In Hot Water: Temperature TMDLs in the Pacific Northwest

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Abstract

This thesis examines temperature total daily maximum load (TMDL) and TMDL implementation plans in the Pacific Northwest in order to determine the common and unique strategies and challenges to TMDL implementation. Water temperatures for many rivers and streams in the Pacific Northwest region are above state water quality standards, threatening habitat quality for cold water salmonids. The study area included seven case study watersheds, which were investigated through interviews and document reviews.

The results of the case study investigations revealed that, in many cases, entities other than the State Department of Environmental Quality were responsible for TMDL implementation; the line of authority between entities implementing the TMDL is unclear, which may lead to confusion between implementers; and the water quality data collected by many groups is not coalesced into one centralized location for comprehensive analysis, which may lead to inefficiencies in TMDL implementation. Moreover, as the Obama administration reforms government agencies' data sharing and reporting procedures, comprehensive and standardized collection and analysis of water quality parameter data may become the norm.

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Acronyms

BLM	Bureau of Land Management
BOR	Bureau of Reclamation
BPA	Bonneville Power Administration
CCWG	Centennial Clean Water Grant Program
CKCD	Central Klickitat Conservation District
CREP	Conservation Reserve Enhancement Program
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
CWA	Clean Water Act
CWSRF	Clean Water State Revolving Fund
DNR	Department of Natural Resources (Washington)
DMA	Designated Management Agency
EPA	United States Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
ESA	Endangered Species Act
GIS	Geographic Information Systems
GRMW	Grande Ronde Model Watershed
IDL	Idaho Department of Lands
ISDA	Idaho Department of Agriculture
IWRB	Idaho Water Resources Board
KCCD	Kittitas County Conservation District
MOA	Memorandum of Agreement
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPT	Nez Perce Tribe
NRC	National Research Council
NRCS	Natural Resource Conservation Service
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
ODOA	Oregon Department of Agriculture
ODOF	Oregon Department of Forestry
ODOT	Oregon Department of Transportation
OWEB	Oregon Watershed Enhancement Board
OWRD	Oregon Water Resources Department
SCC	Soil Conservation Commission
SCD	Soil Conservation District
TMDL	Total Maximum Daily Load
US ACE	United States Army Corps of Engineer
USFS	United States Forest Service

USFWS	United States Fish and Wildlife Service
USGS	United States Geological Service
WDFW	Washington Department of Fish and Wildlife
WLA	Waste Load Allocation
WPU	Watershed Planning Unit
WQMP	Water Quality Management Plan
WSDA	Washington Department of Agriculture
WSDOT	Washington Department of Transportation
WWTP	Waste Water Treatment Plant

Chapter 1. Introduction

This research will focus on water temperature impairments in watersheds in the Pacific Northwest. In this region water temperatures often exceed state water quality standards threatening the survival of iconic cold water salmonids. The Federal Clean Water Act (CWA) mandates that states create a plan, called a temperature Total Maximum Daily Load (TMDL), for reducing water temperatures. Since the 1990's, focus has shifted from creating TMDLs for point sources that cause water impairments (such as factories or power plants) to nonpoint sources (such as polluted runoff from roads and agriculture). Elevated water temperatures are considered a nonpoint source because they arise from a variety of land use activities. Regulating nonpoint source water impairments requires the involvement of multiple agencies and stakeholder groups, making TMDL planning and implementation more complicated. Thus, while nonpoint source TMDLs are required for impaired water bodies, TMDL planning and implementation varies from watershed to watershed.

This thesis focuses on the temperature TMDLs in seven watersheds in the Pacific Northwest states of Oregon, Washington and Idaho. While much of this region remains forested, land use pressures from development and forestry threaten the quality of cold water habitat. Land use practices cause a decrease in the vegetation along the banks of rivers and streams, which causes a reduction in shade and stream bank stabilization; cause streams to become wider and shallower, exposing more surface area to solar radiation; and cause a decrease in flow volume, which increases the heating effects of solar radiation.

Through interviews and review of implementation activities, this thesis examines temperature to determine the common and unique strategies used for TMDL implementation, and the common and unique challenges to TMDL implementation. It was found that groups other than the State Department of Environmental Protection led the TMDL implementation effort. Often these groups were local American Indian tribes and conservation commissions, who implemented water restoration activities through grants from the state and federal government. While leadership from stakeholders was important and may have enhanced participation from other local entities, it was also found that the organizational structure between stakeholder groups was weak and lacked a clear line of authority. This led to confusion regarding the responsibilities of various stakeholders and less than optimal data sharing. Looking forward, TMDL implementation in the Pacific Northwest could be improved through better communication between stakeholders and increasing stakeholder accountability, either through amending the Clean Water Act or by initiative from state departments of environmental protection. The findings of this research helps illuminate the issues surrounding temperature TMDL implementation and contribute to the body of literature surrounding water policy and conservation.

Chapter 2. Background

This section will provide background information on the physical process that affect water temperature the regulatory structure for water temperature reduction; the human activities that cause temperature impairments and the methods available for remediation; and the methods for temperature TMDL implementation.

The Physical Processes That Affect Water Temperature

Riparian shading, channel morphology, and stream flow are the most common physical processes that affect water temperature (LeBlanc, Brown and FitzGibbon, 1996). The riparian vegetation zone performs two temperature-reducing functions: it provides shade, which reduces the total heat flux (solar radiation) that reaches the water body, and it stabilizes the streambank, which restricts sediment from entering the stream. Depending on the size of the water body, the riparian zone ranges from yards to tens of yards for small streams and tens of yards to thousands of yards for large streams (Poole and Berman, 2001). Forest harvesting has been found to alter the riparian microclimate; the removal of riparian vegetation often results in stream heating (Moore, Spittlehouse & Story, 2005). Forest canopies play a significant role in reducing solar radiation. The riparian zone may reduce up to 90 percent of solar radiation in dense canopies but less than 75 percent of solar radiation in open stands (Moore, Spittlehouse & Story, 2005).

Alterations in stream channel morphology, the stream's physical structure, cause changes in channel slope, substrate and width. Channel slope influences streamflow rate. Many land use processes release sediment and cause a flattening of channel slope, which slows streamflow. Channel substrate is material that comprises the bottom of the channel. The roughness of this material influences heat release from a stream. As more sediment is deposited and woody debris are removed from a stream, stream channels become less rough and retain more heat. Streambed width determines the amount of solar radiation entering a water body. Sediment deposits cause stream channels to widen, increasing surface area available for the absorption of solar radiation (Poole and Berman, 2001).

Surface water temperature is a function of stream flow. Higher water temperatures may be caused by low flow rates (Sinokrot and Gulliver, 2000). Because groundwater systems deliver water from all over a watershed to a stream, groundwater recharge is an important factor in ensuring stream flow. When groundwater is removed from the system via wells for uses such as irrigation, less water is available to restore in-stream flow. Surface water withdrawals similarly affect in-stream flow and water temperature.

The Structure of Stream Water Quality Regulation in the US

The Federal Water Pollution Control Act of 1972, known as the Clean Water Act (CWA), is designed to maintain the integrity of water ways. To this end, Section 303 of the CWA provides a mechanism for identifying and rehabilitating polluted streams. Section 303(d) requires that states identify water bodies that do not meet state water quality standards. States are required tosubmit the 303(d) list of impaired water bodies to the EPA.

Once a water body is placed on the 303(d) list, Section 303(d)(2) of the CWA (1972) requires states to specify a total maximum daily load (TMDL) for the pollutant responsible for the water quality impairment. A TMDL is an estimate of the maximum daily amount of a given pollutant that a water body can carry without violating water quality standards set by the state or federal government (Horn, Rueda, Hörmann & Fohrer, 2004). Following EPA approval of the TMDL, Section 303(e)(1) of the CWA (1972) requires states to submit a plan for the rehabilitation of the impaired water body. The CWA (1972) Section 303(e)(3)(a) requires the inclusion of the following elements in the plan: effluent limitations and schedules of compliance, the incorporation of all elements of any applicable area-wide waste management plan, the TMDL, procedures for revision, a plan for intergovernmental cooperation, adequate implementation including schedules for compliance, controls for treated wastewater discharges, and an inventory and ranking of priority needs for construction of waste water treatment facilities. The TMDL processing plan described in CWA Section 303(e)(3)(a) is essentially a plan to bring water temperature to the specified TMDL estimate. While states are required to develop an implementation plan, there are no provisions in the CWA that require states to carry out the recommendations of the implementation plan.

The task of achieving TMDL goals in watersheds where point source discharges create the water quality problem is more straight forward than in watersheds with nonpoint source pollution problems. The reduction of pollutant discharges from point sources is achieved through the National Pollutant Discharge Elimination System (NPDES) program established under CWA Section 402. The NPDES permit is designed to restrict point source pollution levels to meet water quality standards (US EPA Office of Water, 2009). However, if a water body is not meeting water quality standards and is placed on the 303(d) list, a TMDL is required. The TMDL reassigns pollution amounts to each discharging facility to bring the impaired water body into compliance – these assignments are called waste load allocations (WLA). The NPDES permit for each facility is then revised to reflect the WLA given in the TMDL (US EPA Office of Water, 2009). Facilities are required by law to comply with the WLA given in their NPDES permits, often resulting in costly retrofits to discharging facilities.

In watersheds where nonpoint source pollution causes the water quality impairment, a regulatory dilemma arises from the absence of a direct culprit. In this case, the regulatory power of the TMDL and implementation plan is more restricted. The TMDL implementation plan may serve as a guidance document, but it is up to the various government agencies and local stakeholders in the watershed to implement the provisions of the plan to achieve the goals of the TMDL (Boyd, 2000). In the absence of real regulatory enforceability, the degree to which the TMDL water quality goals are met varies from watershed to watershed depending upon the commitment of state agencies and other TMDL partners, and the resources available for implementing management practices (Tobin, 2003).

Temperature TMDLs

Temperature is an important physical parameter which can determine the overall health of aquatic ecosystems. The mortality and growth rate of fish are directly linked to environmental temperature (Pauly, 1980). Most aquatic species survive over a “genetically predetermined temperature range” (Langford, 1990). Some aquatic species are able to adapt physiologically, or have strategies for avoiding temperatures outside of this predetermined range. However, this type of adaptation can stress aquatic organisms by altering species distribution and/or growth rate (Cassie, 2006). Fry (1967) has identified three classification categories for temperature effects on organisms: 1) lethal temperature, which can kill an organism within its lifetime, 2) controlling effects of sub-lethal temperatures, which can affect growth and reproduction, 3) directive effects which, cause behavioral changes such as migrations.

Warm water temperatures also affect the toxicity of ammonia and other materials in water. For example, water temperature affects the dissolved oxygen content of a water body. Colder water holds more oxygen than warmer water so all else equal, as temperatures rise, the oxygen available for aquatic species decreases (Idaho Department of Environmental Quality, 2010).

States are required to set temperature standards for surface water bodies. According to the Clean Water Act (1971), these standards may vary depending on the beneficial uses supported by the water body. The goals of the TMDL are then written based on state water temperature criteria.

A watershed modeling approach is usually used to quantify heat load for temperature TMDLs. Heat flux, or the heating of a water body by solar radiation, can be calculated using surrogate measures, the most common of which is effective shade (Shumar and de Varona, 2009). Effective shade is the amount of solar radiation that is blocked from entering a water body by vegetation and topography. The amount of effective shade required to reduce water temperatures to state temperature criteria is calculated in a model that also contains current effective shade conditions. If current effective shade conditions do not meet the load allocation for shade, TMDL goals are stated in terms of the percent increase in riparian shade required to meet water temperature criteria. Sometimes wetted width-to-depth ratio is added to the model in order to account for the surface area of the water body that could potentially be exposed to heat flux. Larger width-to-depth ratios indicate greater exposed surface area and warmer temperatures. Another is withdrawals occurring within the watershed, which cause a decrease in flow levels.

The Watershed Approach to TMDLs

Because stream conditions are impacted by virtually every kind of land use change and most changes to stream conditions may impact temperature, addressing nonpoint heat reduction is a complex regulatory endeavor. The management activities required to reduce nonpoint source pollution often necessitate a watershed approach to TMDL planning to capitalize on the resources required to assess and plan for temperature reduction. While more than 34,300 TMDLs have been approved since 1995, according to the EPA, "70,000 TMDLs still need to be developed in the next 8-13 years," costing an estimated $1.86 billion to $2.04 billion (EPA, 2008). Watershed TMDLs are viewed by the EPA as a method of reducing the cost of developing TMDLs by creating one TMDL for many impaired segments rather than individual TMDLs for each impaired segment.

The EPA (2008) gives the following criteria for identifying candidates for watershed TMDL development:

- If the impairment is similar for different water bodies within the watershed,
- If an impairment in one stream segment contributes to impairment in another stream segment,
- If the state is required by consent decree to rapidly develop TMDLs for multiple impaired water bodies,

- If the watershed contains both low and high priority impaired water bodies,
- If the watershed has pre-existing water quality improvement programs.

Temperature pollution is a good candidate for watershed TMDLs because nonpoint sources often cause impairment in multiple water bodies within a basin. Given the large number of temperature impaired water bodies in the Pacific Northwest, the watershed approach to TMDL development in this region makes sense. However, it should be mentioned that point sources may also contribute to temperature impairment. These point sources are identified on a watershed scale by the TMDL, and their WLAs reflect watershed temperature goals.

In basins where temperature impairment is widespread, the cumulative effect of temperature reduction is important. As the required magnitude of temperature reduction increases, restoration efforts in far reaches of the watershed is more efficient than efforts nearer to the mainstem (Watanabe, Adams & Wu, 2006). In order to reduce temperature in the main basin channel, temperature remediation in smaller tributaries must occur on a watershed scale.

Because temperature impairments mostly originate from nonpoint sources, multiagency cooperation is needed to develop and implement the TMDL. For example, the state departments of forestry and agriculture work in different areas of a watershed, but regulate temperature polluting activities related to their sector. The coordination between these agencies on a watershed-level increases the efficiency and speed with which the TMDLs are developed and implemented.

Human Influence on Water Temperature

Activities That Contribute to Elevated Water Temperature

Surface water temperature is a function of many different variables. Thus, human induced temperature changes can be attributed to a number of different sources. The causes of temperature change in surface water bodies have been attributed to nonpoint sources such as climate change and land use change, and point sources such as discharges from industrial processes. In the Pacific Northwest, human impacts on temperature are cumulative: as land development and river alteration increase in a watershed, so does the intensity of temperature changes (Poole and Berman, 2001). Human activities decrease riparian shade, increasing solar exposure, and alter channel morphology and streamflow. Nonpoint sources assigned waste load allocations in the Pacific Northwest are silviculture, forest harvesting, roads, agricultural uses and urban uses; industrial uses are assigned waste load allocations as point sources.

Historically, some silviculture (forest management) practices impacted river temperatures and other aquatic habitat quality parameters. According to Eric Watrud, Silviculturist for the USFS Pacific Northwest Region, “prior to the 1970's Forest Practices Acts in both Oregon and Washington, loggers were encouraged to remove large woody debris from streams” because forest managers were worried that fallen trees would clog culverts and damage bridges (E. Watrud, personal communication, July 13, 2010). However, since that time, it has been found that large woody debris actually helps maintain cold water temperatures.

Logging in the Pacific Northwest began during the 1880’s, causing the diminution of riparian canopy. Currently, 60-65 percent of forests in the Pacific Northwest are available for logging (University of Michigan Global Program in the Environment, 2010). In order to manage the water quality effects of forest harvesting in the riparian zone, buffer strips are required along fish-bearing streams in most jurisdictions in the Pacific Northwest (Moore, Spittlehouse & Story, 2005). However, the effectiveness of this approach may be compromised by several natural factors including wind throw and slope.

Livestock grazing and agricultural practices can also increase stream temperature. Livestock are attracted to water, vegetation and shade in riparian areas. The presence of livestock in riparian areas causes soil erosion, loss of streambed stability and hotter and dryer conditions (Belsky, Matzke & Uselman, 2001). Agricultural practices, including groundwater withdrawals for crop irrigation and riparian zone clearing for crop production, reduce the amount of groundwater recharge entering a stream and stream shading.

The extensive road networks constructed in the Pacific Northwest for forest harvesting have been found to increase the intensity and frequency of peak flows, landslides, and debris relative to forested areas (Jones, Swanson, Wemple & Snyder, 2000). Roads have been linked to higher incubation temperatures and influence hatch rates of Chinook Salmon in the Snohomish River in Washington

State (Jorgensen, Honea, McClure, Engie & Holzer, 2009). The increase in peak flows and debris slides increases sediment delivery to water bodies, which in turn increases the surface area exposed to solar radiation.

Watershed-wide urbanization and development impact surface water temperature. Urbanization reduces riparian vegetation, alters channel morphology, and generates impervious surfaces (LeBlanc, Brown & FitzGibbon, 1997). Urbanization is associated with decreased baseflows, increased peak flows, increased sediment loads, decreased channel complexity, and impaired water quality (LeBlanc, Brown & FitzGibbon, 1997). Stormwater runoff from roofs and roads can cause temperature increases in surface waters. As stormwater runs off asphalt it absorbs heat, which is released into the water body when the runoff is discharged (Van Buren, Watt, Marsalek & Anderson, 2000).

