve the understanding of the status of this system for these criteria through future monitoring efforts. Available data indicates that temperature spawning criteria are currently not being met during portions of October and July in most years.

This TMDL was developed to ensure that water is as cool as possible by ameliorating management caused sources of stream heating. The TMDL sets load allocations for solar radiation which establishes effective shade targets needed to meet those load allocations. The load allocations are based on the maximum shade (removal of solar loading) that can potentially be achieved for given stream segments. The effective shade targets, when met, would ensure no increase in water temperature due to anthropogenic sources of stream heating. Meeting the salmonid spawning criteria is an objective of this TMDL. Achieving surrogate targets identified in this TMDL will result in the attainment of optimum temperature regimes for spawning, egg incubation, and fry emergence as well as juvenile rearing that the area is capable of producing. System potential conditions should result in maximum shading and more natural temperature patterns during most of the year.

# 5. TMDL – LOADING CAPACITIES AND ALLOCATIONS

Analysis presented in this TMDL demonstrates that developed solar loading capacities will ensure attainment of the narrative portion of the State's water quality standards. Specifically, the link between shade surrogate measures (allocations) for solar radiation loading capacities and water quality attainment will occur via two processes:

1. *Remove anthropogenic (management related) solar radiation contributions from potentially impacting temperature dynamics in the Lobster Creek Watershed.*
2. *Restore riparian reserves that function to protect stream morphology and encourage bank building processes in severe (large and infrequent) hydrologic events.*

## 5.1 REGULATORY FRAMEWORK

Under the current regulatory framework for development of TMDLs, identification of the loading capacity is an important first step. The loading capacity provides a reference for calculating the amount of pollutant reduction needed to bring water into compliance with standards. By definition, TMDLs are the sum of the allocations [40 CFR 130.2(i)]. Allocations are defined as the portion of a receiving water loading capacity that is allocated to point or nonpoint sources and natural background. EPA's current regulation defines loading capacity as "*the greatest amount of loading that a waterbody can receive without violating water quality standards*."

## 5.2 LOADING CAPACITIES

Loading capacities in the Lobster Creek Watershed are quantified as heat energy from incoming solar radiation expressed as $Btu/ft^2$ per day. Simulations of heat transfer processes indicate that water temperatures increase above natural daily fluctuations when the heat load from solar radiation rises. All streams with significant flow contributions were evaluated (contributing streams providing 5% or more of the drainage area or flow at the point of confluence).

Solar loading capacities are determined for streams based upon future vegetative potential or vegetative system potential. In this assessment the potential to provide measurable shade increases and subsequent temperature improvement has been shown in Appendix A. Even with measurable shade increases, the system is not expected to attain the numeric temperature criteria under all environmental conditions. Stream 7 day maximum average temperatures for the period of record 1990 through 1999 varied as much as 3.5°F.

In this case, a system potential vegetation target will provide maximum shade or effective shade. Therefore, the loading capacity will be set at the system potential vegetative state and no thermal load will be available to allocate to anthropogenic sources. By taking this approach the narrative temperature standard will be attained. System potential vegetation, target shade, and solar radiation loading take into account bankfull channel width and stream orientation for late July and early August. This approach can also be used to determine system potential loading capacity and effective shade conditions for those streams in the Lobster Creek Watershed lacking a system potential analysis. The SHADOW assessment identified potential target shade values ranging from a low of 22% in the mainstem where active channel widths are 100+ feet to nearly full shading where active channel widths are 3 feet. The SHADOW assessment provides reach specific information regarding current and future potential shading conditions.

**The system potential (target shade value) of 92% is the result of weighted averaging based upon reach length and total length of perennial stream assessed.**

Solar energy, calculated for the Lobster Creek Watershed as a maximum of 2440 BTU/square'/day, can be used to give a numeric value for a Total Maximum Daily Load (TMDL). A load value has been derived (BTU's per square foot per day) based on the calculated shade values. Table 10, taken from the Appendix C, displays the existing solar loading and target loading by ownership.

**Table 10 - Existing and Target Solar Loading or TMDL by Ownership**

| **Management Entity** | **Target Shade Value** | **Existing Shade Value** | **Increase Predicted** |
|---|---|---|---|
| USFS | 93% | 91% | 2% |
| Lincoln Timber LLC | 90% | 83% | 7% |
| *All lands (watershed)* | 92% | 88% | 4% |
| | **Target Solar Loading or TMDL** (BTU/sqft/day) | **Existing Solar Loading** (BTU/sqft/day) | **Reduction Predicted** (BTU/sqft/day) |
| USFS | 171 | 220 | 49 |
| Lincoln Timber LLC | 244 | 407 | 165 |
| *All lands (watershed)* | 195 | 293 | 98 |

A target solar loading capacity (based upon system potential vegetative conditions) of 195 Btu/ft$^2$ per day has been derived from reach weighted potential shade modeling. This load is based upon the reach weighted effective shade potential for the watershed. The target value is the load capacity (TMDL) and provides a reference for calculating the amount of pollutant reduction predicted (solar energy). The methodology used to collect data and derive this value is illustrated further in Chapter 2 Appendix C-3.

In terms of water temperature increases, the principle source of heat energy is solar radiation directly striking the stream surface. The total energy budget for the Lobster Creek Watershed is;

- Current Solar Loading = 293 $Btu \cdot ft^{-2} \cdot day^{-1}$
- Targeted loading capacity condition, Solar Loading Capacity = 195 $Btu \cdot ft^{-2} \cdot day^{-1}$

Note that the targeted solar loading capacity condition results in significant diurnal heat energy reductions as indicated in Appendix A. The Heat Source modeling exercise included only the lower 9.5 miles of the mainstem of the watershed. Loading capacities and allocations were based upon the more comprehensive riparian and channel assessments conducted throughout the entire watershed. The Heat Source modeling day selected depicts seasonal warm weather conditions. Solar radiation has been determined to be the predominant heat energy process in the current condition simulation.

## 5.3 SURROGATE MEASURES - DEFINED

The Lobster Creek Watershed TMDL incorporates measures other than "*daily loads*" to fulfill requirements of 303(d). Although a loading capacity for heat is derived [e.g. 195 British Thermal Units (Btu) per square foot per day], it is of limited value in guiding management activities needed to solve identified water quality problems. In addition to heat loads, this TMDL allocates "*other appropriate measures*" (or surrogates) as provided under EPA regulations [40 CFR 130.2(i)]. The specific surrogate used is *percent effective shade.*

A loading capacity of BTU's 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.

**Surrogate Measures** (*"other appropriate measures"*) are used in conjunction with heat **Load Capacity** targets to address water temperature increases. Namely, *percent effective shade* is an effective measure of anthropogenic heat contributions and a descriptor of riparian condition. In essence, the **Surrogate Measure** (percent effective shade) is **allocated** as a translation of the developed solar radiation **Loading Capacities**.

Because 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, reduce stream bank erosion and stabilize channels. Likewise, narrower channels still require riparian vegetation to provide channel stability and shade, thus reducing heat loads (unless confined by canyon walls or shaded by topography).

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). Stream surface shade is dependent on topography as well as riparian vegetation type, condition, and shade quality. 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 prevent or reduce heating by solar radiation.

Allocations in the Lobster Creek Watershed TMDL are derived using heat loads. Percent effective shade (surrogate measure) can be linked to specific areas and, thus, to management actions needed to solve problems that cause water temperature increases (USFS 1993).

## 5.4 WATER QUALITY ATTAINMENT - TEMPERATURE CHANGE RELATED TO SHADE SURROGATE MEASURES AND SOLAR LOADING CAPACITIES

Predictive temperature modeling was conducted using Heat Source (Boyd, 1996). This model examines both the total energy transfer rates to the stream (i.e. the sum of heat energy transfer processes) and the response of water temperature to heat energy absorbed. Heat transfer processes considered in the analysis include solar radiation, longwave (thermal) radiation, convection, evaporation, and streambed conduction. This analysis has been developed using typical streamflows and channel characteristics commonly found in the Lobster Creek Watershed as well as conservative assumptions described in the margin of safety discussion.

**Figure 7 (Appendix A, Figure 18) is provided here** and shows current stream temperature conditions and projected future stream temperature profiles for the mainstem of Lobster Creek. The open circles in Figure 7 are the corresponding same-day 4:00 PM temperatures recorded by the four data loggers deployed in the main stem. The expected future stream temperature profiles are based on the assumed future surrogate conditions. These temperature profiles show stream temperatures at **4:00 PM in the afternoon for July 22, 1999.** The modeling day selected depicts seasonal warm weather conditions. The difference between the lines shows how much reduction in stream temperature might be expected if the assumed future conditions are achieved.

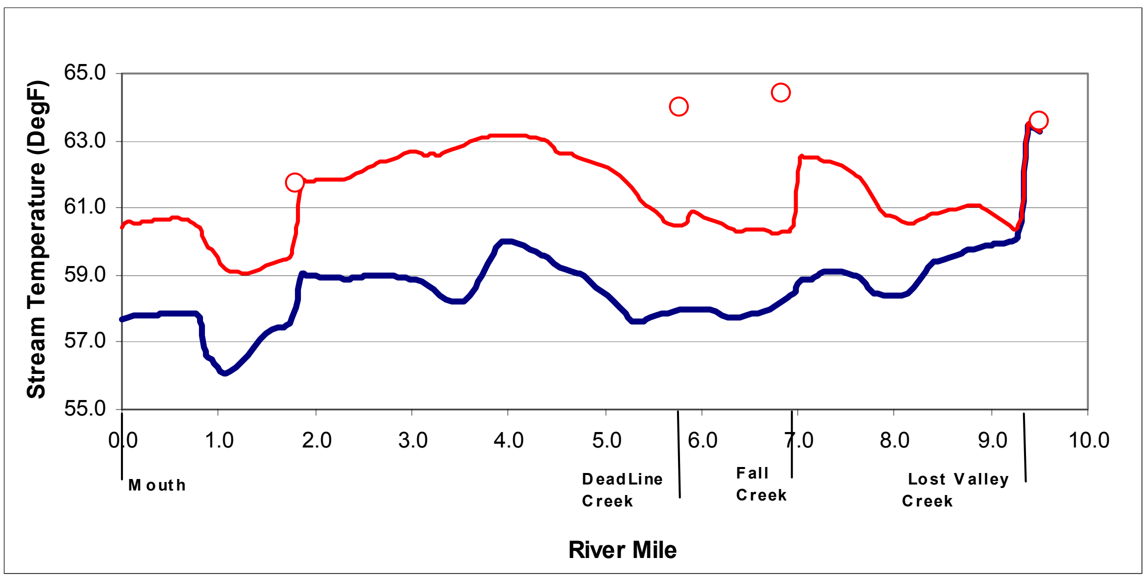
The top line shows the present temperature profile and the bottom line shows the expected system potential temperatures. The model simulations for the future conditions did not assume any additional cooling to any tributary. **Additional cooling in any of the tributary sub-watersheds or increased interaction with basin groundwater could result in additional cooling in the main stem of Lobster Creek.**

The Heat Source model under predicted stream temperatures during calibration in the mainstem below Fall and Deadline Creeks. During calibration various measured parameter inputs were adjusted to attempt to force the calibration simulation to agree with the observed stream temperature. Modeling data for this project was predominantly directly measured so the decision was made to utilize measured data with slight adjustment rather than to force model calibration in the upper watershed. This initial Heat Source modeling effort will be further refined in the future with additional actual field measurements through time.

Stream temperature simulation results (Appendix A) demonstrate that decreasing levels of solar radiation can have a significant stream cooling effect. Language that is more precise would describe the effect of decreased solar loads as preventing stream temperature increases. Simulation results suggest that thermal conditions in the Lobster Creek Watershed can have improved temperature regimes when improved riparian conditions are achieved. Simulated peak stream temperatures are reduced by nearly 3°F in this simulation. This conclusion is consistent with temperature modeling efforts for other waterbodies in the Pacific Northwest (Brown, 1969; Beschta and Weatherred, 1984; Sullivan and Adams, 1990; Boyd, 1996).

Based on this modeling outcome, this system is likely to attain the temperature rearing standard during most conditions. Maintaining the cool water inputs of small tributaries to Lower Lobster Creek mainstem is important to achieving this goal. However the spawning, egg incubation, and fry emergence criteria is not likely to be met during the late summer months and early fall (July, October).

