THE UMATILLA RIVER ANADROMOUS FISH HABITAT PROJECT:

2009-2010 ANNUAL REPORT

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ACRONYMS

ATI	assemblage tolerance index
AWRA	American Water Resources Association
BA	biological assessment
BE	biological evaluation
B&G	Bauer & Gustafson
BIA	U.S. Bureau of Indian Affairs
BLM	U.S. Bureau of Land Management
BMHRC	Blue Mountain Habitat Restoration Council
BMP	best management practice
BO	biological opinion
BPA	Bonneville Power Administration
cfs	cubic feet per second
COTR	Contracting Officer Technical Representative
CREP	Conservation Reserve Enhancement Program
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
CUJ	Confederated Umatilla Journal
dbh	diameter at breast height
DNR	Department of Natural Resources
DOE	Department of Energy
EA	environmental assessment
EIS	environmental impact statement
EPA	United States Environmental Protection Agency
ESA	Federal Endangered Species Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
ft	foot/feet
FY	fiscal year
gpm	gallons per minute
GPS	Global Positioning System
HIP II BO	Habitat Improvement Programmatic Biological Opinion
JPA	Joint Permit Application
km	kilometer/kilometers
lbs	pounds
LiDAR	Light Detection And Ranging
LWD	large woody debris
m	meters
mi	mile/miles
MOA	Memorandum of Agreement
mph	miles per hour
NEPA	National Environmental Protection Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPPC	Northwest Power Planning Council
NWPCC	Northwest Power and Conservation Council
NRCS	Natural Resource Conservation Service
ODEQ	Oregon Department of Environmental Quality

ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
ODSL	Oregon Department of State Lands
OWEB	Oregon Watershed Enhancement Board
OWRD	Oregon Water Resources Department
PCSRF	Pacific Coastal Salmon Recovery Fund
RM	river mile
RM&E	research, monitoring and evaluation
SHPO	State Historic Preservation Office
SOW	Statement of Work
SZA	stream zone alteration
THPO	Tribal Historic Preservation Office
TMDL	total maximum daily load
UAFHP	Umatilla Anadromous Fisheries Habitat Project
UBNPME	Umatilla Basin Natural Production Monitoring and Evaluation Project
UBWC	Umatilla Basin Watershed Council
UCSWCD	Umatilla County Soil & Water Conservation District
UNF	Umatilla National Forest
USACE	United States Army Corps of Engineers
USDA FSA	United States Department of Agriculture Farm Service Agency
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UPR	Union Pacific Railroad
WHIP	Wildlife Habitat Incentive Program
yr	year

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EXECUTIVE SUMMARY

The Umatilla Anadromous Fish Habitat Project (UAFHP) is an ongoing effort to protect, enhance, and restore functional floodplain, channel, and watershed processes to provide sustainable and healthy habitat for aquatic species in the Umatilla River Basin, including threatened Mid-Columbia summer steelhead. Flow quantity, water temperature, passage, and lack of in-stream channel complexity have been identified as the key limiting factors in the basin. During the 2009 and 2010 fiscal years (FY) reporting period (February 1, 2009-January 31, 2011) primary project activities focused on improving in-stream and riparian habitat complexity and restoring natural channel morphology and floodplain function. Six primary fisheries habitat enhancement projects and 3 planning/assessment tasks were accomplished on Meacham Creek, Camp Creek, Wildhorse Creek, Greasewood Creek, Birch Creek, West Birch Creek, McKay Creek, West Fork Spring Hollow, and the Umatilla River. Specific restoration actions included: (1) removal of three longitudinal levees and modification of one angular levee in Meacham Creek; (2) improved 0.1 miles (mi) of Birch Creek by stabilizing 335 feet (ft.) of streambank, improving fish habitat by additions of large wood, and increased density of vegetation; (3) built cattle exclusion fencing over seven mi of Meacham Creek, including 6.24 mi of newly constructed barbed-wire fence and repair and maintenance of 0.42 mi of existing high-tensile fence; (4) conducted 10 planting projects which involved planting 12,811 trees and seeding 600 pounds (lbs.) of native grasses; (5) monitoring and maintenance of 27 conservation easements on 23 individual landowners properties; (6) controlled noxious weeds on 512 acres (109 riparian, 403 upland) within project areas through hand and mechanical removal, biological control and chemical application; (7) completed the Extensive Habitat Assessment of the Umatilla River Watershed; (8) conducted an assessment and baseline inventory of riverine habitat and fish populations in upper McKay Creek; (9) completed planning, permitting, National Environmental Protection Act (NEPA) and Federal Endangered Species Act (ESA) consultation, cultural resource clearance, design and implementation plan for the Meacham Creek Floodplain Restoration and In-stream Enhancement Project in preparation of FY 2011 implementation. We participated in additional secondary projects as opportunities arose. Baseline and post-project monitoring and evaluation activities were also completed within the Umatilla River Basin. Habitat and aquatic assessment inventories were conducted at project sites prior to implementation. Monitoring plans will continue throughout the duration of each project to oversee progression and inspire timely managerial actions. Permitting applications for planned project activities and biological opinions were written and approved. Project activities were based on a variety of fisheries monitoring techniques and habitat assessments used to determine existing conditions and identify factors limiting anadromous salmonid abundance in accordance with the *Umatilla River Subbasin Salmon and Steelhead Production Plan* (Northwest Power Planning Council 1990) and the *Final Umatilla Willow Subbasin Plan* (Umatilla/Willow Subbasin Planning Team 2005).

INTRODUCTION

The CTUIR have hunted and gathered food and fished numerous rivers and streams of the Pacific Northwest for thousands of years. They depended upon anadromous fish for subsistence and trade. The indigenous people of the CTUIR still rely on natural resources from several watersheds located within areas of traditional use to provide them with a multitude of life essentials.

CTUIR's right to fish in its historical fishing places was acknowledged in the Treaty of 1855 that stated: "the exclusive right of taking fish in the streams running through and bordering said reservation is hereby secured to said Indians, and at all other usual and accustomed stations…" (Treaty of 1855, Articles of Agreement, Article 1, page 3). Decreased salmonid abundance has significantly impacted the livlihood of the Tribal community and altered their way of life.

Overfishing, sweeping changes to rivers and streams, and policies that changed the landscape have endangered salmon and created a "salmon crisis" (Montgomery 2003). It is the challenging duty of the CTUIR Umatilla Anadromous Fisheries Habitat Project (UAFHP) to restore and sustain healthy conditions of local watersheds to both assist in salmon recovery and ensure they provide adequate quantities of sustainable natural resources to satisfy the CTUIR's needs and preserve opportunities for traditional ways of life.

The BPA funds the CTUIR and other Pacific Northwest Tribes to restore salmonid habitat as part of its mitigation activities due to the harmful effects and loss of habitat caused by the massive Columbia River hydroelectric dams. The CTUIR UAFHP, #1987-100-01, funded by BPA through the Northwest Power and Conservation Council (NWPCC) in 2003 Fish and Wildlife Program, is an ongoing project initiated by CTUIR in 1987. The UAFHP is an ongoing effort to protect, enhance, and restore functional floodplain, channel, and watershed processes to provide sustainable and healthy habitat for aquatic species in the Umatilla River Basin. Project work further supports the CTUIR Department of Natural Resources ecological and First Foods mission statements to sustain production (Jones et al., 2008). The CTUIR is guided in its habitat restoration activities by the *Five-Year Action Plan for the Development and Maintenance of Habitat Improvement Projects in the Umatilla Subbasin: 2006-2010 For BPA-Funded Fish Habitat Improvement Programs* sponsored by: ODFW and CTUIR (CTUIR and ODFW 2006).

The goal of UAFHP is to protect, enhance, and restore salmonid habitat and abundance in the Umatilla River Basin. The project focuses on the mainstem Umatilla and tributaries that provide spawning, rearing, and migrational habitat for Middle Columbia River Basin ESA Listed summer steelhead and bull trout, as well as for spring chinook salmon, a preferred species of traiditonal importance to CTUIR. Habitat enhancement activities are designed to improve aquatic and riparian habitat resulting in an increase in viable populations of focal species and secondary species of fish and wildlife in the Umatilla River watershed. CTUIR is also engaged in activities to enhance habitat for bull trout, redband rainbow trout, Pacific lamprey, mountain whitefish, fall chinook and coho salmon.

During the 24-year project history, the CTUIR has helped administer and implement a number of fisheries habitat enhancement projects in the Umatilla River Basin. In FY 2009 and 2010, the CTUIR maintained 27 partnership habitat enhancement projects along Meacham Creek, Isquulktpe Creek, Birch Creek, West Birch Creek and the mainstem

Umatilla River, among other sites. The CTUIR has developed effective interagency partnerships and is effectively working at the policy and project levels with various federal, state, and county agencies and private landowners.

The UAFHP is an integral component of the *Umatilla River Subbasin Salmon and Steelhead Production Plan* (NPPC 1990) and is well integrated into the framework of the *Umatilla Subbasin Plan* (Umatilla/Willow Subbasin Planning Team 2005) established by the NWPCC to better coordinate habitat restoration work in the Umatilla River Basin. The CTUIR, ODFW, NRCS, UBWC, and other participating agencies and organizations have made significant progress towards restoring and protecting vital salmonid habitat in the basin.

Noteworthy accomplishments for the CTUIR UAFHP during FY2009:

- Removal of three longitudinal levees and modification of one angular levee (3,161 linear ft) over one-mile of Meacham Creek restoring floodplain and stream channel processes and connectivity, river mile (RM) 5-6.
- Installing 6.54 miles (mi) of fencing to exclude trespass livestock (cattle, horses, and wildlife) on Meacham Creek, RM's 2.0-9.0
- Maintaining 27 conservation easements on 23 properties and partnering with the NRCS Wildlife Habitat Incentives Program (WHIP) and Conservation Reserve Enhancement Program (CREP)
- Planting 5,581 saplings/cuttings at 7 project locations.
- Seeding 400 pounds (lbs) of native grasses at the Meacham Creek Levee Removal Project (RM 5-6) area
- Using hand and mechanical, biological and chemical controls to treat 512 acres (109 riparian, 403 upland) for noxious weeds
- Conducting project maintenance activities at all sites
- Conducting an assessment and baseline inventory of riverine habitat and fish populations in upper McKay Creek
- Developing the Extensive Habitat Assessment of the Umatilla River Watershed

Noteworthy accomplishments for the CTUIR UAFHP during FY2010:

- improving 0.1 miles of Birch Creek by stabilizing 335 ft of streambank, improving fish habitat by additions of large wood, and increased density of vegetation
- Maintaining 27 conservation easements on 23 properties and partnering with the NRCS Wildlife Habitat Incentives Program (WHIP) and Conservation Reserve Enhancement Program (CREP)
- Planting 7,230 saplings/cuttings at 3 project locations.
- Seeding 200 pounds of native grasses at the Birch Creek Bank Stabilization and In-stream Enhancement Project (RM 2.8-2.9) area
- Using hand and mechanical, biological and chemical controls to treat 512 acres (109 riparian, 403 upland) for noxious weeds
- Conducting project maintenance activities at all sites
- Conducting an assessment and baseline inventory of riverine habitat and fish populations in Meacham Creek
- Completing the Extensive Habitat Assessment of the Umatilla River Watershed
- Completing planning, permitting, NEPA and ESA consultation, cultural resource clearance, design and the implementation plan for the Meacham Creek Floodplain Restoration and In-stream Enhancement Project on Meacham Creek (RM's 6.0-7.1)

Subbasin planning teams utilized information from a variety of resource assessment sources to classify existing habitat status, determine limiting factors, and identify priority areas for restoration activities. A combination of both passive and active restoration strategies were then developed to address habitat deficiencies. Collection of aquatic habitat, geomorphology, water quality, and fish abundance data is ongoing and utilized for optimizing adaptive restoration plans at project areas.

Although many project areas are in an early stage of recovery, establishment of conservation easements, construction of riparian exclusion fencing, development of off-channel water sources for livestock, re-vegetation efforts, and in-stream work, such as passage barrier rectification, channel reconstruction, and large wood additions, have resulted in improving trends including:

- Improved stream channel stability with early succession dimension, pattern and profile
- Increased accessibility to suitable habitat conditions in headwater streams via passage rectification
- Decreased channel width-depth ratios, gradient, and entrenchment and increased channel sinuosity, length, floodplain connection, enhanced pool habitat, increased stream shade and undercut banks
- Increased availability of in-stream habitat, including backwater and off-channel rearing areas
- Improved condition of riparian and wetland plant communities for fish and wildlife species
- Increased in-stream habitat complexity and diversity resulting in improved pool-riffle sequences associated with dynamically stable channel morphology

In addition to BPA, CTUIR secured funding for habitat improvements from a variety of sources, including PCSRF, UPR Mitigation, the Unites States Environmental Protection Agency (EPA), Oregon Department of Transportation (ODOT), Blue Mountain Habitat Restoration Council (BMHRC), and NRCS.

Project results are reported in various BPA formats including Pisces status reports, project completion reports, and annual reports. The CTUIR maintains a complete database on project planning, proposals, permitting, implementation, and results through the completion of required project deliverables. For a complete list of reports submitted by the CTUIR's UAFHP dating to 1989, please consult the following website at URL: http://www.efw.bpa.gov/integratedfwp/reportcenter.aspx and search **publications,** typing 1987-100-01 in the project number box provided. Recent projects initiated in FY2007 and continuing in FY2008 are described in *Umatilla River Basin Anadromous Fish Habitat Enhancement Project February 1, 2007-January 31, 2008 Annual Report,* Document ID# P109208, available online at: http://pisces.bpa.gov/release/documents/documentviewer.aspx?doc=P109208 (CTUIR 2008).

PROJECT AREA

Umatilla River Basin

The Umatilla River Basin is located in the northwest portion of the Blue Mountain Ecological Province in northeast Oregon. The Umatilla River Basin comprises 1,465,600 acres of the 6,400,000 acres of ceded CTUIR land (CTUIR 1995) as identified by the Treaty of 1855. Figure 1 illustrates the vicinity of the Umatilla River Basin within the Blue Mountain Province. The Umatilla River drains an area of approximately 2,540 square miles (mi^2) (6,579 square kilometers [km^2]) and flows approximately 89 mi (143 km) from its mouth to where it divides into the north and south forks of the Umatilla River. Each fork adds another approximately 10 mi (16 km) of length. Major tributaries in addition to the north and south forks include Meacham Creek, Birch Creek, Butter Creek, and Wildhorse Creek. The Umatilla River originates at elevations up to 4,228 ft (1,289 m) and flows to an elevation of about 269 ft (82 m) at its confluence with the Columbia River (USFWS 2002).

Geology and Vegetation

The Umatilla River Basin can be roughly divided near the city of Pendleton, Oregon (OR) (RM 53) into two physiographic regions. The lower river, west of Pendleton, has cut a low valley into a broad upland plain called the Deschutes-Umatilla Plateau. Parent geologic materials of the plain are dominated by multiple layers of middle Miocene basalt flows, specifically, the Wanapum and Grand Ronde Basalts, originating 14 to 17 million years ago. Pleistocene and Holocene loess, alluvial, and glaciofluvial deposits are located on top of the Miocene basalts (Walker and MacLeod 1991; USGS 2008). Currently, vegetation on the broad Deschutes-Umatilla Plateau is primarily comprised of dry land crops and sagebrush-grass communities.

The region east of Pendleton is dominated by the Blue Mountain foot hills and the Blue Mountains. The Blue Mountains are accreted terrains that underwent lifting, faulting and folding of volcanic, sedimentary and metamorphic rock from 15-6 million years ago (Alt and Hyndman 1995). The middle Miocene basalts of the lower river are also the dominant parent materials in the headwaters. The river and streams have cut steep-sided canyons into the layers of rock that form the higher elevations of the Blue Mountains. Exposed basalt outcrops fracture into blocks and plates while the unexposed layers remain fairly impervious to water (Walker and MacLeod 1991). The combination of steep canyon walls and impervious bedrock lends to poor ground water recharge (NPPC 1990). Vegetation distribution patterns upstream of Pendleton are typical for the Blue Mountains. Grasses and small shrubs dominate the drier, south facing slopes. Conifers dominate the north facing slopes, higher elevations, and moderately wet areas.

Historically throughout the Umatilla Basin, deciduous trees were abundant in riparian areas on the valley floor. In 1812, Robert Stuart described the Umatilla River near the location of present day Pendleton with “bottoms well covered with cottonwood pofsefs (a good) many

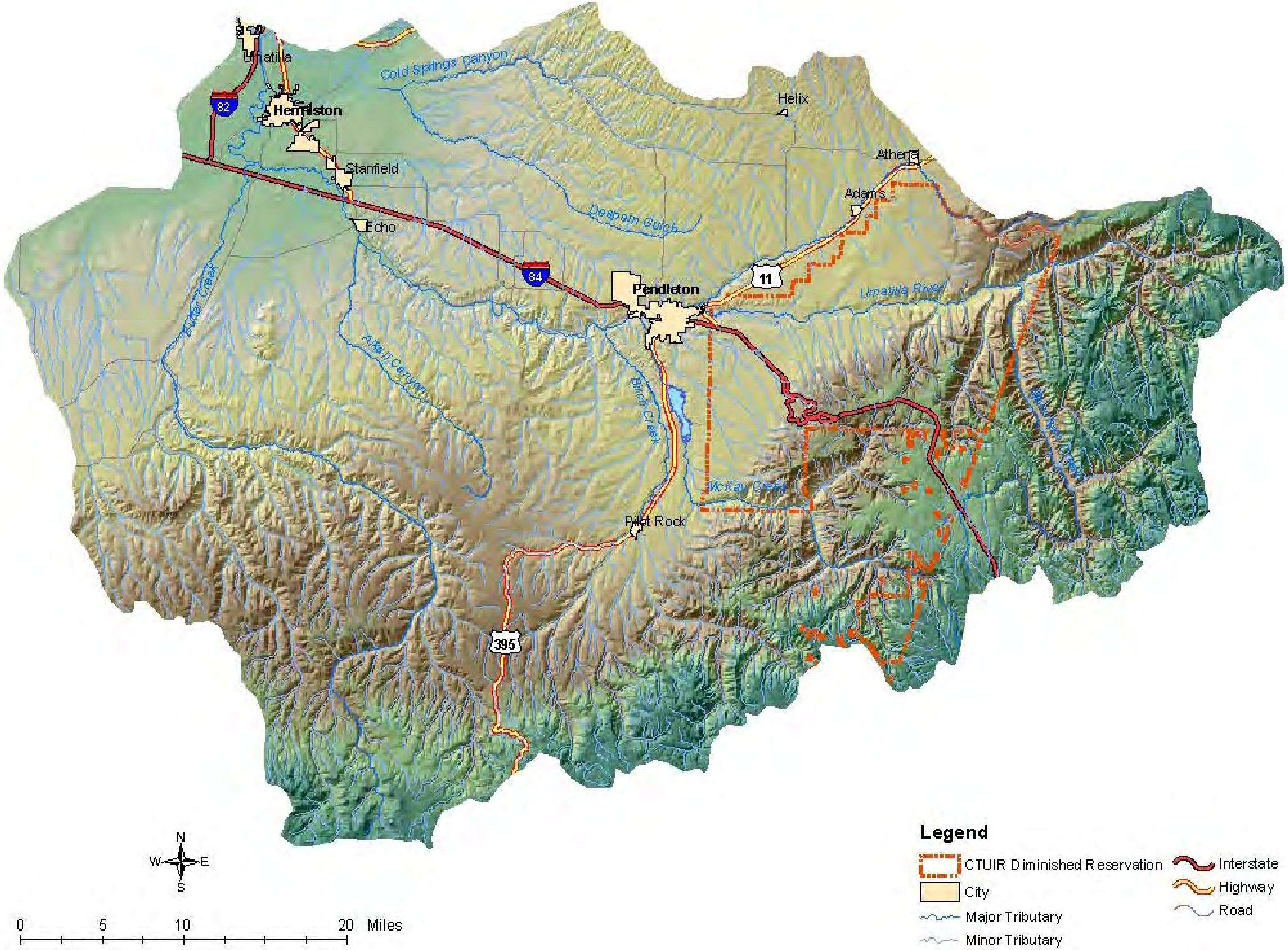

Figure 1. Umatilla River Basin

Swamps and Ponds in which reside a great multitude of beaver" (Rollins 1935, as cited by USFWS 2002, Chapter 10). During this same time period, "[M]any of the pioneers traveling through the area noted the cottonwoods along the river (Nagle 1998, as cited by USFWS 2002, Chapter 10)."

Riparian habitat and vegetation on the mainstem Umatilla River and many tributaries are in poor condition. Land use practices over the last hundred years have cleared most of the riparian vegetation along the rivers and streams for irrigated agricultural, livestock, and urban uses. In the lower Subbasin, losses of riparian vegetation are particularly high; one study estimated those losses at greater than 95% as compared to pre-pioneer settlement conditions (c. 1850; Umatilla/Willow Subbasin Planning Team 2004)

Figure 2 shows the valley form and degraded fisheries habitat conditions in the mid-Umatilla River Basin, including the disconnected floodplain, poor width-to-depth ratios, streambank erosion, channel incision, noxious weeds, and lack of adequate stream shading due to the narrow riparian belt width comprised of secondary growth and located a significant distance from the wetted channel. Three-quarters of the Umatilla River has been constrained by levees, and consequently, approximately 70% of 422 miles of inventoried river and streams are in need of improvement (Umatilla/Willow Subbasin Planning Team 2004).

Figure 2. Typical Reach of the Mid-Umatilla River Basin

Land Use

Agriculture, both cropland and pasture, dominate the use of the Umatilla River Basin at the present time and total one million plus acres (Figure 3). Mixed rangeland accounts for one third of the remaining acres. Several land uses have adverse impacts on the Umatilla Basin Watershed and its fisheries habitat including: (1) agriculture (cropland and pasture, irrigated and dry land), (2) livestock grazing in both forested lands and land not designated for crops, (3) streamside roads, (4) railroads, (5) timber harvest, (6) recreational and municipal water development, (7) housing development and urbanization within the floodplain, (8) irrigation and water withdrawals, (9) recreational use of riparian areas, (10) livestock water developments, and (11) channel modification, such as dams and levees, for flood control projects (USFWS 2002).

When large numbers of livestock have full access to streams, the following impacts may occur: reduction of riparian vegetation, bank erosion, channel incision, reduced stream depths, and reduction of overall water quality. Generally, salmonid abundance is limited in reaches inhabited by unmanaged livestock due to an overall reduction of habitat quality and quantity.

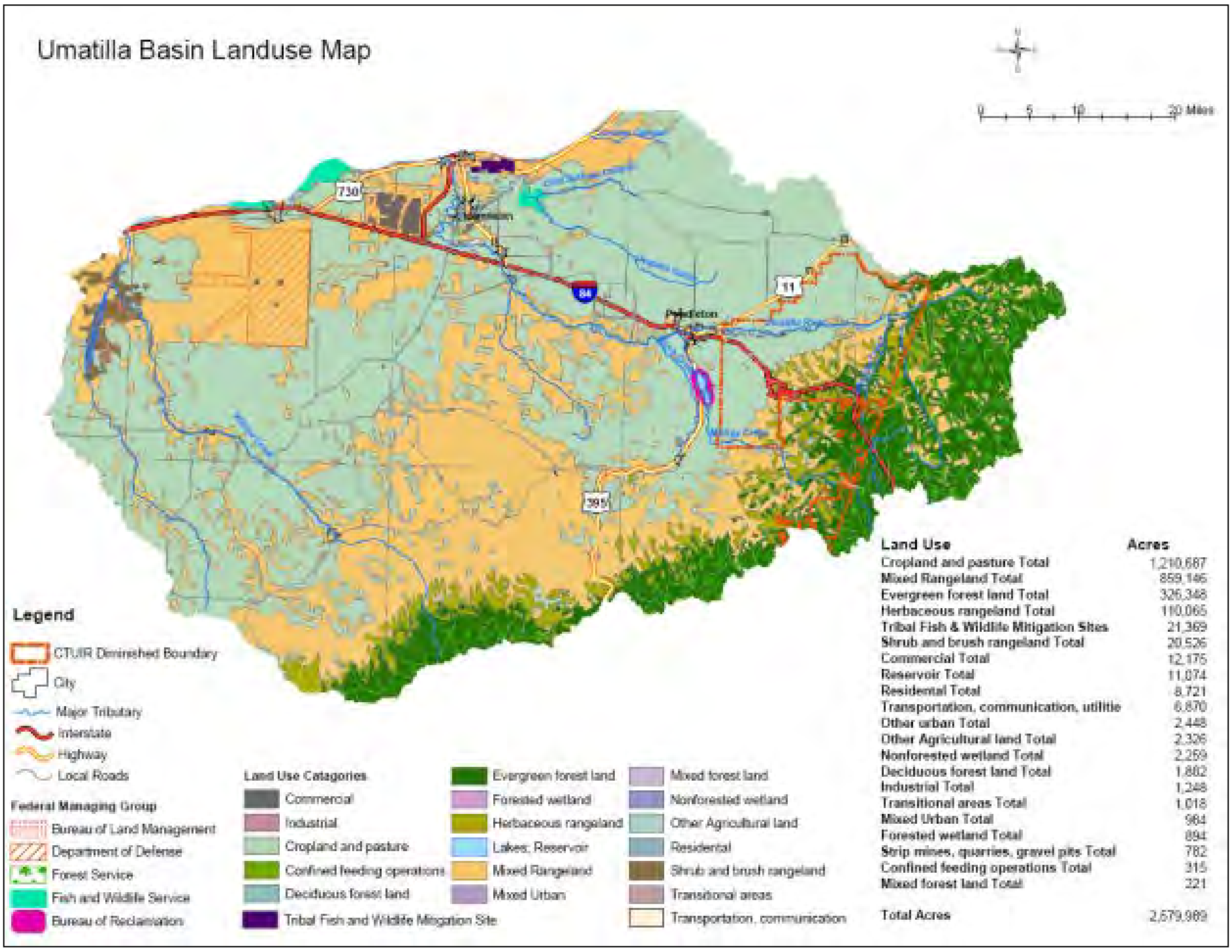

Figure 3. Land Use within the Umatilla Basin

Hydrology

Annual precipitation averages 10 inches/year (in/yr) near the confluence with the Columbia River to 50 in/yr in the headwaters (Taylor 1993). From 1928 to 1999, annual discharge at the gauging station near Umatilla, Oregon (RM 1.9) averaged 345,700 acre-ft (80.7 million cubic meters [m^3]). Average annual discharge of the Umatilla River Basin for calendar years 1995 to 1999 was 531,486 acre-ft (124 million m^3) (USFWS 2002).

U.S. Geological Service (USGS) flow data from 1995-2008 at Gibbon, OR (RM 78.5) and the West Reservation Boundary, Umatilla River (RM 56.1) show unstable, flashy hydrograph patterns and extreme low and high flow episodes.[1] The Umatilla River hydrographs exhibit tall peaks indicative of high flows during high rain, snowmelt, and runoff events in the spring and early winter, but severe drops in flow during the semi-arid summer months, when it is not uncommon to have reaches of major tributaries devoid of flows for months at a time. This phenomenon results from the regional geological characteristics and arid climate, but is also influenced by the poor health of the watershed.

This hydrologic effect is less pronounced in the relatively pristine North Fork Umatilla Wilderness Area, apparently because of minimal human disturbance, higher elevations, developed soils, and expansive riparian areas featuring large woody debris and climax plant communities. It is generally perceived as a "reference" reach.

Anthropogenic Effects on Salmonid Habitat

The Umatilla River Basin historically supported viable and harvestable populations of spring/summer and fall Chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), sockeye salmon (*O. nerka*), summer steelhead (*O. mykiss*), Pacific lamprey (*Entosphenus tridentatus*), bull trout (*Salvelinus confluentus*), steelhead-rainbow trout (*O. mykiss sp.*), and mountain whitefish (*Prosopium williamsoni*). Human-caused alterations have negatively impacted the watershed and caused significant reductions of endemic salmonid populations. Beginning in the late 1800s, fish populations started to decline due to habitat degradation; sockeye and coho were extirpated in the early 1900s. Irrigation and agricultural development throughout the basin in the early 1900s is believed to be the primary cause of the decline of steelhead and the extinction of salmon. Since the completion of the Treaty of 1855, aquatic and riparian habitats have been degraded through irrigation diversions, water extractions, channelization, livestock grazing, logging, agriculture and urban development (Umatilla/Willow Subbasin Planning Team 2004). Subsequently, the abundance of Chinook, steelhead, bull trout, and other fish species has also been dramatically reduced. With declining fish populations, Tribal governments, federal, state and international agencies were obligated to eliminate or significantly reduce subsistence and sport fisheries by the mid-1970s. The Federal government listed Columbia River spring Chinook salmon, summer steelhead, and bull trout as threatened species under the ESA in 1973, 1992, 1997, and 1998, respectively.

The following species listed under the ESA currently occur in the Umatilla River Basin: Columbia River bull trout Critical Habitat (designated), Columbia River bull trout (threatened), and Mid-Columbia River steelhead (threatened). In the mid-1980s, a successful, hatchery-based salmonid reintroduction effort for the Umatilla River was instituted using neighboring strains of various salmonid species. Although hatchery programs currently support subsistence and restricted sport fishing opportunities for steelhead and Chinook salmon, there remains significant need to re-build viable, harvestable, and sustainable fish stocks throughout the basin.

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[1] US Geological Survey Water Data can be found at the following URL, as accessed November 19, 2008:
http://waterdata.usgs.gov/nwis/uv/?site_no=14020850&agency_cd=USGS
http://waterdata.usgs.gov/nwis/uv/?site_no=14020300&agency_cd=USGS

Modern human activities have loaded the Umatilla River with agricultural fertilizers, sewage, pesticides, and suspended sediments, as well as urban and industrial pollution (CTUIR 2008). The Oregon Department of Environmental Quality (ODEQ) listed the Umatilla River Basin on the State's list of water quality limited water bodies' 303(d) list (Please see the ODEQ website at URL http://www.deq.state.or.us/wq/assessment/rpt0406/results.asp for details). A Total Maximum Daily Load (TMDL) was also written for waters within reservation boundaries (CTUIR 2005) that, in combination with CTUIR's habitat enhancement work, should lead to water quality improvements over the long term (Please see http://yosemite.epa.gov/R10/WATER.NSF/TMDLs/Approved+TMDLs#OR, select "Oregon", and navigate to "Umatilla Tribal TMDL" for a copy of this report.).

Throughout much of the watershed, maximum water temperatures exceed lethal limits for bull trout and approach lethal limits for Chinook salmon and rainbow/steelhead trout. The high stream temperatures potentially limit carrying capacity, adversely affect fish fitness, and should be considered as a primary factor limiting salmonid production in the watershed. CTUIR's UAFHP is currently taking steps to address water quality issues through its habitat restoration activities.

Habitat Protection/Restoration Activities

Habitat protection and restoration needs in the basin have been recognized in numerous reviews, planning processes, and reports (CTUIR 1993; CTUIR 2000; Umatilla/Willow Subbasin Planning Team 2004; 2005). The NMFS has recently restarted the recovery planning effort for Chinook salmon and steelhead and tributary habitat restoration. The National Research Council (1996) notes the importance of protecting and rehabilitating freshwater habitat as part of salmon recovery and specifically notes the importance of riparian areas. This body recommended that habitat reclamation or enhancement should emphasize rehabilitation of ecological processes and function (NRC 1996). The USFWS draft bull trout recovery plan also recognized the importance of habitat protection and restoration and specifically noted the need to improve water quality, reduce or eliminate fish passage barriers, and restore impaired in-stream and riparian habitat (USFWS 2002). Pre-project implementation aquatic habitat inventory surveys conducted by CTUIR revealed that habitat quality ranked poor in 85% of areas surveyed and fair in 15% in the Umatilla River. Flow quantity, water quality, passage, and in-stream channel complexity were identified as key limiting factors.

The *Final Umatilla Willow Subbasin Plan* (Umatilla/Willow Subbasin Planning Team 2005) determined that the limiting factors could be addressed through habitat restoration and implementation ("Phase III") of the Umatilla Basin Project. Three restoration scenarios were proposed based on the results of the Ecosystem Diagnostic Treatment model: (1) Habitat restoration of the top priority geographic areas singly plus the implementation of Phase III of the Umatilla Basin Project; (2) Habitat restoration of the top 19 geographic areas plus implementation of Phase III; and (3) Habitat restoration of the top 19 geographic areas with no implementation of Phase III.

Not surprisingly, these results suggested that the greatest amount of action (restoring the 19 geographic areas and implementing Phase III flow increases) has the greatest impact on steelhead and Chinook salmon productivity and abundance. The *Final Umatilla Willow Subbasin Plan* (2005) models recommended that a scenario with habitat restoration coupled with increased flows would be the most effective means of rehabilitating diminished (from historic levels) runs of Chinook and steelhead. Implementation of Phase III will involve increased in-stream flows in the Umatilla River mainstem from Thornhollow (RM 73.5) to the mouth. Priority management strategies are being conducted in accordance with the *Final Umatilla Willow Subbasin Plan* (Umatilla/Willow Subbasin Planning Team 2005). These include:

- Increase water conservation and irrigation efficiency
- Large Wood/Boulder Structure Placement
- Fence/Plant Riparian Zones
- Modify Channel Floodplain Function
- Construct Pool/Riffle – In-stream Modification
- Modify Detrimental Land use Activities
- Restore Upstream/Headwater Attributes to Improve Downstream Conditions
- Increase Passage Efficiency

In accordance with the 2006 NPCC solicitation outline, the FY2008 CTUIR UAFHP focused its restoration activities primarily on the Meacham and Birch Creek watersheds. The Meacham Creek Watershed has long been a primary focal point of the CTUIR effort to improve habitat conditions in the Umatilla Basin because of its location, size, historical significance, and recovery potential. CTUIR has initiated restoration activities to address existing habitat deficiencies as part of a long-term watershed restoration plan.

CTUIR and ODFW work together to co-manage and improve habitat in target areas in the Umatilla River Basin. Priority target geographical areas were established in the *Five Year Action Plan for the Development and Maintenance of Habitat Improvement Projects in the Umatilla Subbasin* (CTUIR and ODFW 2006). The Meacham and Birch Creek watersheds were identified by CTUIR and ODFW in the Five-Year Action Plan as priority areas for fish habitat restoration activities. An analysis of habitat conditions in the Umatilla Basin was conducted by CTUIR and ODFW. In addition to the historical relevance of these watersheds, fisheries data collected over the last two decades illustrated the importance of the basin to anadromous and resident salmonids. These watersheds are a primary focal point of the CTUIR effort to improve habitat conditions in the Umatilla Basin because of the current habitat status, historical significance and recovery potential. CTUIR initiated restoration activities to address existing habitat deficiencies as part of long-term watershed restoration plan. CTUIR is the lead entity responsible to address habitat deficiencies in the following high priority target areas: (1) Birch Creek: RM 2.0 to Hoeft Road (RM 10.5); (2) East Birch Creek: Mouth to Humphrey Bridge (RM 4.0) and Westgate Canyon Ranch (Baker Property); (3) West Birch Creek: Mouth to Bear Creek (RM 5.0); (4) Meacham Creek: Mouth to Forks, RM 15.3 (including tributaries); and (5) Upper Umatilla River: Mission Bridge (RM 59.5) to Meacham Creek (RM 78.8). In 2005, Birch Creek shifted from being solely managed by ODFW to being co-managed with CTUIR.

Our primary areas of focus for restoration projects in FY's 2009 and 2010 were Meacham Creek and Birch Creek (Figure 4). However, project restoration activities occur in other areas of the basin where floodplain and riverine processes are treated with outcomes that are beneficial to ecological processes, water quality and fish production. The following section describes specific areas where projects were implemented by CTUIR's UAFHP in FY2009 and FY2010.

Figure 4. Umatilla River Basin FY2009-FY2010 UAFHP Project Sites

1: Meacham Creek, RM 5-6; 2009 Removal and/or modification of 4 levees.

2: Meacham Creek, RM 2-9; 2009 Installed 6.54 Miles of Livestock Exclusion Fencing.

3: West Birch Creek, RM 3.0; 2009 Installed 0.3 miles of Livestock Exclusion Fencing.

4: Upper McKay Creek Watershed; 2009 Assessment and Baseline Inventory of Riverine Habitat and Fish Populations.

5: Birch Creek, RM 2.8-2.9; 2010 Bank Stabilization and In-stream Wood Habitat Enhancement.

6: Umatilla River Subbasin; 2010 Extensive Habitat Assessment.

7: Umatilla River, B&G Property; 2009-2010 Riparian Plantings and Maintenance on NRCS CREP Tarps.

8: Birch Creek, RM 2.6-3.1; 2009-2010 Riparian Plantings and Maintenance on NRCS CREP Tarps.

Description of Creeks in Project Area

Meacham Creek

The 114,000 acre Meacham Creek Watershed is located in northeast OR, on the west slope of the Blue Mountains, 23 miles east of the city of Pendleton, OR (Figure 5). The headwaters originate near the towns of Meacham and Kamela, OR, near Salmon Back Ridge. Meacham Creek is a 37-mi long major tributary of the Umatilla River that enters near RM 79. Although intermittent in several reaches, it contributes slightly more than half of the summer flow to the mainstem Umatilla River at the confluence. Data from CTUIR shows that Meacham Creek runs 2-3 ºC warmer (16 ºC [60.8 ºF] vs. 13.5 ºC [56.3 ºF]) during the summer than the Umatilla River at the confluence.

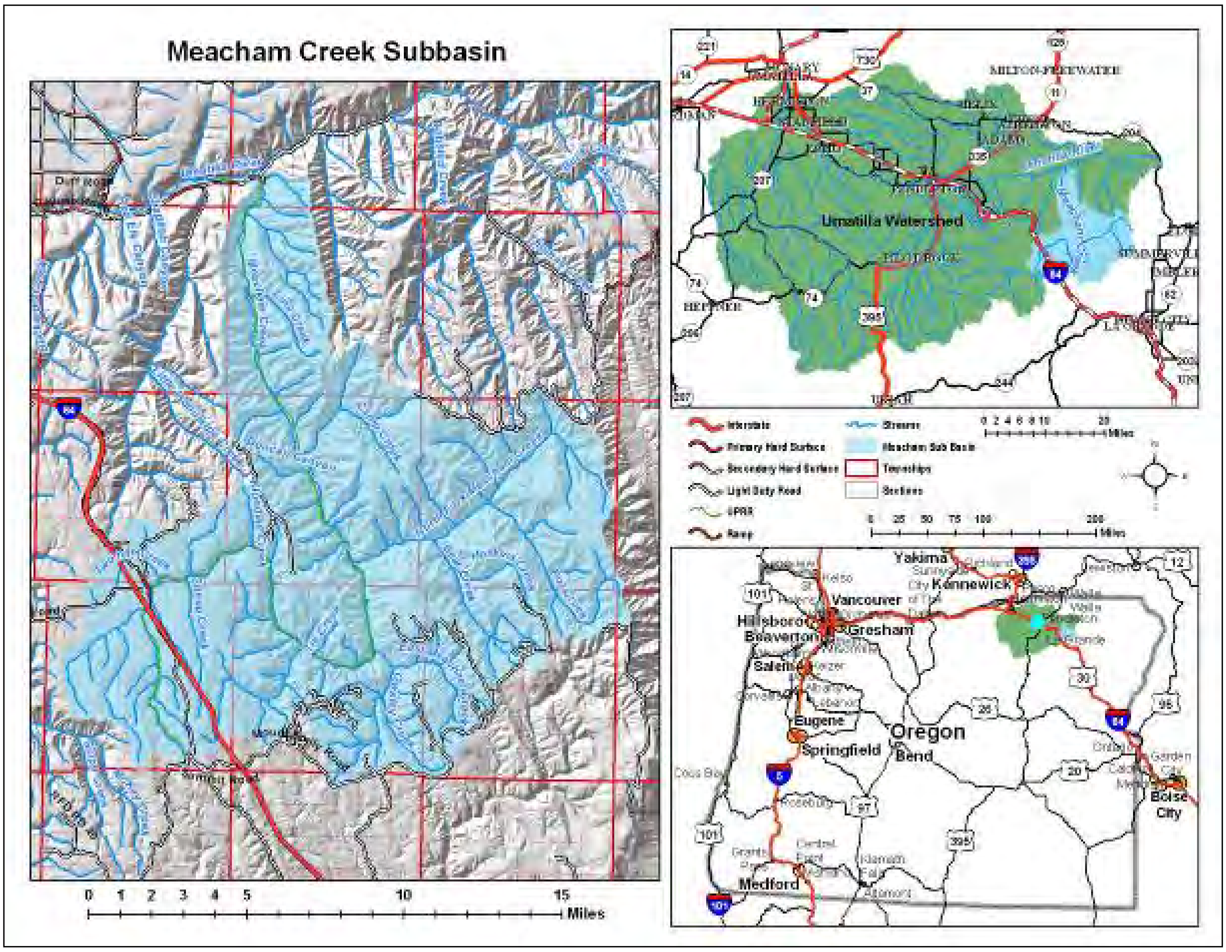


Figure 5. Meacham Creek Subbasin, tributary to the Umatilla Basin.

Topography

The topography of the Meacham Watershed is typical of the Blue Mountain foothills, with broad flat ridges bisected by moderately steep, constraining canyons with a variety of aspects. The valley floor is generally comprised of multiple terraces alternating with moderately steep hill slopes located adjacent to the creek. Elevations range from approximately 1,850 ft above sea level near the mouth of the creek to approximately 2,850 ft at the headwaters. In the lower half of the basin, the watershed is characterized by having a broad valley floor averaging 10.7 times as wide as the active channel. The upper half consists of much steeper and closely orientated hill slopes that encroach upon the channel and contribute increasing proportions of bedrock into the channel and bank composition.

The typical channel morphology is most representative of a Rosgen "C" type classification (e.g., slightly entrenched, meandering, alluvial channels that occur on gentle gradients in broad valleys, as defined in Rosgen 1996) in the lower half of the basin; in the upper basin, the channel becomes increasingly constrained due to natural and human-made conditions.

Hydrology

The USGS maintains a gauging station operated in cooperation with the CTUIR at Gibbon, OR (RM 78.5). The drainage area covered is 176 mi^2. Maximum flows peak at 8,800 cubic feet per second (cfs), while minimums of 7 cfs constitute summer base flows. Several vast dry channel reaches are located intermittently throughout Meacham Creek in the summer months. It has been theorized that substantial fish displacement, stranding, and mortality occurs in the system due to these hydrological conditions.

Plant Communities

Plant communities in the Meacham Watershed exhibit a grass-timber mosaic characteristic, typical in the Blue Mountains. North-facing slopes and the riparian corridor support second growth timber. Grasslands are more common on south-facing slopes. In the riparian areas, cottonwoods and conifers (12-20 in diameter breast height [dbh]) are dominant, various shrubs comprise the second-story growth, and tertiary growth consists of grasses. Riparian shrub communities generally consist of black hawthorn, Himalayan blackberry, willow, and to a lesser extent, ocean-spray, various rose species, elderberry, and common snowberry. Other habitat types include upland shrub, predominantly mallow ninebark/common snowberry and common snowberry/rose plant associations, located in stream or draw bottoms.

Anthropogenic Impacts

The Meacham Watershed is of historical significance to Native American people of the area because of its traditional hunting, fishing and gathering opportunities. There are various ancient sites of cultural significance located adjacent to the Meacham waterways. The primary impacts to Meacham Creek are associated with the adjacent UPR railway, built in the early 1900s at close proximity to the mainstem of Meacham Creek for the majority of its 37 RM’s. Extensive diking, channel relocation or containment, and alteration of the vegetative component are impacts associated with construction and maintenance of railway operations. Many of the large trees in the Meacham watershed were likely removed to fuel steam locomotives during the early days of railroad and to supply the needs of a sawmill formerly located near RM 2 of the North Fork of Meacham Creek (Andrus and Middel 2003). A significant secondary impact to Meacham Creek is the presence of livestock in the riparian area and stream zone, where moderate to heavy grazing pressure occurs.

The current property ownership profile of Meacham Creek and watershed shows a mixture of public, private, and Tribal ownership. Management of the resources in the watershed is controlled by various Tribal, Federal, private, and corporate interests. Much effort is devoted to planning and promoting cooperative participation in the restoration process by the various entities. Project scoping and educational outreach continues to be an important tool in regard to forging mutually beneficial relationships and coordinating restoration efforts among all land managers in the basin.

In limited areas, hunting and fishing opportunities are available to tribal and non-tribal participants, but much of the basin is somewhat restricted to users due to the presence of locked gates at both ends. The UPR installed the gates within the last decade as a means of reducing traffic for railway safety and fire control in an effort to ensure that operations are uninterrupted. The restricted access aids recruitment of numerous fish and wildlife species. This benefit is diluted to some degree by disturbance and mortality associated with the infrastructure of the UPR and its daily operations.

Anadromous Salmonids

The Meacham Creek Watershed produces an anadromous salmonid component which contributes to the harvest of both the recreational and commercial fisheries trades located in the Columbia River and Pacific Ocean as well as the traditional and subsistence uses by Native Americans from the Umatilla Basin. To illustrate the significance of Meacham Creek as a salmonid producer, there are more than twice as many salmonids estimated in the lower 15 mi of Meacham Creek than in the lower 81.8 mi of the Umatilla River, despite having less water volume than the Umatilla River. Currently, the Meacham watershed is a primary producer of steelhead-rainbow trout and is of secondary importance for Chinook salmon and bull trout.

Much of the Meacham Creek Watershed is not in compliance with salmonid temperature requirements and corresponding state and federal water quality standards. Thermal guidelines for bull trout state that water temperatures above 15^{o} C (59º F) limit distribution. This benchmark is consistently exceeded in the majority of the Meacham Watershed. Physical habitat survey data is ranked as poor overall and is summarized in *Umatilla Basin Natural Production Monitoring and Evaluation Annual Report 1992-1993* (CTUIR 1994).

Meacham Creek's suitability for salmonids is currently classified as marginal, but the restoration potential is good despite limitations imposed by the fixed presence of the UPR. Currently, high stream temperatures, lack of summer flow, limited quantity of pools, lack of overall habitat complexity and shortages of large woody debris are considered as factors limiting salmonid carrying capacity and production in Meacham Creek.

Isquulktpe Creek

Isquulktpe Creek is a tributary of moderate size that enters the mainstem of Umatilla River at RM 76.7. Isquulktpe Creek contributes roughly 5% of the Umatilla River's summer flow and is a known destination for significant numbers of adult steelhead spawning. It is dominated by constraining terraces and predominantly single, Rosgen "C" channel morphology (low gradient, meandering, point-bar, riffle/pool, alluvial channels with broad, well-defined floodplains, as defined in Rosgen 1996). Isquulktpe Creek ranked as moderate habitat quality overall for salmonids, primarily due to relative light disturbance and hydrologic stability. Isquulktpe Creek receives very little fishing pressure. Hunting opportunities attract the most recreational users.

An intensive Aquatic Habitat and Fish Inventory survey was conducted by CTUIR in 1994 on Isquulktpe Creek (RM 0-10). Specific results for individual habitat metrics and fish populations can be found in *Umatilla Basin Natural Production Monitoring and Evaluation*

Annual Report 1993-1994 (CTUIR 1995). In 1994, the number of juvenile salmonids estimated in the lower 10 mi were 37,611, 97.1% of which were steelhead-rainbow trout; 2.9% were juvenile spring Chinook salmon. An Aquatic Habitat Inventory and Fish Survey were conducted in the summer of 2008 as part of FY2008 activities (Hoverson et al. 2009). Results indicated an increase in undercut banks from 3.8% to 13.2%, an increase in the quantity of pieces of wood by 250 (220 added by CTUIR via helicopter in 2006) resulting in an increased wood rating for fish benefit from 1.3 to 1.6, and channel shade increased from 5% to 40-45%.

Low numbers of bull trout have been documented in Isquulktpe Creek. It is conceivable to foresee the potential of Isquulktpe Creek as a rearing area for juvenile bull trout and staging area for adults. Historically, Isquulktpe Creek would have theoretically supported moderate abundance of bull trout. The potential for a moderate number of juveniles and low numbers of small adults exists. Poor connectivity between existing populations in other areas of the basin appears to be limiting distribution due to undesirable conditions within the migratory corridor.

McKay Creek

McKay Creek is a moderate-sized tributary that enters the Umatilla River near RM 50.6, just west of Pendleton, OR. It is approximately 36 mi long and its headwaters are in the Blue Mountains near the Umatilla/Union County line. The lower six mi of McKay Creek's hydrology is heavily influenced by the McKay Creek Reservoir and the earthen dam (RM 6) creates a complete passage barrier for migrating fish. The upper 30 mi is inaccessible to migrating fishes but is inhabited by abundant numbers of resident rainbow trout. Historically, it was a preferred destination for anadromous spawning activity (Chinook salmon and steelhead-rainbow trout). Habitat conditions still exist to support spawning and rearing for anadromous fish populations about McKay Creek Reservoir and earthen dam. The lower creek in encroached upon by residential housing developments adjacent to both sides of the creek. The upper reach does have alternating agricultural land use (e.g., crops and grazing). The predominant crop is wheat and alfalfa but the encroachment of hill slopes prevents expansive crop fields.

West Fork Spring Hollow Creek

West Fork Spring Hollow Creek is a small tributary to the Wildhorse Creek. It flows in a northwesterly direction from the foothills of Wildhorse Mountain and enters Wildhorse Creek at RM 13.8. West Fork Spring Hollow Creek is predominantly a non salmonid stream, but there are documented accounts of steelhead-rainbow trout presence.

Birch Creek and West Birch Creek

Birch Creek is a major tributary that enters the Umatilla River near RM 48.5, five mi west of Pendleton, OR. Birch Creek extends 16 mi before meeting West Birch Creek in the City of Pilot Rock, OR. West Birch Creek is of moderate size and measures 10 mi in length. The Birch Creek Watershed headwaters are characterized by elevations up to 4,000 ft above sea level.

Birch Creek

The topography of the Birch Creek Watershed is typical of the Blue Mountain foothills, with broad flat ridges bisected by moderately steep, constraining canyons with a variety of aspects across a broad valley floor. The valley floor is comprised of low and high terraces with much incidence of actively eroding banks with an overall lack of in-stream cover. Thin riparian transects contain sparse tree growth. Water temperatures and habitat conditions throughout Birch Creek are classified as marginal for salmonids. Several passage issues in the lower basin are in the process of being evaluated by the UAFHP and ODFW and are quite problematic for migrating salmonids seeking more desirable conditions in the upstream areas of the basin. The upper reaches consist of moderately-steep, closely orientated hill slopes that cradle the channel and support substantial tree growth, and cooler waters.

Diking and straightening practices have generally concentrated flows into one predominant channel. Therefore, secondary channels account for a small portion of the overall stream length. Much of the large wood in the Birch Creek Watershed was likely removed to clear lands for agriculture or for timber harvest reasons. The poor health of the banks is primarily attributed to land use practices, such as clearing, overgrazing, and channelization and flashy hydrographs. Due to the relatively high composition of fine substrate and eroding banks, turbidity levels can become relatively high during heavy rainfall events. Summer flows are very low and the surface flow deficiency is magnified due to irrigation withdrawals. Open sky exposure to the wetted channel is at generally undesirable and excessive levels.

Mid to lower portions of mainstem Birch Creek are very entrenched and provide poor juvenile rearing habitat for salmonids. Many of these channels have lost connection with their historic floodplain. Their degree of entrenchment is extremely erosive and unstable and produces excessive sediments that fill in pools, embed spawning substrates and accelerate horizontal channel migration.

In addition to poor physical habitat features such as lack of in-stream cover, several water quality issues have been identified as limiting factors of salmonid-rearing production in the Birch Creek Watershed during the summer months. Excessive water temperature, bacteria and sediment loads were identified and listed by the Umatilla Basin TMDL committee. Birch Creek is listed as water quality limited for temperature, habitat modification, and iron concentrations on Oregon’s 1998 303(d) list. Extremely low summer flows are very common and magnify the issues with the categorical TMDL and 303d listings.

Despite severe human impacts and limiting factors, the Birch Creek Watershed is the migratory corridor to some of the most important summer steelhead spawning tributaries in the Umatilla River Basin. Its tributaries continue to provide primary spawning areas for adult steelhead and it is a significant producer of steelhead juveniles.

West Birch Creek

West Birch Creek land use is primarily rural-residential in the lower reach, crop production and grazing in the middle reach, and timber production in the headwaters. The typical vegetative portrait of the lower two-thirds of West Birch Creek is comprised of crop lands or grasses whereas the upper tributaries present a mosaic of diverse, multi-level grass/shrub/tree growth. West Birch Creek has been heavily impacted by agricultural developments along the majority of its length. There are significant quantities of water withdrawals (up to 100%) for agricultural uses, diked and straightened channels, areas of severe livestock grazing, and crop fields in close proximity to the stream channel.

The majority of fish that inhabit lower West Birch Creek in the summer are from the family *Cyprinidae*. CTUIR studies have shown that ratios of non-salmonids (dace, suckers, shiners) to salmonids were approximately 1,000:1 in lower West Birch Creek during the summer.

West Birch Creek has vast, extensive areas of favorable substrate and desirable slope characteristics. These features give the subbasin a favorable spawning potential, but numerous passage issues in the mainstem of Birch Creek hinder the overall potential of this system. If passage and other habitat deficiencies are addressed, the projected potential of steelhead production in the Birch Creek Watershed is quite impressive.

Umatilla River

The Umatilla River originates on the west slope of the Blue Mountains, east of Pendleton, OR and flows 115 mi in a northwesterly direction to the Columbia River at RM 289. The basin has a drainage area of 2,540 mi^2 (6,579 km^2). The basin's hydrologic unit number is 17070103. Many reports describing the Umatilla River are available on the following BPA website at URL: http://www.efw.bpa.gov/integratedfwp/reportcenter.aspx.

The Mid-Umatilla River has been highly altered by human development. Stream channel morphology and flows have been significantly altered by irrigation structures and withdrawals, channelization, development, and clearing of the riparian area and adjacent uplands (CTUIR 2008). Stream temperatures between RM 35 and 49 are positively influenced by cold water releases from McKay Reservoir and provide suitable rearing temperatures for salmonids. These releases elevate flows from 45 cfs to between 250 and 325 cfs (Yoakum, OR flow gage) and decrease water temperatures (CTUIR 2008). The gradient in this reach is relatively constant, and the increased flows provide abundant fast water habitat types (CTUIR 2008). Umatilla River stream temperatures in the 14 mi below the McKay Reservoir are comparable to those found in upper reaches near the headwaters (RM 80-90).

