Report

Cost Estimate to Restore Riparian Forest Buffers and Improve Stream Habitat in the Willamette Basin, Oregon

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1 Executive Summary and Key Findings

DEQ produced this report as part of the U.S. Environmental Protection Agency's 2008 Clean Watersheds Needs Survey. Every four years EPA conducts this survey – mandated by the federal Clean Water Act through sections 205(a) and 516 – to collect data about capital needs and costs to meet the act's water quality goals. DEQ's report concludes that it could cost from $593 million to $1.2 billion to restore streamside vegetation and improve streamside habitat throughout the Willamette basin.

For the first time, this report includes estimated costs of restoring streamside vegetation and habitat from pollution caused by "nonpoint" sources such as farming, forestry and urban activities. Nonpoint activities that result in the loss of streamside vegetation contribute to sediment runoff into streams, increased stream temperatures and a diminished aquatic habitat.

This report also estimates how much heat pollution is reduced by restoring streamside vegetation. DEQ measured reduction in heat pollution in terms of reduction in kilocalories per day received by the stream. (A kilocalorie is the amount of energy it takes to heat one kilogram of water by one degree Celsius.)

Results from this report will help stream habitat restoration planning efforts by DEQ, cities, counties, watershed groups and others interested in improving water quality in the Willamette Basin. The report's cost estimates also can add to current discussions about how – and how much – of this restoration work could be funded.

In addition, this report helps supplement information from DEQ's recently released Willamette Basin Rivers and Streams Assessment Report, produced by DEQ's Laboratory and Environmental Assessment Division. That assessment showed that warm water temperature was the most extensive water quality impairment in the Willamette Basin, with impaired stream bank conditions being another major cause of water quality impairments in the basin's streams and rivers.

Key findings of this report:

- The total cost of restoration work in the basin averages to about $900 million and ranges between $593 million and $1.2 billion. These amounts include 15 years of annual rental payments to landowners for use of lands for restoration purposes.
- About 96,000 acres may need to be restored in the Willamette basin. About 70 percent of those acres are on agricultural lands.
- Annual land rents would average about $13 million (in 2008 dollars).
- About 75 percent of the initial total cost is related to restoration on agricultural lands.
- About 15 percent of the initial total cost is related to restoration inside urban growth boundaries.
- About 12.9 billion kilocalories per day of heat energy would be reduced on agricultural lands once all the restored vegetation reached maturity.

2 Introduction

The Oregon Department of Environmental Quality has listed multiple streams in the Willamette Basin as not meeting water quality standards for temperature, bacteria, and other pollutants (ODEQ 2006a). ODEQ has completed three Total Maximum Daily Load (TMDL) analyses to address most of these water quality impairments (The Tualatin Subbasin TMDL, The Willamette Basin TMDL, and the Molalla-Pudding Subbasin TMDL). All three TMDLs cover the entire basin except in the Yamhill Subbasin. The Yamhill Subbasin TMDL is currently under development. All approved TMDLs called for the restoration of riparian vegetation as one of the management objectives to restore and protect streams from increases in temperature, bacteria loading, and sediment movement. (ODEQ 2001, ODEQ 2006b, and ODEQ 2008). While, the Yamhill TMDL is not approved, this study will include riparian restoration needs for that subbasin as well.

The responsibility to implement the TMDL management objective is delegated to Designated Management Agencies (DMAs). A DMA is a federal, state, or local government agency that has legal authority of a sector or source contributing pollutants. For ODEQ and each DMA, the cost to implement restoration is of great importance when preparing implementation plans and establishing funding priorities. It is also important to understand the pollution reductions that could be achieved from restoration. This report summarizes the cost estimate for riparian restoration and instream improvement, and estimates the reduction in solar energy associated with temperature conditions.

3 Scope and Conceptual Framework

The conceptual framework used here to estimate the cost of restoration relies on three central components: the geographic scope of DMAs, the condition of riparian forests, and the cost of riparian forest and instream habitat restoration. A restoration cost estimate can be generated for each DMA using information on the geographic scope for each DMA, acres of riparian forest or instream habitat that require improvement, and the average cost of restoration. There are many sources of error with this type of analysis so a lower and upper bound have also been calculated to demonstrate the range in potential costs due to uncertainty with the data and methodology. Uncertainty is discussed further in **Section 6**. This section describes the assumptions and methodology used to determine the geographic scope for each DMA and how many acres of riparian forest could be restored. The assumptions and methodology for deriving an average cost for restoration (including habitat and fencing needs) is described in **Section 4**. The assumptions and methodology used to calculate the solar energy reduction is described in **Section 5**.