Industrial land uses place significant stress on surface water quality. Water used for cooling purposes in large industrial processes is discharged at elevated temperatures into rivers and streams (Langford, 1990). Groundwater demands of industrial processes may also contribute to the reduction of in-stream flows. Treated effluent from waste water treatment plants may also raise surface water temperatures if the waste water is discharged at a temperature higher than that of the receiving water body.

Climate change may cause increased air temperatures and decreased rainfall which may lead to higher surface water temperatures. Currently, TMDL documents for temperature impaired streams note that climate change may contribute to elevated water temperatures but conclude that planning for climate change is beyond the scope of TMDLs. Climate change will not be further addressed by this research.

Methods of Temperature Reduction

TMDL managers and watershed organizations may pursue a variety of activities to restore water temperatures in watersheds. Because of the diffuse nature of temperature pollution, remediation activities may occur at different scales throughout the watershed, but may target high priority conditions. Some of the following temperature reduction strategies such as riparian planting and implementation of agricultural best management practices (BMPs) require a higher level of community participation than other more engineering-based solutions such as road culvert replacement and setback levees which are often implemented by government agencies. All of the practices described in this section have been employed in watersheds in the Pacific Northwest.

Riparian planting along impaired stream segments reduces heat flux by increasing shade and providing bank stabilization which helps reduce sediment loading. Riparian planting is a central focus of many implementation plans with multiple agencies working to organize landowners and volunteers to aid in the planting effort. However, because riparian communities can take up to 80 years to reestablish, quantifying the temperature reductions resulting from planting efforts can be problematic. Moreover, newly replanted riparian zones can be vulnerable to damage by weather events and human activities. While weather damage may be hard to remediate, education efforts can accompany riparian planting activities to ensure the longevity of planting projects.

Implementing agricultural best management practices (BMPs) can reduce sedimentation, riparian zone reductions, and groundwater withdrawals. Modern sprinkler system technologies can replace less efficient sprinklers to reduce groundwater consumption for irrigation by up to 43 percent (Vinograd, 2006). Livestock BMPs that reduce temperature pollution include off-stream livestock watering and exclusionary fencing to keep livestock out of the riparian zone (Habron, 2004). Achieving adoption of agricultural and livestock BMPs requires education and multiagency collaboration. Farmers have been found to be more receptive to learning BMPs from other farmers than from outside agents, thus volunteer educational programs may be more effective than educational programs offered directly by state agencies (Habron, 2004).

Road culverts are devices that allow water to pass under roads. These installations often alter channel morphology and cause water quality problems. Culvert replacements may be reinstalled to widen the passage area to enable better fish passage and restore natural channel morphology (Kinyon, 2004).

Setback levees, which are levees that are constructed at a greater distance from the river channel, are a good restoration technique for increasing channel connectivity and riparian habitat for temperature impaired rivers (Konrad, Black, Voss & Neale, 2007). When levees confine a river, stream bed stability and low-velocity aquatic habitat decreases (Konrad, Black, Voss & Neale, 2007). By moving levees away from the floodplain, riparian communities become better established.

Road decommissioning and removal can restore stream banks, channels, and flood plains (Switalski, 2004). According to Switalski (2004), because there are thousands of kilometers of roads in the Pacific Northwest, removal projects should prioritize roads that contribute to sediment loading and water quality problems.

The hyporeic zone is the region beneath and lateral to the stream bed where groundwater and surface water mix (Burkholder, Grant, Haggerty, Khangaonkar & Wampler, 2007). This mixing process is known as hyporeic exchange. Hyporeic exchange does not remove heat from a river, but redistributes it temporally and spatially (Poole and Berman, 2001). Hyporiec exchange depends upon the conductivity of the gravel bars within a stream bed. Increasing hyporiec exchange by removing or reworking gravel bars in stream beds can improve temperature conditions (Burkholder, Grant, Haggerty, Khangaonkar & Wampler, 2007).

Flow augmentation decreases water temperatures by increasing river flow volumes. Flow augmentation may be achieved through water releases from dams, water transfers from other water bodies, and improving irrigation efficiencies.

TMDL Implementation

In the TMDL, each pollution source is given a waste load allocation (WLA). In order to meet temperature criteria, the waste load from each source must be reduced to the allocated amount. For example, temperature impairment may originate from agricultural activities, forest activities, and wastewater treatment plants, all of which will receive a WLA of zero. These sources are not allowed to increase water temperature and methods for reducing their contributions to temperature impairment must be employed.

Meeting WLAs requires the cooperation of various organizations and individuals at the local, state and federal levels. Depending on the state, the TMDL document or the implementation plan will list the agencies and organizations responsible for implementation. Table 1 provides the agencies and organization generally listed in TMDL documents as responsible for implementation. Along with engaging in implementation activities, these entities may also provide programs to help facilitate and fund TMDL implementation.

Table 1 TMDL Partner Agencies and Organizations

Agency or organization	Responsibilities and actions
	Local level
Municipalities	• Municipal point source discharges • Control new construction and development • Adopt ordinances to meet water quality standards
Counties	• Adopt ordinances to meet water quality standards
Tribes	• Manage implementation activities on tribal lands
Conservation Districts	• Help organize volunteers • Provide funding • Run education and awareness campaigns
Irrigation Districts	• Reservoir construction • Monitor groundwater and surface water levels • Monitor water rights and diversions
	State level
Department of Agriculture	• Helps farmers and ranchers implement agriculture BMPs • Helps fund implementation of agriculture BMPs
Department of Forestry	• Helps private land owners harvest trees • Helps private land owners with site preparation and reforestation • Road construction and improvements
Department of Transportation	• Road decommissioning • Culvert replacement
NPDES Permitted Operations	• Meet waste load allocations (WLAs)
Water Resources Department	• Manages withdrawal permits • Provides education for installing best management practices (BMPs)
Department of Fish and Wildlife	• Monitoring • Data analysis
	Federal level
US Forest Service	• Manages federal forest land
US Bureau of Reclamation	• Road decommissioning • Dam decommissioning
Bureau of Land Management	• Implements BMPs

The TMDL should provide a list of priority reaches for targeted implementation and a schedule for implementation (National Research Council, 2001; US EPA, Office of Water, 2008). The diffuse nature of nonpoint source pollution necessitates prioritizing especially impaired or strategically important areas within a watershed. For instance, if the main channel of a river exceeds temperature standards, but upstream tributaries do so as well, it may be more effective to target the tributaries because reduced temperature in those reaches will contribute to reduced temperature in the main channel.

Temperature and shade data alone do not provide a clear idea of implementation progress. Temperature data vary from year to year depending on air temperature and precipitation, so these data are not reliable for tracking TMDL implementation. Alternatively, monitoring the amount of water placed in trust, the number of irrigation improvements made, the number of road improvements made, and temperature sensitive indicator macroinvertebrates[1] may more accurately represent implementation(Jane Creech, personal communication, April 30, 2010).

Tracking implementation progress involves an adaptive management plan that sets forth a schedule for TMDL review. The review is intended to evaluate implementation progress and establish benchmarks for attainment of water quality parameters. If the adaptive management plan finds the provisions of the

[1] Aquatic insects, worms and crustaceans are sensitive to pollutants and their relative abundance can indicate water quality.

implementation plan to be inadequate, revisions should be made (National Research Council, 2001).

Securing funding for implementation is an important component of the implementation process. TMDLs are not guaranteed federal funding, so TMDL implementation is largely dependent on public and private grants. Funding sources vary from state to state, and a list of general funding sources identified through this research is provided in Table 2.

Table 2 Funding Sources

Public	CWA Section 319 Grant Program Clean Water State Revolving Fund State Department of Environmental Quality US Fish and Wildlife Service (USFWS) US Forest Service (USFS) Soil and Water Conservation Districts US Natural Resources Conservation Service (NRCS) Environmental Quality Incentives Program (EQIP) Conservation Reserve Enhancement Program (CREP) Centennial Clean Water Fund Army Corps of Engineers
Private	The Nature Conservancy Ducks Unlimited Pheasants Forever The Wetlands Conservancy The Audubon Society Trout Unlimited

Due to the resource-intensive nature of nonpoint source pollution management, Congress amended the Clean Water Act in 1972 to include Section

319, a federal grant program (US EPA, Office of Water, 2010). Under this Section, states, tribes and territories can apply to the Federal government for financial assistance, education, training, technology transfer, demonstration projects and monitoring (Parker, 2003). Section 319 grant recipients must provide a 40 percent match in dollars or in-kind services. Total annual funding was $37 million in 1990, rose to $237 million in 2004, and was $200.9 million in 2009 (US EPA, Office of Water, 2010).

The Clean Water State Revolving Fund (CWSRF) was established by Congress at the end of the 1980’s to provide low interest loans to a variety of borrowers including municipalities, individuals, businesses and nonprofits. This funding is intended to assist with nonpoint source pollution management programs. On average $5 billion is borrowed annually through CWSRF (US EPA, Office of Water, 2010).

Chapter 3. Introduction to the Case Studies

The following sections introduce the region, the states and the watersheds researched for this thesis, which focuses on three states in the Pacific Northwest: Oregon, Washington and Idaho. Within these states, seven watersheds are examined to identify the common and unique characteristics and challenges of TMDL implementation.

Introduction to the Pacific Northwest and it's Salmonids

The Pacific Northwest region is bounded by the Pacific Ocean to the west and includes the states of Washington, Oregon, the Canadian province of British Columbia, southeast Alaska, western Idaho, western Montana and northern California. This report will focus on the states of Oregon, Washington and Idaho because these states have the most 303(d) listed stream segments of the five Pacific Northwest states, which provide habitat for temperature sensitive salmonids. While the three states must all meet the requirements of the Clean Water Act, individual TMDL development and implementation methods vary.

Roughly 60 percent of this region is forested, and the fresh water streams within forested areas provide spawning and rearing habitat for approximately 50 percent for the area's famous fisheries. Salmonid fisheries have been present in the region over geologic time. Salmonids have become iconic to the region because they carry enormous cultural importance to Indian tribes and form the backbone of the local fishing economy. Salmonids are anadromous species, meaning they hatch in freshwater streams, mature in the ocean and return to freshwater habitats to spawn. There are five species of Pacific salmonids: Chinook, Chum, Sockeye, Coho and Pink. Anadromous Cutthroat Trout and Steelhead Trout are also considered members of the Pacific salmonid family (US Fish and Wildlife Service, 2010).

Each salmon species has several runs of freshwater-to-ocean habitat routes. Within a run, there are distinct types or stocks of salmon which are differentiated physiologically and genetically, and are adapted to the particular conditions of their home rivers. Presently, these stocks are declining. The US Fish and Wildlife Service (2010) estimates that 104 wild stocks are now extinct. In Oregon, the Wollowa River Sockeye is extinct and nine other salmonid species are listed as threatened. In Washington, the Upper Columbia Spring Chinook is listed as endangered and eleven other salmonid species are listed as threatened. In Idaho, the Snake River Coho is extinct, the Sockeye is listed as endangered and two other salmon species are listed as threatened (US Fish and Wildlife Service, 2010).

Various human caused factors contribute to the reduction in stock numbers including hydroelectric systems, habitat degradation, migration passage barriers, excessive ocean and fresh water harvesting, and temperature increases (Litchatowich, 2009). Salmonids are temperature sensitive, with optimal water temperatures ranging from 15 degrees Celsius to 19 degrees Celsius, and lethal temperature limits of around 25 degrees Celsius (Cech and Myrick, 1999) (Brett, 1971). Pacific Northwest states have specific surface water temperature criteria for rivers and streams that provide habitat for salmonids. Temperature requirements for salmonids vary depending on the population's life-cycle stage: spawning, rearing, or navigation. Likewise, state temperature standards vary depending on the expected life-cycle stage of the salmonid inhabitants. The seven day average maximum temperature standard for salmonids in Washington ranges from 9 degrees Celsius to 17.5 Celsius (Washington Department of Ecology, 2007). The seven day average maximum temperature standard for salmonids in Oregon ranges from 10 degrees Celsius to 17.8 degrees Celsius (Oregon Department of Environmental Quality, 2007). The daily maximum temperature standard for salmonids in Idaho ranges from 9 degrees Celsius to 19 degrees Celsius (Idaho Department of Environmental Quality, 2010).

Oregon

During the 1980's and 1990's the EPA and state environmental protection agencies came under a barrage of lawsuits for essentially ignoring Section 303(d) of the CWA and for focusing solely on remediating point source pollution. Through litigation, many states were forced to commit to a schedule for listing impaired water bodies and creating TMDLs (Ruffolo, 1999). In 1999, the environmental defense nonprofit Northwest Environmental Defense Center and the environmental advocacy nonprofit Northwest Environmental Advocates entered into a Consent Decree with the EPA. Under the Consent Decree, the EPA and the Oregon Department of Environmental Quality (ODEQ) agreed to establish TMDLs for all 303(d) listed water bodies in Oregon State by the year 2010.

ODEQ was compelled to generate over 1,000 TMDLs in 11 years. One of the ways ODEQ hoped to manage this feat was by creating 83 watershed TMDLs for multiple stream segments with the same impairment. Another strategy was simultaneous creation of TMDLs for all nonpoint pollution sources within a watershed. This method allowed TMDLs and implementation plans to discuss the interaction between different nonpoint pollution types such as sediment loading and temperature. As of January 2009, Oregon's TMDL status was the following: 35 watershed TMDLs approved by the EPA; 14 watershed TMDL reports in progress; 14 watershed TMDLs initiated; and 20 TMDLs not started. It is unclear whether ODEQ will be able to finish all 83 watershed TMDLs by the deadline set in the Consent Decree (Oregon Department of Environmental Quality, 2009).

The Oregon Plan for Salmon and Watersheds (Oregon Plan) was created in 1997 as a grassroots response to listings of salmonid species under the Endangered Species Act. The Oregon Plan has since evolved into a statewide program to preserve Oregon's salmonids by organizing specific actions to improve water quality and aquatic habitat. These actions are led by individuals from a diversity of sectors, including landowners, community organizations, interest groups, and government agencies.

ODEQ is the head agency responsible for TMDL development and implementation. However, because temperature pollution is caused by numerous land use practices, involvement of other state agencies and private organizations in TMDL development and implementation is necessary to achieve TMDL goals. These agencies, listed in Table 3, often develop independent watershed protection plans and form partnerships with ODEQ to manage water quality.

Table 3 Oregon TMDL State, Local and Federal Partners

TMDL Partner	
Department of Agriculture (ODOA)	• Responsible for nonpoint source reduction from agricultural sources • Administers Agricultural Water Quality Management Program for implementing agricultural BMPs • Administers Oregon's Soil and Water Conservation Districts (SWCD)
Department of Forestry (ODOF)	• Regulates timber harvesting, road construction and reforestation under the 2003 Forestry Program for Oregon established by the Forest Practices Act of 1994
Department of Transportation (ODOT)	• Implements BMPs for road construction and maintenance
Oregon Water Resources Department (OWRD)	• Oversees local irrigation districts, which manage water rights, monitor flow, and administer the conservation planning program for agriculture
Oregon Watershed Enhancement Board (OWEB)	• Provides grants for water quality improvement projects • Administers the Oregon Plan for Salmon and Watersheds
Watershed Councils	• Comprised of volunteers from local communities • Partners with ODEQ to develop and implement TMDLs
Tribes	• Undertakes extensive conservation and restoration programs to ensure habitat for salmonids • Contributes to TMDL development and implementation
Local Government	• Often owns NPDES permitted facilities and are responsible for ensuring NPDES compliance with the TMDL • Helps work with private landowners to implement BMPs • Often enacts zoning rules to incorporate water quality assurance

Bonneville Power Administration (BPA)	• Agency of US Department of Energy • Involved with water quality projects all over Pacific Northwest
Northwest Power and Conservation Council	• Helps states of Idaho, Montana, Oregon, and Washington manage hydro power impacts on water quality and aquatic life in the Columbia River Basin • Funded by hydro power revenue from the BPA
Bureau of Land Management (BLM)	• Preserves sustainable yield of natural resources on public land under the Federal Lands Policy and Management Act • Monitors the impact of management decisions on water quality and to use BMPs to resolve water quality issues
Natural Resources Conservation Service (NRCS)	• Provides agricultural producers with financial assistance to install BMPs
Bureau of Reclamation (BOR)	• Manages irrigation canals, dams and reservoirs • Manages flow enhancement and fish passage projects
US Forest Service (USFS)	• Responsible for ensuring healthy aquatic habitat on national forest land

Washington

In 1997, Washington State's environmental protection agency, Washington Department of Ecology (Washington Ecology), signed a memorandum of understanding with the EPA, which established a schedule mandating the completion of TMDLs for all of the CWA Section 303(d) listed water bodies in Washington by 2013 (Washington Department of Ecology, 2008). Like Oregon, Washington's method for meeting this deadline was through a watershed approach. Washington Ecology aggregated the state's major watersheds into 23 water quality management areas which are managed by regional offices. Washington Ecology broke the TMDL process into five steps: scoping (identifying water quality issues and prioritizing), data collection and analysis (TMDL technical report), plan of action (draft TMDL), and implementation (TMDL implementation plan) (Washington Department of

Ecology, 2008). Since 1996, Washington Ecology has been initiating this process in each water quality management area at a rate of four watersheds per year (Washington Department of Ecology, 2008).