**Figure 7 - Heat Source Modeling Scenario, July 22, 1999 for 4 PM.**



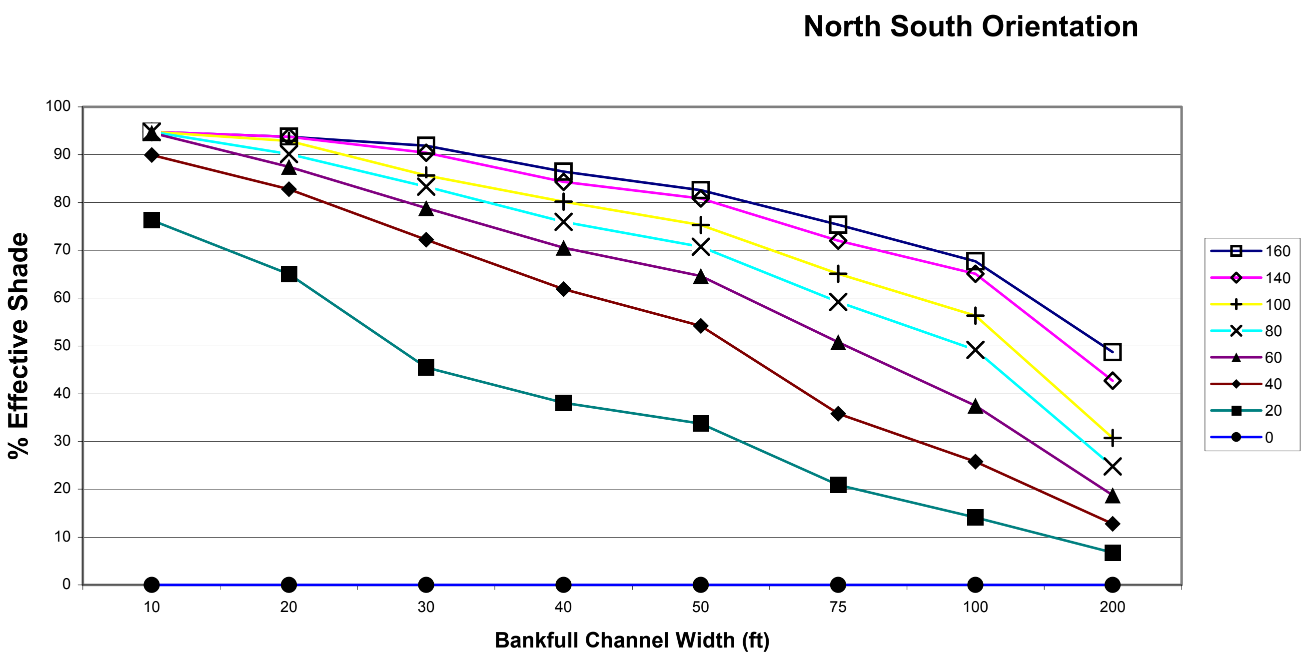

Anthropogenic sources provide no measurable increase in stream temperature when solar radiation loads are equal to or less than the loading capacity for the mainstem. The solar loading target of 659 Btu·$ft^{-2}$·$day^{-1}$ was derived from Heat Source modeling for the **mainstem** only of Lobster Creek. Solar radiation loading of 659 Btu·$ft^{-2}$·$day^{-1}$ represents a reasonable starting point for defining loading capacity (i.e. the greatest amount of solar loading that surface waters can receive without violating narrative water quality standards). The solar loading target of 195 Btu·$ft^{-2}$·$day^{-1}$ was derived from Shadow modeling for the reach weighted shade average for the entire assessed area within the Lobster Creek Watershed.

The average flat plane solar radiation loads above the riparian canopy in the Lobster Creek Watershed vicinity in late July to early August are on the order of 2440 Btu·ft$^{-2}$·day$^{-1}$. Site potential shade values have been utilized to determine that a reduction in potential solar radiation load delivered to the water surface defines the target (*or "appropriate measure*") which has been used for development of effective shade targets for this TMDL.

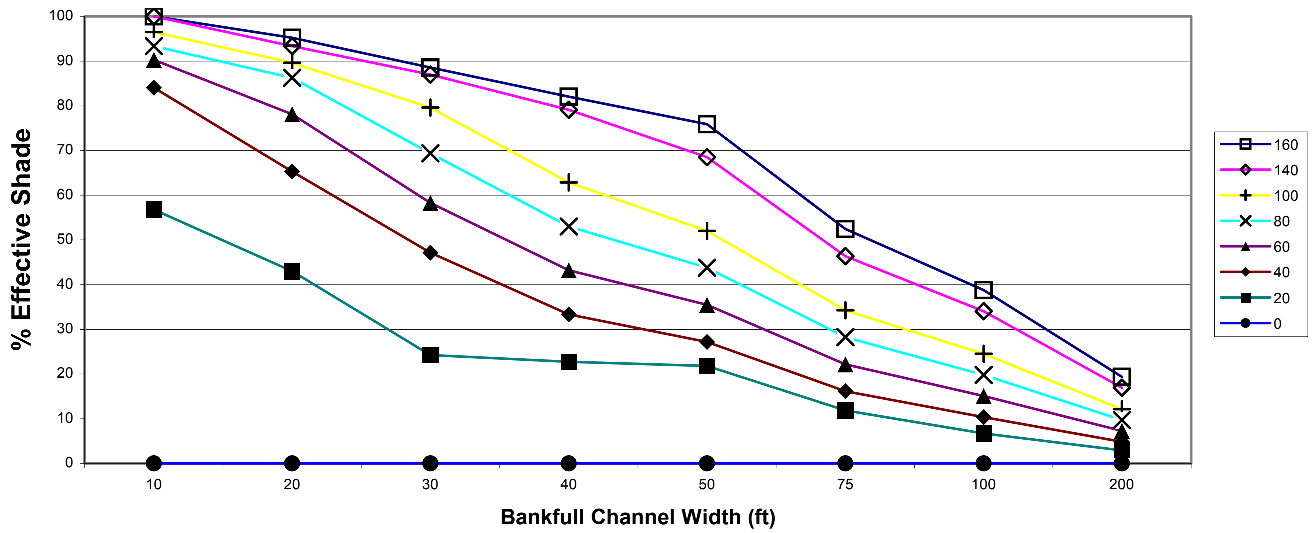
Effective shade does vary per specific site based primarily upon aspect and channel width. WQMP definitions are consistent with the definition of effective shade in this TMDL (i.e. the percent reduction of potential solar radiation load delivered to the water surface). This provides an alternative target (or surrogate) which relates to stream temperatures. By implementing this TMDL anthropogenic stream heating will be eliminated.

Effective shade curves are provided below for three different aspects and for various channel widths and riparian vegetation heights. These curves allow easy viewing of a variety scenarios for riparian vegetation, channel width's, and stream aspect. BTU Loading can easily be determined from % shade values. A total of 2440 Btu·ft$^{-2}$·day$^{-1}$ is available to strike a flat plane at this latitude and longitude.

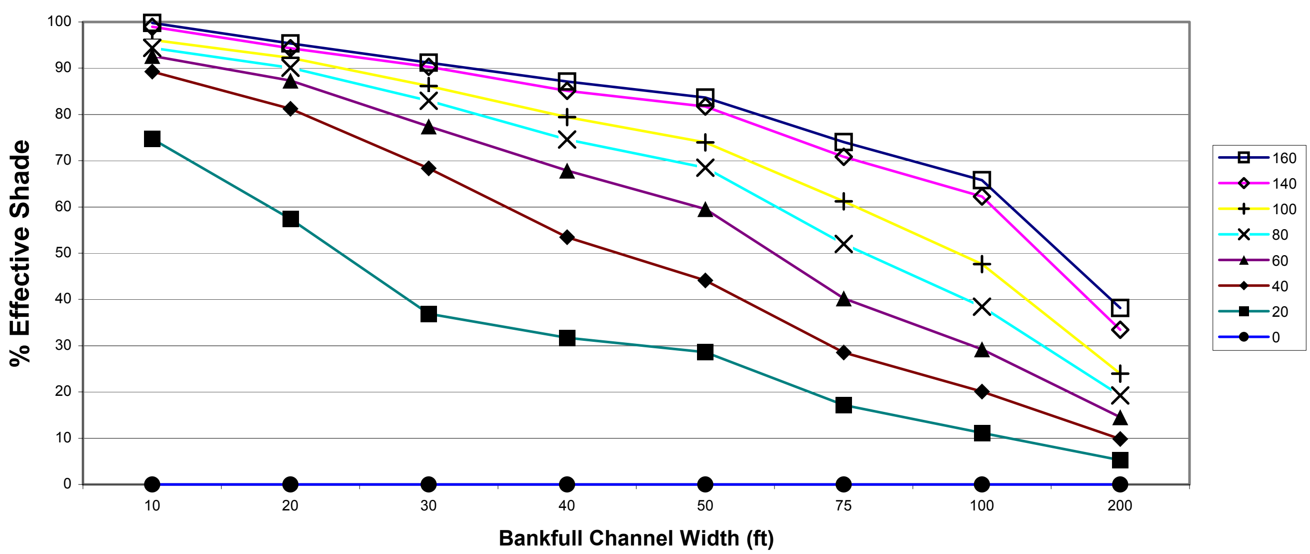
**Figures 8, 9, and 10 - Effective Shade Curves for Three Aspects**



**East-West Orientation**




**Diagonal Orientation**



These shade curves assume a shade density of 80%, terrain slope of 60%, and a tree to channel distance of 5 feet. Overhang assumptions vary by channel width.

Where the naturally occurring quality parameters of waters of the Rogue Basin are outside the numerical limits of the assigned water quality standards, the naturally occurring water quality shall be the standard (340-41-0365 (3).

## 5.5 ALLOCATIONS

Waste Load Allocations

Recreational mining is conducted within the watershed and is considered a point source activity. It is the only point source activity present in the assessment area. As currently conducted, this activity is not affecting riparian and/or channel conditions. This activity is currently managed under the 0700J General NPDES Permit. Since this point source does not contribute additional pollutant load to the system, a waste load allocation of no measurable temperature increase has been assigned. Future point source activities are also assigned a waste load allocation of no measurable temperature increase.

Load Allocations

Solar loading capacities are determined for streams based upon future vegetative potential or vegetative system potential. In this assessment the potential to provide measurable shade increases was evident, but, even with this shade increase, the system is not expected to attain the numeric temperature criteria under extreme environmental conditions. Since the numeric criteria are not being met, no measurable surface water temperature increase resulting from anthropogenic activities is required by the state water quality standard. In this case, a system potential vegetation target will provide maximum shade or effective shade. Therefore, the loading capacity will be set at the system potential vegetative state and no thermal load will be available to allocate to anthropogenic sources. By taking this approach the narrative temperature standard will be attained.

**Table 11 – Load Allocation Summary**

| Source | Allocation |
|---|---|
| Federal Forest Lands | 0 |
| Private Timberlands | 0 |
| Agriculture | 0 |
| Urban | 0 |
| Point Sources | 0 (no measurable increase) |
| Future Point Sources | 0 (no measurable increase) |
| Natural Sources | 100% |

These allocations allow for natural disturbance regimes and their potential adverse impacts on shade in the watershed. Other activities are not allowed a load and are required to manage to reach effective shade targets as possible within the natural disturbance regime.

# 6. MARGIN OF SAFETY

The Clean Water Act requires that each TMDL be established with a margin of safety (MOS). The statutory requirement that TMDLs incorporate a margin of safety 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 margin of safety is expressed as unallocated assimilative capacity or as conservative analytical assumptions used in establishing the TMDL (e.g., derivation of numeric targets, modeling assumptions or effectiveness of proposed management actions).

The margin of safety may be implicit, as in conservative assumptions used in calculating the loading capacity, WLAs, and LAs. The margin of safety may also be explicitly stated as an added, separate quantity in the TMDL calculation. The margin of safety is not meant to compensate for a failure to consider known sources. An implicit margin of safety was developed for this project.

### 6.1 IMPLICIT MARGINS OF SAFETY

Description of the margin of safety for the Lobster Creek Watershed temperature TMDL begins with a statement of assumptions. Several factors relating to margin of safety have been incorporated into the temperature assessment methodology.

- Some groundwater inflow was utilized but other, smaller groundwater inputs were assumed to be zero and this cooling influence on stream temperatures via mass transfer/mixing was not accounted for.
- Cooler microclimates associated with late seral conifer riparian zones were not accounted for in the simulation methodology.
- Improvement in channel conditions is expected to be minimal and localized through time. Some localized areas have experienced event related channel widening and hence should experience recovery as extensive upland sediment abatement projects are implemented and large magnitude storm events reshape channels. Channel improvements were not specifically identified in future condition modeling.
- Shadow and Heat Source modeling inputs restricted maximum future shade densities to less than or equal to 70%. Density within any given stand can vary dramatically through seral stages. Even within areas where quite dense stands are present model inputs did not exceed values of 70%. This shade evaluation process likely results in an underestimation of existing and future % shade values.
- Tributary temperatures were not changed based upon predicted improved future riparian conditions but held to current temperature regimes. The predictive modeling exercise for this basin focused upon the mainstem. Future improvements in tributary temperature regimes have the potential to provide significant cooling to the mainstem. This cooling is not accounted for in the predictive modeling supporting this TMDL.
- System potential vegetation was determined to be late seral Douglas fir, with Hemlock and Port Orford cedar present. Coniferous and mixed hardwood stands are common based upon evaluation of reference sites in the watershed. In the Lobster Creek Watershed, undisturbed riparian areas generally progress towards late seral woody vegetation communities (mixed hardwood, but are conifer dominated). System potential tree height during modeling was determined to be 160'. Maturing near stream hardwood communities may result in improved channel vegetation overhang values. Future condition overhang values were not increased.

Calculating a numeric margin of safety 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 effective shade conditions. Effective shade potential presumed that system potential riparian conditions are the desired future condition for most of the assessment area.

It is understood that human and natural disturbances will likely occur within riparian stands in the future; however, these changes would be very difficult to predict or model. The influences of natural riparian disturbances are not quantified in the scope of this assessment. Wildfire suppression policies of the past 100 years have likely resulted in some reduction of the impacts that fire may have had on riparian shade quality. Given the likelihood of future riparian area disturbances from disease, flood, or fire, the "target" shade increase values predicted by the SHADOW model should be assumed to be a theoretical goal, based on the potential of undisturbed riparian stands to develop shade.

# 7. SEASONAL VARIATION

Section 303(d)(1) requires this TMDL to be "established at a level necessary to implement the applicable water quality standard with seasonal variations." Both stream temperature and flow vary seasonally from year to year. Water temperatures are coolest in winter and early spring months. Winter water temperature levels decrease dramatically from summer values, as river flows increase and available solar energy is at an annual minimum. Warmest stream temperatures correspond to prolonged solar radiation exposure, warm air temperature, low flow conditions, and decreased groundwater contribution. These conditions occur during late summer and early fall and promote the warmest seasonal instream temperatures.

The summer of 1999 was fairly mild. Maximum air temperatures at the ambient air monitoring site in the Lobster Creek mainstem at the gorge for the period of record reached just over 72°F. The maximum ambient air temperature for July 22, 1999 was 65°F. The 1999 years seasonal 7 day maximum average water temperatures were recorded for the period August 23 through August 30. The Heat Source modeling date (7/22/99) was selected because it was in close proximity to the date that field flow measurements were collected (7/15/99) and because the diurnal temperature curve seemed to indicate that coastal fog was not present. Flow measurements were collected during adverse conditions, near the peak solar loading period, and during a period when field staff were available. Supporting temperature data for the period of record taken from the Appendix C is show in Table 12.