DESCRIPTION OF ESA LISTED AND SENSITIVE SPECIES IN THE UMATILLA RIVER BASIN PROJECT AREAS

Bull Trout – Umatilla River Watershed

Bull trout (*Salvelinus confluentus*) are a sensitive species in regard to habitat requirements in that they need complex conditions in addition to high quality cold water. Bull trout numbers have declined dramatically from historical levels in the Umatilla Basin due to degraded habitat conditions and the species is classified as "threatened." Adult bull trout population estimates for the entire Umatilla Basin number approximately 500 individuals. The North Fork of the Umatilla River holds approximately 85% of the basin's bull trout, three fourths of which are located between RM 3-6. The low numbers and concentrated distribution pattern of bull trout in the Meacham Creek Watershed categorizes the population as "increasing threat" and "high risk" of extinction. Not surprisingly a report on the status of Oregon's bull trout (Buchanan and Gregory 1997) classified the small bull trout population in Meacham Creek as "high risk".

It is currently believed that adult bull trout in the Umatilla Basin move downstream in late fall to over-winter in the mainstream Umatilla River where seasonal growing conditions are more suitable. In the springtime, as water temperature begins to increase, adults migrate back into cooler headwater areas. Most bull trout in the Umatilla Basin are residential, showing only limited migratory patterns. The limited movement appears to be an evolutionary adaptation due to the vast detrimental impacts to habitat quality and quantity.

Bull Trout – Meacham Creek Watershed

Meacham Creek is classified as critical habitat for bull trout due to its historical importance, knowledge of inhabitance, and potential for connectivity with the core population located in the North Fork Umatilla River. Bull trout numbers in the Meacham Watershed are highest in the headwater tributaries, and considerably lower in the mainstem (Andrus and Middel 2003). An estimated 15 bull trout inhabit the lower 15.3 mi of Meacham Creek during the summer months. It is suspected that bull trout staging in lower Meacham Creek during this time have migrated in from the upper Umatilla River or North Fork Meacham Creek. Population levels of sexually mature bull trout in the entire Meacham drainage is estimated at less than 50 individuals, most of which are located in the North Fork Meacham Creek, which joins the mainstem Meacham Creek at RM 15.5.

Bull trout have never been documented in Camp Creek. Year-round hospitable habitat is found in only a minority of the Meacham watershed, generally near cold water inflows or relatively deep pools with additional desirable qualities such as shade and cover. Therefore a migratory life stage component would appear beneficial to Meacham's bull trout population. One sub adult bull trout was observed during large wood debris monitoring near Meacham Creek at RM 2.5 on August 28, 2007 (Hoverson et al. 2009).

The habitat conditions for bull trout in the mainstem of Meacham Creek are severely limited and currently classified as marginal at best. Meacham Creek currently lacks both the quantity of complex habitat, and water quality essentials associated with systems that have strong populations of bull trout.

Current bull trout management strategy concentrates on protective measures such as fishing restrictions and preventive monitoring of actions that may cause "take." Population estimate trends show moderate increases since 1998. The combination of education, protection and recovery efforts along with habitat enhancement and closed fishing seasons are probable explanations for the positive response.

Protecting the Meacham sub-population is important to preserve the genetic integrity of the species as well as to enhance the migratory corridor from a connectivity standpoint with the primary core population located in the North Fork Umatilla River. The potential for connectivity improves the odds of species preservation over time, especially during catastrophic events and diversifies evolutionary genetic exchange between populations when conditions dictate the necessity for such. Proposed UAFHP restoration activities are intended to improve the status of bull trout in the Meacham Creek watershed by accommodating the specific needs of the species in an effort to increase numbers of this fragile sub-population over time.

Steelhead Trout – Birch Creek Watershed and Meacham Creek Watershed

NMFS listed summer Middle Columbia River Steelhead as an Ecologically Significant Unit in 1999. In the Umatilla Basin, the wild steelhead run is supplemented with hatchery stock. Many of the returning hatchery fish reproduce naturally. A portion of wild adults are trapped upon their return from the ocean and spawned artificially at hatchery facilities.

Birch Creek Watershed

The Birch Creek Watershed was historically, and continues to be, a major producer of summer steelhead trout, but the current population of this ESA-Listed species is at a fraction of historic levels due to detrimental anthropogenic impacts. However, the basin is considered a primary destination for summer steelhead spawning in the Umatilla Basin. Steelhead-rainbow trout have proven to be best suited for conditions in the Birch Creek Watershed and are the most abundant salmonid species. The dominance of this species can be attributed to the beneficial timing of life cycle characteristics and the resilient adaptation to changing conditions in the basin, which has given the species a competitive advantage over other salmonids.

Meacham Creek Watershed

From 1993-2008, CTUIR established several fish sampling sites throughout the Meacham Creek Watershed. The sites were sampled for fish several times annually, usually during the spring, summer and fall periods. Results showed that densities of captured salmonids were highly variable during different times of year, indicating strong migratory patterns and turnover. Rainbow/steelhead trout are the most abundant salmonid species in the Meacham Creek Watershed throughout the year.

Unlisted, Sensitive Species of Significance to Tribal Culture: Middle Columbia Spring Chinook Salmon

Spring Chinook salmon were extirpated from the system in the early 1900s due to seasonal passage issues in the lower Umatilla River caused by irrigating dams and dewatering. A neighboring strain of spring Chinook salmon has been successfully reintroduced in the Umatilla River using hatchery supplementation techniques. A plethora of management strategies have been successfully exercised in effort to reestablish the species. The abundance of naturally produced juveniles has substantially increased in recent years, and adults now return to the basin annually. Meacham Creek supports all age classes of spring Chinook salmon which shows an increasing trend of abundance. However, there is little evidence of use by juvenile or adult spring Chinook salmon in Birch Creek.

METHODS, RESULTS, AND DISCUSSION OF 2009 STATEMENT OF WORK DELIVERABLES

This section describes methods and results, and discusses completed work elements in an outline similar to our statement of work in Pisces. Each work element with associated identifier code and milestone are listed, followed by a comprehensive summary of completed work under each work element.

Work Element A: 185. Produce Pisces Status Report
Work Element Title: Periodic Status Reports for BPA
Milestone Deliverable: Complete Periodic Pisces Status Reports

CTUIR reported to BPA periodically during the contract period on the status of each statement of work element, and milestones and deliverables using the computer program Pisces:

February-June 2009 (2/1/2009 - 6/30/2009)
July-September 2009 (7/1/2009 - 9/30/2009)
October-December 2009 (10/1/2009 - 12/31/2009)
Final January 2010 (1/1/2010 - 1/31/2010)

The BPA Contracting Officer Technical Representative (COTR) reviewed the Pisces status reports, recommended changes as necessary and accepted them electronically upon approval. Additionally, upon completion of each deliverable milestone, we provided metrics and final project location (latitude and longitude) when required. These Pisces status reports provide a tool for the BPA COTR and administrative staff to track project progress in meeting contract requirements.

Work Element B: 165. Produce Environmental Compliance Documentation
Work Element Title: Prepare Biological Assessments for Applicable Projects
Milestone Deliverable: Official Acceptance and Approval of Biological Assessments by Applicable Compliance Representatives

CTUIR successfully submitted all applicable and required documents to the appropriate federal, tribal, state, county entities for select implementation projects in a timely manner required under work elements related to producing environmental compliance documentation in FY2009 and FY2010. Secondary environmental compliance accomplishments during the reporting period included coordination with various compliance personnel to prepare supplemental documentation and reporting for ongoing and planned management actions. Environmental compliance methods include development of appropriate documentation under various federal, Tribal, state and county laws and regulations governing federally funded project work. Methods involve coordination with various federal and state entities agencies and development and submittal of permit applications, cultural clearances, biological assessments (BA's), NEPA checklists, etc., as necessary. Part of the environmental compliance work element includes planning and developing site-specific proposals tailored to accomplish fisheries goals and meet compliance standards. The details concerning the implementation of treatments and preparations for putting efforts on the ground, including preparations for subcontracting, and specifics in regarding the safeguarding of ESA-Listed species during the implementation process are outlined in the proposals.

The following deliverable was expected for FY2009 projects:

A. Prepare a BA that covers Meacham Creek levee alteration and/or in-stream enhancement.

In FY 2009, project activities related to the Meacham Creek Levee Removal Project (**See Section Selected FY2009 and FY2010 Fish Habitat Enhancement and Restoration Activities)** were separated from work activities related to in-stream enhancement. No BA was completed in 2009 for the Meacham Creek project activities. ESA consultation with NMFS was covered under the BPA Habitat Improvement Programmatic Biological Opinion (HIP II BO) given project activities related to levee removal was covered under the Terms and Conditions of the HIP II BO.

Project Activities covered under the HIP II BO included:

- Collect/Validate Field Data (F:157) – Remove and record density and species of fish if located in unsafe areas during in-stream work.
- Enhance Floodplain (I:180; J29) – Reduce the number of restrictive levees to return floodplain width and natural process. Place LWD and boulders in strategic areas to increase floodplain complexity.
- Install Fence (K:40) – Install 800 ft of cattle exclusion fending between Hoeft Dam and Cunningham Bridge, West Birch Creek.
- Plant Vegetation (L:47) – Supplement riparian vegetation in new and old construction areas.
- Maintain Vegetation (P:22) – Irrigate vegetation and remove weeds on new easements as required to maintain vegetation.
- Remove Vegetation (N:53) – Physical and/or herbicide treatment of noxious weeds on 160 riparian acres.

Work Element C: 165. Produce Environmental Compliance Documentation
Work Element Title: Submit JPA to State and Federal Entities
Milestone Deliverable: Obtain DSL/USACE Approval on JPA Permits

No project work activities in FY2009 required permits under the USACE or DSL. No Joint Permit Applications (JPA's) were filed. As part of the Meacham Creek Levee Removal Project, all work was implemented outside the water channel and above the ordinary high water mark and outside nearby wetlands. CTUIR staff led a field tour of USACE and DSL official staff of the project area to confirm permits would not be necessary related to project activities.

A CTUIR Stream Zone Alteration (SZA) Permit was required for the Meacham Creek Levee Removal Project (CTUIR 2005). A SZA permit was required for project activities related to alteration of the ground contours and perennial vegetation on the Reservation. A SZA permit was approved and granted on July 28, 2009 with conditions:

1) No equipment operation shall take place in the actively flowing stream,
2) All equipment refueling areas shall be at least 50 ft from the stream channel,
3) Any foreign material that is inadvertently spilled in the riparian zone shall be removed immediately,
4) Tree removal shall not constitute a timber harvest as 206 of the 228 trees are less than 12 in diameter at dbh therefore the volume is insufficient to qualify as a timber harvesting activity,

5) The permitted shall notify the CTUIR-DNR Water Resources Office as to the date and time that alteration activities will take place and upon completion of the project for final inspection,
6) Notwithstanding any conditions stated herein, all construction activities will confirm to the standards of the CTUIR SZA Regulations, and
7) In the event any cultural resource artifacts are located during the project cease work and contract the CTUIR Cultural Resources Protection Program.

Work Element D: 165. Produce Environmental Compliance Documentation
Work Element Title: Cultural Resource Protection and Preservation
Milestone Deliverable: Obtain Official Approval from Tribal and State Cultural Resource Preservation Agency Representatives

The following cultural resource protection and preservation milestones were required for FY2009 projects:

A. Obtain cultural resource clearance and approval for Meacham Creek in-stream and levee projects.
B. Obtain cultural resource clearance and approval for Birch Creek passage rectification projects.

CTUIR submitted a letter and attachments with necessary project descriptions and geo-referenced maps on January 22, 2010 for assisting BPA with section 106 National Historic Preservation Act (NHPA) consultations and environmental compliance. The CTUIR DNR Cultural Resource staff completed the cultural resource project area surveys and reports for cultural resource compliance with the State Historic Preservation Office (SHPO). Meacham Creek projects were located on Reservation land and cleared by the Tribal Historic Preservation Office (THPO) through the CTUIR DNR Cultural Resource Program. CTUIR UAFHP obtained cultural resource clearances and approvals by the SHPO and THPO for both the Meacham Creek in-stream and levee removal and riparian fencing projects, and the Birch Creek bank stabilization, habitat input and passage project.

Work Element E: 189. Regional Coordination
Work Element Title: Coordinate With Other Entities Planning and Implementing Habitat Improvements in the Umatilla Basin
Milestone Deliverable: Active Participation with Co-managerial Interests in the Umatilla Basin

CTUIR UAFHP staff completed the following milestones in FY2009:
A. Participate in UCSWCD meetings and interact with stakeholders.
B. Participate in UBWC meetings and interact with stakeholders.
C. Coordinate with Umatilla Basin co-managers ODFW.
D. Network with professional experts in the discipline of habitat restoration.

CTUIR UAFHP staff participated and coordinated with multiple agencies and stakeholders in the Umatilla River Basin including ODFW, USFS, NRCS, conservation districts, USFWS, UBWC and local stakeholders to enhance natural resources, identify problems and solutions, coordinate efforts to prevent duplication, enhance communication and cooperation and identify funding and cost share opportunities within the Umatilla River Subbasin. Coordination with other agencies in planning and implementing habitat improvements in the basin is undertaken to facilitate development of habitat restoration and enhancement projects, participated in Subbasin, ESA planning processes and project selection processes, and assist with providing watershed restoration education. We prepared agreements, if necessary, to assign duties and responsibilities to the appropriate entities. We also developed documents, press releases, web sites, and other communications to impart information to participating stakeholders and the public.

Staff developed and fostered relationships with participating experts in related fields by attending training, professional workshops and working groups, and gained professional advancement and improved project success through informative, instructional interactions. In November 2009, the natural resource students from the University of Idaho (U of I) and CTUIR Department of Natural Resource (DNR) staff participated in the Seeds for the Future Building Workshop in Pendleton, Oregon. This is an annual service learning partnership to foster a significant means of integrating student learning from the Tribes perspective and sharing about our community across state, cultural, and landscape boundaries. U of I students assisted in CTUIR UAFHP staff in planting native vegetation at the Meacham Creek Levee Removal Project for an entire day on October 20th. Project staff provided a handout to the U of I students and presented on Meacham Creek restoration and monitoring activities (Figure 6).

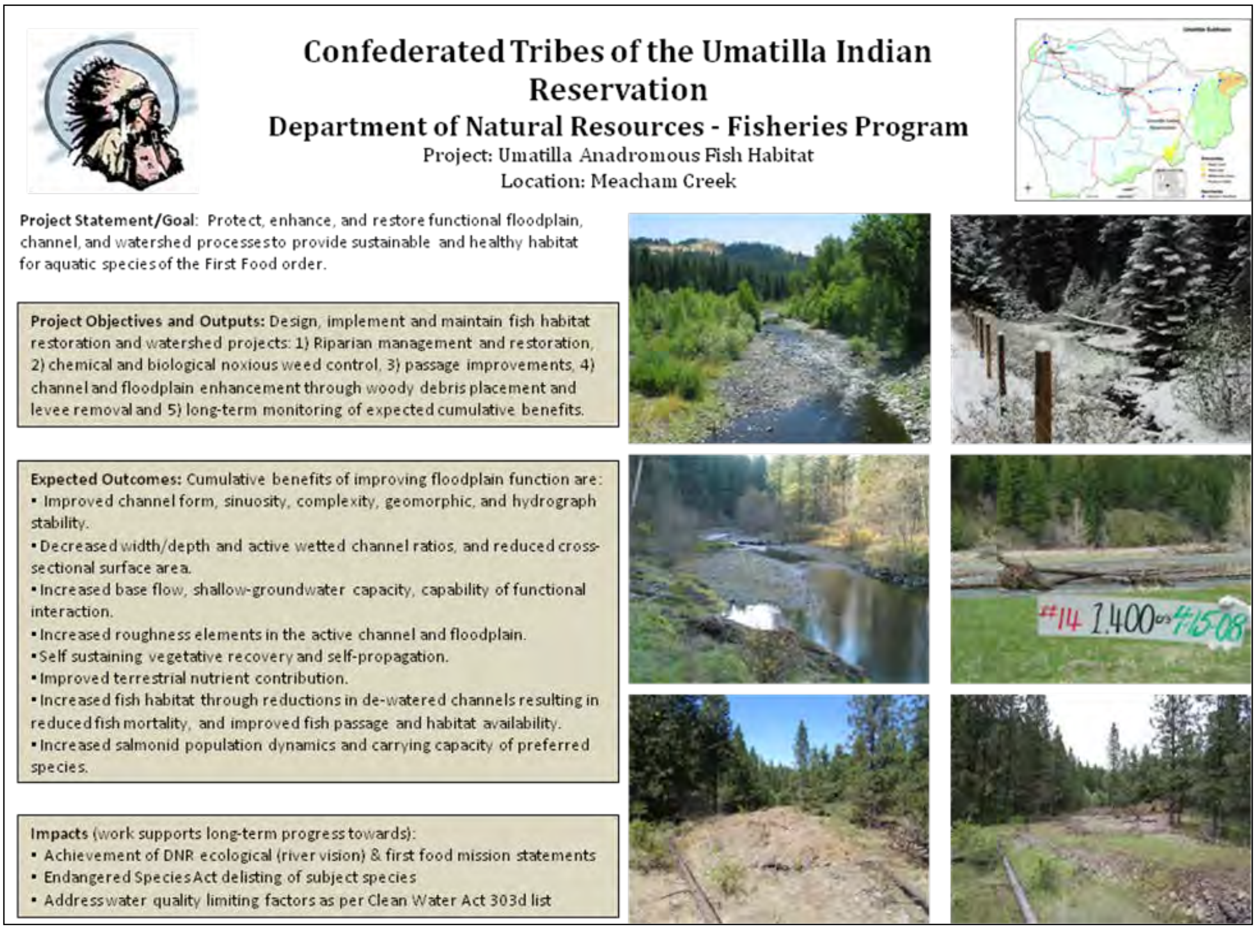


Figure 6. Handout developed for presenting the Meacham Creek subbasin restoration work for University of Idaho college students participating in the Seeds for the Future Building service learning partnership between CTUIR and U of I, November 2009.

CTUIR UAFHP and DNR Fisheries Habitat Program staff attended multiple professional conferences and workshops, and participated in oral and poster presentations of project activities including:

<u>American Water Resources Association (AWRA) 2009 Annual Water Resources Conference (November 2009):</u>

Classification of Physical Habitat for Pacific Salmon in the Umatilla River Watershed – Scott O'Daniel, CTUIR, Pendleton, OR (co-authors: James Webster, Eric Hoverson, Michael Lambert)

Panel: Species Recovery – What Does It Mean? – Panel Moderator Wayne Wright, Geoengineers, Inc., Tacoma, WA (co-panel participant: James Webster, CTUIR, Pendleton, OR)

Induced Complexity: Early Results from a Floodplain Connection Project in Meacham Creek, Oregon – James Webster, CTUIR, Pendleton, OR (co-authors: Scott O'Daniel, Michael Lambert, Eric Hoverson; Figure 7)

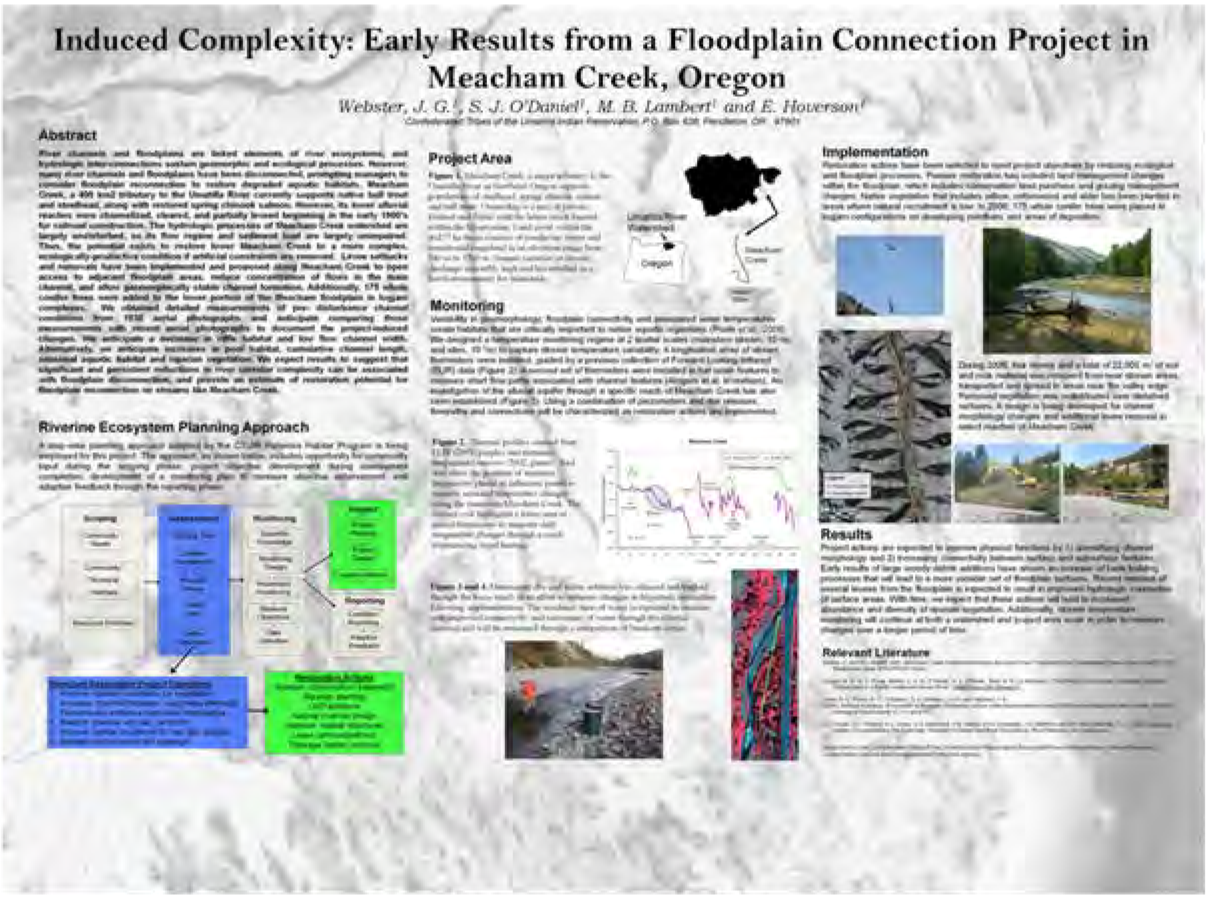


Figure 7. Staff poster presented at the AWRA 2009 Annual Water Resources Conference, November 2009, Seattle, Washington.

Additional posters and oral presentations were presented at local, regional and national professional workshops as part of the development of the Extensive Physical Assessment for Pacific Salmon (See Appendix B).

Work Element F: 157. Collect/Generate/Validate Field and Lab Data
Work Element Title: Collect Various Forms of Professional, Scientific Data for Project Potential Analysis
Milestone Deliverable: Develop and Utilize Applicable and Effective Monitoring Techniques

A. Environmental compliance requirements complete.
B. Conduct photo point documentation of project conditions related to specified project areas.

C. Conduct photo documentation at 36 whole tree configuration sites, in Meacham Creek, various flows.
D. Do aquatic habitat inventory baseline at project areas prior to implementation.
E. Conduct biological fish inventory surveys in association with habitat enhancement projects.

The CTUIR has and continues to invest substantial resources in restoring the sustainability of five Columbia subbasins that constitute the Ceded lands, including the Umatilla subbasin. The Umatilla River Vision (Jones et al. 2008) describes well the rationale for these investments in relationship to the importance of first foods to the future of the Tribal people. In 2009, CTUIR began development of a conceptual bio-monitoring design that evaluates the biological outcomes from restoration actions throughout the five subbasins within the CTUIR Ceded lands to ensure that investments result in actual improvements to the biological productivity.

Detection of measurable changes in biotic conditions, specifically changes to survival and productivity of various salmon life stages, is presumed to be predicated on habitat improvements that result from directed restoration actions taken by CTUIR. Such changes in physical habitat characteristics will be tracked by CTUIR staff, and the resulting data will substantially contribute to elements of the study design for this biotic monitoring program. The relationship between the physical conditions, carrying capacity and productivity of the habitat is thus foundational to the approach taken to measure improvements in life cycle characteristics of target native fish populations, over many generations. The overall goal of the bio-monitoring design is to understand how the restored ecological processes that maintain essential functions and increased habitat complexity individually and accumulatively affect spring Chinook, summer steelhead and bull trout in the five subbasins.

Coinciding with the bio-monitoring design, project staff has developed monitoring strategies in relationship to habitat restoration actions. A suite of physical and biological parameters are collected at restoration project sites implemented under this project. Project effectiveness monitoring parameters include longitudinal surveys, cross-sections, vegetation grids, shade measurements, photo-points, wood counts, bank stability, pebble counts, floodplain mapping, and various stream morphology measurements at restoration project sites. Fish salvages and salmonid abundance surveys are done on a portion of the project sites in coordination with the CTUIR Umatilla Basin Natural Production Monitoring and Evaluation Project (UBNPME); 1990-005-01 and ODFW Evaluation of Juvenile Salmonid Outmigration and Survival in the Lower Umatilla River; and other agencies. Population estimates are determined using multiple methods: three-pass depletion protocol, snorkel surveys, or generated from a complete fish salvage of the project area and expanding these numbers to include the entire project reach. Generally, population estimates are collected only as necessary in an effort to reduce impacts to native salmonid fish including those listed under the ESA. CTUIR continues to develop and utilize applicable and effective monitoring techniques.

Data analysis and findings from biological and physical monitoring are incorporated into project planning, designs, permitting, environmental compliance, and pre- and post-project assessment of project response. Results of the findings are available in various outsourced reports and can be requested through CTUIR's UAFHP. A summary of selected monitoring results can be found in the monitoring section later in the document.

Work Element G: 162. Analyze/Interpret Data
Work Element Title: Analyze/Interpret Scientific Data
Milestone Deliverable: Summarized Data in the Format of Professional Scientific Reports

A. Cumulative addition of suspended solids data, Meacham Creek via professional services subcontract.
B. Cumulative addition of red & carcass data for salmon/steelhead, Umatilla Basin.
C. Cumulative addition of aquatic benthic macroinvertebrates data collected on Meacham Creek.

CTUIR successfully completed these ongoing deliverables for FY2009. CTUIR participated in the analysis and interpretation of suspended solids on Meacham Creek and the Umatilla River and steelhead/salmon redd data on the Umatilla River and all major tributaries where known spawning activity occurs. Benthic invertebrate data was collected and analyzed on Meacham Creek and the Umatilla River. Results of the findings are available in various outsourced reports and can be requested through CTUIR's UAFHP. A summary of selected monitoring results can be found in the section monitoring later in the document.

Work Element H: 175. Produce Design and/or Specifications
Work Element Title: Preparation and Submittal of Engineering Designs/Specifications for Meacham Creek Project
Milestone Deliverable: Delivery of Engineered Implementation Designs/Drawings with Specifications

A. Deliver design drawings & specifics for Meacham levee alteration project.
B. Deliver design drawings & specifics for in-stream channel shaping & enhancement, Meacham Creek.

Meacham Creek, a 400 km^2 major tributary to the Umatilla River in Northeast Oregon currently supports native bull trout and summer steelhead, and restored spring Chinook salmon (Figure 5). Ownership is a mix of private, Federal and Tribal with the lower reach located within the Reservation. Land cover within the 46257 ha basin consists of coniferous forest and transitional rangeland in an elevation range from 540 m to 1760 m. Annual variation in stream discharge is notably high and has resulted in a harsh environment for salmonids.

The lower alluvial reaches of Meacham Creek were channelized, cleared, and partially diked beginning in the early 1900's for railroad construction. The hydrologic processes of Meacham Creek watershed are largely undisturbed, so its flow regime and sediment load are largely unimpaired. Thus, the potential exists to restore lower Meacham Creek to a more complex, ecologically-productive condition if artificial constraints are removed.

Restoration actions have been selected to meet project objectives by restoring ecological and floodplain processes. Passive restoration has included land management changes within the floodplain, which includes conservation land purchase and grazing management changes. Native vegetation that includes willow, cottonwood and alder has been planted in areas where natural recruitment is low. In 2006, 175 whole conifer trees were placed in logjam configurations on developing point bars and areas of deposition. In 2009, four levees and a total of 22, 000 m^2 of soil and rock material was removed from near stream areas, transported and spread in areas near the valley edge (**See Section Selected FY2009-2010 Fish Habitat**

Enhancement and Restoration Activities). Removed vegetation was redistributed over disturbed surfaces.

In October 2009, CTUIR requested proposals for an in-stream design and construction oversight for in-stream channel and floodplain restoration efforts within Meacham Creek (Figure 8). Five proposals were received during the process of which Tetra Tech EC, Inc. was selected and contracted in November 2009 to develop a design and implementation plan, and provide future construction oversight. The contract included providing:

1. A complete in-stream design based upon considerations of:
   - Potential for improved conditions and natural recovery, the types of changes to existing conditions and ongoing activities that are necessary in order to achieve a self-sustaining, functional hydrologic condition.
   - The type of projects that could be implemented to restore and enhance functional hydrologic processes, water quality, geomorphic stability, riparian vegetation and salmonid habitat and where they should be located to achieve the greatest benefit.
   - The extent to which available restoration methods will improve existing habitat.
   - The type of materials which would provide for stable and effective structures while providing adequate habitat given existing and future conditions.
   - The materials required for each structure.

2. An implementation plan based upon considerations of:
   - The most effective order in which implementation should occur to reduce disturbances and cost.
   - Where areas of disturbance will occur (terrestrial & aquatic) and to what extent they will occur.
   - Where the most effective staging areas are located.
   - What equipment maximizes efficiency and minimizes disturbances.
   - The Best Management Practices (BMP's) that shall be required during implementation.

In development of the design and implementation plan, the project team consisted of interdisciplinary technical staff from both the CTUIR and USFS. The proposed design alternatives and final design were also reviewed and approved by the UPR engineers given the close proximity to their rail line and easement.

Three alternatives were considered in the design of this restoration project. Alternatives were evaluated against the following project objectives and criteria for success:

1. Restore floodplain connectivity through removal or modification of the spur dikes in the floodplain, and remove 2,800 ft of levee along the existing channel.
2. Increase channel sinuosity between RM 6.0 and RM 7.1 to 1.15 and increase overall channel length.
3. Increase hydraulic connectivity including hyporheic and river water exchange.
4. Enhance and increase in-stream habitat quality and diversity for key species while restoring channel morphology and incorporating habitat features into the channel and throughout the floodplain.
5. Improve riparian plant density, diversity and vigor by planting native vegetation in the floodplain.

Figure 8. Meacham Creek morphology section proposed for in-stream channel and floodplain restoration efforts.

Alternative 1 involved maintaining the historic meandering pattern and installing continuous protection for the railway in the form of an embankment. There would have been two meanders and a stream length of 6000 ft. This alternative would have remained statically in place and would not have had any side channels included in the design. The overall improvement in habitat quality, diversity, and floodplain connectivity would have been minimal. Alternative 2 included removing spur dikes, and excavating a simplistic single channel created in a new location, outside of the historic channel location. This alternative provided for additional creation of main channel habitat (5,700 ft), but no side channel creation and limited additional off-channel habitat. Alternative 3 included removal of spur dikes, creation of a new channel (6,100 ft) and the addition of side channels (2,678 ft) which would provide off-channel habitat for juvenile fish resources within the area. This alternative offered more immediate results in terms of dissipation of flood flows across the valley, increasing floodplain inundation, improving hyporheic discharge, and addressing ecological functions including improvement of habitat quality and diversity. In terms of habitat benefits, the features in Alternative 3 reflected known spring Chinook habitat types, and would be more likely to address temperature issues at the site due to the hyporheic recharge and the ability to plant large areas along both banks, creating a larger riparian corridor.

The project design and implementation plan was completed in September 2010. The project proposed to restore a section of Meacham Creek by moving the stream into its historic channel alignment and excavating historic meanders in the floodplain, resulting in 5,780 ft of new, reconfigured stream channel (Figure 9). In addition, habitat complexity will be increased by incorporating in-stream habitat improvement features in the channel throughout the project area. The proposed project will either remove or modify six large spur dikes in the floodplain, and remove the 2,800 ft levee along the existing channel. The existing road embankments will be enhanced at specific locations along the floodplain to provide flood protection for events great than 100-yr flood flows. Large log and rock structures will be placed throughout the floodplain. Supporting documentation in regards to the proposed Meacham Creek Floodplain Restoration and In-stream Enhancement Project (RM's 6.0-7.1) are described in multiple planning, permitting, design and design specification documents located at http://data.umatilla.nsn.us/fisheries/index.aspx .

Work Element I: 180. Enhance Floodplain
Work Element Title: Enhance Floodplain Connectivity and Function via Levee Setback at Meacham Creek
Milestone Deliverable: Improve Riverine Process via Levee Setback on Meacham Creek

A. Environmental compliance requirements complete.
B. Enhance riverine process and floodplain connectivity at Meacham Creek via levee setback.

The Meacham Creek Floodplain Restoration and In-stream Enhancement Project (RM's 6-7.1) is a cooperative project between CTUIR and USFS. Each own and manage about 50% each of the project area. Following the site survey and hydrologic and geomorphic analysis, the project design was completed from November 2009 to September 2010 incorporating the following major elements: 1) reshaping of the floodplain and removal or modification of two large spur dikes in the floodplain, 2) excavation of a new channel and side channels to move the stream into its historic channel alignment and meanders in the floodplain, 3) incorporation of in-stream habitat features in the new reconfigured channel and placement of large log and rock structures throughout the floodplain, 4) removal of the existing 2,800 ft protection levee along the existing channel, 5) installation of rock embankment along the existing access road embankment, and 6) re-vegetation of disturbed areas on the floodplain and along the channel.

Restoring, enhancing and protecting 67 acres of floodplain habitat and restoring stream morphology will enhance habitat for listed Mid-Columbia River steelhead and Columbia River basin bull trout and other native fish. Ideally project goals are expected to reduce summer stream temperatures, improve overall channel and floodplain stability, and ultimately

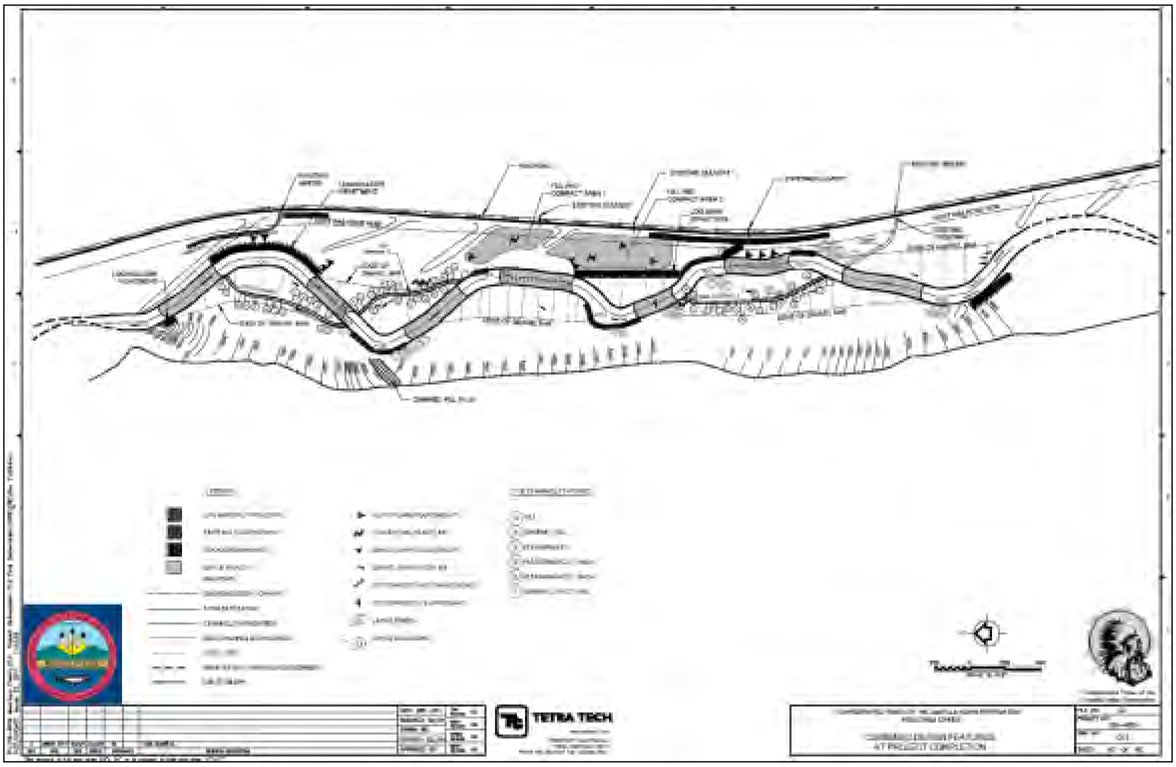


Figure 9. Natural channel design, Meacham Creek, river miles 6-7.1.

improve aquatic habitat conditions. The project goals are supported by the Middle Columbia River Steelhead Recovery Plan (NMFS 2009) and Bull Trout Draft Recovery Plan (USFWS 2002).

This work element will be accomplished in association with work element J: 29. Given the magnitude of the project elements implementation work was re-scheduled to be completed in FY 2011.

Work Element J: 29. Increase In-stream Habitat Complexity
Work Element Title: Improve Habitat Quality and Quantity of Floodplain Habitat Features and Channel in Lower Meacham Creek
Milestone Deliverable: Improve In-stream Habitat Conditions on Meacham Creek

This work will be accomplished in association with the levee removal project (I: 180).
A. Environmental compliance requirements complete.
B. Increase complexity of in-stream habitat features with natural materials.

This work element will be accomplished in association with work element J: 29. Given the magnitude of the project elements implementation work was re-scheduled to be completed in FY 2011.

Work Element K: 40. Install Fence
Work Element Title: Install Riparian Fence at West Birch Creek RM 2.7-3.0 and Meacham Creek
Milestone Deliverable: Installation of Fence at Cunningham Property on West Birch Creek and Lower Meacham Creek

A. Environmental compliance requirements complete.
B. Install riparian fence, West Birch Creek RM 2.7-3.0
C. Install riparian fence on lower Meacham Creek to minimize cattle trespass grazing issues

Meacham Creek Fence Installation RM 2.0-9.0

In 2009, the CTUIR Umatilla Habitat Project repaired existing fence, and built new fence to prevent livestock trespass and grazing damage to the riparian corridor on lower Meacham Creek from RM 2.0-9.0 (Figure 10). These activities are further detailed as three work items, as described:

Work Item 1: Repair and Maintenance of Existing High-Tensile Wire Fence

Utilizing existing high-tensile wire, wooden posts, wooden post braces, and rigid wooden stays, 0.42 mi of high-tensile fence was repaired and maintained. This included performing necessary maintenance, removal of downed trees and encroaching brush, splicing broken wire, re-tensioning wire to appropriate specifications per standards established by the USDA NRCS Range Technical Note No. 20 (Please see the USDA website at ftp://ftp-fc.sc.egov.usda.gov/OR/Technical_Notes/Range/Range20.pdf for details.), replacement of any broken/rotted or otherwise damaged wooden posts and wooden post braces, and replacement of any broken, rotted, or missing rigid wooden stays.

Work Item 2: Removal and Disposal of Existing Barbed-Wire and High-Tensile Smooth-Wire Fence

Approximately 6.12 mi of existing barbed-wire, braided-wire, and high-tensile smooth wire was removed and disposed of. Sound materials salvaged from removed fence lines were used in the construction of new fence.

Work Item 3: Construction of New 4-Strand Barbed-Wire Fence

Constructed 6.24 mi of new, 4-strand barbed-wire fence on lower Meacham Creek (RM 2.0 to 9.0) including seven 14-ft gates (Figure 10). Fencing was constructed in accordance with standards established by the USDA Natural Resources Conservation Service Range Technical Note No. 20.

West Birch Creek Fence Installation and Maintenance RM 2.7-3.0

In FY 2008, CTUIR donated fencing materials to the Cunningham Sheep Company who fenced off the fish migratory corridor on West Birch Creek from RM 2.7 to RM 3.0. Prior to fencing this corridor of stream sheep were allowed full access to the creek and its riparian area which degraded the vegetation within the riparian area (Figure 11). Fencing was completed in the summer of 2008 (Figure 11).

FY 2009 activities include monitoring the fencing at this location to ensure that the constructed fence was functioning as designed in excluding livestock grazing within the riparian areas. No additional maintenance was needed in 2009.

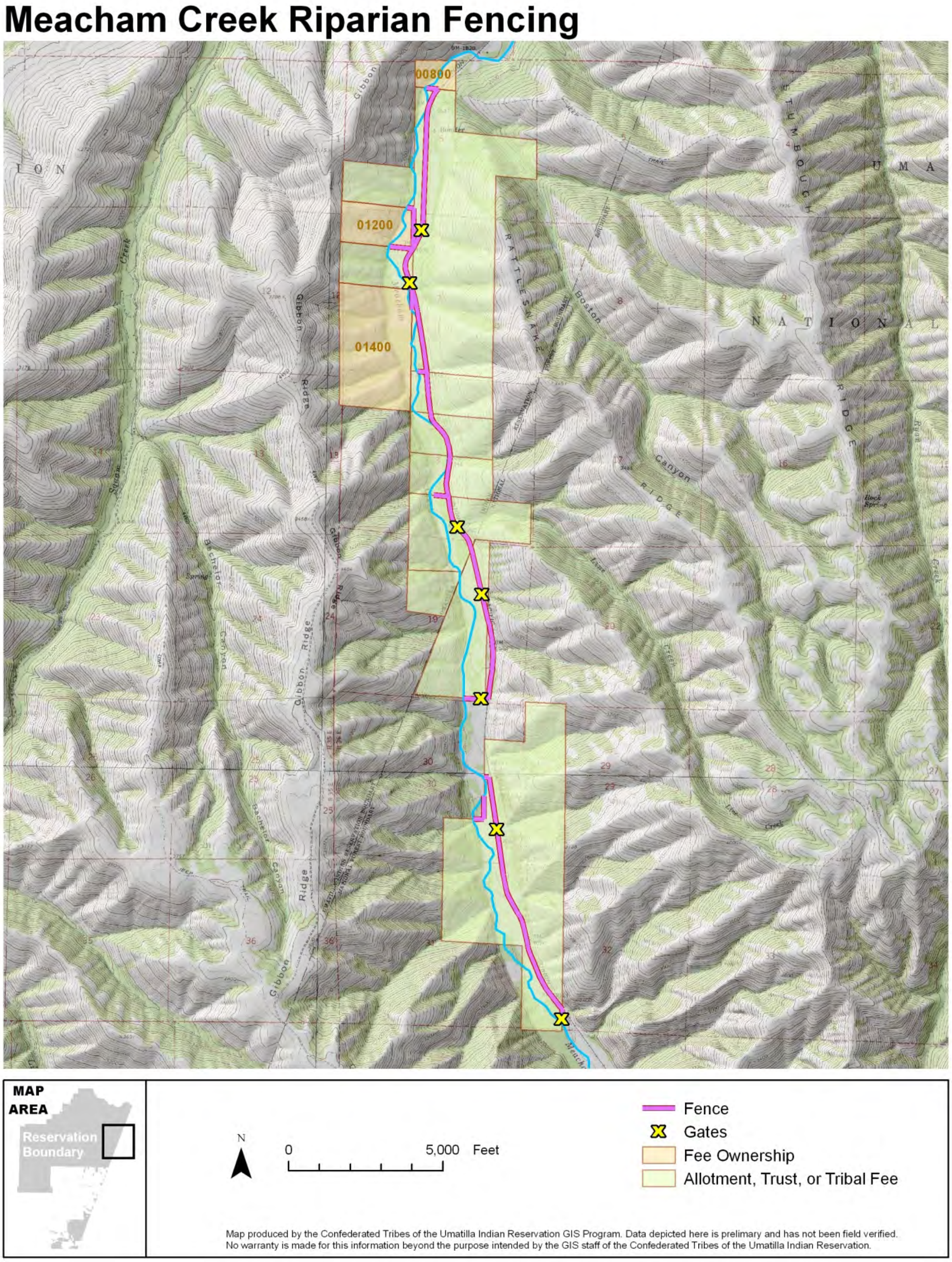


Figure 10. Detailed map of the lower Meacham Creek fence design, 2009.

A. Cunningham – Pre Project Condition Showing Degraded Riparian Conditions Due to Sheep Grazing

B. Cunningham – Post Project Showing New Fencing to Exclude Sheep From Riparian Area

Figure 11. Example of Livestock Exclusion Fencing at West Birch Creek, RM 3.0

Work Element L: 47. Plant Vegetation
Work Element Title: Supplement Riparian Areas of Existing and New Projects with Additional Vegetation
Milestone Deliverable: Vegetative Planting in Existing and New Project Areas

A. Environmental compliance requirements complete
B. Establish vegetation in existing project areas identified as lacking, and potentially successful and feasible
C. Establish improved vegetation conditions in new project areas
D. Build upon agreement with the CTUIR Nursery to supply specified tree species for assorted projects

CTUIR plants vegetation and grass seeds areas where we have implemented existing and new habitat enhancement projects or have identified a need in maintained riparian conservation easement areas. The Meacham Creek Levee Removal Project (RM's 5-6) was implemented in 2009, and included seeding disturbed areas by hand and mechanical means. In 2009, CTUIR conducted planting projects at 7 locations, 6 existing and 1 new project areas, including planting 5,581 plants and distributing 400 lbs of native grass seed (Table 1).

Planting tasks include site planning and development of planting strategies, collection and preparation of materials (pruning and conditioning of live whip material), pre-order coordination with the CTUIR Tribal Native Plant Nursery, and installation. Planting techniques are customized for conditions within each project area. Planting location, species, age, form (cuttings, saplings, bare-roots, potted, plugs), and soil/substrate conditions were considered and addressed during the implementation planning phase. The CTUIR UAFHP works closely with the Tribal Native Plant Nursery to collect local seed and plant stock to provide native plants for particular project areas by elevation and planting zones.

Table 1. Planting materials and grass seed by species, quantity, and size, planted and established at Umatilla River Basin existing and new project sites, 2009.

Water body	River mile	Date planted	Project site location	Species (Common Name)	Quantity Trees/Shrubs	Quantity Seed (lbs)
Birch Creek	2.6-3.1	2/3/09	Peterson easement	Red-osier dogwood	100 plugs	
Birch Creek	2.6-3.1	2/3/09	Peterson easement	Birch	100 plugs	
Birch Creek	2.6-3.1	2/4/09	Peterson easement	Red-osier dogwood	200 plugs	
Birch Creek	2.6-3.1	2/5/09	Peterson easement	Red-osier dogwood	200 plugs	
Umatilla River	41.0-44.0	2/27/09	B & G easement - banks near train bridge	Willows	100 cuttings	
Umatilla River	41.0-44.0	3/4/09	B & G easement - below rip-rap	Willows	250 cuttings	
Umatilla River	41.0-44.0	3/5/09	B & G easement - banks above train bridge	Willows	250 cuttings	
West Birch Creek	2.7-3.2	3/17/09	Cunningham Sheep Co. easement	Red-osier dogwood	100 plugs	
West Birch Creek	2.7-3.2	3/17/09	Cunningham Sheep Co. easement	Chokecherry	100 plugs	
Birch Creek	2.6-3.1	3/17/09	Peterson easement	Red-osier dogwood	100 plugs	
Birch Creek	2.6-3.1	3/17/09	Peterson easement	Chokecherry	100 plugs	
Camp Creek	0.3	3/18/09	Camp Creek - dam removal project area	Willows	175 cuttings	
Birch Creek	2.6-3.1	3/19/09	Peterson easement	Black hawthorn	200 plugs	
Birch Creek	2.6-3.1	3/19/09	Peterson easement	Willows	25 plugs	
Birch Creek	2.6-3.1	3/20/09	Peterson easement	Chokecherry	100 plugs	
Birch Creek	2.6-3.1	3/20/09	Peterson easement	Black hawthorn	100 plugs	
Umatilla River	41.0-44.0	3/27/09	B & G easement	Willows	200 cuttings	
Umatilla River	41.0-44.0	3/27/09	B & G easement	Willows	200 cuttings	
Wildhorse Creek	12.0-12.5	4/10/09	Adams easement	Cottonwood	400 plugs	
Wildhorse Creek	12.0-12.5	4/13/09	Adams easement	Cottonwood	100 plugs	
Greasewood Creek	0.0-1.5	5/4/09	Spratling easement	Willows	800 cuttings	
Greasewood Creek	0.0-1.5	5/1/09	Spratling easement	Willows	900 cuttings	
Greasewood Creek	0.0-1.5	5/5/09	Spratling easement	Cottonwood	50 plugs	
Birch Creek	2.6-3.1	5/5/09	Peterson easement	Cottonwood	100 plugs	
Birch Creek	2.6-3.1	5/7/09	Peterson easement - south of barn	Willows	300 cuttings	
Birch Creek	2.6-3.1	5/8/09	Peterson easement - West side of creek	Willows	200 cuttings	
Meacham Creek	5.0-6.0	10/20-22/2009	Meacham Levee Removal Project - disturbed areas	Mill Creek bluebunch wheatgrass, sugarloaf blue wildrye, Idaho fescue, California brome, basin wildrye		400
Meacham Creek	5.0-6.0	10/23/09	Meacham Levee Removal Project - along removed dikes	Douglas spiarea	15 plugs	
Meacham Creek	5.0-6.0	10/26/09	Meacham Levee Removal Project - along removed dikes	Alder	20 plugs	
Birch Creek	2.6-3.1	10/28/09	Peterson easement - river banks	Willows	20 cuttings	
Birch Creek	2.6-3.1	10/30/09	Peterson easement	Mock orange, elderberry, hawthorn, golden current, chokecherry, snowberry, cascara	15 plugs	
Birch Creek	2.6-3.1	11/3/09	Peterson easement	Mock orange, elderberry, hawthorn, golden current, chokecherry, snowberry, cascara	25 1-3 gal pots	
Birch Creek	2.6-3.1	11/6/09	Peterson easement	Mock orange, elderberry, hawthorn, golden current, chokecherry, snowberry, cascara	36 1-3 gal pots	

Work Element M: 22. Maintain Vegetation
Work Element Title: Maintain Vegetation Plantings at all CTUIR Habitat Implementation Project Areas
Milestone Deliverable: Maximize Survival of Vegetation Plantings in CTUIR Project Areas

A. Environmental compliance requirements complete.
B. Water vegetation and reduce weed competition to improve survival at CTUIR pre-existing project areas.
C. Water vegetation; reduce weeds to maximize survival of riparian plantings at new project sites.

Project activities conducted in FY 2009 included the monitoring and maintenance of 27 conservation easements on 23 individual landowner properties. CTUIR personnel routinely maintain and replant vegetation, water and weed plantings, and maintain structural integrity of riparian enclosure and livestock fencing at project sites. In FY 2009 much emphasis was placed by CTUIR in maintaining vegetation within the Peterson easement located on Birch Creek, RM 2.6-3.1, following an inspection of the project area.

The following project inspection and recommendation was the purpose of the increased work emphasis on the Peterson riparian conservation easement area:

Background: The landowner and the CTUIR entered into a 10-year Riparian Conservation Agreement (Easement) on 1 October 2004. The primary purpose of the agreement was to 1) at the landowners request construct a metal post/four-strand barbwire fence along the east and west property boundaries with three 12-ft metal gates, and prepare the ground and plant native shrubs and trees in the buffer area, 2) design and implement actions needed to eliminate the fish passage barrier near river mile three, 3) control noxious weeds as listed on the Umatilla County noxious weed lists A and B in the project area, and 4) coordinate activities with the CREP project within a 2-yr period. The intent of these improvements is to stabilize the stream channel, increase in-stream habitat diversity, and encourage floodplain, wetland and riparian recovery.

The project was implemented in spring of 2005. Both stream banks of Birch Creek in the Peterson easement were planted with 1,000 native shrub and tree tubelings using 27,000 ft^2 of mulch fabric (tarps) at a rate of 30 ft^2 per stem. A total of 12 tarps were installed on the property. Planted species were Nootka rose, red osier dogwood, golden currant, Douglas hawthorn, and chokecherry. Inspection of the plants during the fall of 2006 revealed about 10 percent survived. The tarps were to be replanted by the original subcontractor during January 2007 with smooth sumac, black cottonwood, red osier dogwood, sage brush, snowberry, elderberry, and Woods rose. It is unclear if replanting occurred by the hired contractor, but the project was replanted by CTUIR in spring 2008 with an additional 3,065 plants, including 675 alder, 300 sage, 255 chokecherry, 200 mock orange, 105 Douglas hawthorn, 105 rose, 100 willow plugs, 25 black cottonwood and 1300 willow cuttings. An additional 1200 plants were planted in 2009 strategically in the project area along eroded stream banks and throughout the tarp project area.

Landowner Tour and Project Inspection: On July 29, 2009, CTUIR staff met with the landowner to tour the project area and discuss concerns the landowner had stressed towards implementation of the project. It is important to note that both the landowner and CTUIR staff both seemed to have the same objective in mind in having the end result be successful.

The following concerns were presented by the landowner:

1. The original contractor (HARE Brothers) hired by CTUIR to implement the riparian tarp project, similar to the NRCS CREP Program, failed. In the site preparation, Mr. Peterson commented that they must have used herbicide spray that leached and resulted in large willows adjacent to the stream to die. The original plantings were also unsuccessful.
2. Lack of project success and riparian stability is resulting in bank failures on the property, resulting in Mr. Peterson losing valuable farm land in the process. Mr. Peterson also noted during a high flow event in the last two years a tree lodged sideways and shifted the main channel to the West bank resulting in the noted bank erosion. The landowner was not granted authority by regulatory agencies to remove the tree immediately. Mr. Peterson would like the river banks restored to pre-flood status and functioning properly in order to protect additional loss of farm land.
3. Prefers not to have sage brush and black cottonwood planted in the project area.
4. Elimination by CTUIR of an existing abandoned concrete water diversion is a risk to the stability of the channel and the water table as it is today.

The following observations of the project were noted by project staff:

1. Mulch tarps were strategically placed originally during project design in areas where riparian was observed to be non-existent and needed.
2. Of the 12 tarps on the project, four were complete failures on the northern end of the property.
3. Of the remaining eight tarps, about a 30-40 percent plant survival rate was observed. Although, plant success included replants from two additional spring plantings. Sage brush was the primary survival on the tarps. Chokecherry and rose also survived or thrived within the project area. Existing plants looked healthy in regards to plant vigor and moisture levels.
4. Deer populations are extremely high and are eating existing plants down to the base stems regardless of plant deer guards on the tarps and along the streambanks. Deer have also completely removed tree saplings by plucking the plants from the planted areas while grazing.
5. Staff observed the dead looking willows (about 10 ft high trees) as described by the landowner, but have no prior knowledge if these trees were alive prior to project implementation. The trees may have died from natural causes.
6. Eroded banks could be observed along the West side river bank in two locations, and the location where the channel had switched sides. When a stream is functioning naturally, erosion of banks can be observed similar to what was observed on the property. This doesn’t lessen our desire to work with the landowner in a cohesive and cooperative approach that not only meets the landowners concern but further stimulates natural stream recovery.
7. The diversion located on the property is a barrier during low flow seasons, and could not pass fish on the day that the project was toured and inspected. This diversion is no longer used for water withdrawal on Birch Creek although it has not been designated as abandoned.