In 2000, Washington Ecology completed the first statewide Water Quality Plan to Control Nonpoint Source Pollution, which it pledged to update and rewrite every five years. In the first phase of the plan, equal emphasis was placed on all potential sources of nonpoint source pollution. Currently, the most common nonpoint source pollutant in Washington is temperature, followed by fecal coliform and dissolved oxygen. In 2005, Washington Ecology observed that certain land uses caused more pollution than others: forestry, agriculture, livestock and human activities. The 2005 plan found that more compliance monitoring and technical assistance for private forest owners was needed to reduce harmful forest practices. Runoff and riparian habitat depletion caused by livestock operations were also found to be a major cause of water quality degradation. Urban land uses were found to cause the biggest impact on water quality due to increased stormwater runoff, impervious surfaces and individual actions such as pet waste and car washing (Washington Department of Ecology, 2007).

In 2000, USFS entered into a Memorandum of Agreement (MOA) with Washington Ecology to repair and close national forest roads to help restore water quality (Washington Department of Ecology, 2010). In the Washington's National

Forests, forest roads were the most significant contributor to water quality degradation.

Washington Ecology's Water Quality Program administers three water quality grant and loan programs: the Centennial Clean Water Grant Program (CCWG), which is funded through state bonds, the CWA Section 319 Nonpoint Source Grant Program, and the Washington State Water Pollution Control Revolving Fund Loan Program (Washington Department of Ecology, 2010). Between 2006 and 2010 Washington Ecology disbursed $15.25 million through CCWG, $9.3 million of CWA Section 319 grants, and $59.3 million through the State Revolving Fund for nonpoint source pollution remediation projects (Washington Department of Ecology, 2010). In 2009, Washington Ecology received an additional $68 million through the American Reinvestment and Recovery Act of 2009, which it disbursed in 2010.

Table 4 lists the agencies that partner with Washington Ecology to develop and implement TMDLs. Agencies that operate at the national level are described in Table 3.

Table 4 Washington TMDL State and Local Partners

Agency	
Department of Agriculture (WSDA)	• Partners with the Conservation Commission to administer the Conservation Reserve Enhancement Program (CREP) for installation of agricultural BMPs
Department of Natural Resources (DNR)	• Administers Forest Practices Act of 1974 • Created the Forest and Fish Report in 1999 to bring its policies into compliance with the CWA and the ESA • Adopted the Washington State Forest Practices Habitat Conservation Plan (HCP) of 2006 to protect 60,000 miles of aquatic habitat on public and private land • Administers the Aquatic Reserves program
Department of Transportation (WSDOT)	•Updates road culverts to restore fish passage and aquatic habitat
Conservation Commission	• Oversees and funds local Conservation Districts with funding from the state legislature • Partners with the Conservation Districts to administer the Irrigation Efficiencies Grants Program
Conservation Districts	• Assists Washington Ecology in developing and implementing TMDLs • Collects water quality data, administer public education programs and coordinate local volunteers
Department of Fish and Wildlife (WDFW)	• Administers the Regional Fisheries Enhancement Group Program • Administers the Aquatic Lands Enhancement Account Volunteer Cooperative Grant Program • Assists agricultural producers in implementing BMPs
Washington State Salmon Recovery Funding Board	• Provides funding for restoration projects, which provide high quality habitat for salmon
Tribes	• Assists with TMDL development and implementation
Local Governments	• Administers urban forestry programs, forest land conversion, runoff control programs, nonpoint source education programs, and water quality monitoring
For list of national partners, see Table 3.	

Idaho

In 2002, the Idaho Department of Environmental Quality (IDEQ) entered into a Settlement Agreement with EPA to develop a schedule for TMDL completion for the 900 water bodies in Idaho listed as impaired in 1998. The Settlement Agreement gave IDEQ a ten year time frame for TMDL completion (Idaho Department of Environmental Quality, 2010). Idaho TMDLs are created on a subbasin level based on USGS Hydrological Unit Codes a system for classifying the United States geographically on watersheds. As of 2004, EPA had approved TMDLs for 34 out of 84 subbasins in Idaho. Each TMDL process in Idaho is initiated with a subbasin assessment which aggregates multiple data types to establish an understanding of water quality concerns and the status of beneficial uses (Idaho Department of Environmental Quality, 2010).

IDEQ does not hold primacy over NPDES-permitted facilities; EPA regulates and assigns WLAs to Idaho NPDES facilities. IDEQ partners with EPA for this task, but EPA holds primacy.

Another unique feature of Idaho's nonpoint source program is that state agencies other than IDEQ write the implementation plan for TMDLs. Often state agencies such as the Department of Agriculture and the Department of Lands write individual plans to remediate nonpoint source pollution from their sectors. These agencies receive input from the Watershed Advisory Group, which provides the agencies with perspective from the public. The Watershed Advisor

Group is responsible for final review of the implementation plan. These entities and other TMDL partners in Idaho are described in Table 5.

Table 5 Idaho State and Local TMDL Partners

Partner	
Department of Agriculture (ISDA)	• Administer a monitoring program for agriculture TMDL implementation plans • Facilitates educational programs to help agricultural land owners implement BMPs
Department of Lands (IDL)	• Administers sustainable forest harvesting practices to maintain water quality and aquatic habitat • Helps landowners implement forestry BMPs
Idaho Water Resources Board (IWRB)	• Created the Idaho State Water Plan, a framework for water allocation • Provides financial assistance for water development and conservation projects
Soil Conservation Commission (SCC)	• Provides financial incentives for agricultural producers to implement BMPs during the TMDL implementation phase • Responsible for completing the Agriculture TMDL implementation plan
Soil Conservation Districts (SCD)	• Administrative arms of the SCC • Works at the watershed level assisting agricultural producers with TMDL implementation
Idaho Fish and Game	• Administers the Idaho Watershed Initiative, a grant program that funds proposals for restoring watersheds and forest habitat
Basin Advisory Group (BAG)	• Members are appointed by IDEQ • Represents the interests of various sectors of a basin • Appoints WAG members
Watershed Advisory Group (WAG)	• Assists with subbasin assessment and TMDL process • Consists of representatives from a diversity of sectors from the watershed community • Advises TMDL writers, run education campaigns, identify pollution sources, and help develop and implement the implementation plan
Technical Advisory Group (TAG)	• Comprised of experts from government agencies and the community • Assists with TMDL implementation
Tribes	• Contributes representatives to Watershed Advisory Groups (WAGs) • Assists with TMDL development and implementation
For list of national partners, see Table 3.	

Chapter 4. Methodology

The purpose of this research is to identify the common and unique strategies for temperature TMDL implementation, and the common and unique issues that challenge temperature TMDL implementation. Case study TMDLs were selected based on characteristics described by the literature as contributing to TMDL success. The unique characteristics of the case studies were further examined to highlight the methods employed for TMDL implementation and the issues that challenge TMDL implementation.

TMDL and implementation documents from the Pacific Northwest were reviewed based on criteria developed in previous TMDL research studies. There have been several research efforts examining the efficacy of TMDLs (Freedman, Nemura & Dilks, 2004) (Cabrera-Stagno, 2007) (Norton et al., 2007). For this research, the rubrics created by the Center for TMDL and Watershed Studies at Virginia Tech (2006) and the National Research Council (NRC) (2001) were used to evaluate the efficacy of Pacific Northwest TMDLs because these studies gave clear descriptive criteria for TMDL evaluation. Both sets of criteria were used to evaluate TMDLs for this study.

In a report prepared for the US EPA in 2006, The Center for TMDL and Watershed Studies at Virginia Tech evaluated TMDLs on a national level to identify the characteristics of strong TMDLs. This study examined the criteria present in TMDLs and implementation plans that resulted in water quality improvements. In a 2001 report to Congress, the National Research Council (NRC) evaluated the quantitative aspects necessary for TMDL success, such as the clear statement of numeric water quality standards. The criteria given by both research groups, presented in Table 6, were used for the selection of case studies for this research.

Table 6 Criteria for Case Study Selection

The Center for TMDL and Watershed Studies	The existence of a watershed plan that is focused and achievable •Focused on issues in the watershed •Achievable through corrective actions that [can] be made/adopted with active stakeholder participation
	Active involvement of stakeholders, local government, and responsible agencies
	Coordination of local governments and state agencies
	Diversity of approaches to address [pollution] sources •Enables participation of various stakeholder groups
	Targeted implementation for specific pollutant sources and polluters
	Staged implementation with interim goals and milestones for education
	Adequate resources •To implement voluntary incentive-based corrective measures •To provide technical assistance and conduct educational efforts •Measured as funding opportunities and the presence of responsible agencies for TMDL implementation
The National Research Council	An appropriate designated use must exist for the water body •Designated use must reflect the values of the users of the water body •Water quality criteria are based on designated use statement
	Physical criteria must be clearly stated in terms of magnitude, duration and frequency
	Criteria must be clearly stated and measureable
	Data which quantifies the pollutant must exist before reduction goals are set
	A plan for adaptive management must be given •The following elements must be present in the plan: "immediate actions, an array of possible long-term actions, and experimentation for model refinement" (NRC 2002). •Plans should include a water temperature and species monitoring program, a schedule for implementation reviews and provisions for amending the TMDL

According to qualitative research design theory, criterion-based selection of case studies can be used to "deliberately examine cases that are critical to the initial theories of the study" (Maxwell, 2005, p. 93). This research hypothesized that TMDL and implementation plans that met the criteria listed in Table 6 were likely to be successful in TMDL implementation. Case studies that met the criteria in Table 6 were further examined to identify the implementation strategies employed and the obstacles to implementation encountered.

A minimum of 10 temperature TMDLs from each Pacific Northwest state, Oregon, Washington and Idaho, were reviewed based on the above criteria. TMDL review occurred in alphabetical order by TMDL name to randomize selection of TMDL documents. There were 23 watersheds with TMDLs but no implementation plans – these basins were excluded from the review. In Oregon, the Department of Environmental Quality completed 28 temperature TMDLs; 19 of these documents were reviewed for the criteria. In Washington, the Department of Ecology completed 24 temperature TMDLs; 10 of these documents were reviewed for the criteria. In Idaho, the Department of Environmental Quality completed 52 temperature TMDLs; 10 of these documents were reviewed for the criteria. Although there was a high number of TMDLs completed for Idaho, implementation plans for 20 of the basins had not been completed or were unavailable at the time of this research. The lack of implementation plans for Idaho reduced the pool of potential case studies in that state from 52 to 32.

Following the review of temperature TMDLs and implementation plans, further examination of each case study was used to identify management strategies and potential challenges. For example, a case may have been selected because the presence of an active local stakeholder group indicated that implementation would be more likely. Further examination from additional data sources helped explain the implementation methods employed by this group and the challenges that threatened TMDL implementation. The triangulation strategy, where information is collected from a diverse range of sources, was used for the case study research. This method “reduces the risk of chance associations and of systematic biases due to a specific method, and allows a better assessment of the generality of the explanation one develops” (Maxwell, 2005, p. 112).

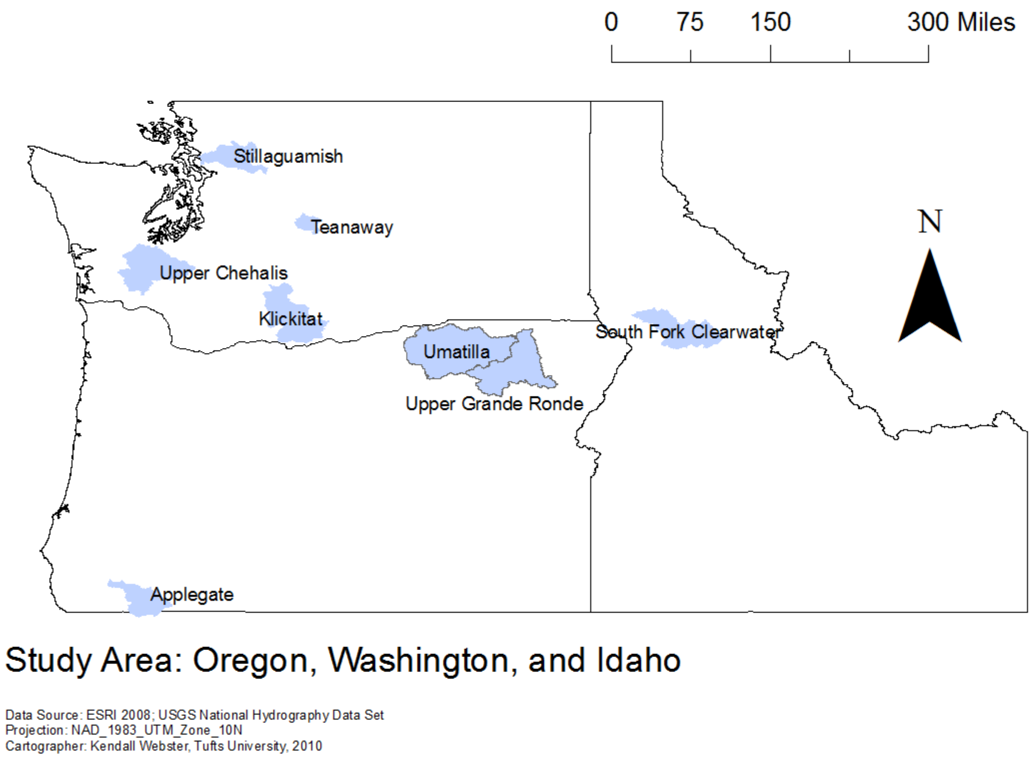
Data sources for case study research included the TMDL and Implementation Plans, documentation of restoration and monitoring efforts conducted by TMDL partners, publications pertaining to the watershed and TMDL, phone interviews with TMDL program managers and/or individuals from local watershed groups. The TMDL and Implementation Plans were reviewed for the criteria given in Table 6. Documentation of restoration and monitoring efforts were often available on watershed council web sites and state department of environmental protection web sites. Academic papers pertaining to the TMDL were reviewed. These publications often included information on the TMDL process or progress toward implementation. Phone interviews were conducted with TMDL managers or program leaders from local watershed councils when TMDL managers were not available. The goal of the interview was to investigate the attitudes of the TMDL managers regarding the strengths of the TMDL and the challenges to implementation. Additional factual information was also gathered through these interviews.

Although each of the case studies demonstrated the criteria given in Table 6, the methodology for implementation and the challenges to implementation varied. The purpose of the triangulation approach for basin review was to determine the common and unique strategies for implementation and the common and unique challenges to implementation. For example, the triangulation method provided an explanation of why a proposed action was not fully implemented or how implementation responsibilities were divided by various entities in the watershed. The distinct and common characteristics of each case study were highlighted to inform developing watershed management plans. Examples of successful implementation activities as well as examples of barriers to implementation will increase the information resource base for future TMDL implementation efforts.

Case Study Watersheds

All of the reviewed temperature TMDL and implementation plan documents that demonstrated the criteria detailed in Table 6 were selected as case studies for this research. Map 1 illustrates the study area and the watersheds selected as case studies. More detailed descriptions of the case studies are provided in the results section of this thesis.

Figure 1 Study Area



Upper Grande Ronde River Subbasin, Oregon

The Upper Grande Ronde Subbasin is an area of about 1,640 square-miles in the northeastern corner of Oregon. The Upper Grande Ronde is one of four subbasins in the Grande Ronde River watershed; the other three are the Wallowa Subbasin, the Imnaha Subbasin and the Lower Grande Ronde Subbasin. Approximately 53 percent of the subbasin is private land centered within the Grande Ronde River Valley. Private land uses are primarily livestock and agriculture. Approximately 46 percent of the subbasin is owned by the USDA Forest Service. The Forest Service land is located along the headwaters of tributary streams and is managed for water quality, timber production, livestock use, wildlife and recreation. There are approximately 45 stream segments in the subbasin on the Federal 303(d) list for violations of bacteria, dissolved oxygen, nutrient, pH, sediment, and temperature criteria. The beneficial uses aquatic life and “aesthetic quality” are identified as not supported in the subbasin (Grande Ronde Water Quality Committee, 2000, p. 12). Salmonids of concern include anadromous Chinook and Steelhead and resident Bull Trout (Grande Ronde Water Quality Committee, 2000).

Applegate River Subbasin, Oregon

The Applegate Subbasin is an area of 5,156 square miles and is one of five subbasins in the Rogue River Basin in southwestern Oregon. Approximately 40 percent of the land is owned by the USFS, 28 percent is owned by the BLM and 32 percent is privately owned. Roughly 90 square miles of the Applegate Subbasin are in Siskiyou County, California. The Applegate Dam, owned and operated by the army corps of engineers, controls flow and temperature in the Applegate River. There are 17 stream segments on the 303(d) list for temperature violations. Temperature incursions exceeded the water quality criteria for the following beneficial uses: salmonid spawning and rearing and aquatic life. The subbasin supports anadromous winter steelhead and fall Chinook, and resident Coho salmonids (Oregon Department of Environmental Quality, 2003).