**Table 12 - Stream Temperature Monitoring Data (temperatures in degrees Fahrenheit)**

| Map Site No. | Location | Years of Record | Min 7-day of record | Max 7-day of record | Avg. 7-day of record | Data Source |
|---|---|---|---|---|---|---|
| | **Lobster Creek Mainstem** | | | | | |
| 1 | Mouth | 1990-1999 | 66.3 | 69.8 | 67.4 | USFS |
| 16 | In gorge | 1999 | | 66.3 | | WS Council |
| 2 | Below Deadline | 1997-1999 | 67.3 | 70.1 | 69.0 | WS Council |
| 4 | REMAP Site | 1997 & 1999 | 69.4 | 69.0 | 69.2 | WS Council |
| 17 | Above Lost Valley | 1999 | | 67.2 | | WS Council |
| | **Tributaries to Mainstem** | | | | | |
| 3 | Deadline Creek at mouth | 1997-1999 | 62.4 | 63.6 | 63.0 | WS Council |
| 5 | Fall Creek at bridge | 1997-1999 | 62.6 | 63.1 | 62.8 | WS Council |
| 6 | Lost Valley Creek at mouth | 1997-1999 | 60.6 | 61.7 | 61.2 | WS Council |
| | **North Fork Lobster** | | | | | |
| 7 | Mouth | 1990-1998 | 62.6 | 65.0 | 64.3 | USFS |
| 8 | At RM 3 | 1996 | | 62.7 | | USFS |
| | **South Fork Lobster** | | | | | |
| 9 | Mouth | 1994-1998 | 66.6 | 68.6 | 67.3 | USFS |
| 10 | At RM 3 | 1996 & 1998 | 63.7 | 64.9 | 64.3 | USFS |
| 11 | At Rd 3310 Bridge, RM 4.3 | 1990-1998 | 60.2 | 63.0 | 62.0 | USFS |
| 12 | 1 Mile above Bridge | 1999 | | 59.8 | | USFS |
| 13 | Trib at 1 mile above Bridge | 1999 | | 60.0 | | USFS |
| 14 | Boulder Creek at Mouth | 1991,1996,1998 | 63.0 | 64.1 | 63.5 | USFS |
| 15 | Boulder Cr at Rd 3237 Bridge, RM 1.3 | 1996 | | 61.3 | | USFS |

- The average 7 day of record averages the 7 day maximum average temperature over the period of record.

An exceedance of the numeric criteria will not be deemed a temperature standard violation if it occurs when the air temperature during the warmest seven-day period of the year exceeds the 90th percentile of the seven-day average daily maximum air temperature calculated in a yearly series over the historic record. However, during such periods, the anthropogenic sources must still continue to comply with their surface water temperature management plans developed under OAR 340-041-0026(3)(a)(D);

# 8. REASONABLE ASSURANCE OF IMPLEMENTATION

The area covered by this TMDL and WQMP includes land managed by the USFS and private timber interests. Private forested lands are managed under the FPA. Of the 44,253 acres within the Lobster Creek Watershed, 26,862 acres are managed by USFS, 13,300 by Lincoln Timber LLC and the remaining 4,100 acres are managed by other private timber land managers. The USFS, Lincoln Timber LLC, The Campbell Group, and the Lower Rogue Watershed Council worked closely together in the development of this TMDL and WQMP for this area. Please see Chapter 2, Appendix C page 20, Proposed Management Measures for both federal and private ownership and information regarding the voluntary activities currently being implemented by Lincoln Timber LLC. Chapter 2 page 9 identifies each responsible entity.

**There are three mechanisms that are already in place to help assure that this water quality management plan will be implemented:**

- Federal land management is guided by the Northwest Forest Plan which is implemented under the Aquatic Conservation Strategy.

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

- The state Forest Practices Act (FPA), implemented by the Oregon Department of Forestry (ODF), regulates forest activities. An interdepartmental review of the FPA will provide the assurance that standards will be met. The Oregon Department of Forestry (ODF) is the designated management agency for regulation of water quality on nonfederal forest lands. The Board of Forestry has adopted water protection rules, including but not limited to OAR Chapter 629, Divisions 635-660, which describe Best Management Practice's (BMP's) for forest operations. These rules are implemented and enforced by ODF and monitored to assure their effectiveness.

  The Oregon Forest Practices Act (FPA, 1994) contains regulatory provisions that include the following objectives: 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. ODF has adopted Forest Practice Administrative Rules (1997) that clearly 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. In addition, monitoring activities identified in the accompanying ***WQMP Elements*** will help determine if management actions are sufficiently protective to meet effective shade allocations set by this TMDL and make appropriate revisions that address water quality concerns.

- There are also many voluntary, non-regulatory, watershed improvement programs (activities) that are already in place and are helping to address the water quality concerns in the Lobster Creek Watershed. Both technical expertise and funding are provided through these integrated programs. Examples of activities promoted and accomplished through these programs include: riparian enhancement, relocating legacy roads that may be detrimental to water quality, replacing problem culverts with adequately sized structures, and improvement and 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.

  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 Salmonid populations. The Oregon Plan considers the condition of salmonids as a critical indicator of ecosystems (CSRI, 1997). The decline of Salmonid populations has been linked in part to impoverished ecosystem form and function. Clearly ocean conditions, fishery harvest, and hatchery and dam management activities also effect salmonid populations. The Oregon Plan has committed the State of Oregon to the following obligations: an ecosystem approach that requires consideration of the full range of attributes of aquatic health, focuses on reversing factors for decline by meeting objectives that address these factors, develops adaptive management and a comprehensive monitoring strategy, and relies on citizens and constituent groups in all parts of the restoration process.

The intent of the Oregon Plan is to conserve and restore functional elements of the ecosystem that supports fish, wildlife and people. In essence, the Oregon Plan is distinctly different from the traditional agency approach, and instead, depends on sustaining a local-state-federal partnership. Specifically, the Oregon Plan is designed to build on existing State and Federal water quality programs, namely: Coastal Zone Nonpoint Pollution Control Programs, the Northwest Forest Plan, Oregon's Forest Practices Act, Oregon's Senate Bill 1010 and Oregon's Total Maximum Daily Load Program.

## 8.1 ADAPTIVE MANAGEMENT

***The Lobster Creek Watershed WQMP, Chapter 2 and Appendix C address adaptive management concepts and future monitoring plans***.

Both ODF and DEQ will continue to work with partners to monitor TMDL implementation and the effectiveness thereof. In the event that data generated through subsequent monitoring efforts indicate that changes are warranted in this TMDL or WQMP, these changes will be made by DEQ, USFS, Lincoln Timber LLC, The Campbell Group, Lower Rogue Watershed Council, and the Oregon Department of Forestry.

The above adaptive management process may result in findings that indicate changes are needed to the current forest practice rules to protect water quality. Any rule making that occurs must comply with the standards articulated under ORS 527.714(5). This statute requires, among other things, that regulatory and non-regulatory alternatives have been considered and that the benefits provided by a new rule are in proportion to the degree that existing forest practices contribute to the overall resource concern.

Establishing TMDL's employs a variety of analytical techniques. Some analytical techniques are widely used and applied in evaluation of source loading and determination of the impacts on waterbodies. For certain pollutants, such as heat, the methods used are newer or in development. The selection of analysis techniques is based on scientific rationale coupled with interpretation of observed data. Concerns regarding the appropriateness and scientific integrity of the analysis have been defined and the approach for verifying the analysis through monitoring and implementation addressed. Without the benefit of long term experience and testing of the methods used to derive TMDL's, the potential for the estimate to require refinement is high.

The Lobster Creek Watershed TMDL/WQMP is intended to be adaptive. This plan allows for future changes in loading capacities and surrogate measures (allocations) in the event that scientifically valid reasons demand alterations. It will be important to recognize and incorporate continuing studies that can provide improved understanding of water quality parameters and surrogates addressed in this TMDL/WQMP.

This TMDL and margin of safety, which is reasonable and results in an overall allocation, represents the best estimate of how standards can be achieved. The TMDL process accommodates the ability to track and ultimately refine assumptions within the TMDL implementation-planning component. Parameters identified in the MOS warrant additional monitoring and characterization. Improved information made available through future monitoring and implementation actions will play an important role in refining surrogate measure through adaptive management.

# 9. PUBLIC PARTICIPATION

To be successful at improving water quality, a TMDL and WQMP must include a process to involve interested and affected stakeholders in both the development and the implementation of the plan. In addition to the DEQ public notice policy and public comment periods associated with TMDL's and permit applications public interests were involved during development and in drafting this assessment and subsequent management plan. These products have been widely presented in Curry County and the document has been made available during development for input and discussion by resource as well as private entities.

***Public participation is also addressed in Chapter 2 and Appendix C Element 8.***

A responsiveness summary document will be prepared by DEQ in reply to comments received at the public hearing and written comments received within the comment period.

# 10. REFERENCES

**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.

**Beschta, R.L. and J. Weatherred. 1984.** A computer model for predicting stream temperatures resulting from the management of streamside vegetation. USDA Forest Service. WSDG-AD-00009.

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

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

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

**Jobson, H.E. and T.N. Keefer. 1979.** Modeling highly transient flow, mass and heat transfer in the Chattahoochee River near Atlanta, Georgia. Geological Survey Professional Paper 1136. U.S. Gov. Printing Office, Washington D.C.

**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.

**Oregon Coastal Salmon Restoration Initiative. 1997.** State Agency Measures.

**Oregon Department of Forestry. 1997**. Oregon Forest Practices Administrative Rules.

**Sinokrot, B.A. and H.G. Stefan. 1993.** Stream temperature dynamics: measurement and modeling. *Water Resour. Res.* 29(7):2299-2312.

**U.S.D.A. Forest Service. 1993.** SHADOW v. 2.3 - Stream Temperature Management Program. Prepared by Chris Park USFS, Pacific Northwest Region.

**U.S.D.A. Forest Service. 1994.** Northwest Forest Plan: Aquatice Conservation Strategy.

**U.**S.D.A. Forest Service. 1999. Lobster Creek Watershed Analysis Iteration 2.0

**Wunderlich, T.E. 1972.** Heat and mass transfer between a water surface and the atmosphere. Water Resources Research Laboratory, Tennessee Valley Authority. Report No. 14, Norris Tennessee. Pp. 4.20.

## Other References of Interest

**Beschta, R.L. 1997.** Riparian shade and stream temperature: an alternative perspective. *Rangelands*. 19(2):25-28.

**Bowen, I.S. 1926.** The ration of heat loss by convection and evaporation from any water surface. Physical Review. Series 2, Vol. 27:779-787.

**Brown, G.W. 1970.** Predicting the effects of clearcutting on stream temperature. *Journal of Soil and Water Conservation.* 25:11-13.

**Brown, G.W. 1983.** Chapter III, Water Temperature. Forestry and Water Quality. Oregon State University Bookstore. Pp. 47-57.

**Brown, G.W and J.T. Krygier**. **1970.** Effects of clearcutting on stream temperature. *Water Resour. Res.* 6(4):1133-1139.

**Harbeck, G.E. and J.S. Meyers. 1970.** Present day evaporation measurement techniques. J. Hydraulic Division. A.S.C.E., Prceed. Paper 7388.

**Ibqal, M. 1983.** An Introduction to Solar Radiation. Academic Press. New York. 213 pp.

**Parker, F.L. and P.A. Krenkel. 1969.** Thermal pollution: status of the art. Rep. 3. Department of Environmental and Resource Engineering, Vanderbilt University, Nashville, TN.

**Rishel, G.B., Lynch, J.A. and E.S. Corbett.. 1982.** Seasonal stream temperature changes following forest harvesting. *J. Environ. Qual.* 11:112-116.

**Sellers, W.D. 1965.** Physical Climatology. University of Chicago Press. Chicago, IL. 272 pp.

**Sullivan K., Lisle, T.E. , Dolloff, C.A. , Grant, G.E. and L.M. Reid. 1987.** Stream channels: the link between forests and fisheries. Pp. 39-97. In: E.O. Salo and T.W. Cundy (Eds.) Streamside management: forestry and fisheries interactions. University of Washington, Institute of Forest Resources, Contribution No. 57. 471 pp.