3.1 Study Area

The Willamette Basin (shown in **Figure 1** and **Figure 2**) is a third field hydrological unit located in Oregon with an area of approximately 30,000 square kilometers. The basin is drained by the Willamette River, the 13th largest river in the lower 48 states in terms of stream flow. About two thirds of Oregon's population lives in the Basin. All the subbasins in the Willamette Basin were included in this study. The subbasins include: the Lower Willamette Subbasin (Hydrologic Unit Code [HUC] 17090012), Tualatin Subbasin (HUC 17090010), Yamhill Subbasin (HUC 17090008), Middle Willamette Subbasin (HUC 17090007), Molalla-Pudding Subbasin (HUC 17090009), Clackamas Subbasin (HUC 17090011), North Santiam Subbasin (HUC 17090005), South Santiam (HUC 17090006), Upper Willamette Subbasin (HUC 17090003), McKenzie Subbasin (HUC 17090004), Middle Fork Willamette Subbasin (HUC 17090001), and the Coast Fork Willamette Subbasin (HUC 17090002).

Figure 1. Willamette Basin, Oregon with subbasins (right).

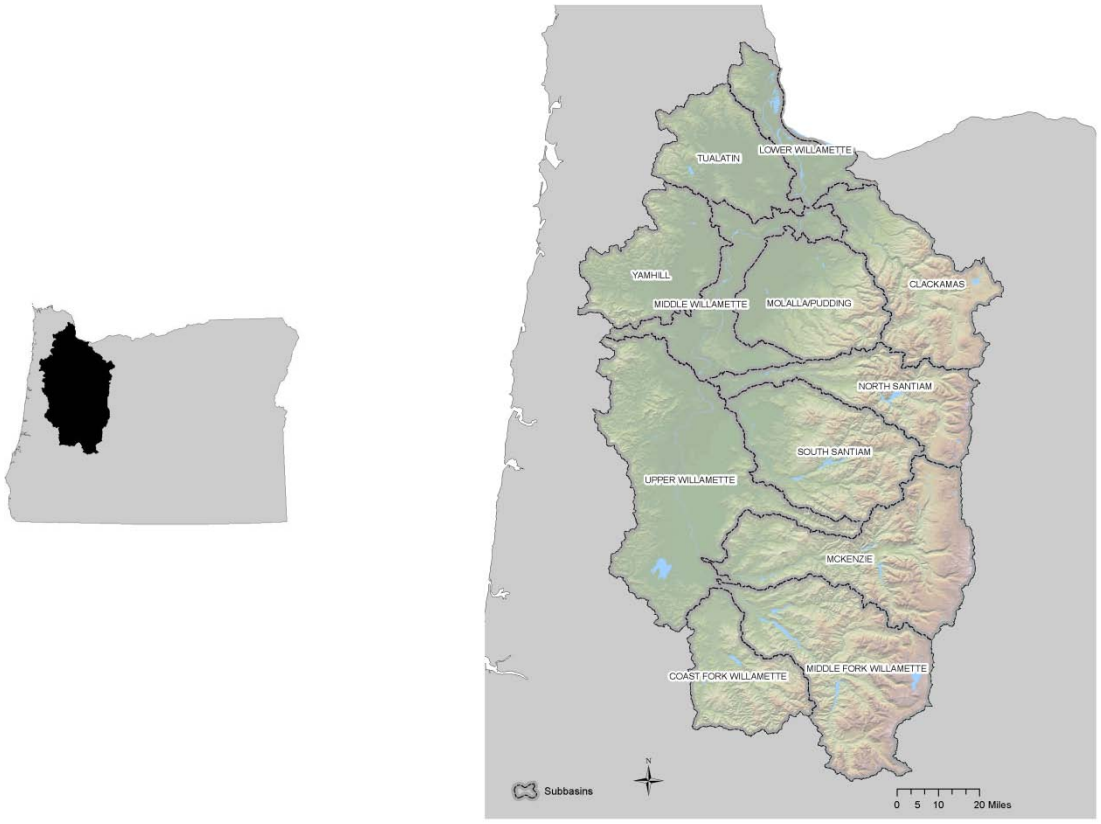
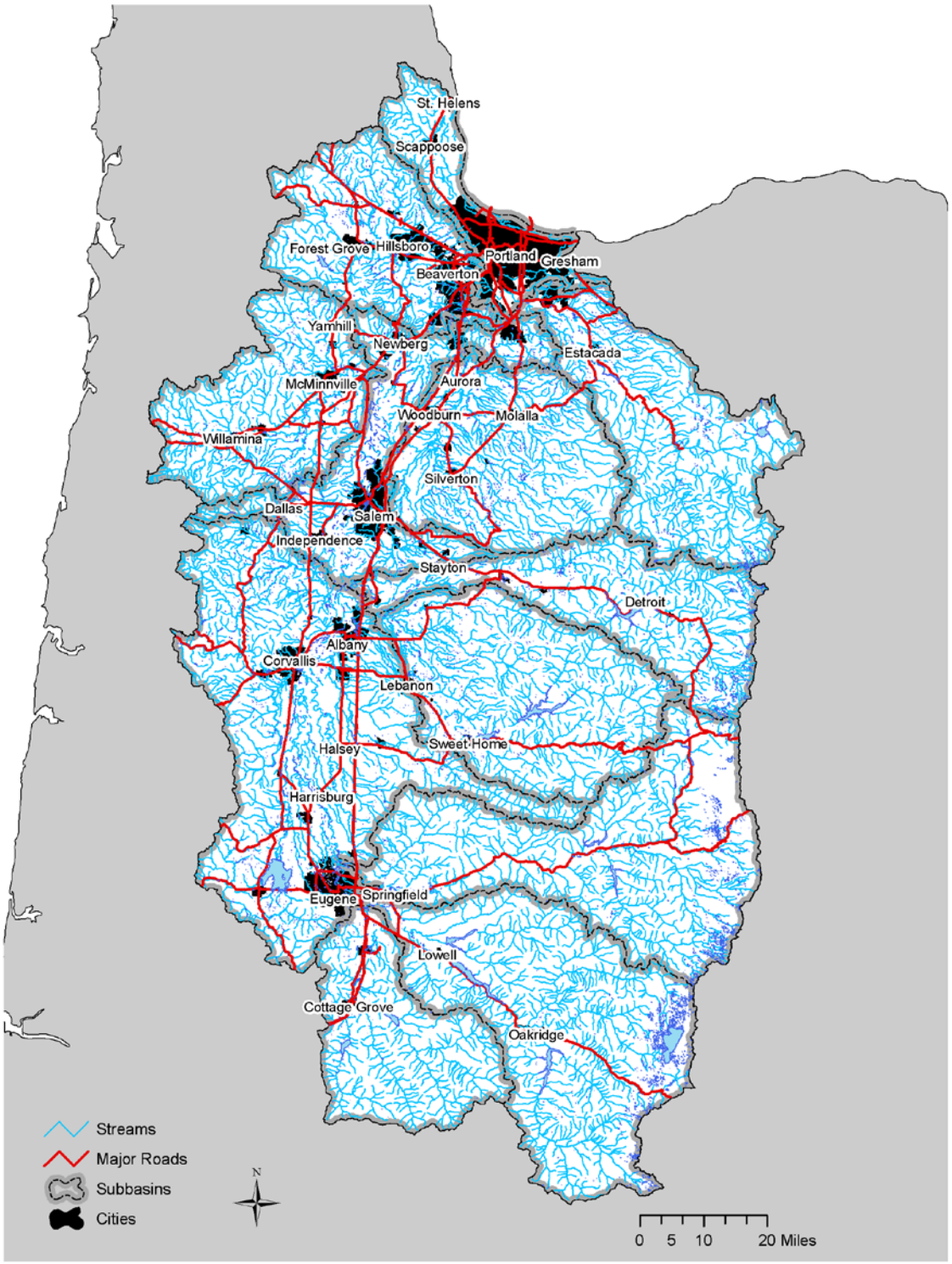