Umatilla River Basin, Oregon

The Umatilla River basin is an area of 2,500 square miles in the Middle Columbia Basin in northeastern Oregon. Eighty percent of the land in the Basin is privately owned, thirteen percent is owned by the USFS and roughly twelve percent is on the Umatilla Indian Reservation. Agricultural and rangelands comprise over eighty percent of the land area, fifteen percent of land area is forested and three percent is urban. The entire Umatilla River mainstem and mid- and upper-basin tributaries are on the 303(d) list for temperature incursions. The Umatilla supports spring Chinook, summer Steelhead, fall Chinook and Coho salmonids (Oregon Department of Environmental Quality, Umatilla Basin Watershed Council & Confederated Tribes of the Umatilla Indian Reservation, 2001).

Upper Chehalis River Basin, Washington

The Chehalis River Basin in western Washington is broken into two subbasins: Upper Chehalis River Basin and Lower Chehalis River Basin. Washington Ecology created separate TMDLs for the two subbasins, but one water quality management plan for both. This research focuses on the 1,293 square-mile Upper Chehalis River Basin. Forest lands constitute about 77 percent of the Upper Basin area, most of the forest land is owned by private corporations. Urban and agricultural uses comprise only 11 percent of total basin area, but are concentrated near the river which magnifies their relative effects on water quality. Nineteen stream segments in the Upper Basin on are the 303(d) for temperature criteria violations. The basin supports Chinook, Coho, Steelhead, Bull Trout and Cutthroat Trout salmonids (Rountry, 2004).

Little Klickitat River Watershed, Washington

The 285 square mile Little Klickitat River Watershed is located in south-central Washington. The watershed is mostly forested with the Yakima Nation being the primary owner of forest lands. The remaining portions of the watershed are owned by the Washington Department of Fish and Wildlife, the USDA Forest Service and private landowners. Eight stream segments in the watershed are on the 303(d) list for temperature criteria exceedences. The watershed supports Chinook and Coho salmonids as well as Steelhead trout, which are listed as the "threatened" under the Endangered Species Act (US Fish and Wildlife Service, 2010) (Anderson, 2005).

Stillaguamish River Watershed, Washington

The 683 square mile Stillaguamish River Watershed is located in northwestern Washington. Approximately 82 percent of the watershed is forested and 52 percent of riparian zones are forested. Two-thirds of the watershed is privately owned and the remaining land belongs to the state and federal government. Agriculture and rural residential are the main land uses along the main stem (principle channel) and major forks of the Stillaguamish River. However, two rapidly growing urban centers increase pressure on watershed hydromorphology. Ten stream segments in the watershed are on the 303(d) list for temperature impairments. The watershed supports North Fork summer Chinook, South Fork fall Chinook, Bull Trout, Coho, Stillaguamish Chum, Steelhead Trout, Sockeye, and sea-run Cutthroat Trout salmonids (Stillaguamish Watershed Implementation Review Committee, 2005).

Teanaway River Basin, Washington

The 207 square mile Teanaway River Basin in central Washington is a major tributary of the Yakima River. The majority of the basin is forested with the Wenatchee National Forest dominating the upper one-third of the watershed. The middle third of the watershed is mainly owned and managed by private timber companies. The lower third of the watershed is agricultural land. Approximately 30 percent of the basin is owned by the state and federal government, while the remaining portion is private or Yakima Nation tribal land. There are eight stream segments on the 303(d) list. Andadromous salmonids include spring-run Chinook and steelhead trout. Resident salmonids include steelhead and cutthroat trout (Washington Department of Ecology, 2009).

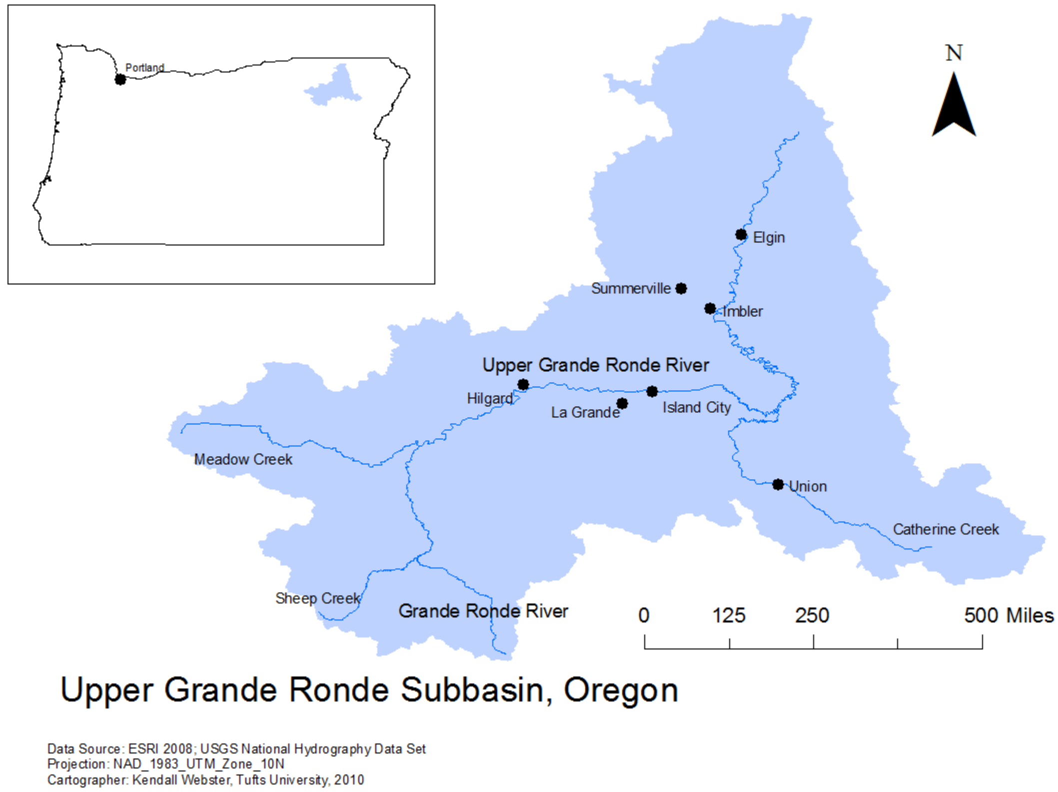
South Fork Clearwater River Subbasin, Idaho

The 1,175 square-mile South Fork Clearwater River Subbasin is located in north-central Idaho. The Nez Perce National Forest occupies approximately 70 percent of the subbasin, 29 percent of the subbasin is privately owned, and 2 percent of the subbasin is owned by the BLM. In 2000, a temperature TMDL was created for six impaired stream segments in the Cottonwood Creek watershed within the South Fork Clearwater River Subbasin. The 2003 temperature TMDL studied for this research addressed twelve additional stream segments on the 303(d) list for temperature. The Subbasin provides habitat to Bull Trout, spring Chinook, Snake River fall Chinook, Steelhead Trout, and Westslope Cutthroat Trout salmonids (South Fork Clearwater River TMDL Implementation Plan, 2006).

Chapter 5. Results

This research focused on temperature TMDLs and implementation plans in the Pacific Northwest where salmonid habitat is threatened by high water temperatures. The goal of this research was to identify the common and unique strategies used for TMDL development and implementation, and the common and unique challenges to TMDL development and implementation. The following section details the findings from the case studies.

Figure 2 Upper Grande Ronde River Subbasin, Oregon



Upper Grande Ronde River Subbasin, Oregon

The TMDL Coordinator for the Upper Grande Ronde Subbasin was retired at the time of this research, no interview was conducted. All information for this case study was gathered from ODEQ, TMDL partner web sites and related publications. Map 2 illustrates the Upper Grande Ronde River, major tributaries to the river, and municipalities within the subbasin.

The Upper Grande Ronde Subbasin Total Maximum Daily Load (TMDL) report and the Upper Grande Ronde Subbasin Water Quality Management Plan (WQMP) were approved in 2000. The TMDL report included TMDLs for temperature, dissolved oxygen and pH, sedimentation, bacteria, ammonia toxicity, habitat modification, and flow modification. The WQMP included strategies for managing temperature, dissolved oxygen, pH, nutrients and algae. Temperature impairments in the thirty-eight 303(d) listed stream segments in the subbasin were caused by stream channelization, riparian vegetation disturbance, reduced summertime saturated riparian soils, and reduced summertime base flows. There were 5 NPDES permitted facilities in the subbasin: the City of La Grande WWTP, the City of Union WWTP, the City of Elgin WWTP, the Boise Cascade particle board plant, and the Island City particle board plant. The cities of La Grande and Union WWTPs and the Boise Cascade particle board plant were considered to contribute significantly to nutrient and temperature impairments (Oregon Department of Environmental Quality, 2010). As of 2003, these facilities no longer discharged into the River. The City of La Grande partnered with the US Fish and Wildlife Service (USFWS) to construct several hundred miles of wetland to receive treated effluent from the La Grande WWTP; treated effluent from the Union WWTP was diverted to the Buffalo Peak Golf course for irrigation; and Boise Cascade installed a constructed wetland to receive discharge from the particle board plant (Diebel, Wolgamott & Boehne, 2003).

The US Forest Service (USFS) owned 46 percent of land area within the watershed (Oregon Department of Environmental Quality, 2010). Much of this land was on the Grande Ronde River main stem and its upper tributaries. In order to improve water quality on its land, the USFS protected nearly all riparian zones, changed grazing allotments to reduce water quality degradation caused by livestock, and implemented many miles of in-stream projects to improve habitat. Water quality problems linked with roads prompted the USFS to decommission over 1,000 miles of roads in the watershed by 2003 (Diebel, Wolgamott & Boehne, 2003).

There were many nonpoint source programs in the Upper Grande Ronde. Most notable was the Grande Ronde Model Watershed (GRMW) program created by the Bonneville Power Administration's Northwest Power and Conservation Council in 1992. This project was intended to "serve as an example for the establishment of watershed management partnerships among local residents, state and federal agency staffs, and public interest groups concerned with the management of a particular watershed" (Grande Ronde Model Watershed, 2006, para. 4). As such, the GRMW was the main TMDL partner responsible for coordinating habitat restoration on public and private lands within the entire Grande Ronde Basin. As of 2006, GRMW implemented 335 projects including 254 miles of stream channel and streambank restoration, 332 miles of fencing, 3328 acres of upland habitat treatment, and 23 irrigation diversion improvements (Grande Ronde Model Watershed, 2006). In addition to restoration activities, the GRMW maintained a data base to track all restoration activities in the Basin with information regarding project leaders, cost, location, monitoring, and completion status. GRMW mapped this tabular data base in Geographic Information Systems (GIS) software to show implementation activities spatially. The GRMW also maintained a spatial data base of water quality monitoring data from US Forest Service (USFS), US Bureau of Reclamation, ODEQ, Oregon Department of Fish and Wildlife (ODFW), Oregon Water Resources Department (OWRD), US Geological Survey, Nez Perce Tribe, and Union and Wallowa Soil and Water Conservation Districts (Grande Ronde Model Watershed, 2006). Most GRMW meetings were open to the public to encourage participation of local residents and other stakeholders.

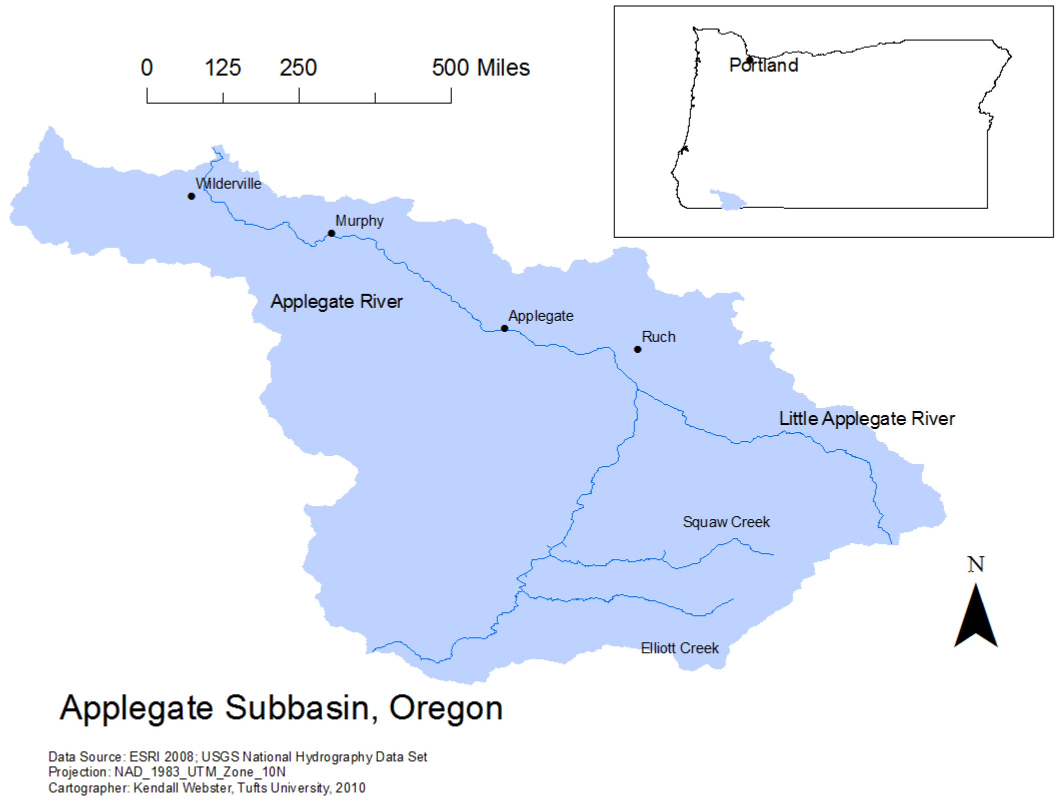
The Confederated Tribes of the Umatilla Indian Reservation (CTUIR) was identified in the TMDL as the responsible entity for TMDL project implementation. CTUIR monitored water quality and collected fisheries data in the subbasin. Through its Geographic Information Systems Program, CTUIR used this data to predict habitat conditions in order to guide restoration efforts (Confederated Tribes of Umatilla Indian Reservation, 2010).

The entire Grande Ronde Basin received funding from multiple sources, including the US Department of Agriculture (USDA) through its Conservation Reserve Enhancement Program (CREP), NOAA Fisheries Restoration Center, US Fish and Wildlife Service Natural Resource Assistance Grants, and the Environmental Finance Network Center. On an annual basis the Basin received an average of $6.2 million from the Bonneville Power Administration for funding GRMW projects and $2.6 million from the Oregon Watershed Enhancement Board (OWEB).

Management Challenges

No interview was conducted for this case study. Instead, management challenges were identified through a conference paper coauthored by the former TMDL Coordinator, Mitch Wolgamott. This paper acknowledged that there was much restoration activity in the watershed, but that some obstacles to obtaining TMDL goals remained. Because riparian planting on private lands was voluntary, the success of riparian planting efforts depended on the degree to which landowners cared for riparian plants (Diebel, Wolgamott & Boehne, 2003). One way in which GRMW combated this issue was through project implementation and effectiveness monitoring (Grande Ronde Model Watershed, 2006). However, other TMDL partners such as the CREP lacked similar project monitoring programs so there was no way to understand whether replanted riparian zones were maintained and allowed to mature.

Figure 3 Applegate River Subbasin, Oregon



Applegate River Subbasin, Oregon

Interview: Jack Shipley, Board Chair, Applegate Partnership and Watershed Council. A phone interview was conducted on July 14, 2010. Map 3 illustrates the Applegate River, major tributaries to the river, and municipalities within the subbasin.

The Applegate Subbasin Total Maximum Daily Load and The Applegate Subbasin Water Quality Management Plan were approved in 2004. No NPDES permitted facilities were permitted to discharge into the Applegate River or its tributaries during the critical summer high temperature period; thus, no WLAs were given to point source dischargers. Temperature impairments in the sixteen 303(d) listed segments of the Applegate River and tributaries were caused by riparian vegetation disturbance, channel modifications and widening, water withdrawals, natural sources, and the Applegate Dam.

The four-mile Applegate Dam, owned and operated by US Army Corps of Engineers (US ACE), was constructed in 1980 to provide irrigation, flood control, recreation and water quality control benefits (Oregon Department of Environmental Quality, 2007). Water releases for stream temperature and flow regulation were determined through a partnership between US ACE and Oregon Department of Fish Wildlife (ODFW) to ensure optimal habitat conditions for native salmonids. The 2004 TMDL reported that the operation of Applegate Dam lowered temperatures during the spring and summer, but increased temperatures during the fall and winter (Oregon Department of Environmental Quality, 2003). This temperature increase negatively affected fall Chinook survival (Oregon Department of Environmental Quality, 2003). In the TMDL, ODEQ provided temperature load allocations for the dam represented by the magnitude of water release flows from the dam, and requested that US ACE and ODFW work with ODEQ to submit a formal temperature management plan. This plan was submitted by US ACE in January of 2009. According the a US ACE water quality specialist interviewed for this case study on July 28, 2010, US ACE worked very closely with ODFW to meet temperature targets set by ODFW. This individual reported that were it not for the flows released from the dam during the critical summer season, temperature impairments in the Applegate River would be much worse than the impairments caused by the dam itself. The debate regarding the impact of the dam on water quality continued, with US ACE agreeing to meet state water quality standards but recommending that ODEQ remove the Applegate River from the 303(d) list.