# APPENDIX A

## Lobster Creek Watershed

## HEAT SOURCE MODELING

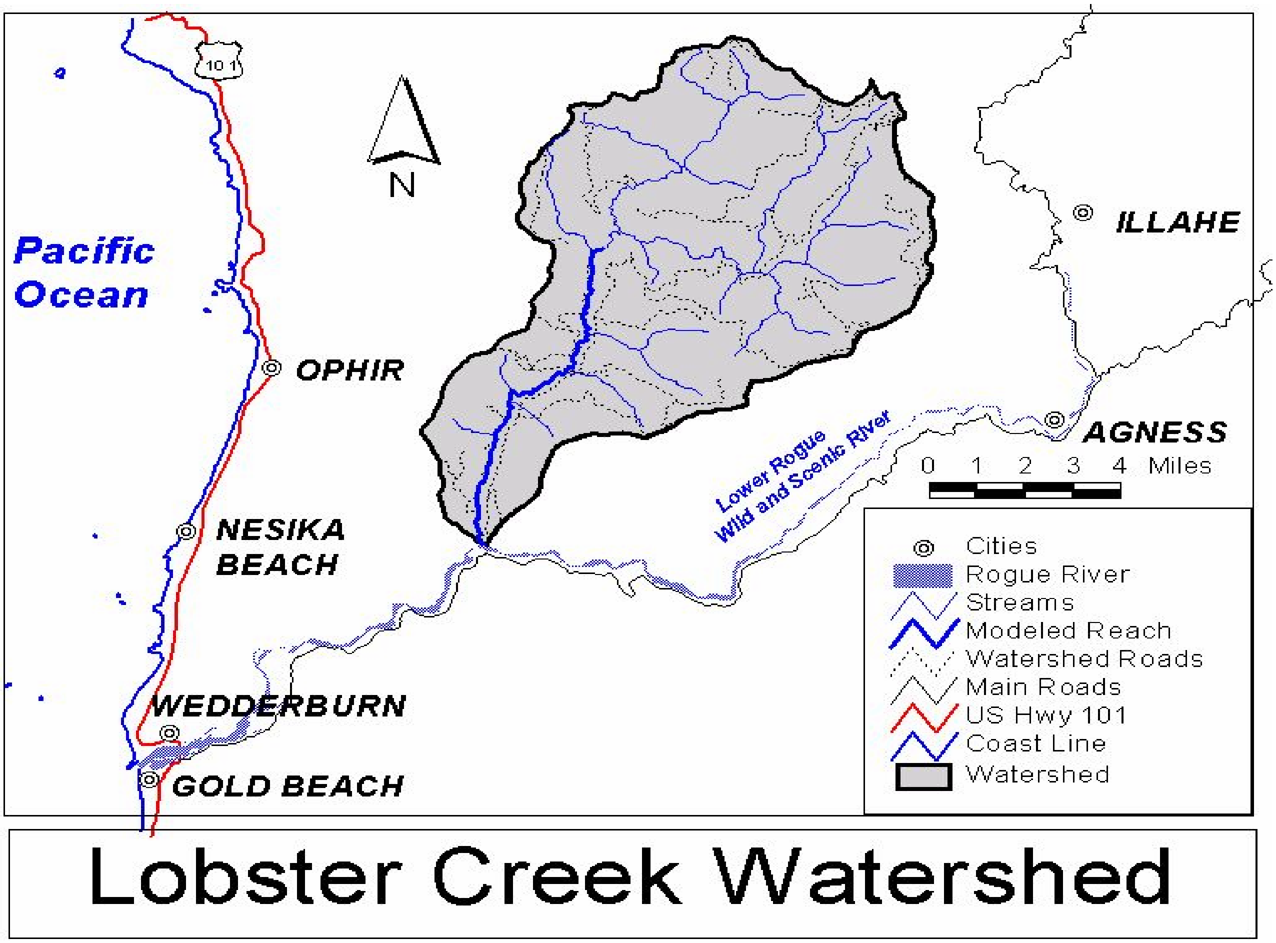
## PREDICITIVE TEMPERATURE MODELING

# Lobster Creek

## Stream Temperature Model

DEQ Western Region

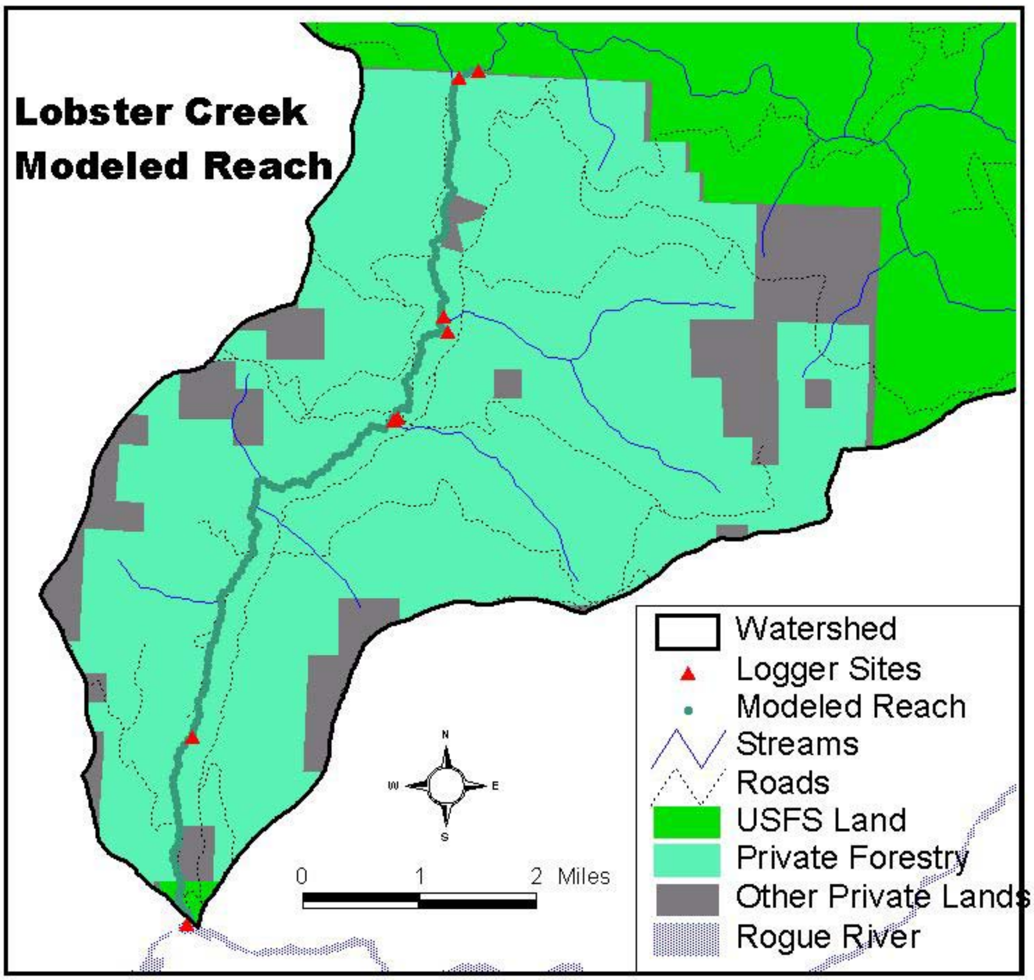
October 8, 2001



## SURVEY PURPOSE

Field measured data (collected on 7/22/1999) was used to calibrate a stream temperature model, *Heat Source 6.0*. The model uses field measurements and model-derived parameters as inputs to simulate how stream temperatures respond to unique conditions within the watershed. Once the model parameters have been balanced so that the simulation accurately describes the conditions measured in the field (the calibration step), reasonable and obtainable "future conditions" are entered into the model. The model re-summates the amount of energy reaching the stream and re-calculates stream temperatures based on those future condition(s) that are assumed. Equilibrium conditions are calculated for each of the 153 segments that make up the Lobster Creek model (segments are 100 meters long).

**Map 1** - Extent of the area modeled and the site of field temperature/flow measurements.
* Note that only the lower 9.5 miles of the mainstem were modeled. Over 25 miles of the mainstem Lobster Creek were assessed for riparian and channel conditions.



The future condition modeled in this project assumes trees in the riparian zone have reached their full size and stand density for this ecoregion, these soils, and this rainfall zone. The “System Potential” scenario assumes these same tree sizes and densities so that shade production is at it’s maximum or system potential. None of the stream flow volumes, velocities, depths or channel characteristics were changed from the calibrations values for the future condition simulations.

Additional vegetative scenarios can be simulated using this calibrated Heat Source model. The calibrated Heat Source model product will be made available to parties interested in exploring the affects on stream temperature with other vegetative scenarios.

Like any model that attempts to “look into the future,” there is likely to be a disparity between what is predicted and what will actually come to pass. Our understanding of the processes that determine stream temperature are imperfect, and any predictions using them are similarly imperfect. Any resulting simulation of the future is less a blueprint with survey point accuracy than a roadmap that identifies only the most obvious landmarks. Roadmaps, however, are useful for planning a journey and navigating to a destination. While only the broadest suggestions of possible management strategies are suggested by the model, they should point us in the right direction.

# Model Input Data Summary

| Data Class | Parameter | Method (measured/calculated) | Source | Future Condition(s) Different from Calibration |
|---|---|---|---|---|
| Stream | Elevation | Measured | DEM Data | No |
| | Gradient | Calculated | Heat Source Model | No |
| | Topographic Shade | Calculated | GIS Utility | No |
| | Stream Reach Aspect | Calculated | GIS Utility | No |
| Flow | Volume | Measured | Field Measurement | No |
| | Velocity | Model Calculated -Fit to Field Data | Heat Source Model | No |
| | Depth | Model Calculated -Fit to Field Data | Heat Source Model | No |
| Channel | Zone *of* Disturbance Width | Measured | Field Measurement | No |
| | Wetted Widith | Measured | Field Measurement | No |
| | Channel Substrate | Measured | Field Measurement | No |
| Shade | Height | Measured | Field Measurement | Yes |
| | Width | Measured | Field Measurement | Yes |
| | *Density* | Measured | Field Measurement | Yes |
| | *Overhang* | Measured | Field Measurement | No |
| Stream Temperature | Main Stem | Measured | Field Measurement | --- |
| | Tributaries | Measured | Field Measurement | No |
| Weather | *Humidity* | Measured | Field Measurement | No |
| | *Wind Speed* | Measured | Field Measurement | No |
| | *Air Temperature* | Measured | Field Measurement | No |

Below is a summary of the model parameters used, how they were derived, and if that parameter was changed between the calibration and the future condition simulations. Parameters in italic type are those used for model calibration.

# METHODS FOR FIELD DATA COLLECTION

Temperature Sets

Instantaneous stream temperatures were taken throughout the summer at five locations within the Lobster Creek mainstem and three tributary locations (see Map 1 for locations) using calibrated and audited logging devices. Each logger data set was reviewed, and it was determined that the data from 7/22/1999 was most suitable for a basin-wide Heat Source simulation. Each data set, if required, was thinned to 24 hourly observations for the day.

Stream Discharge Measurements

Flow measurements were taken at all eight mainstem and tributary sites on 7/15/1999. Measurements were via hand-held current meters. Measurement transacts were chosen in areas with wadeable cross-sections and good stream velocities. Each transact consisted of a minimum of 10 individual measurements.

Stream/Shade Conditions
Riparian characteristics relating to shade quality and quantity were measured from aerial photography, digital imagery and on site field measurements. The shading values so calculated were: shade height, shade density and shade overhang. Values assumed for the "future condition" simulation was based on forest characteristics appropriate to this ecoregion, soil class, species composition and expected tree density. Channel wetted width was also measured via field observations.

Weather Data
Air temperature data used was from the "Gorge" site (most downstream temperature logging site). Humidity and wind speed data used were from the Agness RAWS reporting site.

# Model Inputs

**Elevation/Gradient**
Elevations were obtained from digital elevation information (Digital Elevation Model - DEM - type data). The elevation of the upstream and downstream point of each reach segments was derived. These elevations were related to the elapsed reach lengths so that elevation and gradient profiles could be calculated. See Figures 1 & 2.

Figure 1 – Gradient Profile

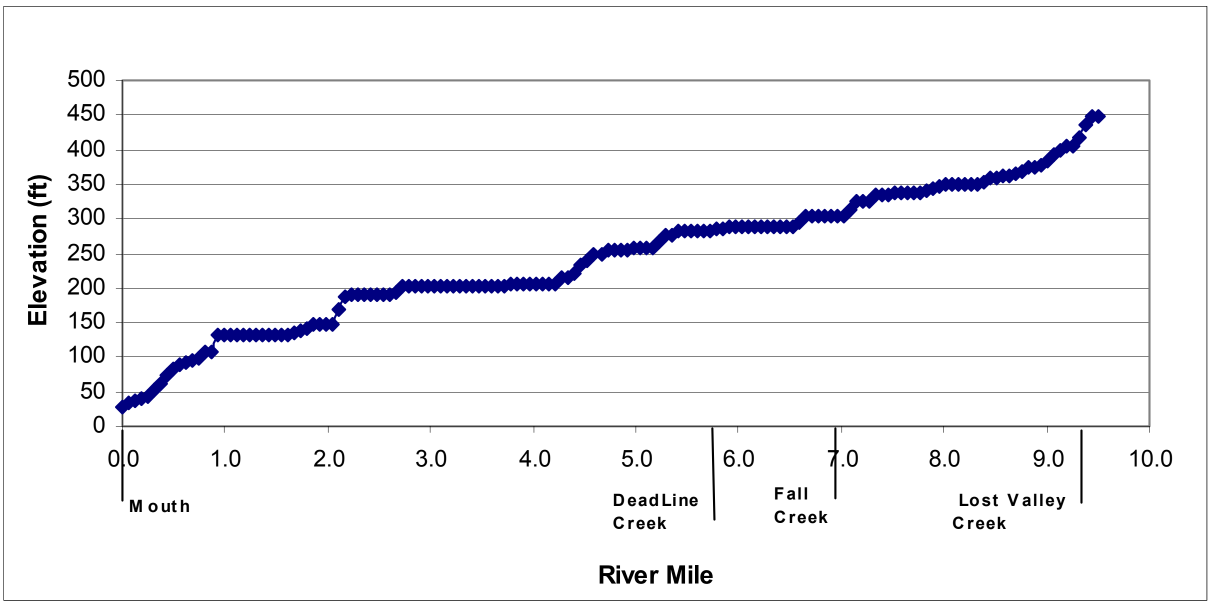
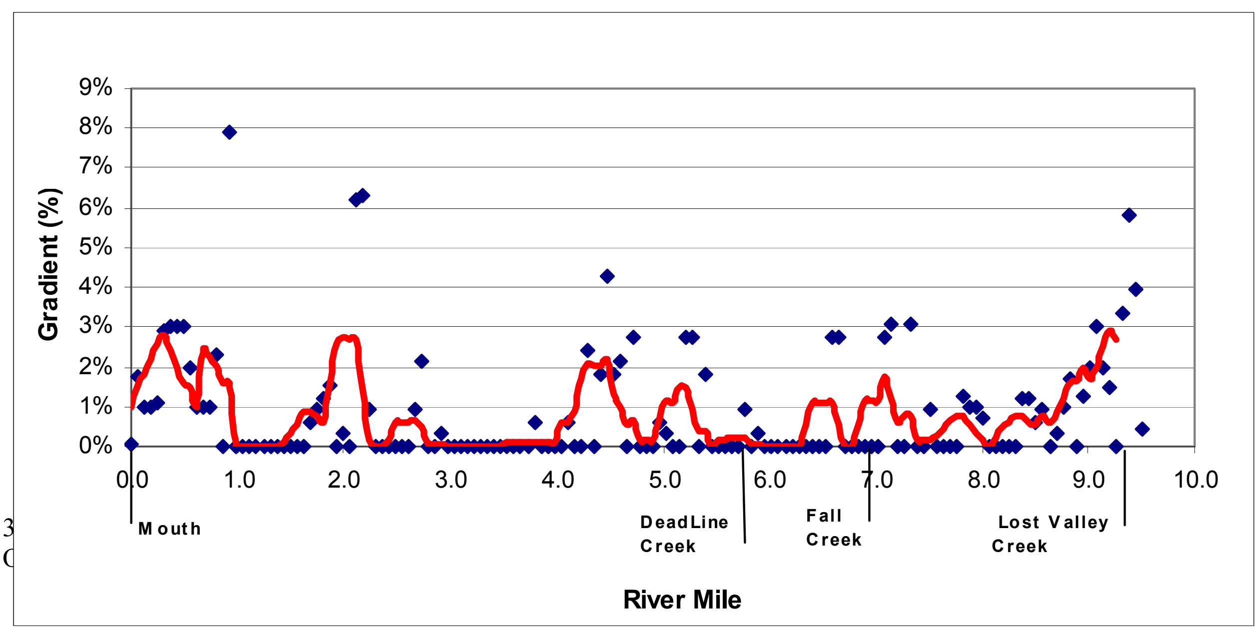


