Corvallis Forest Stewardship Plan

Adopted December 18, 2006

Prepared by

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TROUT MOUNTAIN FORESTRY

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1.Executive Summary

This is a stewardship plan for the 2,352 acre City of Corvallis ownership, which encompasses the lower elevations of the 10,000 acre Rock Creek Watershed on the northeast flanks of Marys Peak. Rock Creek is one of the sub-watersheds of Marys River Watershed, which is in turn one of the many large rural watersheds in the Willamette River Basin. The water that is diverted into City pipes flows not primarily from City-owned lands, but from federal forestland located above the intakes and managed by the Forest Service. City infrastructure includes a 100 million gallon water reservoir, two stream diversion structures and a water treatment facility.

This represents the first comprehensive, multi-resource plan developed in the history of the City's ownership. Historically the City lands had been managed by the US Forest Service under a cooperative agreement. Controversy over the harvest impacts on the Northern Spotted Owl and citizen concern over the negative impacts of clearcutting stopped logging in the City Forest in the late 1980s. In 1993 an attempt was made to resume the timber cutting, but the plan--lacking significant public support and perceived as a timber-focused approach—was not implemented. Given this difficult environmental and political setting, the City operated the water collection and treatment facilities for the next decade, avoiding the issue of future management of the City Forest until the current planning effort.

In 2005, the City began a year-long visioning process with public meetings and with its Watershed Advisory Commission, which resulted in a generally accepted Vision Statement and set of guiding principles for stewardship of City lands within the Rock Creek watershed: "*The City-owned portion of the Rock Creek Municipal Watershed is a professionally managed, healthy ecosystem with diverse forest and productive habitat for all species native to the watershed."*

In 2006, the City hired a consultant team let by Trout Mountain Forestry to assess the current resource conditions and work with the Watershed Commission and citizens to create a stewardship plan. The focus of this effort was to develop a management policy framework that would reflect citizen values and guide future management decisions. Stewardship recommendations focused on a "go slow" risk-averse approach that prioritizes restoration of streams, wildlife habitat and native plant communities. Timber harvest was identified as desirable in some forest stands to restore health and promote wildlife habitat.

Stewardship polices in this plan cover these resources: wildlife habitat, forest health and structure, water quality, fish habitat and stream structure, public access and involvement, native vegetation and invasive species, and planning and monitoring.

Recommended actions include: control of invasive, non-native species; improvement of wildlife habitat by creating snags (tree topping) and selective thinning of overstocked, dense plantations and some middle-aged stands; establishment of an expanded reserve system to more effectively protect streams and other sensitive resources; building a fish ladder and replacing major culverts to improve fish passage; establishing a stream monitoring plan to study water quality issues; allowing non-motorized public access to Old Peak Road (a link in the Corvallis-to-the-sea trail); and annual public tours of the City Forest to promote public involvement.

By promoting forest health and biodiversity and addressing current resource needs, this plan can enhance the protection of municipal water resources and will provide a framework for guiding future stewardship projects.

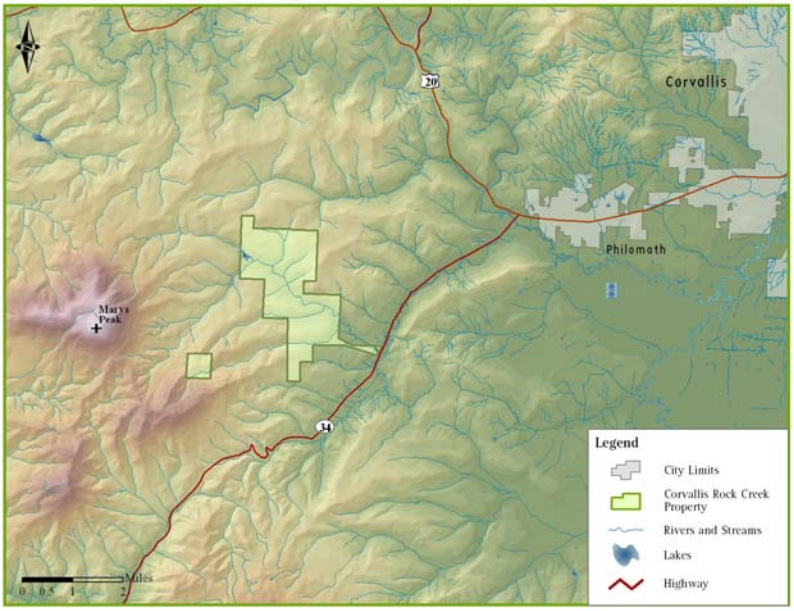
2.Introduction

This chapter describes the vision for the City of Corvallis Forest property, states the purpose of this plan, outlines the planning process used in plan development, and details plan implementation and administration.

Background

The City of Corvallis owns 2,352 acres of forest located on the lower slopes of Marys Peak in western Benton County, Oregon (Figure 1). The major stream flowing through the City's ownership is Rock Creek. The land was acquired by the City in the early decades of the 20th century to protect the Rock Creek Watershed; however, less than 20 percent of the City's land actually lies upstream of the water intake facilities. Although many are accustomed to referring to the City-owned portion of the Rock Creek Watershed as the "Corvallis Watershed," this document will refer to it as the City Forest in recognition of this fact.

Figure 1. *Vicinity map*



The bulk of the Rock Creek Watershed lies in the Siuslaw National Forest, administered by the USDA Forest Service. The Forest Service has designated more than 99% of its lands within the watershed as reserves to be managed for wildlife habitat for riparian and old-growth related species. Approximately one third of the water used by the City of Corvallis comes from the watershed, with the remainder coming from the Willamette River.

Approximately 1,000 acres of the City Forest were harvested during an 80-year period ending in the late 1980s. Then, controversy over the effects of clearcutting and the need to protect old growth for the Northern Spotted Owl and other wildlife species put a stop to the harvesting program, which had been administered by the Forest Service. Several attempts to re-initiate timber management in the subsequent decades have failed due to ongoing citizen concern about environmental impacts.

Vision for the Corvallis Forest

The City Forest constitutes one of the community's most significant ecological, economic and social resources. The City of Corvallis embraces the concept of sustainability, and in 2004 endorsed a policy to use sustainable practices in all aspects of the City's operations. This policy, which is ratified annually, includes a commitment to protect, preserve, enhance, and mitigate damage to the natural environment. This objective -- to plan and manage all City resources in a responsible manner -- leads to the current planning effort for the Corvallis City Forest.

The first year of planning was highlighted by a series of public workshops that helped develop the vision and principles on which this plan is based. With input from these meetings, the Watershed Management Advisory Commission (a standing board that advises the City Council on watershed matters; members listed in Table 1) developed the following Vision Statement:

The City-owned portion of the Rock Creek Municipal Watershed is a professionally managed, healthy ecosystem with a diverse forest and productive habitat for all species native to the watershed.

This vision is further refined in a set of Guiding Principles:

The property is actively managed for multiple sustainable objectives including clean water, productive soils, forest products harvest and recreational opportunities and is:

- A "good neighbor" and integrated into the larger landscape and watershed;
- Comprised of a variety of different ages and types of forest to provide diversity of terrestrial and aquatic habitats;
- Resilient to fire, invasive species, insects and disease;
- Access controlled to minimize risk of fire, water contamination and invasive species introduction;
- Available for limited educational, recreational, and research opportunities;
- Dedicated to supporting high quality water production for the City of Corvallis;
- A generator of revenue that may offset the cost of management, and secondarily to help fund the City of Corvallis water utility system.

With this vision, the City Forest will provide a model for sustainable resource management that will be an inspiration and legacy of stewardship for future citizens. The City's demonstration of stewardship practices will encourage others who strive to become better caretakers of our important natural resources.

Table 1. Watershed Management Advisory Commission members

Member	Affiliation
George Brown	Former Dean, OSU College of Forestry
Jim Fairchild	Neighboring landowner; member, Marys River Watershed Council
Bob Griffiths	Retired Forest Science professor, OSU
David Hamby	Professor,OSU Nuclear Engineering (commission chair)
Frank Morris	Corvallis resident and small woodland owner
Walter Schmidt	Corvallis small business owner
Nicole Strong	OSU Forestry Extension
Gary Springer	(served through April 2006)

Conservation-based management practices will demonstrate that water quality, stream health, wildlife habitat enhancement, and tree harvest can go hand in hand. Protecting the health and diversity of the forest and its ecosystems will be top priorities. This vision sees the City Forest as an important part of the greater landscape, connected to the region by its streams—which provide cool water and important fish habitat for the Marys River basin—and its forests—which provide potentially important habitat for many key wildlife species.

Purpose of the plan

The purpose of this plan is to provide City officials and staff with guidance for the integrated management of the City Forest's resources. Among these resources are species such as the bald eagle, Northern spotted owl, and marbled murrelet, which are listed under the Endangered Species Act. Conservation strategies, habitat improvements, and additional surveys are proposed that will help the City fulfill its legal obligations and stewardship responsibilities under the Endangered Species Act (ESA) and the Oregon Forest Practices Act, administered by the Oregon Department of Forestry (ODF). Accurate resource information and comprehensive management policies are critical to ensure the responsible and long-term stewardship of this extraordinary City property.

Specifically, the Plan serves to:

- Inventory & assess property features, resources, & conditions
- Describe resource management practices to be used
- Provide a comprehensive policy framework to guide future management decisions
- Establish monitoring and evaluation protocols

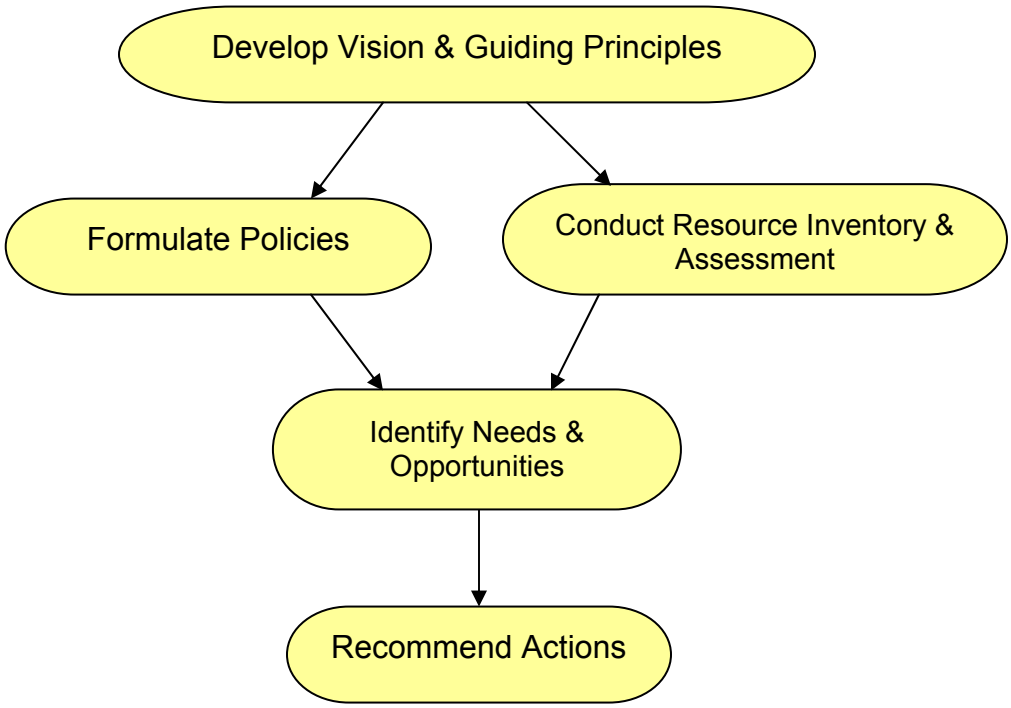
This plan establishes a ***framework*** that will guide management of the City Forest over time. It is not intended to provide an exhaustive inventory of all relevant resources, nor is it intended to provide a highly detailed blueprint for management. Periodic operating plans will provide substantial additional detail relative to proposed activities, and may require additional inventory work.

Many forest planning processes result in a range of alternative approaches that can be implemented. These kinds of plans analyze the relative advantages and disadvantages of each alternative. The current planning effort is different – the City and the consulting team made a conscious decision to develop a single, broadly defined pathway that represents an approach to managing the forest that is most likely to receive broad community support.

Planning Process

The planning process involved five major steps (Figure 2). Resource assessment, policy development, and recommended actions were considered within four general resource areas: stream and fisheries resources, wildlife and vegetation/botanical resources, forest structure/timber resources, and community involvement.

FIGURE 2. *Management Planning Tasks*



A team approach was used for resource inventory/assessment and developing recommended actions. To develop baseline inventories on a wide spectrum of property resources, existing/historic resource inventories were reviewed and new assessments conducted where information was lacking or dated. The plan identifies where additional specific inventories and assessments are needed.

The Planning Team was lead by Scott Ferguson, Mark Miller, and Barry Sims of Trout Mountain Forestry. Team members are listed in Table 2.

Table 2. Planning team, affiliations and roles

Team Member	Affiliation	Project role
Scott Ferguson	Trout Mountain Forestry	Team leader
Mark Miller	Trout Mountain Forestry	Project manager
Barry Sims	Trout Mountain Forestry	Forester
Tom Armstrong	Winterbrook Planning	Planning process, public involvement
Dick Brainerd	Salix Associates	Rare plants, botanical resources
Analisa Gunnell	Ecotrust	Cartography, GIS analysis
Barry Schreiber	Fauna and Flora	Wildlife resources
Steve Trask	Biosurveys	Stream & fisheries resources
Steve Rogers	City of Corvallis	Public Works Director

Public input was solicited throughout the planning process and information on the process was posted on the City website. Public meetings were announced in local newspapers, and direct invitations sent to abutting landowners and interested individuals and organizations. In addition to public workshops and tours, the public was invited to all commission meetings. Although public workshop attendance was light, public comments informed both policies and the final plan draft.

The public input meeting schedule was as follows:

- June 20, 2006 Public Meeting – Policy Options (Fire Station #5)
- June 24, 2006 Public Tour (City Forest)
- August 16, 2005 Public Meeting – Visioning (Library)
- October 4, 2005 Public Meeting – Visioning (Fire Station #5)
- October 10, 2006 Public Meeting – Policy & Actions (Fire Station #1)

A Review Panel was established to provide technical expertise to the planning team and to engage key stakeholders. Panel members reviewed a draft policy document in June 2006 and a second draft Stewardship Plan in October 2006. Their comments were considered in developing the final policies and the final plan document. Members are listed in Table 3.

Table 3. Review Panel members

Member	Affiliation
John Bliss	OSU Starker Chair for Family Forests
Sandra Coveny	Director, Marys River Watershed Council
Gary Springer	Starker Forests, Oregon Small Woodland Owners Assn.
Rana Foster	public member
Frank Davis	Forest Planner, Siuslaw National Forest
Eric Forsman	US Forest Service-Pacific Northwest wildlife researcher
John Tappeiner	OSU/Bureau of Land Management forest ecology, retired
Paul Adams	OSU College of Forestry watershed extension specialist
John Berry	Sierra Club, private woodland owner
Kim Nelson	OSU Fisheries and Wildlife Department
Bill Pearcy	retired OSU Oceanography, Marys River Watershed Council
Al Kitzman	Benton County Parks and Natural Areas
Joan Hagar	US Geological Survey, Wildlife Biologist
Chuck Willer	Coast Range Association

Implementation

This plan was adopted by the City Council on December 18, 2006 by the following motion: to adopt the Watershed Stewardship Management Plan, chapters 1 through 7, *(this reference to chapters 1 through 7 represents the same content as chapters 1 through 9 of this reformatted plan, namely all chapters preceding the appendix*) without the appendices, and direct staff to work with the WMAC on implementation strategies including the details of the management plan related to policies, standards, guidelines, and criteria for selection of any work items and contractors with annual reporting to Council.

The adopted plan will be implemented by the City of Corvallis Department of Public Works. City staff will be responsible for ongoing monitoring and evaluation. Written operational plans will guide City Forest activities. The Watershed Management Advisory Commission will advise the City Council concerning matters relating to the management

of the Corvallis Forest. An annual public tour will review recent activities in the City Forest.

Planning and Administration

The ultimate decision on resource policy and management direction rests with the Corvallis City Council. Once adopted, any policy changes to the Corvallis Forest Stewardship Plan would require the approval of the City Council.

The City Manager and City Public Works staff are responsible for implementing the provisions and recommendations of the plan, and for ongoing management. The Public Works office can provide information on operations (phone: 541-766-6916).

The City will engage other resource professionals as necessary, to supplement their expertise and/or work force. Guidance from or oversight by appropriate resource professionals should be sought for significant resource improvements or modifications.

3.History & Current Resource Conditions

This chapter provides a historical background for the Corvallis Forest, summarizes the socio-economic context, and reviews the current resource situation.

Historical Background

Historic Vegetation Patterns

In the early 1800s (pre-European settlement), the landscape surrounding Corvallis was strikingly different than that which is seen today. Conditions mirrored those found throughout the Willamette Valley and western Oregon. At that time, four major vegetation types occurred in the area: prairie, riparian forest and wetlands, open woodland and upland forest. Open grasslands dominated the vegetation from the floodplain margins to the hillsides of most valleys of the area. Isolated groves of trees were primarily white oak and Douglas-fir. This prairie condition had been intentionally cultivated by the local Calapooya Indians, who routinely burned the valley grasses to maintain important food and fiber "crops," including oak, camas, hazel, and berries, to encourage lush grass growth for game, and to make travel easier. When the first settlers began arriving in the Willamette Valley in the 1840s, there was little standing in the way of pioneer settlement. Diseases brought into the area by early trappers and explorers had already decimated native Indian populations (reducing their numbers by nearly 75 percent). Vegetation patterns changed quickly as a result of the cessation of native vegetation burning, and the beginning of farming and grazing practices by early settlers.

The Corvallis City Forest is located in the transition zone between the valley and upland forest, an area that was affected by the burning practices of native tribes and later agricultural clearing by settlers. The forest shows evidence of long-standing forest cover: some older Douglas-fir remain from stands that originated in the 1600's. They are surviving denizens from an era when these foothills were covered with much more open, multi-aged stands, the result of use of fire by local Indians. Timber harvest began in the City Forest in the early 20th century to supply local sawmills.

Water Use History 1908-2006

The City first began using water from the Rock Creek drainage in 1908. The drainage was set up as a designated watershed by the US Congress in 1920 and in 1922 cooperative administration by the City and the Forest Service began. The City and the Forest Service purchased all the land that was not in public ownership soon after passage of the Congressional acts. The lands on top of Marys Peak are not included in the watershed. Water quality for domestic use is the first priority for all management practices within the watershed on Forest Service property and City land.

Map 1 aerial photo

The system was modernized in 1956 when the present 4.5 million gallon per day water treatment plant was built. Water is supplied to the plant by stream intakes at diversion structures on the South Fork of Rock Creek and Griffith Creek, and by an earthen dam reservoir on the North Fork of Rock Creek. The water that flows into these intakes comes almost entirely from Forest Service land. Combined, they provide a supply of about three million gallons per day. The balance of the City's needs is supplied by withdrawal and treatment of Willamette River water.

Timber Harvest History

1910-1949

Much of the early timber harvesting was done in the first few decades of the twentieth century, just prior to City acquisition of the land. Over four hundred acres of the City Forest were clearcut in this period. During this era, forest practices were unregulated; low value and defective trees were left standing or on the ground, and the forest was left to naturally regenerate.

1950-1986

Corvallis began an active timber harvest program in its ownership in 1957. The US Forest Service managed all timber sale work and regeneration efforts, under a service contract with the City. A large storm event had recently blown down trees in the upper watershed, and concern was raised over an infestation of bark beetles that was attacking the down timber. A decision was reached to develop a salvage logging program to control the insect epidemic. Public support was solicited and received for a salvage logging program on federal lands.

A program of road building, logging and replanting was begun on both federal and City lands. Over 600 acres of timber in the City Forest was clearcut in 20-to-60 acre blocks and replanted to Douglas-fir during the following decades of management. These successful plantations were some of the earliest regeneration efforts in the region. High quality roads were built to access the harvested timber and provide protection against fire. At first, harvesting activities were undertaken when funding was needed for capital improvements to the City water system. Later, harvests were carried out on a schedule dictated by a timber management plan and the revenues were dedicated to capital improvements. The plan called for the forest to be cut at the rate of $1/80^{th}$ of the acres per year (80 year rotation).

1987-2005

The last timber harvest on City-owned land occurred in 1986. Controversy over the harvest impacts on the Northern Spotted Owl and citizen concern over the negative impacts of clearcutting in the City Forest culminated in a decision by the City Council to stop the harvest program. In 1993, an attempt was made to resume the timber cutting, when the City hired a forestry consulting firm to inventory the timber and craft the City

Forest's first detailed timber management plan. The plan lacked significant public support (amid continuing concerns over the management approach and impacts on endangered species) and was not adopted by the Corvallis City Council. This de-facto timber harvest moratorium has continued to the present.

Physical and Landscape Setting

The 2,352 acre City of Corvallis ownership encompasses the lower elevations of the 10,000 acre Rock Creek Watershed on the northeast flanks of Marys Peak. Rock Creek is one of the sub-watersheds of Marys River Watershed, which is in turn one of the many large rural watersheds in the Willamette River Basin. Located on the forested mid-to-lower slopes of four thousand foot high Marys Peak (the highest point in the Oregon Coast Range), the City Forest is about 12 miles southwest of Corvallis, Oregon.

Typical "middle-aged" stand of Douglas-fir with remnant hardwoods

The main stem of Rock Creek is a moderate gradient stream in the lower elevations of the Watershed, (elevation of 400 feet). The five principal tributaries of the main stem include the North, Middle and South forks of Rock Creek, as well as Griffith and Stilson Creeks. The upper reaches of these streams become high gradient as the topography changes to steep slopes rising to the watershed ridgetops at elevations of 1,600 to 4,000 feet.

Upslope of the City lands, the Rock Creek Watershed is primarily owned by the United States Forest Service and is part of the Siuslaw National Forest. There are several small private adjoining ownerships. The City maintains a 100 million gallon water reservoir, two stream diversion structures and a water treatment facility. This system provides Corvallis with approximately one third of its annual water needs.

The topography of the Rock Creek Watershed is dominated by moderate to steep slopes with deeply incised valleys and sharp ridges. The landform is comprised of volcanic and

Map 2 topography

sedimentary rocks formed during the Eocene and Oligocene ages, primarily basalt lava and ash next to sedimentary rocks (sandstone and siltstone) of the Tyee Formation.

The maritime climate features an extended winter rainy season with hot, dry summers. Snow can accumulate in the upper watershed during brief, cold storm events. This is usually followed by melting warm rains a few days later, often creating a surge of elevated water levels that drop soon afterward. The average annual precipitation is above 60 inches.

Natural Resource Conditions

Water System & Water Quality

The majority of the drinking water source area is Forest Service land. Most City land is downstream of the water intakes; only 400 acres are upstream of the water system diversions. While the City's ownership has a minor impact on overall water flows or quality, it contains most of the water system infrastructure and plays a key role in water system security.

The Rock Creek watershed provides approximately one third of the City of Corvallis' water needs, or just less than one billion gallons per year. The watershed provides a near-steady flow of about three million gallons per day, except during the months of September and October when stream flows are lowest. The Taylor Water Treatment Plant in South Corvallis provides treated Willamette River water for the remainder of the City's needs.

The Rock Creek water system provides water at approximately half the cost of the Taylor Treatment Plant, primarily because water from Rock Creek flows to Corvallis by gravity-flow system, greatly reducing pumping costs. It has further advantages as a separate source of supply, and as a closed and secure system.

Water quality of both plants is sampled regularly for over 100 contaminants. The water from each plant is of similar quality, and meets or exceeds all applicable water quality standards.

Fish and Aquatic Resources

The current physical and biotic condition of the Rock Creek aquatic corridor is strongly influenced by historic upslope forest management, as well as municipal infrastructure (roads, dams, trash racks and water diversions). The following sections are based on stream inventory work conducted for this project, as well as work conducted in the past for the Forest Service. The methodologies used and further details regarding this work is included in Appendix C.

Status of Migratory Fish Resources

The historic removal of riparian conifers on City of Corvallis ownership has reduced the input of large wood into the mainstem of Rock Creek. The other potential source of wood, from debris flows, is removed by intake dams, trash racks and booms. The two primary sources of wood recruitment on the City's property and to other downstream segments below city ownership have been compromised. Wood is important for streams because log jams create pools that serve as important fish habitat.