Recommendations: For the purpose of simplification, the project recommendations are directly related to the riparian conservation agreement and the end results meeting our original objectives of riparian and stream function recovery. Although, our desire and long-term goal is to work jointly with the landowner in meeting his needs in order to remove the diversion structure currently blocking fish passage. Upon inspection, we believe some of the following approaches need to be implemented and a more aggressive approach to maintenance implemented in order for this project to be successful. The biggest impact to vegetation is the deer utilization and lacking an aggressive enough maintenance plan to establish tree growth under the existing conditional use.

The following are project recommendations implemented in FY 2009:

1. Installed protective fence around existing small trees and plants on mulch tarps located on the South side of the property above the house; both sides of the stream. Small 5-6 ft high wire fence were installed around living existing trees to protect investment of existing living plants from deer.
2. Project staff will replant portions of the tarps in a staggered approach over the next several years. This approach is to encourage growth through both fence protection from deer as well as increased but manageable weed maintenance and watering.
3. Larger trees (4-8 ft high) will be planted along the riparian in a staggered approach for purposes of a quicker riparian recovery. Planting larger trees will prevent overgrazing from deer in order to establish root structure and prevent failure. Larger trees will also be protected from deer and beaver with wire fencing while establishing root structure over two yrs.
4. Provide a more aggressive maintenance plan of tarps and tree plots along the riparian corridor, including both the mulch tarps as well as the channel banks. Project staff will maintain tarps for weeds and sustain watering as needed to increase plant survival in the project area. Crew access authorization by the landowner is limited in some areas of the project due to crop management on the property, and project success could be supported by better access for maintenance.
5. In a good faith effort we will work with the landowner on a stream channel design and implementation plan to treat streambank erosion that currently exists within the project area channel. A design approach will need an agreed upon approach with the landowner to allow a bank slope of one to one in order to meet desired goals of both the fish program and landowner needs.

Work Element N: 53. Remove Vegetation
Work Element Title: Control of Noxious Weeds in Project Areas by Physical and Chemical Means
Milestone Deliverable: Removal of Non-preferred Species of Vegetative Growth from Project Areas

A. Environmental compliance requirements complete.
B. Physical removal of non -preferred species of vegetative growth from project areas.
C. Weed control in project areas by chemical means.

Noxious and/or undesirable weeds are controlled through hand and mechanical removal, and herbicide and biological control applications in project areas. Weed control is essential in establishing native grass and plant species. CTUIR subcontracts a professional, licensed applicator to spray/control noxious weeds on sites where chemical application is necessary. CTUIR complies with BPA standards and supplies a report to BPA detailing the types and quantities of herbicides applied to specified locations. Biological controls are used in advantageous areas.

The frequency of watering, weeding and maintenance methods for each easement or project site varies. Strategies to address weeds are included in agreements that are either completed by the landowner, CTUIR, subcontractor, and/or through the County Weed Control Board. CTUIR staff provides assistance to landowners by coordinating and managing herbicide application vendors, providing funding, and developing treatment strategies. Manual, biological, and chemical treatment options are utilized by CTUIR and may be employed when consistent with existing standards.

Noxious and/or undesirable weeds are controlled in project enhancement areas by a professional, licensed applicator. The contractor identifies problem weeds, determines the appropriate herbicide and selects the most effective application methods and rates in accordance with the National Oceanic and Atmospheric Administration's (NOAA) Biological Opinion (BO) under BPA's Habitat Improvement Program. The contractor utilizes handgun spraying, backpack spraying and wiper applications to treat perennial, annual and biennial weed species. All herbicide applications are consistent with Oregon Revised Statue 569.350 and Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) Regulations.

Noxious and/or undesirable weeds are present on several project areas. As with our work on conservation easements, CTUIR subcontracts professional, licensed applicators to spray/control noxious weeds on several project sites. In FY 2009, CTUIR removed noxious and/or undesirable weeds through mechanical, biological, or chemical means. CTUIR currently maintains 27 conservation easements on 23 individual landowner properties including 15 locations where CTUIR is obligated to control noxious weeds on 110 riparian non-wetland habitat and 353 upland non-wetland habitat acres in Wildhorse Creek, Umatilla River, McKay Creek, Spring Hollow Creek, and Birch Creek. CTUIR complied with BPA standards and supplied a report to BPA detailing the types and quantities of herbicides applied to specified locations (Table 2). CTUIR chemically treated 62 riparian non-wetland habitat and 17 upland non-wetland habitat acres (Table 2). These are ongoing work sites where environmental compliance has been cleared in prior contract periods.

A weed report was provided by the subcontracted professional, licensed applicator to characterize maintained project areas by watershed. The following is a brief summary of the weed report by watershed treatment area within the Umatilla River Basin:

<u>Umatilla River</u>

Project areas are located in areas where there was historically heavy cattle use and this has led to a high seed source and difficult in treating weeds. Primary noxious weeds that are treated chemically include scotch thistle, diffuse knapweed, star thistle, hound's-tongue, kochia, and hoary cress (white top). New weeds of concern include spike weed, spiny cocklebur, garlic mustard, and Dalmatian toadflax.

Table 2. BPA form annually submitted by CTUIR listing actual herbicide application, both the active ingredient and adjuvant, by location within the Umatilla River Basin, 2009.

LOCATION		6th HYDROLOIC UNIT CODE	ACTIVE INGREDIENT	ADJUVANT USED	RIPARIAN			UPLAND		
Township Range & Section (can be found in Pisces)	OR Latitude and Longitude				Estimate Acres Treated	Estimate of Total Volume of Herbicide Only (Gallons)	Application Method	Estimate Acres Treated	Estimate of Total Volume of Herbicide Only (Gallons)	Application Method
Umatilla R., Becker (Wolfe)	45° 39' 13.05" 118° 57' 28.66"	170701030703	Aminopyralid	R-11	6	0.273 gal	hand wand / spot spraying	3	.16 gal	Mechanized
Umatilla R., Becker (Wolfe)	45° 39' 13.05" 118° 57' 28.66"	170701030703	Chorsulfuron	R-11				1	30 grams	Mechanized
Birch Cr., Peterson	45° 37' 54." 118° 51' 28."	170701030609	Aminopyralid	R-11	3	.03 gal	hand wand / spot spraying	2	.11 gal	Mechanized
Birch Cr., Peterson	45° 37' 54." 118° 51' 28."	170701030609	Metsulfuron	R-11	3	32 grams	hand wand / spot spraying			
Birch Cr., Peterson	45° 37' 54." 118° 51' 28."	170701030609	Dicamba	R-11	3	.06 gal	hand wand / spot spraying			
Wildhorse Cr., Adams	45° 45' 12.79" 118° 34' 33.13"	170701030404	Aminopyralid	R-11	14	.08 gal	hand wand / spot spraying	4	.21 gal	Mechanized
Wildhorse Cr., Adams	45° 45' 12.79" 118° 34' 33.13"	170701030404	Metsulfuron	R-11	14	90 grams	hand wand / spot spraying			
Wildhorse Cr., Adams	45° 45' 12.79" 118° 34' 33.13"	170701030404	Dicamba	R-11	14	.156 gal	hand wand / spot spraying			
Wildhorse Cr., Adams	45° 45' 12.79" 118° 34' 33.13"	170701030404	Chorsulfuron	R-11				2	10 grams	hand wand / spot spraying
Wildhorse Cr., Reynold's	45° 44' 57.92" 118° 35' 0.61"	170701030404	Aminopyralid	R-11	10	.05 gal	hand wand / spot spraying	5	.27 gal	Mechanized
Wildhorse Cr., Reynold's	45° 44' 57.92" 118° 35' 0.61"	170701030404	Dicamba	R-11	10	.11 gal	hand wand / spot spraying			
Wildhorse Cr., Reynold's	45° 44' 57.92" 118° 35' 0.61"	170701030404	Metsulfuron	R-11	10	56 grams	hand wand / spot spraying			
Wildhorse Cr., Schmidtgall	45° 44' 32.06 118° 35' 55.72	170701030404	Aminopyralid	R-11	15	.06 gal	hand wand / spot spraying			
Wildhorse Cr., Schmidtgall	45° 44' 32.06 118° 35' 55.72	170701030404	Metsulfuron	R-11	15	64 grams	hand wand / spot spraying			
Spring Hollow Cr., Pambrum	45° 46' 4.96" 118° 32' 55.89"	170701030402	Aminopyralid	R-11	4	.04 gal	hand wand / spot spraying			
Spring Hollow Cr., Pambrum	45° 46' 4.96" 118° 32' 55.89"	170701030402	Dicamba	R-11	4	.125 gal	hand wand / spot spraying			
Spring Hollow Cr., Pambrum	45° 46' 4.96" 118° 32' 55.89"	170701030402	Metsulfuron	R-11	4	40 grams	hand wand / spot spraying			

Table 2. Continued.

LOCATION		6th HYDROLOIC UNIT CODE	ACTIVE INGREDIENT	ADJUVANT USED	RIPARIAN			UPLAND		
Township Range & Section (can be found in Pisces)	OR Latitude and Longitude				Estimate Acres Treated	Estimate of Total Volume of Herbicide Only (Gallons)	Application Method	Estimate Acres Treated	Estimate of Total Volume of Herbicide Only (Gallons)	Application Method
McKay Cr., Cripes	45° 30' 30.79" 118° 42' 34.29	170701030703	Aminopyralid	R-11	5	.035 gal	hand wand / spot spraying			
McKay Cr., Cripes	45° 30' 30.79" 118° 42' 34.29	170701030703	Metsulfuron	R-11	5	15 grams	hand wand / spot spraying			
McKay Cr., Cripes	45° 30' 30.79" 118° 42' 34.29	170701030703	Dicamba	R-11	5	.046 gal	hand wand / spot spraying			
McKay Cr., Hainey	45° 30' 31" 118° 41' 56"	170701030703	Aminopyralid	R-11	5	.035 gal	hand wand / spot spraying			
McKay Cr., Hainey	45° 30' 31" 118° 41' 56"	170701030703	Metsulfuron	R-11	5	15 grams	hand wand / spot spraying			
McKay Cr., Hainey	45° 30' 31" 118° 41' 56"	170701030703	Dicamba	R-11	5	.046 gal	hand wand / spot spraying			

Birch Creek
Primary noxious weeds that are chemically treated include scotch thistle, star thistle, hound's-tongue, Canadian thistle and poison hemlock. A more recent noxious weed of concern is Russian knapweed (along the hill slope of the Whitney easement) and garlic mustard (mid-project of the Peterson easement).

McKay Creek
Wildlife is numerous in project areas. Blackberries are an ongoing maintenance problem, and they are being treated to push them further back from the stream banks. Also maintaining wildlife "trails" thru the blackberries for wildlife access to the creek. The weeds that have primarily been treated include blackberries, scotch thistle, mullein, cocklebur, and hound's-tongue. A weed of concern that has shown up on the eastern border of the treatment locations is rush skeleton weed.

Wildhorse Creek
The seed bank in Wildhorse Creek is numerous within the watershed. Many of the project areas are under control and need continue maintenance given the rest of the watershed. As weeds are treated and grass comes back, the weeds are gradually declining. The number of noxious weed species chemically treated is numerous including all mustard species (blue, Jim Hill, and tumble), fiddle neck, thistle species (scotch, bull, wavy-leaved, and Canadian), hemlock, knapweed (Russian and diffuse), and hound's-tongue. In addition, weeds of concern include mare's-tail (emerges late-early summer), white top (hoary cress), and star thistle.

Spring Hollow Creek
Spring Hollow Creek is an excellent growing area for trees with deep, rich soil. Trespass cattle have caused delays in growth. Weeds are currently under control with continued maintenance. Weeds of concern include scotch thistle, hound's-tongue, mullein, and mustard species.

Meacham Creek
The floodplain and riparian of lower Meacham Creek is a diverse forest area with opportunity for recovery. Primary noxious weeds that are chemically treated include blackberries, scotch thistle, viper's bugloss, and Dalmatian toadflax. Weeds of concern include sulphur cinquefoil and rush skeleton weed (found at the mouth of Meacham and Isquulktpe creeks). Mullein will be a weed of concern during construction of restoration projects in Meacham Creek. Mullein grows in heavy in disturbed areas and will need treated in order for better restoration of native plants and grass.

In FY 2009, CTUIR used biological controls in four project areas of Meacham Creek from river mile 6.8 to 8.2 to control invasive Dalmatian toadflax. Adult beetles were introduced and approved as biological controls for Dalmatian toadflax by the USDA-APHIS-PPQ for release as bio-control agents.

Work Element O: 186. Operate and Maintain Habitat/Passage/Structure
Work Element Title: Monitor and Troubleshoot Issues that Interfere with Proper Function of In-stream Improvement Structures
Milestone Deliverable: Maintaining Proper Operation of In-stream Habitat Structures

A. Environmental compliance requirements complete.

B. Monitor project areas & initiate process as necessary for repairs to restore function as designed.

CTUIR monitors 6 passage rectification projects to assure that treatments are effectively working and to insure that intrusive objects are not interfering with the designed function of the passage structures (Table 3). Routine quarterly scheduled site visits of individual projects are conducted either independently by the CTUIR or jointly with project partners such as ODFW. Site visits also follow significant flow events or responses to landowner requests at project sites.

Table 3. Habitat passage structures monitored and maintained by CTUIR to meet design specifications, 2007-2010.

Year	Stream	Stream Location	Project Description
2007	Meacham Creek	RM 1.7	Passage rectified by removing large cabled boulders (improved adult passage)
2007	Meacham Creek	RM 20.2	Partial dam removed (juvenile and adult passage)
2007	Camp Creek	RM 0.3	Partial dam removal (juvenile and adult passage)
2007	Greasewood Creek	RM 0.4	Partial dam removal (juvenile and adult passage)
2007	West Birch Creek	RM 3.2	Roughened channel to restore proper gradient and reduce step height at road bridge crossing for adult passage
2008	West Birch Creek	RM 2.7	Hoeft Dam fish passage rectification (juvenile and adult passage)

Project maintenance includes, but is not limited to, meeting specified conditional language in state and Federal permits, maintaining debris that is routinely captured or caught on in-stream structures, responses to landowner requests and concerns, and completion of post-treatment surveys to monitor and quantify changes to physical and ecological responses. If necessary a work plan is developed and contractor hired for completion for project activities greater than routine maintenance. The 2009 project activities involved routine maintenance.

Work Element P: 186. Operate and Maintain Habitat/Passage/Structure
Work Element Title: Secure and Adhere to Details of Conservation Easements Associated with Habitat Projects
Milestone Deliverable: Maintenance of Conservation Easements

A. Environmental compliance requirements complete.
B. Adhere to details of existing easements and/or initiate additional agreements as feasible.

CTUIR currently manages and maintains property in compliance with 27 existing conservation easements within the Umatilla Basin (Table 4). The purpose of these conservation easements is to protect, enhance, and restore functional floodplain, channel, and watershed processes to provide sustainable and healthy habitat for aquatic species in the Umatilla River subbasin. CTUIR routinely conducts custodial maintenance on individual projects to ensure that project structures and fencing are functioning and habitat recovery is progressing towards meeting projects goals and objectives. Activities include, but are not limited to, installing and repairing riparian cattle exclusion fences, maintaining or installing water gaps, riparian and floodplain plantings and maintenance, noxious weed control, maintenance of fish habitat improvement structures, and landowner coordination and education.

In 2009, CTUIR located and digitized signed agreements and began development of a web based tool to assist in the inventory and monitoring of conservation easements managed by the UAFHP within the Umatilla subbasin in northeast Oregon. The conservation easement locator was completed during 2010 project activities and described later in this report under 2010 work elements.

Table 4. Conservation Easements Maintained by the CTUIR: Locations, Duration, Agreement Details and Recommended Renewal Status Projections.

#	Waterway	RM	Start Date	End Date	Actions Performed	Renewal Status
1	Wildhorse	9.5	5/1/2004	5/1/2024	fence, weed, plant, watering, weeding, gradient	Yes
2	Wildhorse	12.0	10/12/1995	10/12/2010	fence, weed, plant, watering, weeding, gradient	Yes
3	Wildhorse	12.5	5/1/2004	5/1/2024	fence, weed, plant, watering, weeding, gradient	Yes
5	Umatilla	42.0	1/1/2001	1/1/2016	fence, weed	Yes
6	Umatilla	43.0	1/25/2003	1/25/2023	fence, weed, well	Yes
7	Cottonwood	1.0	10/1/2001	10/1/2026	culvert replacement	No
8	Mission	2.5	1/1/2001	1/1/2011	barrier remedy, fence, native grass	Yes
9	Umatilla	68.5	10/1/1999	10/1/2014	none	Yes
10	Buckaroo	1.0	10/1/1999	10/1/2014	none	Yes
11	West Birch	3.2	11/4/1999	11/4/2014	barrier remedy, plantings, water, weed	Yes
12	McKay	16.5	6/1/1999	6/1/2014	education, bio monitoring, plant, weed	Yes
13	Umatilla	40.0	9/30/2004	9/30/2024	plant, weed, water, wells	Yes
14	East Birch	10.5	9/1/1997	9/1/2017	fence construction, maintenance	Yes
15	Umatilla	82.5	7/1/2000	7/1/2015	in-stream bank protection	Yes
16	McKay	17.0	12/2/1995	12/2/2011	education, bio monitoring, plant, weed	No
17	West Birch	2.7	2/1/2005	2/15/2025	passage remedy, plant, water, weed	Yes
18	Buckaroo	1.0	10/1/1999	10/1/2014	none	Yes
19	Wildhorse	7.5	11/4/1994	11/4/2009	fence, gradient, weed	Yes
20	Buckaroo	1.5	5/7/2002	5/7/2022	fence, bio monitoring	Yes
21	Spring Hollow	2.5	9/1/1996	9/1/2011	plant, fence, bio monitor	Yes
22	Birch	2.7	10/1/1999	10/1/2014	plant, weed, water	Yes
23	Wildhorse	8.5	10/1/2002	10/1/2020	fence, gradient, weed	Yes
24	Umatilla	87.5	10/1/2002	10/1/2020	in-stream bank protection, channel shaping	Yes
25	Umatilla	61.5	10/1/2002	INDEF	in-stream bank protection, planting	Yes
26	Greasewood	0.5	10/12/1995	10/12/2010	barrier remedy, fence, weed, plant, bio monitor	Yes
27	Meacham	0.5	10/1/1999	10/1/2014	fence, weed	Yes

Work Element Q: 34. Develop Alternative Water Source
Work Element Title: Develop Additional Water Sources and Strategies to Improve Survival of Riparian Vegetation on B&G Resources Property
Milestone Deliverable: Development of Additional Water Sources to Supplement the Low Annual Precipitation of 11 inch Per Yr

A. Environmental compliance requirements complete.
B. Develop water source(s) to supplement riparian plantings.

The Bauer and Gustafson (B&G) Resources Property project site consists of a property parcel along the Umatilla River between RM's 41-44, about 10 mi downstream of Pendleton, Oregon (Figure 12). The landscape setting ranges from active channel floodplain to abandoned floodplain terrace and upland. In October 2004, CTUIR and B&G Resources signed a Riparian Conservation Agreement for the purpose of promoting sound riparian management that will achieve benefits for fish and wildlife habitat, soil and water conservation and increased productivity of adjacent lands. A total of 355 acres (61 riparian and 294 upland acres) have been treated with, but not limited to, riparian fence enclosure or protection, planting native vegetation in riparian, weed control, watering planted vegetation, and alternative water developments (CTUIR 2008).

CTUIR developed the following table to track progress at the B&G Property site. Table 5 shows the date actions were taken by various agencies and the contracting firms hired to carry out the project actions.

In spring 2009, NRCS CREP tracts were replanted with 13,400 sapling trees by CTUIR using a local contractor encompassing 61 acres (Table 6). Original 2006 CREP plantings failed for multiple reasons: 1) poor preparation by original contractor to prepare soil for CREP tract plantings, 2) plantings occurred on high terraces where significant channel incision had occurred resulting in plants largely devoid of water due to the distance from the water table and arid climate at this location, 3) a typical NRCS CREP tract planting plan was developed with no consideration of planting riparian and upland plant species viable at the designated area elevations and low moisture growing environments, and 4) lack of necessary CREP tract maintenance, such as manual and chemical noxious weed control.

In FY 2008 and FY 2009, prior to upcoming FY 2009 plantings, CTUIR worked with the landowner, local property manager and NRCS to devise a site-specific planting and maintenance strategy through the CREP program. The plan included a strategy to meet survival estimates of NRCS CREP tracts of 50% survival of plants after two yrs. This strategy included preparations of the soil in fall 2008 and winter 2009 prior to planting the CREP tracts:

- Plowing once to discourage weed growth, break down existing herbicide residuals, and prepare for planting.
- Rototilling once to break up soil and rigid plant matter to prepare soil for planting.
- Disking three times to break up soil and rigid plant matter to prepare soil for planting.
- Cultivating twice to break up soil and rigid plant matter to prepare soil for planting.
- Rod weeding twice to remove rigid plant matter to prepare soil for planting.
- Spraying herbicide to control noxious weed
- Mowing once to retard weed growth and reduce fire risk.

Following plantings in FY 2009, the strategy for increased survival of NRCS CREP tract plantings further established a maintenance approach to watering plants during the hot summer months for several years to establish root systems for short- and long-term survival. An approach was established to deliver supplemental water to the plants within the CREP tracts. CTUIR applied to the OWRD and received a Limited Water Use License for using well #1 and well #2 established on the property in FY 2008 for off-site livestock watering (Figure 12). The permit allowed the landowner manager and CTUIR to draw water from the

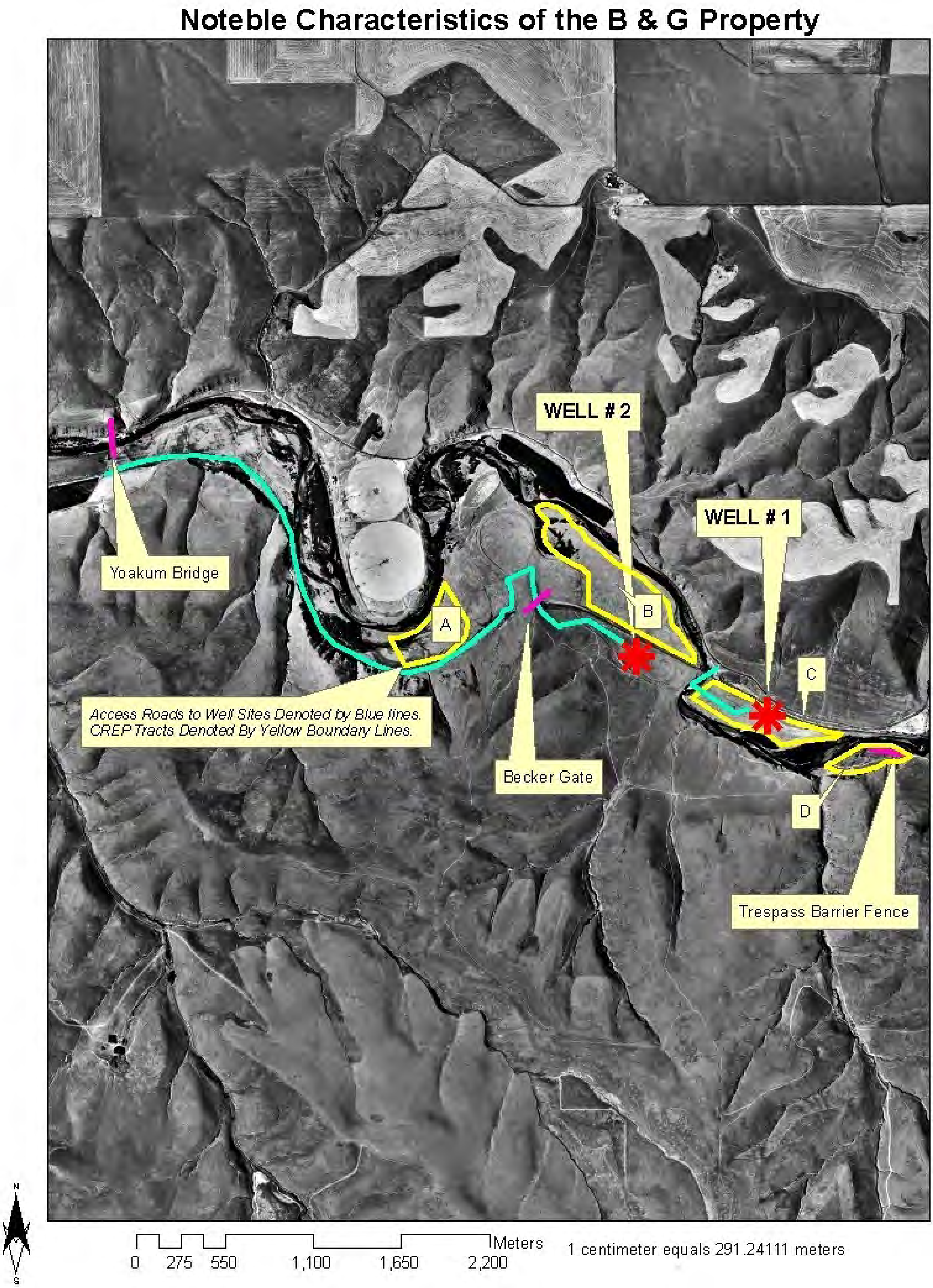


Figure 12. Aerial Photograph of B&G Resources Property, CREP Tracts, and Well Sites.

Table 5. B&G Resources Project Actions, Dates of Work, Contracting Agencies and Contractors.

Date	Action	Contracting Agency	Contractor
10/2004	CTUIR Easement signed	CTUIR	B&G Resources
12/2004	CREP contract signed	NRCS/FSA	B&G Resources
7/2005	Installed exclusion fence on east field near well #1.	CTUIR	CTUIR
7/2005	Installed trespass fence on southeast side.	CTUIR	CTUIR
8/2005	Prepare for work, cultural resource coordination.	CTUIR	CTUIR
12/2005	Burn and mow fields	CTUIR	A2Z Engines
1/2006	Riparian planting (CREP)	B&G	Wild West Riparian
3/2006	Weed removal on tarp areas	B&G	Wild West Riparian
4/2006	Mow areas around tarps	CTUIR	CTUIR
4/2006	Weed control spraying in Zones 1 & 2 (Weed R, Milestone, Aqua neat)	CTUIR	Umatilla County
6/2006	Weed control, aerial spraying of field (Tordon 22k, 2-4D Amine, R-11)	CTUIR	Cliff Hoeft
6/2006	Watered riparian plants	CTUIR	CTUIR
7/2006	Watered riparian plants	CTUIR	CTUIR
7/2006	Weed control, targeting thistle (Clopyralid, Picloram, Chorsulfuron)	CTUIR	McLain Spraying
11/2006	Weed control, aerial spraying (Roundup RT, Class Act, Coral Poly)	CTUIR	Cliff Hoeft
4/2007	Mow in preparation for grass seeding.	CTUIR	Cliff Hoeft
4/2007	Plant grass, no-till drill	CTUIR	Cliff Hoeft
5/2007	Weed control (Clopyralid, Picloram, Chorsulfuron)	CTUIR	McLain Spraying
8/2007	Mowed areas around tarps	CTUIR	CTUIR
1/2008	Drilled 2 wells for livestock watering	CTUIR	Wallace Drilling
5/2008	Noxious weed control – herbicides and physical removal	CTUIR	Ellis Ranch
6/2008	Access Restriction Project, B&G and Becker Easement	CTUIR/ODFW	ODFW
7/2008	Extensive soil preparation for future plantings	CTUIR	Ellis Ranch
1/2009	CREP tract preparation by rod weeding	CTUIR	Ellis Ranch
1/2009	Riparian planting (CREP) – 13,400 saplings	CTUIR	Ellis Ranch
1/2009	Installed 2 solar panels and livestock watering tanks	CTUIR	Ellis Ranch
3/2009	Chemical noxious weed control	CTUIR	Ellis Ranch
3/2009	Apply native grass seed around tarps and mow to retard weed growth	CTUIR	Ellis Ranch
4/2009	OWRD Limited Water Use License attained for watering CREP tracts	CTUIR	CTUIR
6/2009	Installation of PVC experimental watering tubes for CREP tract saplings	CTUIR	Ellis Ranch
6/2009	Well site setup for truck tank and ATV tank watering of CREP tracts	CTUIR	Ellis Ranch
6/2009	Mowed areas around tarps to retard weed growth	CTUIR	Ellis Ranch
10/2009	Watered and weeded sapling trees twice per week over five months to increase survival	CTUIR	CTUIR/Ellis Ranch
10/2009	Mowed areas around tarps to retard weed growth	CTUIR	Ellis Ranch
6/2010	Well site setup for truck tank and ATV tank watering of CREP tracts	CTUIR	Ellis Ranch
6/2010	Mowed areas around tarps to retard weed growth	CTUIR	Ellis Ranch/CTUIR
6/2010	Chemical noxious weed control	CTUIR	Ellis Ranch
10/2010	Watered and weeded sapling trees twice per week over five months to increase survival	CTUIR	CTUIR/Ellis Ranch
10/2010	Mowed areas around tarps to retard weed growth	CTUIR	Ellis Ranch

Table 6. Sapling planted at CREP Sites on the B&G Resources Property by tree species and quantities.

Site 9896		**Site 10504**		**Site 11948**	
Tree Species	#	Tree Species	#	Tree Species	#
Alder, Thinleaf	100	Ponderosa Pine	50	Alder, Thinleaf	50
Choke Cherry	750	Choke Cherry	400	Choke Cherry	300
Cottonwood, Black	200	Cottonwood, Black	100	Cottonwood, Black	200
Currant, Golden	800	Currant, Golden	400	Currant, Golden	300
Dogwood, Red Osier	200	Dogwood, Red Osier	75	Dogwood, Red Osier	50
Elderberry, Blue	1,400	Elderberry, Blue	600	Elderberry, Blue	300
Mock Orange	800	Mock Orange	400	Mock Orange	300
Rabbit Brush	150	Rabbit Brush	100	Ponderosa Pine	50
Rose, Wild	1000	Rose, Wild	400	Rose, Wild	200
Sage Brush	1,500	Sage Brush	600	Sage Brush	250
Sumac	600	Sumac	300	Sumac	50
Willow, Coyote	150	Willow, Coyote	75	Willow, Coyote	50
Ponderosa Pine	150				
Total Seedlings	**7,800**	**Total Seedlings**	**3,500**	**Total Seedlings**	**2,100**

well to water plantings until 30-September 2013. CTUIR project staff and the contracted landowner manager watered CREP tracts once per week using truck and ATV water tank systems from mid-June to mid-October, 2009. The contracted landowner manager watered a total of 60.7 acres of CREP tracts and CTUIR was responsible for 9.6 acres. In addition to watering CREP tracts, the contracted landowner manager hand pulled all weeds within all CREP tracts as well as mechanically mowed outside of CREP tracts to growth of native grass seed and retard weed growth.

With the increased watering, CTUIR set a minimum targeted survival of 70% over two years with a target goal of 80% for the 2009 growing season. On October 15 2009 CTUIR conducted a survival survey and found that we had a survival rate of 72.4%, project-wide. Although we would expect a typical 10% plant loss on CREP tract projects following planting we had a slightly lower survival than our original 2009 target survival. The total water usage in 2009 under the OWRD Limited Use Permit was about 85,490 gallons, or 0.26 acre/ft from well #2.

In 2010, CTUIR continued to implement the newly developed watering plan, control noxious weeds and track survival of plantings to evaluate the feasibility of success in this project area. Project activities included watering and maintaining plants on NRCS CREP tracts and maintaining noxious weeds (Table 5). Plant watering rates on CREP tracts were maintained at once per week. Overall plant survival was inspected from September 20 to September 23, 2010 with an overall survival of 61.5%. CTUIR maintained tracts had an overall survival of 72.4%. The NRCS CREP tracts passed inspection and certification in 2010 for meeting maintenance standards.

Work Element R: 48. Practice No-till and Conservation Tillage Systems
Work Element Title: Tillage Strategies at B&G Project to Improve Vegetative Planting Survival of Preferred Species
Milestone Deliverable: Utilize Area Farming Practice Methods to Till Established Weed Areas at the B&G Property

A. Environmental compliance requirements complete.

B. Conduct tillage strategies at B&G project to improve vegetative survival, NRCS compliance.

Activities accomplished as part of the B&G Property Project, including accomplishments associated with this work element are described in detail above in work element Q: 34.

Work Element S: 156. Develop RM&E Methods and Designs
Work Element Title: Develop Strategic and Scientifically Accepted Monitoring Methods for Application
Milestone Deliverable: Produce Methods for use as Monitoring Project Effectiveness

A. Develop aquatic habitat inventory assessment methods for pre- and post-implementation utility.
B. Develop biological monitoring prototype to show fish community response to habitat components.

The CTUIR has and continues to invest substantial resources in restoring sustainability of five Columbia subbasins that constitute the ceded lands, including the Umatilla subbasin. The Umatilla River Vision describes well the rationale for these investments in relationship to the importance of first foods to the future of the Tribal people (Jones et al. 2008). In 2009, CTUIR began development of a conceptual bio-monitoring design that evaluates the biotic outcomes from restoration actions throughout the five subbasins to ensure that investments result in actual improvements to the biological productivity.

Detection of measurable changes in biotic conditions, specifically changes to survival and productivity of various salmon life stages, is presumed to be predicated on habitat improvements that result from directed restoration actions taken by CTUIR. Such changes in physical habitat characteristics will be tracked by CTUIR staff, and the resulting data will substantially contribute to elements of the study design for this biotic monitoring program. The relationship between the physical conditions, carrying capacity and productivity of the habitat is thus foundational to the approach taken to measure improvements in life cycle characteristics of target native fish populations, over many generations.

The overall goal of the bio-monitoring design is to understand how the restored ecological processes that maintain essential functions and increased habitat complexity individually and accumulatively affect spring Chinook salmon, summer steelhead and bull trout in the five subbasins. Coinciding with the bio-monitoring design, project staff has developed monitoring strategies in relationship to habitat restoration actions.

In support of the bio-monitoring plan design, CTUIR UAFHP staff identified two future project areas and reference reaches within the Umatilla subbasin. The referenced future project areas included one mainstem and one tributary that would directly benefit spring Chinook salmon and summer steelhead. As part of the exercise, staff also identified comparable reference reaches where no project activities would occur that were located above the proposed future projects. We also identified and described fish limiting factors within the Umatilla subbasin, and provided reference documentation of the identified limiting factors.

Work Element T: 174. Produce Plan
Work Element Title: Produce Umatilla River and Willow Creek Watershed Habitat Assessment Plans

Milestone Deliverable: Summarized Data in the Format of Professional Scientific Reports

A. Assess relevant spatial datasets tied to specific watershed reaches.
B. Define channel/floodplain types and a suite of potential conditions in target watersheds.
C. Measure geomorphic patterns, reach-scale channel characteristics, valley type, surface complexity.
D. Create classification of stream segments into functional groups.
E. Identify patterns of salmonid species life-stage distribution and habitat use from existing data.
F. Field validated results of predictions and estimate types, and locations of habitats in segments.
G. Build mathematical models to predict salmonid habitats from mapped variables.
H. Create priority list of potential restoration sites from a census of stream segments per watershed.

Within the context of stream restoration intending to recover habitat for multiple life stages of Pacific Salmon, there is a lack of information on relevant spatial scales available to tribal and state fisheries managers within the Pacific Northwest. Managers often lack the time and resources necessary to conduct field visits and site sampling and then adequately assess the conditions of sampled habitats. Multiple river classification systems developed to better monitor, manage and characterize river ecosystems (Hudson et al. 1992, Maxwell et al. 1995, Montgomery 1995, Poff 1997) have not proven successful tools for such assessments. Quantitative measures linking process-based, physical habitat characteristics to salmonid utilization of these habitats remains a central problem plaguing ESA recovery efforts and sub-basin plans (NWPCC 2005).

Our approach improves on past efforts by predicting coarse scale, potential floodplain conditions for several watersheds in NE Oregon and SW Washington including the Umatilla subbasin. CTUIR classified all stream segments in the Umatilla River watershed using spatially explicit data techniques developed from a suite of nonparametric statistical models. We modeled spatially extensive physical processes using existing 10 meter DEMs and 1:24,000 scale stream data sets that provided continuous values for several important hydrologic and geomorphic parameters. To address varying spatial thresholds in these processes, we developed a multi-scale classification to characterize physical processes for the watershed. The focus of work was to characterize essential habitats for critical salmonid life stages, gain further insight into the scales of physical processes that support those habitats in key channel reaches, and predict the spatial patterns of physical and aquatic diversity across several watersheds (~ 30,000 sq. km area). The comprehensive database of all stream segments and classification will be integrated with our restoration efforts in order to guide restoration site selection and inform our hypotheses driving specific restoration projects.

Analysis and modeling for milestones A-G was completed during the FY 2009 project. A draft report was completed by February 26, 2010 and submitted for peer review. A standalone final report was completed in FY 2010 (Appendix B).

Work Element U: 122. Provide Technical Review
Work Element Title: Review and Provide Technical Input on Issues and Topics That Affect the Areas Natural Resource
Milestone Deliverable: Review and Provide Technical Input on Issues that May Adversely Affect Natural Resources

A. Conduct review and provide input as necessary on natural resource preservation issues.

CTUIR commented on applications for OWEB grants in coordination with the UBWC, on CTUIR's Department of Water Quality SZA Permits and landowner requests for bank stabilization during FY 2009. Comments were provided in order to provide technical input in order to protect and enhance habitat in the Umatilla River subbasin. Reviews included official written comments as well as informal conversations with local landowners.

Work Element V: 132. Produce Annual Progress Report
Work Element Title: Submit Annual Progress Report for the Fiscal Year 2009 Period from February 2009 to January 2010
Milestone Deliverable: Attach 2009 Progress Report in Pisces

A. Submit progress report for external review
B. Confirm BPA has posted the progress report

CTUIR UAFHP staff did not submit the FY 2009 BPA Annual Report by the end of the contract period. Completion of the FY 2009 BPA Annual Report was added as a work element during the FY 2010 contract period from February 2010 to January 2011. This work element again was carried over into the FY 2011 contract period and will be combined with work accomplished during the FY 2010 contract period as one report. By submission of this FY 2009-2010 Annual Report, CTUIR has fulfilled its contractual obligations to BPA by reporting the FY 2009 project details for the period February 2009 to January 2010.

Work Element W: 119. Manage and Administer Projects
Work Element Title: Manage and Administer Project
Milestone Deliverable: Complete and Submit 2010 Draft Statement of Work and Accrual Reports

A. Funding package – conduct internal review (e.g., supervisor or interagency).
B. Accrual – submit September estimate to BPA.
C. Funding package – submit draft to BPA COTR.

This work element includes a suite of management actions required to administer the project, including preparation of annual operations and maintenance budgets, managing and preparing statements of work and budgets, and property inventory to the assigned BPA COTR for the following contract period. The project leader reports quarterly or as necessary on milestones and metrics to BPA using the BPA Pisces Program, supervises, trains, and directs staff activities, conducts vehicle and equipment maintenance and management, performs payroll, purchasing, subcontracting for services, and administers habitat enhancement activities.

METHODS, RESULTS, AND DISCUSSION OF 2010 STATEMENT OF WORK DELIVERABLES

This section describes methods and results, and discusses completed work elements in an outline similar to our statement of work in Pisces. Each work element with associated identifier code and milestone are listed, followed by a comprehensive summary of completed work under each work element.

Work Element A: 119. Manage and Administer Projects
Work Element Title: Manage and Administer Project
Milestone Deliverable: Upload Statement of Work, Budget, Property Inventory for Upcoming Contract Period to Pisces

A. Per COTR, revise/finalize the new contract package (statement of work, environmental compliance documentation, budget, and property inventory).
B. Accrual – submit September estimate to BPA.
C. Funding package – conduct internal review (e.g., supervisor or interagency).

This work element includes a suite of management actions required to administer the project, including preparation of annual operations and maintenance budgets, managing and preparing statements of work and budgets, and property inventory to the assigned BPA COTR for the following contract period. The project leader reports quarterly or as necessary on milestones and metrics to BPA using the BPA Pisces Program, supervises, trains, and directs staff activities, conducts vehicle and equipment maintenance and management, performs payroll, purchasing, subcontracting for services, and administers habitat enhancement activities.

Work Element B: 165. Produce Environmental Compliance Documentation
Work Element Title: Produce Environmental Compliance Documentation
Milestone Deliverable: Receipt of Environmental Compliance Clearance from BPA

The following milestones were contracted for FY2010 projects:

A. Meacham Creek Floodplain Restoration and In-stream Enhancement Project environmental compliance package.
B. Peterson Dam Removal Project environmental compliance.
C. Lower Umatilla River Bank Stabilization and Habitat Restoration Project environmental compliance package.
D. Herbicide use proposals and application summaries for project.
E. Meacham Creek Fence Construction and Maintenance Project environmental compliance.
F. Birch Creek In-stream Habitat Enhancement Project environmental compliance package.

CTUIR successfully submitted all applicable and required documents to the appropriate federal, tribal, state, county entities for select implementation projects in a timely manner required under work elements related to producing environmental compliance documentation in FY 2010. Secondary environmental compliance accomplishments during the reporting period included coordination with various compliance personnel to prepare supplemental documentation and reporting for ongoing and planned management actions. Environmental compliance methods include development of appropriate documentation under various federal, Tribal, state and county laws and regulations governing federally funded project work. Methods involve coordination with various federal and state entities agencies and development and submittal of permit applications, cultural clearances, biological assessments, NEPA checklists, etc., as necessary. Part of the environmental compliance work element includes planning and developing site-specific proposals tailored to accomplish fisheries goals and meet compliance standards. The details concerning the implementation of treatments and preparations for putting efforts on the ground, including preparations for subcontracting, and specifics in regarding the safeguarding of ESA-Listed species during the implementation process are outlined in the proposals.

Cultural Resource Protection and Preservation

CTUIR submitted a letter and attachments with necessary project descriptions and geo-referenced maps on January 22, 2010 for assisting BPA with section 106 NHPA consultations and environmental compliance. The following projects were submitted for compliance:

1) Meacham Creek Floodplain Restoration and In-stream Enhancement Project RMs 6.0 to 7.1,
2) Meacham Creek Riparian Fence Enclosure Project RMs 2.0 to 8.0,
3) Birch Creek In-stream Habitat Enhancement and Peterson Dam Removal Project RMs 2.3 to 3.5, and
4) Lower Umatilla River Streambank Recovery and Habitat Restoration Project RMs 26.3 to 27.3.

The CTUIR DNR Cultural Resource staff completed the cultural resource project area surveys and reports in April-May 2010 and submitted to BPA for cultural resource compliance with the SHPO and THPO. Meacham Creek projects were both located on Reservation land and cleared by the THPO through the CTUIR DNR Cultural Resource Program. CTUIR UAFHP obtained cultural resource clearances and approvals by the SHPO and THPO for both the Meacham Creek in-stream and levee removal and riparian fencing projects and the Birch Creek bank stabilization, habitat input and passage projects prior to implementation.

UAFHP Environmental Compliance Documentation

ESA consultation with NMFS for FY 2010 project activities was covered under the Terms and Conditions of the HIP II BO. Project activities covered under the HIP II BO included:

- Develop RM&E Methods and Designs (I: 156): Incorporate developed strategic and scientifically accepted monitoring methods for application. Conduct necessary experiments (e.g., tracer release experiments, thermographs in ground and surface water, and floodplain piezometers) to assess the hydrologic dynamics and spatiotemporal patterns of ground- and surface-water in proposed restoration reaches.
- Collect/Generate/Validate Field and Lab Data (J: 157): Juvenile production surveys and salvages were completed in relationship to habitat projects. Fish densities, species composition and biometric data were collected and analyzed for pre- and post-project implementation comparisons. Fish were salvaged (moved) as needed to safe refuge during in-stream project work. Conducted aquatic habitat inventory baselines (e.g., tracer release experiments, thermographs in ground and surface water, and floodplain piezometers) necessary to assess the hydrologic dynamics and spatiotemporal patterns of ground- and surface-water in proposed restoration reaches as it relates to summer steelhead, spring Chinook salmon, bull trout and Pacific lamprey.
- Maintain Vegetation (K: 22 and T: 22): Irrigated vegetation and removed noxious weeds (hand, tractor mow and till) to maximize survival of riparian plantings on existing and new easement and project locations.
- Plant Vegetation (L: 47): Supplemented riparian areas, existing and new projects, with additional vegetation.
- Remove Vegetation (M: 53): Physical and/or chemical treatment of noxious weeds on 109 acres of riparian non-wetland habitat and 403 acres of upland non-wetland habitat.
- Install Fence (R: 40): Installed cattle exclusion fencing on the mainstem Meacham Creek.

- Increase In-stream Habitat Complexity and Stabilization (U: 29): The purpose of this work is to quicken recovery of unstable banks and provide in-stream habitat complexity. Full logs with root wads were used to stabilize the eroding stream bank in conjunction with bank re-sloping and vegetative plantings. Rock was used primarily as a ballast to anchor or stabilize large woody debris. No rock weirs or full expanding channel structures were used as part of this project. Two minor variances were requested and approved. One variance was related to the project length exceeding the 250 ft of total bank stabilization by 85 ft as authorized under the HIP II BO. The second variance was an extension of the in-water work window to November 15. The in-water work window for Birch Creek is July 1 – October 31 but more time was needed for the completion of the project given the late start on the project implementation.

An USACE (Portland District) and ODSL Joint Permit Removal-Fill Application Form was completed for the Birch Creek Bank Stabilization and In-stream Habitat Enhancement Project near RM 3 and submitted on August 15, 2010. The Peterson Dam removal was not agreed upon by the landowner and CTUIR and that component was removed from the permitting process. A letter was received on October 15, 2010 by the USACE verifying that the project was authorized under the terms and limitations of Nationwide Permits No. 13 (Bank Stabilization with Conditions. CTUIR also received an ODSL Removal-Fill and Umatilla County Planning land use compatibility and zoning and flood hazard development permits.

<u>Meacham Creek Floodplain Restoration and In-stream Enhancement Project RMs 6.0-7.1 Environmental Compliance Documentation</u>

The Meacham Creek Floodplain Restoration and In-stream Enhancement Project RMs 6.0-7.1 project planning and design began in December 2009. Funding for the Meacham Creek project is provided by the BPA, a federal agency under the Department of Energy (DOE). This project area occurs on both National Forest System land and CTUIR fee lands. Under Section 7 of the ESA all federal agencies must, through consultation with the USFWS and the NMFS, ensure that that actions which they authorize, fund, or conduct are not likely to jeopardize the continued existence of threatened or endangered species or adversely modify their habitats. Therefore, both CTUIR and the USFS had to demonstrate Section Seven compliance.

Habitat for endangered and threatened species listed under the ESA was identified in the Meacham project focus area: bull trout (and designated critical habitat; project area is within the Umatilla-Walla Walla recovery area) and steelhead (middle Columbia River Distinct Population Segment). Based on the 30% design drawings, the proposed Meacham Creek project activities were initially evaluated by CTUIR and USFS staff to be completed under their two existing programmatic BO's including:

- BPA's HIP II BO (NMFS 2008), and
- The BO for aquatic habitat restoration activities implemented by the USFS, U.S. Bureau of Land Management (BLM), and U.S. Bureau of Indian Affairs (BIA) in Oregon and Washington (ARBO; USFWS 2007).

Near completion of the 60% preliminary design it was determined by the CTUIR/USFS project technical team that the project components did not qualify for coverage under the two existing BO's, and a BA and biological evaluation (BE) would need developed for consultation. Project partners determined the USFS would be the lead Federal action agency for consultation. The Umatilla National Forest (UNF), CTUIR, NMFS and USFWS underwent pre-consultation coordination on the Meacham Creek Floodplain Restoration and

In-stream Enhancement Project, following the USFS, USFWS and NMFS streamlining agreement. Following early discussions between the UNF Level 1 Team (UNF, USFWS and NMFS representatives), the UNF, in coordination with the CTUIR, submitted a draft (60% project designs) BA, prepared by Tetra Tech EC Inc. environmental consultant, to the NMFS and USFWS Umatilla Level 1 Team representatives for early review and comment on April 22, 2010.

On May 11, 2010, the CTUIR provided the Umatilla Level 1 Team with a presentation of the project objectives and reviewed the draft BA for any areas of deficiency or concerns of either the NMFS or USFWS. An on-site visit to the project area occurred on May 17, 2010, led by CTUIR biologists with representatives of UNF, USFWS and NMFS for discussion and review of the project. Following incorporation of NMFS and USFWS comments, UNF requested formal consultation with NMFS and provided a BA on July 12, 2010.

On July 30, 2010, NMFS received the 90% project designs for the in-stream construction. A review of the geomorphic assessment and design package was completed by the USFWS geomorphologist, Janine Castro, on August 9, 2010. Several changes were made to the project designs and final 100% designs were resubmitted to NMFS and USFWS and formal consultation was initiated on October 7, 2010.

An ESA BO and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Conservation Recommendations were received by the NMFS on December 3, 2010. The BO by the USFWS was granted on December 14, 2010. Complete administrative records for these consultations are on file at the NMFS and USFWS La Grande Field offices in La Grande, Oregon.

An USACE (Portland District) and ODSL Joint Permit Removal-Fill Application Form was completed for the Meacham Creek Floodplain Restoration and In-stream Enhancement Project RMs 6.0-7.1 and submitted on December 7, 2010, and then following comments modified and resubmitted on January 20, 2011 by CTUIR. A letter was received on February 3, 2011 by the USACE verifying that the project was authorized under the terms and limitations of Nationwide Permits No. 27 (Aquatic Habitat Restoration, Establishment, and Enhancement Activities) and 33 (Temporary Construction, Access, and Dewatering) with Conditions. We had not received an ODSL Removal-Fill permit by the end of the FY 2010 contract period.

NEPA documentation was led by the UNF with assistance from CTUIR. A preliminary assessment was completed and public scoping letter signed by the UNF Walla Walla District Ranger and distributed to 115 interested parties and individuals for public comment on September 30, 2010. The preliminary assessment determined the proposal fell within a categories of actions listed in Part 36 of the Code of Federal Regulations section 220, that are excluded from documentation in an Environmental Assessment (EA) or Environmental Impact Statement (EIS) and there are no extraordinary circumstances that would preclude use of the category 36 CFR 220 (e) (6) "*Timber stand and/or wildlife habitat improvement activities that do not include the use of herbicides or do not require more than 1 mile of low standard road* construction" and (e) (7)- "*Modification or maintenance of stream or lake aquatic habitat improvement structures using native materials or normal practices.*" No public input was received relating to this action.

Work Element C: 185. Produce Pisces Status Report
Work Element Title: Periodic Status Reports for BPA

Milestone Deliverable: Complete Periodic Pisces Status Reports

CTUIR reported to BPA periodically during the contract period on the status of each statement of work element, and milestones and deliverables using the computer program Pisces:

- February-March (2/1/2010-3/31/2010)
- April-June 2010 (4/1/2010 - 6/30/2010)
- July-September 2010 (7/1/2010 - 9/30/2010)
- October-December 2010 (10/1/2010 - 12/31/2010)
- Final January 2011 (1/1/2011 - 1/31/2011)

The BPA COTR reviewed the Pisces status reports, recommended changes as necessary and accepted them electronically upon approval. Additionally, upon completion of each deliverable milestone, we provided metrics and final project location (latitude and longitude) when required. These Pisces status reports provide a tool for the BPA COTR and administrative staff to track project progress in meeting contract requirements.

Work Element D: 132. Produce Annual Progress Report
Work Element Title: Produce Annual Progress Report for the FY 2009 Period (February 2009) to (January 2010)
Milestone Deliverable: Attach 2009 Annual Progress Report in Pisces

A. Review progress report format requirements
B. Internal agency/tribal review of draft
C. Revisions in response to review of draft
D. Submit progress report for external review
E. Submit draft for technical/co-manager review
F. Finalize report

CTUIR UAFHP staff did not submit the FY 2009 BPA Annual Report by the end of the FY 2009 contract period (February 2009 to January 2010). The FY 2009 BPA Annual Report deliverable was added as a work element during the FY 2011 contract period from February 2011 to January 2012. This work element was combined with work accomplished during the FY 2010 contract period as one report. By submission of this FY 2009-2010 Annual Report, CTUIR has fulfilled its contractual obligations to BPA by reporting the FY 2009 and FY 2010 project details for the period February 2010 to January 2011.

Work Element E: 114. Identify and Select Projects
Work Element Title: CTUIR Umatilla Subbasin Restoration Coordination
Milestone Deliverable: List of Final Projects

A. Coordinate regularly with project partners and landowners
B. List projects

CTUIR UAFHP staff annually coordinated and planned projects with State, Federal, and local partners, and private landowners to develop habitat restoration and enhancement projects consistent with local planning documents. CTUIR project development is guided and prioritized by project activities that are supported by the CTUIR DNR ecological and First Foods mission statements to enhance or protect ecological and physical processes thus sustaining biota production (Jones et al., 2008). The CTUIR is guided in its habitat restoration activities by multiple planning documents:

1) Final Umatilla Willow Subbasin Plan (Umatilla/Willow Subbasin Planning Team 2005),
2) Middle Columbia River Steelhead Recovery Plan (NMFS 2009),
3) Bull Trout (Salvelinus confluentus) Draft Recovery Plan (USFWS 2002), and
4) Five-Year Action Plan for the Development and Maintenance of Habitat Improvement Projects in the Umatilla Subbasin: 2006-2010 for BPA-Funded Fish Habitat Improvement Programs sponsored by: ODFW and CTUIR (CTUIR and ODFW 2006).

Projects were identified, prioritized and developed with project partners (ODFW, UBWC, and SWCD) who implement restoration projects within the Umatilla River Basin. Projects that were ranked by priority, CTUIR identified funding sources and projects were prepared for planning, engineering design, permitting and implementation and included in the FY 2011 BPA SOW and budget.

Work Element F: 122. Provide Technical Review
Work Element Title: Review and Provide Technical Input on Issues and Topics that Affect the Areas Natural Resources
Milestone Deliverable: Provide Technical Input and Summaries to Enhance or Protect Natural Resources in the Subbasin

A. Conduct review and provide input as necessary on natural resource preservation issues.
B. Review and provide technical input on issues that may adversely affect natural resources.

CTUIR UAFHP staff reviewed and provided technical input as applicable on plans and proposals by entities within the Umatilla River Basin that may adversely impact floodplain or riverine processes and biota productivity, public project planning relevant to floodplain, river and wetland restoration or impacts, development and review of grant funding proposals, and proposed landowner projects. Project staff provided input to multiple CTUIR departments on annual activities relevant to work within the floodplain, rivers, and wetlands, USACE/ODSL removal-fill permit applications, CTUIR SZA Permit applications on work proposed within the floodplain on Reservation land, grants in coordination with the UBWC and UCSWCD.