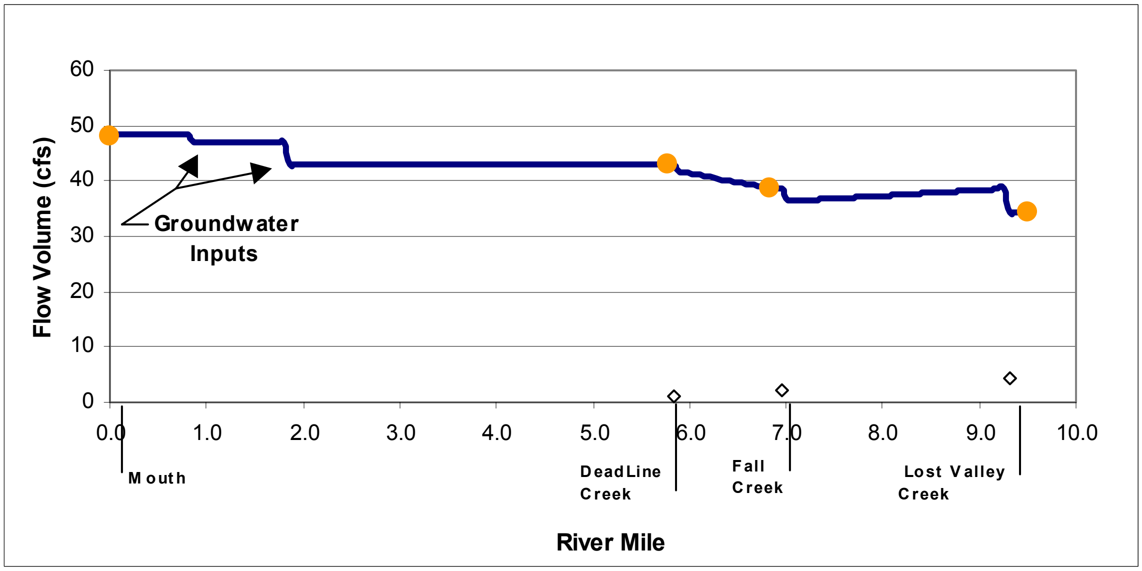

Figure 2 - Points show individual reach gradients, the line shows the running 5-data-point-average gradient.



**Flow Volume**

Flow was measured on the mainstem at the sites shown in Figure 3 as solid dots. Flow measured at tributary mouths is shown as open diamonds. Flows downstream of each tributary are calculated by adding the mainstem flow to the tributary flow. Intervening flow was extrapolated so that a complete flow profile could be constructed. These values remained unchanged for the future condition simulations. Groundwater inputs were added to the model at the locations shown. The location and magnitude of these inputs were estimated.

*Figure 3*

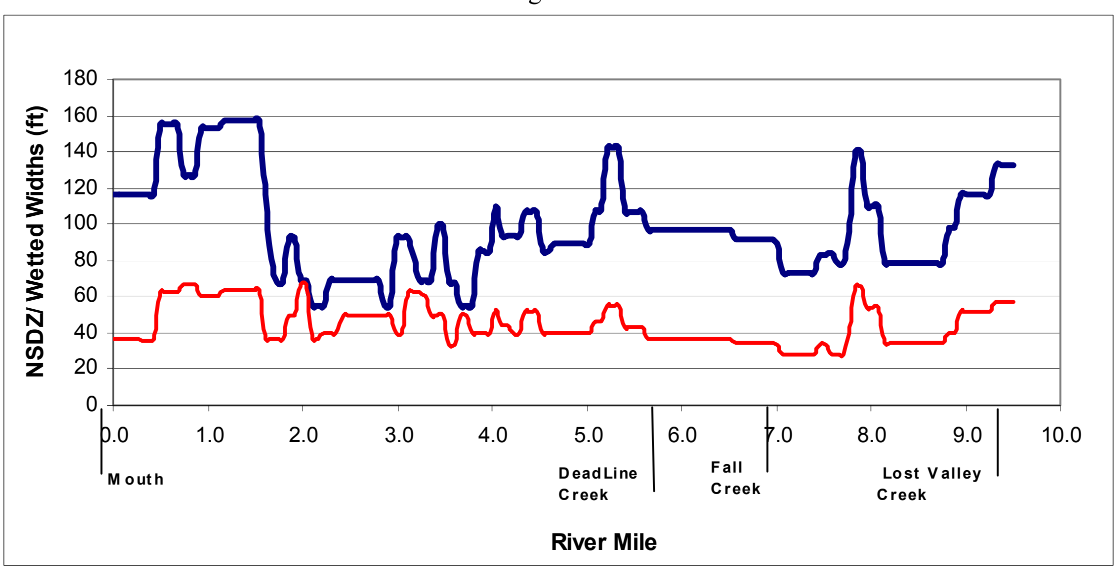



Instream water rights can divert a significant amount of flow from streams during the summer. Lobster Creek is an exception as no water rights are allocated in the entire basin.

**Channel Wetted Width / Near Stream Disturbance Zone Width**

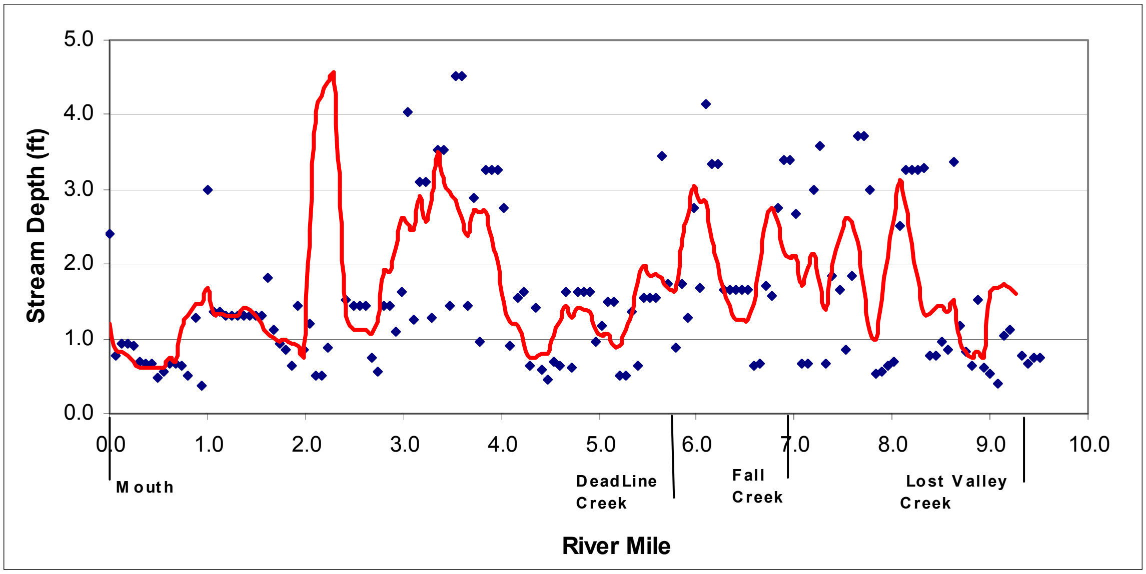
Wetted channel widths (dark red line) and near stream disturbance zone widths (NSDZ – dark blue line) were scaled from aerial photos and field measurements. The near stream disturbance zone is defined as the distance across the stream from one the shade-producing area to the one on the opposite bank. Figure 4 shows the width profiles used in the model. These values remained unchanged for the future condition simulations.

Figure 4



**Average Depth**
Average depth for each segment was calculated from the flow volume and wetted width values used for that segment. Points show depths for each segment, the line shows a running-5-data-point-average of depth. Figure 5 shows the average depth profile used in the model. These values remained unchanged for the future condition simulations.

Figure 5




**Flow Velocity**
Average velocity for each segment was calculated from the channel geometry, segment slope and Manning's "n" used for that segment. The velocity profile is shown in Figure 6. Figure 7 Shows the assumed time of travel along the modeled reach using the flow velocities seen in Figure 6. These values remained unchanged for the future condition simulations.

Figure 6

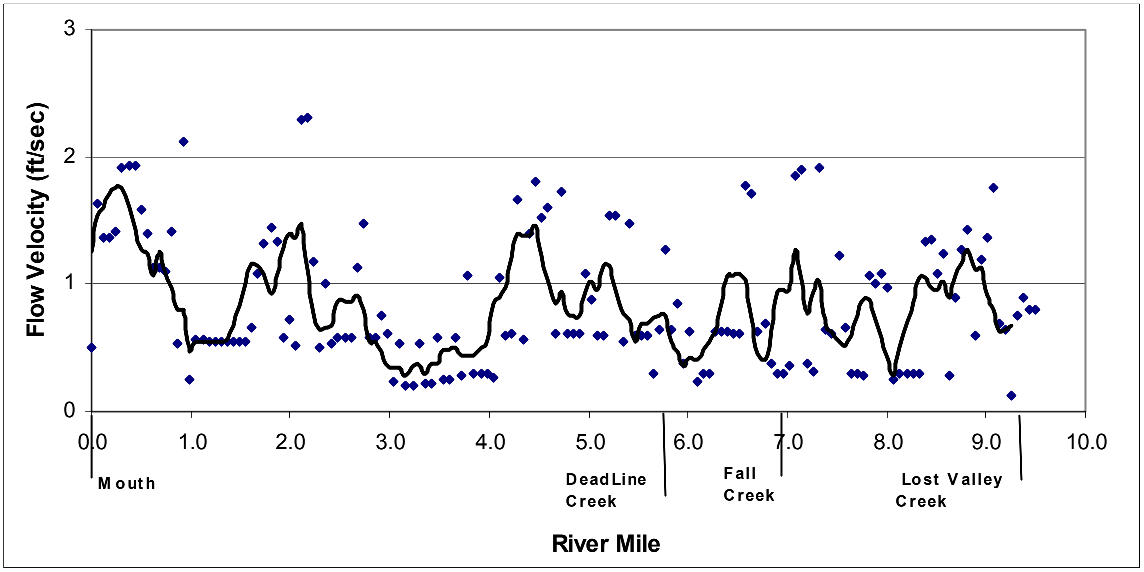
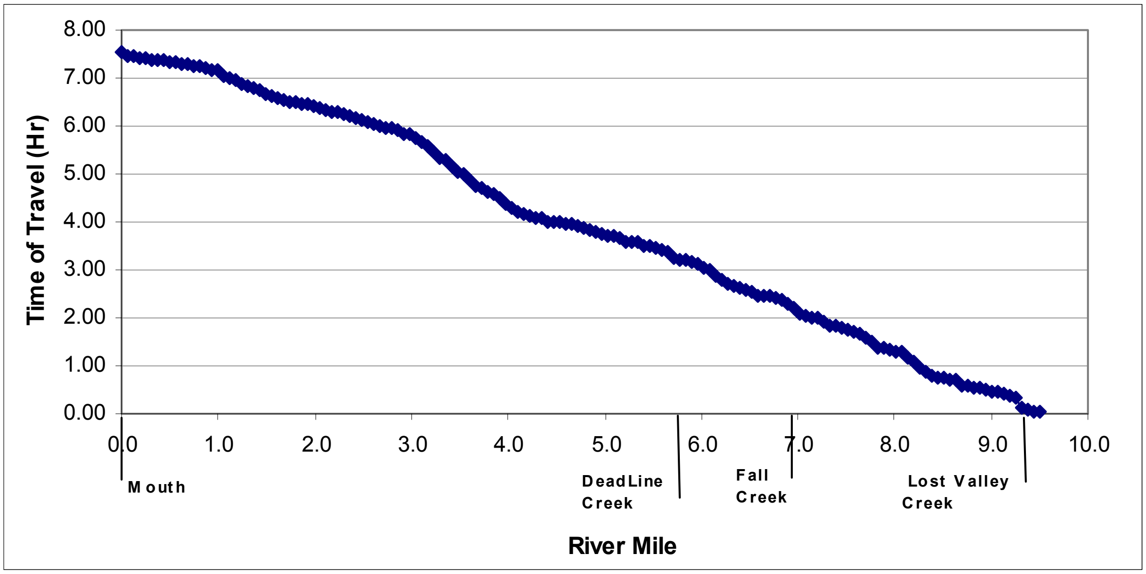