An interruption of gravel and wood delivery to the stream has resulted from the presence of the reservoir on the North Fork and the periodic excavation and removal of accumulated bedload from the pools above the water diversion dams on Griffith Creek and South Fork Rock Creek. Each of these sites currently stops the downstream migration of substrates to the lower mainstem of Rock Creek.

Without a consistent supply of wood and fresh gravel and cobble, the stream channel cannot capture and retain these materials. Winter flows quickly reduce the active channel to its underlying bedrock foundation. This is the current status of large sections of the mainstem of Rock Creek, from its confluence with Greasy Creek to its confluence with the North Fork.

The headwater tributaries within the Rock Creek watershed are steep, originating from 3,000 feet in elevation. They are exposed to the impacts of rain on snow events, and an important source of wood and gravel delivery to the lower mainstem has historically been debris torrent flows. There is ample evidence of this form of resource delivery in the upper mainstem of Rock Creek (South Fork).

Fish Populations

Cutthroat trout (Oncorhynchus clarki) are one of only three species of anadromous fish known to have historically occurred above Willamette Falls (the others are Spring Chinook and Winter Steelhead). However, the genetic structure of the Cutthroat population above Willamette Falls suggests that genetic isolation from the Cutthroat population below the falls is strong (NMFS). This is likely a result of high mainstem Willamette temperatures in the late spring through fall and the presence of C.shasta below the confluence of the Marys River that limits the survival of the few smolts observed migrating downstream over Willamette Falls. This has led NMFS to classify the Coastal Cutthroat above Willamette Falls as members of a unique Evolutionary Significant Unit (Upper Willamette ESU). This classification suggests that the anadromous life history form of the Coastal Cutthroat is not a significant management concern for the Rock Creek watershed.

The endemic fish species of concern in the Rock Creek watershed is the Cutthroat trout. The life history of Coastal Cutthroat trout is the most complex of any salmonid species. There are three unique life history strategies that are likely to exist currently within the watershed (resident, fluvial and adfluvial). Two of these life history forms almost certainly existed prior to colonization of the area by Europeans (resident and fluvial). In addition, genetic mingling likely occurs between these life histories but very little is known of these complex interactions.

Resident Cutthroat are common in the upper reaches of coast range watersheds and are unique in their confined spatial distributions. Adults are sexually mature at a very small size allowing this life history strategy to complete reproduction and rearing in very small stream habitats. The survival advantage for this strategy is significant. Predation from larger fish and other species is minimal, avian predation is dramatically reduced because Mergansers, King Fishers and Great Blue Herons cannot effectively hunt complex small water habitats. Population segments or demes of this life history pattern are strong and well represented in the Rock Creek basin above the water intake structures on Griffith Creek, South Fork Rock Creek, and North Fork Rock Creek (all primarily USFS ownership).

Fluvial Cutthroat trout juveniles leave small headwater streams to rear in larger mainstem habitats (potentially for multiple years) before returning to spawn in Rock Creek and its tributaries. Mature adults are consistently larger than resident adults. Larger size is a result of having been able to take advantage of the conditions in larger, lower stream reaches which provide abundant food resources and optimum temperatures for rapid growth. This greater size acquired at sexual maturity also allows them to utilize a much broader range of habitats for spawning (gravel size). The survival disadvantages in this strategy are significant. Barriers to upstream migration truncate access to high quality spawning habitats. In addition, these barriers can terminate the upstream temperature dependant migrations that are necessary to escape high temperatures that develop in mainstem habitats (Marys River, Greasy Creek, Rock Creek mainstem) during the summer low flow pinch period. This life history pattern exhibits a weak distribution within the Rock Creek watershed, and is the most likely to be influenced by the cumulative effects of water withdrawal on mainstem temperature profiles.

The other life history strategy present within the Rock Creek watershed for Cutthroat trout is the adfluvial form. This life history pattern has developed as a result of human impacts on the landscape.

The adfluvial form describes a component of the population that has adapted to rearing in a lake environment. These fish migrate to stream habitats for spawning and incubation. This strategy has almost certainly developed in the Rock Creek sub basin as a result of the impoundment and associated reservoir environment created by the City of Corvallis dam on the North Fork of Rock Creek. The adfluvial form of the sub basins population is plentiful. It is genetically isolated from the fluvial form since construction of the dam because the outflow is not passable to upstream migrants.

There have been many verified sightings of adult Winter Steelhead (Oncorhynchus mykiss) spawning in the Rock Creek watershed. However, none of the juvenile snorkel surveys conducted in 1994, 1995 or 2006 observed any 1+ (yearling or older) steelhead rearing within the Rock Creek watershed. The 1992 ODFW AHI did however document the presence of Steelhead juveniles rearing in the mainstem. These sparse observations indicate that at a minimum, Steelhead smolts are not consistently being produced from the Rock Creek subbasin. This is not surprising because the downstream impacts facing any anadromous life history pattern in the Marys River and Willamette River basin are formidable. Elevated spring temperatures in these mainstem habitats create a formidable barrier to the survival of downstream migrants. Winter Steelhead adults (unknown origin) continue to stray sporadically into the Rock Creek watershed but have not been effective in recolonization.

Basin Scale Temperature Regimes

Extremely high water quality exists in the headwaters of the Rock Creek Watershed. All headwater streams originate from high coastal elevations and flow through largely intact Late Successional Reserves (old growth reserves) on Forest Service property. Canyons are narrow, steep, heavily canopied and exhibit limited solar exposure (direct sunlight) on the aquatic habitats of Rock Creek tributaries. Wood densities in the headwaters are high, resulting in deep accumulations of transient bedload material (sand, gravel and cobble). These deep loads of gravel and wood debris store and buffer summer flows from the impacts of direct sunlight and air.

Each of the major headwater tributaries (North Fork, South Fork, Middle Fork and Griffith Creek) eventually transitions onto the City of Corvallis ownership, which is positioned lower in the watershed. The natural geomorphology of the City's ownership is described by wider floodplains and flatter channel gradients. These two natural features predispose the stream corridor to increased impacts from air and sun exposure. Wider valley floors lengthen the window of sun exposure which is exacerbated by the east / west aspect of significant portions of the Rock Creek mainstem. In addition, areas of

Map 3 Fish and streams

exposed bedrock create a heat sink in midday and a heat source after the sun leaves the stream. Pool turnover rates (the time water is retained in a single pool) are slower with reduced gradient, resulting in prolonged exposure to warming bedrock and sunlight.

Permitted water withdrawals from the South and North Forks of Rock Creek and from Griffith Creek reduce water delivery to the mainstem of Rock Creek. Water withdrawal expands the time of low flow impact that would naturally be confined to a much narrower period. This results in exposing mainstem aquatic communities to temperatures that exceed DEQ thresholds. The extended exposure increases environmental stress that may have a direct impact on the vigor and survival of both fish and macro invertebrate populations. The combination of impacts has a negative cumulative impact on summer stream temperatures that become progressively more acute in a downstream progression towards the confluence with Greasy Creek.

The Effect of Cumulative Impacts on Fish

All of these basin-scale physical attributes interact to form a cumulative downstream impact on fish abundance, distribution and species composition. An increase in mainstem temperature will expand the upstream distribution of the Red Side Shiner which was observed rearing in high densities in mainstem pools just above the confluence with Greasy Creek. An increase in mainstem temperature will force summer habitat use into smaller cooler tributaries with much lower production potential than mainstem habitats because of limited pool size. An increase in mainstem temperature will result in increasing inter-and intra-specific competition which will result in stress, reduced vigor and lower survival rates.

Summer mainstem temperature profiles are the most significant limitation to the viability of salmonid populations within Rock Creek. The primary factors that lead to this limitation are natural channel morphology, water withdrawal, historical riparian timber harvest, lack of wood and bedload transport, reduction of aquatic complexity, etc. None of the current metrics of

Perched culvert, a barrier to fish, where Stilson Creek joins Rock Cr.

elevated mainstem water temperatures, depressed instream wood densities or reduced flows can be linked to a single watershed impact.

Additional Impacts

(Note: River miles (RM) record the distance along the channel from the confluence with Greasy Creek)

1) There is an abandoned dam and pumping station at RM 1.5 and directly behind the manager's residence. This dam has collapsed but is still spanning across the active channel. The sheet flow that slips over the concrete apron during low summer flows is a potential barrier to salmonids attempting upstream migrations.

2) The collapsed dam (RM 1.5) may have had an impact on the natural channel morphology directly downstream which has concentrated flow into a channel braid that pours over the 4 foot bedrock intrusion that was observed stalling migratory Cutthroat. Blocking this channel braid would restore the historic channel and provide smoother unimpeded upstream passage.

3) There is an abandoned road bed in the active floodplain at RM 1.6 just above the old trestle bridge crossing that cuts off a historical meander bend of Rock Creek. This confines Rock Creek to a narrow channel that contains a 3 foot bedrock falls. This small falls could complicate upstream migrations for salmonids. If this road fill was removed from the floodplain, a historical channel braid would be restored that would circumvent this small falls and provide passage for all age classes during all seasons.

4) Selective conifer harvest was conducted by the City of Corvallis in the riparian corridor from approximately the confluence of Griffith Creek to the confluence of North Fork Rock Creek. The inability of the riparian corridor to contribute large conifer to the active channel has helped create a large woody debris deficit within the mainstem of Rock Creek.

5) A debris torrent legacy from 1964 through the 1990s has effectively scoured large segments of mainstem Rock Creek to bedrock. Wood complexity and bedload materials have not been adequately recruited or retained since these events.

6) Impassable road culverts exist on the Main Fork Rock Creek, Stilson Creek, Tributary D of Rock Creek, Connection Creek (Forest Service) and Tributary 4 of South Fork Rock Creek (Forest Service).

7) A potential future road failure was identified by Bio-Surveys in the May 2006 inventory on the South Fork Rock. The site is 1,600 feet above the water intake dam

where the active stream channel has undercut the supporting toe slope to within 20 horizontal ft of the road centerline.

Wildlife

The diversity and abundance of wildlife populations is largely determined by the presence, location, distribution and condition of the vegetative habitat. This assessment describes key habitat types, associated wildlife and their present condition in the Corvallis Forest. The history and current status of Federally Listed species are summarized. Species lists and further details are included in Appendix B.

Habitat Overview

The Corvallis property is primarily a conifer-dominated forest that includes three fairly distinct age classes: young (20-50 years), mid-aged (70-110 years) and mature (130-180+ years). Areas dominated by hardwood trees are present in the southeast portion of the site and along larger streams. Grass-dominated forest openings are located around the residence/facilities areas, and a reservoir is located along the western boundary.

The property is bordered by Siuslaw National Forest land along the west, which is primarily a mature-conifer forest, managed as a Late Successional Reserve. The objective of this land use is to protect and enhance conditions of late successional and old growth forest ecosystems, which serve as habitat for late successional related species. The north, south and east adjoin younger, privately owned forests and agricultural fields. The 1000+ acres of mature forest habitat on City of Corvallis land and the proximity and connectivity of the City forest to the 8,800 acres of Forest Service lands (including 6200 acres of older forests), create a large block of mature habitat, which include a high number of old-growth trees. This habitat condition is very rare in Northwest Oregon.

Three Federally listed (Threatened) species – Bald Eagle, Spotted Owl and Marbled Murrelet – have previously been documented on City lands.

Current Habitat Conditions and Associated Wildlife

Conifer Habitat

Conifer forests are the predominant habitat throughout much of the ownership, covering 98% of the property. The three conifer age classes vary greatly in their current habitat condition and potential for associated wildlife.

- *Mature conifer habitat (1105 acres)*

These stands are extremely diverse with a high degree of in-stand variability, including a multitude of tree size, age and distribution patterns. Old-growth trees are present throughout the area with a number of the trees exceeding 400 years in age. Douglas-fir is the dominant species and grand fir is also common. Western red cedar is less common but is the dominant species in a few areas. Yew trees are also present, becoming common in some areas and mature Western hemlock is relatively rare. Grand-fir regeneration is abundant in many areas with understory red-cedar and Western hemlock also present. A few pockets of past and recent root disease are evident, creating small forest openings

Old-growth Douglas-fir (l) and western redcedar with hat for scale.

Map 4 Wildlife

The northern stands (north of Rock Creek) are primarily 130 years old. Density of old-growth trees in these stands varies from less than 1 to over 5 trees/acre, with mature fir (2-4 feet in diameter) providing the bulk of tree structure. The southern stands (south of Rock Creek) are primarily 180 years old. Density of old-growth trees in these stands varies from less than 1 to over 20 trees/acre, with large mature fir (2-4' in diameter) providing the bulk of tree structure.

Very large snags (>4 feet diameter) are present but very limited in occurrence in the northern stands. In the southern stands, very large snags are more common with up to 1/acre evident in some areas. Snags 2-3' in diameter resulting from bole breakage of sub- or co-dominant trees are common in both the northern and southern stands.

Very large logs (>4 feet diameter) are present but not abundant, likely a result of a low level of historical tree distribution, and previous salvage. A few large logs are located in old root disease areas and smaller but wildlife-viable logs (2-3 feet diameter) are fairly common.

Understory shrubs are extremely diverse and abundant but variable in distribution (5-100% cover). Due to the rain shadow effect of Mary's Peak, drier site shrub species dominate the northern stands. Low Oregon grape is most abundant with salal and vine maple also common. Snowberry, red huckleberry, ocean spray, hazel, rose, vine maple, hawthorn, goat's beard and trailing blackberry are frequently encountered and poison oak, honeysuckle and rhododendron are also present. Areas of shrub thickets, mostly associated with riparian corridors and old root-disease pockets are mixed with areas of low shrub cover or areas dominated by low Oregon grape, sword fern and carpets of native herbs and forbs. In the southern stands, tall shrub species are more abundant dominated by vine maple and California hazel, providing over 50% in some areas. Low shrub cover, primarily Oregon grape and salal are also very abundant. Minor shrub species (snowberry, red huckleberry, ocean spray, rose, goat's beard and trailing blackberry) and areas dominated by sword fern and carpets of native herbs and forbs are also present

Interior forest habitat is characterized by mature conifer habitat over 500' from the edge of younger stands. Interior forest habitat creates environmental conditions (moisture, temperature, ambient light) required by sensitive plant and animal species allowing for undisturbed ecosystem functioning and provides an important buffer to invasive plant and animal species. Interior forest habitat is very extensive in the roadless northern stands and present along the western Forest Service border and in far south of the Watershed.

The extensive area of mature conifer forests on City land and the connectivity to mature habitat on Forest Service lands create a very large area of the mature-forest, allowing the site to be utilized by all conifer-associated species endemic to the area, which includes

well over 100 vertebrate species. Commonly observed species would include; Winter Wren, Ruby and Golden-crowned Kinglets, Hermit Warbler, Varied and Hermit Thrush, Hutton's and Cassin's Vireo, Pacific-slope flycatcher, Brown Creeper, Western Tanager, Stellar's Jay, Townsend's chipmunk, Douglas and flying squirrel, red-backed and red tree vole. This extensive mature forest cover also allows for species, which require large forested stands including cougar, black bear, American martin and Northern Goshawk.

Dead trees (snags) and dead parts of live trees provide essential nesting, roosting and foraging habitat to a wide array of wildlife species. Over 30% of bird species richness and abundance may be related to the level of cavity-nesting habitat available. The high quality and extensive presence of cavity habitat are providing suitable habitat for all the resident cavity-associated species. Just a few of the associated bird species include woodpeckers including the Pileated Woodpecker, chickadees, nuthatches, wrens, swallows and owls. Associated mammalian species include bats, squirrels (flying, gray and Douglas), Townsend's chipmunks and a number of mustelids.

Logs and other woody debris provide cover, food and unique environmental conditions (moisture, temperature) required by numerous wildlife species. Although not as abundant as would be expected in older conifer habitats, the quantity and quality of large wood is still likely providing suitable habitat for most associated species. These include the mycorrhizal-spreading red-backed vole and insectivorous animals such as shrews, shrew moles and salamanders (clouded, red-backed, ensentina) and reptiles (ring-necked snake).

Overall, the mature conifer stands provide a diverse, vibrant and healthy forest habitat. The presence of Bald Eagle, Spotted Owl, Marbled Murrelet, multiple Pileated Woodpecker pairs and numerous red tree vole nests attests to the viability of the older forest habitat conditions present in the City Forest

- *Mid-age conifer habitat (393 acres)*

These areas are primarily the result of historical logging in the southern portion of the property, but there are some stands of this age that may have originated following agricultural abandonment in the northern portion. All these stands have naturally seeded in with conifers.

The northern stands display a uniform tree distribution of densely growing Douglas-fir with some grand fir, 12-24 inches in diameter. A few small openings (due to the loss of trees to root fall or bole breakage) are present. Large snags and logs are extremely rare, but smaller diameter (<10 inches diameter) snags and down wood are abundant, a result of natural mortality of sub-dominant trees. Herbaceous ground cover (herbs, forbs, ferns) is present but moss/detritus groundcover is more common.

The southern stands are also dominated by densely growing Douglas-fir (15-24 inches diameter), but tree densities and distribution patterns are more varied. These sites also include a few large or old-growth residual fir trees and scattered, mature big-leaf maple and madrone trees. Cavity habitat is present in bole breakage of co-dominant trees and segments of larger hardwood and old-growth firs. A few large residual logs and large decaying stumps are present. Shrub cover is low overall, but can dominate in small open areas. Herbaceous ground cover (herbs, forbs, ferns) is interspersed with moss or detritus covered areas.

The northern stands have a very limited wildlife potential due to their simple tree and canopy structure and the small diameter snags and logs present, which are of little value to snag or log dependant wildlife. Just a few very common bird species including; American Robin, Dark-eyed Junco, Hermit Warbler, Golden-crowned Kinglet, Winter Wren, Pacific-slope Flycatcher, Hutton's vireo and Varied Thrush would frequently be encountered.

The southern stands have a much higher wildlife potential that includes the common bird species found in the northern stands in addition to a number of species associated with particular habitat components. Cavity-habitat, though limited in amount, is providing potential nest-sites for a number of associated species including the primary excavators (Northern flicker, Hairy and Downy Woodpecker and Red-bellied Sapsucker). In addition, a number of secondary cavity-nesting species (Chestnut-backed Chickadee, Red-breasted Nuthatch, Douglas and flying squirrel and Townsend's chipmunk) may also be present. The presence of the large residual trees provides potential nesting structure for the Federally listed species (owl, murrelet and eagle). The small shrub dominated, open areas create the potential for Wilson's, Orange-crowned and MacGillivray's Warbler, Bewick's wren and Song Sparrow. The presence of mature hardwoods provides habitat for the Western tanager and foraging opportunities for Band-tailed Pigeon, Cedar Waxwing and Evening Grosbeak.

- *Young conifer stands (616 acres)*

These stands are the result of clearcut logging and intensive reforestation efforts. All but one unit were harvested before wildlife concerns and mitigation efforts (snags, logs, residual trees, riparian buffers) were employed. All trees were cut and merchantable and unmerchantable material were yarded out of the unit. The sites were usually slash-burned and planted to 300-400+ Douglas-fir trees/acre.

The older units (>35 years) are currently very monotypic, comprised of densely growing, small diameter trees (>18 inches diameter) completely lacking residual large tree structure. They can be virtually absent of snags and large logs with only a few residual

logs and large remaining stumps providing a limited amount of down wood habitat. Shrub species persist in low-stocked areas but are sparse throughout most of the stands.

The younger stands (20-35 years) are in the shrub/sapling successional stage, characterized by dense shrub thickets and areas of closed canopy young fir trees. The most recent harvest unit is somewhat unique as it includes a number of large remnant trees and snags and is still fairly open with a mix of grass/forb and shrub dominated areas.

Although the young open habitat condition (resulting from clearcut logging) is relatively rare on the City's ownership and has been decreasing for the past 20 years, it is an extremely common condition on private and State lands in Northwest Oregon, including adjacent ownerships north, east and south of the City Forest.

The older plantations have a very limited wildlife potential due to their simple tree structure, limited plant diversity and lack of cavity or log habitat. Only very common bird species including American Robin, Dark-eyed Junco, Hermit Warbler, Golden-crowned Kinglet, Winter Wren, Pacific-slope Flycatcher and Varied Thrush

The more recent clearcuts can exhibit a higher degree of wildlife diversity with the potential for species associated with forest openings and shrub habitats, including sparrows (White-crowned, Song, Fox), Bewick's and Winter Wren, American Goldfinch, Orange-crowned, Wilson's and MacGillivray's Warbler, Black headed Grosbeak and Steller's Jay. The one unit with residual trees and snags has the potential for a additional species including the cavity-dependant Tree and Violet green Swallows, Western Bluebird, Northern Flicker, Hairy and Downy Woodpecker, Red-breasted Sapsucker, American kestrel and House wren and hawking species including Townsend's Solitaire, Willow and Olive–sided Flycatcher. However, this is a transitory condition, which will diminish over time with increasing conifer cover.

Minor Habitats

The wetlands, hardwoods, forest openings and rocky areas, though limited in occurrence, provide unique habitat conditions associated with dozens of vertebrate wildlife species. These sites greatly add to the overall biodiversity of the City Forest.

- *Hardwood Habitat*

Mature hardwood trees represent only a small percentage of overall forest cover but are located throughout the watershed, displaying a very high level of species diversity.

In forest areas, hardwoods are located as scattered individual trees or as the dominant tree cover in old root-rot pockets and along perennial drainages. Bigleaf maple is most common, but madrone, chinquapin and Pacific dogwood are also present and cascara is common in the forest understory. An extensive and species rich hardwood tree cover forms a 2-mile long corridor along Rock Creek extending from the reservoir through the southeast of the site. Big-leaf maple is the dominant species, but red alder, Oregon ash, black cottonwood (including >4 feet diameter) and willow species are all common.

Historically, Oregon white oak was likely to have been widespread and the dominant habitat type in the lower portions on the City Forest. Currently, Oregon white oak trees are relatively uncommon on the Watershed, with the highest concentrations located along the eastern 1/3 mile of the Rock Creek access road and around the residential and plant facilities area. Additional oaks are scattered (single trees, small patches) along the north side of Rock Creek and the northern border of the Watershed. Many of the trees are densely growing and of smaller diameters (> 18 inches diameter) but open grown, large diameter trees (>3 feet diameter) are also present. A number of trees are declining due to competition from adjacent fir trees.

Hardwoods offer unique food (mast and lichen), cover, diverse insect fauna, abundant leaf litter, cavity habitat, woody debris and environmental conditions not found in coniferous trees. Even a small percentage of hardwoods in a conifer stand will greatly increase potential bio-diversity. Hardwood-associated species include black-headed grosbeak, black-throated gray warbler, warbling vireo, sharp-shinned hawk and ruffed grouse, all of which are likely to be present in the hardwood dominated areas. In addition, flocks of birds (Evening Grosbeak, Band-tailed Pigeon, Cedar Waxwing, Townsend's and Yellow-rumped Warbler) will forage on madrone berries and the large big-leaf maples provide numerous potential cavity-nest sites.

Oregon white oak habitat is especially important to wildlife with well over 100 species utilizing the trees for nesting, foraging, hiding and resting. Though oak habitat is currently limited on the Watershed, a number of associated species are likely to be present. These include; Western gray squirrel, White-breasted Nuthatch, Downy Woodpecker, Western wood Pewee and Chipping Sparrow.

- *Riparian Habitat (140 acres)*

Riparian habitat is widespread on the ownership, represented by large streams, named and unnamed perennial tributaries, numerous ephemeral drainages and their associated riparian zones and a reservoir located on the western boundary of the site. Riparian tree habitat is variable depending upon past harvest activities. In natural areas, large conifers and large logs are commonly encountered, mixed with deciduous tree cover. In areas of previous timber harvest, conifer tree cover and larger logs are rare, however, a diverse mix of hardwood species now dominates these areas. Shrub diversity and abundance is very high along the stream corridors, including both wet site (salmonberry, thimbleberry,

stink current, creek dogwood, red elderberry) in addition to a number of dry-site shrub associates. Areas with limited shrub cover will often display a mix of native forbs and herbs providing a complete ground cover. The reservoir adjoins mature conifer habitat on the north, south and west.

The reservoir provides habitat for a large number of aquatic associated species. Nesting by Mallard and Wood Duck, Hooded Merganser and Pie-billed Grebe and winter foraging by a dozen other waterfowl species would be expected. Foraging by the aquatic feeding Great blue and Green Heron, Belted Kingfisher, and insectivorous swallows, swifts and bat species is extremely likely.