Work Element G: 191. Watershed Coordination
Work Element Title: Umatilla River Watershed Coordination Duties
Milestone Deliverable: Coordinate Watershed Association Activities

A. Coordinate with NRCS and local conservation districts
B. Coordinate with UBWC
C. Coordinate with co-manager ODFW and other Federal agencies
D. Network with professionals in the field of habitat restoration

CTUIR UAFHP staff participated and coordinated with multiple agencies and stakeholders in the Umatilla River Basin including ODFW, USFS, NRCS, conservation districts, USFWS, UBWC and local stakeholders to enhance natural resources, identify problems and solutions, coordinate efforts to prevent duplication, enhance communication and cooperation and identify funding and cost share opportunities within the Umatilla River Subbasin. Staff further coordinated with other agencies in planning and implementing partner habitat restoration and enhancement projects, ESA planning processes, and project prioritization and selection processes. We prepared agreements, if necessary, to assign duties and responsibilities to the appropriate entities. We also developed documents, press releases, web sites, and other communications to impart information to participating stakeholders and the public.

In 2010, CTUIR and ODFW habitat project staff partnered to organize and establish the Umatilla Basin Restoration Team (Restoration Team). The first official meeting of the Restoration Team was April 2, 2010. The Restoration Team is an informal group formed of agency or entity representatives that do restoration work within the Umatilla River Subbasin floodplain and riverine system. Initial members included CTUIR, ODFW, conservation districts, USFWS, USFS, The Freshwater Trust, NRCS, UBWC, and the Columbia-Blue Mountain Resource Conservation & Development Council.

The purpose of the Restoration Team was established to build a coordinated and strategic approach to the restoration of habitat in the Umatilla Basin. Identified benefits of the Restoration Team include:

1) Have similar objectives in our mission statements, and where our mission statement objectives are unique we have an opportunity to utilize that uniqueness as a team,
2) Opportunity to share long range objectives and forecasted work activities,
3) Coordination meetings and correspondence can be used as a venue for identifying projects, and working together towards accomplishing restoration work in the Umatilla Basin,
4) Facilitate grant writing, and
5) Local economic project benefit of matching dollars to facilitate projects through money contribution, manpower, equipment or expertise.

The Restoration Team met monthly for the first couple months in development of the team and now has settled on quarterly meetings. The Restoration Team agreed the primary focus area was the Umatilla River/Willow Creek Basin. Initially, CTUIR UAFHP staff organized the first couple meetings, created agendas and provided meeting notes. The UBWC Coordinator is now responsible for organizing meetings and providing meeting agendas and minutes. The Restoration Team will be the future vessel for fish habitat restoration coordination the Umatilla River Basin.

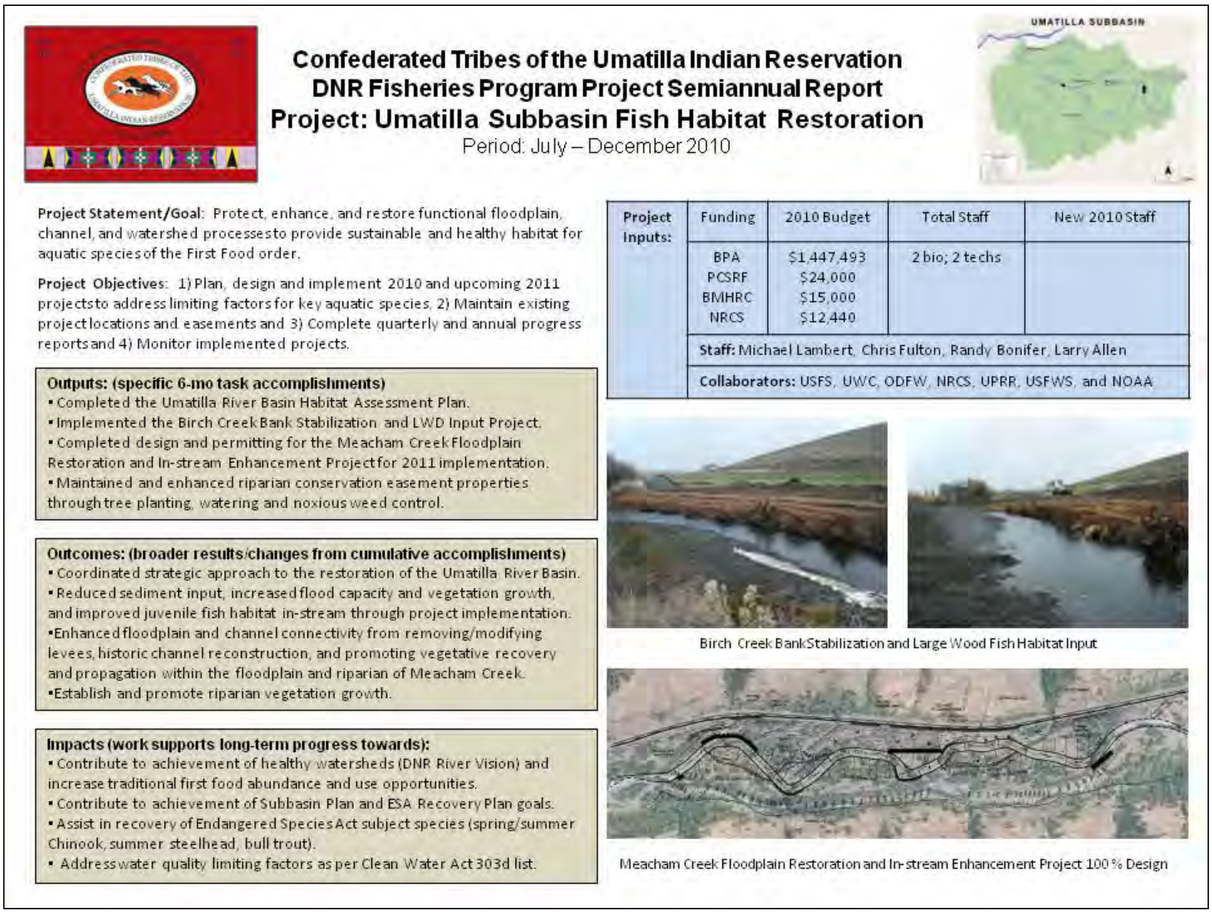
In 2010, an oral presentation was developed for The Meacham Creek Floodplain Restoration and In-stream Enhancement Project RMs 6.0-7.1 and presented to the UBWC, CTUIR Committees and Commissions, Restoration Team, and ESA consultation meetings during development and planning of project activities.

Work Element H: 99. Outreach and Education
Work Element Title: Public Outreach and Education
Milestone Deliverable: Complete Outreach and Education Activities

CTUIR UAFHP staff educated the public on natural resource protection and restoration principles, and communicated on project activities throughout the year. This work included giving project tours and presentations (field, written, and verbal) and participating in local and regional workshops, symposia and/or conferences (training, project presentation, and memberships), newspaper articles and public education (local school districts or college programs).

CTUIR UAFHP staff completed CTUIR semi-annual reports summarizing project objectives and outputs, expected outcomes, and resulting impacts of project restoration activities (Figure

13). These reports are used by the CTUIR DNR to inform CTUIR staff and government officials, other agencies and entities, and the public of project activities.



Confederated Tribes of the Umatilla Indian Reservation
DNR Fisheries Program Project Semiannual Report
Project: Umatilla Subbasin Fish Habitat Restoration
Period: July – December 2010

UMATILLA SUBBASIN

Project Statement/Goal: Protect, enhance, and restore functional floodplain, channel, and watershed processes to provide sustainable and healthy habitat for aquatic species of the First Food order.

Project Objectives: 1) Plan, design and implement 2010 and upcoming 2011 projects to address limiting factors for key aquatic species, 2) Maintain existing project locations and easements and 3) Complete quarterly and annual progress reports and 4) Monitor implemented projects.

Project Inputs:	Funding	2010 Budget	Total Staff	New 2010 Staff
	BPA PCSRF BMHRC NRCS	$1,447,493 $24,000 $15,000 $12,440	2 bio; 2 techs	
	Staff: Michael Lambert, Chris Fulton, Randy Bonifer, Larry Allen			
	Collaborators: USFS, UWC, ODFW, NRCS, UPRR, USFWS, and NOAA			

Outputs: (specific 6-mo task accomplishments)
- Completed the Umatilla River Basin Habitat Assessment Plan.
- Implemented the Birch Creek Bank Stabilization and LWD Input Project.
- Completed design and permitting for the Meacham Creek Floodplain Restoration and In-stream Enhancement Project for 2011 implementation.
- Maintained and enhanced riparian conservation easement properties through tree planting, watering and noxious weed control.

Outcomes: (broader results/changes from cumulative accomplishments)
- Coordinated strategic approach to the restoration of the Umatilla River Basin.
- Reduced sediment input, increased flood capacity and vegetation growth, and improved juvenile fish habitat in-stream through project implementation.
- Enhanced floodplain and channel connectivity from removing/modifying levees, historic channel reconstruction, and promoting vegetative recovery and propagation within the floodplain and riparian of Meacham Creek.
- Establish and promote riparian vegetation growth.

Impacts (work supports long-term progress towards):
- Contribute to achievement of healthy watersheds (DNR River Vision) and increase traditional first food abundance and use opportunities.
- Contribute to achievement of Subbasin Plan and ESA Recovery Plan goals.
- Assist in recovery of Endangered Species Act subject species (spring/summer Chinook, summer steelhead, bull trout).
- Address water quality limiting factors as per Clean Water Act 303d list.

Birch Creek Bank Stabilization and Large Wood Fish Habitat Input

Meacham Creek Floodplain Restoration and In-stream Enhancement Project 100 % Design

Figure 13. CTUIR semi-annual report for the Umatilla Subbasin Fish Habitat Restoration Project, July – December, 2010.

Project staff provided information on project activities to local newspapers in FY 2010. The Birch Creek Bank Stabilization and In-stream Habitat Enhancement Project RM 3.0 was reported in the CTUIR Confederated Umatilla Journal (CUJ) monthly newspaper in January 2011 (Figure 14).

Another educational activity our staff participated in is the Seeds for the Future Building Workshop. Each November, the natural resource students from the University of Idaho (U of I) and CTUIR DNR staff participate in a two day workshop in Pendleton, Oregon. This is an annual service learning partnership to foster a significant means of integrating student learning from the Tribes perspective and sharing about our community across state, cultural, and landscape boundaries. U of I students assisted in CTUIR UAFHP staff in planting native vegetation at the Meacham Creek Levee Removal Project for an entire day on October 20th, 2010. About 40 college students and several professors participate in the workshop.

Project staff also developed and fostered relationships with participating experts in related fields by attending training, professional workshops and working groups, and gained professional advancement and improved project success through informative, instructional interactions. CTUIR UAFHP and DNR Fisheries Habitat Program staff attended multiple professional conferences and workshops, and participated in oral and poster presentations of project activities including the 2010 OWEB Biennial Conference.

Partnerships on Birch Creek improve trek for steelhead

By the CUJ

REITH – A habitat improvement project completed in early November on a short stretch of Birch Creek about 2.8 miles from its confluence with the Umatilla River is testimony to successful partnerships between governments and landowners.

The project, bringing together Tribal, county, state and federal governments, and a private landowner, will restore unstable banks, increase riparian vegetation, and create improved habitat for salmon and steelhead, including Middle Columbia River Steelhead, which are listed as threatened under the federal Endangered Species Act.

'There is so much entailed from start to finish on an in-stream project like this.'
Chris Fulton, project leader for the CTUIR

Treatments on about 335 yards – on each side of Birch Creek - included the placement of nearly 60 large conifers with their intact rootwads to stabilize the eroding stream bank, more than 100 cubic yards of large boulders as ballast to anchor the large woody debris, nearly 4,000 square yards of biodegradable coconut fabric, and thousands of willow plantings, said Chris Fulton, assistant fisheries habitat project leader for the Confederated Tribes of the Umatilla Indian Reservation, who took the lead on this project on land owned by Homer Peterson.

Although the parties were in agreement that the project was needed, implementing the project within a compressed timeframe posed some logistical challenges.

"There is so much entailed from start to finish on an in-stream project like this," Fulton said.

The process started in late May of this year with the hiring of Anderson-Perry and Associates (La Grande) for a large-scale topography survey of the streambed and floodplain. The same engineering firm developed the design for the project, which triggered application for necessary permits – from the U.S. Army Corps of Engineers, NOAA Fisheries, Oregon Depart-

See Birch Creek, Page 33

A better Birch Creek

A backhoe, above, does work along the bank of Birch Creek. About 335 yards on either side of the creek was improved during the project. At left, logs so big they wouldn't fit in the 30-foot truck bed, thunder to the edge of Birch Creek where the Confederated Tribes, in conjunction with several agencies and the landowner, recently completed a habitat improvement project that should make it easier for migrating salmon and steelhead to reach their destinations.

Continued from Page 30

ment of State Lands and the Umatilla County Planning Department. While that process was going on, the source material – huge logs – was being located. Boulders were sourced from Rod Anderson Construction, Inc. from their rock quarry near Rieth. A partnership with both the Oregon Parks and Recreation Department and the Oregon Department of Transportation yielded 59 dead and dying conifer trees near Emigrant Springs State Park. Next came contracting to excavate and haul the trees to the habitat improvement site, and to hire a second excavating company to implement the project instream.

The trees were near roads, so an excavator pushed over the trees, which were placed whole on a specialized dump truck. All seemed to be going well until the first day of hauling when it snowed on Cabbage Hill. The trucks had to chain up on the mountain and chain down on the flats.

"It was down to the wire. The contractor we hired to excavate and haul the logs couldn't start work until the first day we started work instream – and that day it snowed on Cabbage Hill. It was critical that we received the logs and boulders without delay because every day lost increased the risk that streamflows would exceed the pumping capacity of our bypass, and that adult salmonids would arrive at the downstream end of our project reach requiring passage upstream. We were on the edge of our seat because we didn't have the permits in hand until two weeks before we began work on October 25 - and the typical in-water window ends October 31."

Fulton applied for a 15-day extension and received it - with the caveat from ODFW and NOAA that if any coho salmon showed up in the bottom end of the project where the streamflow had been diverted then the work had to stop for the winter.

The project was completed on Nov. 3 – three days into the extension period but before any coho or steelhead arrived.

Figure 14. CTUIR CUJ newspaper article on the Birch Creek Bank Stabilization and In-stream Habitat Enhancement Project, RM 3.0, January, 2011.

<u>2010 OWEB Biennial Conference:</u>
Workshop Panel: Restoring and Monitoring Meacham Creek – Panel Moderator James Webster (CTUIR Habitat Program Supervisor), CTUIR, Pendleton, OR (co-presenters: Dave Crabtree (USFS Fisheries Biologist), Scott O'Daniel (CTUIR Research Geographer), Michael Lambert (Fisheries Habitat Biologist, Meacham Project Manager)

Learning Objectives:
After attending this presentation, participants will

1. Gain an increased understanding of the portfolio of efforts and range of partners working to restore Meacham Creek.
2. Learn about a unique approach to developing a vision and strategy for restoration planning and design.
3. Be able to take elements from Meacham Creek's monitoring plan and techniques for application in their own watershed.

Presentation Description:
Floodplain and channel processes in Meacham Creek, a tributary to the Umatilla River, have been negatively impacted by past and current land management actions. As a result, the channel is disconnected from the floodplain and shallow groundwater table, streambanks are exposed and unstable, roughness features to dissipate flood flow energy are lacking, in-stream aquatic habitat has been removed and simplified, and water quality in terms of stream temperature and sediment routing is degraded. Guided by the First Foods Concept and the Umatilla River Vision a multiple phase restoration approach is being implemented to restore conditions for key salmonids and other aquatic species. The mix of land ownership and vested interests in the watershed requires significant communication and cooperation for project planning and implementation. Presentations will include an explanation of the Umatilla River Vision and its application to the Meacham Creek project, a description of the cooperative partnerships that have led to a successful planning effort, details of project actions and early results, and a description of detailed monitoring for hydrologic changes.

Additional posters and oral presentations were presented at local, regional and national professional workshops as part of the development of the Extensive Physical Assessment for Pacific Salmon (See Appendix B).

Work Element I: 156. Develop RM&E Methods and Designs
Work Element Title: Incorporate Developed Strategic and Scientifically Accepted Monitoring Methods for Application
Milestone Deliverable: Produce Methods for Monitoring Project Effectiveness

A. Assist in refining aquatic habitat inventory assessment methodology for restoration projects.
B. Implement biological monitoring protocol to show fish community response to habitat components.

The CTUIR has and continues to invest substantial resources in restoring the sustainability of five Columbia subbasins that constitute the ceded lands, including the Umatilla subbasin. The Umatilla River Vision (Jones et al. 2008; River Vision) describes well the rationale for these investments in relationship to the importance of first foods to the future of the Tribal people. In 2009, CTUIR began development of a conceptual bio-monitoring design that evaluates the biotic outcomes from restoration actions throughout the five subbasins to ensure that investments result in actual improvements to the biological productivity.

Detection of measurable changes in biotic conditions, specifically changes to survival and productivity of various salmon life stages, is presumed to be predicated on habitat improvements that result from directed restoration actions taken by CTUIR. Such changes in physical habitat characteristics will be tracked by CTUIR staff, and the resulting data will substantially contribute to elements of the study design for this biotic monitoring program.

The overall goal of the bio-monitoring design is to understand how the restored ecological processes that maintain essential functions and increased habitat complexity individually and accumulatively affect spring Chinook salmon, summer steelhead and bull trout in the five subbasins. As part of the bio-monitoring design, CTUIR UAFHP staff identified project reach areas, mainstem and tributary, as well as a non-treatment reference reaches for meeting design criteria and analysis. Coinciding with the bio-monitoring design, project staff developed monitoring strategies in relationship to habitat restoration actions. In 2010, project staff modified and incorporated aquatic habitat inventory assessment methodology for baseline and post-project monitoring into project activities. Implementing monitoring strategies aimed at offering repeatable actions to quantify change and shape adaptive management decisions. Monitoring protocols and methods are being developed and defined, and will be uploaded to the Pacific Northwest Aquatic Monitoring Partnership website (MonitoringMethods.org) in future contracts.

Work Element J: 157. Collect/Generate/Validate Field and Lab Data
Work Element Title: Monitoring and Evaluation CTUIR Umatilla Anadromous Fish Habitat Project
Milestone Deliverable: Complete Data Collection and Summarized Findings

A. Environmental compliance requirements complete.
B. Analyze suspended solids and turbidity data from project area streams.
C. Analyze fish population data in relation to habitat enhancement project areas.
D. Analyze macroinvertebrate data from project area streams.
E. Conduct photo point documentation of project conditions related to specified project areas.
F. Conduct photo documentation at 36 whole tree configuration sites, in Meacham Creek, various flows.
G. Do aquatic habitat inventory baseline at project areas prior to implementation.

Data analysis and findings from biological and physical monitoring are incorporated into project planning, designs, permitting, environmental compliance, and pre- and post-project assessment of project response. Results of the findings are available in various outsourced reports and can be requested through CTUIR's UAFHP. A summary of selected monitoring results can be found in the monitoring section later in the document.

Work Element K: 22. Maintain Vegetation
Work Element Title: Maintain Trees and Shrubs, and Grass Seeding in Umatilla River Basin Habitat Enhancement Areas
Milestone Deliverable: Maximize Survival of Planted Trees and Shrubs in Enhancement Project Areas

A. Environmental compliance requirements complete.
B. Water vegetation and reduce weed competition to improve survival at CTUIR pre-existing project areas.

C. Water vegetation; reduce weeds to maximize survival of riparian plantings at new project sites.

Project activities conducted in FY 2010 included the monitoring and maintenance of 27 conservation easements on 23 individual landowner properties. CTUIR personnel routinely maintain and replant vegetation, water and weed plantings, and maintain structural integrity of riparian enclosure and livestock fencing at project sites. In FY 2010 continued much emphasis maintaining vegetation within the Peterson easement located on Birch Creek, RM 2.6-3.1. Mature native plants were wrapped with hog wire for deer protection. From April 6-8, 2010, project staff repaired the fence enclosure and panels at the Spratling conservation agreement on Wildhorse Creek built for excluding cows from the creek. Finally, staff repaired a fence enclosure water gap crossing at the Haynie property on McKay Creek from September 21-22, 2010.

Work Element L: 47. Plant Vegetation
Work Element Title: Supplement Riparian Areas of Existing and New Projects with Additional Vegetation
Milestone Deliverable: Complete Scheduled Tree and Shrub Plantings in Project Areas

A. Environmental compliance requirements complete.
B. Agreement with the Native Plant Nursery for growing plants and developing plant protocol.
C. Establish planting locations in existing project areas for increased recovery.
D. Establish improved vegetative conditions in new project areas.

CTUIR staff planted vegetation and distributed grass seed in areas where we have implemented existing and new habitat enhancement projects or have identified a need in maintained riparian conservation easement areas. The Birch Creek Bank Stabilization and In-stream Habitat Enhancement Project RM 3.0 was implemented in 2010, and included planting native plants and seeding disturbed areas by hand and mechanical means. In 2010, CTUIR conducted planting projects at 3 locations, 2 existing and 1 new project areas, including planting 7,230 plants and distributing 200 lbs of native grass seed (Table 7).

Planting tasks include site planning and development of planting strategies, collection and preparation of materials (pruning and conditioning of live whip material), pre-order coordination with the CTUIR Tribal Native Plant Nursery, and installation. Planting techniques are customized for conditions within each project area. Planting location, species, age, form (cuttings, saplings, bare-roots, potted, plugs), and soil/substrate conditions were considered and addressed during the implementation planning phase. The CTUIR UAFHP staff work closely with the Tribal Native Plant Nursery to collect local seed and plant stock to provide native plants for particular project areas by elevation and planting zones.

Work Element M: 53. Remove Vegetation
Work Element Title: Control of Noxious Weeds in Project Areas by Physical and Chemical Means
Milestone Deliverable: Treat 512 Acres (109 Riparian and 403 Upland) in Enhancement Areas

A. Environmental compliance requirements complete.
B. Physical removal of non -preferred species of vegetative growth from project areas.
C. Weed control in project areas by chemical means.

Noxious and/or undesirable weeds are controlled through hand and mechanical removal, and herbicide and biological control applications in project areas. Weed control is essential in establishing native grass and plant species. CTUIR subcontracts a professional, licensed applicator to spray/control noxious weeds on sites where chemical application is necessary. CTUIR complies with BPA standards and supplies a report to BPA detailing the types and quantities of herbicides applied to specified locations. Biological controls are used in advantageous areas.

The frequency of watering, weeding and maintenance methods for each easement or project site varies. Strategies to address weeds are included in agreements that are either completed by the landowner, CTUIR, subcontractor, and/or through the County Weed Control Board. CTUIR staff provides assistance to landowners by coordinating and managing herbicide application vendors, providing funding, and developing treatment strategies. Manual, biological and chemical treatment options are utilized by CTUIR and may be employed when consistent with existing standards.

Noxious and/or undesirable weeds are controlled in project enhancement areas by a professional, licensed applicator. The contractor identifies problem weeds, determines the appropriate herbicide and selects the most effective application methods and rates in accordance with the NOAA BO under BPA's Habitat Improvement Program. The contractor utilizes handgun spraying, backpack spraying and wiper applications to treat perennial, annual and biennial weed species. All herbicide applications are consistent with Oregon Revised Statue 569.350 and FIFRA Regulations.

Noxious and/or undesirable weeds are present on several project areas. As with our work on conservation easements, CTUIR subcontracts professional, licensed applicators to spray/control noxious weeds on several project sites. In FY 2010, CTUIR removed noxious and/or undesirable weeds through mechanical, biological, or chemical means. CTUIR currently maintains 27 conservation easements on 23 individual landowner properties including 15 locations where CTUIR is obligated to control noxious weeds on 109 riparian non-wetland habitat and 403 upland non-wetland habitat acres in Wildhorse Creek, Umatilla River, McKay Creek, Spring Hollow Creek, Birch Creek and Meacham Creek. CTUIR complied with BPA standards and supplied a report to BPA detailing the types and quantities of herbicides applied to specified locations (Table 8). In 2010, CTUIR chemically treated 83.75 riparian non-wetland habitat and 91 upland non-wetland habitat acres (Table 8). These are ongoing work sites where environmental compliance has been cleared in prior contract periods.

In addition to the CTUIR UAFHP, the CTUIR DNR Range Department used goat grazing for biological control treatment of yellow starthistle along the canyon walls of Meacham Creek from RM 1.0 to 4.0.

Table 7. Planting materials and grass seed by species, quantity, and size, planted and established at Umatilla River Basin existing and new project sites, 2010.

					Quantity	
Water body	River mile	Date planted	Project site location	Species (Common Name)	Trees/Shrubs	Seed (lbs)
Birch Creek	2.6-3.1	3/22/10	Peterson easement	Grey rabbitbrush	16 1 gal pots	
Birch Creek	2.6-3.1	3/22/10	Peterson easement	Black hawthorn	50 1 gal pots	
Birch Creek	2.6-3.1	3/22/10	Peterson easement	Cascara	50 1 gal pots	
Birch Creek	2.6-3.1	3/23/10	Peterson easement	Mallow ninebark	50 1 gal pots	
Birch Creek	2.6-3.1	3/23/10	Peterson easement	Nootka rose	4 1 gal pots	
Birch Creek	2.6-3.1	3/23/10	Peterson easement	Douglas spiarea	15 1 gal pots	
Birch Creek	2.6-3.1	3/23/10	Peterson easement	Snowberry	15 1 gal pots	
Birch Creek	2.6-3.1	4/26/10	Peterson easement	Pacific willows	30 cuttings	
Meacham Creek	5.0-6.0	10/20/10	Meacham Levee Removal Project - along removed dikes	Douglas fir, ponderosa pine	1000 10 cu in plugs	
Meacham Creek	5.0-6.0	10/20/10	Meacham Levee Removal Project - along removed dikes	Ponderosa pine	1000 10 cu in plugs	
Birch Creek	2.8-2.9	10/28/09	Birch Creek Bank Stabiliztion and In-stream Habitat Enhancement Project	Mill Creek bluebunch wheatgrass, sugarloaf blue wildrye, Idaho fescue, California brome, basin wildrye		200
Birch Creek	2.8-2.9	10/28/09	Birch Creek Bank Stabiliztion and In-stream Habitat Enhancement Project	Willow species	5000 cuttings	

Work Element N: 186. Operate and Maintain Habitat/Passage/Structure
Work Element Title: Inspect and Maintain Function of In-stream Improvement Structures
Milestone Deliverable: Maintain Proper Operation of In-stream Habitat Structures

A. Environmental compliance requirements complete.
B. The inspection, replacement and/or maintenance of passage and habitat structures.
C. Hire contractor to perform work.
Deliverable: D. Maintain proper operation of in-stream habitat structures.

See Work Element O: 186 above in the section Methods, Results, and Discussion of 2009 Statement of Work Deliverables for a report on 2010 project work activities. The 2010 project activities involved routine maintenance.

Work Element O: 186. Operate and Maintain Habitat/Passage/Structure
Work Element Title: Maintenance of Habitat Features Associated with Project Conservation Easements
Milestone Deliverable: Maintenance of Land or Structures Associated with Conservation Easements

A. Environmental compliance requirements complete.
B. Adhere to details of existing easements and/or initiate additional agreements as feasible.
Deliverable: C. Maintenance of land or structures associated with conservation easements.

CTUIR currently manages and maintains property in compliance with 27 existing conservation easements within the Umatilla Basin (Table 4). The purpose of these conservation easements is to protect, enhance, and restore functional floodplain, channel, and watershed processes to provide sustainable and healthy habitat for aquatic species in the Umatilla River subbasin. CTUIR routinely conducts custodial maintenance on individual projects to ensure that project structures and fencing are functioning and habitat recovery is progressing towards meeting projects goals and objectives. Activities include, but are not limited to, installing and repairing riparian cattle exclusion fences, maintaining or installing water gaps, riparian and floodplain plantings and maintenance, noxious weed control, maintenance of fish habitat improvement structures, and landowner coordination and education.

In 2009, CTUIR located and digitized signed agreements and began development of a web based tool to assist in the inventory and monitoring of conservation easements managed by the UAFHP within the Umatilla subbasin in northeast Oregon. The conservation easement locator was completed during 2010 project activities (Figure 15).

<u>Conservation Easement Locator</u>
This web map locator is designed as a tool to assist in the inventory and monitoring of conservation easements managed by the UAFHP within the Umatilla subbasin in northeast Oregon. The purpose of these conservation easements is to protect, enhance, and restore functional floodplain, channel, and watershed processes to provide sustainable and healthy habitat for aquatic species in the Umatilla River subbasin.

This web map can be used to view information on parcels containing conservation easements by selecting the current property owner name and clicking on an icon in the map (Figure 15). Please note that the property owner name in the legal description may not be the same as the

Table 8. BPA form annually submitted by CTUIR listing actual herbicide application, both the active ingredient and adjuvant, by location within the Umatilla River Basin, 2010.

LOCATION		6th HYDROLOIC UNIT CODE	ACTIVE INGREDIENT	ADJUVANT USED	RIPARIAN			UPLAND		
Township Range & Section (can be found in Pisces)	OR Latitude and Longitude				Estimate Acres Treated	Estimate of Total Volume of Herbicide Only (Gallons)	Application Method	Estimate Acres Treated	Estimate of Total Volume of Herbicide Only (Gallons)	Application Method
Umatilla R., Becker (Wolfe)	45° 39' 13.05" 118° 57' 28.66"	170701030703	Chorsulfuron	Syl-Tac				3	84 grams	Mechanized
Umatilla R., Becker (Wolfe)	45° 39' 13.05" 118° 57' 28.66"	170701030703	Metsulfuron	Syl-Tac				3	42 grams	Mechanized
Umatilla R., Becker (Wolfe)	45° 39' 13.05" 118° 57' 28.66"	170701030703	Picloram	R-11				12	3.0 gal	Mechanized
Umatilla R., Becker (Wolfe)	45° 39' 13.05" 118° 57' 28.66"	170701030703	Clopyralid	R-11	6	0.56 gal	hand wand / spot spraying			
Umatilla R., Becker (Wolfe)	45° 39' 13.05" 118° 57' 28.66"	170701030703	Aminopyralid	R-11	7	0.270 gal	hand wand / spot spraying			
Umatilla R., Becker (Wolfe)	45° 39' 13.05" 118° 57' 28.66"	170701030703	Metsulfuron	R-11	7	40 grams	hand wand / spot spraying			
Umatilla R., Becker (Wolfe)	45° 39' 13.05" 118° 57' 28.66"	170701030703	Dicamba	R-11	2	0.25 gal	hand wand / spot spraying			
Umatilla R., Becker (Wolfe)	45° 39' 13.05" 118° 57' 28.66"	170701030703	2, 4D (amines)	R-11	2	0.25 gal	hand wand / spot spraying			
Birch Cr., Peterson	45° 37' 54." 118° 51' 28"	170701030609	Aminopyralid	R-11				7	0.38 gal	Mechanized
Birch Cr., Peterson	45° 37' 54." 118° 51' 28"	170701030609	2, 4D (amines)	R-11				7	0.875 gal	Mechanized
Birch Cr., Peterson	45° 37' 54." 118° 51' 28"	170701030609	Aminopyralid	R-11	10	.06 gal	hand wand / spot spraying			
Birch Cr., Peterson	45° 37' 54." 118° 51' 28"	170701030609	Metsulfuron	R-11	10	16 grams	hand wand / spot spraying			
Birch Cr., Whitney	45° 37' 54." 118° 51' 28"	170701030609	Aminopyralid	R-11				15	0.82 gal	Mechanized
Birch Cr., Whitney	45° 37' 54." 118° 51' 28"	170701030609	Aminopyralid	R-11	5	0.156 gal	hand wand / spot spraying			
Birch Cr., Whitney	45° 37' 54." 118° 51' 28"	170701030609	Chorsulfuron	R-11	5	40 grams	hand wand / spot spraying			
Spring Hollow Cr., Pambrum	45° 46' 4.96" 118° 32' 55.89"	170701030402	Aminopyralid	R-11	5	.05 gal	hand wand / spot spraying			
Spring Hollow Cr., Pambrum	45° 46' 4.96" 118° 32' 55.89"	170701030402	Metsulfuron	R-11	5	12 grams	hand wand / spot spraying			

Table 8. Continued.

LOCATION		6th HYDROLOIC UNIT CODE	ACTIVE INGREDIENT	ADJUVANT USED	RIPARIAN			UPLAND		
Township Range & Section (can be found in Pisces)	OR Latitude and Longitude				Estimate Acres Treated	Estimate of Total Volume of Herbicide Only (Gallons)	Application Method	Estimate Acres Treated	Estimate of Total Volume of Herbicide Only (Gallons)	Application Method
Spring Hollow Cr., Pambrum	45° 46' 4.96" 118° 32' 55.89"	170701030402	Aminopyralid	R-11				4	0.22 gal	Mechanized
Spring Hollow Cr., Pambrum	45° 46' 4.96" 118° 32' 55.89"	170701030402	Metsulfuron	R-11				4	28 grams	Mechanized
Spring Hollow Cr., Pambrum	45° 46' 4.96" 118° 32' 55.89"	170701030402	2, 4D (amines)	R-11				4	0.50 gal	Mechanized
McKay Cr., Cripes	45° 30' 30.79" 118° 42' 34.29	170701030703	Triclopyr (TEA)	R-11	2	.050 gal	hand wand / spot spraying	4	1.0 gal	Mechanized
McKay Cr., Cripes	45° 30' 30.79" 118° 42' 34.29	170701030703	Metsulfuron	R-11	2	56 grams	hand wand / spot spraying	4	112 grams	Mechanized
McKay Cr., Hainey	45° 30' 31" 118° 41' 56"	170701030703	Chorsulfuron	R-11	5	6 grams	hand wand / spot spraying			
McKay Cr., Hainey	45° 30' 31" 118° 41' 56"	170701030703	Aminopyralid	R-11	5	0.06 gal	hand wand / spot spraying			
Wildhorse Cr., Adams	45° 45' 12.79" 118° 34' 33.13"	170701030404	Aminopyralid	R-11	6	.05 gal	hand wand / spot spraying	18	0.98 gal	Mechanized
Wildhorse Cr., Adams	45° 45' 12.79" 118° 34' 33.13"	170701030404	Chorsulfuron	R-11	0.25	7 grams	hand wand / spot spraying			
Wildhorse Cr., Adams	45° 45' 12.79" 118° 34' 33.13"	170701030404	Metsulfuron	R-11	6	24 grams	hand wand / spot spraying	18	155 grams	Mechanized
Wildhorse Cr., Adams	45° 45' 12.79" 118° 34' 33.13"	170701030404	2, 4D (amines)	R-11	6	0.28 gal	hand wand / spot spraying	18	2.25 gal	Mechanized
Wildhorse Cr., Adams	45° 45' 12.79" 118° 34' 33.13"	170701030404	Dicamba	R-11	1	0.03 gal	hand wand / spot spraying			
Wildhorse Cr., Adams	45° 45' 12.79" 118° 34' 33.13"	170701030404	Triclopyr (TEA)	R-11	1	0.03 gal	hand wand / spot spraying			
Wildhorse Cr., Schmidtgall	45° 44' 32.06 118° 35' 55.72	170701030404	Aminopyralid	R-11	12	.0625 gal	hand wand / spot spraying			
Wildhorse Cr., Schmidtgall	45° 44' 32.06 118° 35' 55.72	170701030404	Metsulfuron	R-11	12	112 grams	hand wand / spot spraying			
Wildhorse Cr., Schmidtgall	45° 44' 32.06 118° 35' 55.72	170701030404	2, 4D (amines)	R-11	12	0.25 gal	hand wand / spot spraying			
Wildhorse Cr., Reynold's	45° 44' 57.92" 118° 35' 0.61"	170701030404	Aminopyralid	R-11	10	0.156 gal	hand wand / spot spraying	3	0.165 gal	Mechanized

Table 8. Continued.

LOCATION		6th HYDROLOIC UNIT CODE	ACTIVE INGREDIENT	ADJUVANT USED	RIPARIAN			UPLAND		
Township Range & Section (can be found in Pisces)	**OR Latitude and Longitude**				Estimate Acres Treated	Estimate of Total Volume of Herbicide Only (Gallons)	Application Method	Estimate Acres Treated	Estimate of Total Volume of Herbicide Only (Gallons)	Application Method
Wildhorse Cr., Reynold's	45° 44' 57.92" 118° 35' 0.61"	170701030404	Metsulfuron	R-11	10	280 grams	hand wand / spot spraying	3	42 grams	Mechanized
Wildhorse Cr., Reynold's	45° 44' 57.92" 118° 35' 0.61"	170701030404	2, 4D (amines)	R-11	10	0.3125 gal	hand wand / spot spraying	3	0.375 gal	Mechanized
Wildhorse Cr., Reynold's	45° 44' 57.92" 118° 35' 0.61"	170701030404	Dicamba	R-11	10	0.31 gal	hand wand / spot spraying			
Meacham Creek, CTUIR	45° 38' 31.2" 118° 21' 28.8"	170701030206	Aminopyralid	R-11	6	0.23 gal	hand wand / spot spraying	5	0.27 gal	Mechanized
Meacham Creek, CTUIR	45° 38' 31.2" 118° 21' 28.8"	170701030206	Triclopyr (TEA)	R-11				20	2.25 gal	Mechanized
Meacham Creek, CTUIR	45° 38' 31.2" 118° 21' 28.8"	170701030206	Metsulfuron	R-11	6	42 grams	hand wand / spot spraying	20	252 grams	Mechanized
Meacham Creek, CTUIR	45° 38' 31.2" 118° 21' 28.8"	170701030206	2, 4D (amines)	R-11	6	0.19 gal	hand wand / spot spraying	20	2.25 gal	Mechanized
Meacham Creek, CTUIR	45° 38' 31.2" 118° 21' 28.8"	170701030206	Chorsulfuron	R-11	0.5	28 grams	hand wand / spot spraying			
Meacham Creek, CTUIR	45° 38' 31.2" 118° 21' 28.8"	170701030206	Clopyralid	R-11	2	0.19 gal	hand wand / spot spraying			
McKay Cr., Cripes	45° 30' 30.79" 118° 42' 34.29	170701030703	Aminopyralid	R-11	5	.035 gal	hand wand / spot spraying			
McKay Cr., Cripes	45° 30' 30.79" 118° 42' 34.29	170701030703	Metsulfuron	R-11	5	15 grams	hand wand / spot spraying			
McKay Cr., Cripes	45° 30' 30.79" 118° 42' 34.29	170701030703	Dicamba	R-11	5	.046 gal	hand wand / spot spraying			
McKay Cr., Hainey	45° 30' 31" 118° 41' 56"	170701030703	Aminopyralid	R-11	5	.035 gal	hand wand / spot spraying			
McKay Cr., Hainey	45° 30' 31" 118° 41' 56"	170701030703	Metsulfuron	R-11	5	15 grams	hand wand / spot spraying			
McKay Cr., Hainey	45° 30' 31" 118° 41' 56"	170701030703	Dicamba	R-11	5	.046 gal	hand wand / spot spraying			

current owner. Tax lot numbers are also subject to change, and may differ from those in the legal description as well. At the very least, it is currently a useful tool to locate and identify the tax lot(s) upon which each specific easement is located, along with the name(s) of the current and previous owner(s), and an aerial view of the tax lot upon which the easement is located. Over time, additional features such as tarps, riparian fences, and riparian buffer areas will be delineated on the map for project management. This web tool will be further developed to become a repository of project metrics such as ft of riparian fencing, planting totals, acres treated with herbicide, and total easement acres, etc. Furthermore, photo points will be added to observe change over time.

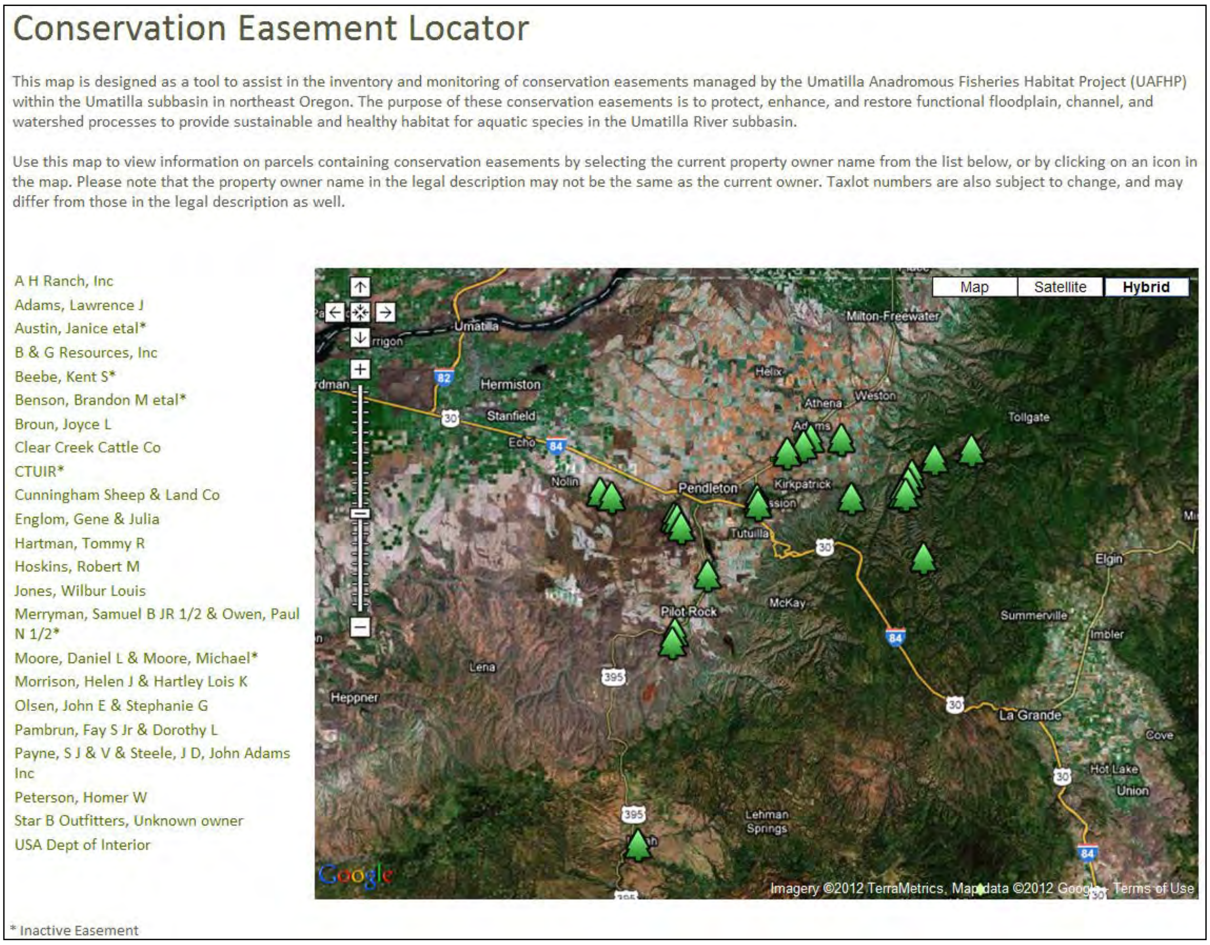


Figure 15. Screen shot of the UBAFH Project conservation easement locator web map.

Work Element P: 29. Increase In-stream Habitat Complexity and Stabilization
Work Element Title: Meacham Creek Floodplain Restoration and In-stream Enhancement, RM's 6.0 to 7.1
Milestone Deliverable: Complete Channel Reconstruction or Enhancement on 1.1 Miles of Stream

A. Environmental compliance requirements complete.
B. Materials for structure composition obtained (purchase of logs, boulders, cable, etc.).
C. Materials for structures staged at implementation sites.
D. Site plan to include maps, structure types and locations.
E. Construction begins.
F. Inspect completion of the project.

G. Complete as-built active channel and floodplain surveys.
Deliverable: H. Complete channel reconstruction or enhancement on 1.1 mi of stream.

This work element will be accomplished in association with the following work element Q: 180 Enhance Floodplain/Remove, Modify, Breach Dike. Given the magnitude of the project and associated work activities including planning, permitting, NEPA and ESA consultation, cultural resource clearance, and design, implementation work activities were re-scheduled for completion in FY 2011.

In FY 2010 a project design was completed outlining potential restoration opportunities. During FY 2010 it was anticipated that the full design would need to be implemented in phases due to the expense of implementing all aspects of the design on 1.1 mi of stream channel. Due to the new funding flexibility of the Columbia River Fish Accords, we have the ability to reschedule past cost savings and re-prioritize funds from other projects and future years in order to implement the design in one year rather than the phased approach. By implementing in one year as opposed to phasing the work over several years, it will reduce mobilization costs for the project and minimize the environmental disturbance to one year.

In FY 2010, project staff completed the following deliverables in support of implementing the Meacham Creek Floodplain Restoration and In-stream Enhancement Project RM's 6.0-7.1 for work elements (WE P29 & Q180):

1) The CTUIR Cultural Resource Program staff surveyed the project area, completed a report, and received clearance by SHPO through BPA.
2) Contractor was solicited and hired to support CTUIR and the USFS in development of a BA/BE, Design, Geotechnical Survey and Permitting. A BA was completed including a geomorphic assessment, hydrologic analysis, and hydraulic modeling using HEC-RAS. The BA was completed for ESA consultation and the BE was completed to meet the USFS Forest Practices Act requirements.
3) CTUIR and USFS completed the project design and implementation plan in September 2010.
4) CTUIR and USFS submitted the BA and Design to the NMFS and USFWS for ESA consultation.
5) A geotechnical survey was completed to evaluate floodplain material for implementation of the developed design.
6) A Participating Agreement was completed between the USFS and CTUIR for project activities.
7) All aspects of project design and need for access to the project site was coordinated with the UPR. The UPR owns and operates a railway along the project area. The CTUIR and USFS have been coordinating review of the design, and investigation of the UPR easement within the project area in regards to how it impacts the design. The UPR engineers have been engaged in reviewing the project design.
8) A request for proposal for construction implementation was advertised and a contractor was selected for implementation.
9) CTUIR project staff assisted the CTUIR Department of Economic Development in developing a timber sale on CTUIR fee lands for harvest and staging of 300 whole trees for the project.

Work Element Q: 180. Enhance Floodplain/Remove, Modify, Breach Dike
Work Element Title: Enhance Floodplain Connectivity and Function via Levee Setback on Meacham Creek, River Miles 6.0-7.1

Milestone Deliverable: Complete Levee Removal and Floodplain Enhancements to Meacham Creek

A. Environmental compliance requirements complete.
B. Produce site plan.
C. Subcontractor hired for implementation.
D. Implement levee removal.
E. Complete as-built active channel and floodplain surveys.
Deliverable: F. Complete levee removal floodplain enhancements to Meacham Creek.

This work element will be accomplished in association with the prior work element Work Element P: 29 Increase In-stream Habitat Complexity and Stabilization. Given the magnitude of the project and associated work activities including planning, permitting, NEPA and ESA consultation, cultural resource clearance, and design, implementation work activities were re-scheduled for completion in FY 2011.

Work Element R: 40. Install Fence
Work Element Title: Install Riparian Fence Enclosure in Meacham Creek, River Miles 2.0-9.0
Milestone Deliverable: Ten Miles of Fence Constructed on Meacham Creek

A. Environmental compliance requirements complete.
B. Flag area for fence location.
C. Complete and send out bid packages.
D. Selected contractor for construction.
E. Fence construction.
F. Approve construction work.
Deliverable: G. Ten miles of fence constructed on Meacham Creek.

This work element is re-scheduled for FY 2011. This project originally called for constructing 10 mi of riparian protection fencing from RM's 2.0-9.0 primarily along the west canyon wall of Meacham Creek. The proposed new fence is located partially within project work area identified in the prior WE's P29 and Q180 to restore a portion of Meacham Creek, and CTUIR didn't want to build a fence within an area that would be disturbed. This project intended to expand on a fence that was built in 2009 along the east side of the floodplain along the UPR Right-of-Way.

In FY 2010, CTUIR completed a survey and design, and due to the steep slope on the West side of the canyon we strategically have designed the fence to utilize steep facing slopes to exclude cattle. Based on these findings and new design, we are proposing to construct three miles of four strand barbed-wire fence and remove and dispose of old barb and barbless hi-tinsel fence located adjacent to Meacham Creek from RM's 2.0-9.0. Fence construction will include installation of gates as well as river crossings. NRCS specifications are used for fence construction and cost estimates are based on construction in hills/canyons.

Work Element S: 29. Increase In-stream Habitat Complexity and Stabilization
Work Element Title: Lower Umatilla River Bank Stabilization and Habitat Restoration
Milestone Deliverable: Complete Implementation of the Channel Reconstruction on 1.5 Miles of Stream

A. Environmental compliance requirements complete.

B. Sub-contractor hired for implementation.
C. Materials for structure composition obtained (purchase of logs, boulders, cable, etc.).
D. In-stream construction.
E. Riparian planting.
Deliverable: F. Complete implementation of the channel reconstruction on 1.5 miles of stream.

This project is located on the Umatilla River at approximately RM 27, beginning at the Stanfield Irrigation Dam and ending at the bridge below the city of Echo, Oregon. CTUIR and the UBWC proposed to evaluate the existing river corridor conditions and to design and implement restoration work that would provide stable functioning habitat for juvenile Chinook salmon, coho salmon, and Threatened summer steelhead. This project was a continuation of a project implemented by the UBWC in the summer of 2007. This project was funded by OWEB and no BPA funding was contributed to this project directly.

Proposed work was to protect and compliment prior UBWC activities in the area in providing stable functioning fish habitat. Prior to beginning new project activities, the original UBWC project area completely failed due to erosive effects from heavy winter ice build-up followed by heavy winter rain runoff. The ice jams eroded away the existing bank and bank structures leaving highly vertical raw banks in the project area. CTUIR felt that investing project dollars within an unstable isolated project area, without looking at floodplain and riverine processes over a substantial project reach area would be a poor investment of habitat dollars.

A decision was made not to proceed with this project as proposed. Prior to additional habitat work in the project area, a more intensive physical survey along with a geomorphic and hydrologic analysis will need to be completed with recommended alternatives. CTUIR did complete the cultural resource survey but a report was not finalized.

Work Element T: 22. Maintain Vegetation
Work Element Title: Enhance Native Vegetation Growth in the B&G Resources Property, Umatilla River (River Miles 41-44)
Milestone Deliverable: Maintain 355 Acres (61 Riparian, 294 Upland) in Project Area

A. Environmental compliance requirements complete.
B. Till established weed areas of the B&G Property.
C. Manual and mowing application to retard weed growth.
D. Truck water 13,400 plants on CREP riparian tracts (61 acres).
Deliverable: E. Maintain 355 acres (61 riparian, 294 upland) in project area.

Activities accomplished in FY 2010 under this work element are fully described in detail in the methods, results, and discussion of 2009 SOW deliverables work element Q: 34.

Work Element U: 29. Increase In-stream Habitat Complexity and Stabilization
Work Element Title: Birch Creek Bank Stabilization and Habitat Restoration, River Mile 2.8
Milestone Deliverable: Complete In-stream Habitat and Bank Stability Structures

A. Environmental compliance requirements complete.
B. Site plan to include maps, structure types and locations.
C. Negotiations with landowners completed.
D. Sub-contractor hired for implementation.

E. Materials for structure composition obtained (purchase of logs, boulders, cable, etc.).
F. Materials for structures staged at implementation sites.
G. Implement work within the in-stream work window.
Deliverable: H. Complete in-stream habitat and bank stability structures.

Activities accomplished in FY 2010 under this work element are fully described in detail in the report section **Selected FY's 2009-2010 Fish Habitat Enhancement and Restoration Activities**.

Work Element V: 174. Produce Plan
Work Element Title: Incorporate Umatilla River and Willow Creek Watershed Habitat Assessment Plan Findings into Project
Milestone Deliverable: Incorporate Final Plan into the Project Annual Report

Activities accomplished under this work element are fully described in detail in the methods, results, and discussion of 2009 statement of work deliverables work element T: 174. A draft report was completed by February 26, 2010 and submitted for peer review. A standalone final report was completed in FY 2010 (Appendix B).

Work Element W: 174. Produce Plan
Work Element Title: Meacham Creek Vegetation Survey and Repeatable Monitoring Strategy
Milestone Deliverable: Produce Draft Plan for a Repeatable Riparian and Floodplain Vegetation Monitoring Strategy

A. Prepare draft plan.
Deliverable: B. Produce draft plan for a repeatable riparian and floodplain vegetation monitoring strategy.

Meacham Creek, located in Northeast Oregon, is a tributary to the Umatilla River and provides important habitat for native bull trout, summer steelhead, and recently restored Chinook salmon. Flows in Meacham Creek have a high annual variability, and habitat stability for salmonids is limited. Vegetation in the basin generally includes coniferous forests and rangeland, and the elevation ranges from 540 meters to 1,760 meters. Riparian communities in the area include willow, cottonwood, and alder.

Starting in the early 1900s, the lower reaches of Meacham Creek were channelized, cleared of vegetation, and constrained by levees to accommodate the construction of the railroad. Restoration efforts in recent years have focused on reconnecting the creek with its floodplain and improving riparian conditions through passive and active efforts. Since 1998, 48 percent of the projects implemented by the CTUIR UAFHP have been primarily riparian planting projects or riparian planting has been part of the overall project implementation strategy. Riparian planting projects have the potential to improve bank stability, increase streamside shading, reduce erosion, and provide other benefits within a moderate amount of time (5 to 20 years).

Restoration efforts in the Umatilla Basin include changes in land management such as purchasing land for conservation and alterations in the way grazing is managed on the landscape. Active projects to plant riparian species have also been accomplished in the basin, including the installation of species such as willow, cottonwood, and alder. Redistribution of native vegetation has also occurred in concert with floodplain restoration projects. Current records show completed projects in Meacham Creek at the Williams and Bearchum project sites, although other completed projects within the Meacham Creek Basin may have occurred. Additional information on completed projects within the survey area will be collected (as needed) prior to plan development.

In order to monitor and measure the progress of these vegetation restoration efforts, the CTUIR proposed to develop a Vegetation Monitoring Strategy and Survey Protocol and covered the area between RM 0 to 14 in the Meacham Creek watershed. The purpose of effectiveness monitoring is to determine whether the outcomes of management actions are achieving the objectives of the action. The Meacham Creek Vegetation Monitoring Strategy and Survey Draft Protocol was completed by January 31, 2011, reviewed and edited, and the finalized document completed in April 2011 (Tetra Tech 2012). The Meacham Creek Vegetation Monitoring Strategy and Survey Protocol (April 2011) is available for reviewing on the following CTUIR website at: http://data.umatilla.nsn.us/fisheries/index.aspx.