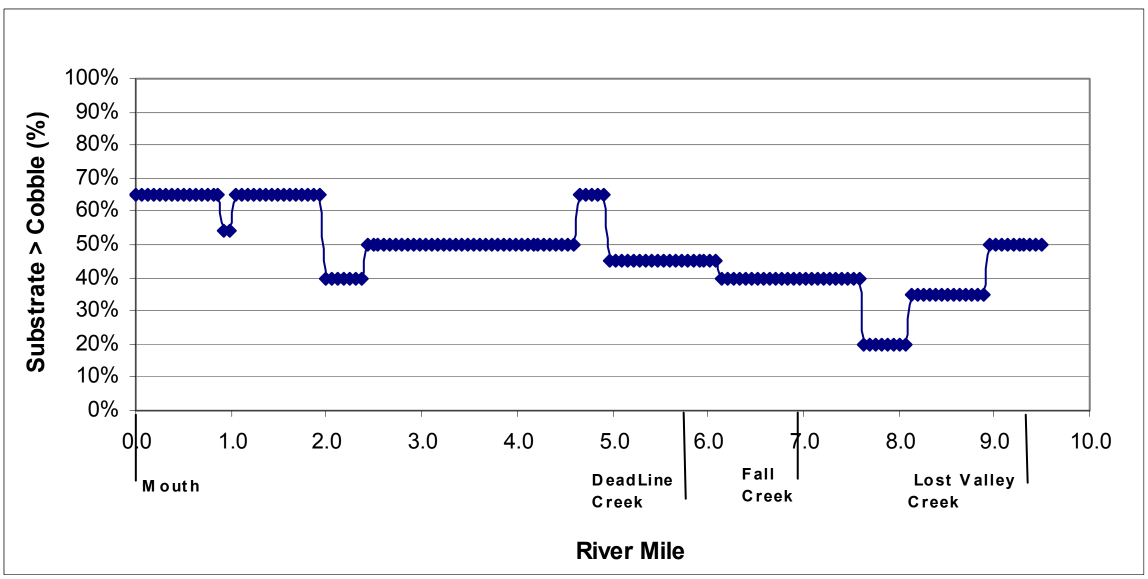

Figure 7




## Channel Substrate

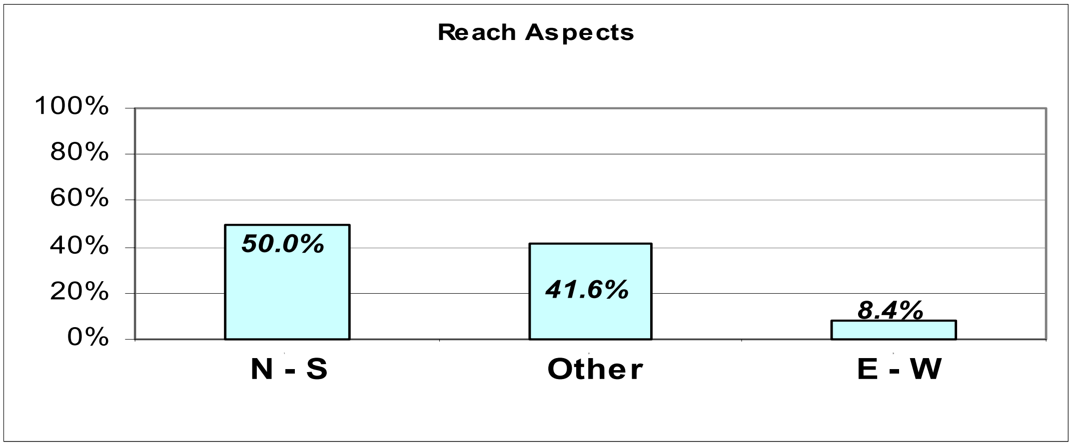
Channel substrate larger that cobble size can absorb solar energy and re-release it during the night. Figure 8 shows where this kind of substrate occurs in the Lobster Creek mainstem. These values were also used for the future condition simulations.

Figure 8



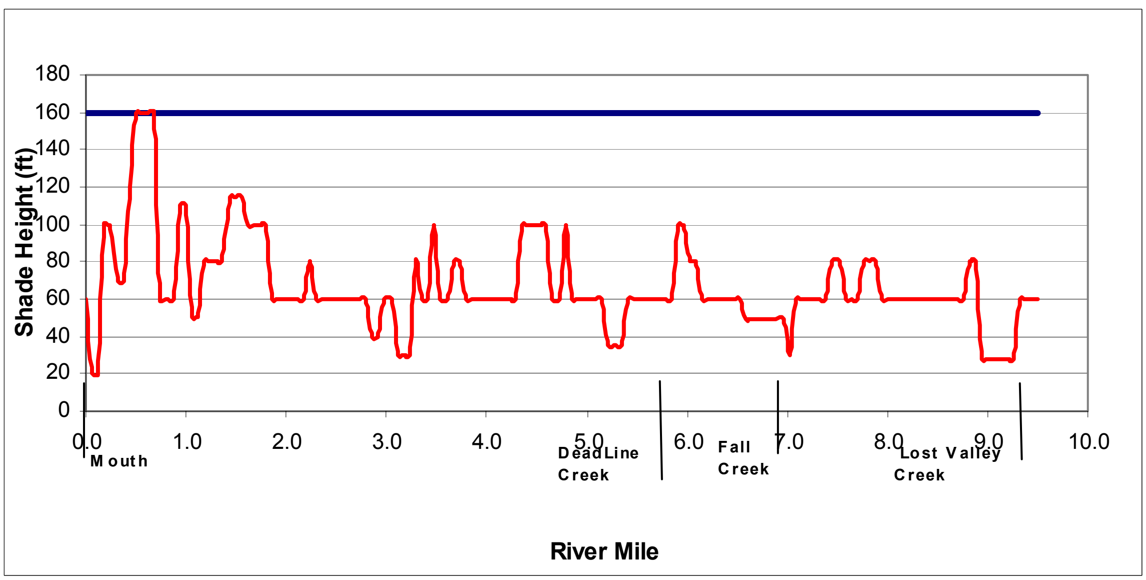
**Stream Aspect**
Figure 9 shows the relative amount of the Lobster Creek main stem study reach headed in these general compass headings. Aspect is important because North – South streams are less influenced by riparian shading as a means of temperature control while East – West streams are greatly affected by riparian shade. About 50% of the stream miles along Lobster Creek should have an average or better than average response to riparian shade as a means for temperature control.

Figure 9



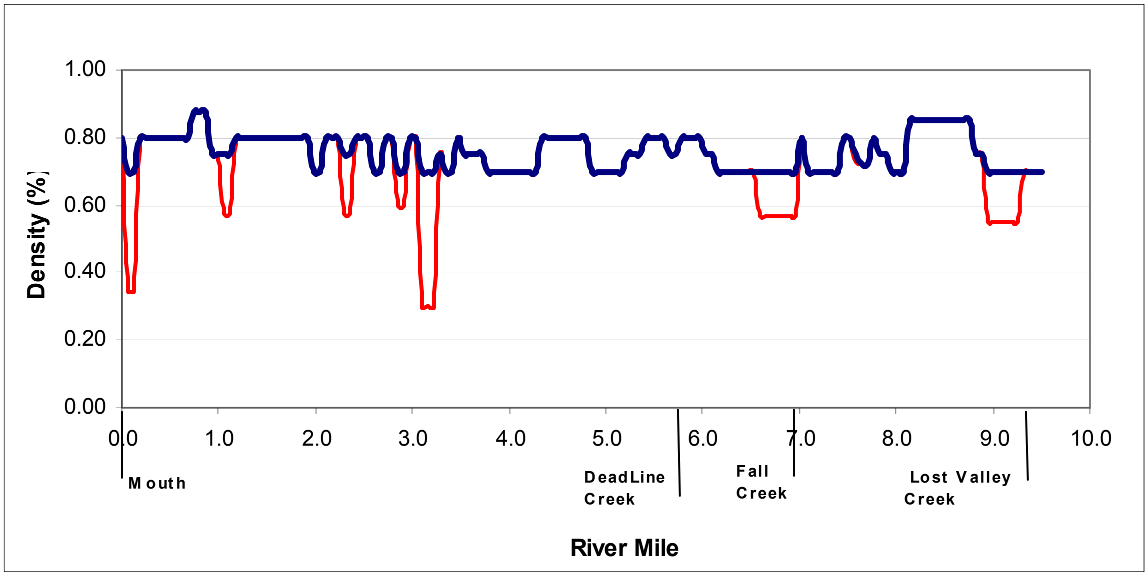

**Shade Height**
Shade height is one of three shade parameters that are assumed to change in the future condition simulation. The calibration condition for shade height, based on field measurements, is shown in Figure 10 as the lower line. The assumed future condition at management and system potential is shown as the upper line. This graph averages the left and right bank measurements at each segment together. The model calculates the total shade production in a segment using both the left bank and right banks values.

Figure 10



**Shade Density**
Shade density is also assumed to change in the future. The lower line in figure 11 is field measured shade density as it exists today. The future shade density assumed in the future scenario is shown as the upper line. This graph averages the left and right bank measurements at each segment together. The model calculates the total shade production in a segment using both the left bank and right banks values.

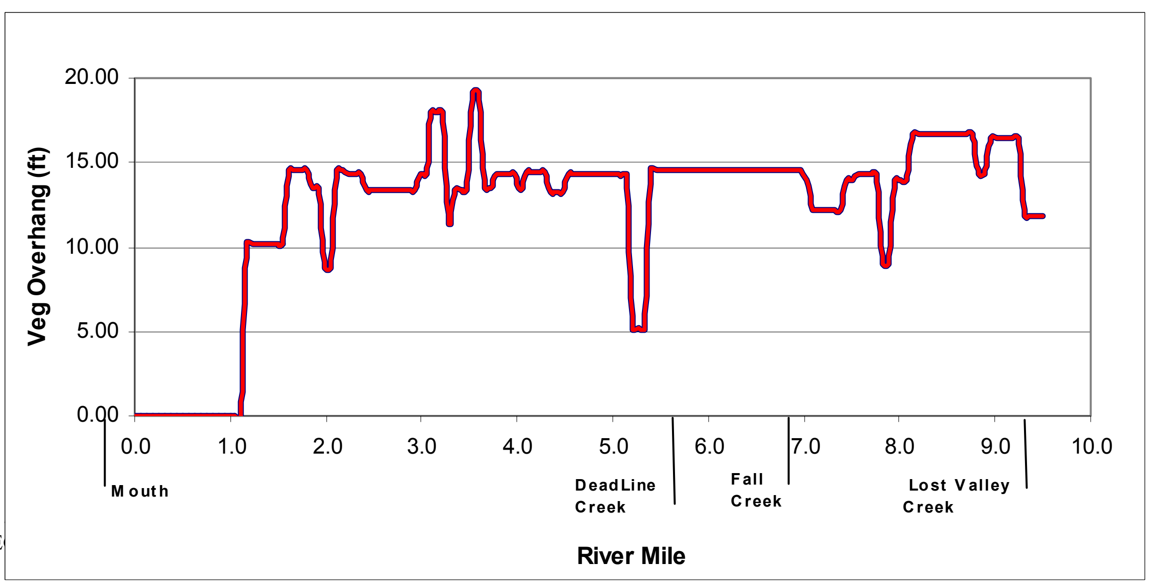
Figure 11




**Shade Width**
The width of the shade–producing riparian belt is assumed to be 100 feet currently for the modeled reach for private timber lands. This width is based upon current Oregon Forest Practices Act riparian requirement for large fish bearing streams. Lands managed under federal ownership assume a shade producing riparian belt of 300 feet. Again this riparian width was selected because it represents current federal lands riparian management practices. The shade-producing riparian belt was increased to 300 feet throughout the modeled reach in the system potential scenario to maximize shade densities in system potential stands.

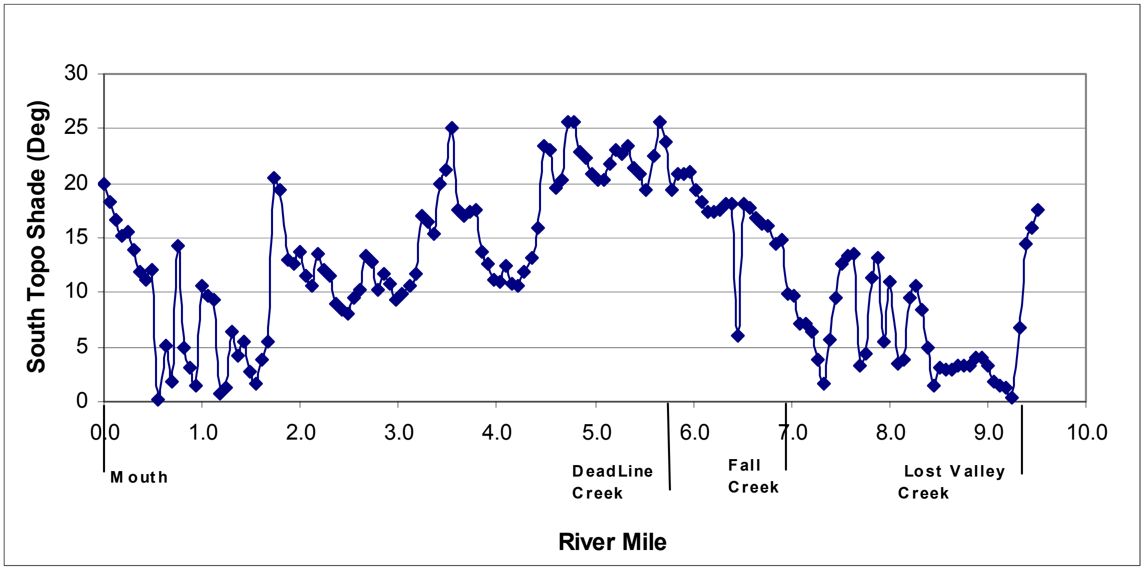
**Shade Overhang**
The shade overhang profile shown in figure 12 is the same one used for both calibration and future conditions simulations. This graph averages the left and right bank measurements at each segment together. The model calculates the total shade production in a segment using both the left bank and right banks values.

Figure 12



**Topographic Shading**
Topographic shading is defined as the shading provided to the stream by ridgelines or hills. It is extremely localized and unique for each system. Southern shading can result in an appreciable lowering of solar energy during the day. East/West shading effectively shortens the amount of daylight hours by delaying local sunrise or hastening local sunset. Figure 13 shows that some parts of Lobster Creek get a generous amount of topographic shading to the south.