The riparian zones surrounding streams represent the interface of the aquatic and upland habitats, providing habitat for both aquatic and terrestrial wildlife. The areas exhibit a rich and unique herbaceous and shrub community and a diversity of tree species and can represent important corridors for wildlife dispersal. Some riparian-associated wildlife species include: yellow warbler, willow flycatcher, black-headed grosbeak, beaver, muskrat, raccoon, river otter, several bat species and a number of salamanders (Northwestern, Dunn's and Red-backed salamander, rough skinned newt and red-legged frog.

- *Forest openings (meadows, grasslands, clearcuts and small in-forest openings)*

Open forest habitat is very limited on the City Watershed, located in few small meadows along the Rock Creek entrance road in the southeast of the site and a small meadow (1 acre) located in the northeast of the Watershed. The largest area (20+ acres) is located around the water plant facilities and associated residences. This area includes larger open areas (5-10 acres) interspersed with smaller meadows. Non-native grass species provide the overwhelming ground cover, but native forbs and grasses, though limited in occurrence are also present. The distribution pattern of the existing grassland creates a large amount of edge habitat (abrupt transition from open to shrub and forest habitats).

Open habitat is required by a number of wildlife species that are not likely to inhabit dense forested areas. These include both species requiring open areas for nesting and foraging and many others that utilize open ground for foraging and interior and edge trees and shrubs for nesting and hiding cover. Although the open areas are relatively small, they are still providing habitat for many of the grassland-associated wildlife species. Bird species likely to utilize the City Forest's open areas include sparrows (White-crowned, Song, Fox, Golden-crowned and Savanna), Spotted Towhee, Orange-crowned Warbler, Common Yellowthroat, Bewick's Wren, Mourning Dove, American Goldfinch, California quail and Western Bluebird. In addition, a number of reptiles (alligator lizards, Western racers and gopher snakes), small mammals (certain shrews and voles), and raptors (American kestrel) may only be encountered in open habitats. These habitats can also provide important foraging areas for large mammals (elk, deer). Species

associated with very large open areas (Horned lark, Northern Harrier, Short-eared owl and Western Meadowlark) are not likely to be present.

- *Rocky areas*

Areas of exposed gravel, rock, and boulders are most common in the shallow soils located north of Rock Creek and old riparian slide areas but are also present throughout the remainder of the ownership.

Snags such as this one north of Rock Creek provide important habitat for a wide range of wildlife species

Exposed rocky areas provide unique habitat conditions required by a number of salamander and reptile species and are likely utilized by a number of the associated species including; fence lizard, Western skink, Dunn's and Red-backed salamander.

Listed Species Present

Federal and State listed species are those designated as Threatened or Endangered under the Endangered Species Act with mandatory protection of the species and its critical habitat.

Bald eagle (Federal and State-Threatened)

This species nests and roosts in mature and old-growth conifers near large bodies of water. A bald eagle nest site is located on City lands approximately 1 mile from the reservoir (foraging site). A second nest tree is located within 50 meters, with the single pair of birds alternating between nest trees. The site has been active since 1996, producing 16 young. Surveys conducted in 2006 indicated active nesting early in the season, but failure to produce young.

As the City Forest includes abundant mature/old-growth conifer, a permanent large body of water, minimal human disturbance and planned protection of the current nest stand,

occupancy of the area and reproductive success would be expected in the future.

Oregon State Department of Forestry restrictions include no disturbance within ¼ mile (up to ½ mile line of sight) between January 1st – August 31st during nesting years.

The USFWS requires a 100 meter no harvest buffer and a 200 meter restricted harvest buffer around nest sites.

The Oregon Eagle Foundation conducts yearly surveys of the site, which can determine nesting status and the necessity for activity restrictions. Inactive nests can be confirmed after May 15th.

Northern Spotted Owl (Federal and State-Threatened)

The species is associated with mature conifer or mixed forests containing large trees, snags, multi-tree layers and closed canopy.

In the early 1990s there were 3 owl activity areas on City lands (2 pairs and 1 single) and six owl activity centers located on adjacent Forest Service land. Since 2000, only single pair occupancy has been confirmed remaining on City property, located in the center of the Watershed near Stilson creek. There were no owl responses elicited from the site during the 2006 surveys efforts, but a visual of an owl was reported after the survey season. A single owl was reported in the area during the 2005 survey season. Additional owl activity areas are located within1.5 miles to the west on Federal lands, and some of these birds likely utilize or may be dependant on City lands for foraging activity and maintaining interior forest habitat conditions.

In recent years, the invasion of barred owls into the Oregon Coast Ranges has had a significant adverse impact on spotted owl populations. The barred owl is more aggressive and will often displace the spotted owl from historic nest groves. At least one of the owl sites on Forest Service land has recently been taken over by barred owls. The 2006 owl surveys documented current activity in only 4 spotted owl sites on the Mary's River Watershed (Federal and City lands), compared to 9 locations displaying activity in 2000. The trend appears to be continuing and represents a grave threat to future spotted owl population levels both locally and regionally. The situation is currently in a state of flux and predictions for the future of spotted owls in the City Forest is unknown. Delaying activities in existing spotted owl habitat until the situation becomes clearer may be prudent.

Oregon Department of Forestry restrictions include no disturbance (harvest or hauling) within ¼ mile of potential nest sites between March 1st and Sept. 30th and the establishment of a 70-acre no harvest area around activity centers.

The USFWS requires a minimum of 42% of suitable habitat within a 1.5-mile habitat circle surrounding owl activity sites (1,906 acres). A habitat circle based on Stilson creek includes just under the 1,906 acres of mature habitat recommended by the USFWS. This encompasses most mature habitat on City land except in the south of property outside the 1.5 mile circle. Degradation or loss of additional suitable habitat would be considered an illegal "take" by the USFWS.

If thinning operations maintain a minimum 60% canopy closure and important habitat components are protected, the federal biological determination would be "may affect, not likely to adversely affect" the spotted owl.

Yearly surveys are being conducted by the Forest Service, which can determine nesting status and the necessity for activity restrictions. Conducting private surveys in the Stilson Creek area may be desirable in order to determine nesting status as early as possible (June 07).

Marbled murrelet (Federal and State-Threatened)

This species spends most of its time at sea and uses inland mature forest habitat for nest sites. Murrelets do not build a nest and require large moss covered lateral limbs, debris accumulations or mistletoe clumps in the upper canopies of large old trees as platforms for their single egg. Surveys conducted in early 1900s documented at least 5 murrelet sites on Forest Service lands and 1 confirmed site on City lands, located in the Stilson Creek area. These were "occupancy/presence" surveys with no attempt to locate nests. A nest was subsequently located on City lands north of the reservoir. No recent surveys have been conducted, however, the widespread presence of potential nest trees, minimal habitat alteration since the 1990s and the high fidelity to nesting sites suggests that survey efforts would likely result in the documentation of additional nesting locales. Maintaining interior forest habitat is important for maintaining nesting habitat and in reducing the potential of avian predation at nests.

Endangered species

What is the City's legal obligation?

Oregon Department of Forestry (ODF) rules for habitat protection are not as strict as those promulgated by the US Fish & Wildlife Service(USFWS). So which rules does Corvallis have to follow?

The City Forest is not Federal land, yet the USFWS rules are still legally applicable – they supersede state law.

Some landowners have chosen to develop Habitat Conservation Plans (HCP) as a way to create a legally permissible management approach in areas with endangered species. But HCPs can be costly and time-consuming to develop.

Corvallis will have to work closely with the USFWS to ensure harvests provide the required protections for key species

USFWS restrictions include no harvest activity within ¼ mile of potential nest sites between April 1st and September 15th, unless otherwise authorized by a biological opinion.

If standard harvest operations are over 100 meters from potential nest trees the Federal biological opinion would be "may affect, not likely to adversely affect" the murrelet, and harvest activities during the breeding season would be permissible.

The USFWS has developed guidelines for thinning in younger stands with suitable nest structure (less than 6 suitable nest trees within a 5-acre movable circle). These guidelines exclude potential nesting structure from the harvest project and apply protection measures to ensure that the proposed action would not adversely affect the murrelet. If the City follows these guidelines, thinnings would be permissible in young plantations, most of the northern middle aged stands and portions of the southern middle aged stands. Harvests in mature stands would not be permissible unless survey efforts documented absence of murrelets.

A 2-year survey effort is required prior to beginning activities (during breeding season) in areas of potential nest sites. Un-surveyed potential habitat would be considered occupied, with associated harvest restrictions. If the 2-year survey effort documents absence of murrelets, harvest restrictions would not be required. However, as spotted owl habitat overlaps potential murrelet habitat, maintaining a 60% canopy closure would still be required for most of the Watershed.

Federal Murrelet management guidelines

- Prohibit removal or damage of trees with potential nesting structure and adjacent with branches that interlock the branches of any tree with potential nesting structure.
- Maintain a 150' unthinned buffer around all trees with potential nest structure. No trees should be removed for any reason associated with the timber harvest including roads, landings or yarding corridors.
- Maintain an average canopy closure of 60% post treatment (averaged over each 40-acre area) in the zone between 150-300 feet of all trees exhibiting potential nesting structure. Consider additional, site-specific prescriptive measures to maintain or enhance habitat conditions, as deemed necessary in the zone between 150-300 feet.
- Maintain an average canopy closure of at least 40% post treatment (averaged over each 40-acre area) within the proposed thinning unit
- Prohibit the creation of any gap opening >0.25 acre in size within a distance equal to one site potential tree height of potential nesting structure

Sensitive Species with Potential to be Present

The Oregon Department of Fish and Wildlife maintains a list of "Sensitive Species." These are naturally-reproducing native animals which may become threatened or endangered throughout all or any significant portion of their range in Oregon. There are no legal obligations associated with species management.

ODFW sensitive species designation includes 4 categories (Critical, Vulnerable, Undetermined and Peripheral).

- Critical – Species for which listing as threatened or endangered is pending, or those for which listing as threatened or endangered may be appropriate if immediate conservation actions are not taken.
- Vulnerable – Species for which listing as threatened or endangered is not believed to be imminent and can be avoided through continued or expanded use of adequate protective measures and monitoring.
- Peripheral or Naturally Rare – Peripheral species are those whose populations are on the edge of their range. Naturally rare species are those with historically low numbers due to naturally limiting factors.
- Undetermined Status – Species for which status is unclear and requires father scientific data.

Mammals

White-footed vole – (State sensitive–Undetermined status)

The species is associated with small permanent drainages dominated by red alder and a dense deciduous understory. The species was documented on City land in the early 1950's. Planned riparian protection should maintain preferred habitat of the species.

Fringed myotis (State Sensitive-Vulnerable)

The species is associated with older Douglas-fir forest in the vicinity of water. Habitat for the species is present in the City Forest. Planned protection of mature conifer and riparian areas will maintain habitat for the species.

Silver-haired bat (State Sensitive–Undetermined status)

The species is associated with older Douglas-fir and hemlock forests, which is present in the City Forest. Planned protection of mature conifer will maintain habitat for the species.

Long-eared myotis (State Sensitive–Undetermined status)

The species is associated with mature conifer forest, which is present in the City Forest. Planned protection of mature conifer will maintain habitat for the species.

Long-legged myotis (State Sensitive–Undetermined status)

The species is associated with mature conifer forest, which is present in the City Forest. Planned protection of mature conifer will maintain habitat for the species.

Western gray squirrel (State Sensitive–Undetermined status)

The species is associated with oak or conifer/oak habitats. Suitable habitat is present in the southeast of the parcel and around the residence area. Maintaining and increasing oak habitat would benefit the species.

American martin (State Sensitive-Vulnerable)

The species is associated with mature conifer forest with down logs for cover, which is present in the City Forest. Planned protection of mature conifer and increasing the level of down wood will maintain and enhance habitat for the species.

Birds

Purple martin (State Sensitive-Critical)

The species requires large snags in open habitat near permanent water for nesting. There were numerous sightings on City land in the early 1970's and confirmed nesting in 1998 on OSU land (recent harvest unit) north of the watershed. Large forest openings with suitable snags are rare in the City Forest with the highest potential for nesting located around the reservoir. Establishing nest boxes around the reservoir should be considered.

Northern Goshawk (State Sensitive-Critical)

The species is associated with large patches of late successional forests, which are present in the City Forest. Planned protection of mature conifer will maintain habitat for the species. The species has been reported on City land. Conducting surveys to document its status should be considered.

Pileated Woodpecker (State Sensitive-Vulnerable)

The species is associated with conifer forests containing large trees and snags for foraging and nesting which are present in the City Forest. Multiple breeding pairs have been documented on City land.

Willow Flycatcher (State Sensitive-Vulnerable)

The species is associated with thick riparian vegetation along streams through meadows and marches but also can be located in brush and young fir trees in savanna habitats. Habitat for the species is present in the City Forest. Planned protection of riparian areas should maintain habitat for the species.

Olive-sided Flycatcher (State Sensitive-Vulnerable)

The species is associated with open forest, forest edge and savanna. It often perches on trees and snags that provide a clear overview of the surrounding area. Habitat for the species is present in the City Forest.

Western Bluebird (State Sensitive-Vulnerable)

The species is associated with agricultural lands, clearcuts and open oak forests. The species is cavity-dependant requiring a nest box or snag within or adjacent to open habitat. Potential habitat for the species is present in the oak/grass dominated area around the residence/facility.

Reptiles

Sharptail Snake (State Sensitive-Vulnerable)

The species is associated with deciduous woodlands especially oak and moist coniferous forest edges. Potential habitat for the species is present in the oak/grass dominated area. around the residence/facility.

Vegetation and Botanical

The City Forest is located in a transition zone between the Willamette Valley and the Coast Range. Vegetative cover on the property is predominantly coniferous forest dominated by Douglas fir (*Pseudotsuga menziesii*). Stand ages vary from young stands which originated following logging 22 to 50 years ago, to middle-aged stands which originated following logging or farm abandonment 50 to 100 years ago, to older stands which contain very old, widely spaced Douglas fir that are up to 500 years old surrounded by a subdominant layer of 100 to 200 year-old Douglas fir that colonized after aboriginal burning ceased at the time of Euro-American settlement. Understory vegetation in these stands is quite varied. See the wildlife section above for descriptions of shrub and herbaceous layers within the forest types.

Vegetation patterns within the City Forest are influenced by the rain shadow effect of Marys Peak. On dry, south facing slopes (mainly north of Rock Creek), the dominant vegetation is the Douglas-fir/poison oak (warm) plant association. On north facing, moister slopes (primarily south of Rock Creek), the dominant plant association is Western hemlock/Oregon grape-salal. These plant communities have been greatly influenced by past harvest practices or natural disturbances which determine composition and successional pathways.

Small areas of grassland habitat remain in the City Forest including narrow strips of remnant upland prairie along the lower portion of Rock Creek Road, a weedy pasture area north of Henkle Way and immediately west of Highway 34, degraded prairie/pasture around the water treatment facilities and residences and a weedy meadow near the northern boundary of the property. Grassland areas are a small remnant of larger areas of open habitats, including prairie and savanna that were present at the time of Euro-American settlement.

Rare species

A significant population of peacock larkspur (*Delphinium pavonaceum*) was documented on the property. This species is a federal Species of Concern and is listed as Endangered by the State of Oregon. The population consists of an estimated 1582 plants. These occur in 3 subpopulations. The largest subpopulation (1279 plants) is located in narrow strips of remnant native prairie on both sides of the lower portion of Rock Creek Road between the Rock Creek crossing and a point approximately 0.45 miles west of the creek crossing. Another 300 plants grow on a small rocky knoll adjacent to Highway 34, and 3 plants were found in the fallow field adjacent to the north side of Henkle Way, southeast of the Rock Creek Road junction.

Moist, forested, northerly slopes in the City Forest are potential habitat for tall bugbane (*Cimicifuga elata*). This species is a state candidate for listing as threatened or endangered. A full survey of potential tall bugbane habitat was beyond the scope of this project. A sample of approximately 70 acres of potential habitat was surveyed to assess habitat conditions. No tall bugbane was found during these surveys, but suitable habitat is present on northerly slopes within the ownership, and there is a good likelihood that tall bugbane is present.

Although no other rare plants were documented within the ownership, the native prairie remnants detected along Rock Creek Road and on the rocky knoll adjacent to Highway 34 are significant for their concentration of native prairie species. These areas should be protected and managed to maintain them free of invasives and woody vegetation. Adjacent open areas should be considered for restoration to native prairie or savanna. A population of Kincaid's lupine (*Lupinus sulphureus* ssp. *kincaidii*) is located along

Henkle Way on private land north of the property. If prairie or savanna habitats are restored, this population could serve as a seed source for establishment of a population on the city's ownership. Oak woodland habitats in other parts of the ownership should be considered for restoration through removal of overtopping conifers and control of understory invasives.

Invasive species

Roadside weed surveys were conducted along all drivable roads within the City Forest. Weed species and abundance were recorded for each 1/10th mile segment along each road. In addition, targeted weed assessments were made of a sample of habitats within the ownership.

The most significant weed threat in the City Forest is false brome (*Brachypodium sylvaticum*). At present it is most concentrated along roads and riparian areas, but it is beginning to move out into the general forest. False brome was found along every road in the ownership. It was also seen along roads that have been decommissioned.

In most forested areas, the understory is comprised of native species. There are a few areas where Himalayan blackberry (*Rubus armeniacus* aka *R. discolor*) is established and spreading in understory areas. A few ornamental species have escaped and are spreading in understory areas, including English ivy and English holly, but these are limited to a few areas low in the watershed. Introduced, perennial grasses and forbs are present in prairie habitats and threaten the peacock larkspur population and other native prairie species.

Control of false brome and Himalayan blackberry should be made a high priority. Understory and soil disturbance should be minimized during management activities to reduce opportunities for these and other exotics to invade forest habitats. Periodic weed surveys should be instituted to detect and control new invaders before they are entrenched.

Forest Stands

The 2,352 acre land base contains one of the largest concentrations of old-growth on non-federal land in Oregon. More than 98% of the area is forested, and the stands are dominated by Douglas-fir. Minor species include western hemlock, bigleaf maple, red alder, grand fir, Oregon white oak, Oregon ash, and western red cedar. The forest is composed of a diversity of ages reflecting the logging history of the site.

Young stands

Approximately 34%, or 797 acres, were logged within the past 22 to 50 years. These stands were clearcut using industry-standard techniques of the day on harvest blocks

averaging about 20 acres. Site preparation and prompt reforestation have resulted in young, very dense monocultures of Douglas-fir, with only occasional minor species and very little understory vegetation. These young stands are primarily located south of the main stem of Rock Creek, and they occur in both lower and upper elevation sites and on both north and south facing aspects. Access for managing these stands is fairly good using the existing logging road network. Steep slopes would require skyline tower logging.

Middle-aged stands

A second grouping of stands is roughly middle-aged, ranging from 50 to 110 years old, and comprises 443 acres, or 19% of the land base. These middle-aged stands reflect a diversity of origins. In the northeastern and northwestern corners of the property, there are stands in this group that may have originated following farm abandonment around the turn of the 20th century. These lands appear to have been cultivated and are on gently sloping to flat terrain. They likely seeded in naturally, following cessation of farming. Timber is predominantly Douglas-fir at very high stocking densities, but there are some widely scattered residual trees that may be as old as 300 years. Access for managing these stands is quite good due to the terrain and long distance from streams; ground-based harvesting equipment may be used in most cases. A second cluster of stands in this age group occurs in the southern part of the ownership within the Griffith Creek drainage. The terrain here is much steeper, and these stands originated after logging that occurred in the 1920s through the 1940s. The standard logging practices of that time did not result in complete removal of all mature timber; some of the trees with defect or rot were left standing, and numerous cull logs remain on the ground. The area was left to reforest naturally, which occurred over a period of at least two decades. The resulting stands have higher species and age class diversity and contain some of the critical biological legacies of old-growth stands, such as very large (greater than 5 feet in diameter) trees and snags and down wood. The stands that became established after logging exhibit variable density, from fairly open with high inclusion of hardwoods and shrubs, to very dense with the potential for high levels of competition-induced mortality. Upland areas are accessible for management using tower yarding techniques. The Franklin Ridge Road provided good access to these stands prior to being decommissioned in the 1990s.

Older stands

The third category includes the stands that have never been logged. These areas comprise 46%, or 1,083 acres of the total ownership, primarily in large blocks on the north side of the main stem of Rock Creek, and in scattered remnants to the south. Although federal forestland in the nearby Siuslaw National Forest contains large acreages of old growth, concentrations of older timber in private, state, or municipal ownership in the Coast Range are relatively rare.

These stands typically have widely spaced old-growth Douglas-fir with several additional age classes of Douglas-fir, as well as western hemlock, grand fir, and bigleaf maple that

have regenerated naturally over time. In some relatively small areas of wetter soils, western red cedar is a dominant species.

Analysis of historical records, as well as the age class distribution of the forest stands, makes clear that prior to European settlement, this area was subject to frequent low intensity burning propagated by native tribes. The current old growth trees, some of which are now 500 years old or more, were growing in a fairly open condition prior to the early 1800s, with regular burning keeping down the brush and preventing the large-scale establishment of more dense forest stands. Following European settlement and the end of burning, there began a sustained period of natural regeneration that "filled in" the gaps among the dominant old growth trees.

The resulting stand structure consists of widely spaced, dominant old-growth trees surrounded by patches of young Douglas-fir that readily colonized the burned over ground. These sub-dominant stands range in age from 125 to about 200 years. In many cases they are now outcompeting the residual dominants for light, and causing the dominants to lose the lower portions of their crowns due to excessive shade. In a few areas, residual Oregon white oak and madrone, both of which require ample sunlight to thrive, are clinging to life under the shade of towering 150 year-old Douglas-fir – a reminder that these areas were much more open in times past.

While old-growth stands are often characterized by high levels of rot, with some snags and large down logs, the old growth in the Corvallis Forest does not fit that description. Because the trees were in an open grown condition for centuries, they have retained very healthy, full crowns, and have developed large, stable root systems. As a result, only a small percentage of these giants have succumbed to rot or windthrow over the past two hundred years; hence there is a relative paucity of large snags and down logs on the forest floor.

Timber Volumes

The last estimate of timber volume was done for the 1993 Draft Management Plan. In that plan, volume estimates were taken from the 1984 Management Plan, with no attempt to verify accuracy. Current volume estimates (Table 4) were derived from growing 1993 volumes forward, with no additional data collection. These numbers should be used for illustrative purposes only. Field reconnaissance was done to check their reasonableness.

Of the estimated 95 million board feet of Douglas-fir on the Corvallis Forest, plantations make up a relatively small percentage of the total volume. The 640 acres* of young stands contain approximately 8 million board feet of merchantable timber, primarily in the older age classes. Middle aged stands contain approximately 25 million board feet volume, while the older, more numerous stands have the bulk of the volume at 62 million feet.

Table 4. *Estimated timber volumes by age class*

	Acres*	**Volume****	**Volume Per Acre Range**
Plantations:			
< 26 years old	125	….	….
26-40 years old	351	4.2 million board ft.	7-18,000 bd. ft.
41-50 years old	164	3.8 million board ft.	18-30,000 bd. ft.
Middle Stands 51-110 years old	432	25 million board ft.	32-70,000 bd. ft.
Older Stands 111-180 years old	883	62 million board ft.	60-86,000 bd. ft.

*Acres are taken from the original 1984 stand type map. They do not match acres presented elsewhere in this plan. The original stand type map does not include acres that were in reserve areas at that time.

**Volumes are rough estimates and should be used for comparison purposes only.

Map 5 Forest Structure

Soils, roads and slope stability

The City property contains soils of the Blachly, Honeygrove, Jory, Klickitat, and Ritner series (Knezevich 1975). As in much of the Coast Range, the area has narrow valley bottoms and steep slopes. The soils are typically gravelly clay loams on steep slopes and gravelly clay on lower slope positions. They are deep, well drained and of volcanic origin. Both earthflows and debris torrents can occur in the upper elevations and steeper portions of the ownership; however, the entire main block of the City's ownership is rated low risk for debris torrents (USDA Forest Service 2005). Slumps and small earthflows are the primary hillslope erosion processes on the property.

Slope stability is an important factor in determining what kinds of forest management activities are possible or desirable. Because many streams in the area, including the main stem of Rock Creek, are lacking in large woody structures for fish habitat, unstable slopes are particularly poor candidates for clearcut harvesting. Doing so would remove the potential to deliver large woody debris to streams, which is necessary for building fish habitat such as deep pools.