Data digital entry forms were also developed for use with Trimble GeoExplorer units to facilitate data collection and to remove the need for post-field data entry. The GPS forms included data dictionaries to collect location and site information for each plot. In addition, a MS Access database was developed including integrated calculations for summary indicators as described in the Meacham Creek Vegetation Monitoring Strategy and Survey Protocol.

SELECTED FY2009-2010 FISH HABITAT ENHANCEMENT AND RESTORATION ACTIVITIES

Meacham Creek Levee Removal Project, RM 5-6

Introduction

The 114,000 acre Meacham Creek watershed is a 37-mi long tributary of the Umatilla River, entering at RM 78.8 and contributes approximately half of the flow to the Umatilla River during high flow events and a significant amount to the baseflow (Figure 5). Meacham Creek originates near the town site of Kamela, Oregon at approximately 4500 ft elevation. Data from CTUIR shows that Meacham Creek runs 2-3 ºC degrees warmer (16 ºC [60.8 ºF] vs. 13.5 ºC [56.3 ºF]) during the summer than the Umatilla River at the confluence. The USGS maintains a gauging station on Meacham Creek at Gibbon, OR (USGS 14020300) in cooperation with the CTUIR (RM 1.4). The drainage area covered is 176 mi^2 with a maximum peak flow recorded as 8,800 cfs, while minimums of 7 cfs constitute summer base flows. Three channel reaches of Meacham Creek flow intermittently and subsurface during the summer months, but provide short reprieve to high temperatures during low summer flows.

The primary negative impact to Meacham Creek is an adjacent railway built in the early 1900's that has included the construction of extensive levees, channel relocation, channelization, and vegetation alteration. The Meacham Creek Watershed Assessment and Action Plan (Andrus and Middell 2003) concluded the following: 1) Railroad tracks border the stream for the majority of its 37-mi length; 2) A ledge was blasted out of the adjacent hill slope in the upper canyon to make room for the railway; 3) Following construction, Meacham Creek repeatedly collided into the railroad prism in the lower valley and threatened to undo what had been built; 4) Angled dikes and parallel levees were constructed to force the stream away from the tracks and, following floods, bulldozers were used to create a straight channel that was free of logs; and 5) Early trains were fueled by wood and may partly explain the shortage of large woody material in the valley.

A significant secondary impact to Meacham Creek is high intensity grazing by domestic livestock in the riparian area. More than a century of concentrated cattle and sheep grazing has limited tree regeneration in many areas, degraded shrub and herbaceous conditions, and has led to unstable streambank conditions. Current natural regeneration of riparian plant species is most successful in areas where livestock are excluded.

Additional impacts have included timber harvest (high-grading from the riparian area), road construction, and some urban development. These activities have contributed to high water temperatures, unstable channel bed and banks, simplified and degraded aquatic habitat conditions, poor riparian vegetation conditions, and possibly reductions in late season flow. The extent of impacts dictates that watershed scale processes must be considered in restoration planning and a holistic watershed approach is necessary for success.

The Meacham Creek Levee Removal Project was supported by the Meacham Creek Assessment and Action Plan (2003). The development of action alternatives draws from knowledge gained from other restoration and assessment efforts. As a result of these efforts, the portion of the mainstem Meacham Creek from the confluence of the North Fork Meacham Creek downstream to the confluence with the Umatilla River (approximately 15 RM's) has been identified as the highest priority for active watershed restoration and termed the "Focus Area" (Figure 16). The proposed project actions build on restoration activities since 2006. As a multi-year and multi-funded effort, the implementation actions overlap locations within the 15-mi Focal Area and may include the same action being implemented over several years. For example, there have been and will continue to be multiple efforts of riparian planting in the Meacham Creek floodplain during the spring and fall that will overlap with whole tree additions and natural channel construction. These efforts are integrated and designed to provide support to each other.

Limiting Factors

Historically Meacham Creek was a major spring Chinook, steelhead and coho salmon producing tributary to the Umatilla River, along with healthy populations of bull trout and resident redband trout. Currently, Meacham Creek provides habitat and refuge for spring Chinook salmon, summer steelhead and bull trout, but at reduced levels due to degraded habitat and water quality conditions.

Meacham Creek is water quality limited primarily by high water temperature. Physical aquatic habitat is also in poor condition and been shown to be a limiting factor to the health of important aquatic species. The primary cause of habitat degradation in Meacham Creek is hydro-modification from simplification of the channel by channelization and streambank modification for the purpose of protecting the infrastructure of the UPR Railway.

Support for Implemented Work

The Meacham Creek subbasin is of historical significance to the Tribe because of its traditional hunting, fishing and gathering opportunities. There are various ancient sites of cultural significance located adjacent to the Meacham waterways. The Meacham Creek

Figure 16. Meacham Creek Restoration Project Focus Area, River Miles 0-15.0.

subbasin produces an anadromous salmonid component which contributes to traditional and subsistence harvest by Tribal members. Proposed goals and objectives will support capacity building and long-term progress towards 1) achievement of the CTUIR DNR ecological river vision and first foods mission statements, 2) ESA delisting of Columbia River bull trout and middle Columbia River steelhead, and 3) addresses water quality limiting factors per the Clean Water Act 303d list.

The Middle Columbia River Steelhead Recovery Plan supports this project by identifying the actions of reconnecting Meacham Creek to the floodplain, removing dikes and levees, as well as reconnecting side channels and off-channel habitat as the first priority under Strategy 3. Restoring natural channel form, placing stable wood and other large organic debris in the streambed, stabilizing and protecting streambanks, and constructing rock and log weirs to create pool habitat or elevating incised channels have also been identified as first priorities in the Middle Columbia River Steelhead Recovery Plan under Strategy 4. Degraded floodplain and channel structure, altered sediment routing, altered hydrology, and water quality (temperature) have been identified in the Middle Columbia River Steelhead Recovery Plan as major factors limiting steelhead populations in Meacham Creek (NMFS 2009).

Exploring solutions with UPR for improving migratory habitat in the Meacham Creek Subbasin is identified as the highest priority in the Bull Trout Draft Recovery Plan within the Umatilla/Walla Walla Recovery Unit (RU). Furthermore, restoring floodplain function and channel complexity is the second highest priority identified in the Bull Trout Draft Recovery Plan within the Umatilla/Walla Walla RU. Altering the dike in the mainstem of Meacham Creek has been identified in the Bull Trout Draft Recovery Plan as an action that would improve channel complexity and improve fish habitat and potential use by bull trout. The construction and maintenance of the UPR, which parallels mainstem Meacham Creek, along with dikes or levees in place to protect the railroad from flooding, is identified in the Bull Trout Draft Recovery Plan as significantly altering stream and channel complexity, riparian shade, and likely affecting stream temperatures (USFWS 2002).

The overall project directly addressed the processes that support the First Foods of water and salmon and the five Umatilla River Vision touchstones (Jones et al. 2008), water quality limitations identified in the CTUIR TMDL and Umatilla TMDL, and degraded habitat conditions identified in the Meacham Creek Assessment and Action Plan (Andrus et al. 2003) and Umatilla Watershed Analysis (Umatilla National Forest 2001).

Objectives and Goals

The objective of the Meacham Creek Levee Removal Project (RM's 5.0-6.0) was to restore, enhance and protect 50 acres of floodplain habitat and restore stream morphology while enhancing fish habitat. The Meacham Creek Levee Removal Project goals included:

- Improved channel form, sinuosity, complexity, geomorphic, hydrograph stability.
- Increased base flow, shallow-groundwater capacity, capability of functional connection and interaction between the channel and floodplain.
- Improved water quality conditions in terms of in-stream temperature modification.
- Eventual self-sustaining increase in vegetation complexity and growth.
- Increased fish habitat complexity and availability.
- Increased salmonid population dynamics and carrying capacity of preferred species.

Implementation

The Meacham Creek Assessment and Action Plan (Andrus et al. 2003) identified most levees/dikes within the Meacham Creek Watershed. In 2008, CTUIR surveyed, mapped and prioritized levees for removal or modification in the floodplain. This task required the detailed refinement of the property boundary layer within the CTUIR Geographical Information System (GIS) system and ground-truth of property boundaries and levee/dike locations. The ground truth survey of levees/dikes for removal involved identifying levees that limit connectivity between the channel and floodplain and if removed provide benefits for achieving biological and ecological objectives in Meacham Creek. Protection of the UPR Right of Way was considered as part of levee/dike removal. CTUIR has coordinated with and educated local landowners and land managers to inform them on the benefits of levee/dike removal for floodplain/channel restoration and the opportunities to remove specific levees without future impacts to infrastructure.

In August-September 2009, four high priority levees were either removed or modified over one mile of stream to increase the area of the active floodplain to promote natural riverine process, including channel sinuosity, complexity, and the ability of the stream to dissipate hydraulic energy at higher stream flows (Figure 17). A total of 3,200 linear ft of levees were removed ranging from 717 ft to 1254 ft long with an average width of 44 ft and height of 4.5 ft. Only 200 linear ft of the upper most angular levee (south end of the project) tied into the adjacent UPR Right of Way was modified. This provided horizontal movement within the project area for channel migration and floodplain inundation during bankfull events with remaining protection of the UPR Railway.

The levee setback design involved sculpting about 24,000 cubic yards of levee material down to the ordinary high water mark and re-distribution of material within the floodplain in low depositional areas (Figure 18). Fill areas were prioritized along the UPR Right of Way to develop higher ground surface elevations for high water protection, and within areas of the floodplain where historically fill was removed to construct the levees (Figure 19). Levee material consisted of floodplain material comprised of cobble substrate (83%), 12% sand and 5% boulders.

Prior to excavation of levee material, 371 whole trees with root wads attached were cleared and sorted by size and set aside. An excavator was used to dig around the rootwad of selected trees and removed and staged them for redistribution following levee material excavation. Following excavated removal of whole trees, top soil was bladed from the surface of the levees and stockpiled. Upon removal of levee material, top soil sediment was re-distributed upon the surface of the disturbed areas for seeding and planting, and trees less than 12 in dbh were redistributed for floodplain surface roughness. Larger trees greater than 12 in dbh were stockpiled for later use in the proposed 2011 implementation project for planned channel construction and floodplain inputs. Maximum haul route distances were less than 0.25 mi from excavation areas.

Following completion of excavation disturbed areas were seeded with 400 lbs of native grass seed mix in October 2009 (Table 1). An EPA grant also funded 4,000 local ecotype native trees and shrubs (thin leaf alder, black cottonwood, water birch, elderberry, willow, snowberry, and mock orange) for planting within the project area. The trees and shrubs were planted in October 2009. In October 2010, an additional 1,000 ponderosa pine, 1,000 Douglas fir, 20 alder and 20 willow cuttings were planted (Table 7). Early results indicate ground cover is adequate from grass seeding and planting mortality has been low. Some ungulate browsing has occurred but not detrimental to plant establishment.

Photo points were established within the project area to capture ground surface elevation change from project activities, and monitor visual change in floodplain function over time (Figure 20).

Figure 17. Identified Levees (Red) for Removal or Modification as Part of the Meacham Creek Levee Removal Project, RM's 5.0-6.0.

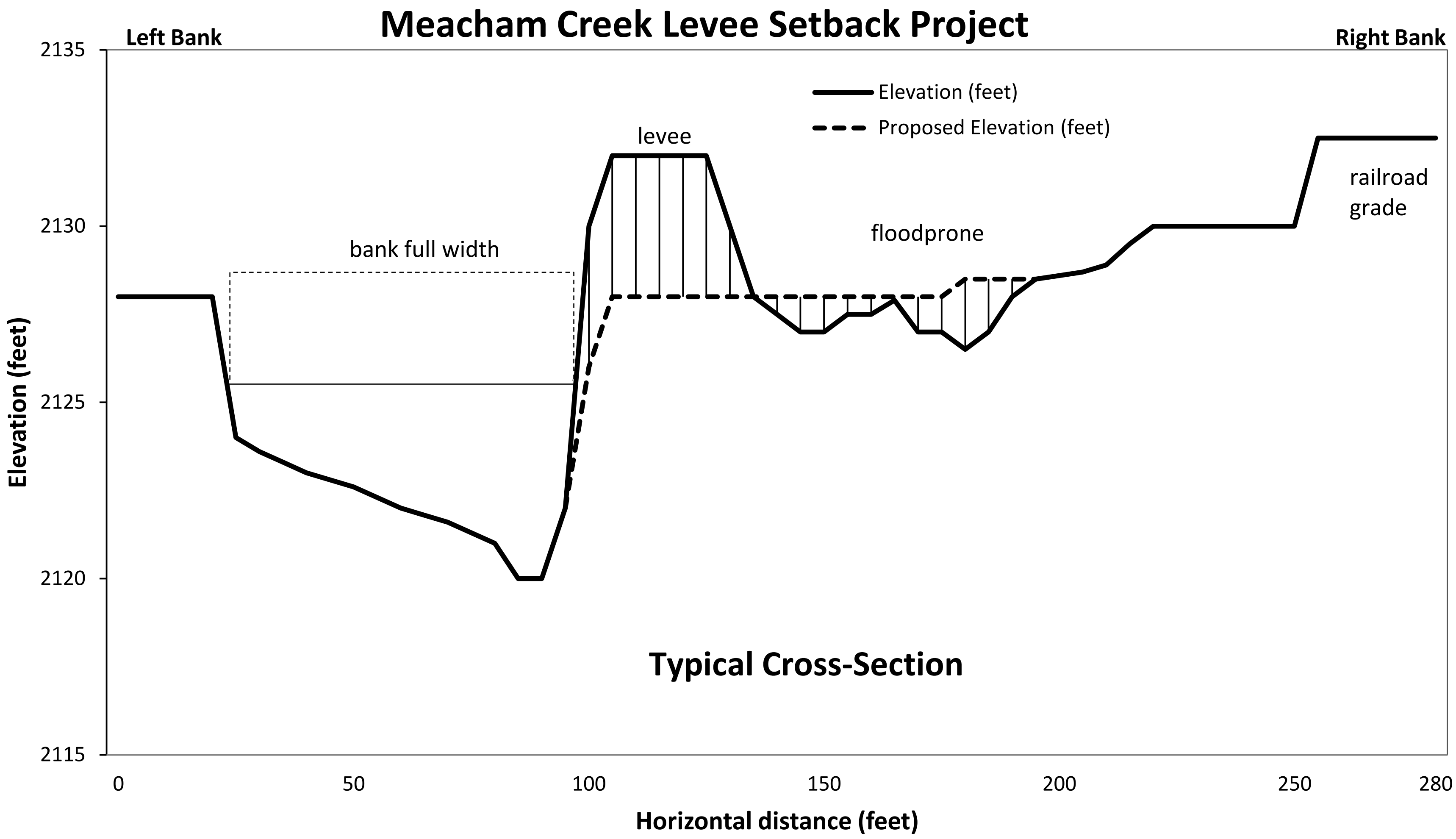


Figure 18. Typical cross section diagram of the existing and final (after alteration) surface area at the Meacham Creek Levee Removal Project, RM's 5.0-6.0.

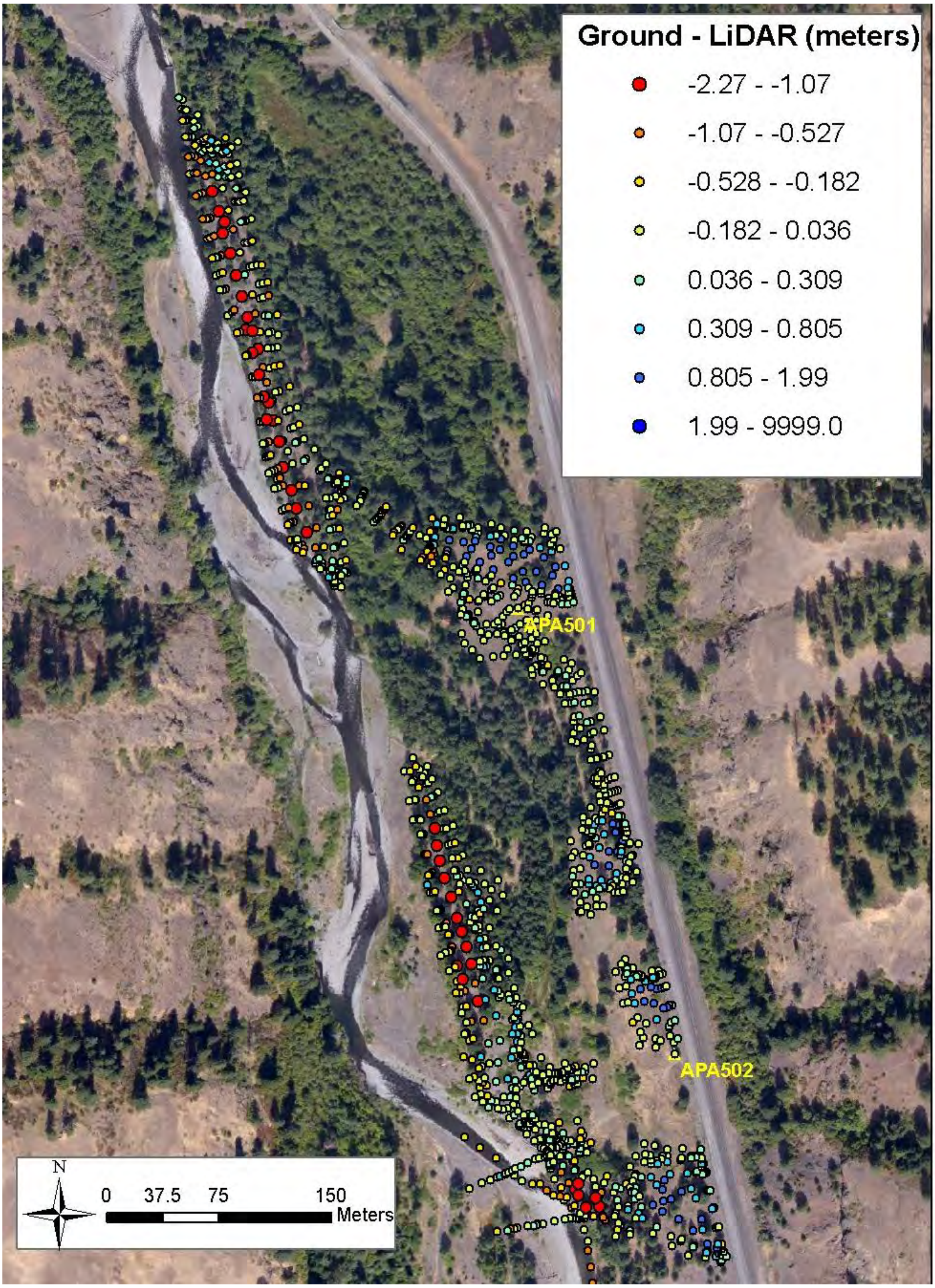


Figure 19. Elevation differences between the pre-project 2009 LiDAR ground model and 2010 as-built survey. A negative value indicates that the LiDAR elevations were higher than the ground survey elevations.

An as-built survey was completed following project construction in by Anderson-Perry and Associates from November 12 to November 24, 2009. The as-built survey consisted of three parts:

1) Project Survey Control – established horizontal and vertical survey controls using static GPS and conventional total station methods. The horizontal datum was Oregon State Plane, North Zone, coordinate values and the vertical datum was NGVD 88.
2) Project As-built Survey – Surveyed horizontally and vertically elevations of all worked, graded or filled areas within the project area where dike removal and remediation has taken place.
3) Active Channel Survey – located horizontally and vertically within the thalweg of the Meacham Creek. Shots were taken at 50 ft intervals and included all significant grade breaks in the active channel. Cross sections were taken from top of bank perpendicular to the active channel and extending to the opposite top of bank perpendicular to the active channel and extending to the opposite top of bank including the high water mark where it is visually evident. Cross sections were taken at 300 ft intervals along the reach.

Planning and design was funded through the 2007 and 2008 EPA NPS319 grants and BPA funding while the implementation of modifications was cost-shared between funding from BPA, the BMHRC, and NRCS WHIP. A 2009 EPA NPS 319 grant cost shared planting vegetation.

Early 2010 results indicate a greater connection between the channel and floodplain inundation during bankfull events within the project area (Figure 21). Surface water is accessing secondary channels with habitat complexity good for overwintering fish habitat. Excavated levee areas have been partially inundated with water in some locations during greater than bankfull events.

Birch Creek Fish Habitat Bank Stabilization Project, RM 2.8

Introduction

Birch Creek is a 291 square mile drainage, tributary to the Mid-Umatilla River Basin, which originates from the Blue Mountains flowing in a northern direction entering the Umatilla River downstream of Pendleton Oregon (Figure 4). Elevations within the basin range from 1,080 ft above sea level near Birch Creek's confluence with the Umatilla River and 4,980 ft in the peaks of the Blue Mountains that divide the watershed. Stream flow in Birch Creek is typical of streams in a semi-arid climate where winter flows can be quite substantial with very low summer base flows.

The project is located within the Peterson Riparian Conservation Agreement area near RM 2.8 (Figure 4). The landowner and CTUIR entered into a 10-yr Riparian Conservation Agreement (Easement) on 1 October 2004. The primary purpose of the agreement was to 1) at the landowners request construct a metal post/four-strand barbwire fence along the east and west property boundaries with three 12-ft metal gates, and prepare the ground and plant native shrubs and trees in the buffer area, 2) design and implement actions needed to eliminate the fish passage barrier near river mile three, 3) control noxious weeds as listed on the Umatilla County noxious weed lists A and B in the project area, and 4) coordinate activities with the CREP project within a two year period. The intent of these improvements

September 2009 June 2010

Figure 20. Before and after photo points of the four levees removed or modified as part of the Meacham Creek Levee Removal Project.

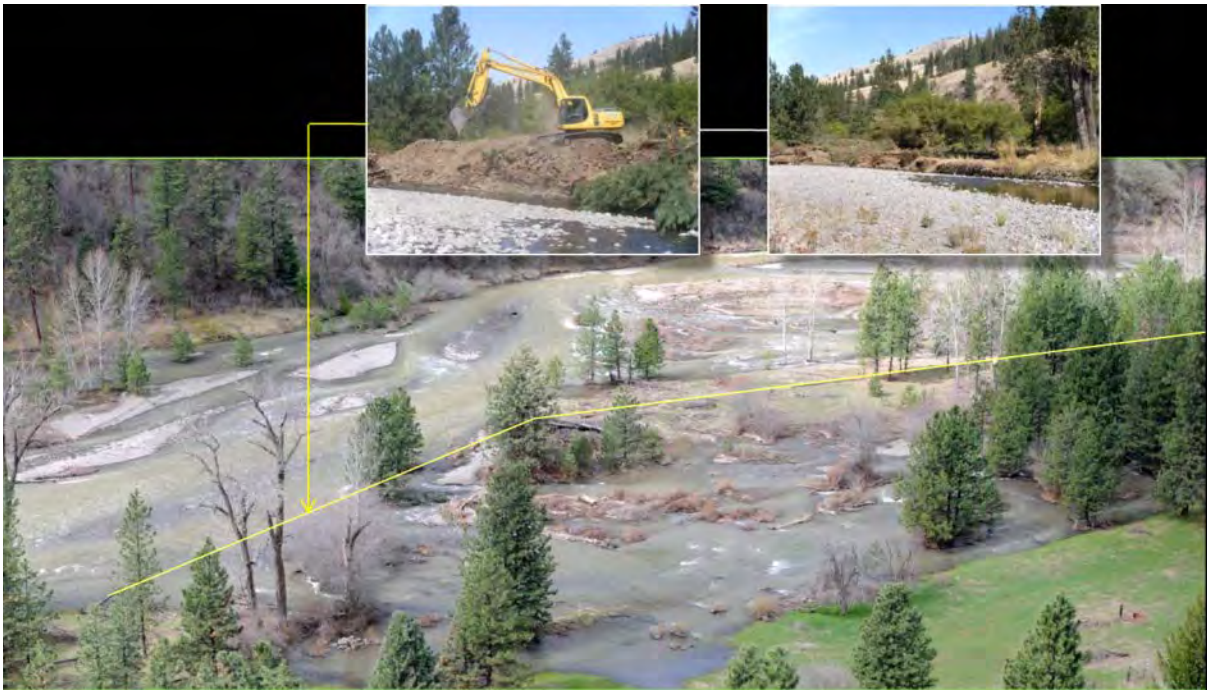


Figure 21. Ridge Line Photograph of the Meacham Creek Levee Removal Project (April 2011) with a Drawing and Photographs where Levee Removal Occurred.

is to stabilize the stream channel, increase in-stream habitat diversity, and encourage floodplain, wetland and riparian recovery.

Project activities were implemented in spring of 2005. Both stream banks of Birch Creek in the Peterson easement were planted with 1,000 native shrub and tree tubelings using 27,000 ft^2 of mulch fabric (tarps) at a rate of 30 ft^2 per stem. A total of 12 tarps were installed and planted on the property. An additional 1200 plants were planted in 2009 strategically in the project area along eroded stream banks and throughout the tarp project area where survival was low.

In 2009, the landowner and CTUIR met to inspect and evaluate project activities. One concern the landowner expressed was inadequate protection along several areas of bank resulting in bank failure. As a result of several small bank failures, the landowner was losing agricultural land resulting in increased sediment input into Birch Creek. Prior riparian plantings were not established and matured enough to provide adequate protection against bank erosion in these areas and the landowner felt if left un-checked could lead to further gross land loss. CTUIR agreed to develop a project that could provide bank protection and stabilization along with the addition of fish habitat structure.

Limiting Factors

The main stem Birch Creek supports summer steelhead-resident rainbow trout (Oncorhynchus mykiss) and a variety of non-salmonid fish. Limited spawning habitat exists in the headwaters of Birch Creek. Summer steelhead adults migrate through the system from November through June. Juvenile summer steelhead-rainbow trout rear throughout the system when water temperature and flow are tenable.

The EPA lists Birch Creek as Section 303d water quality limited for flow, temperature, sediment and nutrients. Of those parameters, flow and temperature are the most limiting factors for salmonid reproduction. Past management activities, such as channelization, road construction, and agricultural practices, have impaired salmonid habitat in most project reaches of Birch Creek. Additional habitat limiting factors include:

- Limited large pool habitat
- Channelization
- Lack of adequate riparian characteristics
- Disconnected floodplain
- Low channel sinuosity
- Unstable flow hydrograph patterns

Support for Implemented Work

The topography of the Birch Creek Watershed is typical of the Blue Mountain foothills, with broad flat ridges bisected by moderately steep, constraining canyons with a variety of aspects across a broad valley floor. The upper reaches consist of moderately-steep, closely orientated hill slopes that cradle the channel and support substantial tree growth, and cooler waters. The valley floor is comprised of low and high terraces with much incidence of actively eroding banks with an overall lack of in-stream cover. Thin riparian corridors contain sparse tree growth.

Diking and straightening practices have generally concentrated flows into one predominant channel. Therefore, secondary channels account for a small portion of the overall stream length. Much of the large wood in the Birch Creek Watershed was likely removed to clear lands for agriculture or for timber harvest reasons. The poor health of the banks is primarily attributed to land use practices, such as clearing, overgrazing, and channelization and flashy hydrographs. Due to the relatively high composition of fine substrate and eroding banks, turbidity levels can become relatively high during heavy rainfall events. Summer flows are very low and the surface flow deficiency is magnified due to irrigation withdrawals. Open sky exposure to the wetted channel is at generally undesirable and excessive levels.

Mid to lower portions of mainstem Birch Creek are very entrenched and provide poor juvenile rearing habitat for salmonids. Many of these channels have lost connection with their historic floodplain. Their degree of entrenchment is extremely erosive and unstable and produces excessive sediments that fill in pools, embed spawning substrates and accelerate horizontal channel migration.

The purpose of this project was to quicken recovery of unstable banks and provide in-stream habitat complexity within this section of Birch Creek. As part of this project design, existing gravel bars and stream complexity were maintained within the reach.

Objectives and Goals

The objective of this project was to place 335 ft of large wood in-stream along the streambank, slope the erosive banks and plant additional riparian plantings, and place two small in-stream large wood structures in-stream. The Birch Creek Fish Habitat Bank Stabilization Project goals included:

- Improved channel form and sediment conditions.
- Self-sustaining increase in vegetation diversity and growth.
- Increased fish habitat complexity and availability for rearing.

- Increased salmonid population dynamics and carrying capacity of preferred species.

Implementation

Lack of mature riparian vegetation and ongoing erosive banks within the Peterson Conservation Agreement on Birch Creek led to finding a solution to stabilizing short stretches of bank erosion while providing wood input for fish habitat. Project activities over several years involved plantings on tarps within the riparian area for long term riparian recovery, and future stabilization of the riparian for stream function. CTUIR also planted a variety of native plant species along the stream channel toe for increased roughness, erosion control, and overhanging riparian cover for fish habitat (Table 7). Although plantings have occurred within the project area a more immediate fix was necessary to stop erosion and stabilize the streambank for long-term recovery.

In 2010, CTUIR hired an engineering firm Anderson Perry to survey the channel profile and provide cross-sectional survey elevations for the entire project area. Following completion of the survey, Anderson Perry worked with CTUIR to develop a set of design drawings and technical specifications for the site plan, bank sections, and construction details for the bank stabilization design (Figure 22). The purpose of the project design was to increase the stability of the streambank in the vicinity of the ranch house and outbuildings, and, utilizing bioengineering and vegetative planting techniques, transform the eroding, unstable streambanks into a more stable, appropriately sloped and vegetative condition. The use of large wood components will provide additional deep-water fish habitat where it is currently nonexistent.

Following completion of the 60% design by Anderson Perry, CTUIR completed and submitted for an USACE/DSL Fill-Removal JPA for completion of the project work on September 8, 2010. The USACE/DSL Fill-Removal Permit along with other Umatilla County land use permits were approved for the proposed construction from October 1 to October 31, 2010. An extension of the in-stream work window was granted from October 31, to November 15, 2010 during construction. Project ESA consultation with NMFS for listed summer steelhead-rainbow trout in Birch Creek was covered under the BPA HIP II BO with a variance. A variance was allowed to exceed the 250 ft of total bank stabilization by 85 ft.

Representatives from the CTUIR Cultural Resource Protection Program conducted preliminary surveys of the project areas and granted official clearance to proceed with implementation activities. CTUIR UAFHP prioritizes the involvement of Cultural Resource staff to ensure that cultural interests are protected and preserved in a manner consistent with CTUIR policy.

The Birch Creek Fish Habitat Bank Stabilization Project was implemented from October 25 to November 12, 2010. Prior to in-stream construction water was contained by an upstream diversion dam and pumped downstream using two diesel pump units with independent 8 inch suction lines equipped with fish screens, capable of moving 4,000 gallons per minute (gpm) or 8.9 cfs downstream through a 12 inch discharge line that stretched about 700 ft. These ran continuous throughout the project construction period in order to keep most water outside of the project reach for work activities. Sediment control features, such as straw bales were established at the lowest end of the project for filtering suspended sediments from remaining water in the project area.

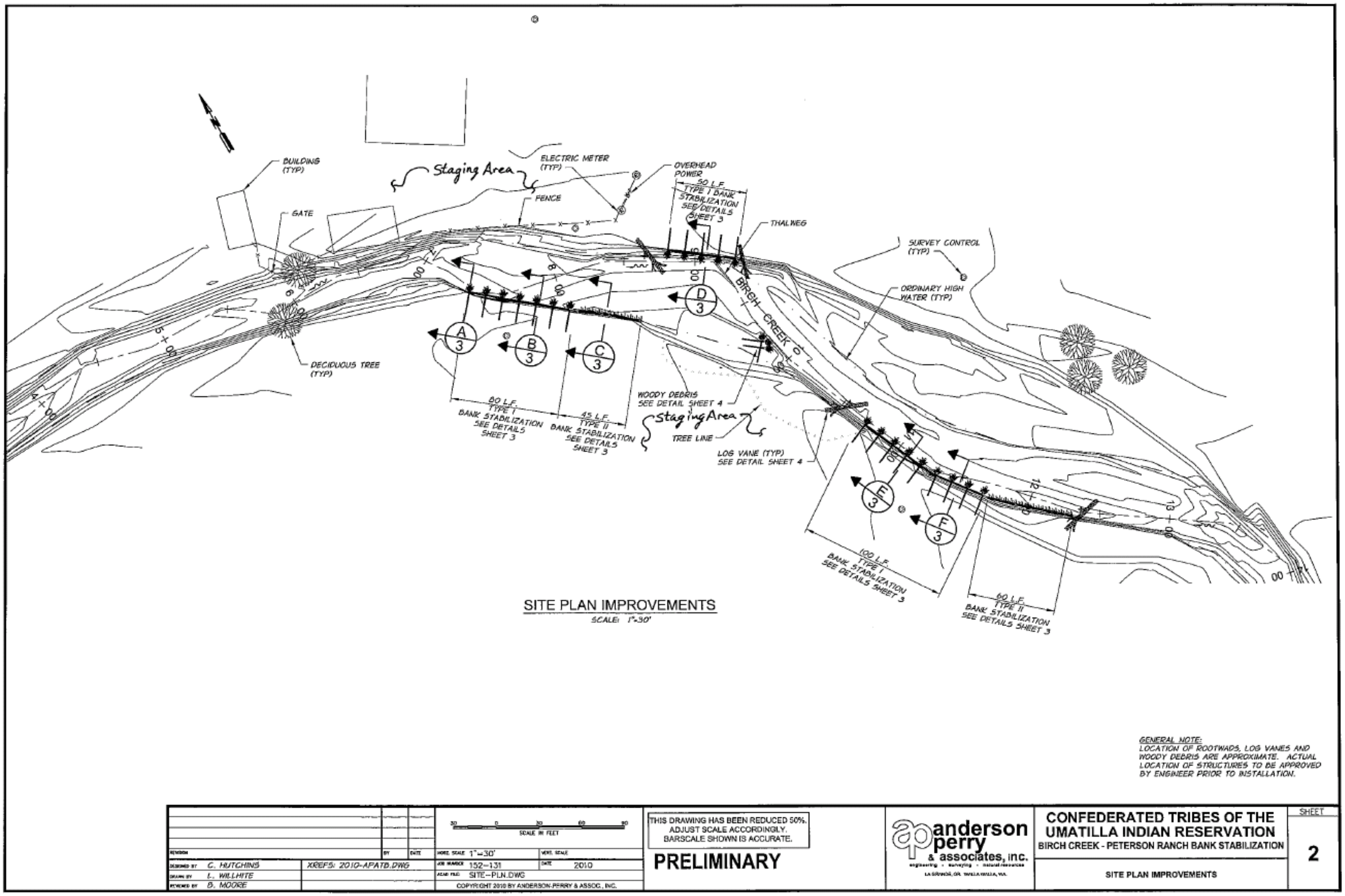


Figure 22. Engineer Design Site Plan Improvements, Birch Creek, RM 2.8

No plume or sediment was visible downstream of the project area throughout the construction period. A fish salvage team consisting of a team leader and five additional staff with two electro-fishers, block seines and sampling gear completed multiple passes until all fish were removed from the project area. A total of 14 listed summer steelhead-rainbow trout and about 4,388 non-salmonids, including bridge lip suckers, red-sided shiners, northern pikeminnow, speckled dace, and sculpin, were removed from the project reach and released upstream of the project. No mortalities occurred during the fish salvage.

A total of 335 ft of streambank was treated with typical streambank stabilization diversion structures over 635 ft of stream (Figure 22). The project included 60 large conifers with their intact rootwads, 110 cubic yards of large boulders as ballast to anchor the large woody debris, and about 4,000 square yards of biodegradable coconut fabric, and about 6,000 willow plantings. Soil lifts with willow whip plantings were used to establish a stable bank. The project included two engineered logjams using large woody debris (Figure 23). All large woody debris installations complied with the size requirements outlined in *A Guide to Placing Large Wood in Streams* (ODFW/ODF 1995) and placement guidance in the *Oregon Aquatic Habitat Restoration and Enhancement Guide* (ODFW/ODF 1999).

Figure 23. Before-after photo points of treated erosive banks along Birch Creek, RM 2.8.

MONITORING

Background/Rationale

The CTUIR Fisheries Habitat Program continues to invest substantial resources in restoring the fisheries habitat within the Umatilla Subbasin and its tributaries. In order to ensure that investments result in actual improvements to biological productivity, an extensive long-term monitoring plan has been setup. This monitoring plan aims to evaluate the effects on biotic and abiotic ecological processes as a result of habitat restoration efforts. With time, we expect watershed treatments to improve stream functions by 1) diversifying channel morphology 2) increasing floodplain connectivity 3) decreasing annual maximum stream temperatures 4) increasing summer base flow 5) increasing abundance of and diversity of riparian vegetation and 6) increasing macroinvertebrate abundance and diversity.

Within the subbasin we have setup baseline monitoring to help understand relationships between our in-stream restoration efforts and aforementioned ecological processes. In order to accomplish this we continue to conduct a combination of monitoring activities and methods included within the Umatilla Subbasin Fish Habitat Restoration Monitoring Plan located at the Pacific Northwest Aquatic Monitoring Partnership website (Citation URL: http://www.monitoringmethods.org/Protocol/Details/681). This protocol is specific to physical monitoring (except for aquatic macroinvertebrate monitoring) and is continually being refined. The protocol does not include any information on monitoring fish populations. It is believed that measurable changes in physical habitat improvements are a predictor for improved changes to survival and productivity of various salmon and trout life stages.

Furthermore, in the context of habitat restoration actions, project staff must consolidate regional and local data in order to assist in project activities, such as local and regional project presentations, permitting, development of biological assessments and evaluations, design, pre- and post-project analysis, project effectiveness, and long-term biological and physical recovery response. The UAFHP coordinates with multiple CTUIR and ODFW research projects that monitor and evaluate the success of the Umatilla Fisheries Program as a whole. These projects deal with natural production monitoring (CTUIR Umatilla Basin Natural Production Monitoring and Evaluation Project; 1990-005-01 and ODFW Evaluation of Juvenile Salmonid Outmigration and Survival in the Lower Umatilla River; 1989-024-01) and are critical for evaluating natural production relative to sustainable habitat for salmonids. This project utilized data from research projects in the basin to identify trends in response to habitat management actions which will help prioritize future restoration actions. Juvenile production and adult spawn surveys from the above fish monitoring projects were used to examine relationships between production and restored function in the Umatilla River Basin and help to document fish benefits to restoration actions. In addition to biological and physical monitoring, project staff further coordinated with the CTUIR Water Quality Program to attain water quality data as environmental baseline and response for project activities.

Monitoring Objectives

1. Evaluate changes in water quality as a result of stream restoration within the Umatilla Subbasin
2. Evaluate changes in summer low flow periods as a result of stream restoration within the Umatilla Subbasin
3. Study changes in thermal regime as a result of stream restoration projects within the Umatilla Subbasin
4. Evaluate changes in riparian stands as a result of stream restoration projects within the Umatilla Subbasin.
5. Track changes in biotic and abiotic ecological process within the Umatilla Subbasin, specifically in and around restoration project areas.
6. Track the effectiveness of designed stream restoration features within the Umatilla Subbasin
7. Track the changes in macroinvertebrate populations and richness within the Umatilla Subbasin

Key Assumptions

Improvements in fish habitat and physical stream characteristics will result in improvements in sustainable fish populations.

Temporal Design Description

<u>Photo Point Documentation</u>

We conducted selected photographic data points within the Umatilla Basin from about 150 photo locations over 24 sample sites in habitat restoration projects or conservation easement locations completed or managed by CTUIR. Photo point monitoring intensity varies depending on the magnitude of size and project type. New projects typically have a higher intensity of photo locations and less within five years. Currently, CTUIR is heavily monitoring the 2009 Meacham Creek Levee Removal and 2011 Floodplain Restoration and In-stream Enhancement projects. These are large scale floodplain/channel connectivity projects; each one-mile in length. Photo point sites are set up in order to track the progression of landscape features (i.e. vegetation, channel morphology) of past, present and future projects (i.e. Figure 20 & Figure 23). Repeatable photo point documentation is used to monitor and quantify the general magnitude of change in habitat characteristics to distinguish trends and determine the relation to habitat enhancement projects as a means of effectiveness monitoring.

The CTUIR Umatilla Basin Photo Points Method is based off of the 2002 USDA "Photo Point Monitoring Handbook" by Frederick C. Hall (http://www.fs.fed.us/pnw/pubs/gtr526/gtr526A1.pdf). Photo points are uploaded and archived in the CTUIR photo point database depository (http://intranet/resources/dnr/fisheries/Photo%20Points/Forms/AllItems.aspx) for comparable visuals for tracking physical appearance changes over time. This database is currently only accessible by CTUIR staff.

<u>Water Quality/Sediment Monitoring</u>

Meacham Creek is listed on the state 303(d) list as having elevated summer temperatures that are detrimental to fish rearing. High summer temperatures are the driver for the extensive restoration efforts taking place on Meacham Creek. In an effort to monitor long term changes in summer water temperatures a longitudinal profile of HOBO pendant stream temperature loggers have been deployed in Meacham Creek since 2005. Eleven temperature monitors are arranged in a longitudinal fashion starting at RM 2 and ending at RM 16.5 (Figure 24) from July through September. Many of the temperature loggers bracket planned habitat restoration reaches. Temperature loggers are deployed to go off hourly starting in mid-spring and ending in early fall with the expectations of capturing stream temperatures during low flow and high temperature periods during the summer months. Low flow-high temperature periods are important to monitor because they are when fish are most vulnerable to physical stressors, particularly temperature. These longitudinal temperature collection sites are well supported by CTUIR management and are expected to be collected well into the future.

Additional temperature sites are setup in off channel pools, spring brooks and other similar features that are only connected to Meacham Creek during the summer months through hyporheic/groundwater exchange. These sites are meant to monitor the effectiveness of the planned 2011 Meacham Creek Floodplain Restoration and In-stream Enhancement Project RM's 6-7.1 to contribute cool thermal refugees for rearing fish. These sites are also meant to complement the Meacham Creek Geomorphic-Hyporheic Flow Study being conducted which is described later in this section. CTUIR is expecting to continue to monitor some of these sites after the groundwater monitor project is complete, and is planning on adding the sites to its annual stream temperature monitoring program described above.

In order to analyze stream temperature data and the effectiveness of aforementioned restoration projects, CTUIR has adopted the ODEQ's standards of generating a 7 day maximum average daily temperature for each site (Figure 25). The 7 day maximum average daily temperature averages the highest daily temperatures in any given consecutive seven day period. Long term exposure to high temperatures are more indicative of how temperature affects fish health rather than short term exposure to elevated temperatures. Additionally, the 7 day maximum average daily temperature helps eliminate any bias in temperature monitoring that could be affected by one or two days of abnormally elevated ambient temperatures.

CTUIR cost share operates with the USFS an automated water sampler (ISCO) near the mouth of Meacham Creek (RM 2.0). Water samples are analyzed under subcontract at the USFS Water Quality Laboratory for turbidity, total suspended solids, total dissolved solids, and specific conductivity. Data is entered into the CTUIR water quality data base. About 1600 samples are processed yearly.

Analyzed data can measure changes in suspended solids and turbidity from watershed activities, and is a good measure of water quality. Samples for turbidity, total suspended solids, and specific conductivity will be collected and transported to the USFS Water Quality Laboratory for analysis. Sampling procedures and water quality analysis will conform to the stipulations included in the latest edition of EPA's Water Quality Criteria (1986) and A Guide to the Sampling and Analysis of Water and Wastewater (1987). All approved data is then uploaded to

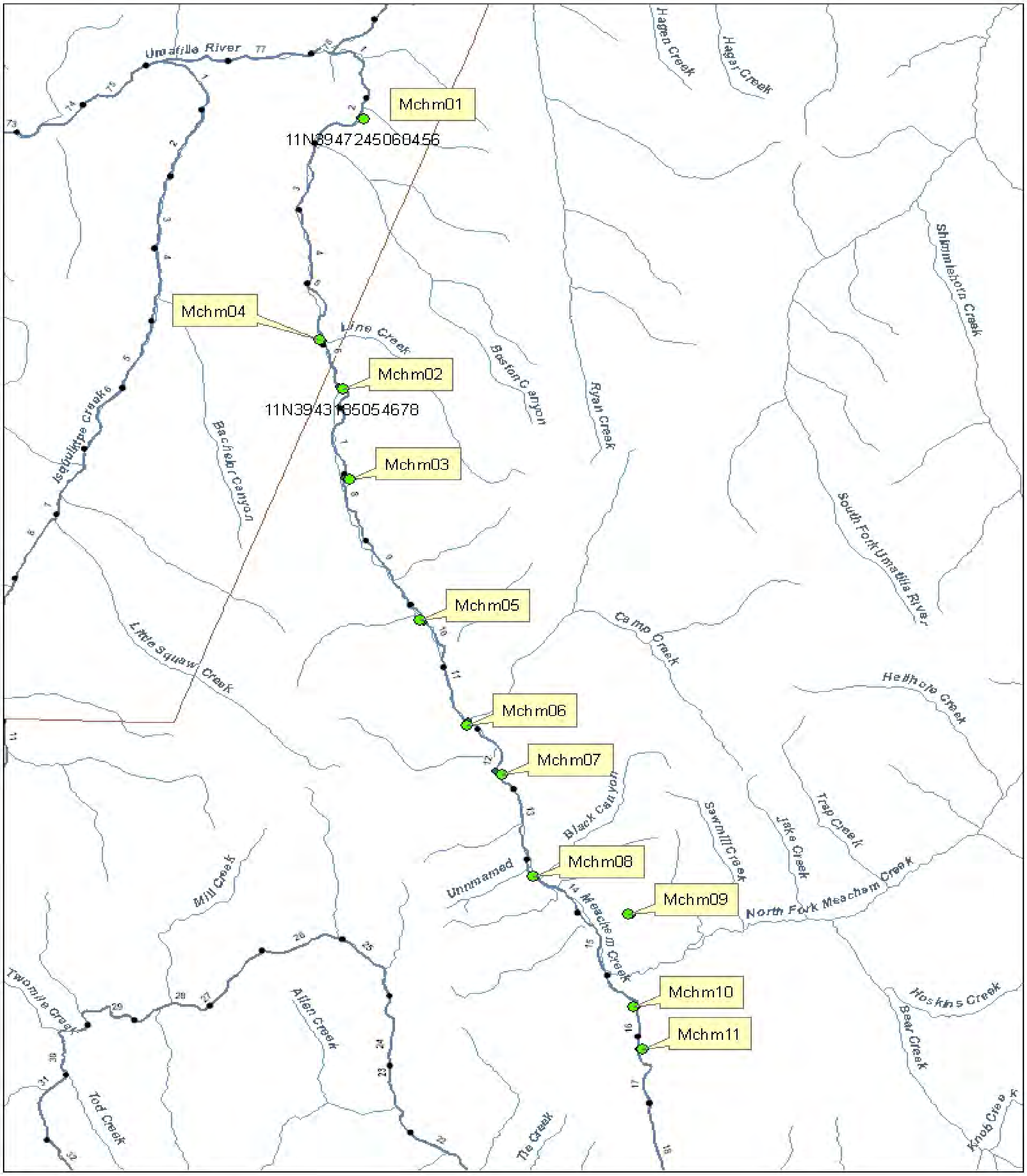


Figure 24. Temperature monitoring sites located within the Meacham Creek subbasin between RM 0-16.5, 2005 to present.

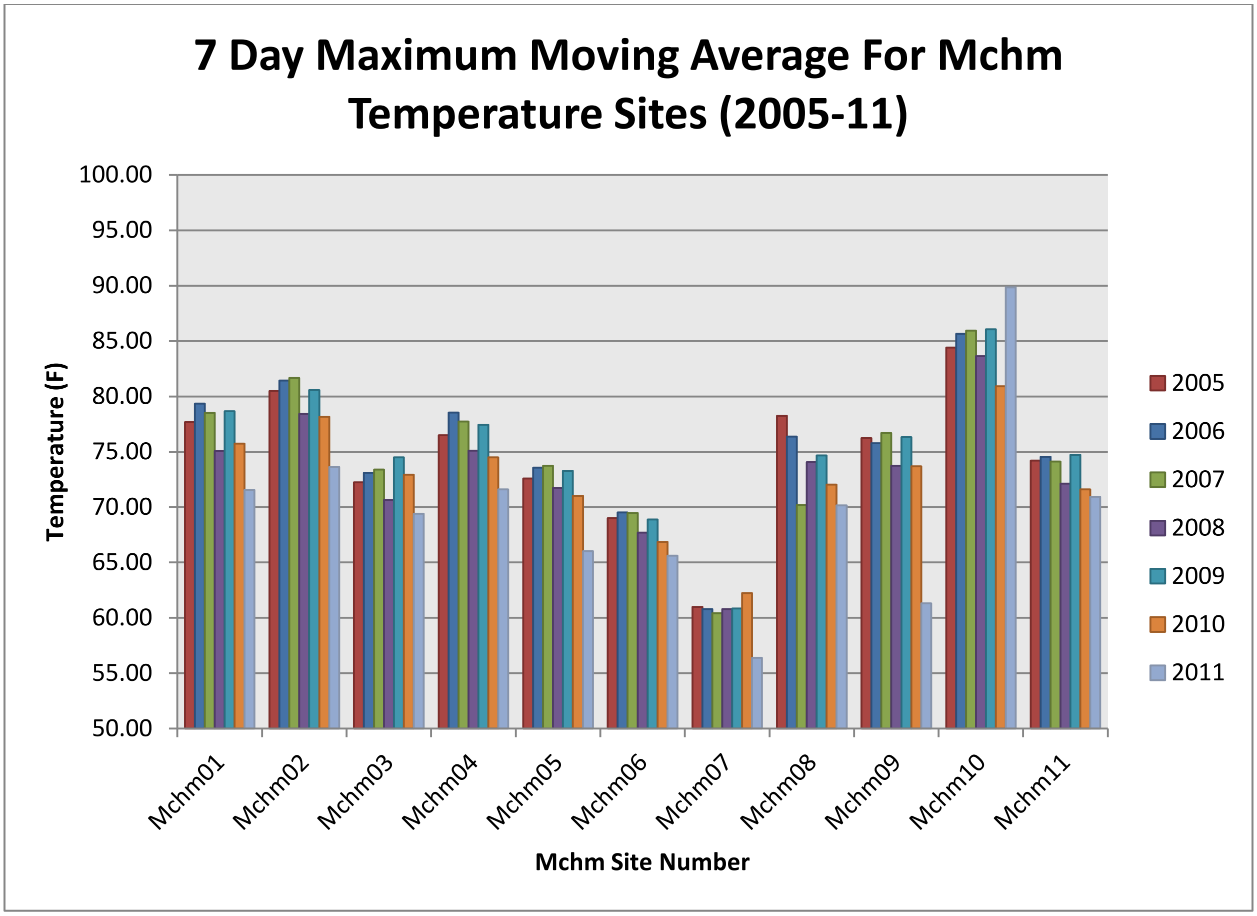


Figure 25. Seven consecutive day average of the daily maximum temperatures (7-day maximum moving average at all Meacham Creek sites since 2005

the CTUIR water quality data base semi-annually. Figure 26 is a summarized turbidity plot from 2009 to 2011. Meacham Creek is a low sediment input stream and not listed for turbidity. Monitoring will continue to be used for evaluating habitat project effectiveness from long-term project ground disturbance.

Meacham Flow/Hydrology Monitoring (USGS)

The flow/hydrology monitoring is a 50% cost share funded project with the USGS to operate and maintain the Meacham Creek real-time flow gage at RM 1.5 (near Gibbon; 35-yr record). USGS provides timely and accurate instantaneous stream flow data for various in-stream actions. These instantaneous stream flows are an integral element in determining the available in-stream resources (e.g. fish) and the available out of stream resources (e.g. people). Data is utilized for long-term monitoring and hydrological flow analysis for project planning and design. This data is integral in CTUIR's ability to design effective restoration projects in Meacham Creek, which is a priority area for restoration.

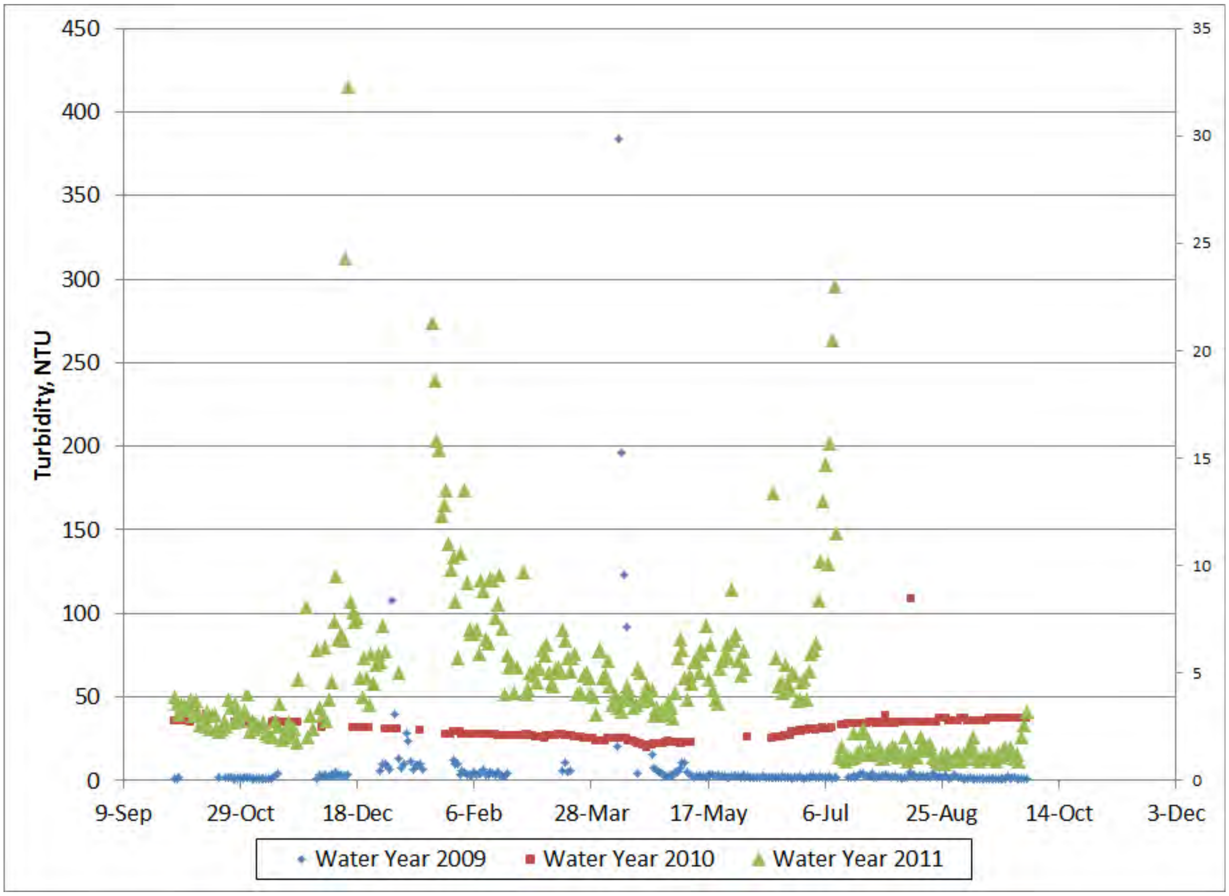


Figure 26. Meacham Creek turbidity plot in nephelometric turbidity units, 2009-2011.