Figure 13




# Model Calibration

All models require some calibration to make the computer simulation match the observed data. For this series of *Heat Source* simulations, the parameters that changed during the calibration process were Manning's "n", average channel width and average channel depth. The average width/depth values, although not measured in each of the 153 segments, were compared to a handful of actual measurements (usually taken during flow volume measurements). Care was taken so that model-calculated values did not divert significantly from the field-observed

With the exception of riparian shade width, humidity and wind speed, all data obtained from field measurements or scaled from photos were used as recorded. Adjustments to the calibration parameters ceased when the simulation output matched the observed field data. Once the model calibrated to the instream temperature data, only riparian shade values (height, width, and density) were changed for the simulation of site potential.

Most models are calibrated to one set of conditions. A unique feature of the *Heat Source* model is that it allows calibration simulations to be compared directly to observed stream temperature logged during an entire 24 hour day. This allows calibration to not only daily minimum and maximum values, but also the ability to fit modeled heating and cooling rates to observed data. For this study, the main-stem of Lobster Creek had five data loggers where simulated vs. observed data sets could be compared. A summary of how well the modeled set matched the field measured set is shown below. Each logger summary is based on 24 data pairs (one pair for each hour throughout the day).The Heat Source model under predicted stream temperatures during calibration in the mainstem below Fall and Deadline Creeks. During calibration various measured parameter inputs were adjusted to attempt to force the calibration simulation to agree with the observed stream temperature.

| Logger Location | Approximate River Mile | "r Squared" Value | Standard Deviation (Deg F) | Standard Error (Deg F) |
|---|---|---|---|---|
| U/S of Lost Valley Creek | 9.5 | 1.000 | 0.00 | 0.00 |
| REMAP Site | 6.8 | 0.945 | 2.88 | 0.54 |
| D/S of Deadline Creek | 5.8 | 0.935 | 1.98 | 0.72 |
| At Gorge | 1.8 | 0.954 | 0.72 | 0.36 |
| At Mouth | 0.0 | 0.939 | 1.26 | 0.36 |
| | Avg | 0.955 | 1.37 | |

Modeling data for this project was predominantly directly measured so the decision was made to utilize measured data with slight adjustment rather than to force model calibration in the upper watershed. This initial Heat Source modeling effort will be further refined in the future with additional actual field measurements through time.

# Model Outputs

### Effective Shading in the Riparian Zone

Effective shading is defined as the amount of available solar flux intercepted before reaching the stream. Lobster Creek Watershed reach weighted shade average allows 293 BTU/SqFt/Day to enter the stream when the available solar flux is 2440 BTU/SqFt/Day would be calculated as (all units are BTU/SqFt/Day):

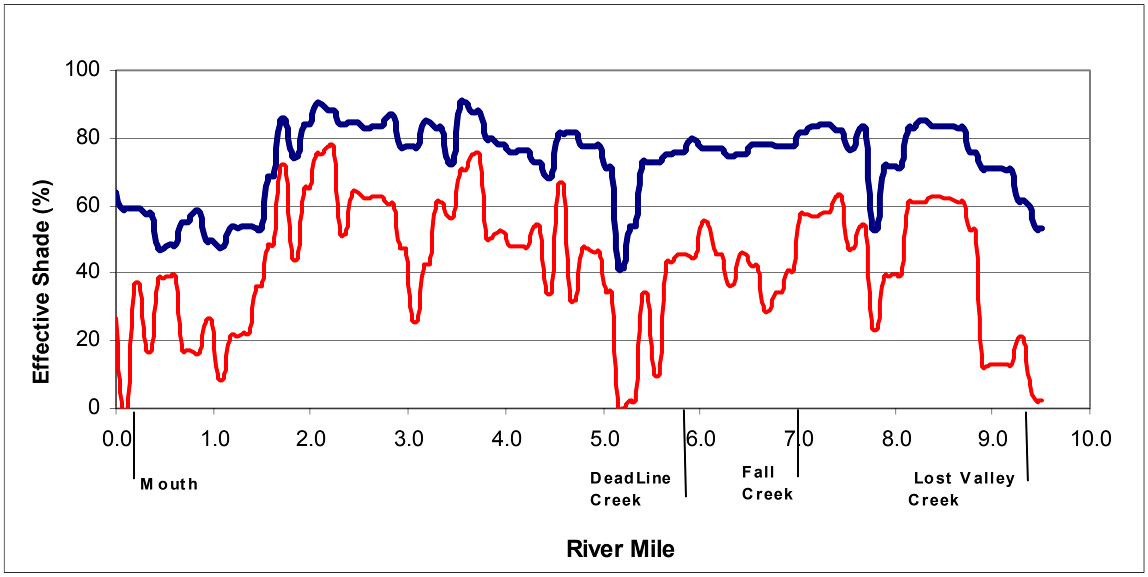
| | |
|---|---|
| Total Available Energy | 2400 |
| Energy Blocked | 2440-293 = 2147 |
| Effective Shade Percentage | (2147/2440)*100 = 88 % (These values will range for specific reaches from 41% to 91%) |

The amount of effective shading provided to the stream by riparian vegetation in the present and future conditions for the lower 9.5 miles of the main stem.

| | |
|---|---|
| Total Available Energy | 2400 |
| Energy Blocked | 2440-659 = 1415 |
| Effective Shade Percentage | (1415/2440)*100 = 73 % (These values will range for specific reaches from 41% to 91%) |

Figure 16 and Map 2 show the amount of effective shading provided to the stream by riparian vegetation in the present and future conditions for the lower 9.5 miles of the main stem. Present conditions provide a distance-weighted average of 42% effective shade (lower line) and system potential conditions (top line) should provide 73% effective shade. Figure 17 is the percentile plot of this same % effective shading data.

Figure 16




## Solar Flux

Figure 14 shows the total daily solar flux loading by river mile for the lower 9.5 miles of Lobster Creek. The upper line shows the total amount of solar energy available to the Lobster Creek system on a typical late July day. The variations in available energy are due to local topographic shading conditions. The data is presented in reference to its longitudinal location and each segment reacts differently to shade. In some cases, a segment will experience more than 293 BTUs of energy even if it's surroundings are at site potential. Conversely, some segments are at less than the 293 value today, even without site potential shade. The next line down is the daily solar flux available for stream heating under current conditions. The lower line uses the assumptions of the system potential condition.

Figure 14 - Total daily solar flux loading by river mile (lower 9.5 miles mainstem)

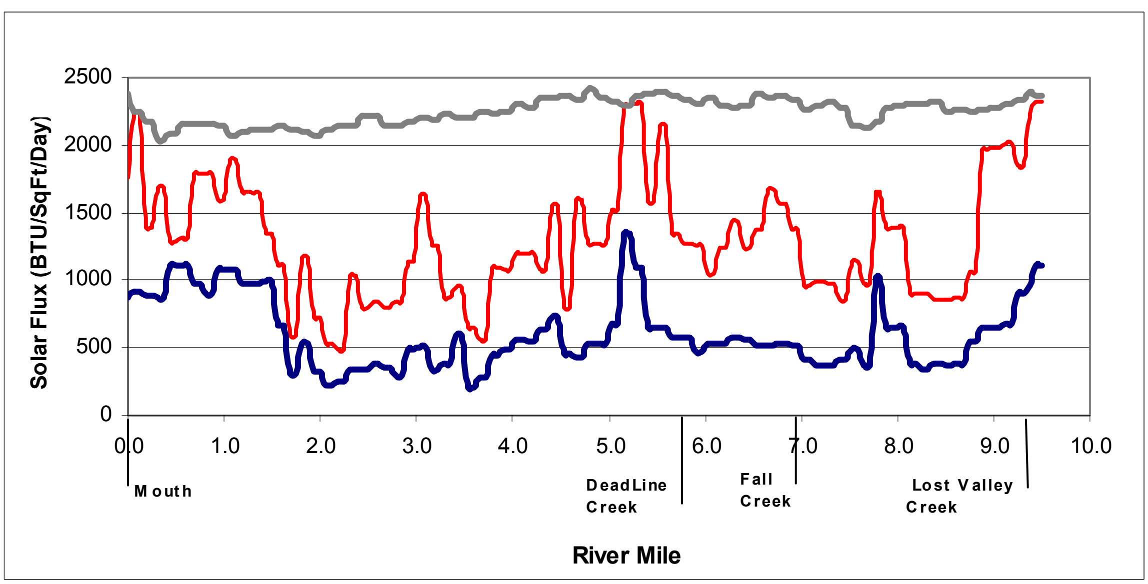



Figure 15 shows the solar flux information displayed as percentile plots. Colors are the same as in figure 14.

Figure 15

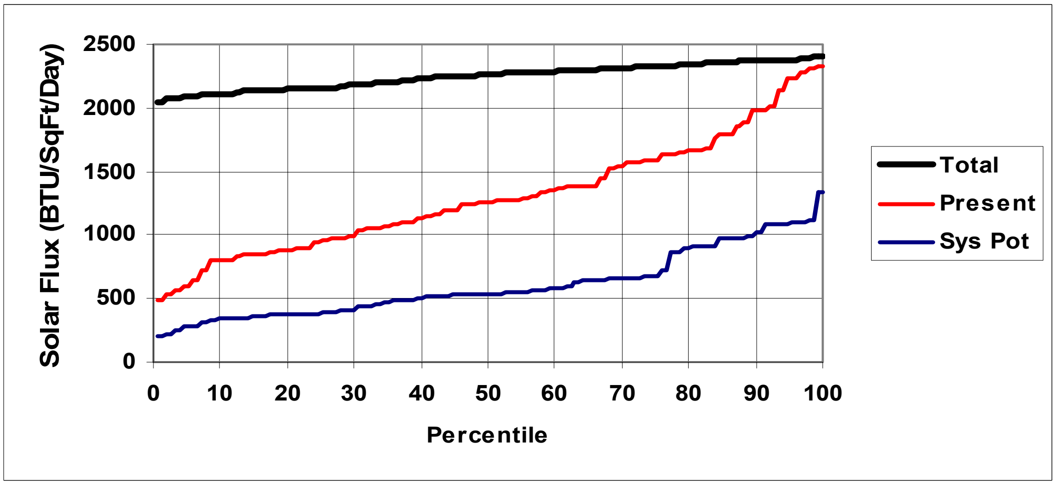
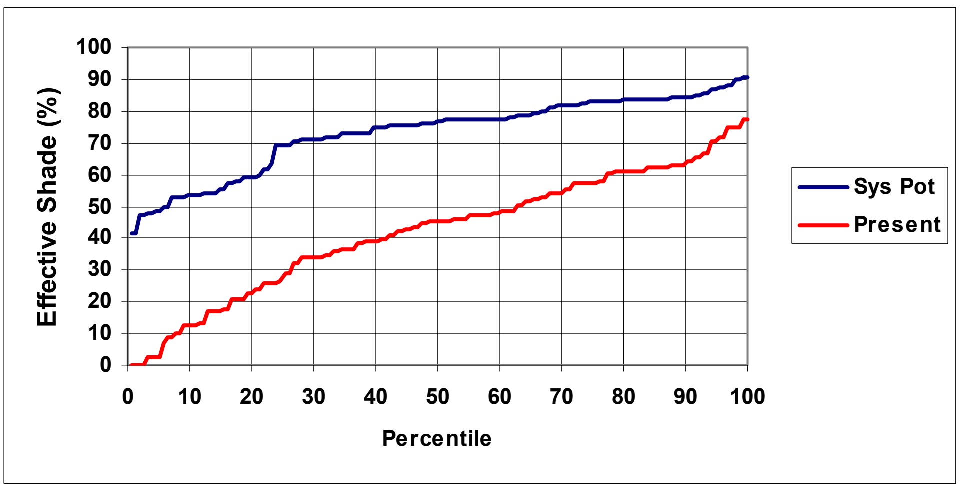
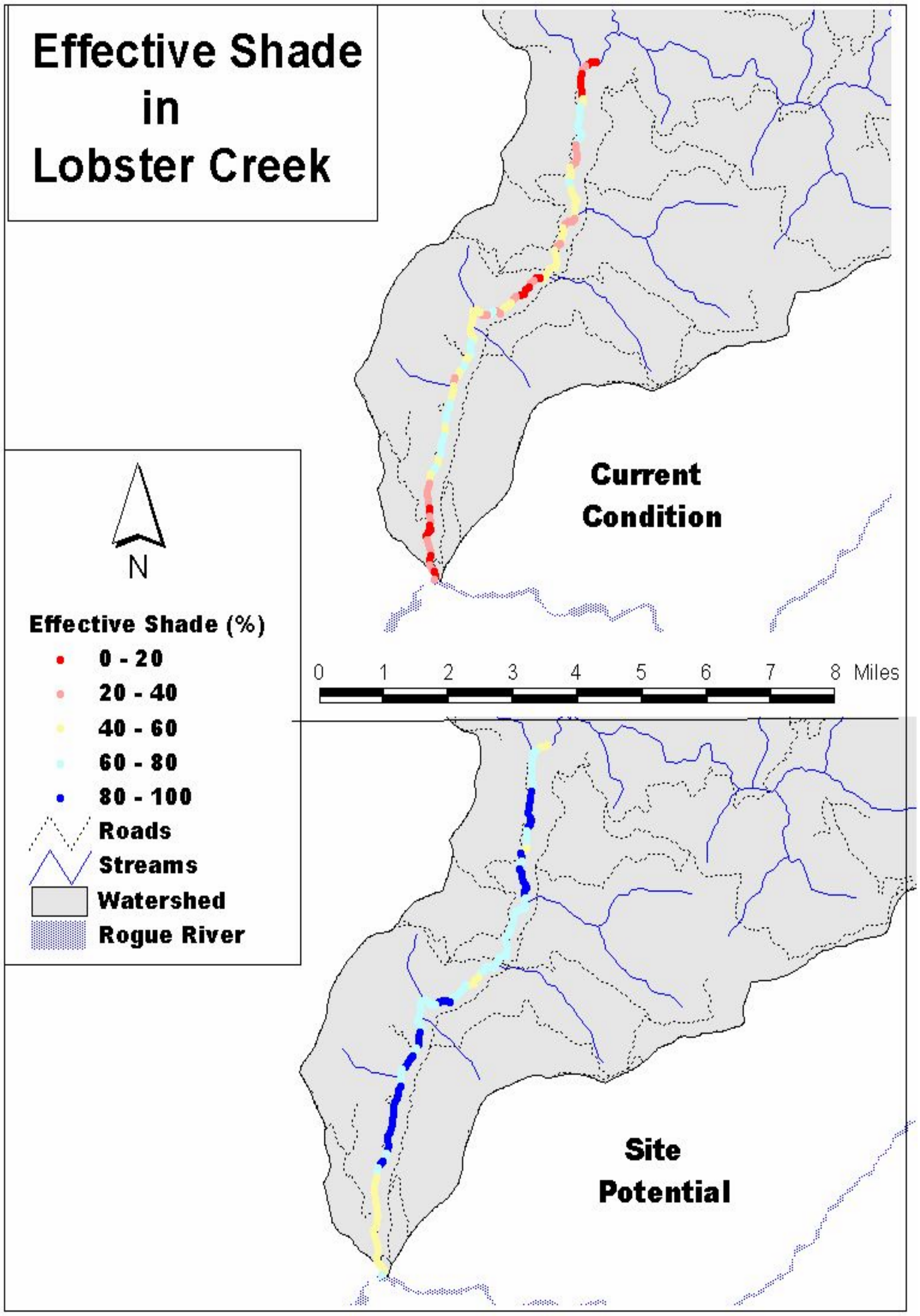