The road system, which is mostly owned by the Forest Service, presents another potential challenge for water quality and fish habitat. The first road in the watershed was built in 1906 to follow Rock Creek from Highway 34 to the original water impoundment. A road system was developed primarily for logging purposes starting probably in the 1920s. The road system was upgraded and expanded in the 1950s and 1960s as the Forest Service began salvage harvesting in the upper reaches of the watershed following windthrow and subsequent insect outbreak. In 2003, the Siuslaw National Forest conducted a Forest Roads Analysis that included the City's ownership; it analyzed the condition of the road network and included a system for prioritizing road maintenance within the larger Marys River watershed (USDA Forest Service 2003). The status of existing roads in the City's ownership is summarized in Table 5.

Portions of the road system, mainly on the south side of the main stem of Rock Creek, have been upgraded and maintained by the Forest Service. Recently, the City has taken over maintenance for some of these roads to facilitate access to its facilities. These roads are generally well constructed and in good condition with relatively low maintenance requirements. There are few mid-slope locations; the roads are mainly located on ridgetops, with mostly moderate to low grades.

On the north side of Rock Creek, the roads do not provide direct access to Forest Service lands, and therefore have not received similar maintenance and upgrades. These include

the Old Trail Road (#3405-111) and the Old Peak Road (#2005-111). Both of these roads are low gradient, but the Old Trail Road contains numerous culverts that block fish passage to main stem tributaries.

Following a minor surface landslide flow and movement of a deep seated slump, the Franklin Ridge Road (#3005) was decommissioned by the Forest Service in the late 1990s.

Table 5. *Major roads in the Corvallis Forest*

Road #	Name	Length	Purpose/use	Status	# culverts
2005-111	Old Peak Road	1/2 mile	Timber management; recreation	Open	None
3005	Franklin Ridge Road	¾ mile	Timber management; access to Forest Service land	Decommissioned	None
3405	Rock Creek Road	3 miles	Main access road; access to intake structure on South Fork	Open	21
3405-111	Old Trail Road	2 miles	Pipeline maintenance; access to reservoir	Open	9
3406	Griffith Ridge Road	1 ¼ miles	Timber management; access to Forest Service land and outlier City parcel	Open	8
3406-112	Middle Fork Spur Road	¾ mile	Ridgeline access for timber management	Open	None
3408	Miller Ridge Road	1 mile	Access to Forest Service land and outlier City parcel	Open	1
3408-112	Unnamed	½ mile	Ridgeline access for timber management	Open	None
3409	Unnamed	1/8 mile	Access to Forest Service land	Decommissioning recommended by Forest Service	None

Road numbering based on Forest Service conventions

Social and Economic Context

The Corvallis City Forest is located in rural Benton County, near Philomath. Although the setting is rural, the importance of this asset to the City of Corvallis and surrounding communities cannot be underestimated. The community of Corvallis takes pride in its

location at the heart of the Willamette Valley and in the beauty of the surrounding forested hills. The slopes of Marys Peak form an easily recognizable backdrop that help define a city that is a blend of its rural resource-based economy (timber and agriculture) and educational and technological strengths (Oregon State University and high-tech industries). The Rock Creek Watershed, while supplying only one third of the City's needs, is perceived as the reason for the high quality water and is seen as important habitat for fish and wildlife. Another social benefit (though intangible) is the "sense of place" and connection to the surrounding resource lands that a watershed can foster in a small community. This is evidenced by the concern over past management practices and the current public interest in forest health and fisheries management issues in the City Forest.

Economic impacts of the City Forest are primarily limited to water supply. The City of Corvallis has restricted public access and prohibits recreation to protect the resource. The watershed contributes to the economic climate of the area by providing clean air and clean water (into Rock Creek) and helps protect the viewshed (forested hills) from town.

Timber harvests on the City Forest have made a direct contribution to the local economy in the past. Harvests have contributed revenue to the City, produced expenditures in the private sector, and generated jobs for local contractors and mill workers by providing a periodic source of sawlogs to mills in the region.

Recreation and Visual

The Corvallis Forest is closed to public entry, and posted against trespass. Access is strictly controlled; all gates are locked, and keys are strictly monitored. Public recreation is generally not allowed. However, walk-in deer hunting has been allowed beginning approximately 1960 as a means to reduce deer browse on planted seedlings. Abutting Forest Service lands in the upper watershed are open to limited public recreation, including some roads, and several segments of trails open to hiking and mountain biking.

There is regular public interest in seeing and visiting the property. A permit process and strict policies for group use are in place; permission is granted on a case-by-case basis. By reciprocal agreement Siuslaw National Forest and the City jointly notify each other whenever permission is granted to an individual or group to enter the watershed.

A local group has proposed using Old Peak Road on the north perimeter of the property as the route for the envisioned Corvallis-to-the-Sea Trail. They see this route as a key linkage between Philomath and Marys Peak.

Because most of the property is not open to public access, visual concerns are limited. Little of the property is visible from publicly traveled roads. Most vistas are limited to

distant views of some upper east and south facing ridge tops. Much of the property when viewed from inside the ownership is very scenic, especially riparian views along Rock Creek Road (#3405), older forest stands, and views from ridge tops.

Education and Research

The closed watershed provides excellent opportunities for controlled studies in forestry, hydrology, botany and other disciplines that need areas protected from outside interference. The Corvallis Forest has been used frequently by local schools and colleges, and fish and wildlife researchers. Education and research access to the watershed property is allowed only by permission and special use permit. Group tours average six per year. There are two active monitoring or long-term research projects currently underway on the property.

Fire Management

The City has a policy of active suppression of any fires, and cooperates with the Oregon Department of Forestry for fire protection and monitoring, for which the City pays an annual per acre fee. To minimize fire hazards and risks, the water plant staff regularly mow roadsides and around facilities to reduce fine fuels, clear blowdowns on roads to maintain vehicle access, and patrol roads for trespass. Most fire starts in the Coast Range are human caused. Public access closure of the watershed eliminates the most probable cause of fires.

Revenue

The City maintains two funds to support water system operations and projects. The "Water Fund," primarily funded by revenue from water receipts, is used for water system operations, planning, and administration. A separate "Water Timber Fund" receives revenue from the City Forest property, including timber sale receipts. This fund is used for maintenance and projects on the property, and also supports capital water projects.

Facilities

Numerous facilities for water production and treatment are located on the property. These include the North Fork Reservoir, active diversion structures on Griffith Creek and the South Fork of Rock Creek, and an inactive diversion on the Middle Fork of Rock Creek. Water is piped from these diversions to a treatment plant on the property. Water treatment structures include the water treatment plant, two settling ponds, two backwash lagoons, and a backwash tank. Two year-round residences provide on-site housing for the water treatment plant operators. Other structures include maintenance and utility sheds and a communications tower. Leaving the City property, water enters an interconnected system of eight storage reservoirs and 246 miles of distribution lines located throughout the City of Corvallis.

4.Policies

This chapter documents how the watershed will be managed. A Vision Statement and Guiding Principles provide overall guidance. For each resource area Policies stated that will guide all future stewardship activities. All subsequent operational plans will be guided by these policy statements, and field results will be judged by the level of compliance with the intent of these resource policies.

Vision Statement

The City-owned portion of the Rock Creek Municipal Watershed is a professionally managed, healthy ecosystem with a diverse forest and productive habitat for all species native to the watershed.

Guiding Principles

The property is actively managed for multiple sustainable objectives including clean water, productive soils, forest products harvest and limited recreational opportunities and is:

- A "good neighbor" and integrated into the larger landscape and watershed;
- Comprised of a variety of different ages and types of forest to provide diversity of terrestrial and aquatic habitats;
- Resilient to fire, invasive species, insects and disease;
- Access controlled to minimize risk of fire, water contamination and invasive species introduction;
- Available for limited educational, recreational, and research opportunities;
- Dedicated to supporting high quality water production for the City of Corvallis;
- A generator of revenue that may offset the cost of management of the property, and secondarily to help fund the City of Corvallis water utility system.

Desired Future Condition

The desired future forest on the watershed property will include:

- Reserve areas to protect water quality and other sensitive resources.
- Plant communities dominated by native species that are vigorous and resilient to disturbance and climate change.

- Forest stands representing a variety of different ages and types, to provide a diversity of wildlife habitats.
- Healthy streams with high quality water that provide good aquatic habitat for native fish and other stream dwellers.
- Key old forest structural features that are nurtured and protected, including large trees, multi-aged stands, and biological legacies, including snags, large cavity trees, coarse woody debris, hardwoods, and shrubby openings.
- Special features and unique communities that are identified and maintained, including oak savanna/oak woodland, meadow habitats, and riparian forests.
- An arrangement of forest stands and plant communities across the property that provides connectivity of wildlife habitats, and integrates with that of the surrounding landscape.

Resource Policies

Specific recommendations to help implement these policies are included in the following chapter. Additional standards and guidelines under each resource policy area are included in Appendix A.

Forest Age/Structure

It is the policy of the City of Corvallis to manage the Corvallis Forest to protect older forest stands and old forest legacies within younger stands, while providing a variety of different ages and types of forest and habitat conditions.

Reserves

It is the policy of the City of Corvallis to establish Reserve Areas on the Corvallis Forest to protect streams and water quality, wildlife and other areas of unique habitat or ecological values.

Fish Habitat & Stream Structure

It is the policy of the City of Corvallis to increase stream diversity and to enhance fish habitats on the Corvallis Forest, including fish passage, riparian protection and improvement.

Wildlife Habitat

It is the policy of the City of Corvallis to enhance wildlife habitats, promote connectivity, protect unique habitats and increase diversity on the ownership.

Water Quality

It is the policy of the City of Corvallis to protect and enhance the quality of water and the health of the aquatic environment within its ownership. Corvallis seeks to minimize the adverse effects of necessary water withdrawals on stream health.

Native Vegetation & Invasive Species

It is the policy of the City of Corvallis to promote native plant communities and actively monitor, control, and reduce invasive plant populations.

Roads

It is the policy of the City of Corvallis to reduce road impacts on water quality within the Corvallis Forest, and to minimize new road construction.

Herbicides

It is the policy of the City of Corvallis to allow the use of limited quantities of forest herbicides for invasive weed control.

Public Access

It is the policy of the City of Corvallis to prohibit general access to the Corvallis Forest, but implement access controls to allow educational, research, special permitted usage. The City's policy includes allowing access to Old Peak Road for non-motorized Corvallis-to-the-Sea use.

Neighbors

It is the policy of the City of Corvallis to cooperate with neighboring landowners and aligned organizations to ensure quality water for the citizens of Corvallis, protect wildlife and stream habitats, and to achieve joint objectives and projects.

Fire

It is the policy of the City of Corvallis to protect the Corvallis Forest from wildfire and to manage forest stands to reduce fire risk.

Planning & Monitoring

It is the policy of the City of Corvallis to adopt and implement a Stewardship Plan for the Corvallis Forest, and to monitor management to minimize adverse impacts and meet Plan goals and objectives.

5.Management Recommendations

This chapter summarizes management needs and opportunities by resource area, and prioritizes recommendations. A timeline for suggested activities and operations follows at the end of the chapter.

Fish Habitat & Stream Structure

Opportunities

- Aquatic conditions can be improved in the mainstem of Rock Creek by boosting instream wood complexity, establishing riparian conifers, removing the remnants of an old dam and reconnecting an historic stream channel.
- Additional suitable habitat can be made accessible to Steelhead, Cutthroat, and Pacific Lamprey by providing fish passage around diversion structures and perched culverts on Rock Creek Tributaries.
- Water quality and aquatic systems can be safeguarded by improving road maintenance, protecting against sedimentation and including riparian forests on Rock Creek and its tributaries in management reserves.
- Water quality and quantity information can be enhanced by monitoring stream flows and water quality conditions below intake structures.
- Review Water System management procedures for opportunities to increase downstream water quality and quantity for fish.

Recommended Actions Fish Habitat & Stream Structure

1.1 Retrofit the South Fork Rock Creek diversion structure fish ladder to improve function

1.2 Replace the Middle Fork Rock Creek main culvert

1.3 Design and build a fish ladder on the Griffith Creek diversion structure

1.4 Redirect stream flow from side channel to historic channel on the main stem Rock Creek

1.5 Monitor stream flows and temperatures below water catchments to develop baseline data and identify impacts

1.6 Add large woody structures (trees, logs) along the main stem of Rock Creek

1.7 Replace the Stilson Creek main culvert

1.8 Replace the main culvert on Tributary D

1.9 Remove the collapsed concrete dam on the main stem of Rock Creek

1.10 Consider various changes in Water System management protocol to improve water quality and quantity

Wildlife Habitat

Opportunities

- The rich array of native biodiversity can be maintained and expanded.
- Snag and woody debris levels can be increased.
- Hardwoods and shrub health and diversity can be increased.
- Riparian habitats can be protected and enhanced.
- Maturing forests can provide good habitat for many old-forest dependent species.
- Young plantations can be thinned for biodiversity. Stands can be managed to increase species diversity.
- The large, contiguous acreage of maturing and riparian forests can benefit wildlife on a landscape-wide basis (beyond the property boundary).

Restoration options

Snag Creation

Snags are important habitat components that are currently scarce on the City Forest, particularly in young plantations. Creating snags would encourage nesting by primary excavators including:

- Northern Flicker
- Hairy Woodpecker
- Downy Woodpecker
- Red-bellied Sapsucker

and provide foraging opportunities for Pileated Woodpecker.

In addition, a large number of secondary cavity-nesting species, including

- Chestnut-backed Chickadee
- Red-breasted Nuthatch
- Screech, Pygmy and Saw whet Owl
- Douglas and Flying squirrel
- Townsend's Chipmunk

may utilize the stands.

Recommended Actions Wildlife

2.1 Thin young stands to create future stand diversity and increase vigor of residual trees

2.2 Thin middle aged stands to maintain and increase diversity (only when action will not disturb or impact habitat of sensitive and listed species).

2.3 When lacking, create snags and down logs in conjunction with harvest operations. Provide additional small mammal, amphibian and reptile habitat by creating brush piles.

2.4 Survey for Murrelets to update species status and provide management guidelines for planned activities.

2.5 Increase oak habitat where it exits by reducing overall conifer cover

2.6 Promote areas of grassland habitat by removing encroaching trees

2.7 Plant conifers in riparian zones, where lacking and where ecologically appropriate

2.8 Top trees, create cavity-habitat, and increase down wood in reserves

Forest Structure and Harvests

Opportunities

- A mix of moderate terrain and good road location above the steeper slopes enables small scale, environmentally sensitive logging techniques.
- Tree vigor and wildlife habitat quality can be improved by a program of restoration thinning in young and middle aged stands. The range of tree ages can be maintained and expanded.
- Threatened "legacy" trees (centuries old fir) can be maintained in stands by thinning younger trees around them.
- Where appropriate, the diversity of tree species can be increased by cutting fir to open small regeneration patches and using a variety of species in new plantings.
- The wide variety of forest types and planned operations offer opportunities for demonstration and education.

Recommended Actions
Forest Structure

3.1 Conduct timber inventory cruise

3.2 Thin young stands to increase structure and complexity

3.3 Thin middle aged stands of agricultural origin to promote diversity and tree vigor

3.4 Conduct trial thinnings in middle aged and old stands to promote forest health

Restoration options
Variable density thinning

Variable density thinning includes, as the name suggests, a mix of thinning techniques (light thin, heavy thin, small gaps, no thin) to create future stand diversity and increase growth and structural diversity of residual trees. Researchers have found that variable density thinning in young conifer stands can rapidly increase diversity of breeding songbirds. Species such as Western tanager, Townsend's solitaire, red-breasted sapsucker, hairy woodpecker, American robin, gray jay and dark-eyed junco are likely to increase in presence and abundance after thinning. There are a few species, including hermit warbler, golden-crowned kinglet, winter wren and varied thrush, whose densities may decrease after thinning; however, they are all very common species which will persist in the thinned stands and are also abundant in older conifer forests.

Table 6. Forestry Prescriptions

Recommended stand treatments can be grouped into five general categories
Thinning — In some areas overcrowding is resulting in decreasing crown size and declining tree vigor. Individual tree selection thinning may be from above (removing larger trees), below (removing smaller trees), or balanced (removing trees of all sizes). Thinning should encourage transition to uneven-aged structure in stands that have two or more crown layers. Each entry should remove no more than 35 percent of stand volume, except in special circumstances where the harvest goal is to encourage understory tree regeneration or shrub layer growth in small areas (gaps). Thinning intensity will vary according to site-specific needs. Thinning is needed on several hundred acres of plantations and some middle-aged stands over the next 10 years.
Regeneration — To harvest groups of mature or at-risk trees and initiate new seedlings, or create more structural diversity. Group selection cutting will create small patches (one tree height) or large openings (several tree heights up to 5 acres) based on light requirements and stand condition. At least 15 percent of the original stand would be retained in large openings. Regeneration harvesting is not needed over the next 10 years due to the high acreage of young plantations.
Hardwood Release— Madrone, bigleaf maple, and oak are being overtopped by faster growing fir in some stands. Maintenance and restoration of these trees may be needed where they are important components of wildlife habitat diversity. Depending on location and stand condition, fir may be either slashed (for seedlings and saplings), girdled, topped (to create wildlife habitat), or commercially logged.
Habitat improvement — Site specific treatments target specific habitat conditions for improvement (i.e.. stream restoration, riparian plantings, oak restoration, snag creation). Several habitat improvements have been recommended.
Wait — Stand has no current needs.

Native Vegetation and Invasive Species

Opportunities

- Stable and healthy native plant communities are present.
- Healthy shrub understory plant communities are abundant, particularly in naturally regenerated forest stands.
- Invasive, non-native species are not yet widely established across the property, allowing effective early control.
- Planned habitat improvements offer opportunities for demonstration and education.

Restoration options

Oregon white oak

There are still a few scattered oak trees in the City Forest, but they are disappearing as younger but taller conifers shade them out. Protecting existing oak trees through established oak restoration techniques will preserve these legacies for future generations and increase the potential for a number of oak associated species including

- Gray squirrel
- White-breasted Nuthatch
- Chipping Sparrow
- Western Bluebird
- Sharp-tailed snake.

Recommended Actions Vegetation

4.1 Develop a restoration and management plan for rare plant populations and for special habitats such as prairie, savanna and oak woodland

4.2 Control and reduce False Brome with targeted herbicide applications

4.3 Develop a weed control plan and protocols for all forest management operations

Water Quality

Recommended Actions Water Quality

5.1 Develop a stream monitoring plan to assess water quality and stream health

5.2 Protect expanded and relocated Reserve Areas that include Rock Creek, its tributaries, and slide prone areas

5.3 Monitor stream flows and temperatures below water intakes; research minimum flow criteria

5.4 Maintain and/or enhance riparian forests to promote stream shade

5.5 Prohibit general access to the City Forest

5.6 Increase road maintenance to reduce sediment delivery to streams

5.7 Use results of the stream monitoring program to inform and improve stewardship activities within the watershed

Public Access and Roads

Opportunities

- Public interest in the City Forest will be fostered by providing limited access.
- Old Peak Road is isolated from the watershed infrastructure and public access can be allowed for non-motorized use without compromising security.
- Public Works employees live and work onsite and can provide some assistance with controlling access.
- Watershed monitoring will be benefited by providing continued access for education and research.
- In some locations, the road system can be improved (new culverts, rock surfacing and grading). Regular road inspection and maintenance will help preserve the current system and protect water quality.

Recommended Actions Public Access and Roads

6.1 Allow educational and research access by special permit

6.2 Conduct an annual public tour

6.3 Develop criteria for permitting or denying access to the public

6.4 Research the significance of equestrian use on the spread of invasive weeds

6.5 Establish a regular program to monitor and maintain the road system

6.6 Re-establish Franklin Ridge Road for fire control and forest restoration (City portion)

Restoration options

Forest openings

Prior to European settlement, the City Forest was subject to native burning, and as a result, there were likely many open areas scattered throughout the forest. These forest openings have diminished since burning stopped, and especially over the past 20 years due to the absence of clearcut harvest and the successional development of previous harvest units into shrub/sapling and pole stands. Therefore, the few open, grass dominated areas represent the only remaining habitat for the many associated wildlife species. Increasing the size of these areas by removal of encroaching fir trees and shrubs is strongly recommended. Restoration of native grass and forb species in these areas will greatly increase the potential for invertebrate species and enhance the foraging potential by vertebrates.

Reserves

Opportunities

- An expanded Reserve Area will ensure long-term protection of important interior and forest riparian habitats.
- Some steep slopes with potential to contribute large woody debris to streams currently are not afforded Reserve status.
- Important tributaries of Rock Creek, including Stilson Creek, are not currently protected as Reserves.

Management Actions Reserves

7.1 Expand the current Reserve Area to include additional tributary streams and steep slopes with potential to deliver wood to streams (See Reserve Map for delineation of proposed Reserve Area).

Neighbors and Aligned Organizations

It is the policy of the City of Corvallis to cooperate with neighboring landowners and aligned organizations to ensure quality water for the citizens of Corvallis, protect wildlife and stream habitats, and to achieve joint objectives and projects.

Opportunities

- Habitat connectivity can be optimized by coordinating management activities with adjacent owners
- Local organizations can provide technical expertise, project support, and monitoring assistance
- Joint restoration projects can leverage funding sources
- Road maintenance can be coordinated with the Siuslaw National Forest
- Participating in the newly formed Marys Peak Stewardship Group can provide an opportunity to influence regional planning and direct funds to locally important restoration projects

Recommended Actions Cooperation with Neighbors

8.1 Designate a member of the Watershed Advisory Committee as a representative to the Marys Peak Stewardship Group, and participate in regular meetings

8.2 Develop a cooperative Road Maintenance Agreement with Siuslaw National Forest

8.3 Confer with Siuslaw National Forest and other abutting owners when planning restoration activities

8.4 Coordinate with Marys River Watershed Council and other organizations when developing monitoring and restoration plans

8.5 Engage community volunteers to assist with monitoring

8.6 Invite neighbors and interested groups on annual public tour

Map 6 Reserves

6.Recommendation Timetable

Corvallis Forest
2007–2010

Note: the following is a planning scheme for the first four years. Actual extents and timing of activities will dependent on log markets, available labor, availability of additional funding sources, and other factors. Project specifications and budgets should be prepared prior to scheduling operations.

year	action*	activity	notes
2007	1.1	Retrofit South Fork Rock Creek fish ladder	
	1.2	Investigate funding for Middle Fork culvert replacement ……	Forest Service & OWEB funding
	1.3	Secure funding for Griffith Creek fish ladder	may be available
	2.3	Create snags and down logs, identify legacy trees …….. and wildlife trees	in conjunction with harvest and in reserve areas
	2.4	Begin survey for Murrelets ……...	where operations are planned
	3.1	Conduct forest stand inventory	
	3.2	Thin older plantations (approx 30 acres)	
	3.3	Thin middle aged stands of ag origin (30 acres)	
	4.2	Develop invasive plant control plan	
	5.2	Conduct annual public tour …….	Tour ongoing activity
2008	1.3	Build fish ladder for Griffith Creek	Begin when cost share
	1.2	Secure funding for Middle Fork culvert replacement	funds are available
	1.2	Replace Middle Fork culvert ……..	Cooperative venture
	2.3	Continue annual effort to create snags and wildlife structures	
	2.5-2.6	Remove encroaching trees in grass and oak habitats	
	2.7	Plant conifers in riparian zones where lacking	
	2.1	Pre-commercial thin younger plantations	
	3.2	Thin older plantations (approx 30 acres)	
	3.3	Thin middle aged stands of ag. origin (30 acres)	
	4.2	Begin False Brome control program (four year annual effort)	
	5.2	Conduct annual public tour	
2009-10	1.4	Redirect stream flow from side channel on Rock Creek	
	1.5	Monitor stream flows below water catchments ……	Part of a stream monitoring plan
	1.6	Add woody debris to main stem of Rock Creek	
	1.7	Secure funding and replace Stilson Creek main culvert ……	When cost share funds are
	3.2	Thin older plantations	available
	3.3	Thin middle aged stands of ag. origin	
	4.2	Continue False Brome control program	
	5.2	Conduct annual public tour	
	5.1	Continue research/monitoring/educational projects ……..	Emphasize cooperative ventures and partnerships

1 See below for the preliminary cost and revenue estimates for these recommendations.
* Action numbers are from the recommendations tables found earlier in this section

7. Draft Cost/Revenue Estimates 2007-2016

Forest Structure	**Income**	**Cost**
• Inventory Forest Stands:		$30,000
Commercial Thinning Projections:		
• Thin all young stands >30 years old, 30% removal (280 acres, 2.24 mmbf, net $1,785/ac):	$500,000	
• Thin middle-age ag-origin stands, 25% removal (145 acres, 2.175 mmbf, net $6,000/ac):	$870,000	
• Trial thin in middle stands for forest structure (44 acres, 0.570 mmbf, net $4,550/ac):	$200,000	
Total acres treated = 469 ac (20 % of total acreage)		
*Total income = $1,570,000 ($157,000/year)**	**$1,570,000**	

Fish Habitat/Stream Structure	
• South Fork fish ladder improvement:	$10,000
• Middle Fork culvert replacement:	$100,000
• Stream monitoring plan and flow monitoring:	$25,000
• Griffith Creek diversion fish ladder addition	$75,000
• Stilson Creek culvert replacement:	$100,000
• Trib D culvert replacement:	$25,000
• Redirect stream flow from side channel on Rock Creek	$5,000
• Add wood to main stem Rock Creek:	$25,000
Total cost = $365,000 ($36,000/year)	

Wildlife Habitat	
• Murrelet surveys (up to $1,500 per survey site):	$15-30,000
• Tree topping for snag creation (100 trees/year @$75/tree):	$75,000
• Pre-commercial thinning for forest structure (young stands <30 years old, 300 ac @$75/ac):	$25,000
• Riparian Planting:	$5,000
Total cost = around $135,000 ($14,000/year)	

Invasive Species	
• Develop Weed Control Plan:	$3,000
• False-brome control (1st treatment: est. 10 days @ $2,000/day for 5-man crew):	$20,000
• False-brome control (2nd and 3rd treatments):	$20,000
Total cost = $43,000 ($4,300/year)	

Public Access & Roads	
• Annual Public Tour:	$3,000
• Monitor and maintain road system	$100,000
• Re-establish Franklin Ridge Road	TBD
Total cost = $103,000 ($10,000/year)	
(Costs do not include probable grant funding) Estimated Total Costs:	**$675,000**

* Costs of operational plans are included in harvest management costs

8.Monitoring and Adaptive Management

The following discusses the types of plans and reports needed to guide effective management and ensure adequate recordkeeping. A system for monitoring plan implementation and management practices is described. Monitoring plan implementation and management practices are the responsibility of City staff, as advised by the Watershed Management Advisory Commission and approved or directed by City Council.