Seventy percent of the subbasin was owned by the USFS and the Bureau of Land Management (BLM). These TMDL partners collected water quality data and implemented restoration projects on their land. BLM maintained a publically available GIS data base with implementation projects completed by the BLM and the USFS. Additionally, BLM completed annual program summaries and monitoring reports for each of its regions which it submitted to ODEQ.

In 1998, a group of nonfederal landowners, state and federal agencies, and local, county and municipal representatives called the Project Integration Team (PIT) created the Little Applegate River Watershed Management Plan. This plan, launched by the Oregon Governor's Office and other state and federal agencies, targeted the 32 percent of the subbasin that was privately owned, and was intended to satisfy the requirements of the Clean Water Act (CWA) as well as the Endangered Species Act (ESA). The plan broke the subbasin into smaller watershed planning units, and for each unit included "1) a water quality and habitat characterization of each watershed; 2) an examination of water quality and habitat characteristics that [provided] measures of stream conditions; 3) a comparison of current conditions with CWA standards and ESA desired conditions for stream habitat in the future; 4) an identification of environmental and management factors contributing to the current conditions; and 5) common objectives for attaining water quality standards and reaching desired future conditions" (Oregon Department of Environmental Quality, 2003, pg. 22). ODEQ determined that the tools provided by the plan would sufficiently meet the TMDL implementation requirements and, with these tools, land managers could meet the provisions of the ESA and the CWA (Oregon Department of Environmental Quality, 2003). ODEQ determined that the existence of the Little Applegate River Watershed Plan provided reasonable assurance that implementation targets would be met on private land. However, ODEQ did not provide an explanation or schedule for implementation of this plan.

The Applegate Partnership and Watershed Council (Applegate Partnership) was formed in 1992 by Board Chair Jack Shipley. The Applegate Partnership began a water quality monitoring program and conducted water quality assessments for all of the sub-watersheds in the subbasin. Shipley reported that these data were not "collated into a unified piece" (Jack Shipley, personal correspondence, July 14, 2010). The Partnership wanted to begin a water quality data archive with the University of Oregon, but they could not raise the $1 million required to do so. Thus, there was no schedule for review of water quality data. With grants from ODEQ and OWEB, the Partnership also organized fish passage improvement, aquatic habitat restoration, road rehabilitation, floodplain enhancement and protection, re-vegetation of native riparian and upland plant communities, and agricultural BMP projects (Rogue Basin Watersheds, 2008). Shipley reported that despite the lack of TMDL reviews or collaborative data evaluation, having the TMDL “raised our awareness and provided good guidance” (Jack Shipley, personal correspondence, July 14, 2010).

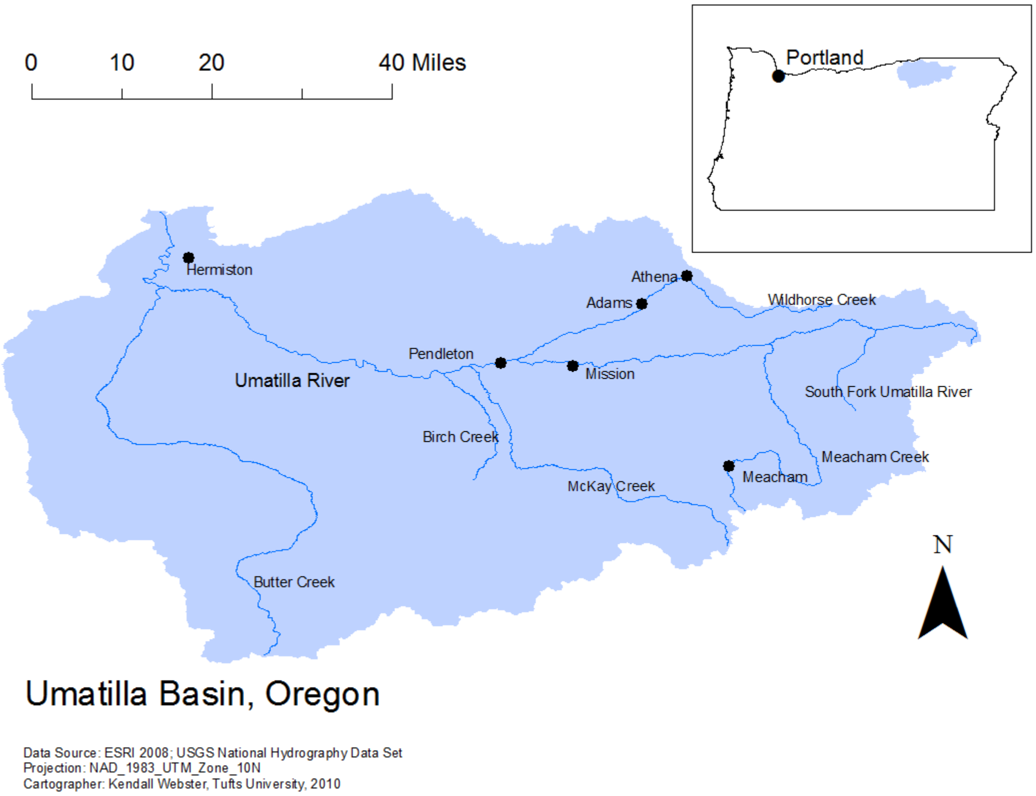
Management Challenges

Shipley reported that one of the biggest challenges for his organization was raising funds to implement restoration projects. The operating budget of the Partnership was reduced from $1.5 million to $500 thousand between 2005 and 2010. The Partnership used to employ specialists to assist with program development, but now all the funding the Partnership received was put directly into projects. The lack of funding meant that the Partnership, which was the most likely candidate for tracking water quality and implementation data, no longer planned to maintain these data for watershed planning purposes.

In December of 2009, the Federal Regulatory Commission issued a license to a Utah-based utility company, Symbiotics, to attach a 10 megawatt hydropower generating facility to the Applegate Dam (Freeman, 2009). ODEQ found that construction of the hydroelectric project could potentially impact temperatures, dissolved oxygen, sediment and turbidity (Oregon Department of Environmental Quality, 2007). These issues were not resolved at the time of this research.

Thus far, ODEQ had not conducted a five year TMDL review with the TMDL DMAs and partners. Thus, in the seven years since the TMDL was written, the aggregate water quality data and implementation efforts of these entities were not evaluated. The absence of a formal review of water quality data and implementation projects may indicate that management decisions were not guided by a complete understanding of the current subbasin conditions and that resources were not being used efficiently.

Figure 4 Umatilla River Basin, Oregon



Umatilla River Basin, Oregon

Interview: Don Butcher, TMDL Coordinator, Oregon Department of Environmental Quality. A phone interview was conducted on June 17, 2010. Map 4 illustrates the Umatilla River, major tributaries to the river, and municipalities within the basin.

The Umatilla River Basin Total Maximum Daily Load and Water Quality Management Plan was approved in 2001 as one document. Riparian degradation, channel morphology and hydrology were found to be the main sources of temperature impairment for the 287 miles of Umatilla River and tributaries on the

303(d) list. There were five NPDES permitted facilities in the basin. Two of these facilities, the City of Pendleton and the City of Hermiston WWTPs, were allowed to discharge during summer months and received WLAs in the TMDL. The WLAs required the Pendleton and Hermiston WWTPs to reduce discharge temperatures by roughly four degrees Fahrenheit during the months of July and August.

TMDL coordinator, Don Butcher, reported that in 2001, the Umatilla Basin TMDL was the only TMDL in Oregon developed through a community led process. Butcher's predecessor, Bruce Hammon, approached various stakeholder groups and offered them the opportunity to help develop the TMDL. Citizen and Technical Advisory Committees were formed, sponsored by ODEQ, the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), and the Umatilla River Watershed Council. The Advisory Committees "ultimately had veto power over every decision made" during TMDL development (Don Butcher, personal correspondence, June 17, 2010). There were 150 individuals involved in the process, which took five years. Thus, the TMDL was supported by local residents, organizations, and agencies; these entities continued to conduct monitoring after the TMDL was completed. However, ODEQ did not replicate this community-led TMDL development process in other basins due to the resource intensive nature of the process.

According to Butcher, the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) was "one of the best partners in the basin" in terms of scientific knowledge, restoration capacity, and interest in water quality restoration (Don Butcher, personal communication, June 17, 2010). While the Umatilla River Basin TMDL did not apply to the Umatilla Reservation, CTUIR actively reinforced the TMDL process with TMDL methodology development, staff, guidance, and monitoring (Oregon Department of Environmental Quality, 2001). Through its Umatilla Basin Project, the CTUIR Department of Natural Resources focused on Spring Chinook habitat restoration, working to plant riparian areas and making in-stream habitat improvements on the Umatilla River and six of its tributaries (Confederated Tribes of Umatilla Indian Reservation, 2005). In an effort to restore flows diminished by irrigation withdrawals, CTUIR partnered with the US Bureau of Reclamation, US ACE, Irrigation District, ODFW, and others to implement the Umatilla Water Exchange Project, which delivered water from the Columbia River to participating irrigation districts. This "bucket for bucket" exchange transferred water from the Columbia River rather than withdrawing it from the Umatilla; this water was then returned to the Columbia River via the Umatilla River after it was used (Confederated Tribes of Umatilla Indian Reservation, 2005). CTUIR also monitored water quality in the basin and tracked these data in a GIS program (See Grande Ronde Case Study). CTUIR received funding through partnerships with the watershed council and others entities.

The Umatilla Basin Watershed Council assisted with developing the TMDL and WQMP. The Council also helped fund restoration projects in the basin through grants from OWEB, helped to create a plan to distribute BPA funding of local projects, conducted water quality monitoring, and education and awareness events in the watershed (Umatilla County, 2010).

The USFS managed 13 percent of the Basin including the Umatilla National Forest. The USFS conducted water quality monitoring, habitat restoration, and road maintenance on its land.

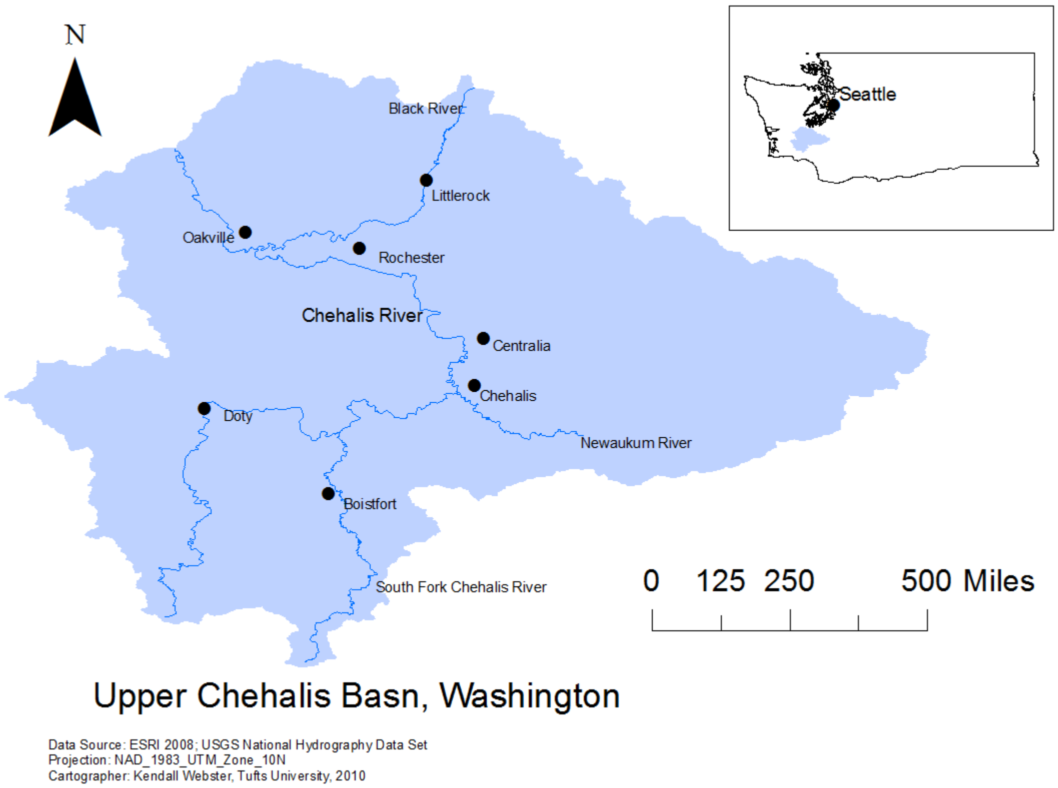
Management Challenges

Butcher identified several management challenges in implementing the Umatilla River TMDL. Eighty percent of the Basin was used for agricultural production; Butcher reported that while Oregon Department of Agriculture (ODA) wrote a specific implementation plan for management of agricultural nonpoint sources, much more work was needed to implement and track agricultural BMPs. The ODEQ TMDL program did not grant ODEQ direct authority to require implementation of agricultural implementation plans; in the Umatilla Watershed, ODA's plan was largely voluntary. Additionally, ODEQ lacked oversight paths for TMDL implementation. Butcher expressed that there was an "absence of a clear line of authority in the [implementation] process" and that there were "big questions as to whether the TMDL [was] destined to sit on the shelf or not" (Don Butcher, personal correspondence, June 17, 2010).

Various parameters were monitored throughout the basin to track the progress of TMDL implementation. At the time of this thesis, long-term monitoring plan was under development, and the Umatilla Watershed Council was working on hiring an analyst who would evaluate and compile data. While there was adequate information on baseline conditions and pollution causes, Butcher reported that he hoped the next version of the Umatilla monitoring plan will include provisions for remote sensing data collection. He added, “more focus on effectiveness, BMPs, landscape change and analysis would enable better understanding of management options, risks, and opportunities and give a stronger voice to natural resource protection and recovery” (Don Butcher, personal correspondence, June 17, 2010). However, ODEQ had not developed a protocol for developing this type of tracking system, and Butcher and his colleagues will have to start from scratch creating a new management model.

Despite the work of ODEQ and TMDL partners in the watershed, Butcher concluded that one of the biggest threats to water quality was “on-going impediments to BMP adoption, due to economics and traditional land use views; and perhaps climate change as well” (Don Butcher, personal correspondence, June 17, 2010).

Figure 5 Upper Chehalis River Basin, Washington



Upper Chehalis River Basin, Washington

Interview: Dave Rountry, Water Cleanup Lead, Washington Department of Ecology Southwest Region. A phone interview was conducted on June 3, 2010. Map 5 illustrates the Chehalis River, major tributaries to the river, and municipalities within the basin.

The Chehalis River Basin/Grays Harbor temperature TMDL and Implementation Plan was completed and approved in 2004 as a single document that included TMDLs for dissolved oxygen and fecal coliform bacteria. The results of the temperature data analysis surprised the communities of the Chehalis

Basin by showing much more temperature impairment than previously anticipated. The most vulnerable stretch[2] of the Chehalis River system occurred in the most populated area where waste water treatment plants were most abundant. As a result, the point source waste load allocations of the WWTPs were stringent: the TMDL prohibited discharges to the river during the critical low-flow and high temperature cycle of the river system. There were eight NPDES-permitted dischargers in the basin, including two WWTPs in the cities of Centralia and Chehalis. In order to comply with the new WLAs, expensive retrofits were necessary. One city built a new plant below the critical reach so it could continue discharging year-round. The other city created a hardwood poplar plantation so it could apply reclaimed wastewater as irrigation during harsh river conditions. However, retrofits were required even without the impetus of the TMDL since pre-TMDL discharges too frequently violated permit conditions.

The revelation that the TMDL, as well as the waste water treatment plant discharge permits, called for retrofits generated conflict during the early stages of the TMDL development. One outcome of this early disagreement between Washington Ecology and the municipalities was that Washington Ecology was forced to perfect the language and requirements of the TMDL which may have sped implementation during later stages.

The TMDL found that along with inadequate in-stream flows caused by water withdrawals and channel morphology, degraded riparian conditions were

[2] In this reach, the Chehalis River was wider and shallower, and had the lowest flows and highest temperatures of the entire river.

the main cause of temperature impairment in the basin. After retrofitting the WWTPs, remedying these nonpoint sources was the main focus of temperature remediation efforts. One of the reasons for the stringent WWTP WLAs was that Washington Ecology did not consider it practical to expect the nonpoint remedies to succeed alone in bringing the river into compliance with water quality standards.