<u>Aquatic Habitat Inventory and Fish Monitoring</u>

McKay Creek Subbasin

In 2009, the CTUIR DNR completed a rapid analysis of cultural, fisheries, and physical stream habitats to assess the potential for anadromous fish in McKay Creek, tributary to the Umatilla River Basin, in order to relate cultural, biological and physical measures to inform decisions about passage through the McKay dam (Figure 27). This effort focused on

1) A synoptic snapshot of the McKay basin,
2) Information sufficient to estimate the success of anadromous fish in the basin, specifically spring Chinook salmon and summer steelhead-rainbow trout, and
3) First order relationships between cultural sites, resident fish measures (potential richness, biomass, density and life history) and physical stream attributes.

The purpose of the rapid analysis assessment was to provide CTUIR decision makers of the potential for restoring anadromous passage to McKay Creek. Within the next few years, the CTUIR, in cooperation with the BOR could seek to create passage for anadromous fish through McKay Dam, which could address; 1) Tribal goals for First Foods, 2) expansion of high quality habitat for Pacific Salmon, in support of the ESA, 3) Umatilla Indian Reservation restoration, 4) Tribal cultural perpetuation, and 5) modernization of aging public infrastructure. The aquatic habitat inventory and final report is located in Appendix A.

Meacham Creek Floodplain Restoration and In-stream Enhancement Project (RM 6-7.1)

In 2010, an environmental baseline was established for Meacham Creek for the geographical area surrounding the Meacham Creek Floodplain Restoration and In-stream Enhancement Project (RM 6-7.1). This information was attained from multiple agency assessments and subbasin planning documents as well as newly collected summarized site data and formulated into the Final BA (Tetra Tech 2010). The project biological assessment included a summary of water quality, habitat access, habitat inventory analysis, channel conditions/dynamics, flow/hydrology, watershed conditions, and geomorphic assessment.

In addition to the full description of the environmental baseline we also used multiple fish population data sources to establish the potential effects of project activities on listed fish populations of Mid-Columbia River Steelhead and Columbia River bull trout.

Fish Population Monitoring

In the context of habitat restoration actions, project staff consolidated regional and local data in order to assist in project activities, such as local and regional project presentations, permitting, development of biological assessments and evaluations, design, pre- and post-project analysis, project effectiveness, and long-term biological and physical recovery response. The Umatilla Anadromous Fish Habitat Project coordinates with multiple CTUIR and ODFW research projects that monitor and evaluate the success of the Umatilla Fisheries Program as a whole.

These projects deal with natural production monitoring (CTUIR Umatilla Basin Natural Production Monitoring and Evaluation Project; 1990-005-01 and ODFW Evaluation of Juvenile Salmonid Outmigration and Survival in the Lower Umatilla River; 1989-024-01) and are critical for evaluating natural production relative to sustainable habitat for salmonids.

This project utilized data from research projects in the basin to identify trends in response to habitat management actions assisting with prioritizing future restoration actions. Juvenile production and adult spawn surveys from subbasin monitoring projects were used to examine relationships between production and restored function in the Umatilla River Basin and help to document fish benefits to restoration actions. Fish data was also collected and utilized in the Extensive Habitat Assessment of the Umatilla River Watershed (**See Appendix B**).

Experimental Design Description

Macroinvertebrate Study

Macroinvertebrate baseline data has been collected since 2005 using a modified EPA Environmental Monitoring and Assessment Program (EMAP) protocol for targeted riffle sampling (Peck et al. 2006). A suite of environmental variables were collected and measured at 16 site locations over two large reach project areas (RM's 2-4.5 and RM 5-7) in Meacham

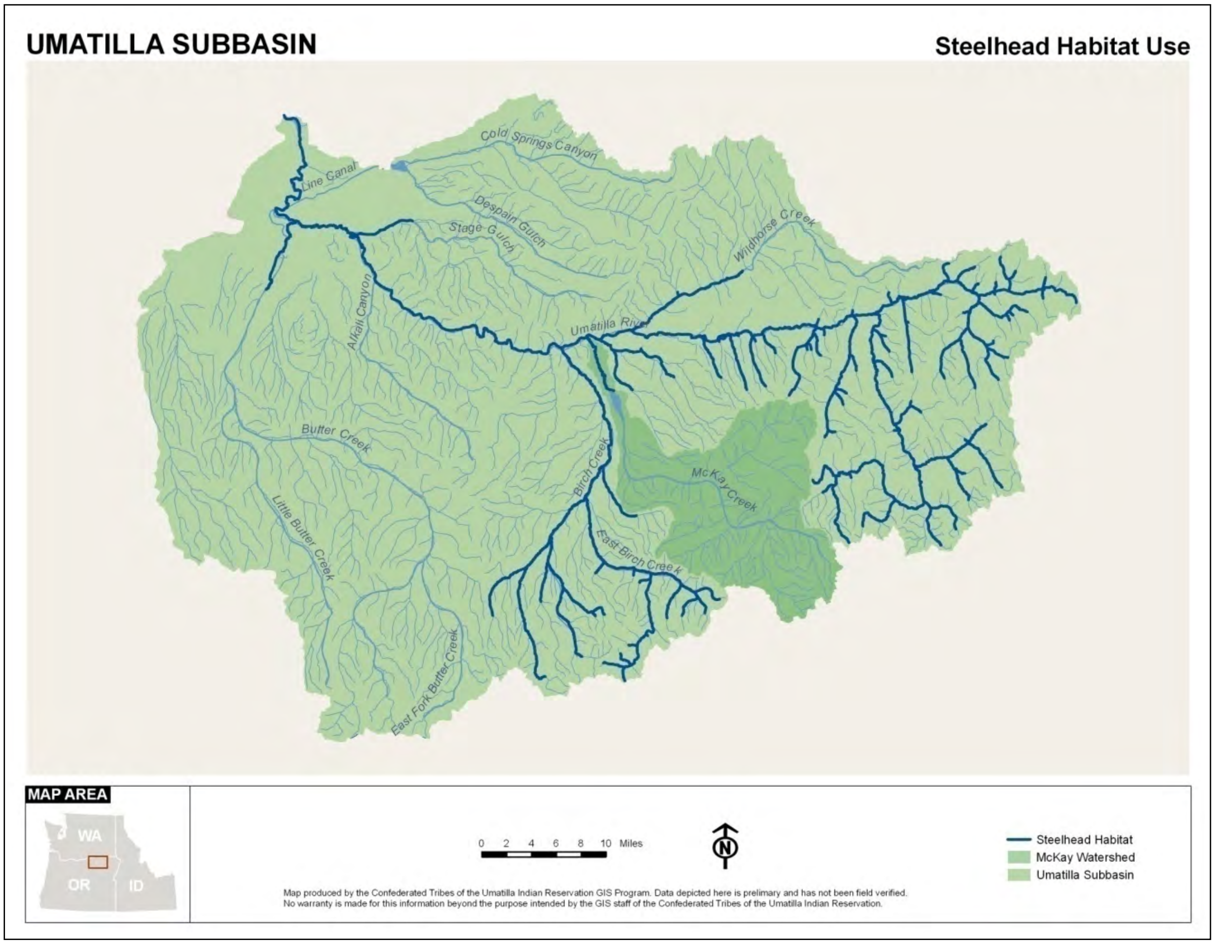


Figure 27. Map of the Umatilla Subbasin highlighting the McKay Creek drainage and steelhead habitat use.

Creek at the time of macroinvertebrate sampling. These variables include habitat metrics: slope, substrate composition, water depth and velocity, wetted width, cover, woody debris, percentage of filamentous algae, and water quality measurements (turbidity, conductance and dissolved oxygen). The primary objective of the macroinvertebrate sampling is to provide pre-restoration data on the macroinvertebrate community of Meacham Creek that can be used to examine changes in stream quality after large restoration projects. Secondary objectives include: a) an examination of environmental variables that correlate with macroinvertebrate community structure. This provides insights into the variables that are important in driving macroinvertebrate community structure in Meacham Creek and b) a comparison of the macroinvertebrate community in Meacham Creek to that in the North Fork of the Umatilla River.

Data analysis included a multivariate analysis (ordination) and an examination of five metrics commonly used in biological assessments:

1) Assemblage Tolerance Index (ATI). This metric was developed by the US Environmental Protection Agency using macroinvertebrate and human disturbance data from the US EPA EMAP survey of over 1100 sites in the western US (Whittier and Van Sickle 2010). To develop this metric tolerance values were assigned to individual macroinvertebrate taxa by relating their abundance to a synthetic human disturbance index. The human disturbance index was based

upon nine variables from three general classes related to the lotic environment – water quality, physical habitat at the sample reach, and human activity in the sampled watershed above the sample reach (Whittier and Van Sickle 2010). The ATI is an average tolerance value for the macroinvertebrate assemblage at a study site weighted by the relative abundance of each taxon:

$$ATI = \Sigma(TV_i \times RA_i),$$

where TV_i is the tolerance value of taxon "i" and RA_i is its relative abundance within the assemblage.

Tolerance values for taxa are scaled from 0 to 10 with sensitive taxa having low tolerance values and tolerant taxa having high tolerance values. With improvement of conditions within a restored reach the ATI score is expected to decrease (as the relative abundance of sensitive taxa increases).

2) Inferred Temperature. This metric was developed by the Oregon Department of Environmental Quality using macroinvertebrate and temperature data from 328 sites throughout Oregon (Huff et al. 2006). This metric was developed and is calculated in a similar fashion as the ATI. From the 328 sites, invertebrate taxa were assigned an optimal temperature based upon abundance and the average of the daily maximum water temperature for the warmest 7-day period. The inferred temperature metric is calculated as:

$$\text{Inferred Temperature} = \Sigma(TempOpt_i \times RA_i),$$

where $TempOpt_i$ is the temperature optima for taxon "i" and RA_i is its relative abundance.

Summing these values across all taxa within an assemblage provides an "inferred temperature," which is the water temperature estimated based upon a site's assemblage composition. Huff et al. (2006) found a good fit between inferred temperatures and actual water temperatures (measured using dataloggers) for the Oregon data set. However, they found that in relatively warm systems, macroinvertebrate assemblages tended to underestimate actual maximum water temperatures and in cold systems macroinvertebrates tended to overestimate maximum water temperatures. In his bio-assessment of a restoration project in the Grande Ronde watershed that involved channel reconstruction, Whitney (2007) found this metric to be responsive to the restoration efforts.

3) Taxa Richness. This is a count of the number of taxa found in the macroinvertebrate assemblage. Taxa richness is predicted to increase with increasing environmental quality (Karr and Chu 1999; Whitney 2007).

4) Mayfly-Stonefly-Caddisfly (Ephemeroptera-Plecoptera-Trichoptera, EPT) Taxa Richness. This metric is a count of the number of taxa found within these three orders of aquatic insects. Taxa within these three groups are generally sensitive to a variety of human impacts, and thus their taxa richness is predicted to increase with increasing stream habitat quality (Karr and Chu 1999).

5) Assemblage Diversity. Assemblage diversity is a function of both taxa richness and the relative abundance of each taxon. Shannon diversity (H') is the specific diversity metric calculated for the Meacham Creek macroinvertebrate data:

$$H' = -\Sigma p_i \log_e p_i,$$

where p_i is the relative abundance of species "i".

Diversity is predicted to increase with increasing habitat quality (Karr and Chu 1999).

Ordination analyses allow an examination of the entire macroinvertebrate community in a manner that takes into account both the taxa of organisms and their relative abundance. Results show the most likely environmental variables that determine community structure.

Monitoring results provide solid baselines for measuring changes in organism taxa and abundance after restoration activities are implemented. Only baseline data are available through sample year 2010. The data are shown in scatterplot form for all five metrics in Figure 28. A comparison of the regression slopes for the within-project sites and the control sites revealed that, as predicted for the before restoration data, no differences in slopes existed for any of the five metrics examined (Table 9). In addition, none of the regression equations were significant (Table 9) indicating that the metrics are not displaying any linear trends through time.

Macroinvertebrate sampling occurred at the seven Meacham Creek sites in September 2011 approximately 1 month after the historic channel was opened. While these samples are still being processed, our observations in the field indicated that very few macroinvertebrates had colonized the new channel by September 2011. Because the restoration has recently taken place we propose to continue to sample macroinvertebrates in the project area (and at the control sites above and below the project area as well as at the North Fork Umatilla sites) annually for the next five years to capture the dynamics of the initial colonization of the opened channel. After five years enough data will have been collected to conduct the analyses we have outlined here in a robust fashion. After five years macroinvertebrate monitoring should continue; however, an evaluation of the need for annual monitoring should be made.

Meacham Creek Geomorphic-Hyporheic Flow Study

Protocol: Meacham Creek Geomorphic-Hyporheic Flow Study (URL Citation: http://www.monitoringmethods.org/Protocol/Details/677).

Background/Rationale

CTUIR proposes to strategically implement enhancement work on Meacham Creek RM's 6-7.1 to enhance floodplain and stream morphology, while providing enhanced habitat for fish. Enhancement techniques include, but are not limited to, woody debris placement in channel and in floodplain, levee setback or removal, channel reconstruction for increased in-stream habitat complexity and stabilization, and native plant and grass restoration. Project actions are expected to improve physical functions by 1) diversifying channel morphology and 2) increasing connectivity between surface and subsurface features. With time, we expect watershed treatments will lead to increased abundance and diversity of riparian vegetation, and increased fish habitat diversity. This research will document the effects of a conventional restoration project on hyporheic exchange and water temperature at multiple scales in Meacham Creek.

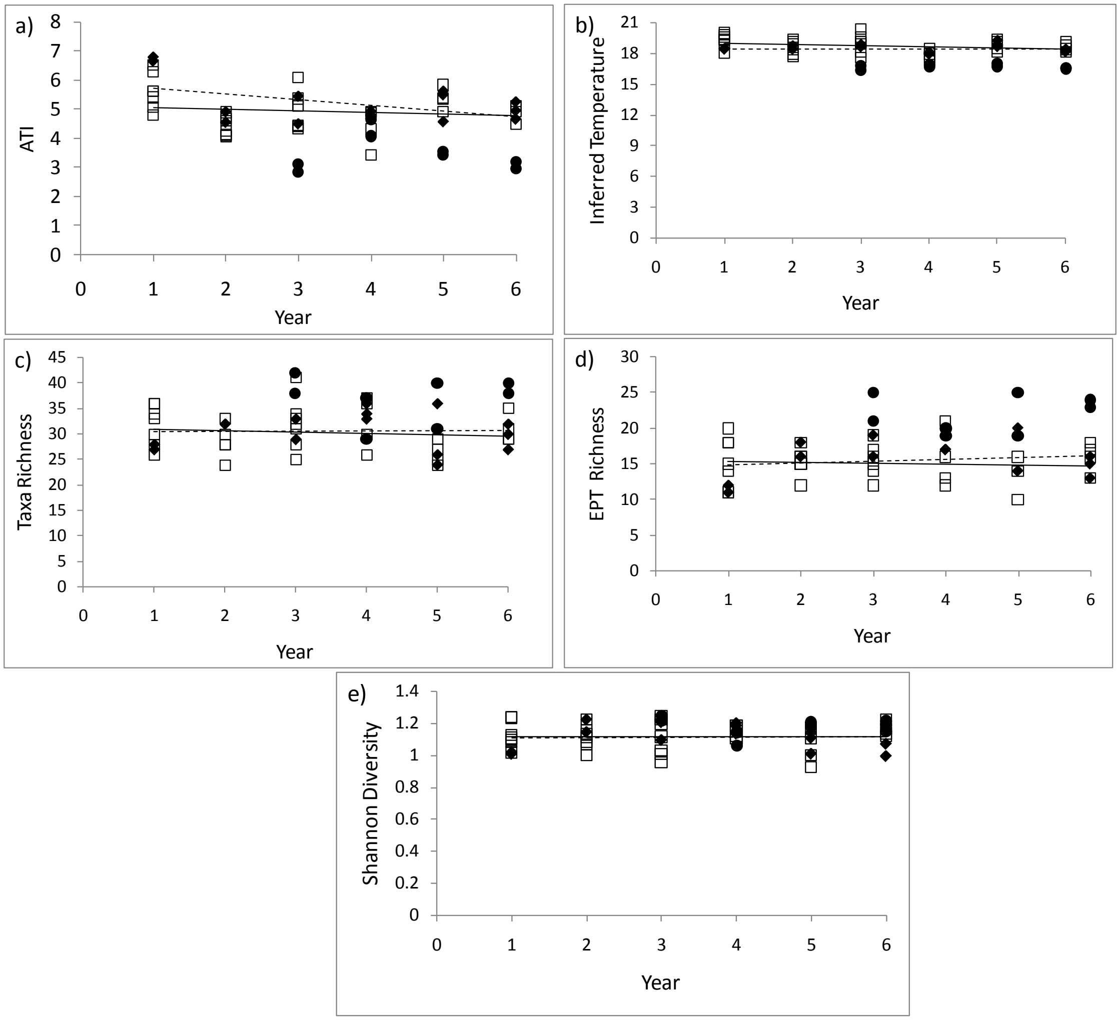


Figure 28. The five metrics illustrated across the six sampling years. The metrics are a) the Assemblage Tolerance Index (ATI), b) inferred temperature, c) total taxa richness, d) richness of Ephemeroptera-Plecoptera-Trichoptera (EPT) taxa, and e) Shannon diversity. Values for control sites are open boxes and the regression is shown with a solid line. Values for within-project sites are shown as filled diamonds and the regression is shown with a dotted line. Values for the North Fork sites are shown as filled circles. The x-axis shows the sampling years with 2005 as Year 1 and 2010 as Year 6.

This includes project goals of: 1) Quantify water residence time distribution both prior to and after restoration actions to assess changes in recharge and discharge between Meacham Creek and its alluvial aquifer (hyporheic exchange), 2) Establish a monitoring network of stream thermographs to measure changes in surface and subsurface water temperature due to restoration actions, 3) Pilot a new method of stream restoration monitoring that will have broad utility to other restoration efforts in the region, and 4) Produce and submit a manuscript for peer reviewed publication describing the results of the study.

Table 9. Regression equations for control and within-project sites for each of the five metrics. Significance values for each regression are also given. The last column "Slope comparison" is a test of the control and within-project regression slopes for each metric.

Metric	Site Group	Regression	Regression p-value	Slope comparison
ATI	Control	ATI = 5.1 – 0.053*Year	0.47	F = 1.22, p = 0.27
	Within-project	ATI = 5.9 – 0.19*Year	0.08	
Inferred Temperature	Control	Temp = 19.1 – 0.12*Year	0.11	F = 0.90, p = 0.35
	Within-project	Temp = 18.5 – 0.01*Year	0.86	
Taxa Richness	Control	Richness = 31 – 0.28*Year	0.53	F = 0.15, p = 0.70
	Within-project	Richness = 30 +0.02*Year	0.97	
EPT Richness	Control	EPT = 15 – 0.13*Year	0.65	F = 0.60, p = 0.44
	Within-project	EPT = 15 + 0.26*Year	0.52	
Shannon Diversity (H’)	Control	H’ = 1.12 – 0.0002*Year	0.98	F = 0.001, p = 0.97
	Within-project	H’ = 1.11 + 0.0003*Year	0.98	

This research is in partnership with Montana State University and will be a critical first step in understanding the efficacy of conventional restoration strategies for hyporheic rehabilitation. Efforts will provide a first empirical test of whether geomorphic restoration is cost effective means of managing water temperature in streams that violate EPA’s water temperature standards for the region and nationally. This research will also provide the first reach-scale evaluation of a stream restoration specifically implemented to meet the objectives of hyporheic restoration and temperature mitigation. Finally, this work would serve as a model for partnership between academia and managers in developing research-based monitoring strategies that facilitate learning and thus adaptive identification of effective structural and process-based restoration strategies for reestablishing vertical connectivity (Ward 1989, Stanford and Ward 1993) by restoring hyporheic hydrology in river ecosystems.

Objectives for this Protocol

Develop and implement a study that evaluates the hydrologic effectiveness of stream reach treatment methods in Meacham Creek, Oregon.

Study Design

A series of 30 monitoring wells were installed in 2011. The wells are distributed throughout the floodplain at the restoration and are spatially-distributed in a pattern designed to capture changes in subsurface water movement and temperature in response to channel plan form changes due to restoration. A temperature and level logger is deployed in each well. In addition, approximately thirty water temperature loggers have been deployed in open water locations in the main channel as wells as in spring brooks and backwater channels throughout the floodplain at the restoration site. The temperature loggers are deployed in a pattern meant to capture groundwater temperature shifts easily measured in hydrologic features that arise due to groundwater upwelling. These data should allow relatively fine-scale measurement of the distribution of groundwater surface and water temperature throughout the Meacham Creek floodplain. The wells and loggers have been either surveyed with a total station or their position logged via Global Positioning System (GPS).

Temperature and water level loggers are deployed in approximately sixty locations throughout the Meacham Creek floodplain. Each logger records a temperature/level measurement once per hour. The loggers will be deployed for a total of 18 to 24 months.

Groundwater Modeling

In late 2010 and early 2011, groundwater hydrology of the baseline and restored channel alluvial aquifers was modeled using the USGS groundwater modeling software MODFLOW (Harbaugh 2005), where the main input into the aquifer was the water surface elevation of the creek plan form. Surface water elevation was derived from first-return Light Detection and Ranging (LiDAR) for the baseline condition, and under the restored condition it was based on "filling" the design channel pools and the riffle ground elevations. In either case, aquifer thickness was assumed to be 5 m in the valley center, tapering to 0.5 m at the valley wall using the LiDAR terrain model as the surface. Once the potentiometric flow surface was developed, subsurface flow path lines through the potentiometric flow field were generated by releasing "particles" along the creek using the USGS solute modeling software MODPATH (Pollock 2008).

The groundwater modeling predicted that there would be a significant shift in groundwater surface elevation, as well as in the pattern and magnitude of exchange between groundwater and surface water in the project reach. Based on these initial hydrologic simulations of the site (Figure 29), it is predicted that the residence time distribution of hyporheic water will shift to include a higher number of intermediate duration hyporheic flow paths, but that the magnitude of gross hyporheic exchange may either increase or decrease, depending on the change in hydraulic conductivity (Figure 30).

SUMMARY AND CONCLUSIONS

The CTUIR UAFHP completed six primary habitat enhancement projects centered on improving in-stream and riparian habitat complexity and restoring natural channel morphology and floodplain function within the Umatilla River Basin. An Extensive Habitat Assessment of the Umatilla River Watershed was completed in order to characterize essential habitats for critical salmonid life stages, gain further insight into the scales of physical processes that support those habitats in key channel reaches, and predict the spatial patterns of physical and aquatic diversity across the watershed. In addition, CTUIR conducted an assessment and baseline inventory of riverine habitat and fish populations in upper McKay Creek to educate CTUIR policy members on benefits of restoring fisheries in McKay Creek to historic conditions. Lastly, maintenance work of ongoing riparian or passage projects continued at 27 pre-existing long-term easement properties with 23 individual landowners.

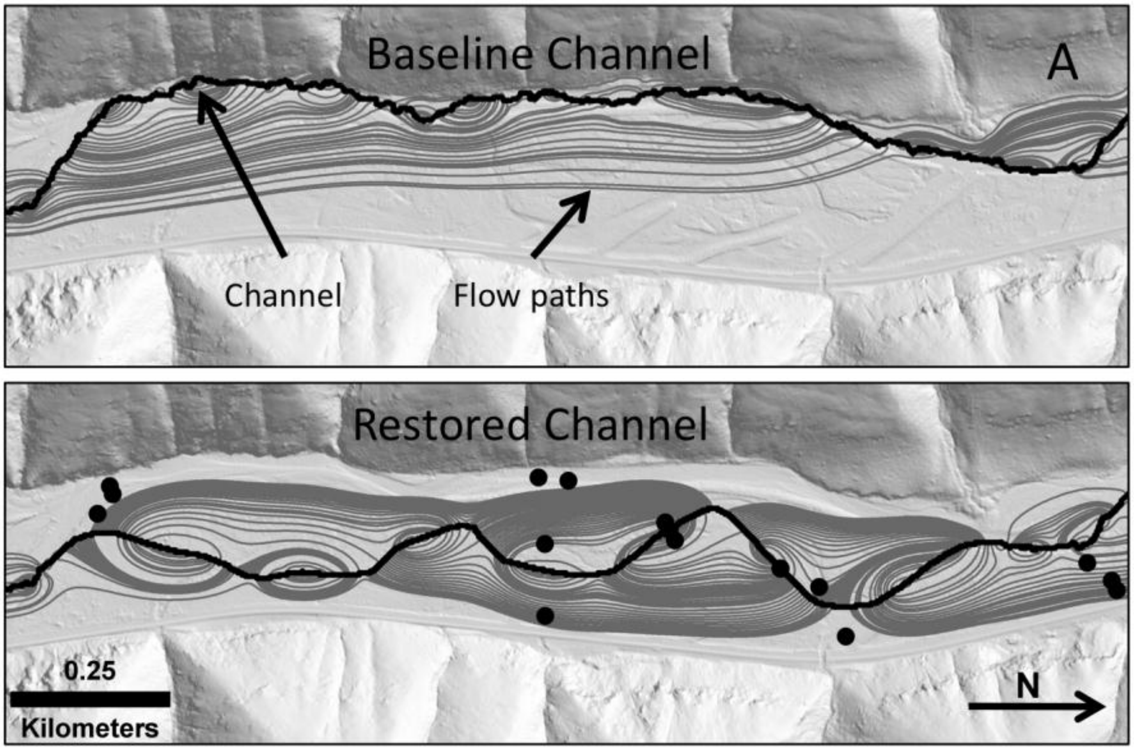


Figure 29. Results from MODFLOW simulation showing expected influence of restoration on hyporheic flow paths (grey lines) on the Meacham Cr. restoration site. Dots show locations of installed monitoring wells in the project site area.

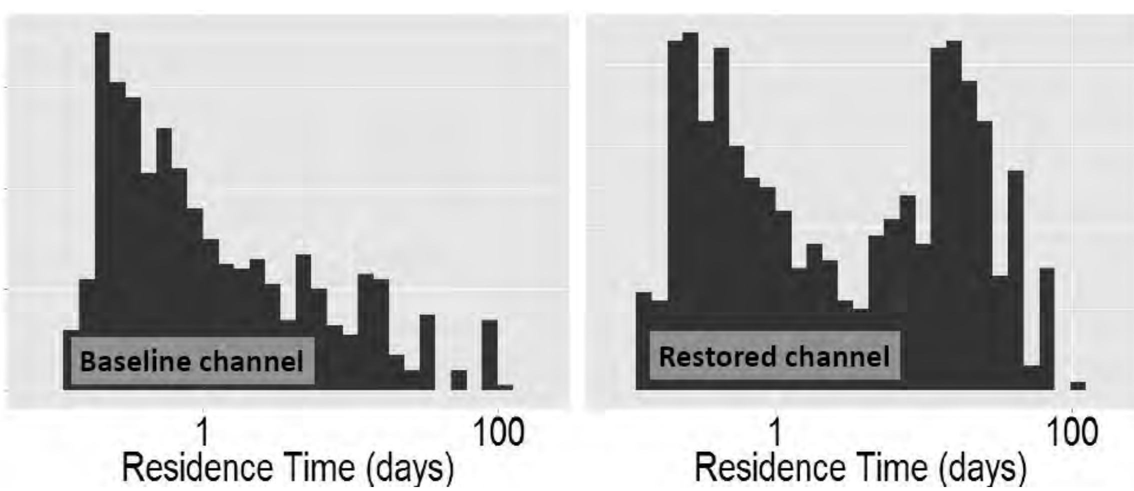


Figure 30. Simulated hyporheic flow-path residence time distributions based on MODFLOW groundwater models depicted in Figure 29.

Major project highlights included removal of three longitudinal levees and modification of one angular levee in Meacham Creek, built cattle exclusion fencing over seven miles of Meacham Creek, improved 0.1 mi of Birch Creek by stabilizing 335 ft of streambank, improvement of fish habitat by additions of large wood and increased density of vegetation, and planted about 12,811 saplings and cuttings over 10 planting project areas.

A principal strength and focus of the CTUIR UAFHP project is the ability to work cooperatively with the various entities throughout the restoration process. Staff participated and cooperated with multiple agencies and stakeholders in the Umatilla Basin Watershed including ODFW, USFS, NRCS, conservations districts, USFWS, UBWC and local stakeholders to enhance or protect natural resources, identify problems and solutions, coordinate efforts to prevent duplication, enhance communication and cooperation and identify funding and cost share opportunities within the Umatilla River Subbasin. This was magnified by the development of the Umatilla Basin Restoration Team. This forum was established to build a coordinated and strategic approach to the restoration of habitat in the Umatilla Basin.

The CTUIR continues to emphasize more attention toward project planning in regard to developing a systematic approach for site selection based on scientific data as well as to increase efforts towards effectiveness monitoring (both have been considered as shortfalls in the past from review committees). The new CTUIR philosophy emphasizes adaptive management as a means of maximizing success at each project site.

The UAFHP is an ongoing effort to protect, enhance and restore functional floodplain, channel and watershed processes to provide sustainable and healthy habitat for aquatic species in the Umatilla River Basin, including Threatened Mid-Columbia steelhead. Project work further supports the CTUIR DNR ecological and First Foods mission statements to sustain production. Applying the River Vision floodplain principles have been successfully applied in effort to reestablish the salmonids to self-sustaining levels. We expect an exponential response of salmonid populations once habitat floodplain and channel function is addressed and improved. We believe a positive correlation between habitat improvement, salmonid density, and fitness levels will shift the status of ESA-Listed species towards a safer level of sustainability in the Umatilla River Basin.

SUMMARY OF EXPENDITURES

CTUIR UMATILLA ANADROMOUS FISHERIES ENHANCEMENT PROJECT
FY2009 BUDGET

Contract Period: February 1, 2009 – January 31, 2010
Project # 1987-100-01 – Contract 42025

		Contracted Budget	Actual Expenditures	Variance
	PERSONNEL			
5000	Salaries	$302,062	$268,518	$33,544
5010	Fringe Benefits	$103,788	$88,574	$15,214
	PERSONNEL SUB TOTAL	**$405,850**	**$357,092**	**$48,758**
	TRAVEL			
5101	Per diem	$16,048	$9,219	$6,829
5150	Training	$5,670	$2,887	$2,783
5160	Vehicle Insurance	$2,074	$1,362	$712
5190	Vehicle Expense	$22,798	$15,032	$7,766
	TRAVEL SUB TOTAL	**$46,590**	**$28,500**	**$18,090**
	SERVICES & SUPPLY (S&S)			
5210	Supplies	$1,350	$581	$769
5225	Field Materials	$16,303	$14,628	$1,675
5226	Books/Journals	$300		$300
5250	Non-Capital Equipment	$10,240	$4,768	$5,472
5400	Communications	$1,200	$347	$853
5410	Postage/Freight	$250	$28	$222
5430	Dues and Subscriptions	$187	$187	
5432	Permits/License	$50	$25	$25
5436	Permits/Fees	$2,500	$168	$2,332
5440	Equipment Rental	$700	$162	$538
5450	Printing/Duplication	$250	$31	$219
5460	Insurance	$100	$11	$89
5470	Repairs & Maintenance	$5,500	$1,306	$4,194
5480	Advertising	$600		$600
	S&S SUB TOTAL	**$39,530**	**$22,242**	**$17,288**
	DIRECT TOTAL	**$491,970**	**$407,834**	**$84,136**
8500	Indirect 38.2%	$181,284	$149,187	$32,097
6100	Subcontract Fees	$490,675	$396,892	$93,783
6300	Capital Equipment	$8,000	$7,941	$59
6510	Utilities	$550	$427	$123
	PROJECT TOTAL	**$1,172,479**	**$962,281**	**$210,198**

CTUIR UMATILLA ANADROMOUS FISHERIES ENHANCEMENT PROJECT
FY2010 BUDGET

Contract Period: February 1, 2010 – January 31, 2011
Project # 1987-100-01 – Contract 46159

		Contracted Budget	Actual Expenditures	Variance
	PERSONNEL			
5000	Salaries	$248,438	$219,881	$28,557
5010	Fringe Benefits	$76,225	$72,244	$3,981
	PERSONNEL SUB TOTAL	**$324,663**	**$292,125**	**$32,538**
	TRAVEL			
5101	Per diem	$7,714	$4,541	$3,173
5150	Training	$7,985	$8,195	($210)
5160	Vehicle Insurance	$2,196		$2,196
5190	Vehicle Expense	$23,962	$23,875	$87
	TRAVEL SUB TOTAL	**$41,857**	**$36,611**	**$5,246**
	SERVICES & SUPPLY (S&S)			
5210	Supplies	$2,500	$1,573	$927
5225	Field Materials	$95,713	$17,359	$78,354
5226	Books/Journals	$440	$245	$195
5250	Non-Capital Equipment	$17,300	$9,333	$7,967
5400	Communications	$500	$233	$267
5410	Postage/Freight	$250	$365	($115)
5436	Permits/Fees	$5,100	$1,312	$3,788
5440	Equipment Rental	$700	$638	$62
5450	Printing/Duplication	$250	$28	$222
5460	Insurance	$100	$28	$72
5470	Repairs & Maintenance	$5,500	$476	$5,024
5480	Advertising	$600	$600	
	S&S SUB TOTAL	**$128,953**	**$32,190**	**$96,763**
	DIRECT TOTAL	**$495,473**	**$360,926**	**$134,547**
8500	Indirect 37.87%	$173,613	$146,948	$26,665
6100	Subcontract Fees	$772,332	$377,695	$394,637
6300	Capital Equipment	$5,525		$5,525
6510	Utilities	$550	$382	$168
	PROJECT TOTAL	**$1,447,493**	**$885,951**	**$561,542**

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Appendix A - Aquatic Habitat Inventory and Fish Monitoring Report: McKay Creek, June 17, 2009

CTUIR UMATILLA ANADROMOUS FISHERIES HABITAT PROJECT

A Columbia River Basin Fish Habitat Project

Aquatic Habitat Inventory and Fish Monitoring Report:
McKay Creek, June 17, 2009

Summarized From Data Collected June 11-12, 2009

CONTRACT # 42025
Northwest Power Planning Council Project # 1987-100-01

Prepared For:
Confederated Tribes Umatilla Indian Reservation
Department Natural Resources Fish and Wildlife, and Global Information System Programs

Prepared By:
Eric D. Hoverson

Project Leader – Umatilla Anadromous Fisheries Habitat Project

Confederated Tribes Umatilla Indian Reservation
Department Natural Resources Fish and Wildlife Program

CONFEDERATED TRIBES UMATILLA INDIAN RESERVATION

BONNEVILLE POWER ADMINISTRATION

INTRODUCTION

McKay Creek is a moderate-sized tributary that enters the Umatilla River near RM 50.6, just west of Pendleton, Oregon. The basin contains approximately 50 miles of potential habitat for anadromous salmonids. The headwaters are located in the Blue Mountains near the Umatilla/Union County line. The lower six miles of McKay Creek's hydrology is heavily influenced by the McKay Creek Reservoir. The construction of McKay Dam in 1927 created a complete passage barrier for migrational fish. The upper 45 mi is inaccessible to migrating fishes but is inhabited by abundant numbers of resident rainbow trout. Historically, the upper reaches of McKay Creek were preferred destinations for anadromous spawning activity (primarily Chinook salmon and steelhead trout) and were a valued gathering area for members of the Tribal community. Currently, favorable habitat conditions still exist if not for the presence of the fish weir at RM 0.2, and earthen dam located at RM 6.

Over the past decade, the presence of anadromous salmonids (bull trout, Chinook, steelhead, and whitefish) located downstream from the dam has been well documented by CTUIR fisheries personnel. The predominant land use in the lower reaches is comprised of residential developments located at very close proximity to the creek. Primary land uses in the upper reach are comprised by grazing and agricultural crops.

Recently, the CTUIR Fisheries Umatilla Habitat Project conducted an assessment and baseline inventory study of riverine habitat and fish populations in the upper McKay Creek Basin. The data was collected primarily to facilitate the ongoing habitat assessment study being conducted by CTUIR and to initiate the examination of feasibility in regard to potentially re-establishing anadromous salmonids in the McKay Creek Basin. The assessment documented in-stream and riparian habitat conditions, as well as rainbow trout densities and species abundance estimates of non-salmonids.

METHODS

Aquatic habitat Inventory

Aquatic habitat Inventory methods developed by ODFW (Moore et al. 2002) were used to inventory aquatic and riparian habitat at four, 50-m long sites located upstream from the earthen dam in the McKay Creek Basin. Individual site lengths were measured using a range finder.

Habitat inventory surveys were conducted in the field by one person walking upstream, dividing the stream into a series of individual habitat quadrats. Quads were identified as riffle, rapid, glide, or scour pool, and numbered sequentially. Dimensions of quadrats were determined primarily on distinct hydraulic features as defined in the ODFW methods.

The following data was recorded for each quad; habitat type, latitude, longitude, length, wetted and high-flow width, depth, shade, canopy, wood rating, substrate composition, channel type, percent flow, bank class, and undercut bank. Wood ratings were categorical and useful for quantifying the value of in-river woody debris habitat for fish. In addition, pieces of woody debris were tallied if they met minimum size requirements, and were located within the high water channel. Shade values were taken when standing at the center point of each qaudrat. Canopy estimates were made from the middle of riparian zones and located adjacent to each individual stream quadrat inventoried. Notes were taken to supplement the standard entry requirements.

Fish Population Inventory

A crew of three or four persons from the CTUIR UAFHP conducted fish surveys. One backpack electro shocker manufactured by Smith Root Inc. was used to sample fish from a total of 200 m of creek at four different locations inventoried for habitat (Figure 1). Block nets were used at the lower and upper ends to isolate each site. Care was taken to not displace fish from the survey site as block nets were being set. Quadrats with a variety of unit-types with diverse physical characteristics were sampled to represent the general habitat complexity features commonly found in the upper McKay Basin. Salmonids species were targeted and captured with dip nets and removed on successive electro fishing passes until a depletion rate of 50% or greater was achieved. Electro fishers were operated in a similar manner for the same number of seconds as the previous pass. Electro shocker settings remained consistent between each removal pass.

Captured fish were temporarily held in buckets, and then placed in a flow-through live-well upstream from the uppermost block net. All captured salmonids were measured and released back into the site, or in some cases relocated just up or downstream from the sampled reach if conditions appeared significantly better. Electro fishing catch data were expanded using the maximum-likelihood method developed by Van Deventer and Platts (1989).

Figure 1. Fish capturing methodology using electrofishing gear.

RESULTS

Aquatic Habitat Inventory

An Aquatic Habitat Inventory was conducted at four, 50-m locations in the upper McKay Creek Basin during June 11-12, 2009. Two sites were located at the main stem of McKay Creek, and 1 site on each of the north and south forks. Major habitat components included the following averages compiled from all sites: (1) average wetted width: 7 m; (2) average active channel width: 18m; (3) average depth: 0.22m; (4) maximum depth: 0.65m; (5) substrate consisted of the following types: 53% gravel, 18% cobble, 14% bedrock, 9% sand, 6% boulder; (6) 8% of the bank length was classified as undercut; (7) wood rating for fish was 1.4; (8) channel shade was 34%; (9) canopy closure was 19% in the riparian area; and (10) water temperature was 65^0 Fahrenheit (F).

In addition to common habitat degradation phenomenon of the region (channel manipulation/simplification, reduced quantity/quality of riparian areas etc.), other detrimental issues noted were; the presence of a sewage treatment plant adjacent to the creek, abundant algae, and the removal of large woody debris from the stream channel.

Fish Population Monitoring

On June 11-12, 2009, CTUIR electro fished four, 50-m sites on the main stem, north and south forks of McKay Creek. Figure 2 illustrates the diversity of habitat features sampled at four sites. A total of 74 rainbow trout averaging 112 millimeters fork length were captured within the four study sites. The minimum fork length was 84 millimeters and the maximum was 200 millimeters. The expanded population estimate at the four sites was 79 salmonids. The average salmonid density per site ranged from 3-12 salmonids per $100m^2$. The overall density was estimated at 6.5 salmonids per $100m^2$. The following numbers of non-salmonid species were visually estimated at the four sites; 6,750 speckled dace, 1,125 sculpin, 360 shiners, and 10 suckers. Additionally, other notable observations were impressive quantities of aquatic caddis fly larvae and crayfish.

The water temperature at RM 0.2 of McKay Creek was an impressive 53 F, due to the hypolimnium effluent withdrawn from the reservoir. The lower reach of McKay Creek (RM 0-6) appears to have very good potential for spring Chinook salmon if suitable minimum flows can be maintained, and the fish weir removed. Figure 3 shows typical habitat features located downstream from McKay Dam.

There has been a history of problems associated with very low flows downstream of McKay Dam when water is typically stored during the winter months. This has caused significant mortality of fishes located below the dam during episodes of cold winter temperatures, which had resulted in areas of frozen water, and subsequent fish mortality.

NF McKay Creek, RM 0.5

SF McKay Creek, RM 0.1

McKay Creek, RM 13.0

McKay Creek, RM 20

Figure 2. Habitat conditions sampled at four sites.

McKay Creek Fish Weir, RM 0.2

McKay Creek Habitat Upstream From Fish Weir, RM 0.3

Figure 3. Fisheries passage barrier and habitat features located downstream from McKay Dam.

CONCLUSIONS

McKay Creek has excellent restoration potential for listed anadromous salmonid species if habitat deficiencies and passage issues are addressed, and water is managed more favorably for fishes. The potential is primarily based on the historic status of the system as well as the desirable stream elevation and channel gradient, and large quantity of suitable spawning substrate and associated habitat features. The current distribution and abundance of rainbow trout, despite the reduction of habitat quality is also indicative of the favorable restoration potential of the McKay Creek Basin.

McKay Creek has excellent potential for an impressive run of anadromous steelhead trout in the upper 45 mi of habitat, all the way up to the appropriately named "Salmon Back Ridge". The creek above the dam is very well suited for all life stages of steelhead if passage issues are rectified for upstream and downstream migrants. Upper McKay Creek could potentially produce results similar to Isquulkpte or Birch Creek in regard to steelhead productivity.

Habitat located downstream from the dam should be considered not only as steelhead habitat, but potentially as a strong producer of salmon, mainly Chinook, but also coho. Of some concern to restoring salmonids in the lower reach of McKay Creek is the close proximity and potential adverse effects of the sewage treatment plant for the City of Pendleton, Oregon. Meeting water quality standards are not required within the "mixing zone", a 400-yd stretch of water that allows non-compliance with traditional water quality standards and relies on a dilution zone to eventually comply with water quality standards. In the late 1990's, CTUIR sampled the sewage treatment effluent channel and could not find a single living organism within this channel, of which had direct connection to the Umatilla River.

The impacts from McKay Dam in regard to habitat degradation and subsequent damage to the anadromous salmonid component may offer opportunities for mitigation. Mitigation appears justified based on the sequence of actions and associated impacts of McKay Dam to Listed fish species and other natural resources relied upon by the CTUIR community in this area of traditional use. Ultimately, decisions in regard to the feasibility of restoration activities and assessment of compatibility with Tribal objectives will dictate if salmonid restoration activities shall be instituted by Tribal management entities in the McKay Basin.

Appendix B - Extensive Habitat Assessment of the Umatilla River Watershed

Extensive Habitat Assessment of the Umatilla River Watershed

Prepared by Scott O'Daniel
Confederated Tribes of the Umatilla Indian Reservation

Citation:
Scott O'Daniel. 2012. Extensive Physical Assessment for Pacific Salmon; Umatilla River, Oregon, Confederated Tribes of the Umatilla Indian Reservation, Pendleton, Oregon.

Table of Contents

Figures

1 Abstract

In order to inform fisheries management, we used widely available spatial datasets to apply models over large areas to produce rapid, comparable stream habitat assessments. Geologic, hydrologic, and geomorphic variables that influence channel morphology across the Umatilla subbasin were measured. We use several digital elevation model (DEM) derived measures (channel slope, sinuosity, floodplain width, valley slope, wavelength of the channel meander belt and ratio of channel segment length to floodplain width) to produce both standard and statistically derived stream classifications. We create channel classifications using both Montgomery and Buffington (1997) methods and a statistical classification using K-means clustering and fuzzy sets. Using information from this stream classification we compare target segments to all similar segments using a probability distribution rather than analog or reference segments. Classification and regression trees (CART) and neural networks were evaluated in predicting spawning areas (redds) for Oncorhynchus mykiss (summer steelhead) and Oncorhynchus tshawytscha (spring Chinook salmon). Classification and regression trees and neural networks were used to predict potential stream segments capable of redds occupation. In the Umatilla basin, the results of CART produced an R^ of 0.68 for summer steelhead and 0.79 for spring Chinook. In the Umatilla basin, these results suggest that the sum segment length of summer steelhead redds distribution may increase from 1.3% to 4.2% of the network, while outputs for spring Chinook suggest that redds distribution change from 1.9% to 3.6% across the watershed. These results will be used to direct more detailed assessment and scoping for fisheries restoration and population management.

2 Background

Over the past century, stream classification efforts have changed dramatically. Classification can be generally defined as sets of observations or characteristics that are organized into meaningful groups based on measures of similarity or difference (Naiman et al. 1992). One of the most important functions of a stream classification system is communication. Information can be compactly presented if a classification scheme is appropriate for the area to which it is applied. The nomenclature of a classification system is a type of short-hand which transfers complex sets of characteristics with only a few symbols, summarizing a considerable amount of information in a relatively compact form.

There are numerous stream classification approaches that have been and are currently being applied in the field. Some of the more well-known classifications are those of Davis (1899), Schumm (1963), and Vannote and others (1980), but there have been many other attempts at classifying rivers. No single classification system is comprehensive enough to exclude all others. Rather, classification systems are developed in certain physiographic and climatic areas with specific intended uses. The Davis (1899) classification is based on erosional processes and has three main categories of young, mature, and old; Schumm (1963) classified rivers based on stream aggradation and degradation, while Vannote and others (1980) classified rivers according to their ecologic function (Naiman et al. 1992). All of these classification systems are useful for specific purposes, but all have very definite limitations.

Fisheries managers working throughout the CTUIR ceded lands lack the time and resources required to assess existing salmonid habitats, and estimate habitat impairment based exclusively on site visits and field sampling. Numerous river system classifications (Hawkes 1975, Hudson et al. 1992, Maxwell et al. 1995) have been developed to describe, monitor, manage, and efficiently protect river ecosystems. However, unsuccessful combinations of status and assessment procedures relating species populations through expert classification systems have not produced models capable of guiding recovery efforts and more specifically, recent sub-basin plans (NWPCC 2005). Our approach to this problem requires both a classification system that simplifies the natural complexity of rivers, and a model to characterize the suite of primarily physical traits while including existing biological traits at specific, often unsampled, river locations throughout the stream network. Further, we expect to compare like stream segments across and within basins where similar geologic/geomorphic conditions permit. This approach should allow us to compare ecological features that exist in discontinuous stream segments. River scientists (including hydrologists, geomorphologists, fish biologists and stream ecologists) agree that local river conditions are the cumulative product of physical and climatic conditions in the upstream catchment, local valley constraints, and unique ecological properties of the site (Lotspeich 1980, Frissel et al. 1986, Maxwell at al. 1995, Bryce and Clarke 1996, Imhof et al. 1996, Poff 1997, Hawkins et al. 2000).

Physical and biological assessments require an accurate characterization of observed and expected conditions; the status of which can be measured using a combination of field and remotely sensed data. River functions expected to exist under minimal disturbance or reference condition, serve as benchmark to which sites of unknown status are assessed (Karr et al. 1986, Baker et al. 2002). In fluvial systems, determining the appropriate reference condition for a given site is especially challenging. Inadequate data exists to base a target condition given the large, natural variability that existing among and within systems. To address this need, we will create a statistical/geographical model of habitat forming physical processes. Then, using existing biological data for Pacific Salmon, we will relate the presence of salmon life stages (spawning, rearing and migration) to physical habitat measures and locations. The feasibility of statistically modeling site-specific biological reference conditions from physical properties of the site and the associated catchment landscape is already well demonstrated (Hawkins et al. 2000, Wiley et al. 2002). The main challenge constraining widespread use of modeled reference conditions is not primarily conceptual but logistical. To date there has not been an example of a comprehensive dataset for restoration planning that utilizes much of the available spatial data combined with a process based understanding of river functions. We propose to develop such a restoration dataset for the target watersheds by completing the following steps.

Pure geomorphic river classifications are widely used at both the reach (Rosgen 1994) and valley-segment scales (Frissell et al. 1986, Maxwell et al. 1995, Cupp 1989). Geomorphic valley segments have a distinct valley slope, valley cross-sectional profile, degrees of constraint by valley walls, and fairly homogeneous, or predictably patterned, channel meso-scale hydraulic habitats such as pools, glides, and riffles. Geomorphic valley segments are therefore descriptive of some aspects of aquatic habitat, occur at a macro-scale that we believe concurs with the scale at which fish and other mobile aquatic biota operate (Bayley and Li 1992, Gowan et al. 1994, Schlosser and Angermeier 1995, Zorn et al. 2002), and can be readily delineated across large regions by examining maps of valley slope and form. Geomorphic classifications can indirectly capture variations in key ecological factors such as chemistry, hydrology, and temperature that also strongly shape the aquatic biota.

3 Watershed Context

The mainstem Umatilla River is 89 miles long and the river and its tributaries drain an area of nearly 2,290 square miles. The network geometry of the Umatilla River watershed, with the exception of Wildhorse Creek, includes major tributaries entering the river from the south (**Figure 1**).

Historically, natural flow conditions in the Umatilla River were characterized by low baseflows in the summer and fall, large brief winter peak flows caused by rain and rain-on-snow events, and elevated spring and early summer high flows caused by snowmelt in the upper watershed. Like many rivers in the inland Pacific Northwest, discharge of the Umatilla River is over-appropriated for out of stream uses.

Dam operations, flood control regulations, and agricultural and urban diversion have altered the timing and magnitude of historical flows. These changes in hydrologic conditions have reduced normative geomorphic processes in a portion of the Umatilla River watershed. These changes are most obvious on McKay Creek, below McKay Creek Reservoir. McKay Dam blocks all exchange of fish and sediments, and severely alters the flow regime between the lower 7 miles of the stream and the upper 36 miles. The annual flows of sediment, water and accompanying materials (LWD and other organics) is critical to maintaining the dynamic habitats that Pacific salmon are adapted to use (Benda et al. 2003). Fish habitat surveys (Holverson 1996) have identified high quality habitats above the McKay Dam and noted the potential to increase available high quality habitat by providing passage above the McKay dam.

Figure 1. Location of the Umatilla River watershed in Northeast Oregon. Note that lower, northern tributaries including, Despain Gulch and Cold Spring canyon are diverted into the Umatilla River through an inter-basin exchange at Cold Springs.

The topographic relief in this watershed varies from the Blue Mountains characterized by steep valleys to the southern edge of the Palouse, with broad hills deep loess soils. The lowest portion of the Umatilla watershed is characterized by shallow soils and part of the southern extent of the Channeled Scablands resulting from the Missoula floods.

Anthropogenic legacies are foregone where humans live. In urban and urbanizing systems, we can work to understand the ways in which lotic processes and function changes in response. Moreover, as our understanding improves, particularly with regard to compromised resiliency (Jorgensen, 1990; Wissmar and Beschta, 1998; Larson et al. 2001), we can alter the ways that we interact with the environment in order to improve ecosystem functions. Alternatively, perhaps what may happen in these urban systems is that they settle into a different system state (e.g. O'Neill et al. 1988) resulting from functional impingements (e.g. hardened banks and flow alterations) and as such do not respond or behave according to our predictions – in space or time. Therefore, the recovery trajectories that we expect for these altered systems may not be fully informed because of our poor understanding of cross-scale interactions and the ways in which they affect the nature and extent of ecosystem alterations (Peters et al. 2007).

3.1 Geology

Broadly, the geology of the Umatilla river watershed is characterized by the structures of Columbia River basalts (Clarno formation). In sporadic locations throughout the basin, the basalts are overlain by several types of sediments. Sands and silts are the oldest of these while cobbles and occasionally boulders represent more recently deposited material. The Reith anticline and Agency syncline characterize the largest structural features of the basin. These structural features also dictate the general topography of the landscape (Hogenson 1964). Additionally, in several areas, primarily in the northern portion of the basin, where loess deposits are common, an obvious deposit of Mazama ash is evident in road cuts and other erosional features.

The following excerpt from Hogenson (1964) characterizes the channels in the Umatilla River watershed.

> *The Umatilla River is a consequent stream in most of its course across the Pendleton plains and the Umatilla lowland; that is, its general course was determined by preceding geologic and tectonic events. However, where it crosses Rieth Ridge the river seems to be antecedent flowing on rocks that were uplifted after its course was established. It flows through a shallow canyon where it traverses the lowlands east of Pendleton, then crosses Rieth Ridge in a sharp canyon between Pendleton and Echo. The canyon is narrow and steep-walled and reaches a maximum depth of about 750 feet. Two miles north of Echo the river reaches the lowland area covered by the glaciofluviatile deposits. From there to the mouth of Butter Creek, its valley is broad and shallow. West of the mouth of Butter Creek, the Umatilla River turns northward and flows through a shallow, narrow canyon to the Columbia River.*

All the tributaries to the Umatilla River are consequent. Ryan Creek, Meacham Creek, Squaw Creek, and several smaller streams drain the Blue Mountain upland and join the Umatilla River in the upland area. Wildhorse Creek drains part of the Blue Mountain slope and the south flank of the Horse Heaven Hills and enters the Umatilla River in the Pendleton plains. McKay and Birch Creeks drain part of the Blue Mountain upland and the Blue Mountain slope and flow into the Umatilla River in the Pendleton plains.

3.2 Geomorphology and Hydrology

The fluvial geomorphology of the Umatilla River has many unique characteristics and, as is true in many semi-arid systems, is intimately connected with the flow regime of the basin. Further, the character of the geomorphic landscape throughout the floodplain of the Umatilla River has been shown to regulate summer water temperature regimes (O'Daniel 2008).The interaction between the annual flood(s) and the sediment that is redistributed during these events structures the channels in the floodplain and sets the template for the subsurface flowpaths that route water through the floodplain between channels.