Plans

The Stewardship Plan for the Corvallis Forest shall be reviewed every 10 years, and revised as needed. Operational Plans shall be prepared annually. Operational plans include the harvest prescription or project specifications, including maps, stand delineations, reserve areas, intended outcomes and implementation details. Brief Project Reports are prepared following completion of the project, detailing immediate results.

Monitoring

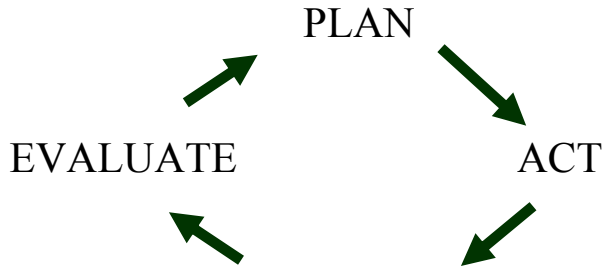
Monitoring provides information to help determine if the forest management activities are meeting the City's Vision and Guiding Principles, and are adhering to the Plan's Policies and Guidelines. Through the monitoring process determinations may be made as to whether the Plan needs to be amended or management activities need to be redesigned.

The objectives of monitoring are to:

- Assess the implementation of the plan and strategies
- Evaluate the effectiveness of the strategies in achieving the expected results.
- Assess the assumptions built into the plan.
- Evaluate the extent to which goals are being met.
- Practice adaptive management.

Monitoring is an essential part of an adaptive management loop — a framework for continually improving the state of our knowledge about the forest, and acting on new information. This simplified adaptive management process is shown in Figure 3.

Figure 3. *Adaptive management*



MONITOR

Baseline information is needed on all resources addressed in monitoring plans. Additional information is needed on forest stand inventory, Marbled Murrelet populations, and water quality and quantity. These data will be collected (or collection initiated) during 2007.

Monitoring questions are a useful way to begin the monitoring process. By formulating questions, useful measurement indicators can be identified, protocols developed, and data collected. Evaluating this new information may confirm the effectiveness of the management strategy and practice, or indicate that a revision to a plan, policy or practice is needed. This monitoring plan identifies an initial set of questions, and data to be collected for the City Forest.

This monitoring plan is intended to be a beginning. It is intended that it be revised over time, as the plan adapts to change.

Methods

To make monitoring cost-efficient and useful, this plan focuses on integrating monitoring into on-going forest management, not creating a separate process. This philosophy emphasizes an integrated approach where, as possible, information is collected during operational work, as part of the project. This may take the form a resource project report (e.g. cutting invasive weeds out of roadways) or a timber harvest report that collects on-site data during the activity.

There are several methods that can be used to monitor forest management activities:

- Sampling & direct measure
- Inventory
- Advisory groups
- Resource project reports
- Special projects

Sampling & Direct Measure: Periodic or ongoing measures are typical ways of monitoring water flow and quality. Extensive monitoring is done as a part of water system operations, and can be expanded to answer other monitoring questions.

Inventory: Measurement of resource conditions on a periodic basis provides a baseline of initial conditions, and helps to measure change in the forest and impacts of management activities. Included in this Plan are fish population and habitat surveys, rare plant and invasive species surveys, and a road culvert inventory. Additional inventory is recommended for timber resources, Marbled Murrelet populations, and water quality and quantity.

Watershed Management Advisory Commission: The Watershed Management Advisory Commission shall periodically meet to evaluate the progress in plan

implementation and discuss what is working well, what problems there are, and suggest possible adjustments to be made. As appropriate, technical review committees may be established to provide input to staff, the Watershed Management Advisory Commission or City Council.

Resource Project Reports: These are project reports, including pre-operational plans and post-operational reports. For example, a timber harvest plan will describe existing conditions, the harvest prescription and how it meets goals for stand development and structure such as tree density, snags, wildlife and legacy trees, down wood, etc.

Special Monitoring Projects: There may be cases where special monitoring projects are developed to answer specific questions. These can provide educational opportunities for students or interested citizens who want to be involved in data collection, with coordination and evaluation support from a resource professional. For example, additional wildlife species surveys.

Table 7 shows some of the planned monitoring activities on the City Forest:

Table 7. ***Monitoring Activities and Objectives***

Activity to be Monitored	Monitoring Objective	Methods	Frequency	Conditions Requiring Action
Water Quality & Aquatic Resources	Analyze stream flows & water withdrawals to determine aquatic impacts; Evaluate fish habitat, populations, and changes over time	Measure flows and temps above/below diversions; Aquatic insect surveys; Fish population & habitat surveys	Stream flow/temp – ongoing or periodic Aquatic insects – annual Fish pop/habitat – every 5-10 yrs	Declines in aquatic insect numbers or species diversity; negative changes in habitat conditions that depart from desired conditions
Wildlife Habitat	Update Marbled Murrelet population information; Measure change in quantity & types of wildlife habitat	Murrelet surveys; Snag, down wood, & shrub layer inventory	Murrelet – every 5 years Snag/CWD/shrub – with forest inventory, every 10 yrs	Any negative changes in populations or habitat conditions that depart from desired conditions
Vegetation & Botanical Resources	Determine presence or absence of rare plants; Measure changes in invasive plant populations	Field surveys in accordance with established protocols	Rare plants – survey prior to timber harvesting (as part of layout operations) Invasives – after management operations & every 5 yrs	Any rare plant sighting; Any increase in invasive species populations
Timber Management, Growth, & Mortality	Growth response to harvest; Change in snags & woody debris abundance; Reforestation establishment	Timber inventory; Operational reports; Stocking surveys	Inventory – every 10 yrs Operational reports – during routine field work Stocking surveys – 2nd & 4th year after establishment	Growth reduction or mortality Any declines in snag or CWD levels; Numbers not meeting ODF rules, seedling survival <75%, suppressed height growth

9.Public Involvement

The Watershed Management Advisory Commission provides a regularly scheduled means for public and professional input. This volunteer commission meets periodically to review operation plans, evaluate the progress in plan implementation and discuss program successes and problems, and suggest possible adjustments to be made. The Commission is advisory in nature, and per the Corvallis Municipal Code, members are appointed by the Mayor and confirmed by the City Council. The public is invited to Commission meetings and opportunities are provided for public comment.

An annual tour of the City Forest will also be open to interested members of the public.

GLOSSARY

anadromous Fish species which migrate from the ocean to freshwater rivers or streams to spawn

basal area A measure of tree density. The cross sectional stem area of all standing trees, measured at 4.5 feet above the ground, expressed as square feet per acre.

bedload Accumulated sand, gravel, cobbles, and wood within a stream channel. Bedload migrates down a stream system, providing important habitat for most aquatic organisms.

biodiversity The entire spectrum of plants, animals and other life forms, and their associated environments

clearcut Most or all trees in a harvest area are removed: opening size greater than 2 acres

commercial harvest A timber stand improvement or harvest operation that results in a net landowner income

DBH Tree measurement; diameter at breast height (4.5 feet above ground)

even-aged All trees within a forest stand are of the same age

geomorphology Characteristics and configuration of landforms

group selection Trees to selected to harvest are in groups; opening size is from several tree crown widths up to 2 acres

individual tree selection Trees to harvest are selected individually; opening size is one tree crown width

Late Successional Reserve Land within US Forest Service ownership designated under the Northwest Forest Plan to be managed for the creation of old growth forest conditions

mature Condition of optimal tree value, after tree vigor and growth have slowed, yet before the onset of decay

MBF Log measurement statistic; one thousand board feet. One board foot equals a board one inch thick by 12 inches square

merchantable Trees of sufficient size and quality to be commercially marketable.

mycorrhizae A mutually beneficial association of the mycelium of a fungus and the roots of certain trees and plants, where the fungus provides moisture and nutrients to the plant, and the plant provides carbohydrates to the fungus.

operability Ease with which logging machinery could work a site; often limited by rockiness, steep slopes, wetness, etc.

patch cut A harvest where small areas (0.5-2 acres) are cut, taking most of the standing trees with the exception of clumps of younger conifers and older residual wildlife trees

prescribed burn A fire intentionally set and closely managed to produce a specific management effect. Prescribed fires are typically slow moving, cool burning, and carefully controlled to prevent escape.

regenerate To establish a new stand of tree seedlings

regeneration Seedlings of commercial tree species

riparian zone Areas next streams, lakes, estuaries and wetlands consisting of wet soils and the transitional habitat between wetland and upland; practices are typically regulated by law.

salmonid Fishes from the family Salmonidae, including salmon, trout, and char. Many species are anadramous.

savanna A plant community characterized by primarily grasses, with shrubs and widely scattered and open trees.

scarification Exposing mineral soil mechanically to prepare a harvested site for natural reseeding

seedling Tree greater than six inches tall but less than one inch DBH

snag Standing dead and/or dying tree. Important habitat element for numerous wildlife species

timber type A homogeneous unit of forestland, delineated because it supports trees of common species, age, potential, etc.

understory Trees, shrubs, and herbs growing under a canopy of larger trees.

uneven-aged Trees within a forest stand are of two (or more) distinct age groups

unmerchantable Trees lacking sufficient size and quality; not commercially marketable.

woody debris Down woody material on the forest floor, ie. fallen and rotting logs and limbs. An important source of organic matter and soil nutrition

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Appendix A: Policy Standards and Guidelines

Forest Age/Structure

It is the policy of the City of Corvallis to manage the Corvallis Forest to protect older forest stands and old forest legacies within younger stands, while providing a variety of different ages and types of forest and habitat conditions.

Standards and Guidelines

Silviculture

- Retain alder, bigleaf maple and minor tree species in Douglas-fir dominated stands to increase diversity.
- Selection thinning and variable density thinning are the preferred harvest methods, especially in areas of high visual and/or environmental sensitivity.
- Typical thinning removals should average 20-35 percent of the trees. No more than 50 percent of stand volume should be removed in any thinning entry .
- The harvest cycle is determined from response of the thinned trees . Stands are re-entered when thinning is needed to reach stand development goals.
- Small openings (less than 1 tree height in width) will be used to encourage and regenerate shade tolerant species and increase forest stand diversity. Larger openings (1–3 tree heights) to regenerate moderate- or shade-intolerant species. Group selection (patch cutting with retention) is the preferred method of regenerating stands, with the maximum group size being 5 acres.
- Harvest openings (patch cuts) blend in with the natural terrain. A minimum of 15 percent of the initial stand is retained. Retained trees are selected to promote windfirmness.
- The distance between harvest openings shall be sufficient to promote stand windfirmness and wildlife cover, and is generally a minimum of 1.5 tree heights .

Sustainable harvest level

- Property harvest level calculations consider only areas available for harvesting (reserve areas excluded).
- Total harvest volumes over a ten-year period do not exceed total growth during any ten-year period.
- Preferred harvest levels are 50–70% of growth for young stands (to allow stands to become more mature), up to 100% of growth for non-reserve older stands (to maintain tree vigor and allow gaps for regeneration).

Rotation

- For even-aged stands the target age at maturity ranges from 75 to 200 years.
- For uneven-aged stands, harvest regulation is based on maintaining a at least two or three different ages of trees within the stand.
- Seedlings and saplings ultimately comprise a minimum of 5% of the managed forest. Adequate regeneration is needed every 20 years to maintain this balance..

Timber harvesting

- A professional forester supervises all aspects of timber harvest operations, including: marking trees to be cut; wildlife, legacy trees, and other protected resources. The forester provides ongoing stumpage accounting, and notifies the City in case of contract or environmental infractions.
- All legacies of the older forest (e.g. residual trees, snags, large cull logs) receive high levels of protection.
- Boundary lines are marked prior to any nearby harvest activity. Adjoining property owners are notified before harvest start-up.
- Logging is conducted in ways that insure public safety and minimize user conflicts.
- Logging equipment is specified to facilitate small harvests, low site disturbance, and minimized road-building costs. The smallest equipment that will do a satisfactory job at a reasonable cost is utilized.
- Logging is restricted to dry-season conditions (to minimize soil impacts and road building costs), and avoided during early spring (to limit bark damage).
- Loggers fall trees and process logs to minimize waste and maximize timber yields.
- Ground logging equipment is restricted to designated skid trails.
- After logging, cleanup of landing areas removes all unmerchantable material and trash.

Reforestation

- Natural regeneration is favored where it exists or can be initiated. Scarification is used to encourage natural regeneration on appropriate sites. Advance (pre-existing) regeneration is protected from damage during logging.
- Unless early sufficient advance regeneration is present, any harvest operation that reduces stand basal area below 80 sq.ft. per acre is replanted (per Oregon law).

- When planting, a variety of native, site-adapted commercial tree species are used. No single species comprises more than 85% of the future stand. Seedlings from appropriate seed zones are used.
- Planted seedlings and natural regeneration are kept vigorous and free to grow by judicious and economical vegetation control. Manual brush cutting is the preferred control method.
- Logging slash is left in place. Piling is restricted to regeneration areas with excessive slash volumes. In such situations piles are kept less than 4 feet tall (unless piles are created for wildlife habitat).

Salvage

Impacts from wind, fire, insects or disease that kill groups of trees are considered a part of the natural disturbances of a healthy forest. Any salvage harvest plan will consider the value of leaving dead trees undisturbed in the forest. Factors such as location, quantity of diseased or dead trees, wildlife habitat value, and economic value will be considered when evaluating timber salvage options.

- Salvage harvesting will be evaluated on a case-by-case basis, and must be consistent with polices protecting water quality, forest health and wildlife habitat.
- Salvage harvesting will not take place in reserves unless the down or dead trees pose a verifiable risk to forest health.
- Timber salvage will be conducted in a manner that minimizes impacts on resources. Salvage operations that unnecessarily add to forest disturbance (new road construction, soil disturbance on steep slopes) will be avoided.

Reserves

It is the policy of the City of Corvallis to establish Reserve Areas on the Corvallis Forest to protect streams and water quality, wildlife and other areas of unique habitat or ecological values.

<u>Standards and Guidelines</u>

- Consider management practices of abutters in reserve configuration to maximize habitat connectivity and resource protection.
- Designate reserve area boundaries based on topographic features. Minimum reserve distances shall be 200 feet on each side of main streams, and 100 feet for minor perennial streams.
- Include as reserves slide prone areas near streams for future recruitment of logs for stream structure.
- No new roads shall be constructed in reserve areas.

- No commercial timber harvest in reserves, with the exception of thinning plantations (outside of the stream inner gorge) to produce late seral structure.

Fish Habitat & Stream Structure

It is the policy of the City of Corvallis to increase stream diversity and to enhance fish habitats on the Corvallis Forest, including fish passage, riparian protection and improvement.

Standards and Guidelines

General

- Restoration works are prioritized for high quality habitats.
- Management efforts are designed to maintain viable populations of all native fish species present, and select invertebrates.
- Fisheries professionals are involved in planning for resource improvements when appropriate.

Riparian areas

Riparian areas are defined as the land within 200 feet of Rock Creek and its major tributaries, and within 100 feet of minor perennial streams. All of the riparian areas are within the larger reserve system.

- Timber removal is prohibited within stream riparian areas, except in special cases to promote old forest development. Practices promote older forest structure and diversity.
- Skid trails or roads in riparian areas are retired or relocated wherever possible.
- Equipment operation in riparian areas is prohibited, except for restoration activities.
- Restoration activities within riparian areas use methods with the lightest possible impacts.

Fish habitat and stream structure

- Key (anchor) habitats are given the highest levels of protection.
- Degraded or at-risk habitats are targeted for improvement or restoration.
- In-stream work is conducted during periods of lowest flow (as per Oregon law), and with all necessary precautions to protect water quality.

Wildlife Habitat

It is the policy of the City of Corvallis to enhance wildlife habitats, promote connectivity, protect unique habitats and increase diversity on the ownership.

Standards and Guidelines

General

- Prioritize management actions to benefit listed species, to promote connectivity, and for areas of highest habitat improvement need.
- Involve wildlife professionals in planning for resource improvements when appropriate.
- Design forest management efforts to maintain viable populations of all native vertebrate species present on the site, and select invertebrates.
- Habitats of rare, threatened, endangered, or sensitive species are given high levels of protection.
- Management of mixed stands protects veteran broadleaf trees (especially maple, oak and madrone).
- Increase areas of grassland cover by removing encroaching trees. Restore native grass and forbs species in existing grass areas.

Legacy and wildlife trees

- Trees that are unique for their size, age, species, wildlife value or location are protected. Criteria for legacy and wildlife tree selection and management are followed.
- Trees currently older than 200 years are identified and retained as legacy trees.
- Increase oak areas by release/thinning of existing trees/saplings/seedlings.
- Wildlife trees are cultivated to provide critical habitat (den cavities, nests, perch sites) or mast (acorns, seeds, or fruit).
- Wildlife trees are retained during harvest and allowed to naturally die, providing future snags and large woody debris.
- Legacy trees are reserved from harvest until target numbers are exceeded. Any future harvest of legacy trees will ensure target numbers are maintained.

Snags and coarse woody debris

- Snags and down logs are actively cultivated for wildlife habitat. Criteria for snag selection and management are followed.
- Snags are permanently retained and allowed to naturally deteriorate, except where posing a safety hazard near roads, trails or structures. Salvage of dead trees is allowed in some circumstances (see Salvage Policy).
- Trees are cut, limbed and bucked in place (slash and cull log sections are left in the woods).
- Pulp and firewood removals are restricted (to encourage coarse woody debris recruitment).
- Coarse woody debris levels are managed to promote soil productivity. A minimum of 20 tons CWD per acre is maintained (property wide average); additional recruitment is encouraged.

Water Quality

It is the policy of the City of Corvallis to protect and enhance the quality of water and the health of the aquatic environment within its ownership. Corvallis seeks to minimize the adverse effects of necessary water withdrawals on stream health.

Standards and Guidelines

- In areas of City-owned land above the water intakes, water quality is given the highest priority in stewardship planning and operations.
- Timber salvage operations must be conducted so as not to significantly impact stream health or water quality through sedimentation.
- No timber salvage operations are permitted in Reserve Areas unless dead trees are a risk to forest health.
- Limit timber harvest and log truck hauling to dry season conditions.
- Consider impacts of public access on water quality when issuing permits.

Native Vegetation & Invasive Species

It is the policy of the City of Corvallis to promote native plant communities and actively monitor, control, and reduce invasive plant populations.

Standards and Guidelines

Plant communities

- Rare and endangered species are given the highest levels of protection.

- Areas of uncommon or sensitive plant communities are protected from adverse impacts. Road building in such areas is not allowed.
- Degraded plant communities are actively managed to promote biological diversity and ecosystem health.
- Conduct rare plant surveys prior to all management activities in potential rare plant habitats (i.e. *Cimicifuga elata*). When rare plant populations are found, modify management activities to protect them and their habitats.
- Collection of native plant material or mushrooms for commercial or personal purposes is not allowed.

Exotics

- Surveys to identify potential invasive exotics are conducted prior to management activities.
- Control false brome and Himalayan blackberry along roads, in riparian areas and wherever they are invading forest or prairie habitats.
- Conduct periodic noxious weed surveys and control new populations before they become firmly established.
- Neighboring landowners are encouraged to institute their own invasive species controls near common boundaries.
- An undisturbed soil buffer is left around populations of exotics to slow their rate of spread.

Restoration

- Rare plant specialists are involved in planning for plant restoration and weed control.
- Protect and manage the peacock larkspur population (*Delphinium pavonaceum*) to maintain and, if possible increase population size through control of invasive exotics and woody vegetation.
- Restoration activities minimize ground disturbance, unless deemed an appropriate management technique.
- Restoration activities are initiated first on a small scale and on low risk sites. Large-scale efforts are applied only when proven effective on each site.
- Local seed sources are used for restoration and revegetation, as practical.

Roads

It is the policy of the City of Corvallis to reduce road impacts on water quality within the Corvallis Forest, and to minimize new road construction.

Standards and Guidelines

- Follow Oregon Department of Forestry Forest Road Management Guidebook: Maintenance and Repairs to Protect Fish Habitat and Water Quality (January 2000)
- Culverts on fish bearing streams are upgraded to allow fish passage.
- Roadbeds and cleared right-of-ways are kept to the smallest size necessary for log truck access.
- Roads and skid trails are designed to follow slope contours, and use dips, water bars where practical, and seeding as needed to control erosion. Out-sloped roads are preferred.
- Haul road grades are kept to no greater than 20%; skid trail grades no greater than 35%.
- Stream crossings are avoided.
- Landings are kept to the absolute minimum size and number necessary for logging safety and efficiency.
- Skid trails, landings and haul roads cover less than 5% of the land area.
- Temporary roads built are closed and revegetated upon completion of logging operations.

Herbicides

It is the policy of the City of Corvallis to use limited quantities of forest herbicides for invasive weed control.

Standards and Guidelines

- The least persistent and lowest toxicity chemical offering effective control will be used.
- Targeted application by backpack sprayer or single stem injection are the preferred methods.
- No aerial application is allowed.

Public Access

It is the policy of the City of Corvallis to prohibit general access to the Corvallis Forest, but implement access controls to allow educational, research, special permitted usage. The City's policy includes allowing access to Old Peak Road for non-motorized Corvallis-to-the-Sea use.

Standards and Guidelines

- The property is posted to prohibit trespass; gates block all access roads, and keys are strictly controlled.
- Water system staff patrol the property and help to prevent trespass.

Fire

It is the policy of the City of Corvallis to protect the Corvallis Forest from wildfire and to manage forest stands to reduce fire risk.

Standards and Guidelines

- All wildfires occurring on the forest shall be controlled as soon as possible. There will be no "let-burn" areas on the forest.
- In the unlikely event that controlled burns are deemed necessary, they will be managed by or planned with the assistance of the Oregon Department of Forestry.
- No accumulations of slash will remain within 60 feet of roads, landings, or hiking trails, except in the case of piles created for wildlife habitat.

Planning & Monitoring

It is the policy of the City of Corvallis to adopt and implement a Stewardship Plan for the Corvallis Forest, and to monitor management to minimize adverse impacts and meet Plan goals and objectives.