While no centralized data base existed for water quality data and implementation activities, two partner meetings were held at Washington Ecology to discuss the various implementation projects accomplished by TMDL partners. The TMDL partners present at the most recent meeting in 2009 included representatives from local Conservation Districts, USDA, two land trusts, the Chehalis Basin Partnership, the municipalities, US Department of Energy (USDOE), the Confederated Tribes of Chehalis Reservation, local colleges, including Grays Harbor College, and the Chehalis Basin Education Consortium. During this meeting partners discussed their accomplishments which were entered into the Chehalis TMDL Progress Table (Chehalis Basin Partnership and Washington Department of Ecology Implementation Workshop, 2009). Most of the reported remediation efforts involved riparian planting, education and stormwater management. The two land trusts in the subbasin reported that over 20,000 acres of land had been or will be placed under conservation easements. These land trusts also conducted water quality monitoring and land use analyses which were unavailable for public review due to anticipated land speculation issues. Grays Harbor College conducted water quality monitoring in 95 locations within the subbasin and reported the findings of their on-going data analysis. In addition to the TMDL partner meetings, water chemistry data were discussed by Washington Ecology and TMDL partners on a monthly basis (Chehalis Basin Partnership and Washington Department of Ecology Implementation Workshop, 2009).

Detailed funding amounts for restoration activities in this watershed were obtained because the TMDL Lead for the Basin submitted a Section 319 Nonpoint Success Story (2009) which was posted on the EPA Water Quality web site. The Success Story focused on management practices for reducing bacteria levels. Spending for bacteria remediation projects was assumed to reflect spending for temperature remediation because most bacteria remediation strategies also reduce temperature and vise versa. Between 1996 and 2008, TMDL partners received roughly $96 million from Washington Ecology for water quality restoration projects. Of that amount, point source (facility reconstruction) projects received $91.5 million, and nonpoint source activity projects received $4.3 million. According to the Success Story, wastewater treatment plant upgrades also received $75.5 million in state revolving fund loans and $16 million in Washington's Centennial Clean Water Fund grants. Section 319 grants, Centennial Clean Water Fund grants, Aquatic Lands Enhancement Account grants and additional funding from other TMDL partners supplied monetary support for nonpoint source remediation projects. The agriculture BMPs implemented to reduce bacteria included riparian planting and cattle fencing projects on tribal land, public land and private land (US EPA, 2009).

The water quality improvement projects that took place in the Chehalis Basin were not always considered to be driven by the management objectives of the TMDL. The TMDL project development and implementation occurred coincidentally within a separate dedicated Watershed Planning Unit (WPU) effort. The WPU of about 25 local government, business and citizen partners conveniently served as the central workgroup for the TMDL. The integration of TMDL water quality and water supply work provided efficiency, effectiveness, and convenience for both groups.

The TMDL Lead for this Basin reported that Washington Ecology purposefully stepped away from project implementation allowing the WPU community and TMDL partners to take the lead. This strategy may have been used to avoid new resistance from local governments who objected to the TMDL in its early developmental stages. Either way, community-driven restoration initiatives were encouraged in the basin. Washington Ecology's primary function was to communicate water quality issues and priorities, facilitate bottom-up decisions and actions by TMDL partners, and to channel state and federal funding for local use. This bottom-up approach in which partners are responsible for implementation is considered to be beneficial (Benham, 2006). However, this strategy could create problems if remediation efforts and water quality information are not coordinated. As reported by the Washington Ecology Chehalis Basin TMDL Lead, Dave Rountry, "the critical link is the network of people and information" (Dave Rountry, personal correspondence, June 3, 2010).

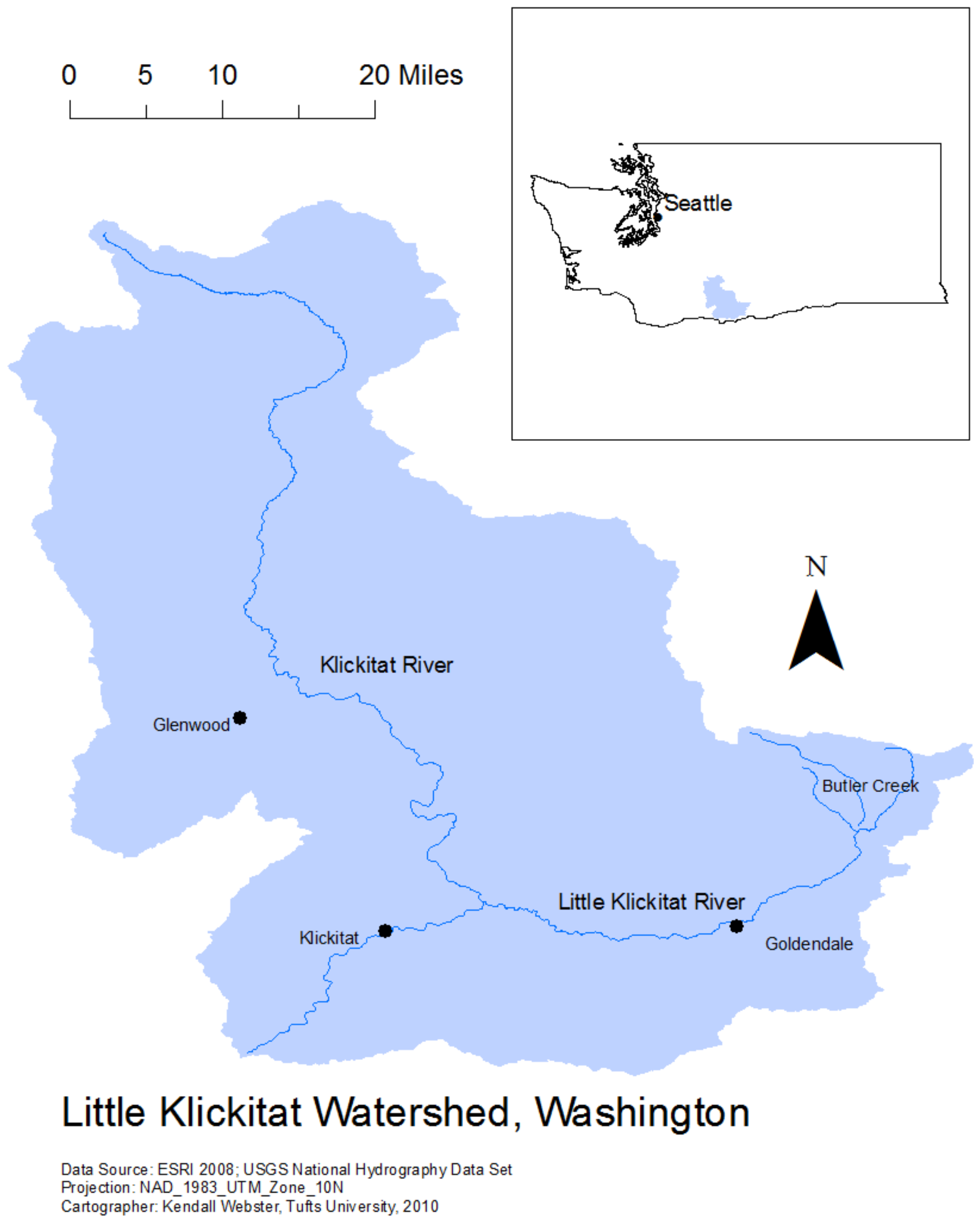
Management Challenges

Washington Ecology and TMDL partners made a clear effort to evaluate monitoring data and track restoration implementation projects. Both the Success Story and the 2009 TMDL partner meeting reported that bacteria levels were declining as a result of implementation efforts. Bacteria are a water quality parameter that provides evidence of change through water quality sampling. Because the results of temperature remediation efforts may take 80 years or more to show, progress toward meeting temperature TMDL goals may only be understood by tracking progress toward meeting percent shade targets represented by miles of riparian vegetation planted, or by tracking other implementation efforts that reduce temperature. Because there was no spatial representation of these implementation efforts to compare to baseline conditions, understanding progress toward meeting temperature goals was difficult.

The Upper Chehalis River Basin was prone to storm events and flooding. The Basin experienced three 100-year storms over the past five years which tore out riparian projects, displaced homes and businesses, and may have discouraged land owners from investing in riparian planting on their property. Rountry speculated that unpredictable extreme weather events would become more likely, challenging the efforts of Washington Ecology and TMDL partners (Dave Rountry, personal correspondence, June 3, 2010).

Future development and conversion of agricultural and forest land also posed a threat to water quality in the subbasin. Dikes and levees were already common in the flood-prone landscape; and they became a controversial topic in an escalating flood management policy debate occurring throughout the subbasin. The TMDL Lead forecasted that flood control structures will change as an outcome of the flood debate. Those changes, along with increasing land conversion for residential and commercial use, will cause more changes in the river system. At the time of the interview, the scope of the TMDL did not reach far into land use or flood management planning, and new developers did not necessarily have to honor the goals or restrictions of the TMDL.

Figure 6 Little Klickitat River Watershed, Washington



Little Klickitat River Watershed, Washington

Interview: Ryan Anderson, Watershed Restoration Lead, Water Quality Program, Washington Department of Ecology. Phone interview conducted on June 11,

2010. Map 6 illustrates the Little Klickitat River, major tributaries to the river, and municipalities within the watershed.

The Little Klickitat River Watershed Temperature TMDL was approved in 2003, followed by the Detailed Implementation Plan in 2005. The primary cause of temperature impairment in the watershed was low levels of riparian shade (Anderson, 2003). Other causes included low stream flows, stream geomorphology alterations due to sediment loss, widening of the near stream disturbance zone due to recent flood events, and one NPDES-permitted facility, the city of Goldendale WWTP, which received a reduced WLA in the TMDL (Anderson, 2003). With help from state grants, the plant reduced effluent temperatures, but not enough to meet the WLA. Thus far, the plant has avoided installing cooling towers to reduce discharges, but may be required to after its NPDES permit is renewed in 2013.

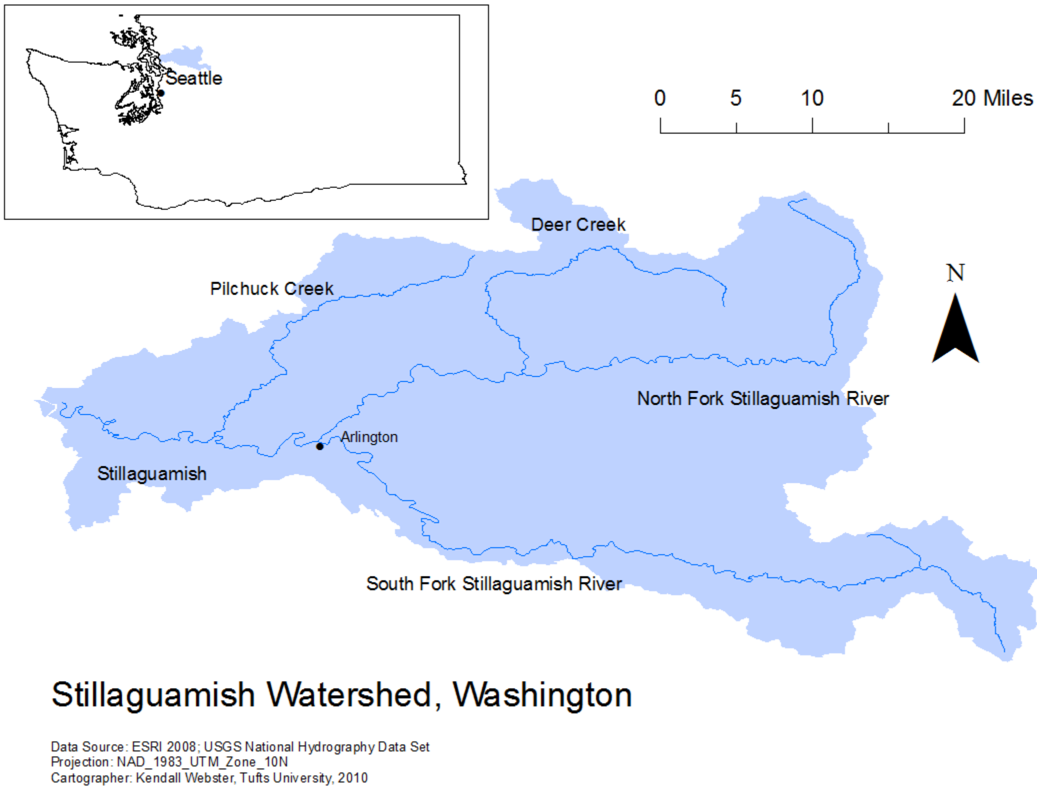
Water quality monitoring and implementation activity data for the Little Klickitat River Watershed TMDL has yet to be reviewed. Two main organizations collected water quality data in the watershed: the Central Klickitat Conservation District (CKCD), which completed a study of its temperature data findings; and the Yakima/Klickitat Fisheries Project, which collected fisheries habitat and abundance data at 36 sites throughout the Klickitat Basin. Between 2006 and 2010, the CKCD received approximately $1 million in grants from Washington Ecology for TMDL implementation. Much of the CKCD's implementation work consisted of stream bank restoration, riparian planting and private landowner assistance. The CKCD also received $371,753 from the NRCD for helping agricultural producers replace inefficient irrigation systems (Central Klickitat Conservation District, 2008). The Yakima/Klickitat Fisheries Project was a joint project between the Yakima Indian Nation and the Washington Department of Fish and Wildlife (WDFW), and was sponsored by the Bonneville Power Administration (BPA). Besides monitoring and managing fisheries in the watershed, the Yakima/Klickitat Fisheries project also conducted educational sessions with local school groups (Yakima/Klickitat Fisheries Project, 2006).

In 2005, Klickitat County published the Klickitat Basin Watershed Management Plan (Plan) which was intended to manage water quality, quantity and aquatic habitat for the entire Klickitat Basin. The Plan updated the data and findings of the Little Klickitat temperature TMDL and used the TMDL as the basis for management decisions in the watershed. Washington Ecology (2005) participated in the development of the Plan and used it as a framework for future decision-making in the Klickitat Basin (Watershed Professionals Network and Aspect Consulting, 2005). Klickitat County was named the lead agency responsible for receiving funding and implementing the Plan. In 2009, Washington Ecology awarded $1 million to Klickitat County for Plan development and implementation (Watershed Professionals Network and Aspect Consulting, 2005).

Management Challenges

Mr. Anderson reported that he believed that the Little Klickitat Watershed TMDL was being implemented successfully despite initial resistance from the municipalities. However, Anderson noted that "there is a lot of monitoring we could do… but we're kind of running out of money" (Ryan Anderson, personal communication, June 11, 2010). A lack of adequate resources forced TMDL leaders to choose implementation over monitoring which may create future dilemmas if it is unclear what has been accomplished and what remains to be accomplished. However, Anderson expressed a positive vision for the future, reporting that temperature data were already lower at some sites and that "if we keep up our pace of implementation, we'll see changes in 10 to 15 years" (Ryan Anderson, personal communication, June 11, 2010).

Figure 7 Stillaguamish River Watershed, Washington



Stillaguamish River Watershed, Washington

Interview: Ralph Svrjcek, Water Cleanup Specialist, Washington Department of Ecology. A phone interview was conducted on June 4, 2010. Map 7 illustrates the Stillaguamish River, major tributaries to the river, and municipalities within the watershed.

The Stillaguamish River Watershed Temperature Total Maximum Daily Load Study (TMDL) was completed in 2004, followed by the Stillaguamish River Watershed Total Maximum Daily Load Water Quality Improvement Report Implementation Strategy in 2006. The TMDL found riparian vegetation disturbance, channel widening and reduced summertime base flows to be the primary drivers of temperature impairment in the twelve 303(d) listed segments in the Stillaguamish River Watershed. There were two NPDES-permitted facilities in the watershed, the Arlington Wastewater Treatment Plant and the Indian Ridge Corrections Facility Wastewater Treatment Plant (Lawrence, 2006). The City of Arlington planned to upgrade the Arlington WWTP so that discharge flows would be diverted to a constructed wetland during low river flow periods in the summer (Chin, 2008). The second WWTP at the Indian Ridge Corrections Facility was closed at the time of the TMDL. Should the facility reopen, it will receive a waste load allocation to maintain compliance with the TMDL (Lawrence, 2006).

There were many stakeholder groups involved with monitoring and implementation in the Stillaguamish Watershed. According to Ralph Svrjcek, Washington Ecology's Stillaguamish TMDL Lead, some of these groups logged monitoring information in GIS data bases. The Snohomish County Conservation District (SCD) was among the most active TMDL partners in the watershed. The SCD provided technical assistance for water quality management to public and private landowners, monitored water quality, and implemented restoration programs. Snohomish County was also an important watershed stakeholder, providing support to the Stillaguamish River Clean Water District Advisory Board, a citizen committee which reviewed funding and work plans, and recommendations to TMDL partners. The SCD undertook a unique campaign involving surveys and focus groups to understand the community's knowledge of water quality issues in the watershed. Svrjcek reported that the SCD's future education and outreach campaigns will incorporate social marketing strategies based on the findings of SCD's research.