During flows at or above the bankfull stage, sediments are redistributed across the floodplain and create distributions of substrate that, along with other factors) structure aquatic communities. The downstream hydraulic gradient is an

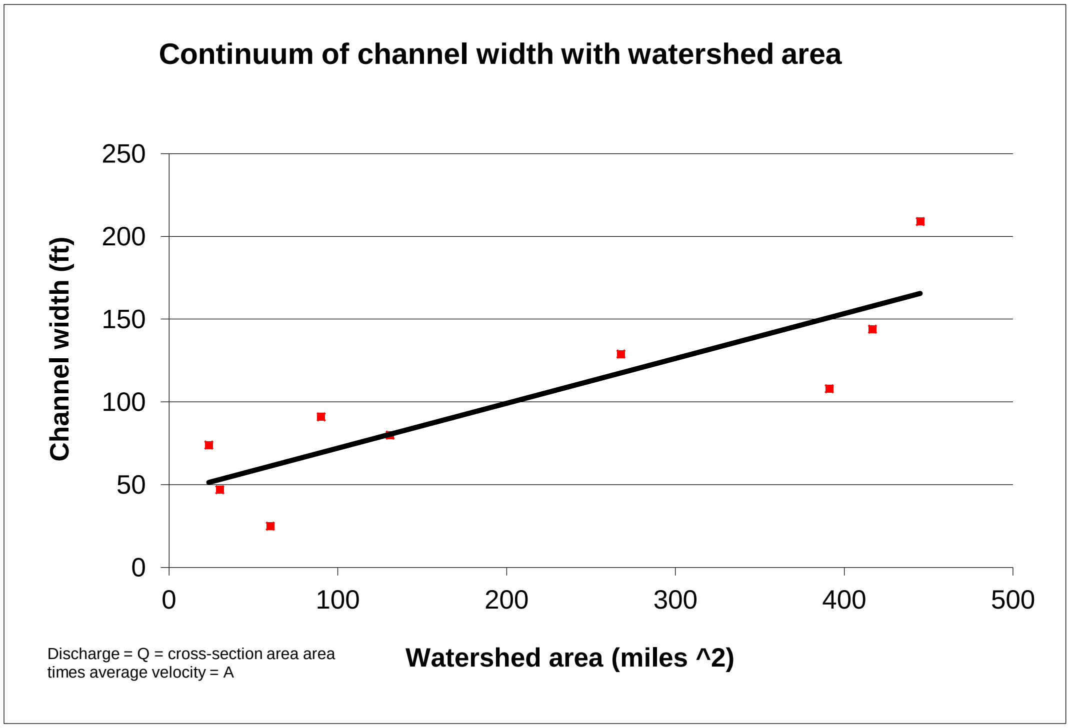

Figure 2. Plot of watershed area and channel width collected in 2000 along the mainstem Umatilla River (Clifton et al. 2000). The regression line, shown in the figure above describes an R^2 value of 0.74.

Channel and floodplain forms vary as a function of position among the numerous variables within a landscape. Channel gradient, degree of channel confinement, catchment hydrology and flood history, sediment character and supply, vegetation and human impacts to some degree all control stream form and behavior. Bagnold (1966) adopted stream power as a theoretical basis for evaluating bedload transport. Since, it has been widely used to better understand such form and behavioral characteristics, in particular channel patterns and meander dynamics (Ferguson 1981) and changes induced as a result of human intervention (Brookes 1988). Stream power has also been used as a factor to delineate riverbed processes, notably when braiding has taken place (Van den Berg 1995). Information from an intensive survey of a variety of stream channel throughout the Umatilla River in 2000, were used to calculate stream power shown in Figure 3.

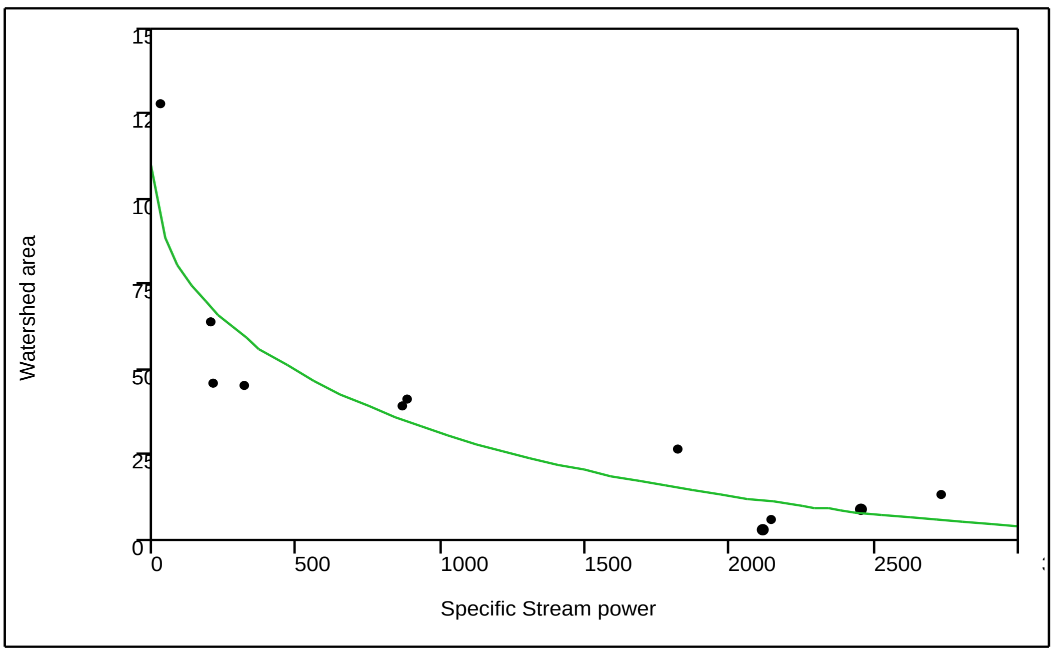

Figure 3. Plot of watershed area and specific stream power for the mainstem Umatilla River. Watershed area units are shown in square miles and the specific stream power units is shown in watts per meter squared.

Stream power is the energy available to transport sediment. Knighton (1999) defined the origin of the energy as coming from potential or position energy and as the water flows down gradient, that energy is converted into the kinetic form. Here (Figure 3) it is used to perform erosion and transportation work once a critical threshold determined has been reached. Because the stream power function is a strong indicator of broad scale sediment movement, through channel networks, we use the regression relationship derived in Figure 3 to predict stream power throughout the Umatilla River watershed. This information was written into the GIS dataset.

As mentioned above, it is important to consider the frequency of annual flood(s), along with the sediment sizes in setting expectations for the course scale array of aquatic habitats in the Umatilla River system. Using the long record of flow near the mouth of the Umatilla River (USGS gauge # 14033500), a flood frequency plot is generated (Figure 4). The annual exceedance probability,
River channels are in part shaped by the water's ability to move sediment around, and in general, bigger discharges can move more sediment than smaller ones. One can imagine that the pattern of flooding on a river may have a large influence on the geomorphic characteristics of that river, for example, the width and depth of the channel, the relative elevation of the floodplain, maybe even channel migration rates.

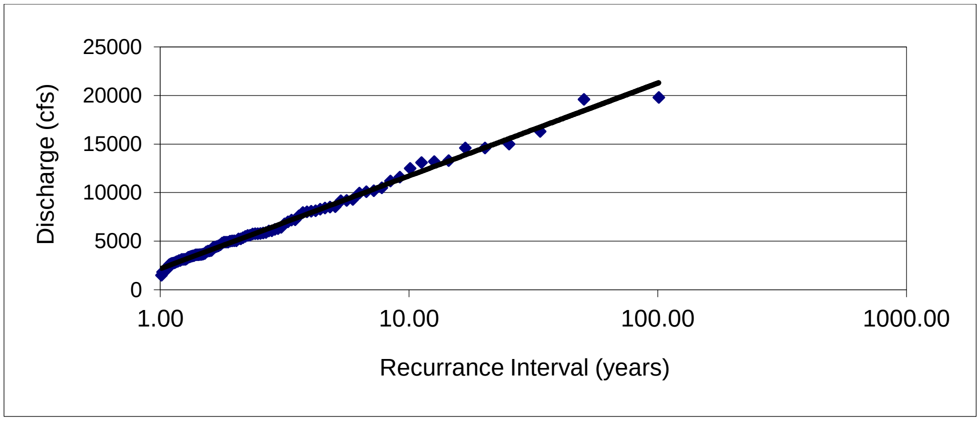

Figure 4. Pearson flood frequency plot is shown above. This plot was created from data collected at the Umatilla gauge on the Umatilla River (USGS 14033500).

3.3 Land Cover

The landscape of this semi-arid watershed is dominated by mixed ponderosa conifer forest with lesser amounts of perennial grasslands and shrub plant communities (Kauffman, Thorpe & Brookshire, 2004). Riparian vegetation consists of woody species such as willow, hawthorn, alder, and wild rose, as well as various sedges and grasses (Torgersen et al., 1999; Beschta & Ripple, 2005). Historical modifications to the watershed include dredge mining, channel straightening, and road construction (McDowell, 2001; Torgersen & Close, 2004) and current land use modification consists primarily of cattle grazing and logging. Compared to narrow valley segments, wide valley segments have experienced greater human modification, which has resulted in channelization, decreases in sinuosity, and loss of large woody debris (McDowell, 2000).

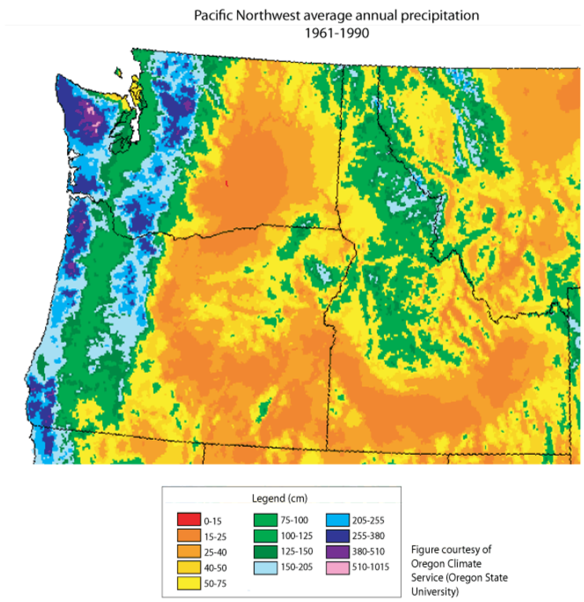

Figure 5. Map of annual precipitation for the PNW (http://www.cses.washington.edu/cig/pnwc/pnwc.shtml).

3.4 Climate influences on the Umatilla River Watershed

At the broadest scales, precipitation varies by decadal and multi-decadal climatic signals including El Niño/Southern Oscillation (ENSO), and the Pacific Decadal Oscillation (PDO).

ENSO and PDO are known to be associated with local climate in the PNW. ENSO originates with anomalies in tropical sea-surface temperatures, but affects climate across western North America, especially winter conditions. El Niño conditions tend to produce warmer drier winters and La Niña conditions tend to produce cooler wetter winters in the PNW. Both ENSO and the PDO is an index of variability in climate of the Pacific Ocean.

The PDO affects local climates in the PNW at 20-40 year intervals. The PDO is less frequent than ENSO. The positive phase of the PDO is associated with warmer drier winters, whereas the negative phase is associated with cooler wetter winters. Interestingly, the phase of the PDO may affect the strength of El Niño and La Niña events. Local variability in the PNW combined with extended dry conditions could predictably affect stream flows for a particular year.

One way to summarize the changes of ENSO and PDO cycles is using the Palmer Drought Severity Index (PDSI). PDSI is a composite monthly index of regional climatic conditions calculated from precipitation and temperature changes (Alley 1984). Another attribute of this index is that it incorporates both immediate (same-month) and cumulative (multi-month) effects of drought. Synoptic scale patterns centered over the Pacific Ocean (ENSO and PDO) are known to affect local level climate in the PNW. Using the PDSI one can gain basic insight into the variability of the wet and dry year cycles that are likely effect stream flows.

Aspects of climate change are critically important to the hydrology of the PNW. Within the last 50 years, peak flows from snowmelt dominated, unregulated rivers have shifted 1-3 week earlier in the season. Additionally winter flows have increased and summer flows have decreased (Stuart 1993). During the same time snowpack has declined by approximately 35% (Mote 2003). Understanding the variability in temperature patterns of western rivers is important to those who use them for power generation, commercial and substance fishing and recreation.

Figure 6. Topographic map of the PNW (http://www.cses.washington.edu/cig/pnwc/pnwc.shtml).

Within the Interior PNW, there is a wide range of precipitation regimes that increase in frequency and intensity with elevation and generally with latitude. This climate is characterized by strong seasonal patterns, with annual precipitation generally less than 50 cm, and as little as 20 cm in low elevation areas throughout the Columbia Basin in Washington and Oregon (the geographic center of the Columbia Basin in roughly Richland, Washington - Figure 6). Precipitation is an important climatic regulator that along with geology could serve to further describe the Interior PNW as *geoclimatic* zones (*sensu* Hadyn 1988). The Umatilla River watershed has a strong, temporally coherent pattern of mild, moderately wet winters and hot, dry summers.

3.5 Primary sub-watersheds and tributaries

A regular pattern is developed as the mainstem Umatilla River descends from the confluence of the North and South Forks to the confluence with the Columbia River.

It is noteworthy that nearly all of the natural tributaries of the Umatilla River enter on the south side of the river. By differentiating "natural tributaries" from other interbasin transfers, such as, Cold Springs Reservoir, we wish to highlight the differences between patterns formed by long term fluvial processes and interbasin transfers. Fluvial patterns across the landscape have created forms that Pacific salmon have evolved in, whereas, interbasin transfers deliver water into point on the landscape, often out of context with natural flow patterns and volumes.

The southern entering tributaries initiate in the Blue Mountains and are active, gravel bedded streams that include alluvial floodplains and developed deltas where they join the Umatilla River. These tributaries create a low elevation landscape along the southern margin of the Umatilla River floodplain – the historically diverse and likely, productive area has been occupied by transportation routes for nearly 150 years. The supporting road and rail beds have reinforced a separation between the active floodplain and the transportation surfaces. The single, perennial, northern tributary to the Umatilla River is Wildhorse Creek.

Several similarities in physical attributes of Umatilla River tributaries are noted from Figure 7. The cumulative drainage area graph displays (from left to right) the contribution areas of each of the tributaries. Where tributary streams join the mainstem Umatilla River there a consistent reduction in local slope and sinuosity at each confluence. This pattern is consistent and pronounced at all of the historic tributaries. Elevation breaks at each of these confluences is not shown in these data. However the graphic correlation between the changes in sinuosity, slope and cumulative drainage area is clear.

Moving up from the mouth of the Umatilla, Butter Creek is the first large tributary one encounters. Butter Creek drains 465square miles and is, by area, the largest tributary basin in the Umatilla River watershed. However, the location of this watershed is on the western edge of the basin and captures the smallest amount of precipitation in the Umatilla River watershed. The upper reaches of Butter Creek drain portions of the Umatilla National Forest, as the elevation of the river declines, rangelands and irrigated portions of the floodplain are more frequent. Like many tributaries to the Umatilla River, the mouth of Butter Creek is diked confining the creek to a small portion of the historic delta. The near absence of native riparian vegetation, conversion of the majority of the historic floodplain and pervasive grazing, compounded by an average of 9 inches of annual precipitation creates a less than ideal condition for native aquatic organisms.

Continuing upstream along the Umatilla River the next tributary junction is Stage Gulch. Canyons and gulches in the Umatilla River watershed are geomorphically significant (See Figure 7). The upward adjustment in the cumulative upstream area graph, upstream of Butter Creek is Stage Gulch. Thus the historic contribution of flow and sediment from Stage Gulch into the mainstem Umatilla River has created a unique landform with an associated signal of sufficient power to be detected by a relatively course stream dataset (the NHD). This is shown in Figure 7 between Butter and Birch creeks. There is a clear increase in drainage area at the confluence of Stage Gulch and the mainstem Umatilla River. Stage Gulch is a moderately incised drainage network that currently supports industrial agriculture in the upper elevations and contains rangelands in the lower elevations. Because the contemporary state of flow from Stage Gulch is intermittent, scant conservation efforts have been undertaken in this watershed.

Birch Creek is a large drainage that, like others in the Umatilla River watershed, begins in forested land cover and descends through a variety of rangelands and irrigated fields before joining the mainstem Umatilla. Birch Creek is a large watershed draining 291 square miles. Conservable variation in stream forms and temperatures have been noted in this watershed. For example, Pearson Creek that is primarily on USFS land is likely spring fed, maintaining a relatively constant flow and temperature regime throughout the course of the year. Accordingly, Pearson Creek does not have a large near channel disturbance zone (Boyd et al 2004). Pearson Creek also has a more narrow range of substrate sizes. Alternatively, many other reaches of Birch Creek (East Birch in the upstream vicinity of Pilot Rock and the mainstem of Birch Creek near the mouth) are highly alluvial streams that contain large point bars, move notable amounts of sediment and have a range of dynamic forms in time. Currently, river substrate is removed from these areas resulting in unstable stream channels (in the case of the East Fork of Birch Creek) or the near complete separation of stream channels from their floodplains (shown at the confluence of the mainstem Umatilla River and Birch Creek). Despite these limitations of physical aquatic habitat diversity, summer steelhead use Birch Creek to successfully spawn and rear. Additionally Birch Creek is located at a mid-point in the stream network of the Umatilla River watershed. The Birch Creek basin provides important habitat diversity in multiple locations for anadromous fish to disperse in the event of a large disturbance (ex. wildfire), and access to varying physical environments where anadromous fish can diversify their life history strategies.

The next tributary to the Umatilla River is McKay Creek. Although currently McKay Creek reservoir blocks the passage of anadromous fish, considerable high quality habitat exists in the upstream reaches of this drainage. The structure of stream network in the McKay Creek basin is similar to Birch Creek – with the exception that a majority of the basin is on the Umatilla Indian Reservation. A noteworthy attribute of the McKay Creek watershed is the alluvial floodplains on the lower, mainstem stream. While there are sporadic home sites along this section of McKay Creek, several moderately large meander scrolls accompanied by a diverse age class of native riparian vegetation function are present throughout the lower reaches (above the reservoir). Several relatively low elevation moderate stream order confluences characterize the network structure of streams in McKay Creek.

Upstream from McKay Creek are several small streams, nearly all from the south, that contribute to the Umatilla River. The streams, Tutuila, Mission, Moonshine, Buckaroo and Iskuulpa, are arrayed across an increasing elevation, drainage size and flow gradient. These changes are accompanied by significant increases in topography and precipitation moving up the Umatilla River corridor.

Meacham Creek is the largest tributary drainage to the Upper Umatilla River. Additionally, Meacham Creek and the next downstream tributary, Isquulktpe Creek contain the greatest number of redds of any tributaries in the Umatilla watershed. Isquulktpe Creek has the highest densities of spawning steelhead in the basin (Contor et al 2003). Both spring Chinook and summer steelhead spawn in Meacham Creek (Contor et al 2003). The mainstem of Meacham Creek is a low gradient stream that is nearly 30 miles in length. At the confluence of Meacham Creek and the Umatilla River, Meacham contributes more than double the flow of water sediment and, historically, wood. It is noteworthy that the bridge across Meacham Creek is not built at the mouth, but slightly further upstream than most of the other southern tributaries on the Umatilla River. The bridge was built just as the Creek enters the floodplain of the mainstem Umatilla River. The location of the bridge has not been used as a specific hypothesis in comparing the alterations along Meacham Creek, nevertheless, the last reach of Meacham Creek includes a natural confluence with the Umatilla River.

Additionally, the Union Pacific Railroad (UPRR) has maintained a mainline track up the Meacham Creek mainstem for approximately one hundred years. The cumulative impact of track maintenance, expansion and flood prevention have resulted in a dramatically straight and simplified mainstem Meacham Creek.

The confluence of the North and South Forks of the Umatilla River combine to create the mainstem Umatilla within the boundary of the Umatilla National Forest. The North Fork Umatilla is both smaller in size, flow and area than the South Fork. The histories of the two basins are subtly different in management, but wholly different in geologic character (Clifton et al 2000). During the past 30 years, the North Fork of the Umatilla River is currently managed as a wilderness area and the South Fork Umatilla River was managed for timber production until approximately 1992. Differences in geologic parent material results in difference water storage capacities and varying flow regimes. Clifton et al. 2000 document these changes in flow and the geologic conditions that characterize each basin.

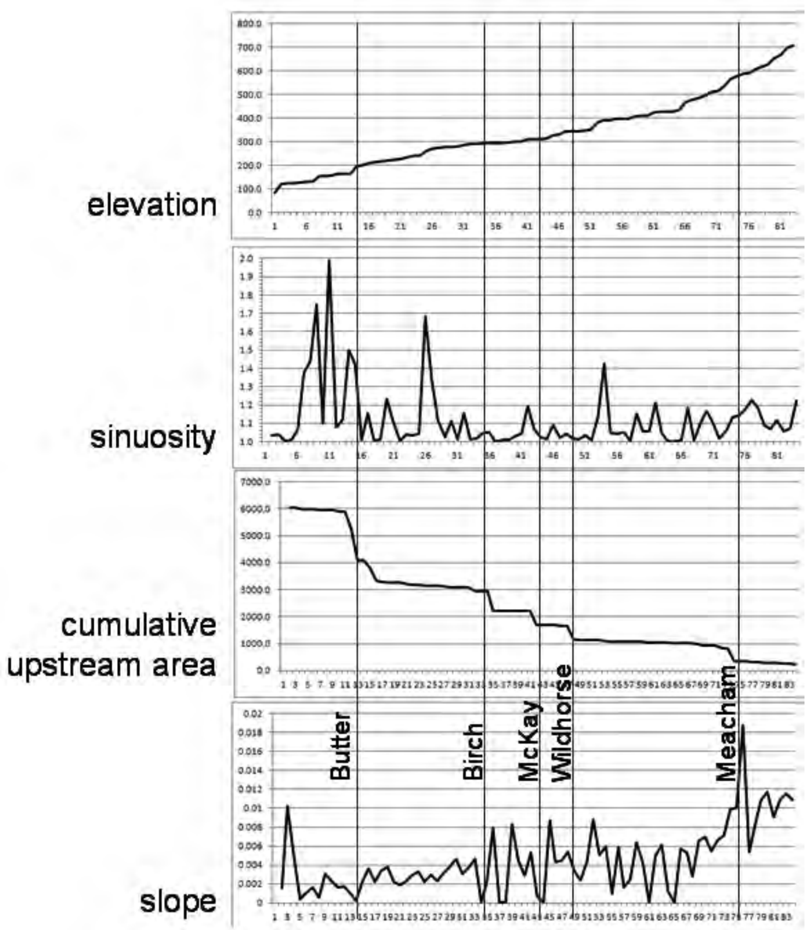

Figure 7. The above graphs reflect data from the National Hydrological Dataset (NHD). Four parameters of the mainstem Umatilla River are shown. The horizontal (Y) axis shows the river mile – following flow from left to right. The major tributaries are labeled and the position of each tributary as it enters the Umatilla River is shown by the corresponding vertical line.

4 SPATIAL DATASETS AND GIS PROCESSING OF STREAM SEGMENTS

4.1 Overview of Spatial Datasets

The fundamental aspect of hydrologic data development is the delineation of watershed and sub-basin boundaries. While there are several variations to the original algorithm, the primary method involved in delineating watershed boundaries from DEM data is the eight point pour method developed by Puecker et al. (1975). The basic idea in Puecker's method is to assign a flow direction to each grid cell based on the neighboring cell with the lowest elevation.

It is important to note that raw DEM data often contain pits, where no neighboring grid cell has a lower elevation. Therefore pre-processing algorithms to fill pits (raise the elevation of the pit until a "pour point" occurs) must be part of the overall process for defining a flow vector grid (Garbrecht, 1995). Often a general flow pattern of a terrain model emerges when displaying the directions of a flow direction grid.

Once the flow direction grid has been computed, a flow accumulation grid is created. This is done by counting the number of contributing cells to each cell in the grid (cells whose flow path eventually passes through the cell). Cells which are potentially part of a stream network will have a larger flow accumulation value, whereas cells near watershed boundaries and where overland flow dominates will have a low flow accumulation value.

At this point the watershed and sub-basin outlet points for watershed delineation must be identified. Traditionally this has been a difficult process because it requires interaction by a user in order to select the appropriate point(s). Many grid based watershed delineation algorithms simply create sub-basins for each branch in the stream, where the branches may have controlling parameters such as thresholds on contributing area and/or number of grid cells making up the branch. However, as graphical user-interfaces have become more powerful, watershed and sub-basin outlets can be graphically selected by a user. It is important to be able to hand-pick outlet points because often the hydrologic model needs to be developed for a location corresponding to a road crossing or where a detention structure is to be built. Such locations rarely coincide with outlets determined from traditional, automated methods.

Once the outlet locations are specified, watershed and sub-basin delineation can be performed. The process is similar to the definition of flow accumulations in that the flow direction from each grid cell is traced until either an outlet cell or the edge of the grid is encountered. If an outlet cell is found then the grid cell is assigned the id of the basin for that outlet point. If the edge of the flow direction grid is found then the cell is assigned a "no data" value, meaning that it does not contribute flow to any of the defined outlets. The process of assigning basin identifications to grid cells can be optimized by first assigning the basin ids to all stream cells upstream from the outlet points. Then, whenever a traced grid cell flow path encounters a stream cell it can be assigned the same basin id as the stream cell encountered. Separate sub-basins were determined for each upstream branch of the interior outlet point.

4.1 Assembling GIS Datasets

Two datasets were assembled to characterize the stream channel network of the Umatilla River watershed – one at 1:24,000 and on at 1:100,000.

Stream classification models require consistent, accurate data. To support spatially relevant stream restoration actions, it is necessary to produce a hydrologically consistent stream coverage and digital elevation model. Currently available data are spatially inconsistent and must be corrected to support network analysis over a large area. The following section describes this process. The input data initially used in Extensive Physical Habitat Assessment (EAHA) development consisted of 10m DEMs from USGS, 1:24k hydrology, monthly 30-year average precipitation grids at 90m resolution, and historical streamflow for USGS gauging stations. Tasks required to prepare the data, include creating a hydrologically correct DEM, and a runoff grid for hydrologic modeling was performed using the Grid module of ArcInfo. The analysis incorporates many of the techniques described by Saunders and Maidment (1996), Reed and Maidment (1995), and Olivera et al. (1996). The approach presented is based on 10 m DEMs to support a consistent grid size and to improve the visual appearance of the final output.

The first step is based on the 10m USGS DEMs. The DEMs were downloaded and merged for the Umatilla Watershed to create a complete mosaic. These data were resampled using the ArcInfo Majority Filter command. The Grid Fill command was then run to remove all sinks from the DEM (ESRI 1992). This step identifies and fills all sinks in the continuous grids and removes inconsistencies in the USGS DEM data as a result of continuous values being discretized or "binned" to approximation to a continuous surface.

The second step involved working with the 1:24000 scale stream coverage is to create single topologically correct arcs representing stream channels. All lakes and reservoirs, resulting from inflowing rivers and streams, were bisected with a single arc. Any braided, stray or unconnected streams, ponds or lakes were removed from the study area coverage. The goal was to enforce water flow with a single arc for the surface flow direction and flow accumulation Grid functions. When all streams were hydrologically "corrected," the coverage was then converted to a grid with a resolution of 10m. The rasterized stream network was then thinned to ensure single cell stream width.

The third step applies a "burn in" process by merging the raster stream network with the off-stream DEM cells raised 50 meters. It is important to keep the original DEM values for the stream grid so that flow direction and slope within the stream can be calculated. After the streams have been "burned" into the

DEM, the DEM is then filled again with flow direction and accumulation grids calculated. This process is necessary to produce what is termed a hydrologically corrected DEM with flow direction and accumulation grids.

The fourth and last step is to create a runoff grid built on the relationship between precipitation and stream flow based on a regression relationship between historical stream flow and 30-year average annual precipitation grid values. The precipitation grids are 90m in cell size and were extrapolated to grid format from the observation collection points. The historical to calculate an equivalent depth of recorded stream flow in mm/year. The regression value of the equivalent depth of recorded stream flow versus the average annual precipitation provides a regression equation to apply to the precipitation grid to estimate runoff (Saunders and Maidment, 1996). The runoff grid represents the relationship between precipitation and stream flow. A cumulative runoff grid is developed by running a weighted flow accumulation with the runoff grid. The runoff grids are used with flow accumulation and flow direction grids to model the flow estimation, pollutant concentrations, and potential maximum yearly loadings. Stream flow is recorded during the same time that the precipitation grids were recorded. For each gauging station location, the watershed is delineated and the average precipitation for the watershed area determined.

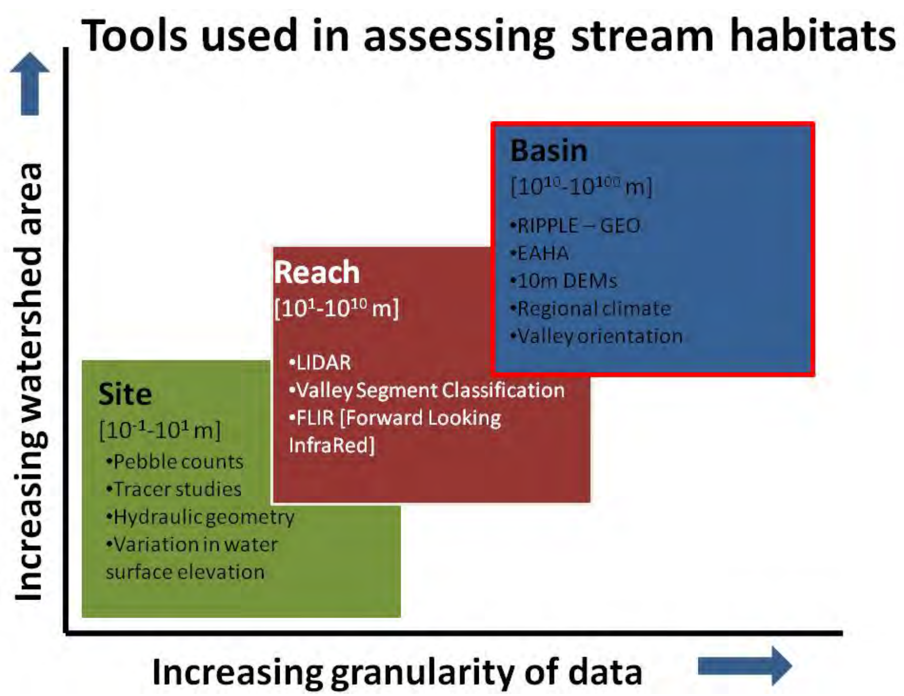

Figure 8. The figure above describes the tools used in evaluating varying scales of stream habitats.

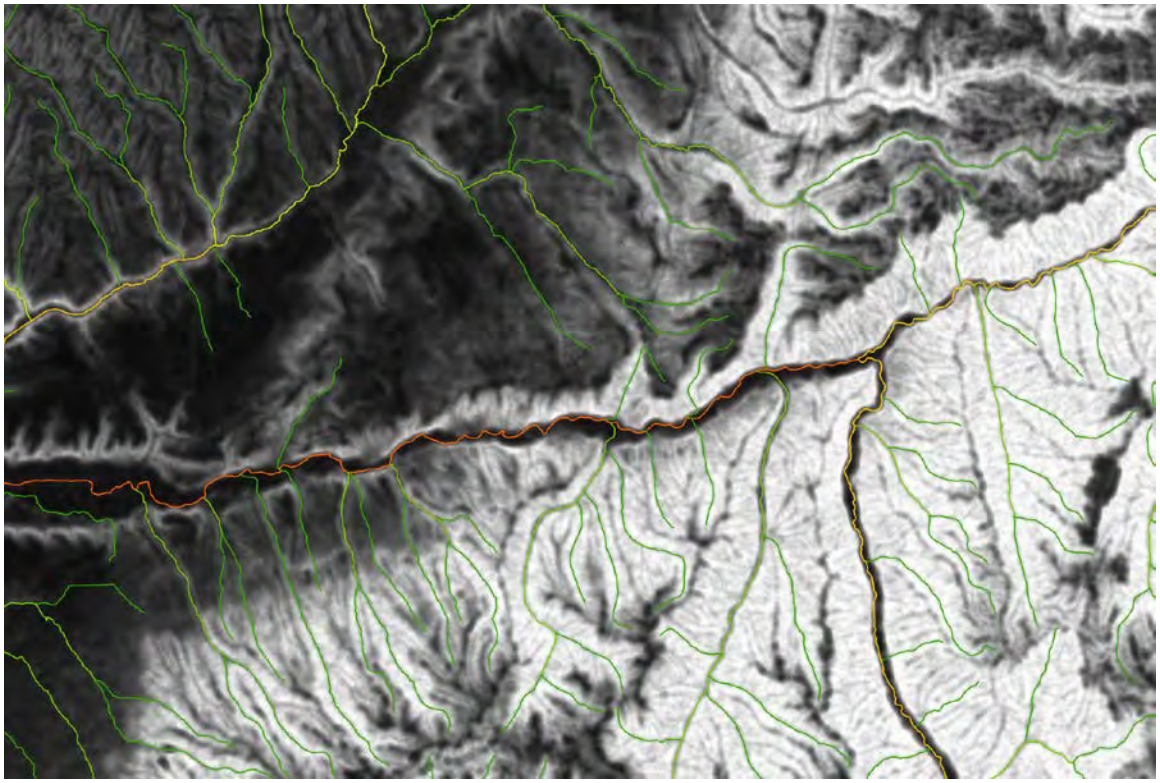
Figure 9. Terrain classes depicting similar neighborhoods of elevation across the Upper Umatilla River Watershed. These data were derived from 10m USGS DEMs.

As the accuracy and spatial scale of available data improves, the models that rely on these data will improve as well. The development of 1:24,000 NHD data also provides improved support for modeling activities.

Broad morphometric classes were derived for the Umatilla River watershed (Figure 8). We use a variability filter to classify elevation from a commonly available 10 meter USGS DEM dataset (**Figure 9**). The **Figure 9** image shows increasing topographic variability as increasing brightness. The Holocene floodplains of the mainstem Umatilla River and large tributaries, McKay Creek (shown on the west, or left, portion of the image) and Meacham Creek (shown on the east, or right, portion of the image) are evident. Not surprisingly, the toe slopes of floodplains are crisply defined owing to the dramatic change in elevation at slope edges. Also, a contrast in the broad character of the uplands is expressed through finer grained topographic variation north, and east, of the Umatilla River, as compared to the type of variation south of the mainstem Umatilla River.

Morphometric analyses used a composite of 67 individual USGS 7.5-minute, 10-m grid digital elevation models (DEMs). The GIS software applications ArcGIS and ArcInfo workstation from ESRI were used for analysis. Anomalous low-points (sinks) in the DEM were filled using the "fill" function in the grid module in ArcInfo to produce a "filled" DEM raster ("grid"). Flow direction and flow accumulation grids were generated using the "flow direction" and "flow accumulation" functions in the grid module in ArcInfo. Stream profiles were calculated for basins less than 10 km2 using a routine ("profix2.aml") that "walks" up and then down the stream valley and extracts the x, y, and z coordinates, as well as flow accumulation for each point in the stream profile from the DEM, flow accumulation, and flow direction. The output then is used to generate a spatially referenced table of x, y, and z coordinates of stream profile points and flow accumulation at each point ("point coverage" in ArcInfo).

Individual study basin grids were generated with the "watershed" function in the grid package in ArcInfo. A spatially referenced table of x, y, and z coordinates of watershed boundaries (a "polygon coverage" in ArcInfo) was generated using the study basin grids as a boundary. Hillslope gradient distributions in the study basins were calculated using the "hillslope" function using a 315 degree sun angle in the Grid package in ArcInfo.

4.2 Biological data

The CTUIR Fisheries Program collects data on the location of Pacific Salmon redds along the mainstem and throughout the upper Umatilla River watershed. This effort has been consistently active for more than two decades (Contor et al. 2005). During the last six year these data were collected using a GPS and contain easily used spatial information. Data from 2004-2009 (5 years) were available with standard geographic locations, latitude and longitude. These data include both steelhead and spring Chinook salmon are available at (http://data.umatilla.nsn.us/fisheries/escapement/index.aspx). This data location was last accessed on 2/20/2010.

Figures 10 and 11 show basic distributions of the types of habitats that summer steelhead and spring Chinook salmon use.

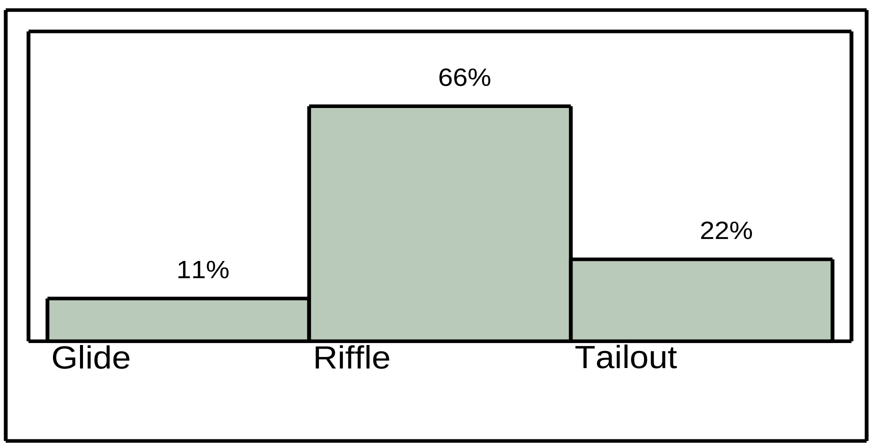

Figure 10. Histogram of steelhead redds organized by the habitat features where they were collected. These data were captured in the Umatilla River watershed from 2004-2008.

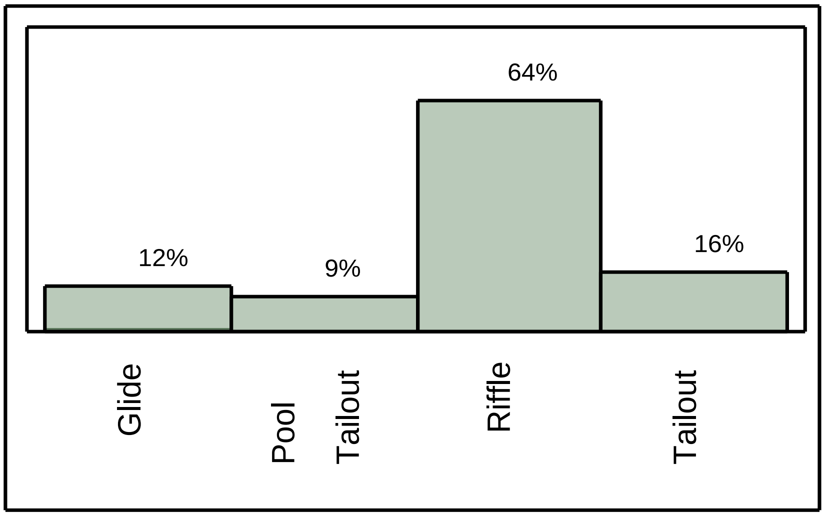

Figure 11. Cluster Histogram of Spring Chinook redds by the habitat features where they were collected. These data were collected in the Umatilla River watershed from 2004-2008.

The paucity of spatially diverse juvenile salmon data collected in the Umatilla River watershed resulted in its omission from this effort. While there are large datasets describing juvenile salmon characteristics, these data are not spatially registered and, therefore, not considered as a part of this effort.

Data availability and consistency

It is noteworthy that the only available set of redds data, in an easily usable digital format, is available through the CTUIR. These data were obtained from the CTUIR web site (http://data.umatilla.nsn.us/fisheries/index.aspx). Redds data collected by ODFW are available for streams in the Umatilla River watershed, however, they are collected and aggregated into large segments (> 1 mile) that are significantly larger than the average stream segment for this study. The data collected by the CTUIR RM&E Program are collected primarily on the Umatilla Indian Reservation and in the upper half of the watershed. Redds data collected by ODFW are used as qualitative validation data for the purpose of confirming CART and NN model predictions

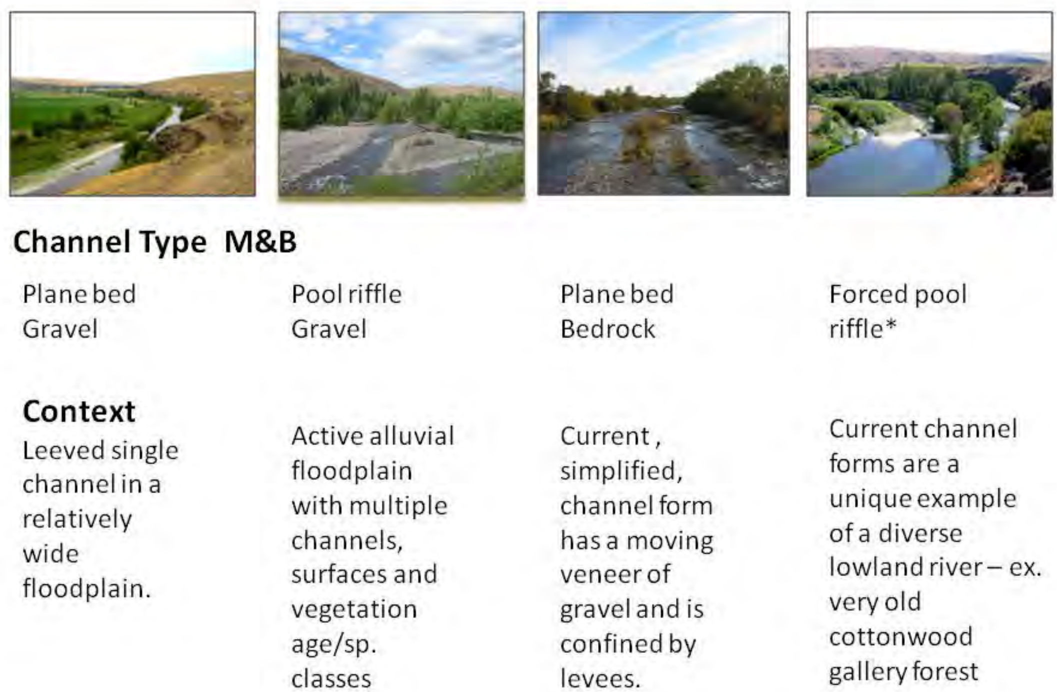

Figure 12. Channel type examples with the Umatilla subbasin showing distribution channel types of mainstem river sites.

5 GEOMORPHIC CLASSIFICATION OF STREAM CHANNELS

Stream classification using GIS and DEM's has gained acceptance over the past 20 years. Two classifications were created for streams in the Umatilla River watersheds: a modified Montgomery and Buffington (2003) and a statistical classification using hierarchal clustering.

Individual parameters considered in the physical classification were derived using public domain data sets (see Figure 7) and conform to the general guidance given by Montgomery and Buffington. The speed of acquiring and processing the data was primary in deciding to select the parameters considered in this assessment.

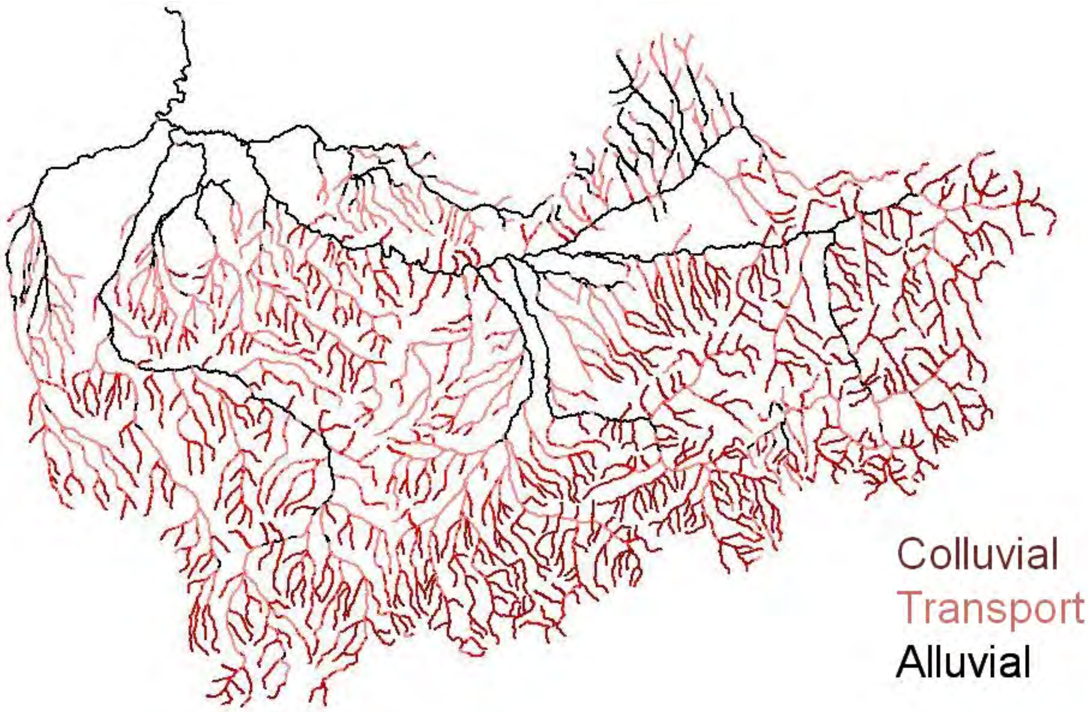

Figure 13. Channel type map of the Umatilla subbasin showing distribution of geomorphic classes.

A statistical classification was conceived as an alternative to Rosgen (1994) and Montgomery and Buffington (1997) types of classifications: it was implemented in order to better understand the distribution of physical parameters within the individual basin and view the spatial arrangement of these parameters. Further, current classifications do not address the internal variability displayed within a watershed.

There are several notable patterns in Figure 13. First is the extensive and continuous network of alluvial channels that connect to the mainstem Umatilla River. These low elevation landscapes are common in the mid and lower reaches of all major tributaries to the Umatilla River, Butter, Meacham, Birch and McKay creeks. While these alluvial zones are smaller and less continuous in Iskuupla and are intermittent in these alluvial zones are the most commonly used spawning site for Pacific Salmon in the Umatilla watershed.

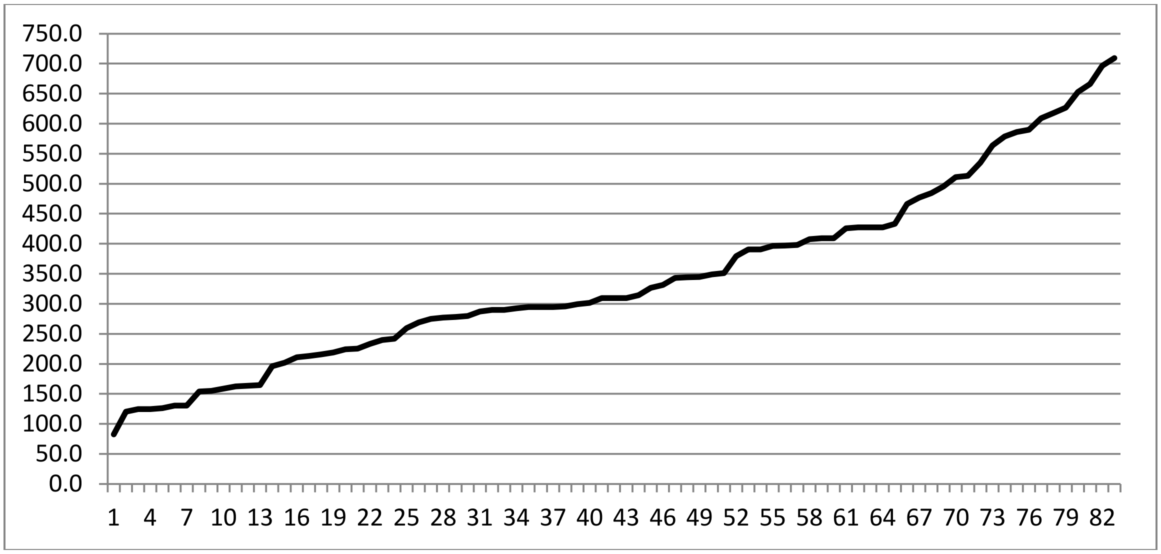

Figure 14. Elevation profile of the Umatilla River.

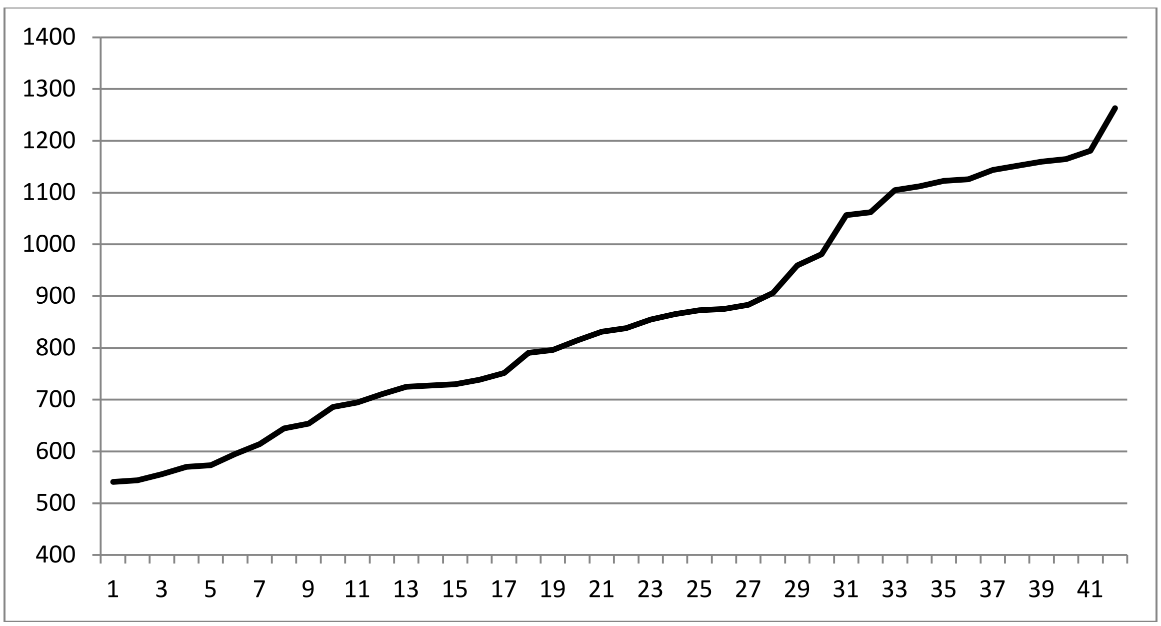

Figure 15. Elevation profile of Meacham Creek.

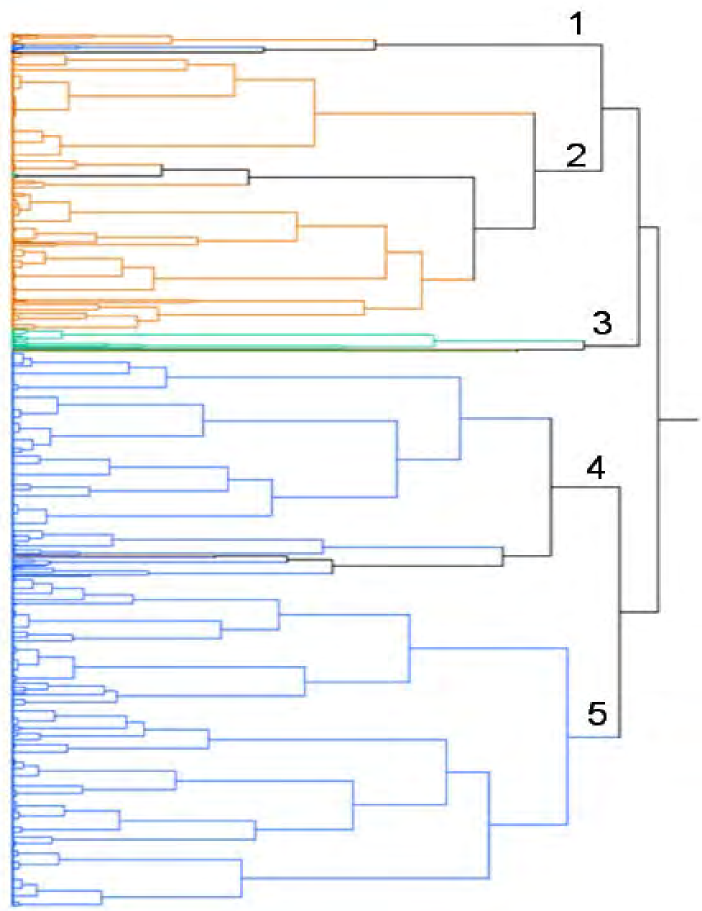

Figure 16. Hierarchical clustering for stream segments in the Umatilla River watershed. Blue leaders show mountain streams, gold lowland streams and green color indicated streams that have been influenced by irrigation systems (typically straightened or conform to a non-normative geometry.

Three classifications for channel types were attempted in this project. Two of them were fully successful and we did not have adequate information for the third. The first was a Montgomery and Buffington (1997) classification, the second was anticipated to be a Rosgin classification and the third was a statistical, cluster analysis classification.

The Montogomery and Buffington classification emphasized channel slope, contributing area and floodplain width. These parameters are classified into three groups, colluvial, transport and alluvial. A visual example of the Montogomery and Buffington classification is shown in Figure 15.

A spatially extensive stream classification based on the Rosgin classification would be valuable because it would relate the popular system of stream characterization to differing scales, make intuitive sense to a great number of restoration practitioners and create comparable outputs among basins. However the Rosgin classification relies on entrenchment as a key parameter in the initial stage. Entrenchment was difficult to consistently estimate from the DEM data that we used for this work. Because we could not consistently measure entrenchment from the DEM, we abandoned the Rosgin classification.

Finally, we created a statistical classification using hierarchical agglomerative clustering, Figure 16. The technique clusters like parameter values into a tree where similar values are located near to each other in display space and can be sliced at multiple levels to produce a classification with a varying numbers of classes. This is a "bottom up" approach where each observation starts in its own cluster, and pairs of clusters are merged as the hierarchy is built. Hierarchical agglomerative clustering method builds the structure from the individual elements by progressively merging clusters.

6 USE OF CLASSIFICATION AND REGRESSION TREES AND NEURAL NETWORK TO PREDICT SALMON SPAWNING LOCATIONS

The primary purpose of this assessment is to predict the potential locations of spring Chinook and summer steelhead in the Umatilla watershed. In order to accomplish this I used Classification and Regression Trees (CARTs) as implemented in JMP (http://www.jmp.com/), R (http://www.r-project.org/) and CART(http://salford-systems.com/cart.php). Additionally, Neural Networks (NN) were used to predict the presence of redds along the stream network. These non-parametric models were selected to predict redd locations because they have been successfully used in other fields, have not yet been applied to this problem. Further, these models represent a combination of physical and biological datasets that, together, have been seldom used in addressing salmon management in the Umatilla River watershed.