Standards and Guidelines

- Operational plans are prepared (at least every three years) to plan and detail stewardship activities and periodic harvests.
- Operational plans are written by a professional forester, and based on statistically relevant resource inventories and assessments of forest values and functions.

- Operational plans perpetuate or enhance the full range of forest values and functions, as possible.
- Input from wildlife, fishery, and botany professionals is solicited and incorporated into operational plans.
- Forest resources are inventoried and the stewardship plan is updated approximately every 10 years.
- Operational plans for harvests include detailed maps and brief operational notes. Maps include stand delineations, reserve areas, and locations of any landings and skid trails. Operational notes include unit prescriptions, project specifications, intended outcomes, timber harvest volume and value estimates, and implementation details.
- Each year a brief annual report on the condition and status of the City Forest is presented to the City Council. The annual report includes a balance sheet showing income and expenses.

Appendix B: Wildlife

Table 1. Bird *species that may utilize the Corvallis City Forest*

	Forest	Forest openings	Wetland
Great-blue heron			X
Green heron			X
Pie-billed grebe			X
Canada goose			X
Wood duck			X
Mallard duck			X
Green-winged teal			X
Blue-winged teal			X
Cinnamon teal			X
Northern Pintail			X
Gadwall			X
American widgeon			X
Lesser scaup			X
Bufflehead			X
Ring-necked duck			X
Hooded merganser			X
Ruddy duck			X
American coot			X
Turkey vulture	X	X	
Osprey			X
Bald eagle	X		X
Sharp-shinned hawk	X		X
Cooper's hawk	X	X	
Northern goshawk	X		
Red-tailed hawk		X	
Rough-legged hawk		X	
American kestrel		X	
Ring-necked pheasant		X	
Ruffed grouse		X	
Wild turkey		X	
California quail		X	
Mountain quail		X	
Killdeer		X	
Marbled murrelet	X		
Band-tailed pigeon	X		
Mourning dove		X	
Western screech owl	X		X

Table 1. (Cont.) *Bird species that may utilize the Corvallis City Forest*

	Forest	Forest openings	Wetland
Northern pygmy owl	X	X	X
Great-horned owl	X	X	X
Spotted Owl	X		
Barred owl	X		
Northern saw-whet owl	X		
Common nighthawk	X	X	
Vaux's swift	X		
Anna hummingbird		X	
Rufus hummingbird		X	X
Belted kingfisher	X		
Red-bellied sapsucker		X	X
Downy woodpecker	X		X
Hairy woodpecker	X		X
Northern flicker	X	X	
Pileated woodpecker	X		
Olive-sided flycatcher	X	X	
Western wood peewee	X		
Willow flycatcher			X
Pacific-slope flycatcher	X		
Purple martin		X	X
Tree swallow		X	X
Violet-green swallow		X	X
Barn swallow		X	
Gray jay	X		
Steller's jay	X	X	
Scrub jay		X	X
American crow		X	
Common raven		X	
Black-capped chickadee	X		
Chestnut-backed chickadee	X		
Common bushtit		X	X
Red-breasted nuthatch	X		
White-breasted nuthatch	X (oak)		
Brown creeper	X		
Bewick's wren		X	X
House wren		X	
Winter wren	X		
American dipper			X
Ruby-crowned kinglet	X	X	
Golden-crowned kinglet	X		
Western bluebird		X	

Table 1. (Cont.) *Bird species that may utilize the Corvallis City Forest*

	Forest	Forest openings	Wetland
Townsend's solitaire		X	
Swainson's thrush	X	X	
Hermit thrush	X		
American robin	X	X	X
Varied thrush	X		
Wrentit		X	
Cedar waxwing	X		X
European starling		X	
Hutton's vireo	X		
Warbling vireo			X
Cassin's vireo	X		X
Orange-crowned warbler		X	
Nashville warbler		X	
Yellow-rumped warbler	X		
Black-throated gray warbler	X (H)		
Townsend's warbler	X		
Hermit warbler	X		
MacGillivray's warbler		X	X
Common yellowthroat		X	X
Wilson's warbler		X	X
Western tanager	X		
Black-headed grosbeak	X		X
Evening grosbeak	X		
Spotted towhee		X	
Chipping sparrow		X	
Fox sparrow		X	X
Song sparrow		X	X
White-crowned sparrow		X	
Golden-crowned sparrow		X	
Dark-eyed junco	X	X	X
Brewers blackbird		X	X
Brown-headed cowbird		X	X
Purple finch		X	X
House finch		X	
Red crossbill	X		
Pine siskin	X		
American goldfinch		X	

Table 2. *Amphibian and reptile species that may utilize the Corvallis City Forest*

Amphibian	Forest	Forest openings	Wetland
Northwestern salamander	X	X	X
Long-toed salamander	X	X	X
Pacific giant salamander	X	X	X
Clouded salamander	X	X	
Ensatina	X		
Dunn's salamander			X
Western red-backed salamander	X	X	
Rough-skinned newt	X	X	X
Western toad		X	X
Pacific chorus frog	X	X	X
Red-legged frog	X	X	X
Bullfrog			X

Reptile	Forest	Forest openings	Wetland
Northern alligator lizard	X	X	X
Southern alligator lizard		X	X
Western fence lizard		X	
Western skink		X	X
Rubber boa		X	
Sharp-tailed snake		X (oak)	
Ring-necked snake	X		
Gopher snake		X	
Western terrestrial garter snake		X	X
Northwestern garter snake		X	
Common garter snake		X	

Table 3. *Mammalian species that may utilize the Corvallis City Forest*

	Forest	Forest openings	Wetland
Trowbridge shrew	X		
Vagrant shrew		X	X
Pacific shrew		X	X
Pacific marsh shrew			X
Shrew-mole	X		X
Coast mole	X	X	X
Townsend's mole		X	X
Yuma myotis		X	X
Long-eared myotis	X		X
Long-legged myotis	X		
Silver haired bat	X		X
Fringed myotis	X		X
Little-brown myotis			X
California myotis		X	X
Hoary bat	X		X
Big-brown bat	X		
Brush rabbit		X	
Mountain beaver	X		X
Flying squirrel	X		
Townsend's chipmunk	X		X
Douglas squirrel	X		
Western gray squirrel	X (H)		
California ground squirrel		X	
Dusty-footed woodrat	X		X
Bushy-tailed woodrat	X		
Western pocket gopher		X	
Deer mouse	X	X	X
Townsend's vole			X
Creeping vole		X	
Red-backed vole	X		
White footed vole			X
Red tree vole	X		
Long-tailed vole		X	X
Pacific jumping mouse			X
Porcupine	X		
Coyote		X	
Raccoon			X
Stripped skunk			X
Spotted skunk	X	X	X
Short-tailed weasel		X	

Table 3. (Cont.) *Mammalian species that may utilize the Corvallis City Forest*

	Forest	Forest openings	Wetland
Long-tailed weasel	X	X	X
Mink			X
American Martin	X		
River otter			X
Muskrat			X
Nutria			X
Black bear	X		
Bobcat	X	X	
Cougar	X	X	
Beaver			X
Black-tailed deer	X	X	
Roosevelt elk	X	X	
Opossum			X
House mouse		X	

Appendix C: Fish and Aquatic Habitat Analysis

Introduction

This section of the Rock Creek Analysis focuses on current physical and biotic conditions of the aquatic corridor. By necessity, a hydrologic unit such as Rock Creek must be portrayed as a single functional unit that extends beyond the boundaries of the City of Corvallis ownership. This is imperative because stream corridors are dynamic and always responding to upstream influences.

This is a watershed scale review of complex interactions that integrate to form a stream system with quantifiable physical and biological attributes. The analysis attempts to dissect some of these complex interactions by working backwards from current conditions. These include fish distributions, the abundance and distribution of aquatic habitats, water management regimes and historical upslope management activities.

Cause and effect relationships are illuminated to facilitate the design of a comprehensive restoration strategy aimed at maximizing watershed health. Maintenance of a high quality municipal water supply for the City of Corvallis can only be insured by sustaining long term watershed health in the Rock Creek basin. Watershed functions downstream of the City of Corvallis ownership will always be influenced by the decisions and guidelines contained in the City's stewardship planning document.

Resources utilized

1) Aquatic Habitat Inventories were conducted by Bio-Surveys,LLC. for the Forest Service (USFS) in 1994 and 1995. These detailed inventories were conducted on all of the major tributaries and the mainstem of Rock Creek above the confluence with North Fork Rock Creek.

2) Aquatic Habitat Inventories were conducted by ODFW for the lower 3.9 mile mainstem section of Rock Creek in 1992. These detailed inventories pass through multiple ownerships from the mouth at the confluence with Greasy Creek, to the intake diversion dam above the confluence of the North Fork. Most of the impacts both historical and contemporary manifest themselves within this un-inventoried segment.

2) Fish distribution and abundance inventories were conducted by Bio-Surveys,LLC. in May of 2006. These surveys utilize the Rapid Bio Assessment (RBA) protocol, which examines a 20 percent sample of all pool habitats. The survey included mainstem Rock Creek and all of its tributaries.

3) Geological Survey (USGS) flow data collected from the mainstem Rock Creek. station at river mile 0.4 between the years 1946 – 1953 and 1975 – 1980. Approved data was not available from this station after the summer of 1980.

4) USFS temperature data collected in 2005 from the mainstem of Rock Creek at approximately RM 1.8 near the confluence of the Middle Fork of Rock Creek.

5) The 2005 USFS Marys River Watershed Preliminary Analysis document was utilized for specific culvert inventory data and general background information.

6) The 1993 Forest Management Plan produced by Woodland Management for the City of Corvallis Rock Creek Municipal Watershed was reviewed but limited information on aquatic function was contained in this document.

Physical Habitat

Rock Creek is a forth order headwater tributary of Greasy Creek that joins the Mary's River, a primary artery of the Willamette River basin. Rock Creek originates on the east and north east slopes of Marys Peak from approximately 3,000 ft in elevation. The Rock Creek basin is one of the few west slope tributaries of the Willamette that is consistently influenced by annual snow pack. The Rock Creek watershed encompasses approximately 11,000 acres. The U.S. Forest Service (USFS) is the primary owner of lands surrounding the 2,219 acres of the City of Corvallis lands.

An Aquatic Habitat Inventory (AHI) was conducted on the South, North and Middle Forks of Rock Creek by Bio-Surveys in July of 1995 and on the mainstem of Rock Creek by ODFW in July of 1992. The following is a summary of those findings.

<u>Mainstem Rock Creek</u>

The AHI began at the confluence of Rock Creek and Greasy Creek and extended approximately 4.0 miles to the City of Corvallis water intake diversion dam. This stream segment contains the confluence of all of the major Rock Creek tributaries (Griffith, North Fork, South Fork, Middle Fork, Stilson and Tribs A, B, C and D). Approximately 73% of this 4 mile segment is the property of the City of Corvallis. The remaining ownerships are small private parcels managed for both timber production and rural residential agriculture.

The 4 mile mainstem was described in 3 separate reaches that encompass two distinct valley forms. The lower reach from the mouth to 800 meters above the confluence of Griffith Creek exhibited a terrace constrained active channel within a broad valley floor and a disconnected historical floodplain. The remaining two reaches were similar in valley morphology exhibiting a narrow valley floor with a moderate V- shape. The floodplain exhibits greater potential than reach 1 for connectivity in a 50 year flood event but terrace and hillslope confinement maintain a condition conducive to resource transport through the majority of both reaches.

The riparian corridor is dominated by deciduous species and exhibits extensive species diversity. The potential for the recruitment of conifers to the aquatic corridor for the provision of stable complex woody debris is extremely low. This is reflected in the wood densities documented for this segment during the 1992 ODFW Aquatic Habitat Inventory. There were 0 pieces / mile of key large woody debris (> 24" diameter) observed in each of the 3 reaches. Only 20 percent of the pool habitats (21 / 106) had at least 3 pieces of wood, including pieces as small as 10' long and 6" in diameter.

Directly related to this observed deficiency in channel complexity is the current composition of substrates within the mainstem. Low wood densities have resulted in a high percentage of stream substrates scoured to the parent bedrock in both pool and riffle habitats. Reaches 2 and 3 of the mainstem exhibited 37% and 26 % of all pool surface areas scoured to bedrock. Reach 1 below Griffith was less severe with only 8 percent of pool surface areas scoured to bedrock. Gradients in this lower reach are decreasing from 1.3% to 0.7 % and deposits of silt, sand and organics become dominant substrate features (32% of all pool surface areas).

South Fork Rock Creek

The South Fork of Rock Creek is synonymous with the upper mainstem of Rock Creek within the remainder of this analysis. The AHI began at the confluence of the North Fork of Rock Creek and continued 3.6 miles to the end of significant Cutthroat habitat. The stream has 16 tributaries and a drainage area of 3,339 acres. Tributaries 4 and 8 were also surveyed in 1995. The lower 0.4 miles of the South Fork, is the property of the City of Corvallis and a water intake diversion dam is near the property line at the upstream end of their ownership. The remainder of the sub basin is owned by the USFS. The diversion dam is a definitive barrier to both adult and juvenile salmonids.

The South Fork valley width ranges between 40 and 60 ft and the gradient averages 6% to approximately the confluence of Tributary 10. Above this point the stream gradient increases to average 15%.

The mainstem channel is simple below the diversion dam at RM 0.4, with low instream wood densities and low pool frequency. The mainstem channel above the diversion dam is complex with instream wood densities that progressively increase from 10 – 28 pieces of large key wood / mile (> 24" diameter). The quantifiable complexity is the result of large wood contributed from the riparian and from a harvest related debris torrent event from Tributary 12.

Tributaries 3, 4, and 8 contribute about 60% of the flow into the South Fork. In July 1995, flow was estimated at 5 cfs above the diversion dam. Temperatures in the South Fork and both surveyed tributaries ranged from 47^{o} to 57^{o} F during the survey.

The mainstem contains high quality spawning and rearing habitat for salmonids while tributaries 4 and 8 contain only minor aquatic habitat surface areas with limited production potential. Upstream fish passage is blocked by the water diversion dam at RM 0.4.

Most of the South Fork mainstem is characterized by an undisturbed mature conifer riparian condition dominated by Douglas Fir, Western Red Cedar, and

Hemlock. On the City of Corvallis ownership below the diversion dam (RM 0.4) however, past timber harvest removed almost all riparian conifers. A combination of no riparian wood recruitment and the blockage of transient wood and debris flows by the dam and associated trash rack have left this 0.4 mile section of stream corridor Creek extremely deficient in complex woody structure. The remainder of lower mainstem Rock Creek suffers from the same simplicity as a result of these same two impacts.

At this juncture it is significant to note that the migratory wood that could be recruited to the lower mainstem of Rock Creek from the adjacent North Fork sub basin is terminated at the reservoir with a floating trash boom. The combination of wood removal features on both the South and North Forks results in a complete lack of transport of headwater wood resources to the lower mainstem of Rock Creek.

North Fork Rock Creek

The North Fork sub basin encompasses approximately 2,145 acres. The stream is created by the confluence of Chintimini Creek and Tributary 13 on USFS ownership. The 1995 survey included the mainstem of the North Fork above the reservoir to RM 2.1 where the gradient increased to 15%. The North Fork's drainage basin includes 13 tributaries. Most of the mainstem flow is created in the lower 0.5 miles above the City of Corvallis municipal reservoir. Tributary 11 was surveyed to the point where the gradient exceeded 20%.

The 7.5 acre reservoir is the result of an earthen dam on the City of Corvallis property that is positioned such that overflow from the dam spillway immediately joins the South Fork to corporately form the mainstem of Rock Creek. The reservoir spillway does not allow upstream fish passage and the development of fish passage is not feasible at this site.

The reservoir is a major component of the municipal water supply and it has been constructed with a subsurface intake and gate valve structure to facilitate draining and maintenance of the reservoir.

The North Fork lies in a v-shaped valley approximately 60 to 70 ft wide with steep lower slopes (50% to 60%). The mainstem habitats increase in complexity above RM 1.2 with instream wood densities increasing from 16 pieces / mile (>24" dia) in reach 1 to 24 pieces / mile in reach 2. The active channel is moderately entrenched and the average gradient shifts from 5% below RM 1.2 to 8% upstream. No legacy of debris torrent events was apparent and all instream wood complexity was naturally recruited (no cut ends were observed). During the 1995 survey, water temperatures ranged between 50^{o} and 55^{o} F.

The riparian corridor consists of a mature tree seral stage dominated by Douglas Fir, Western Red Cedar, and Hemlock. A fire legacy can be observed on the north slopes above RM 1.2. The riparian canopy is dense with greater than 60% closure.

Middle Fork Rock Creek

The Middle Fork Rock Creek survey extended 2.2 miles. The Middle Fork sub basin encompasses approximately 832 acres. The first 1 mile of stream corridor traverses City of Corvallis ownership. Above RM 1.0 is within the USFS boundary

except for the upper head wall of the sub basin that transitions back onto City ownership.

The Middle Fork exhibits a narrow valley with steep side slopes (40% to 80%). At the stream's mouth, the valley floor is approximately 100 ft wide. The Valley floor width gradually decreases to 20 ft in the upper reach. The gradient averages 3% through RM 1 and increases to an average of 9% above the abandoned water diversion dam. The active stream channel is simple in configuration and dominated by rapid habitat. The Middle Fork has 5 tributaries that contribute only minor flow. All of these tributaries exhibit gradients greater than 15% and provide no significant aquatic habitat potential.

There is a significant difference in habitat complexity between the stream segments below and above the water diversion dam at RM 1.0. (located on the property boundary). This is a result of the differential upslope management between ownerships (City of Corvallis and USFS). Instream key wood densities on City of Corvallis ownership up to RM 1.0 were 7 piece / mile (logs >24" diameter). Key wood densities on the USFS ownership were 17 pieces / mile. A history of timber harvest is evident on City of Corvallis ownership transitioning to a mature tree seral class on USFS ownership above City property. The riparian corridor on USFS ownership is dominated by large Western Red Cedar, Hemlock, and Douglas Fir. Most large conifers have been removed from the riparian on the City of Corvallis ownership. This lower 0.8 miles has been replanted and the young seral regeneration exhibits excellent canopy closure.

Winter flows do not transport significant volumes of woody debris in this sub basin from the upper reaches, to the mainstem of Rock Creek. The upper reaches exhibit excellent wood recruitment from the riparian corridor but the floodplain is very narrow and woody components are retained and not transported. This is a function of the small drainage area and the resultant decrease in hydraulic potential during winter flow regimes. There was no debris flow history observed in the active stream channel.

The lower segment of the Middle Fork contains high quality spawning habitat for Cutthroat. The abundant gravels diminish with increasing gradient upstream. There is a culvert 120 ft above the confluence with mainstem Rock Creek that is a definitive barrier for both adult and juvenile Cutthroat. At RM 0.9, an abandoned concrete water diversion dam blocks all upstream fish passage. This dam was constructed on top of a bedrock slide that by itself forms a natural barrier to fish passage.

Griffith Creek

Griffith Creek originates at approximately 2,700 ft in elevation and joins mainstem Rock Creek at approximately 400 ft in elevation, at river mile RM 1.1. Creek Griffith Creek's subbasin is approximately 1,200 acres in size. Griffith Creek flows through privately owned property to approximately RM 0.2 and the junction of Rock Creek Road. From the road crossing to RM 1.1 is the property of the City of Corvallis. Above RM 1.1 the creek flows within the confines of the Siuslaw National Forest except for a 0.5 mile segment of aquatic and riparian corridor owned by the City of Corvallis that begins at RM 3.4.

The 1994 survey included 4 miles of Griffith Creek between its confluence with Rock Creek and the end of significant aquatic habitat for resident Cutthroat.

The stream exhibits limited sinuosity (1.1), and occupies a narrow valley with an average floodplain width of 30 ft. The gradient averages 5% up to RM 1and 8% above that point. A diversion dam and intake structure for the Corvallis municipal water system is located at RM 1.1. The dam is a definitive barrier to both adult and juvenile salmonids.

A distinct differential in stream flow was observed above and below the intake structure during the September 9, 1994 inventory with reserve stream flows estimated at 0.5 cfs.

There is a radical difference in habitat complexity between the stream segments below and above the water diversion dam at RM 1.0. (located on the property boundary). This is a result of the differential upslope management between ownerships (City of Corvallis and USFS). Instream wood densities on City of Corvallis ownership up to RM 1.0 were 2 pieces / mile (logs >24" diameter). Wood densities on the USFS ownership were 24 pieces / mile. City of Corvallis ownership exhibited a riparian corridor consisting of 94% small tree seral class dominated by Alder and Big leaf Maple. The USFS ownership exhibited a riparian corridor consisting of 76% mature tree seral class dominated by Douglas Fir and Western Hemlock. The only divergence from this mature tree seral stage in the upper 3 miles of the Griffith Creek sub basin was the 0.5 mile corridor near the top of the inventory that transitioned back into the City of Corvallis ownership.

Water Quality and Quantity

The USFS collected extensive continuous temperature monitoring data during the summer of 2005 to evaluate the headwater tributaries of Rock Creek as potential sources of pinch period temperature refugia for both adult and juvenile salmonids. The summary data is contained in figure 1.

(Figure 1) Summary of USFS Temperature Monitoring, 2005 (Barb Ellis Sugai)

Site Name	GIS number	7-day average max	Days above DEQ threshold of 64 deg	Instantaneous Maximum Temperature
SF Rock Creek Above Connection Creek	2120	60.8	0	61.5
Connection Creek	2121	61.2	0	61.7
SF Rock Creek above dam	2122	60.9	0	61.6
Rock Creek downstream from the NF and SF confluence	2123	66.4	26	67.5
Stilson Creek	2124	62.5	0	63.6
Mainstem of Rock Creek just below confl. Of Middle Fork	2125	67.8	43	69

Middle Fork Rock Creek	2126	62.3	0	63.4
Griffith Creek above dam	2127	60.9	0	61.3

None of the headwater tributaries above the City of Corvallis water intake structures met or exceeded the DEQ threshold for temperature throughout the summer of 2005. The mainstem of Rock Creek below the intake structures on City of Corvallis ownership however, exceeded the threshold temperature throughout the distribution of the sample (from just below the confluence of the North Fork to the last point of monitoring just below the confluence of the Middle Fork.). The duration of the exceedance increased by 65% in the 2 miles between the two sample sites resulting in 43 days above 64 degrees (figure2) near the confluence of the Middle Fork. The Rock Creek mainstem continues an additional 1.8 miles downstream of this lower sample site to the confluence of Greasy Creek. No data were collected in this lower stream segment. However, as downstream cumulative impacts continue to mount, it is likely that the number of days in which the DEQ threshold is surpassed would be even greater with higher instantaneous daily maximums.

A USGS stream discharge gauging station was in operation at RM 0.4 during two periods, 1946-1953 and 1975-1980. A summary of the discharge data for each of these periods is represented in figures 3 and 4.