Other active TMDL partners included the Stillaguamish-Snohomish Fisheries Enhancement Task Force, the Stillaguamish Tribe, the City of Arlington, and the Stillaguamish Implementation Review Committee. The nonprofit organization, Stillaguamish-Snohomish Fisheries Enhancement Task Force, administered education programs, monitoring, and habitat restoration in the watershed (Stillaguamish-Snohomish Fisheries Enhancement Task Force, 2010). The Stillaguamish Tribe administered riparian and wetlands restoration projects to restore Stillaguamish Chinook salmon habitat and conducted monitoring (Stillaguamish Tribe of Indians Natural Resources Department, 2010). The City of Arlington became a Tree City in 2003. Tree City USA is a National Arbor Day Foundation program which requires that member cities develop comprehensive urban/community forestry programs. As a Tree City, Arlington spent $2.00 per capita on trees, which it then planted and cared for (City of Arlington Parks and Recreation, 2010).

Grant amounts provided through Washington Ecology from the Washington State Centennial Grant Program (the CWA Section 319 Grant Program) and the Clean Water State Revolving Fund Program were obtained from published grant offer lists on the Washington Ecology web site. Between 2005 and 2009, the SCD received $1.07 million for watershed restoration and other TMDL implementation projects. Snohomish County received roughly $1.4

million from Washington Ecology for WWTP upgrades and an additional $500,000 for TMDL implementation. The Stillaguamish-Snohomish Fisheries Enhancement Task Force received $245,700 for tributaries restoration. The Stillaguamish Tribe received $665,750 for sediment monitoring and landslide remediation (Washington Department of Ecology, 2010).

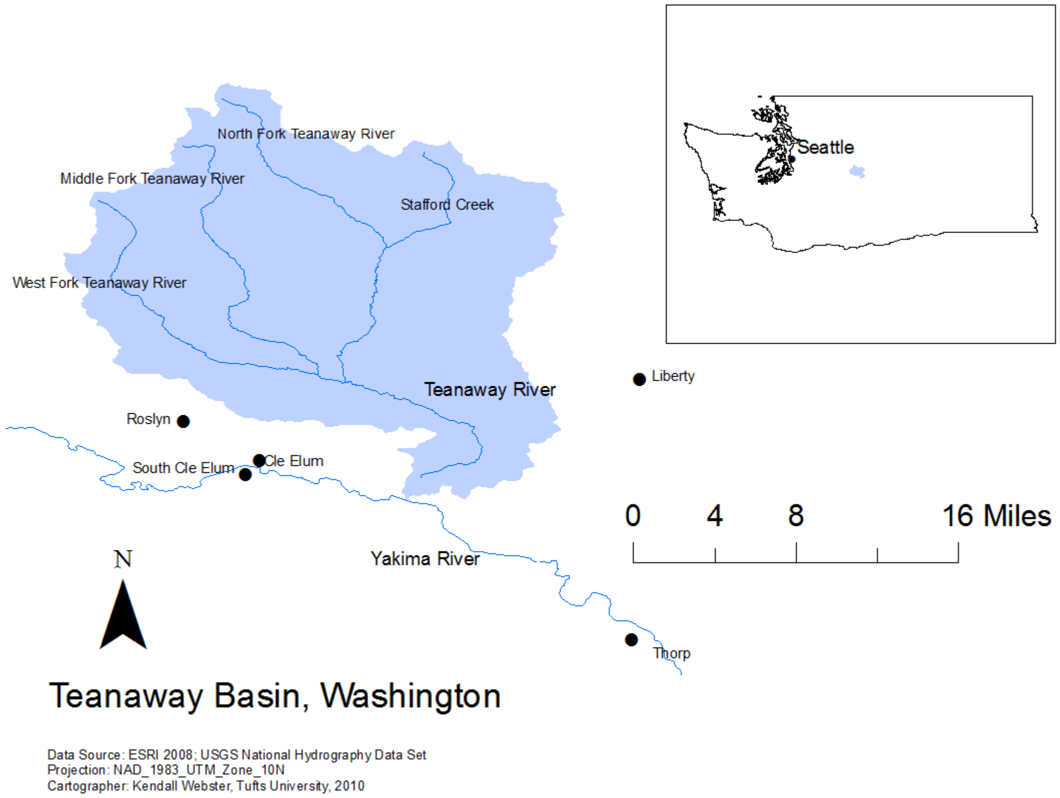
Management Challenges

The Stillaguamish Watershed experienced landslides that occurred as a result of poor logging practices during the early 20th Century. The landslides caused the Stillaguamish River to carry a heavy sediment load, which caused the river to become wider and shallower. While the Stillaguamish Tribe received funding to manage sediment, landslides continued to create management problems in the watershed (Lawrence, 2006).

Svrjcek reported that keeping track of monitoring and implementation data was a shared responsibility of Washington Ecology and the TMDL partners. Svrjcek asserted that river- and tributary-wide riparian plantings were needed, but that it was difficult to target funds for future plantings due to a lack of understanding of what was already accomplished. Some TMDL partners maintained spatial data bases of riparian planting projects and other watershed characteristics, but assimilation of this information from multiple sources did not occur.

Svrjcek also reported that while the TMDL itself did not provide any new regulatory forces, it served to focus stakeholder interests within the watershed. For example, the TMDL called for 100-foot buffers from the Stillaguamish River for private landholdings. Svrjcek and others found this provision to be an unrealistic demand for developed areas where lot sizes were small. However, Svrjcek acknowledged that this provision served as an important guide for TMDL partners developing and managing future projects to improve the watershed (Ralph Svrjcek, personal correspondence, June 4, 2010).

Figure 8 Teanaway River Basin, Washington



Teanaway River Basin, Washington

Interview: Jane Creech, TMDL Lead, Washington Department of Ecology Central Region. A phone interview was conducted on June 2, 2010. Map 8 illustrates the Teanaway River, major tributaries to the river, and municipalities within the basin.

The 207 square mile Teanaway River Watershed lies within the Yakima Subbasin. Additionally, the Teanaway River is a major tributary to the Yakima River. The Teanaway Temperature Total Maximum Daily Load was approved in 2001 followed by the Teanaway Temperature Total Maximum Daily Load

Detailed Implementation Plan in 2003. Temperature impairments in Teanaway's eight 303(d)-listed stream segments were caused by a lack of streamside shade; the increased channel width-to-depth ratio caused by heavy sediment loading during early 20th Century logging activities; streambank instability, which increased sediment deposits; and low summer in-stream flows (Irle, 2001; Creech, 2003). No point source discharges existed in the basin.

There were several TMDL partners active within the watershed. The USFS owned and managed the Wenatchee National Forest which comprised the lower third of the Watershed. In keeping with its 2000 Memorandum of Agreement with Washington Ecology, USFS maintained abandoned and degraded roads in the National Forest. Since 1996, USFS also treated approximately 200 acres of riparian area on the North Fork Teanaway River and Teanaway tributaries through its Respect the River Program (US Forest Service, 2010).

The Kittitas County Conservation District (KCCD) performed monitoring in the watershed and worked with landowners to install BMPs to improve irrigation efficiencies and protect riparian zones. Currently, the KCCD was working on a project in the watershed converting irrigation systems on six private properties to provide enhanced fish passage in improved in-stream flow (Kittitas County Conservation District, 2010). The KCCD initiated its Yakima Tributary Access and Habitat Program (YTAHP) in 2002 in response to the ESA listing of Summer Steelhead trout in the Mid Columbia River. The YTAHP received over $3.3 million from the Bonneville Power Administration, the Salmon Recovery

Funding Board, and other state and regional programs, to improve irrigation efficiencies, correct fish passage barriers, plant the riparian zone, and improve in-stream habitat by installing large woody debris in Yakima River tributaries, which include the Teanaway River (Kittitas County Conservation District, 2008). The KCCD recently obtained a grant on behalf of the Mid Columbia Fisheries Enhancement Group for riparian restoration projects in the Teanaway Watershed and the Yakima River Basin.

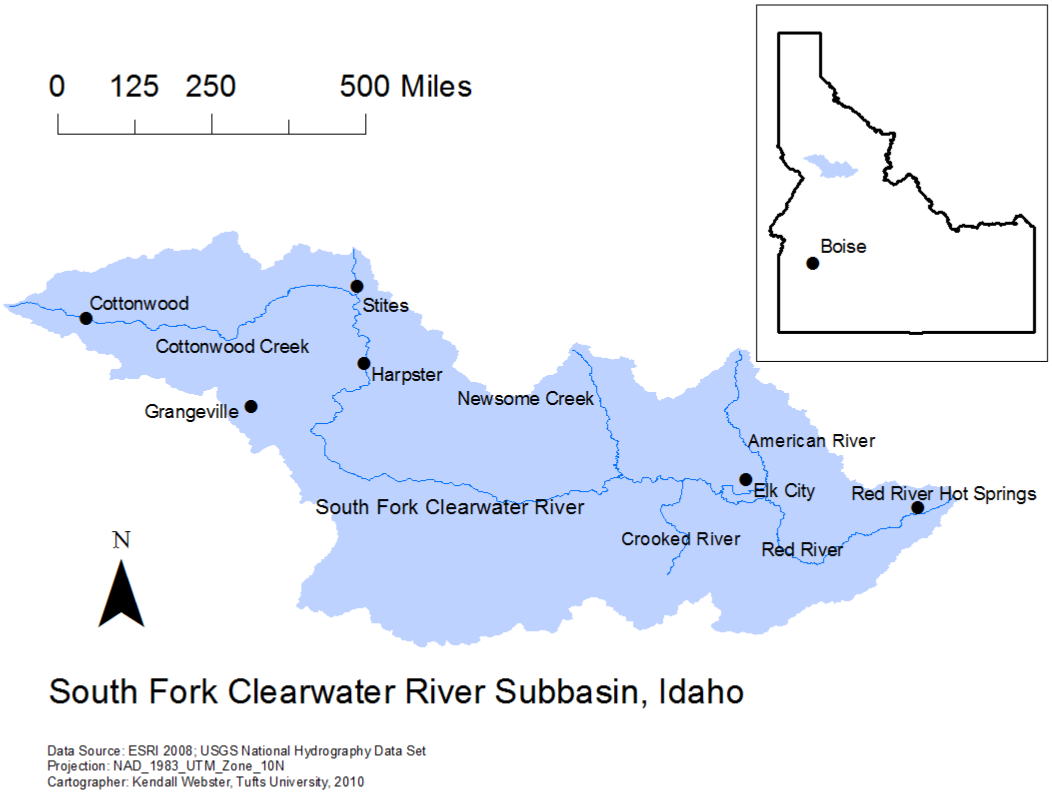
According to Jane Creech, Washington Ecology TMDL Lead, the Yakama Indian Nation employed fish biologists to monitor and analyze water quality and salmonid habitat in the Yakima Subbasin. The Yakama Nation also conducted riparian planting projects.

Creech remarked that the two to four million dollars of federal funding received by the Teanaway Watershed was considerable given the small scale of the watershed (Jane Creech, personal correspondence, April 30, 2010). The Yakima Subbasin received an average of $13.7 million in funding from the Bonneville Power Administration, some portion of which was applied to projects in the Teanaway. Through YTAHP, the Teanaway Watershed also benefitted from the National Resource Conservation Service, Environmental Quality Incentives Program spending which totaled $426,240 from 2002 to 2008 (Kittitas County Conservation District, 2008).

Management Challenges

According to Creech, Washington Ecology and Teanaway TMDL partners tracked implementation though the number of new riparian sites planted, the amount of water placed into trust, irrigation improvements, road improvements and indicator macroinvertebrates (Jane Creech, personal correspondence, April 30, 2010). Despite good TMDL progress tracking, high stakeholder involvement and the numerous grant sources for TMDL implementation, Creech noted that TMDL targets "may be difficult to meet because of future development" (Jane Creech, June 2, 2010). One-third of the watershed was owned by private timber companies, most notably the American Forest Land Company, which owned the majority of private forest land. During the TMDL development phase, the owner of the American Forest Land Company supported the TMDL and participated in its creation. Since that time, company ownership changed. Creech expressed concern that the company will eventually split up and that forest land will be sold for development. Creech reported that Washington Ecology and other resource agencies will have to be vigilant to ensure that future developments maintain good riparian buffers. Washington Ecology also worked with Kittitas County to incorporate TMDL provisions into deeds on future land transactions (Jane Creech, personal correspondence, June 2, 2010). Creech remarked, however, that the current momentum of conservation and restoration projects in the watershed will likely continue. She pointed to the investment of the Yakama Tribe in fisheries conservation, the capital spending from Mid Columbia Fisheries Enhancement Group and the investment of the USFS in the National Forest, as indication of this continuing trend (Jane Creech, personal correspondence, June 2, 2010).

Figure 9 South Fork Clearwater River Subbasin, Idaho



South Fork Clearwater River Subbasin, Idaho

Interview: John Cardwell, Regional Surface Water Manager, Idaho Department of Environmental Quality, Lewiston Idaho. A phone interview was conducted on June 4, 2010. Map 9 illustrates the South Fork Clearwater River, major tributaries to the river, and municipalities within the subbasin.

The South Fork Clearwater River Subbasin Assessment and TMDLs report was completed in 2003 followed by the South Fork Clearwater River TMDL Implementation Plan in 2006. The nonpoint sources for temperature impairments in the twelve 303(d)-listed segments of the South Fork Clearwater

River and its tributaries were reduced riparian vegetation and increased stream width (Dechert and Woodruff, 2003). There were several point sources in the subbasin including five WWTPs, two industrial facilities and several suction dredge mining operations. Only one of these point sources, the Grangeville WWTP, contributed a significant heat load. The Grangeville WWTP discharged into Threemile Creek, a tributary of the South Fork Clearwater River, and was found to cause water temperature increases in the tributary during the summer and fall (Dechert and Woodruff, 2003). The EPA had primacy in authorizing NPDES permits in Idaho and set the Grangeville WWTP temperature limits to reflect the WLA provided in the TMDL. These limits were met by resistance from the City of Grangeville and the South Fork Clearwater Advisory Group (WAG). IDEQ requested that EPA remove the temperature limits for the WWTP until further research was conducted to verify that salmonid spawning was a designated use in Threemile Creek, and to determine the extent of the temperature impact caused by the WWTP (US EPA Region 10, 2005). This request was approved by the US EPA, through a final temperature limit for the Grangeville WWTP has yet to be issued.

John Cardwell, Regional Surface Water Quality Manager for IDEQ's Lewiston Region, reported that IDEQ relied on authorized DMA's to implement the TMDL while IDEQ served as a facilitator for this process. This subbasin had a relatively large area of 1,175 square miles within the Nez Perce National Forest, occupying 68 percent of the total area of the National Forest (Dechert and Woodruff, 2003). Thus, the USFS was a major Designated Management Agency

(DMA) for this TMDL. The USFS conducted fish habitat monitoring, implementation and effectiveness monitoring, and installed BMPs on National Forest land. However, Cardwell reported that forestry projects were difficult for IDEQ to track and that IDEQ's ability to obtain data specific to TMDL implementation effectiveness from the USFS was cumbersome.

The Nez Perce Tribe (NPT) worked with IDEQ to develop the TMDL and Implementation Plan and continued to be instrumental in securing funding for implementation. In 1984, the NPT entered into a cooperative agreement with the Bonneville Power Administration to use BPA funding for fish habitat improvements (The South Fork Clearwater River Watershed Advisory Group, 2006). The NPT conducted a diversity of restoration projects including in-stream structures, riparian planting, fencing, and restoration of dredge mining. The NPT also worked with the USFS to decommission abandoned roads and install fencing.

Management Challenges

Cardwell reported that IDEQ encountered numerous challenges with implementing this TMDL. He pointed out that the South Fork Clearwater River Subbasin was a sensitive watershed that has been impaired primarily by past land use practices, but when "compared to other watersheds in the state [the South Fork Clearwater River] could be considered pristine," (John Cardwell, personal correspondence, June 4, 2010). Cardwell expressed concern that the Idaho water temperature standards may not have been accurate and that it may have been impossible to meet the water quality temperature standards at every point in every water body in the subbasin. He believed that there were conceptual problems with the Clean Water Act because it does not establish authority over nonpoint source activities on private lands. Additionally, while IDEQ assumes that the DMAs manage their responsibilities, it has no authority over these entities to compel them to do so.

The Idaho State Water Quality Program required TMDLs to be reviewed on a five-year cycle. This review had not occurred at the time of this research. Tracking implementation was problematic for IDEQ due to funding constraints and issues with obtaining and coordinating information from DMAs. The current method for synthesizing water quality data in the subbasin was through shared data presentations between IDEQ and advisory groups followed by discussion. There was no spatial data base for treatment controls implemented, or aggregate water quality data base evaluating treatment, and no formal collaborative adaptive planning process based on the results of a data analysis.

Cardwell reflected on these problems and expressed his belief that TMDLs were “a pie in the sky planning goal” due to the lack of a good framework for implementation of pollutant controls, authority to manage non point sources, and funding (John Cardwell, personal correspondence, June 4, 2010).

Chapter 6. Discussion

The following section provides a summary of the common and unique strategies and challenges of TMDL implementation in the Pacific Northwest watersheds selected as case studies. This summary is followed by a discussion of the policy implications of these findings.

Common Strategies for TMDL Implementation

Table 7 illustrates the common strategies for TMDL implementation and the subbasins that employed these strategies. The subbasins are indicated by their initials.