Figure 17



Map 2


Effective Shade
in
Lobster Creek
N
Effective Shade (%)
0 - 20
20 - 40
40 - 60
60 - 80
80 - 100
Roads
Streams
Watershed
Rogue River
0 1 2 3 4 5 6 7 8 Miles
Current
Condition
Site
Potential

## Stream Temperature

Figure 18 and Map 3 shows current stream temperature conditions and projected future stream temperature profiles. The open circles in Figure 18 are the corresponding same-day 4:00 PM temperatures recorded by the four data loggers deployed in the main stem. The expected future stream temperature profiles are based on the assumed future condition. Temperature profiles show stream temperatures at **4:00 PM in the afternoon on July 22, 1999.** The difference between the lines shows how much reduction in stream temperature might be expected if the assumed future conditions are achieved.

In Figure 18, the top line shows the present temperature profile and the bottom line shows the expected system potential temperatures. The model simulations for the future conditions did not assume any additional cooling to any tributary. **Additional cooling in any of the tributary sub-watersheds or increased interaction with basin groundwater could result in additional cooling in the main stem of Lobster Creek.** The percentile plot of temperature data is shown in figure 19.

Figure 18

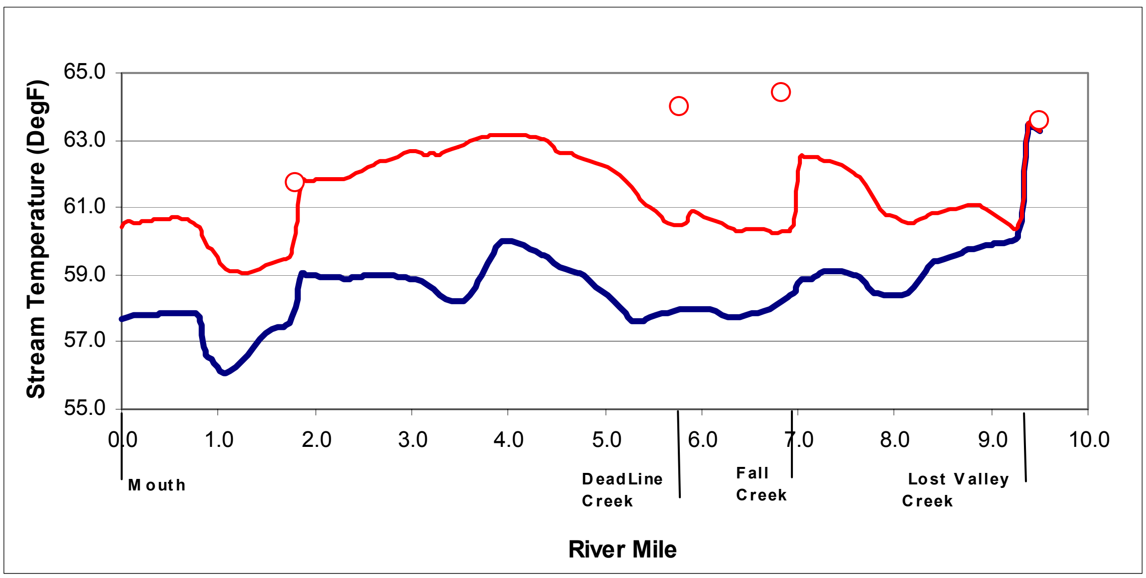
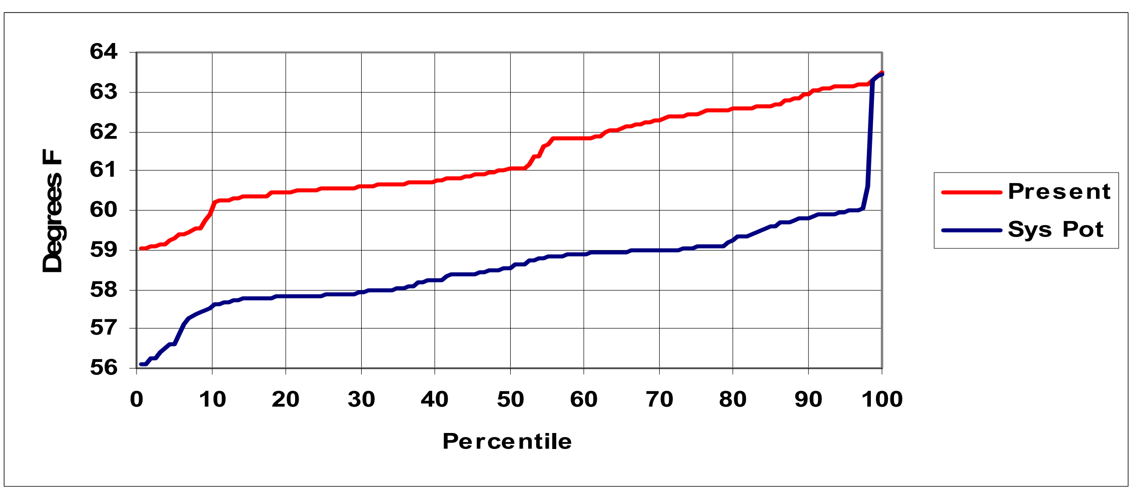
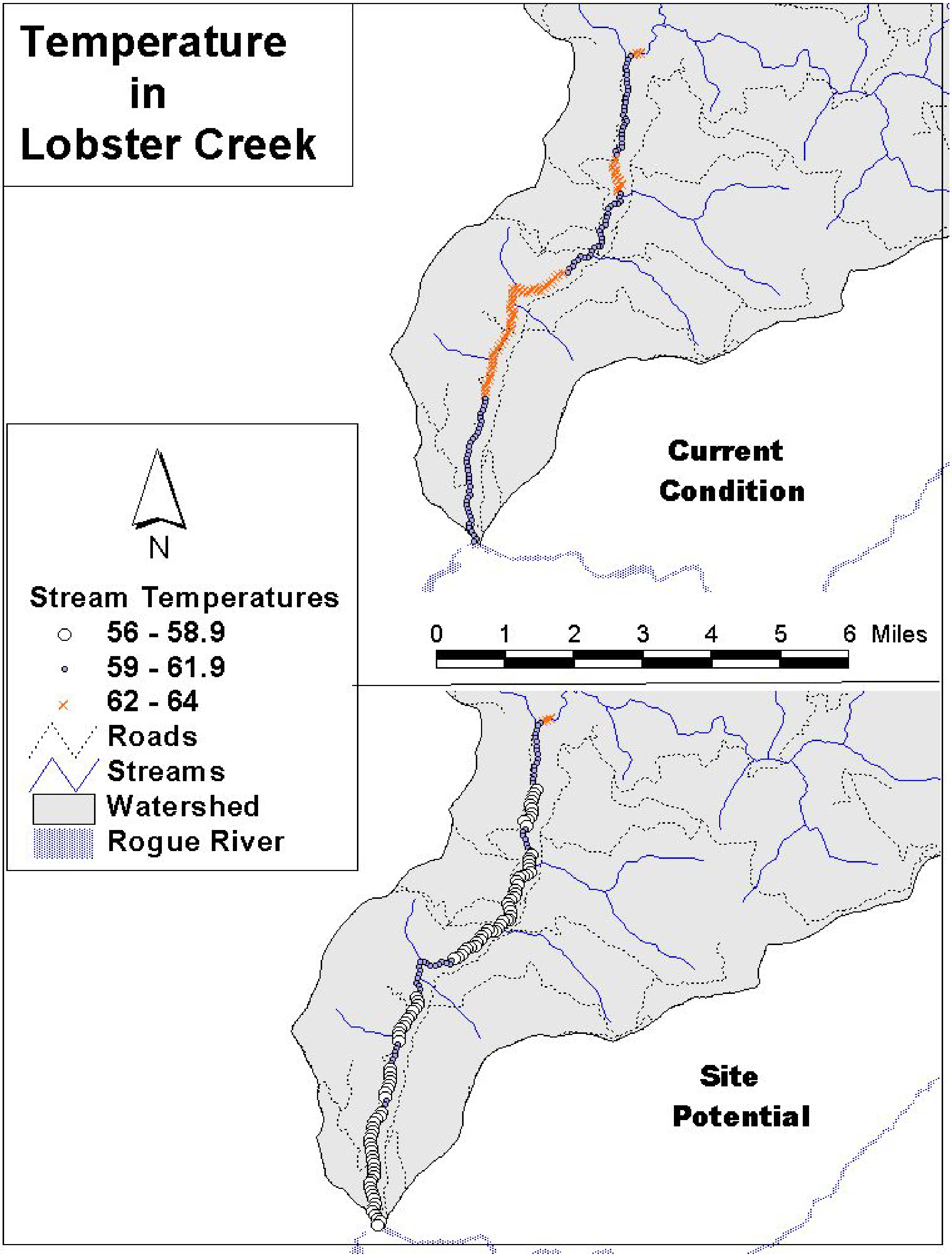



*Figure 19*



# Map 3


Temperature
in
Lobster Creek
N
Stream Temperatures
56 - 58.9
59 - 61.9
62 - 64
Roads
Streams
Watershed
Rogue River
Current
Condition
0 1 2 3 4 5 6 Miles
Site
Potential

The next two graphs (Figure 20 and 21) show the temperature data broken into 5 different temperature–range intervals. These intervals are roughly comparable to probable success of salmonid survival/reproduction. At the extremes, temperatures below 58 Degrees are optimal for reproduction, temperatures above 72 degrees are lethal to immature fish. These graphs show the same information, only displayed in different formats. Again, these temperatures would be expected **at 4:00 PM in late July.**

Figure 20

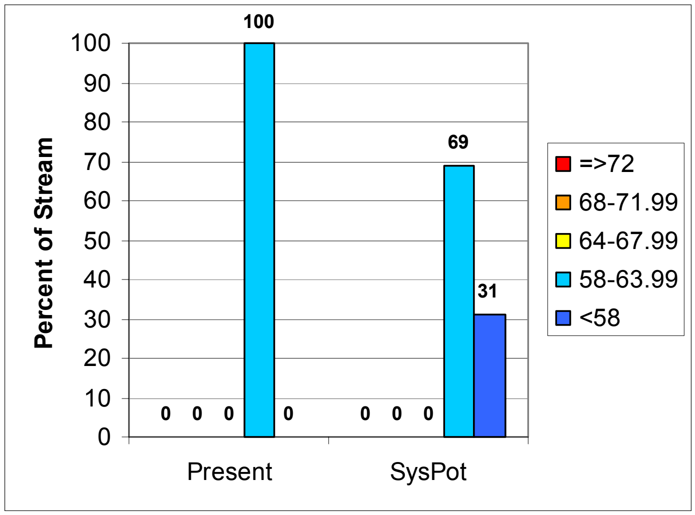
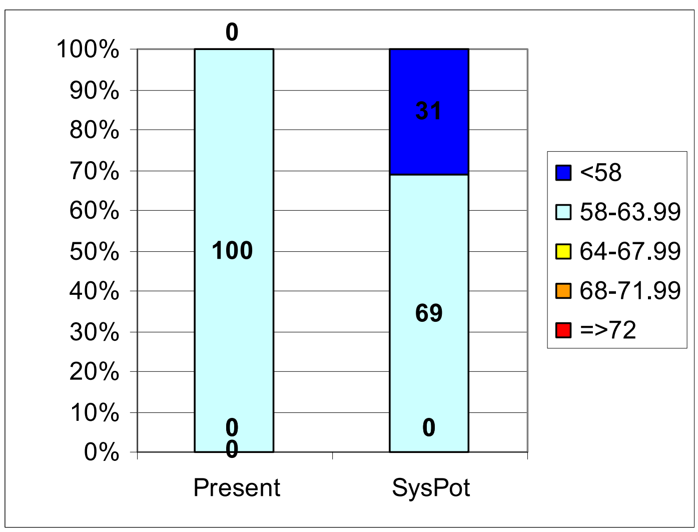



Figure 21




Stream temperatures for the selected modeling day did not exceed the 64°F numeric criteria. Figure 20 indicates that 100% of the time under current conditions attains the numeric criteria. Lobster Creek did exceed the numeric criteria during the summer of 1999. Figure 21 reflects a cooler temperature regime under system potential conditions for the day selected for this modeling exercise

The 1999 years seasonal 7 day maximum average water temperatures were recorded for the period August 23 through August 30. The Heat Source modeling date (7/22/99) was selected because it was in close proximity to the date that field flow measurements were collected (7/15/99) and because the diurnal temperature curve seemed to indicate that coastal fog was not present. Flow measurements were collected during adverse conditions, near the peak solar loading period, and during a period when field staff were available.