Figure 3

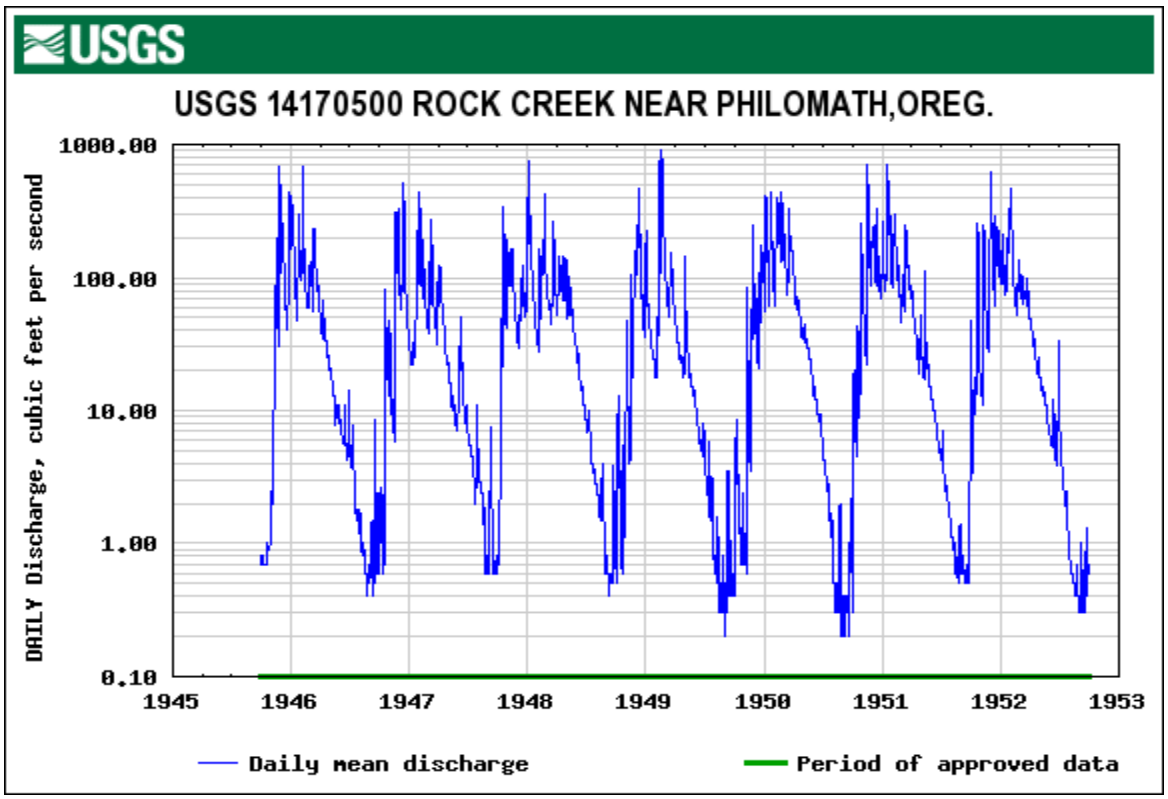
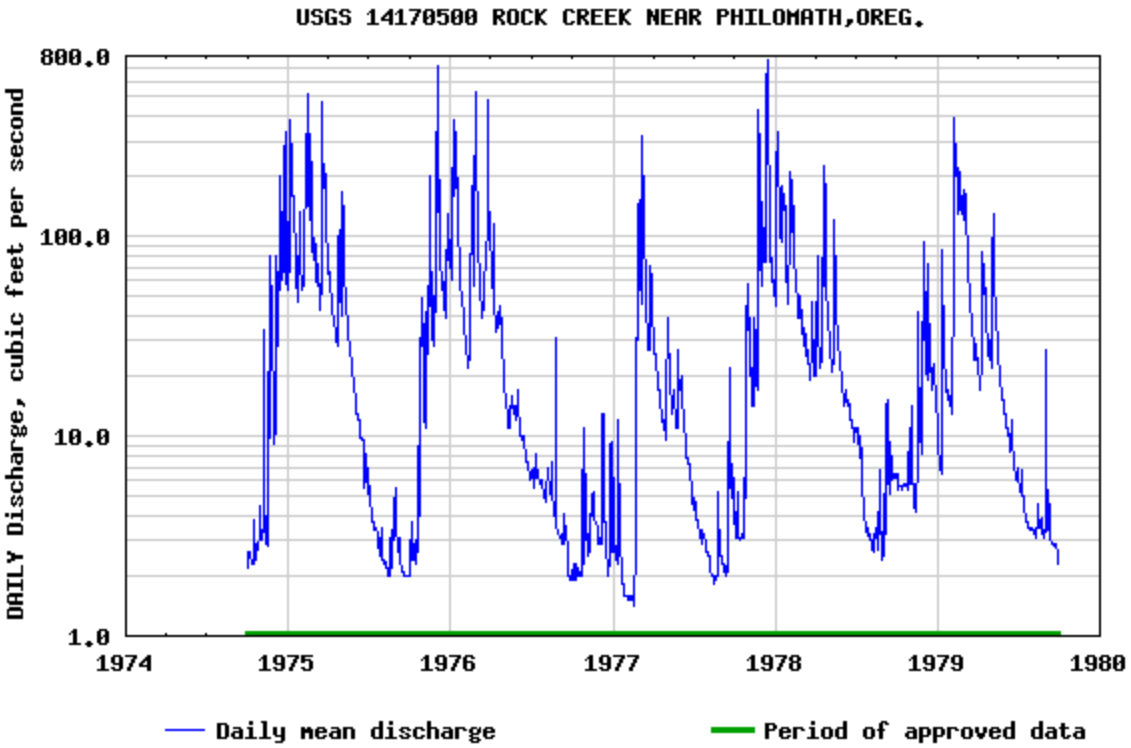

USGS
USGS 14170500 ROCK CREEK NEAR PHILOMATH,OREG.
DAILY Discharge, cubic feet per second
1000.00
100.00
10.00
1.00
0.10
1945
1946
1947
1948
1949
1950
1951
1952
1953
Daily mean discharge
Period of approved data

Figure 4



The annual minimum summer flows are the critical data points in these figures. The data indicate that critically low flows were historically documented in the lower mainstem of Rock Creek. In the older suite of sampled years (1946-1953), summer flows as low as 0.2 cfs were documented. At this flow regime pool habitats become isolated with intermittent surface flow in riffle and rapid habitats (the foundation habitats for many species of macro invertebrates). The most contemporary flow data (1975-1980) indicates that some sort of alteration in either water usage or infrastructure occurred between the decade of the 50's and 70's. Minimum summer discharge volumes never dropped below 1cfs with most annual minimums hovering around 2 cfs. At this flow regime, habitat isolation and sub sub-surface flows are probably not experienced. There is insufficient historical biological information available to assess what discharge volumes are appropriate for proper function in the lower mainstem of Rock Creek. However, initiating discharge monitoring at this site would be extremely valuable for attempting to quantify the known cause and effect relationships that exist between the abundance and distribution of biotic communities and the availability of pinch period summer flows.

Fish Populations

Cutthroat trout (Oncorhynchus clarki) are one of only three species of anadromous fish known to have historically occurred above Willamette Falls (the others are Spring Chinook and Winter Steelhead). However, the genetic structure of the Cutthroat population above Willamette Falls suggests that genetic isolation from the Cutthroat population below the falls is strong (NMFS). This is likely a result of high mainstem Willamette temperatures in the late spring through fall and the presence of C.shasta below the confluence of the Marys River that limits the survival of the few smolts observed migrating downstream over Willamette Falls. This has led

NMFS to classify the Coastal Cutthroat above Willamette Falls as members of a unique Evolutionary Significant Unit (Upper Willamette ESU). This classification suggests that the anadromous life history form of the Coastal Cutthroat is not a significant management concern for the Rock Creek watershed.

The endemic fish species of concern in the Rock Creek watershed is the Cutthroat trout. The life history of Coastal Cutthroat trout is the most complex of any salmonid species. There are three unique life history strategies that are likely to exist currently within the watershed (resident, fluvial and adfluvial). Two of these life history forms almost certainly existed prior to colonization of the area by Europeans (resident and fluvial). In addition, genetic mingling likely occurs between these life histories but very little is known of these complex interactions.

Resident Cutthroat are common in the upper reaches of coast range watersheds and are unique in their confined spatial distributions. Adults are sexually mature at a very small size allowing this life history strategy to complete reproduction and rearing in very small stream habitats. The survival advantage for this strategy is significant. Predation from larger fish and other species is minimal, avian predation is dramatically reduced because Mergansers, King Fishers and Great Blue Herons cannot effectively hunt complex small water habitats. Population segments or demes of this life history pattern are strong and well represented in the Rock Creek basin above the water intake structures on Griffith Creek, South Fork Rock Creek, and North Fork Rock Creek (all primarily USFS ownership).

Fluvial Cutthroat trout juveniles leave small headwater streams to rear in larger mainstem habitats (potentially for multiple years) before returning to spawn in Rock Creek and its tributaries. Mature adults are consistently larger than resident adults. Larger size is a result of having been able to take advantage of the conditions in larger, lower stream reaches which provide abundant food resources and optimum temperatures for rapid growth. This greater size acquired at sexual maturity also allows them to utilize a much broader range of habitats for spawning (gravel size). The survival disadvantages in this strategy are significant. Barriers to upstream migration truncate access to high quality spawning habitats. In addition, these barriers can terminate the upstream temperature dependant migrations that are necessary to escape high temperatures that develop in mainstem habitats (Marys River, Greasy Creek, Rock Creek mainstem) during the summer low flow pinch period. This life history pattern exhibits a weak distribution within the Rock Creek watershed, and is the most likely to be influenced by the cumulative effects of water withdrawal on mainstem temperature profiles.

The other life history strategy present within the Rock Creek watershed for Cutthroat trout is the adfluvial form. This life history pattern has developed as a result of human impacts on the landscape.

The adfluvial form describes a component of the population that has adapted to rearing in a lake environment. These fish migrate to stream habitats for spawning and incubation. This strategy has almost certainly developed in the Rock Creek sub basin as a result of the impoundment and associated reservoir environment created by the City of Corvallis dam on the North Fork of Rock Creek. The adfluvial form of the sub basins population is plentiful. It is genetically isolated from the fluvial form since construction of the dam because the outflow is not passable to upstream migrants.

There have been many verified sightings of adult Winter Steelhead (Oncorhynchus mykiss) spawning in the Rock Creek watershed. However, none of the juvenile snorkel surveys conducted in 1994, 1995 or 2006 observed any 1+ (yearling or older) steelhead rearing within the Rock Creek watershed. The 1992 ODFW AHI did however document the presence of Steelhead juveniles rearing in the mainstem. These sparse observations indicate that at a minimum, Steelhead smolts are not consistently being produced from the Rock Creek subbasin. This is not surprising because the downstream impacts facing any anadromous life history pattern in the Marys River and Willamette River basin are formidable. Elevated spring temperatures in these mainstem habitats create a formidable barrier to the survival of downstream migrants. Winter Steelhead adults (unknown origin) continue to stray sporadically into the Rock Creek watershed but have not been effective in recolonization.

Current Cutthroat Distributions

Mainstem Rock Creek

Approximately 5.8 miles of the mainstem of Rock Creek was surveyed from its confluence with Greasy Creek to the end of significant headwater aquatic habitat. This survey considers the South Fork of Rock Creek as a continuation of the mainstem which agrees with USGS LLID protocol. The results of this inventory are displayed in figures 5 and 6.

FIGURE 5

Rock Cr Cutthroat Density May 2006

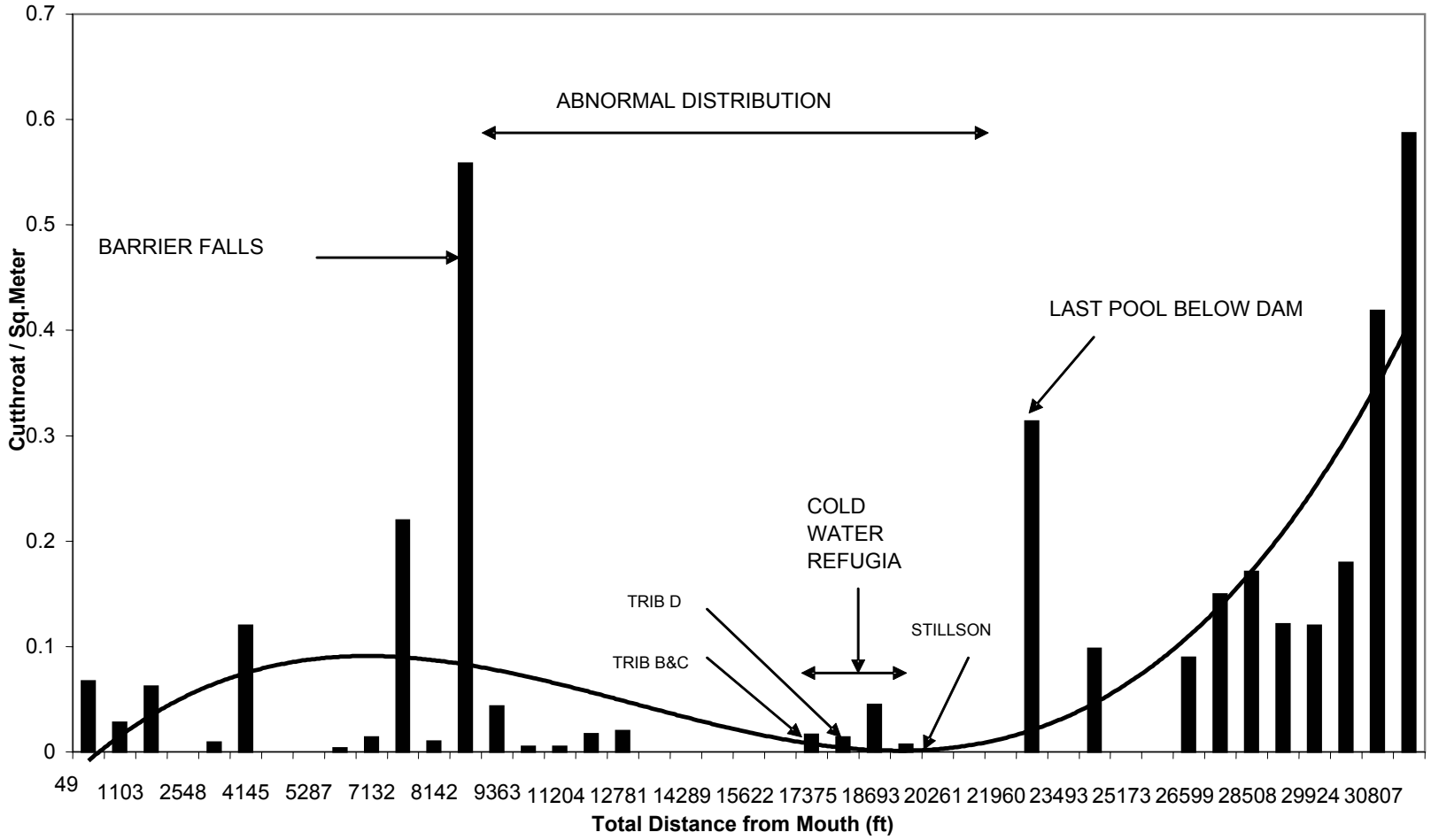
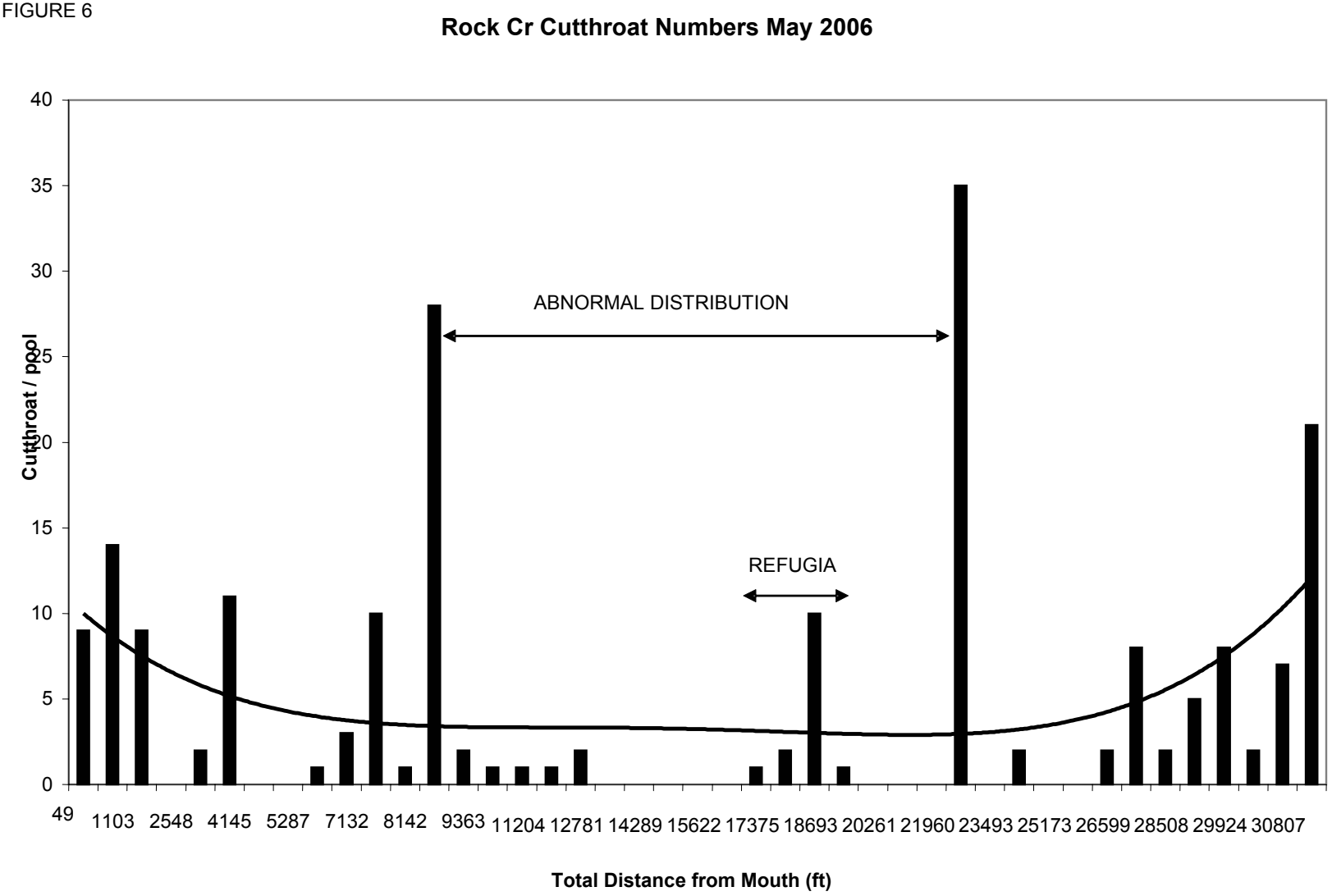


FIGURE 6


Rock Cr Cutthroat Numbers May 2006
Cutthroat / pool
40
35
30
25
20
15
10
5
0
ABNORMAL DISTRIBUTION
REFUGIA
49
1103
2548
4145
5287
7132
8142
9363
11204
12781
14289
15622
17375
18693
20261
21960
23493
25173
26599
28508
29924
30807
Total Distance from Mouth (ft)

Normal distribution was observed upstream from the mouth to approximately RM 1.5. At this point a large accumulation of older age class Cutthroat (28 fish) was observed stalled at a 4 ft bedrock intrusion falls (photo 1). Cutthroat of multiple age classes 1+, 2+ and 3+ were observed jumping at the falls and not succeeding. There was a definitive upstream migration occurring (May 19, 2006). Another large accumulation of older age class Cutthroat (35 fish) was observed at the confluence of the North Fork. (RM 4.2). Passage in the North Fork is truncated immediately above this pool by the spill from the Rock Creek Municipal Reservoir and shortly above this pool in the South Fork by a water intake diversion dam. These distribution patterns and direct observations indicate that a strong spring migration of Cutthroat toward higher basin habitats was occurring.

There are two fundamental reasons why this migration could have been occurring.
1) An increase in lower mainstem water temperatures driving fish to seek cooler upstream habitats.
2) An active migration to upstream spawning habitats.

Regardless of the motivation, access to upstream habitats is not currently achievable for Cutthroat trout because of both natural and man made barriers to migration. The modification of these barriers (both natural and artificial) will be incorporated into a prioritized list of restoration prescriptions. Provision of access to other tributary habitats exhibiting upstream movements of juvenile Cutthroat (Griffith Creek, Middle Fork Rock) will be included in the prioritization.

There was no compelling evidence of upstream migratory behavior in Stilson Creek or Trib D during the May 2006 inventory. It is possible that an inventory conducted later in the summer would detect upstream temperature dependent movement because mainstem temperatures would be approaching the threshold temperatures that trigger the migration behavior. These two tributaries will rank lower than some other tributaries on the prioritized restoration list due to their lower production potential.

The natural barrier at RM 1.5 has been modified by changes in channel dynamics. The changes are a consequence of altered stream hydraulics created by a water diversion intake dam that used to store water for a pumping station. This dam has collapsed (photo 3). This may have altered the channel, forcing water over the highest and steepest point of the bedrock intrusion. This change to the historical flow pattern over the bedrock created a barrier to Cutthroat during low flow regimes.

There is a 2.6 mile corridor of the Rock Creek mainstem that exhibited abnormal fish distribution. This reach extended from the barrier falls at RM 1.5 to the water intake dam on South Fork Rock Creek. Forty seven percent of all pool habitats within this stream segment were completely devoid of any Cutthroat. Where cutthroat were present, their extremely low rearing densities did not match the density trends observed above and below this segment. Clearly there is some cause and effect relationship associated with this abnormal distribution pattern.

There are three outstanding physical habitat attributes that could independently or collectively be influencing the abnormal distribution observed in Cutthroat abundance within this stream segment.

1) Poor instream habitat complexity, due to the lack of LWD recruitment. The reach is scoured to bedrock.
2) The influence of the barrier falls at RM 1.5
3) The influence of seasonally critical low flows from water withdrawal

There was an anomaly observed within this abnormal distribution where 4 different tributary streams converged with the mainstem (figure 5) in a 0.5 mile stretch (Tribs B, C, D and Stilson). It is likely that the cold water influence of this cluster of tributaries was creating micro habitats of summer refugia. In addition, a short block of mature seral riparian conifer canopy interfaced with the active channel within this 0.5 mile long zone. This resulted in large full spanning wood contributions and the development of channel braids and interactive floodplains. Again, a complex series of interactions was at work to provide habitats and habitat conditions preferred by rearing salmonids. The discussion on "Watershed Function" will address the issues in this reach.

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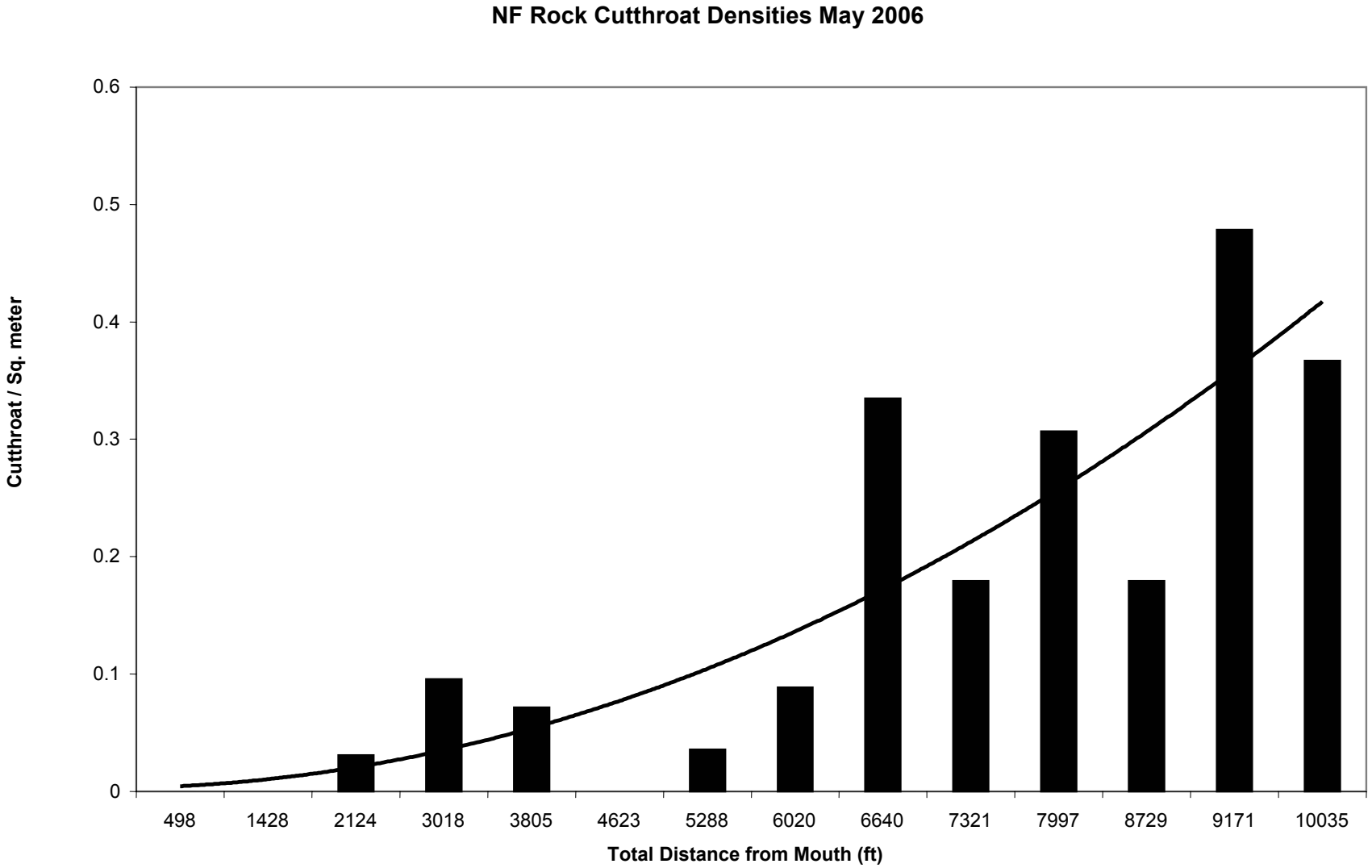
North Fork Rock Creek

The North Fork splits from the mainstem as tail water that is the result of surface spill from the City of Corvallis Municipal Reservoir. Fish migration from this ~ 7.5 acre lake is downstream only. The Cutthroat above the lake are isolated from the fluvial form. The distribution of Cutthroat above the reservoir was normal and yet descriptive of the differences in habitat quality (figure 7). The first mile of aquatic habitat exhibited lower instream wood densities (16 large key wood pieces / mile) than the adjacent upstream segment. This condition resulted in simplified aquatic habitat with lower rearing densities and lower actual abundance than observed in the more complex habitats above RM 1.0.