CARTs, or decision trees, were created by Morgan and Sonquist (1963) for use in the social sciences, however Breiman et al. (1984), popularized this method for use by broader audiences. In recent years CARTs have emerged as powerful statistical tools for analyzing complex ecological datasets because they offer a useful alternative when modeling nonlinear data containing independent variables that are suspected of interacting in a hierarchical fashion (De'ath and Fabricius 2000). CART models do not make parametric assumptions, no implicit assumptions are made about the normal data distributions (linear relationships) about the dataset.

The CART method is a type of binary recursive partitioning where both continuous and categorical response variables can be considered in the model. CART modeling consists of at least three steps: creating a tree, terminating a tree and pruning a tree. In creating the tree, this method utilizes a binary splitting rule, where each primary node is portioned or split into two secondary nodes. This splitting process is recursively repeated until a "tree" or a set of rules that define the conditions to meet the predicted variable are met. Setting limits on the size of the tree is defined by user and typically is guided by a comparing a running r squared value and the likelihood that the continued splits are meaningful to the problem being modeled.

Hierarchical algorithms find successive clusters using previously established clusters. These algorithms can be either agglomerative ("bottom-up") or divisive ("top-down"). Agglomerative algorithms begin with each element as a separate cluster and merge them into successively larger clusters. Divisive algorithms begin with the whole set and proceed to divide it into successively smaller clusters.

Another advantage of CART is that the result is a simple set or rules that can be exported to other software packages (ex. GIS or relational databases) with minimal effort and translation.

Utilizing the tree structure, one can interpret the importance of each parameter by the location in the tree: a primary split indicates a parameter with greater predictive power than a parameter found at a terminal node of the tree. As is common in interactive statistical techniques, CART processing balances increased splitting (potentially over fitting) with small trees (yielding low predictive power).

Neural Networks (NN) mimic models that capture the process and systems believed to be at work in the human brain. These models apply particular knowledge learned from successfully addressed problems and "experience" to confront new problems and make reasonable predictions to solve them. This type of model searches for patterns in the data and seeks to classify and predict future realizations from the existing dataset. Interacting neurons process inputs and interactions between the individual parameters in the dataset. Each of these interactions are weighted as the neurons seek to improve the predictions at each level of the process. The models that are presented here have three levels of neuron interactions (see the Neural Network section in the appendices for more information). The first layer is a relatively straight forward combination of parameters in the existing dataset, the second layer of neurons is hidden and contains weighted values that are combinations of the first layer and the third layer is the output or the prediction/classification. Weights are adjusted on the variables in the input datasets and the result of each model run is iteratively compared to the input dataset to determine the power of the prediction, in that particular model run.

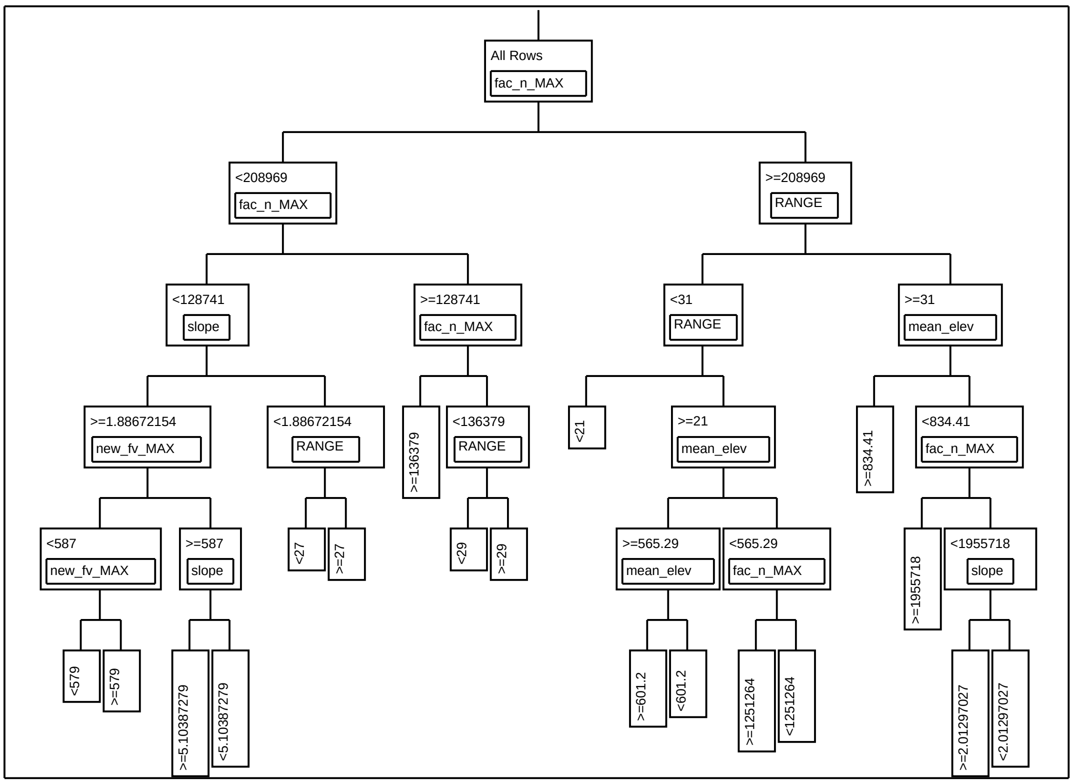

Figure 17. 17 node tree showing the relationships between habitat parameters and spring Chinook redds (R^2 = 0.69).

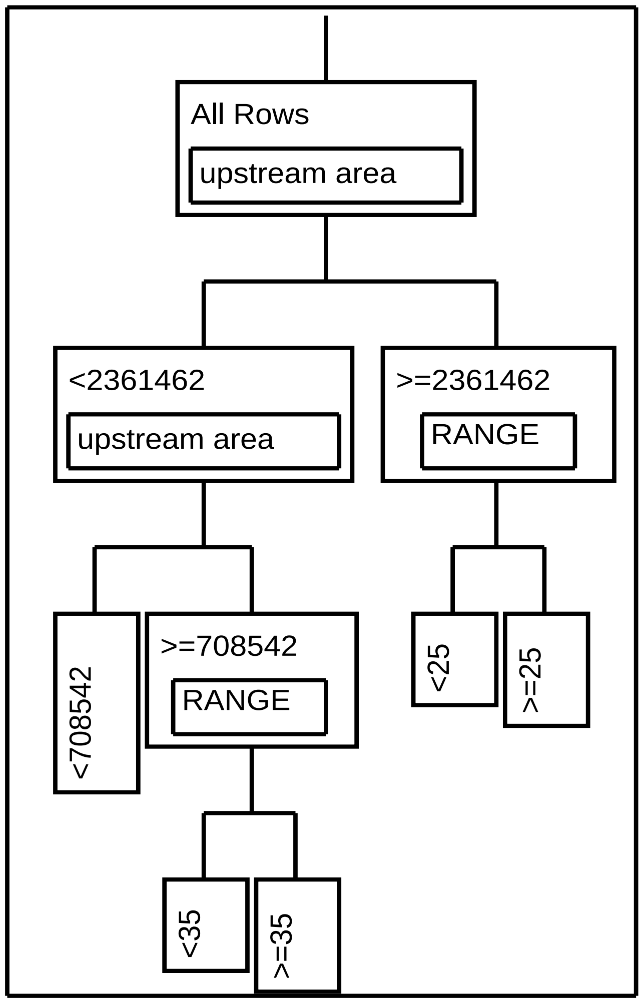

Figure 18. Four node tree showing the relationships between habitat parameters and summer steelhead redds (R^2 = 0.58).

The CART models developed here are shown in **Figure 17** and **Figure 18**. The spring Chinook model shows a relatively high cost and large tree for the prediction power. It could be argued that this tree is overfit for this application. In this case over fitting would yield a tree that described each instance of the prediction set as a terminal node on the tree.

The summer steelhead tree is considerably simpler and more straightforward. Abundance and conditions at treatment and control sites to pinpoint reasonable causes of the observed effects.

7 RESULTS

Outputs from the NN and CART models show relatively realistic distributions of both summer steelhead and spring Chinook.

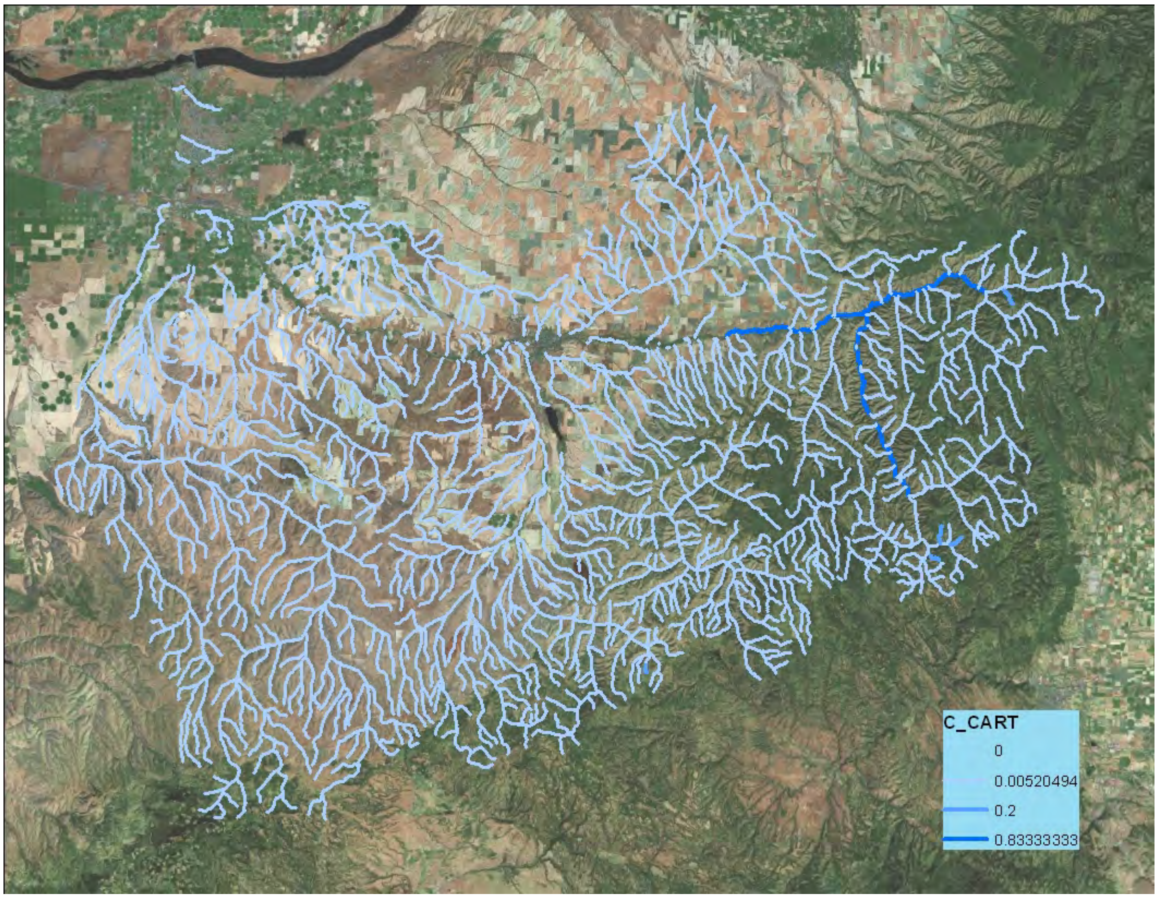

Figure 19. The predicted distribution of spring Chinook, as a result of CART analysis, is shown in increasingly darker shades of blue.

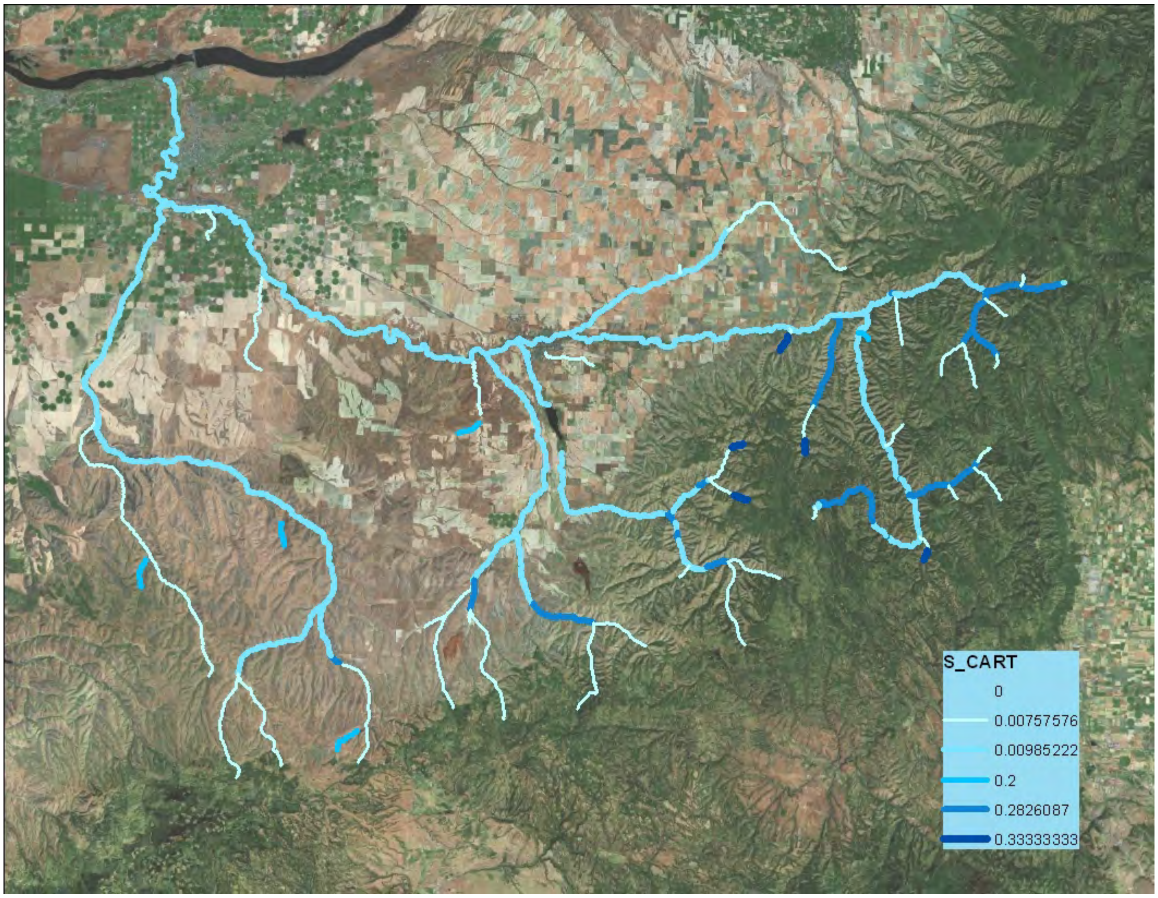

Figure 19. The predicted distribution of summer steelhead, as a result of CART analysis, is shown in increasingly darker shades of blue.

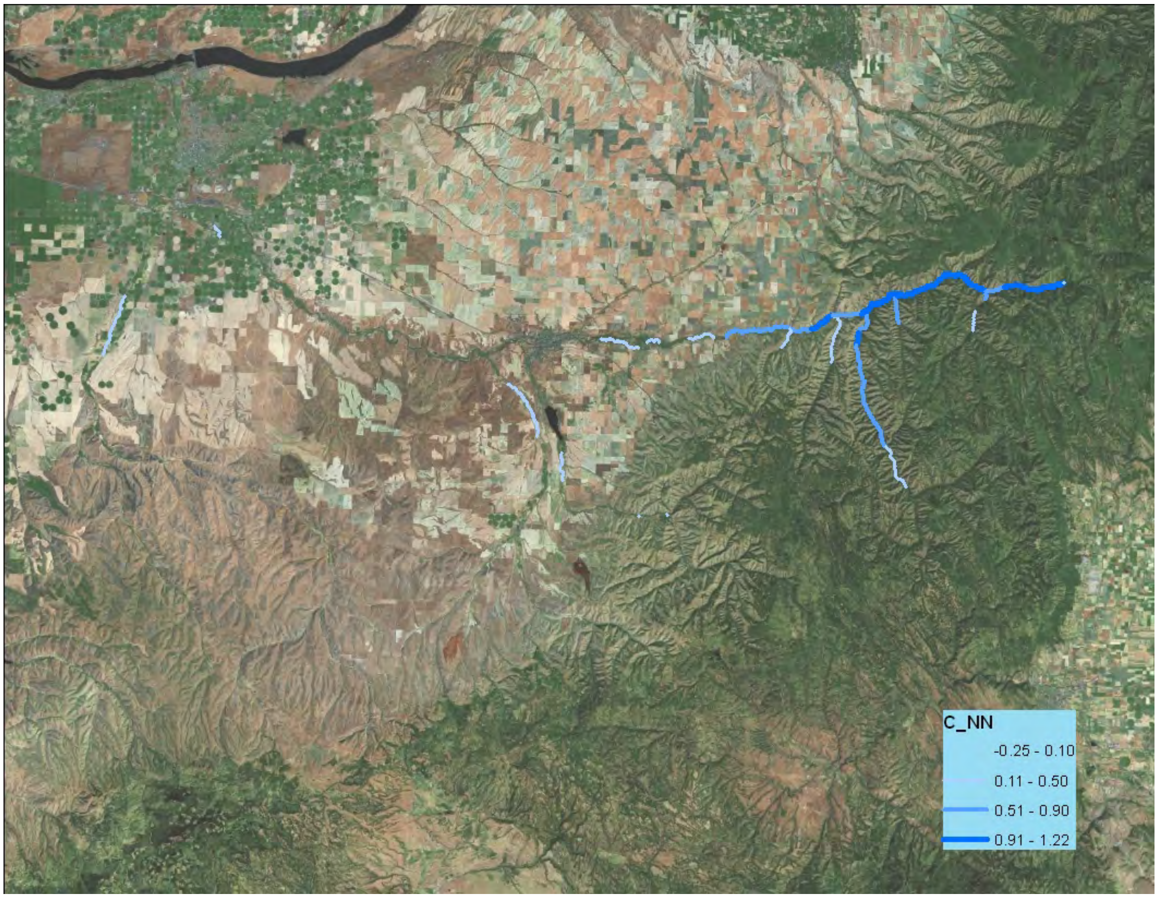

Figure 20. The predicted distribution of spring Chinook, as a result of Neural Network analysis, is shown in increasingly darker shades of blue.

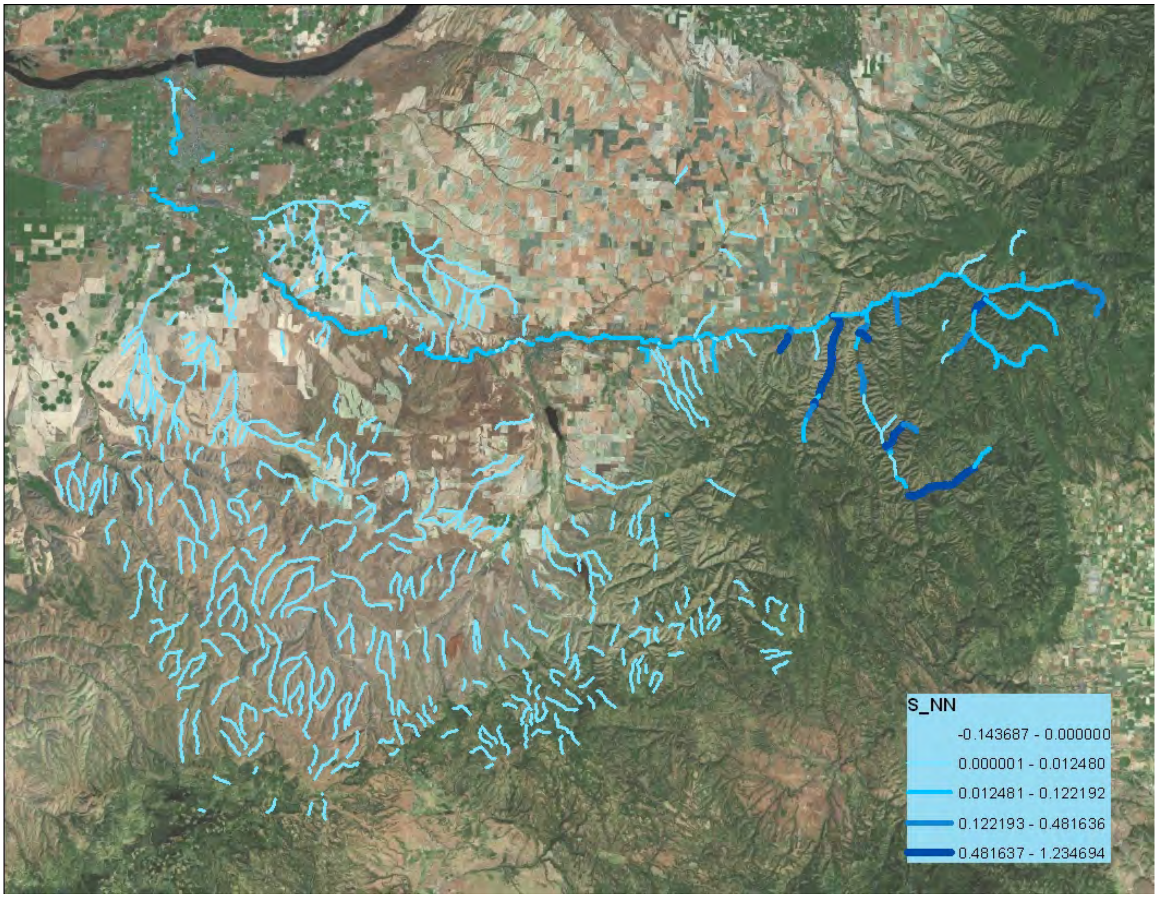

Figure 21. The predicted distribution of summer steelhead, as a result of Neural Network analysis, is shown in increasingly darker shades of blue.

Conclusions

There is more to an assessment of habitat than simple calculations of habitat area and amount. Clearly, the spatial arrangement of habitats throughout the Umatilla River watershed streams is important in describing the distribution of summer steelhead and spring Chinook salmon. Considering the spatial arrangement of habitats and occupied patches of salmon provided a spatial context for the interpretation of multiple spatial scales that represent different population and environmental processes.

Integrating the context of the stream network into analysis at multiple spatial scales included an important dimension of the environment in which Pacific salmon evolved, and juvenile fish must survive. The riverscape in which salmon must endure includes a diversity of habitats with varied productivity and connectivity among years and environmental conditions. Ultimately, the persistence of salmon depends on access to multiple, diverse and connected habitat. Salmon evolved the ability to embrace the diversity of habitats and environmental conditions that naturally occur in the Pacific Northwest. This adaptability is how they have coped with the frequent disturbances and the inconsistent spawning and rearing conditions that are historically found in the Umatilla River basin.

Management strategies that fail to consider the network context of stream habitats ignore a critical element of the riverscape for summer steelhead and spring Chinook salmon. Relying on persistent, although relatively small reach areas with high annual productivity is not an adequate, long term management strategy to preserve Pacific Salmon in the Umatilla watershed. Rather, management strategies that consider the spatial distribution of habitats and the variety of habitat variability in different subbasins will be better suited to the complex environmental conditions in which these organisms evolved.

8 CONCLUSIONS AND RECOMMENDATIONS

This effort successfully tests the utility of the NHD dataset to model summer steelhead and spring Chinook; however the initial 1:24,000 dataset that was developed should be further explored.

Large scale similarities between these results and past EDT modeling results for the Umatilla River watershed suggest that these statistical models are roughly consistent with the expert opinion process.

While I used presence and absence data to simply model the potential reaches where summer steelhead and Spring Chinook made redds; a model based on fish densities would produce more realistic results and results that better explained the interactions between these two (and likely other) aquatic species. Further modeling of juvenile salmon densities and, potentially, adult life stages within a stream network context would, likely, provide additional important information for managers.

Expanding these methods to address fish communities would likely benefit juvenile salmon studies by incorporating the aquatic portion of the food web into a spatial context. For example, a program of work that includes synoptic collection of juvenile salmon data could be further expanded in subsequent years to include aquatic and terrestrial inputs (including native aquatic communities and potentially food webs).

Considering the predictions of climate change on semi-arid basins, like the Umatilla, it would be prudent to consider further developing habitat simulation models to depict the potential future ranges of salmon populations. While the course, physical approach taken here was successful in showing statistically significant results in predicting redds of summer steelhead and spring Chinook, these conditions are not likely to be long lived during the next century.

Emerging software to predict patterns of organism movement throughout networks, in this case stream networks, could add considerable biological realism to this work (e.g. http://www.circuitscape.org/Circuitscape/Welcome.html and http://www.nrel.colostate.edu/projects/starmap/). While the native tools to develop these least-cost path models exist in Arc Map, these programs make the application of circuit/network theory more approachable because it considers effects of all possible pathways across a landscape simultaneously. In terms of statistical techniques, implementing a set of predictions using Random Forests techniques (Brieman and Freeman 1998) may provide improved results over the ones presented in this report. Random Forests techniques provides an existing and rich source of covariate information, in the NHD dataset, and is likely a useful tool in further exploring the problem of predicting life stages of Pacific Salmon.

The clustering in the steelhead and spring Chinook datasets suggest that particular reaches are selected for spawning year after year. We show that these patterns are not random and they are characterized by particular physical conditions. Thus management of these particular reaches is critical in maintaining the existing habitat and better understanding the controls on these habitats will allow the CTUIR to more efficiently restore adjacent stream reaches. For example, because spring Chinook use multiple channel reaches, river managers could target limiting development or stream simplification projects. Both of these modifications frequently result in channel simplification that would reduce spawning habitat for spring Chinook.

Additionally, this exercise generated several questions that are outside the scope of the current effort:

- What might the effects of climate change mean to resident aquatic species in the Umatilla River, that salmon rely on for early life stages?

- Using the distribution of segment length, managers could anticipate local habitat gaps and adjust their sampling protocols accordingly.

- Greater potential genetic exchange between populations increases heterozygosity and minimizes loss of genetic variation. What might be the result of changing hatchery practices, climate variation and increased spawning success on the downstream extent of current Umatilla salmon populations?

9 PRESENTATIONS AND OUTREACH

During the project period several presentations and posters were given to share the efforts of this work and to gain insight into the limitations and alternative applications to other stream management scenarios. During late 2008, throughout 2009 and continuing into 2011, posters and talks at regional and national meetings have contributed to improving this work.

American Association of Geographers (AAG), Seattle WA. April 11-16, 2011

River Research Northwest (RRNW), Stevenson, WA. February 3-6, 2011

Presented at the American Geophysical Union (AGU), San Francisco, CA. , December 11-16, 2010

Oregon Watershed Enhancement Board Meeting (OWEB), Pendleton, OR. , November 3-6, 2010

North American Benthological Society (NABS) Meeting, Santa Fe, New Mexico, June 6-11th, 2010

Northern Rockies Chapter, Urban and Regional Information Systems Association (URISA), Coeur d'Alene, Idaho, April 6-10, 2009
GIS/Geomorphology: Fusing information from 10 meter DEMs with field data sets

Northwest GIS Users Conference, Sun Valley, Idaho, October 20-24, 2008
Creating GIS derived metrics to describe semi-arid streams and floodplains

Below are a few examples of the abstracts that are associated with this effort -

Classification of physical habitat for Pacific Salmon in Semi-Arid Basins in Washington and Oregon

Currently, significant efforts are aimed at improving freshwater habitats that Pacific Salmon require for spawning and rearing. In order to inform fisheries management, we measure geologic, hydrologic, geomorphic variables that influences channel morphology across the Umatilla and Walla Walla River watersheds. We calculate several DEM derived measures (channel slope, SD channel slope, sinuosity, floodplain width, valley slope, wavelength of the channel belt and ratio of channel segment length to floodplain width) to produce both standard and statistically derived stream classifications. To estimate bed grain size, we used morphologic measurements from 10 meter DEMs and the Shields equation (Buffington et al. 2004). These watersheds are characterized by a long, low gradient, mainstem stream profiles with relatively steep tributaries. Simple logistic regressions were used to compare geomorphic attributes and limiting life stages (egg and juvenile at life stages) for Oncorhynchus mykiss and Oncorhynchus tshawytscha. Widely available spatial datasets allow one to apply models over large areas to produce rapid, comparable stream habitat assessments.

Presented at the American Water Resources Association meeting (AWRA) Seattle, WA. 2009

DEM preparation for measuring physical habitat for Pacific Salmon in the Umatilla River Watershed

Currently, significant efforts are aimed at improving freshwater habitats that Pacific Salmon require for spawning and rearing. In order to inform fisheries management, we measure geologic, hydrologic, geomorphic variables that influences channel morphology across the Umatilla and Walla Walla River watersheds. We calculate several DEM derived measures (channel slope, SD channel slope, sinuosity, floodplain width, valley slope, wavelength of the channel belt and ratio of channel segment length to floodplain width) to produce both standard and statistically derived stream classifications. To estimate bed grain size, we used morphologic measurements from 10 meter DEMs and the Shields equation (Buffington et al. 2004). The Umatilla River is characterized by a long, low gradient, mainstem profiles with relatively steep tributaries. The distribution of channel morphologies has a strong spatial threshold, with slope and valley width controlling higher stream orders. Widely available spatial datasets allow one to apply models over large areas to produce standard, comparable stream habitat assessments.

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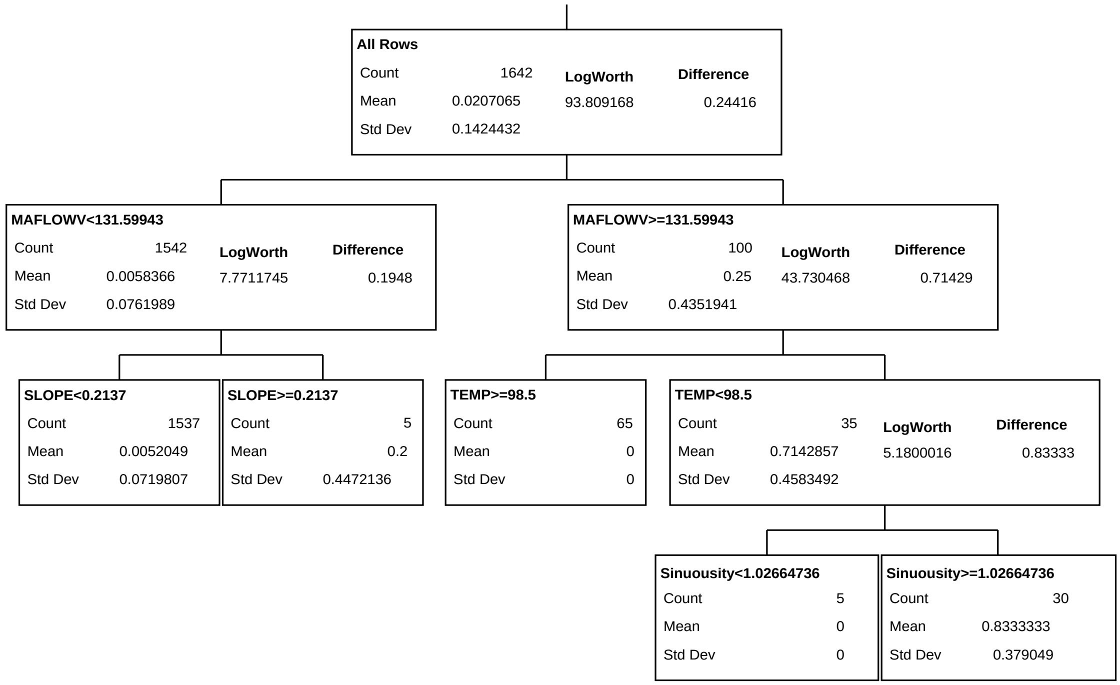
11 APPENDIX A.

Classification and Regression Trees for Spring Chinook Salmon and Summer steelhead

Classification and Regression Trees

Spring Chinook

RSquare	N	Number of Splits
0.612	1642	4



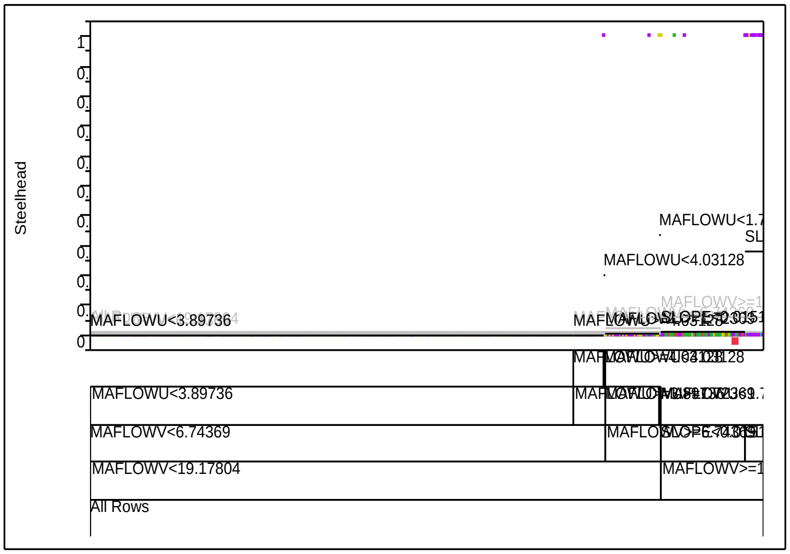
Crossvalidation

k-fold		SSE	RSquare
10	Folded	13.5241597	0.5938
	Overall	12.9250271	0.6118

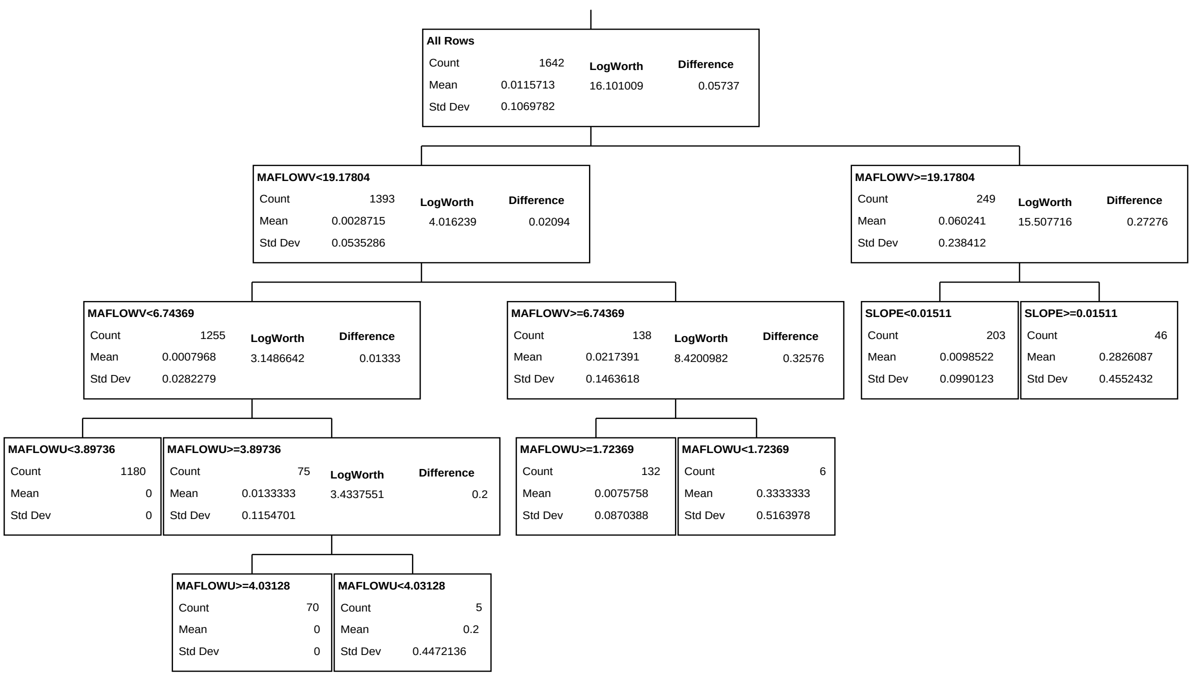
Column Contributions

Term	Number of Splits	SS	SS
Sinuosity	1	2.97619048	
MAFLOWV	1	5.59850969	
SLOPE	1	0.18911037	
TEMP	1	11.6071429	
Total	4	20.3709534	

Summer steelhead



RSquare	N	Number of Splits
0.232	1642	6



Crossvalidation

k-fold		SSE	RSquare
10	Folded	15.9076744	0.1530
	Overall	14.4321401	0.7315

Column Contributions

Term	Number of Splits	SS	SS
MAFLOWU	3	0.80822822	
MAFLOWV	2	0.74977483	
SLOPE	1	2.79000302	
Total	6	4.34800606	

Neural Net
Spring Chinook

	Specify
Hidden Nodes	3
Overfit Penalty	0.01
Number of Tours	4
Max Iterations	75
Converge Criterion	0.001

No Cross Validation

Method:
Gauss Newton

Fit History

Nodes	Penalty	RSquare
3	0.01	0.83167

Current Fit Results

	Objective
SSE	276.23037439
Penalty	60.332453523
Total	336.56282791
N	1642
Nparm	55

1 Converged At Best
1 Converged Worse Than Best
0 Stuck on Flat
0 Failed to Improve
2 Reached Max Iter

Y	SSE	RMSE	SSE Scaled	RMSE Scaled	RSquare
Chinook	5.6047295322	0.05849522	276.23037439	0.41065656	0.8317

Summer steelhead

	Specify
Hidden Nodes	3
Overfit Penalty	0.01
Number of Tours	4
Max Iterations	75
Converge Criterion	0.001

No Cross Validation

Method:
Gauss Newton

Fit History

Nodes	Penalty	RSquare
3	0.01	0.68414

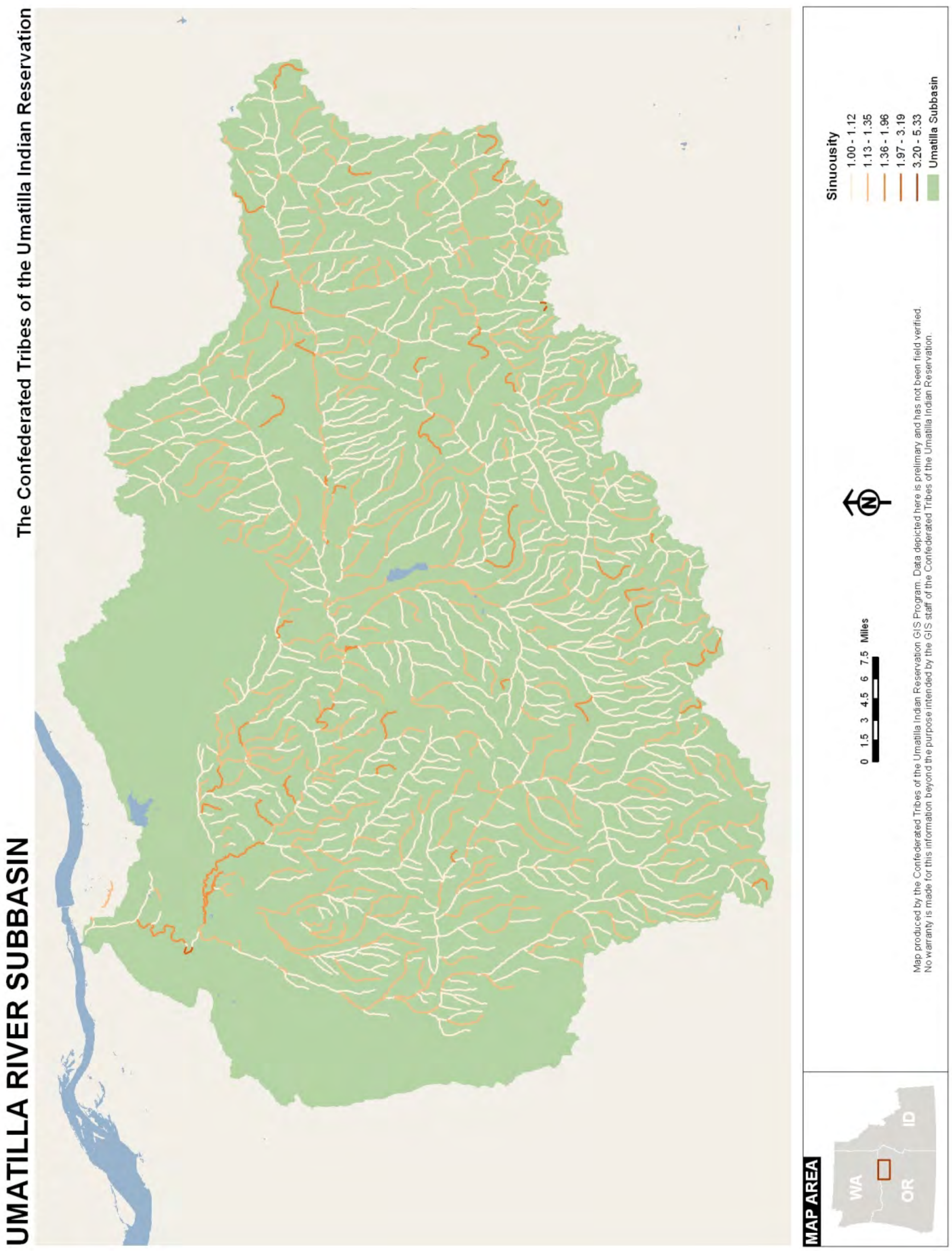
Current Fit Results

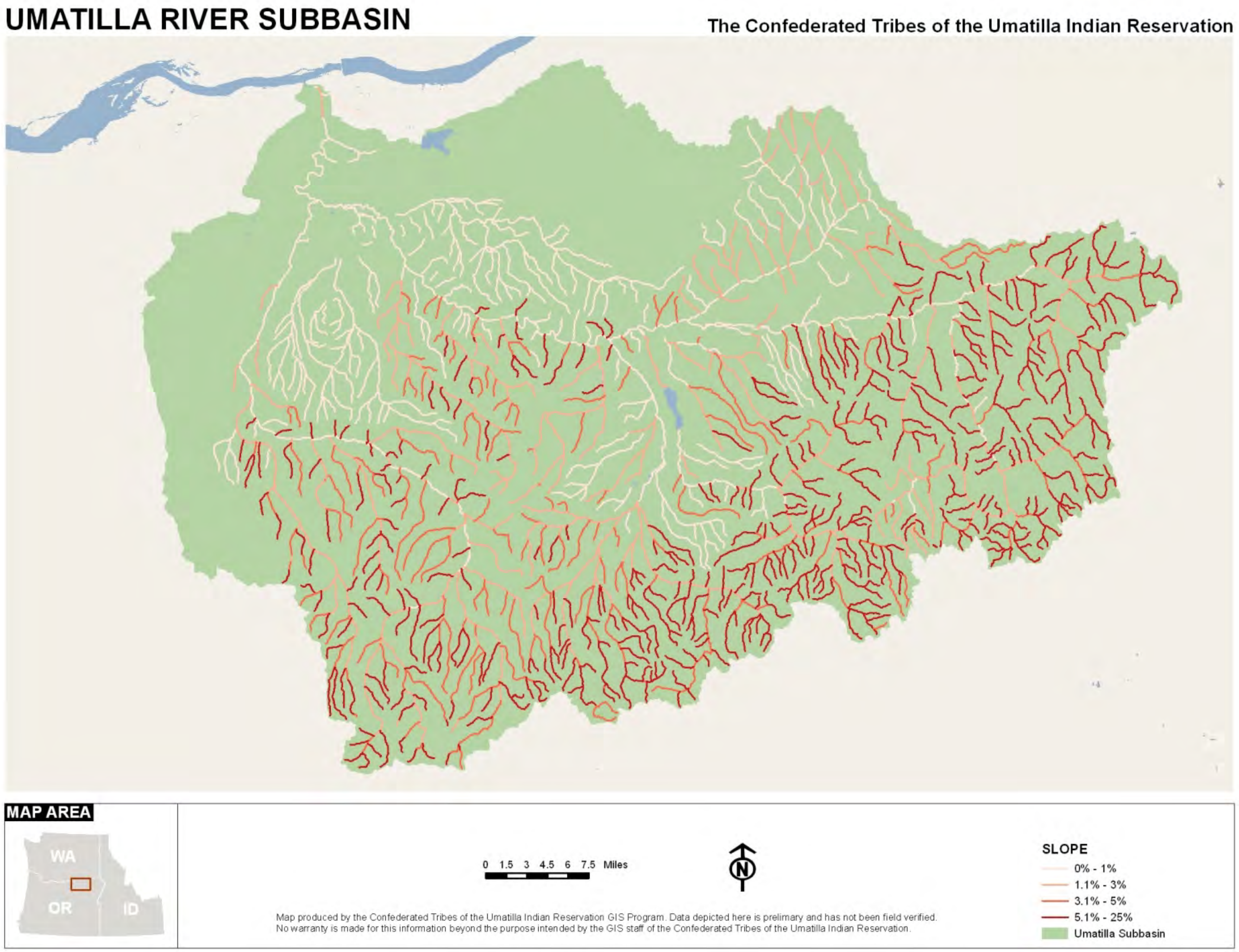
	Objective
SSE	518.331994
Penalty	98.838779521
Total	617.17077352
N	1642
Nparm	58

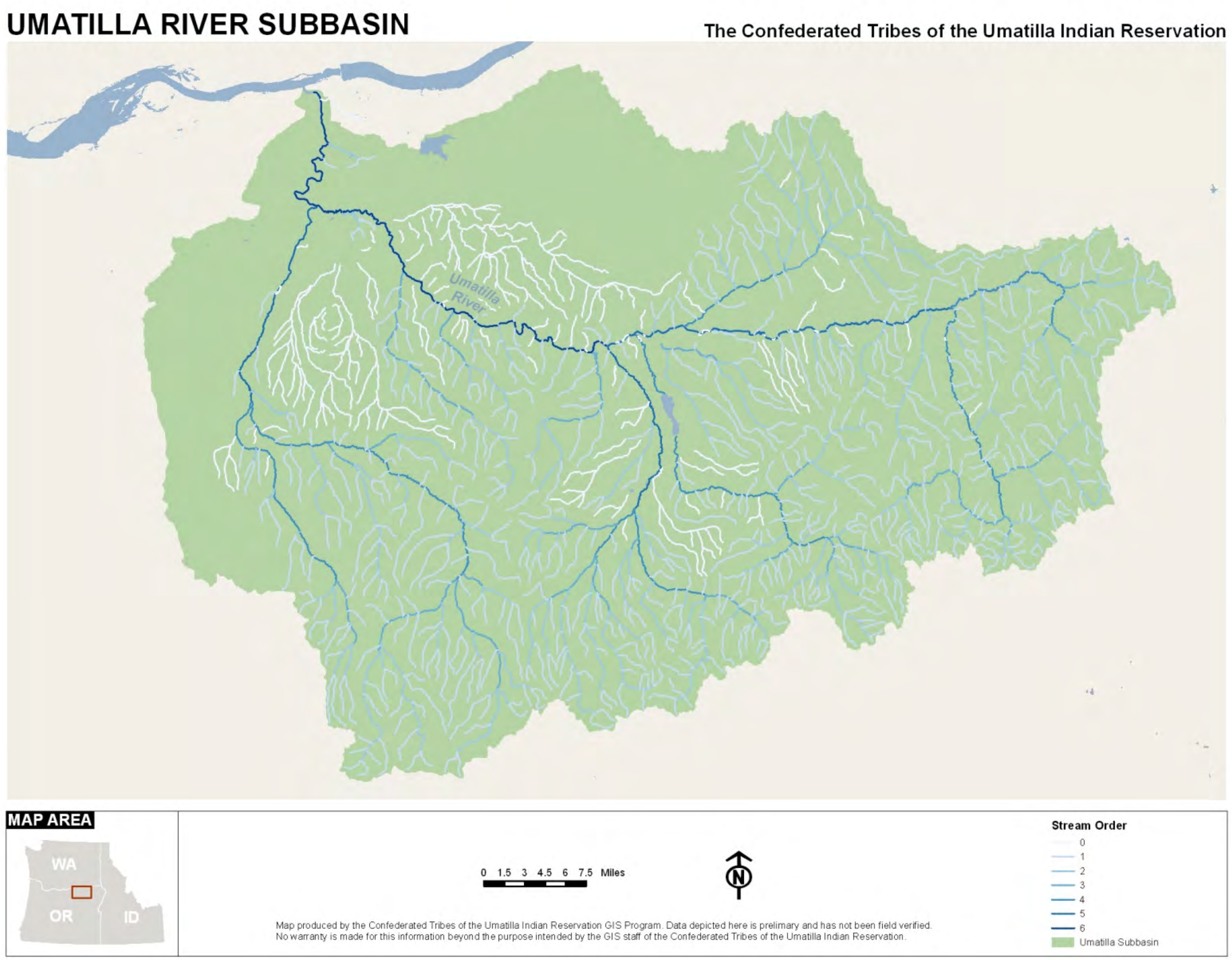
1 Converged At Best
3 Converged Worse Than Best
0 Stuck on Flat
0 Failed to Improve
0 Reached Max Iter

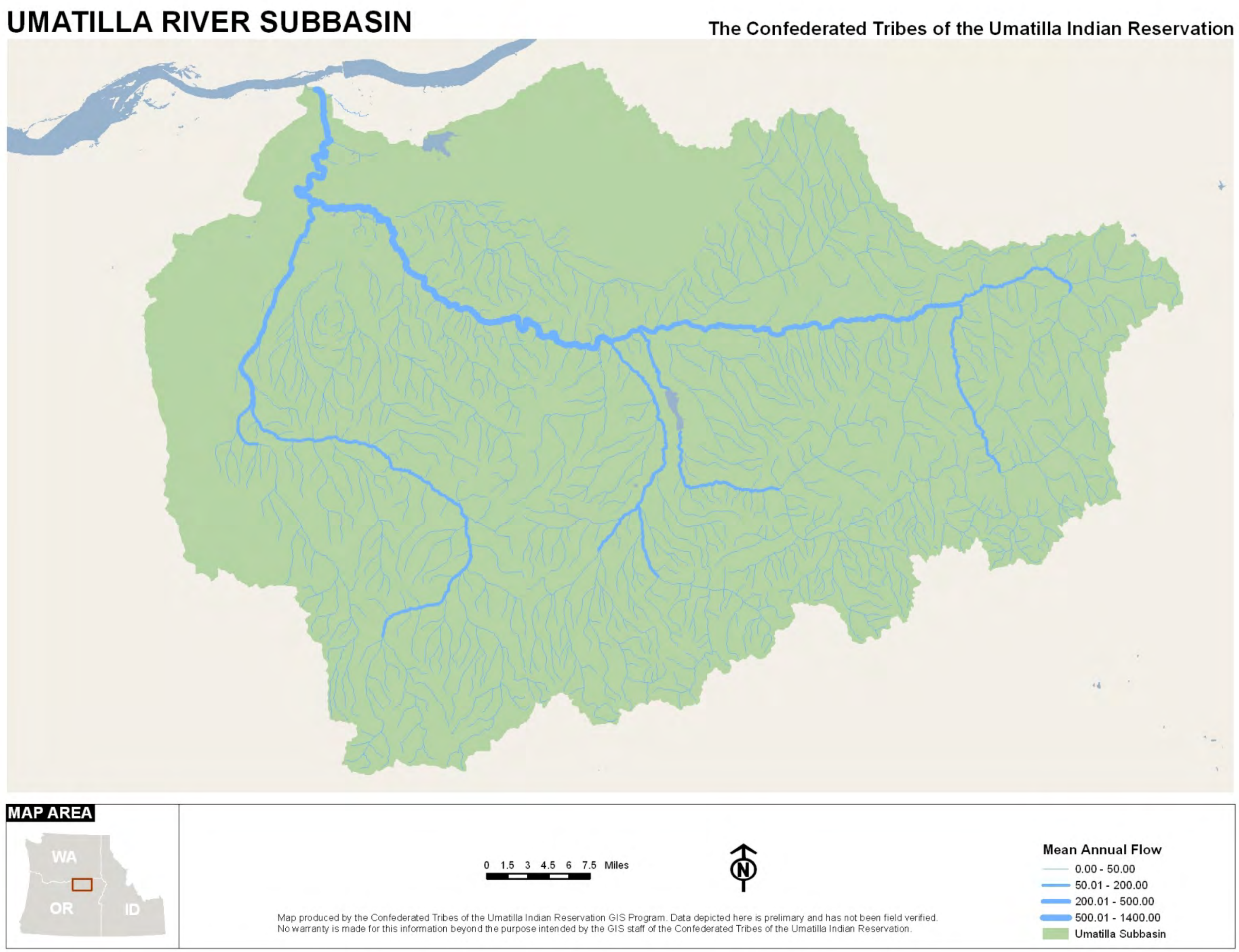
Y	SSE	RMSE	SSE Scaled	RMSE Scaled	RSquare
Steelhead	5.9319625889	0.06017862	518.331994	0.56253178	0.6841

12 APPENDIX B.




UMATILLA RIVER SUBBASIN
The Confederated Tribes of the Umatilla Indian Reservation
MAP AREA
WA
OR
ID
0 1.5 3 4.5 6 7.5 Miles
N
Map produced by the Confederated Tribes of the Umatilla Indian Reservation GIS Program. Data depicted here is prelimary and has not been field verified.
No warranty is made for this information beyond the purpose intended by the GIS staff of the Confederated Tribes of the Umatilla Indian Reservation.
SLOPE
0% - 1%
1.1% - 3%
3.1% - 5%
5.1% - 25%
Umatilla Subbasin


UMATILLA RIVER SUBBASIN
The Confederated Tribes of the Umatilla Indian Reservation
Umatilla River
MAP AREA
WA
OR
ID
0 1.5 3 4.5 6 7.5 Miles
N
Map produced by the Confederated Tribes of the Umatilla Indian Reservation GIS Program. Data depicted here is prelimary and has not been field verified.
No warranty is made for this information beyond the purpose intended by the GIS staff of the Confederated Tribes of the Umatilla Indian Reservation.
Stream Order
0
1
2
3
4
5
6
Umatilla Subbasin


UMATILLA RIVER SUBBASIN
The Confederated Tribes of the Umatilla Indian Reservation
MAP AREA
WA
OR
ID
0 1.5 3 4.5 6 7.5 Miles
N
Map produced by the Confederated Tribes of the Umatilla Indian Reservation GIS Program. Data depicted here is prelimary and has not been field verified.
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Mean Annual Flow
0.00 - 50.00
50.01 - 200.00
200.01 - 500.00
500.01 - 1400.00
Umatilla Subbasin