Table 7 Common Strategies for TMDL Implementation

	UGR	A	U	UC	LK	S	T	SFC*
Large amount of public land	x	x					x	x
Alternative management plan is the primary planning document	x	x			x			
Stakeholder group is the primary management entity	x	x						
Local tribe is the primary management entity			x	x				
Conservation district is the primary managing entity					x	x	x	

* UGR = Upper Grande Ronde, A = Applegate, U = Umatilla, UC = Upper Chahalis, LK = Little Klickitat, S = Stillaguamish, T = Teanaway, SFC = South Fork Clearwater River

In four of the eight case studies, a large percentage of the land is publically owned. In these cases, the government agency that owns the land is responsible for implementing the TMDL restoration goals. The agencies often have their own water quality management plans and requirements for monitoring and restoration. Due to their legal mandates and financial resources, TMDL implementation is more reliable on public land than on private land. In the Upper Grande Ronde Subbasin in Oregon, the USFS owns forty-six percent of the land area. In this case, the USFS works to protect nearly all the riparian zones, obliterates abandoned roads and collects water quality data on its lands. In the Applegate Subbasin in Oregon, seventy percent of the land is owned by the USFS and the BLM, which work together to maintain a combined water quality data base that is available on the BLM web site. Thirty percent of the Teanaway River Basin in Washington is the Wenatchee National Forest, where the USFS maintains riparian zones and abandoned and degraded roads, and monitors water quality. The Nez Perce National Forest occupies sixty-eight percent of the South Fork Clearwater River Basin in Idaho where the USFS implements forestry BMPs and conducts fish habitat and implementation effectiveness monitoring.

In three of the case studies, alternative management plans (documents other than the TMDL implementation plan) are used as the primary planning documents for implementing the TMDL the entire watershed, or some portion of the watershed. The Grande Ronde Subbasin Plan was developed in 2004 by the Grande Ronde Model Watershed program to protect sensitive species and habitats. The plan refers to the load allocations established in the 2000 Upper

Grande Ronde Subbasin TMDL, and provides a subbasin assessment as well as restoration strategies. The Little Applegate River Watershed Plan created in 1998 serves as the primary watershed planning document in the Applegate River Subbasin. This plan was created to meet the requirements of the ESA and CWA simultaneously, and was determined in the 2003 TMDL implementation plan to be "more than adequate to meet the TMDL implementation requirements" (Oregon Department of Environmental Quality, 2003, pg. 22). The Klickitat Basin Watershed Management Plan was created in 2005 by Klickitat County and was intended to manage water quality, quantity and aquatic habitat in the Klickitat Basin. This plan updates the findings of the temperature TMDL and is considered to be the main framework for management decisions in the subbasin.

In two of the case studies, a stakeholder planning group is the main management entity. The Grande Ronde Model Watershed program is the main TMDL partner responsible for coordinating habitat restoration in the Upper Grande Ronde Basin. This planning group was created by the Northwest Power and Conservation Council in 1992 to serve as an example of a management partnership between public and private agencies, industry, and local residents. Annually, several million dollars are funneled from Bonneville Power Administration to the Grande Ronde Model Watershed program to fund their comprehensive monitoring and restoration projects. The Applegate Partnership and Watershed Council is the main implementing agency in the Applegate River Subbasin. This group receives grants from ODEQ and OWEB to conduct restoration projects and implement agricultural BMPs on privately-owned land.

In two of the case studies, local tribes are the primary entity for watershed management. The Chehalis Tribe leads implementation in the Chehalis River Subbasin, coordinates restoration efforts on and off tribal lands, and facilitates coordination between TMDL partners in the subbasin. The Confederated Tribes of the Umatilla Reservation (CTUIR) supported TMDL development with staff, monitoring and guidance in the Umatilla River Basin. CTUIR receives grants from ODEQ and other government agencies for restoration projects, which it often implements through partnerships with other TMDL partners.

In three of the case studies, county conservation districts are the primary entity for watershed management. The Central Klickitat Conservation District (CKCD) collects water quality data and publishes analyses of their findings. The CKCD also receives grants from Washington Ecology and the NRCD to coordinate restoration projects and help agricultural producers with irrigation system replacement. The Snohomish County Conservation District (SCD) in the Stillaguamish River Watershed provides support to the local watershed advisory board, monitors water quality, provides implementation assistance to private landowners, and coordinates restoration efforts. The Kittitas County Conservation District (KCCD) in the Teanaway River Watershed receives millions of dollars to conduct monitoring, help implement agricultural BMPs on private land, replant riparian zones, and help restore habitat.

Unique Strategies for TMDL Implementation

In several watersheds, unique programs and partnerships guide implementation. These methods are typically the result of highly active TMDL partners and involve funding and support from government agencies.

The Grande Ronde Model Watershed (GRMW) program is one of ten Northwest Power and Conservation Council Model Watershed-sponsored programs in the Pacific Northwest. GRMW is a particularly potent watershed council because it receives millions of dollars in funding from Bonneville Power Administration, and is accountable to the Northwest Power and Conservation Council, to whom it submits annual progress reports. The primary focus of the Model Watershed program is to offset the fish kills and habitat loss caused by hydroelectric plants in the Columbia River Basin. Thus, the main focus of the GRMW program is not TMDL implementation, but many of its functions further the water quality goals of the TMDL.

There are two unique aspects of implementation in the Umatilla River Basin. The Umatilla Basin TMDL is the only watershed TMDL in Oregon that was developed as a community led process. ODEQ worked with TMDL partners to involve participation from at least 150 individuals in the watershed. This stakeholder group had ultimate veto power over the provisions of the TMDL and deliberated for five years before completing the TMDL. Because of this intensive stakeholder process, the TMDL was widely accepted and continues to be supported by the community, which cooperates with the implementation projects coordinated by Confederated Tribes of the Umatilla Indian Reservation (CTUIR) and other TMDL partners. CTUIR, which operates the Umatilla Basin Project, is committed to restoring habitat for spring Chinook salmon. The disappearance of spring Chinook in the 1970's was partially attributed to low river flows caused by irrigation withdrawals. In 1988, CTUIR was authorized along with several government agencies to divert water from the Columbia River to the Umatilla River to restore flows in the Umatilla River. This water is ultimately returned to the Columbia River via the Umatilla River. Water transfers of this scale to restore salmonid habitat are uncommon: this particular project was only possible because of the partnership created between CTUIR and its governmental collaborators.

The Yakima Tributary Access and Habitat Program in the Teanaway River Watershed was initiated by the Kittitas County Conservation District in response to the 2002 ESA listing of summer Steelhead in the Mid Columbia River. This project has received over $3.3 million from Bonneville Power Administration and other funders to install habitat restoration projects in the Yakima River and its tributaries. While this project does not apply directly to the Teanaway River TMDL, it furthers the goals of the TMDL and functions as one of the dominant implementation strategies in the Teanaway River Watershed.

Common Challenges to TMDL Implementation

Table 8 summarizes the shared challenges to TMDL implementation, and the subbasins that experienced these challenges.

Table 8 Common Challenges to TMDL Implementation

	UGR	A	U	UC	LK	S	T	SFC*
Authority of TMDL is insufficient	x		x	x				x
Limited funding		x			x			x
Conflicts with waste water treatment plants				x	x			x
No central location for data		x	x	x	x	x	x	x
No TMDL review		x	x		x			x
Natural factors challenge achievement of TMDL goals				x		x		

* UGR = Upper Grande Ronde, A = Applegate, U = Umatilla, UC = Upper Chahalis, LK = Little Klickitat, S = Stillaguamish, T = Teanaway, SFC = South Fork Clearwater

In four of the eight case studies, TMDL coordinators reported that the authority of the TMDL is not strong enough to compel TMDL partners and other stakeholders in the watershed to honor the restrictions set in the TMDL. Several restoration programs including the Conservation Reserve Enhancement Program (CREP) operate in the Upper Grande Ronde Subbasin. Some of these projects, such as the GRMW, voluntarily track implementation. However, CREP does not track implementation of the agricultural BMPs it facilitates and ODEQ does not have authority to require it to report on implementation. In the Upper Chehalis River Basin over 70 percent of the land is owned by private corporations, which can sell the land to developers who may not have to honor the restrictions of the TMDL. In the Umatilla River Basin, 80 percent of the land area is used for agricultural production. While ODA submitted an implementation plan for agriculture, this plan is largely voluntary. The TMDL coordinator in the basin reported that, while remediation on agricultural land was much needed, ODEQ lacked the authority to compel ODA to honor its implementation plan. The TMDL coordinator for the South Fork Clearwater River Subbasin reported that because the Clean Water Act does not establish authority over landowners, IDEQ struggles with implementing the requirements of the TMDL.

In three case studies, TMDL leads reported that limited funding challenged TMDL implementation. In the Applegate Subbasin, the Applegate Partnership reported that budget cuts prevent the creation of a centralized system for tracking monitoring and implementation data. In the Little Klickitat Watershed, implementation monitoring does not occur because resources are limited and TMDL partners view implementation projects as funding priorities. The TMDL lead in the South Fork Clearwater River Subbasin reported that IDEQ has been unable to track restoration due, in part, to funding constraints.

In three case studies, TMDL leads reported that conflicts with wastewater treatment plants (WWTPs) occurred. In the Chehalis River Basin, the findings of the TMDL water quality analysis shocked the local municipalities who were required to reduce WWTP discharges in order to comply with their WLAs. This revelation caused conflict and slowed TMDL development during its initial stages. While the WWTP in the Little Klickitat River Watershed has reduced effluent temperatures, it has not been able to meet its WLAs and may be forced to install expensive cooling towers when its NPDES permit is renewed. In the South Fork Clearwater River Subbasin, several TMDL partners are conducting additional water quality and habitat assessments. Depending on the results, the WWTP may be able to avoid the expensive retrofits, which it is compelled to make in order to meet its current WLA.

In all of the case studies except for the Upper Grand Ronde River Subbasin, the TMDL leads reported that monitoring and implementation data are not collected in a central data base. This is mainly due to limited funding and coordination between the State Department of Environmental Quality and TMDL partners. In five of the case studies, some spatial data is collected. However, the Upper Grande Ronde Subbasin is the only watershed for which these data are compiled in a central data base. The lack of good monitoring and implementation tracking programs is problematic because TMDL leads are unable to gauge progress toward meeting TMDL goals and direct future management activities. In basins where temperature pollution is widespread, the cumulative effect of temperature reduction is important. As the required magnitude of temperature reduction increases, "implementing restoration efforts in more distant reaches of the watershed is more efficient than efforts nearer to the points of monitoring" (Watanabe, Adams & Wu, 2006, p. 629). However, without spatial representation of monitoring and implementation data, strategic planning for restoration projects is difficult.

In four of the case studies a TMDL review has not occurred. This may be due to a lack of funding; there was also some indication that because temperature improvements occur over a long time period, formal TMDL reviews are not useful until ten years after the adoption of the TMDL implementation plan. These case studies included the Applegate River Subbasin, the Little Klickitat River Watershed, the South Fork Clearwater River Subbasin, and the Umatilla River Subbasin. The Chehalis River Subbasin was the only case study for which a TMDL review has occurred. It was unclear whether TMDL reviews occurred in the remaining three case studies.

In two of the case studies, the TMDL leads reported that natural factors made temperature management especially problematic. Temperature impairment in the Chehalis River is the most acute in the widest, shallowest reach, which also happens to be the site of the most populated area of the basin, as well as two WWTPs. The findings of the temperature study caused conflict between TMDL leads and the municipalities, who were required to make expensive changes to the WWTPs. Additionally, the Upper Chehalis River Basin is prone to storm events and flooding which damage riparian projects. Private landowners in that area have become discouraged with implementing restoration projects on their property. The Stillaguamish River Basin experienced particularly intensive logging during the early 20th Century causing topsoil to become unstable. Since that time, landslides have occurred frequently in the basin causing the channel to become shallower and wider, frustrating efforts to decrease water temperature.

Unique Challenges to TMDL Implementation

While most of the challenges encountered by TMDLs were commonly shared, two of the case studies experienced unique obstacles during the TMDL process.

The four mile Applegate Dam on the Applegate River was built in 1980 by the US Army Corps of Engineers (US ACE) to perform various functions including irrigation and fish and wildlife enhancement. The dam is controlled by US ACE which works with Oregon Department of Fish and Wildlife (ODFW) to plan release flows throughout the year. The 2004 TMDL found that, while the dam helps lower temperatures during the summer months, it contributes to elevated temperatures from October through February. Upon request by ODEQ, US ACE submitted a temperature management plan for the dam. However, US ACE holds that the TMDL is unfair in its treatment of the dam and does not credit the dam for lowering overall river temperatures. In this case, ODEQ is challenged by a structural feature that alters the morphology of the Applegate River. Additionally, US ACE is challenged because it is responsible for the dam, which is scrutinized by the TMDL.

Idaho was the only state in this study where the EPA holds primacy for issuing NPDES permits. In the South Fork Clearwater River Subbasin, the City of Grangeville WWTP was found to contribute to temperature impairments and was subject to more stringent limits on its EPA mandated NPDES permit. These limits were contested by the City of Grangeville as well as several state agencies including IDEQ. IDEQ struggles with the federal control over point source permitting which may undermine the local TMDL process.

Chapter 7. Policy Implications and Conclusions

The purpose of this research was to examine temperature TMDLs in the Pacific Northwest in order to determine the common and unique strategies and challenges to TMDL implementation. The findings of this research demonstrated that TMDLs require participation from many different agencies and stakeholder groups; the TMDL is not always the primary water quality planning document in a watershed; the language of the Clean Water Act does not give TMDLs sufficient regulatory enforceability; the line of authority between agencies implementing the TMDL is not clear; and the system for data collection and analysis does not use water quality data to its full potential.

The policy implications of this research should be considered as states transition from TMDL writing to TMDL implementation. One of the most important findings of this research is that the lack of regulatory enforceability of TMDL implementation plans prevents a process of accountability. This problem leads to the issue described above, where one TMDL partner does not share data and communicate results of implementation. Without the authority to demand this information, it is difficult to understand the progress of uncooperative TMDL partners. Strengthening the language of the Clean Water Act to make implementation of TMDLs mandatory to all partner agencies would prevent this problem from occurring. It is possible that universal cooperation could also be achieved through a community-led process, demonstrated in the Umatilla River Basin case study, where TMDL implementation has been successful. However, this approach requires financial resources beyond the means of most departments of environmental quality, and requiring compliance with TMDL implementation would dissuade agencies from avoiding their responsibilities.

The current structure for TMDL implementation is formed upon a loose collaboration of TMDL partners. While amending the Clean Water Act to strengthen the regulatory authority of the TMDL implementation plan may not be immediately achievable, establishing a more concrete line of authority between TMDL partners would clarify their roles and responsibilities. The line of authority may be established after the TMDL is written, but before implementation occurs. Perhaps the next best solution to a community-led TMDL process would be to convene TMDL partners prior to implementation to create an agreement on the specific roles and responsibilities of each entity. During this period, TMDL partners could also establish a schedule for reporting implementation efforts and water quality data, as well as a method for communicating this information to the public.

Another problem related to the lack of enforceability of the implementation plan is the absence of a formalized procedure for data collection and analysis. The majority of the case studies reported that water quality and implementation data are not collected in a centralized location. It is likely that the effectiveness of restoration efforts would improve with a better understanding of water quality and habitat conditions. Without this feedback, restoration activities fall short of their potential. Additionally, data should be complied in a spatial data base, such as Geographic Information Systems (GIS), in order to increase understanding of land use and restoration activities on water quality. In the Umatilla River Basin, TMDL leads are already moving ahead with the development of a GIS water quality data base with over 15 parameters including riparian vegetation (from GIS orthoimagery), temperature and restoration activities. Ideally, this effort will become a trend for directing future TMDL implementation. Recently, the Obama administration has announced a push for data sharing and reporting among government agencies, which will require the development of mechanisms for data gathering, evaluation and sharing that will be standardized across agencies (Kamensky, 2010). This effort may be aided by universities and academics on the cutting edge in water quality research and watershed modeling.

While a formal schedule for TMDL review is supposed to occur every five years in most watersheds, five-year TMDL reviews rarely occur. This five-year interval may not be necessary if less formal processes for data review are determined. With a spatial data base, TMDL partners can review the progress of implementation on their own time, and can meet when the group deems necessary.

The TMDLs for this study were selected because they exemplified the best temperature TMDL implementation practices in the region. Even these impressive TMDL efforts showed room for improvement. Overall, the organization of TMDL implementation should be amended in order increase the efficiency of water quality restoration efforts. Recommendations for achieving better organization include strengthening the language of the Clean Water Act so that provisions of the TMDL have regulatory force, clarifying the line of authority between TMDL partners, using centralized spatial data bases for collecting water quality and land use data, and agreeing on a review process that is based on data results.

In the United States, TMDLs are one of the most important tools for safeguarding aquatic habitat and ensuring water quality. While prospects for amending the language of the Clean Water Act are limited, this research shows that there is much that states and TMDL partners can do to improve TMDL implementation and water quality restoration. Indeed, the case studies for this research demonstrated that a lot can be accomplished despite the limitations of the Clean Water Act. The most important strategy for TMDL success in this climate is the collaboration and cooperation of TMDL partners.

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