FIGURE 7


NF Rock Cutthroat Densities May 2006
Cutthroat / Sq. meter
0.6
0.5
0.4
0.3
0.2
0.1
0
498
1428
2124
3018
3805
4623
5288
6020
6640
7321
7997
8729
9171
10035
Total Distance from Mouth (ft)

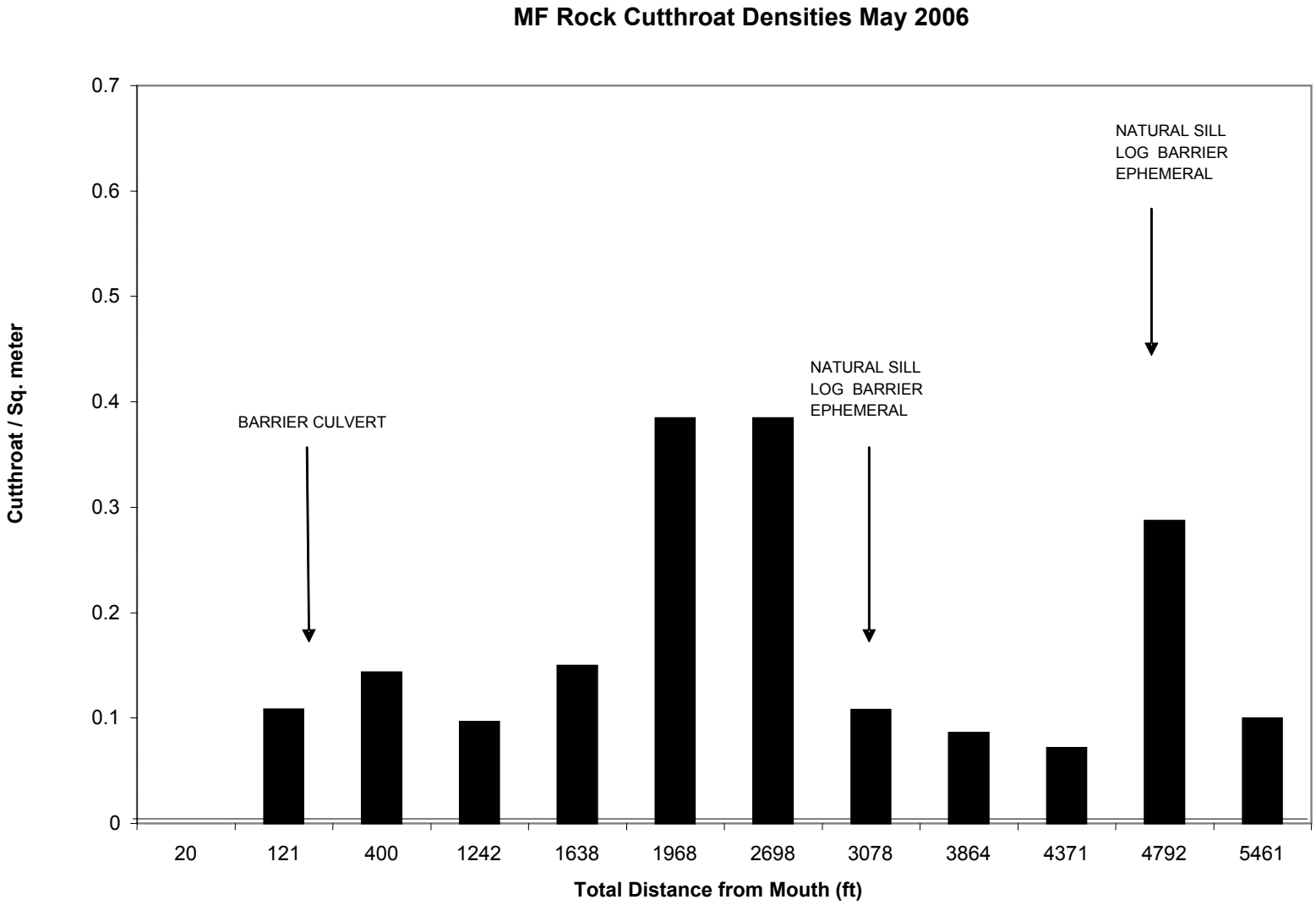
The primary issue associated with the reservoir is that the surface spill skims stratified warm water off the top 1-2 inches of the reservoir surface. This spill contributes unseasonably warm water to the mainstem of Rock Creek until the spill is terminated by municipal withdrawals at some variable date in early June. From this point on through the first fall rains, the contribution of the North Fork to the mainstem of Rock Creek is terminated. It no longer impacts mainstem water temperatures with warm surface spill, but it also no longer contributes downstream flow to mitigate mainstem temperatures. Manipulation of overflow and reserve reservoir flows will be a topic of discussion within the Recommendations section.

Middle Fork Rock Creek

Cutthroat distribution in the Middle Fork was essentially normal above the barrier culvert under the main road 120 ft above its confluence with Rock Creek. However, there was an accumulation of 0+ age Cutthroat below the culvert that appeared to be seeking upstream refugia. The culvert here exhibits a 3 ft perch and is a definitive barrier to the upstream migration of both juvenile and adult salmonids. In addition the culvert is undersized and does not meet the new ODF bank full width criteria. This condition can result in restricting the flow of naturally recruited wood and substrate resources to the mainstem through the catastrophic process of storm driven debris flow events. Recall that it is critical to provide upstream temperature dependent migration routes for juveniles because of the identified issue of elevated mainstem temperatures in Rock Creek.

There are two additional natural barriers to migration in the Middle Fork that exist at RM 0.58 and RM 0.91. They are caused by natural sill log pours of 1.5 and 2.5 vertical feet (figure 8). Both of these are ephemeral barriers and not a concern for modification. An abandoned water intake dam exists at RM 1.0 on top of a natural barrier falls. This is the definitive end of both juvenile and adult upstream migrations. The concrete dam is of little concern for fish distribution patterns because it was constructed on top of an impassable bedrock slide. There has been some concern that the structure could impede the downstream migration of a storm driven debris torrent event. This is unlikely because the channel confinement from opposing hill slopes at the dam site would not allow the dispersion of the hydraulic potential contained in a debris torrent event.

FIGURE 8


MF Rock Cutthroat Densities May 2006
Cutthroat / Sq. meter
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
BARRIER CULVERT
NATURAL SILL
LOG BARRIER
EPHEMERAL
NATURAL SILL
LOG BARRIER
EPHEMERAL
20
121
400
1242
1638
1968
2698
3078
3864
4371
4792
5461
Total Distance from Mouth (ft)

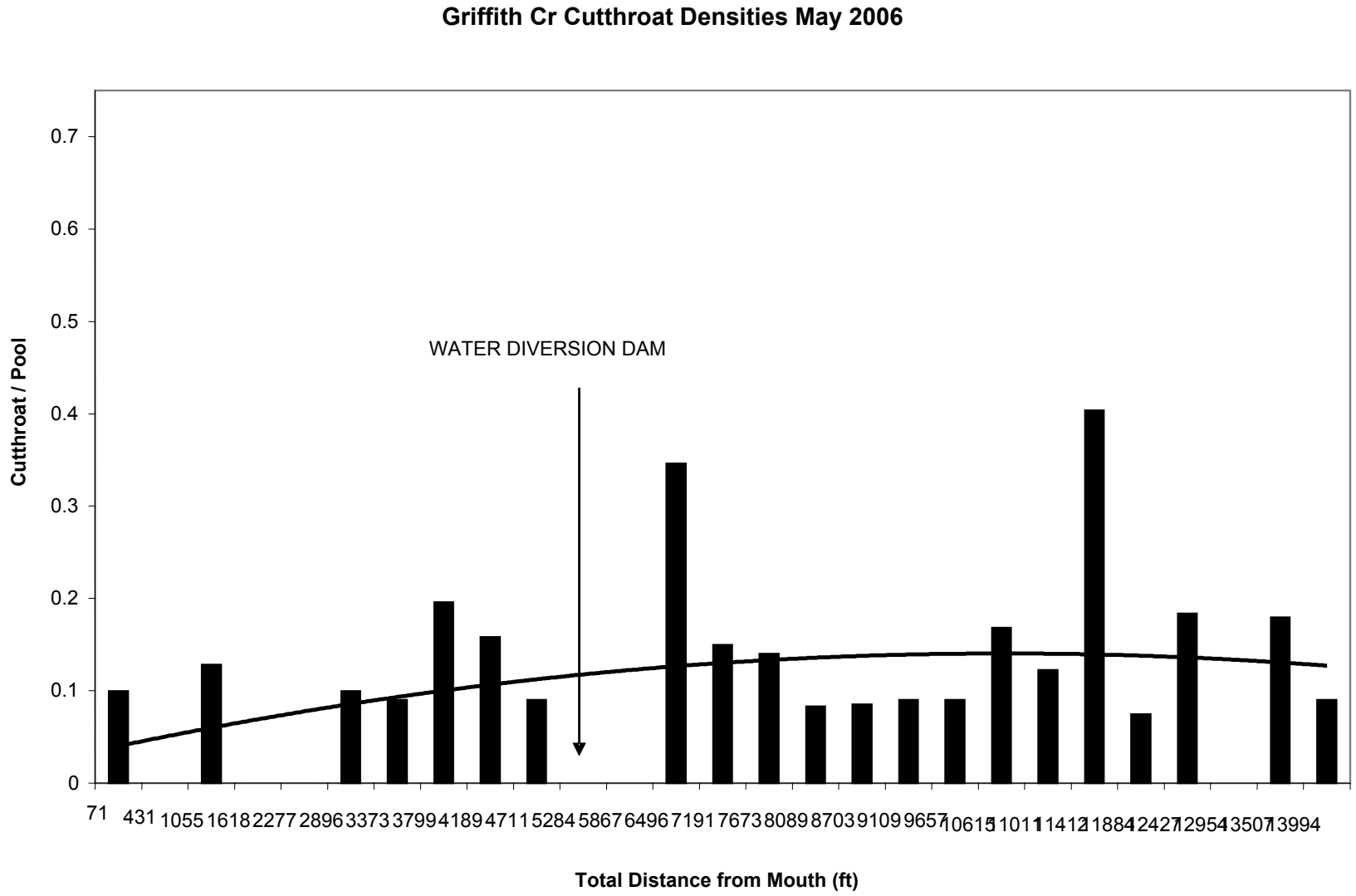
Griffith Creek

Cutthroat distribution in Griffith Creek also appeared normal. The May 2006 snorkel inventory results displayed only a weak signal for the upstream migration of juvenile or adult Cutthroat to the impassable diversion dam (figure 9). The full extent of this upstream migratory behavior would not be fully manifested until mainstem Rock Creek temperatures approached threshold conditions later in the summer (August / September).

To support the existence of this temperature dependent upstream migration in Griffith Creek we referred to the snorkel inventories conducted on September 9 of 1994. These surveys indicate 0+ Cutthroat densities in the one mile reach below the water diversion dam (definitive barrier) were double those observed above the diversion dam. There is much higher quality habitat above the dam. The inference here is that juveniles were likely escaping mainstem Rock Creek habitat but not able to proceed above the migration barrier (water intake dam).

There is a radical difference in habitat complexity between the stream segments below and above the water diversion dam at RM 1.0. (located on the property boundary). This is a result of the differential upslope management between ownerships (City of Corvallis and USFS). Instream wood densities on City of Corvallis ownership up to RM 1.0 were 3 pieces / mile (logs >12" diameter). Wood densities on the USFS ownership were 57 pieces / mile. City of Corvallis ownership exhibited a riparian corridor consisting of 94% small tree seral class dominated by Alder and Big leaf Maple. The USFS ownership exhibited a riparian corridor consisting of 76% mature tree seral class dominated by Douglas Fir and Western Hemlock.

FIGURE 9


Griffith Cr Cutthroat Densities May 2006
Cutthroat / Pool
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
WATER DIVERSION DAM
71
431
1055
1618
2277
2896
3373
3799
4189
4711
5284
5867
6496
7191
7673
8089
8703
9109
9657
10615
11011
11412
12188
12427
12954
13507
13994
Total Distance from Mouth (ft)

Addressing Watershed Function

The current physical and biotic condition of the Rock Creek aquatic corridor has everything to do with processes that are inextricably linked to both upslope forest management and municipal infra structure (roads, dams, trash racks and water diversions).

Status of Migratory Resources

The removal of riparian conifers on City of Corvallis ownership has reduced the short term riparian recruitment potential to the active channel of mainstem Rock Creek. The other potential source of wood, from debris flows, is removed by intake dams, trash racks and booms. So, the two primary sources of wood recruitment on the City's property and to other downstream stream segments below city ownership have been compromised.

An interruption of the substrate budget (gravel in and gravel out), has resulted from the presence of the reservoir on the North Fork and the periodic excavation and removal of accumulated bedload from the pools above the water diversion dams on Griffith Creek and South Fork Rock Creek. Each of these sites currently truncates the downstream migration of substrates to the lower mainstem of Rock Creek.

Without a consistent supply of wood and freshly recruited substrate, the stream channel cannot capture and retain migratory bedload (gravel and cobble). Winter flows quickly reduce the active channel to its underlying bedrock foundation. This is the current status of large sections of the mainstem of Rock Creek, from it's confluence with Greasy Creek to its confluence of the North Fork.

The headwater tributaries within the Rock Creek watershed are steep, originating from 3,000 ft in elevation. They are exposed to the impacts of rain on snow events, and an important source of resource delivery to the lower mainstem has historically been debris torrent flows. There is ample evidence of this form of resource delivery in the upper mainstem of Rock Creek (South Fork). We have addressed how this important natural process is currently impacted by dams and intake structures and established how these impacts have resulted in simplified mainstem habitats. It is significant at this juncture to suggest that maintaining a long range vision for upslope forest management criteria include the identification of slide prone headwater tributaries and the protection of the wood resources that exist in these debris torrent run out corridors. Not only must the steep slopes be identified as reserve areas, but the reserves must include the down slope riparian corridors in torrent pathways that will be responsible for contributing large wood volumes to this type of event.

Basin Scale Temperature Regimes

Extremely high water quality exists in the headwaters of the Rock Creek Watershed. All headwater streams originate from high coastal elevations and flow through largely intact Late Successional Reserves (LSR) on USFS property. Canyons are narrow, steep, heavily canopied and exhibit limited solar exposure on the aquatic habitats of Rock Creek tributaries. Wood densities are high, resulting in deep accumulations of transient bedload

material (sand, gravel and cobble). These deep bedloads of migratory substrate store and buffer summer flows from the impacts of direct sunlight and air.

Each of the major headwater tributaries (North Fork, South Fork, Middle Fork and Griffith Creek) eventually transitions onto the City of Corvallis ownership, which is positioned lower in the watershed. The natural geomorphology of the City's ownership is described by wider floodplains and flatter channel gradients. These two natural features predispose the stream corridor to increased impacts from air and solar exposure. Wider valley floors lengthen the window of solar exposure which is exacerbated by the east / west aspect of significant portions of the Rock Creek mainstem. Add the decrease in stored bed load from low wood densities on City property and the stream begins to exhibit exposed bedrock functioning as summer heat sinks. Pool turnover rates (the time water is retained in a single pool) are slower with reduced gradient, resulting in prolonged exposure to warming bedrock and sunlight.

Permitted water withdrawals from 3 of the 4 primary contributors of flow for the municipal water supply (South Fork, North Fork and Griffith Creek) reduce water delivery to the mainstem of Rock Creek. Water withdrawal expands the temporal window of low flow impact that would naturally be confined to a much narrower period. This results in exposing mainstem aquatic communities to temperature regimes that exceed DEQ thresholds for temperature. The extended exposure increases environmental stress that may have a direct impact on the vigor and survival of both salmonid and macro invertebrate populations. The combination of impacts has a negative cumulative impact on summer stream temperatures that become progressively more acute in a downstream progression towards the confluence with Greasy Creek.

The Effect of Cumulative Impacts on Fish

All of these basin scale physical attributes interact to form a cumulative downstream impact on fish abundance, distribution and species composition. An increase in mainstem temperature will expand the upstream distribution of the Red Side Shiner which was observed rearing in high densities in mainstem pools just above the confluence with Greasy Creek. An increase in mainstem temperature will force summer habitat use into smaller cooler tributaries with much lower production potential than mainstem habitats because of limited pool size. An increase in mainstem temperature will result in increasing inter and intra specific competition which will result in stress, reduced vigor and lower survival rates.

Summer mainstem temperature profiles are the most significant limitation to the viability of salmonid populations within Rock Creek. We have identified the primary factors that lead to this limitation, natural channel morphology, water withdrawal, historical riparian timber harvest, the lack of wood and bedload transport, reduction of aquatic complexity, etc. As we have displayed in this review none of the current metrics of elevated mainstem water temperatures, depressed instream wood densities or reduced flows can be linked to a single watershed impact. What is clear is that many contributing factors that are related to the final expression of elevated mainstem temperatures can be effectively addressed with aggressive upslope management prescriptions designed to go beyond State Forest Practice guidelines for riparian protection and with a prioritized restoration strategy that improves current conditions by addressing watershed function

on the basin scale and provides escape avenues for salmonids when mainstem summer temperatures approach survival thresholds.

Addressing these limitations within the framework of this stewardship plan is the goal of this analysis.

Additional Impacts

1) There is an abandoned dam and pumping station at RM 1.5 and directly behind the manager's residence. This dam has collapsed but is still full spanning across the active channel. The sheet flow that slips over the concrete apron during low summer flows (photo 3) is a potential barrier to 0+ age salmonids attempting upstream migrations.

2) The collapsed dam (RM 1.5) may have had an impact on the natural channel morphology directly downstream that has concentrated flow into a channel braid that pours over the 4 ft bedrock intrusion that was observed stalling migratory Cutthroat. Blocking this channel braid would restore the historic channel and provide smoother unimpeded upstream passage.

3) There is an abandoned road bed in the active floodplain at RM 1.6 just above the old trestle bridge crossing that cuts off a historical meander bend of Rock Creek. This confines Rock Creek to a narrow channel that contains a 3 ft bedrock falls. This small falls could complicate upstream migrations for 0+ age salmonids. If this road fill was removed from the floodplain a historical channel braid would be restored that would circumvent this small falls and provide passage for all age classes during all seasons.

4) Selective conifer harvest was conducted by the City of Corvallis in the riparian corridor from approximately the confluence of Griffith Creek to the confluence of NF Rock Creek. The inability of the riparian corridor to contribute large conifer to the active channel has helped create a LWD deficit within the mainstem of Rock Creek.

5) A debris torrent legacy from 1964 through the 1990's has effectively scoured large segments of mainstem Rock Creek to bedrock. Wood complexity and bedload materials have not been adequately recruited or retained since these events.

6) Impassable road culverts exist on MF Rock, Stilson Creek, Trib D, Connection Creek (USFS) and Trib 4 of SF Rock (USFS).

7) A potential future road failure was identified by Bio-Surveys in the May 2006 inventory on the SF Rock. The site is 1,600 ft above the water intake dam where the active stream channel has undercut the supporting toe slope to within 20 horizontal ft of the road centerline.

Recommendations

The identification of elevated summer water temperatures as the primary limiting factor for salmonids in the mainstem of Rock Creek suggest that it is imperative to

address the maintenance of mainstem water quality for protecting the long term function of not only Rock Creek and its biotic communities, but also of the mainstem habitats lower in the Marys River Watershed that are the recipients of the cumulative impacts of upper basin management strategies. There are two distinct approaches to improving mainstem water temperatures.

1) The maintenance and preservation of water quality.
2) The maintenance and provision of water quantity.

Addressing water quality

1) Management of the North Fork Rock Municipal Reservoir should include tracking water temperatures from the reservoirs surface spill and in the adjacent South Fork Rock Creek beginning in April. When these two temperatures begin to diverge and an elevation is detected in the North Fork spill, the sub surface gate valve (at the base of the earthen dam) should be opened to match the spill volume. This would extend the period of cold water contribution to the mainstem of Rock Creek until cessation of the normal surface spill in June.

2) Protecting identified point sources of cool tributary contributions to the mainstem of Rock. This is the case with riparian corridors surrounding Tributaries B, C, D and Stilson. Within these tributary corridors it is critical to not only protect surface flow from solar exposure but to provide a riparian setback ample enough to maintain a thermal buffer to the air / water interface. This may require riparian management area (RMA) criteria more stringent than specified under ODF guidelines.

3) Protect all streams that exhibit surface flow during summer from any solar exposure. This will be especially significant for upslope thinning prescriptions. Upslope 1st order riparians should not be exposed with a blanket thinning prescription. Higher riparian densities will be required to provide a thermal barrier.

Addressing water quantity

1) Managing late summer water reserves within the reservoir to supplement summer pinch period low flows in the mainstem of Rock Creek may be an attainable source of additional flow volume during some years.

2) Establishing minimum reserve stream flow criteria for each of the Rock Creek sub basins with water intake structures (Griffith, SF and NF Rock) would insure that any future pressure for expansion of the Rock Creek facilities water capacity would need to consider the impacts on watershed function addressed in this stewardship plan.

3) Creating, enhancing or restoring interactive floodplains (including ponds and wetlands) is an effective way of both restoring natural ecosystem function and storing ground water in the hyporheic zone. This type of restoration can result in extending spring runoff flows later into the low flow summer period which result in decreased stress on biotic communities. The placement of large instream wood structures can lift the active channel up to interface with its floodplain by accumulating migratory substrates

and impounding flows. In addition, nutrient storage is boosted in these aggraded channels which results in supporting food web interactions.

Restoration Prescriptions

How Restoration Prescriptions are Prioritized
Priority

1) Provides immediate access to cold water habitats for spawning and upstream temperature dependent migrations
2) Restores degraded system function (long term vision)
3) Protects upslope riparian habitats to insure the long term provision of cold summer flows
4) Provides guidelines for protecting downstream habitats (including Greasy Creek and Marys River)

Prioritized Restoration Strategy

1) SF Rock fish passage retrofit at water intake structure
2) MF Rock Culvert replacement
3) Griffith Creek fish passage retrofit at water intake structure
4) Redirection of stream flow from side channel to historic channel at bedrock intrusion at RM 1.5
5) Establish flow management schedule for NF Rock
6) Boost instream wood complexity in mainstem Rock Creek throughout City ownership
7) Develop partnership with large private land owner below the confluence of Griffith Creek to boost instream wood complexity and mitigate for cumulative downstream impacts on Greasy Creek and Marys River
8) Stilson Creek Culvert replacement
9) Trib D Rock Culvert replacement
10) Remove collapsed concrete dam at RM 1.55
11) Reconnection of historic channel at RM 1.6
12) Boost instream wood complexity in Griffith Creek on City ownership
13) Develop methodology for excavating accumulated substrates and recycling to active channel at diversion dams
14) Establish method for passing transient wood from reservoir and trash racks
15) Trib 4 SF Rock culvert replacement (juvenile barrier)
16) Connection Creek culvert replacement (juvenile barrier)
17) Establish minimum flow criteria for SF Rock
18) Establish minimum flow criteria for Griffith Creek
19) Establish minimum flow criteria for NF Rock

Data Gaps and future monitoring needs

1) Flow gauging stations in Griffith Creek below the water diversion dam, the SF of Rock below the water diversion dam and on the mainstem of Rock at the old USGS site at RM 0.4.
2) Temperature profiling for the lower mainstem of Rock Creek to assess pre and post restoration actions that effect the aquatic habitat limitation of elevated summer temperature.
3) Continued fish distribution inventories to monitor restoration response.