Figure 2. Willamette Basin streams, cities, and major roads.



3.2 Designated Management Agencies

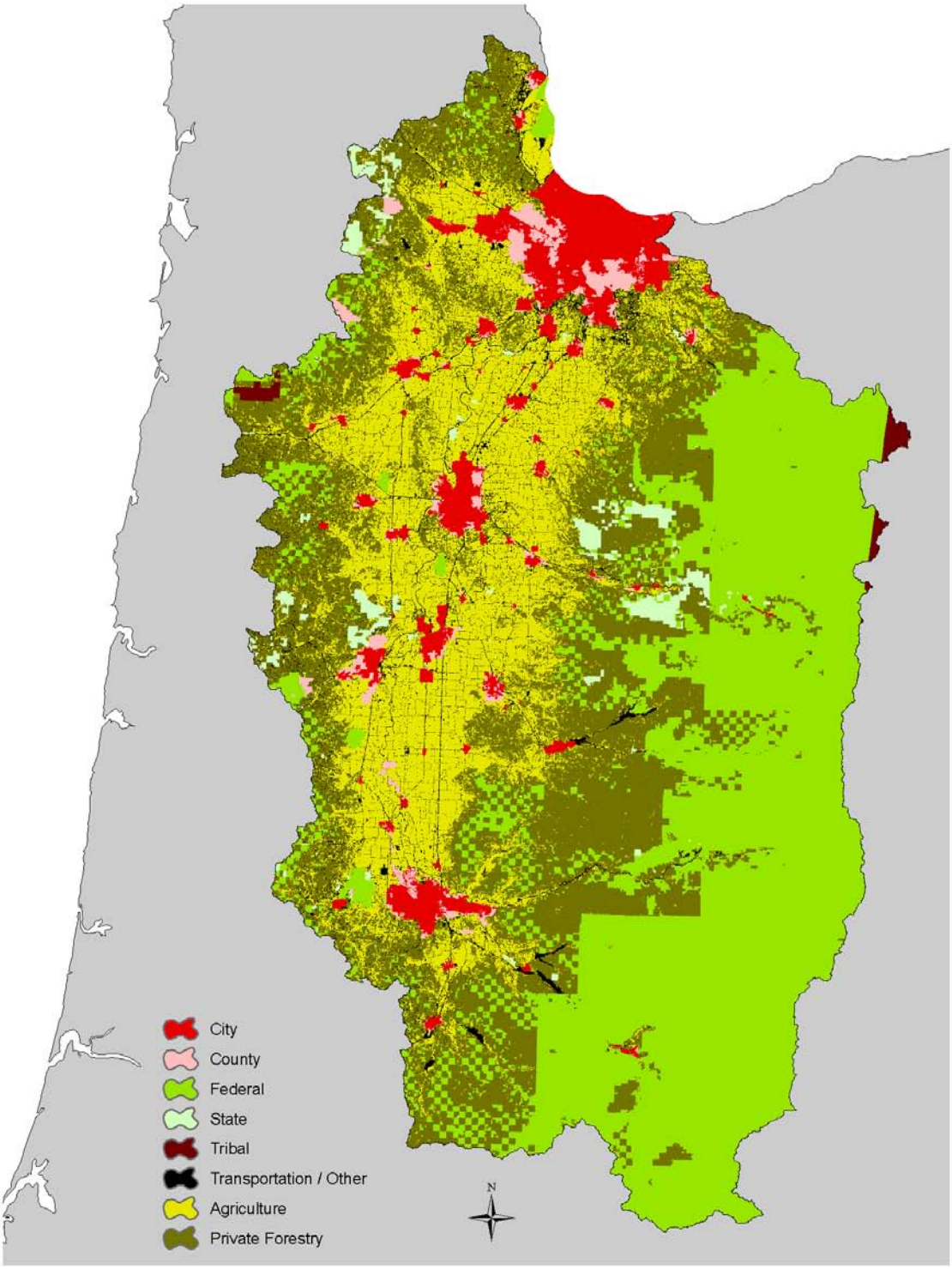
Each TMDL includes a water quality management plan that assigns responsibility for implementation of the TMDL load allocations to DMAs. DMA boundaries were established using GIS data available for each jurisdiction. Jurisdictional boundaries were obtained from the State of Oregon Geospatial Data Clearinghouse.

The Oregon Department of Forestry (ODF) and the Oregon Department of Agriculture (ODA) are the DMAs responsible for private forestry and agriculture activities respectively. Because these activities are based on land use, the geographic scope was defined using typical forestry and agriculture land use classifications contained in the 2001 National Land Cover Dataset (NLCD) (Homer et al 2004). The assumptions used to define all of the DMA boundaries are described in **Table 1.** A map of DMA boundaries is shown in **Figure 3**.

Table 1. Assumptions used to spatially define each DMA.

DMA	Spatial Definition Assumptions
Cities	All ownership classes within city boundaries as defined in 2007.
Counties	All county government owned land and other unincorporated ownership classes inside an urban growth boundary, but outside of city boundaries.
Federal Agencies	All federal agency ownership outside of an urban growth boundary
State Agencies	All state agency owned land outside an urban growth boundary. State parks inside an urban growth boundary were also assigned to their respective state management agency.
Agriculture (ODA)	Private land outside an urban growth boundary that is in agricultural land uses or likely regulated under agricultural water quality management plans. Agricultural land uses were defined as NLCD version 2001 landcover codes #71 (Grassland/Herbaceous), #81 (Pasture/Hay), #82 (Cultivated Crops), #90 (Woody Wetlands), and #95 (Emergent Herbaceous Wetland). Note: Woody Wetland and Emergent Herbaceous Wetlands were included because they are the dominant riparian vegetation types in agricultural land uses in the Willamette Valley.
Private Forestry (ODF)	Private land outside an urban growth boundary in forestry land uses. Forestry land uses were defined as NLCD version 2001 landcover codes #31 (Barren Land), #41 (Deciduous Forest), #42 (Evergreen Forest), #43 (Mixed Forest), and #52 (Scrub/Shrub). Note: Barren Land and Scrub/Shrub were included because these vegetation types typically represent areas of recent harvest activity or new forest growth.
Transportation	Transportation infrastructure (highways, streets, forest roads) was not addressed in this study nor assigned to a specific DMA because of the difficulty in evaluating the acreage within the right of way available for restoration. There is more discussion about restoration around impervious surfaces and buildings in section 2.3.

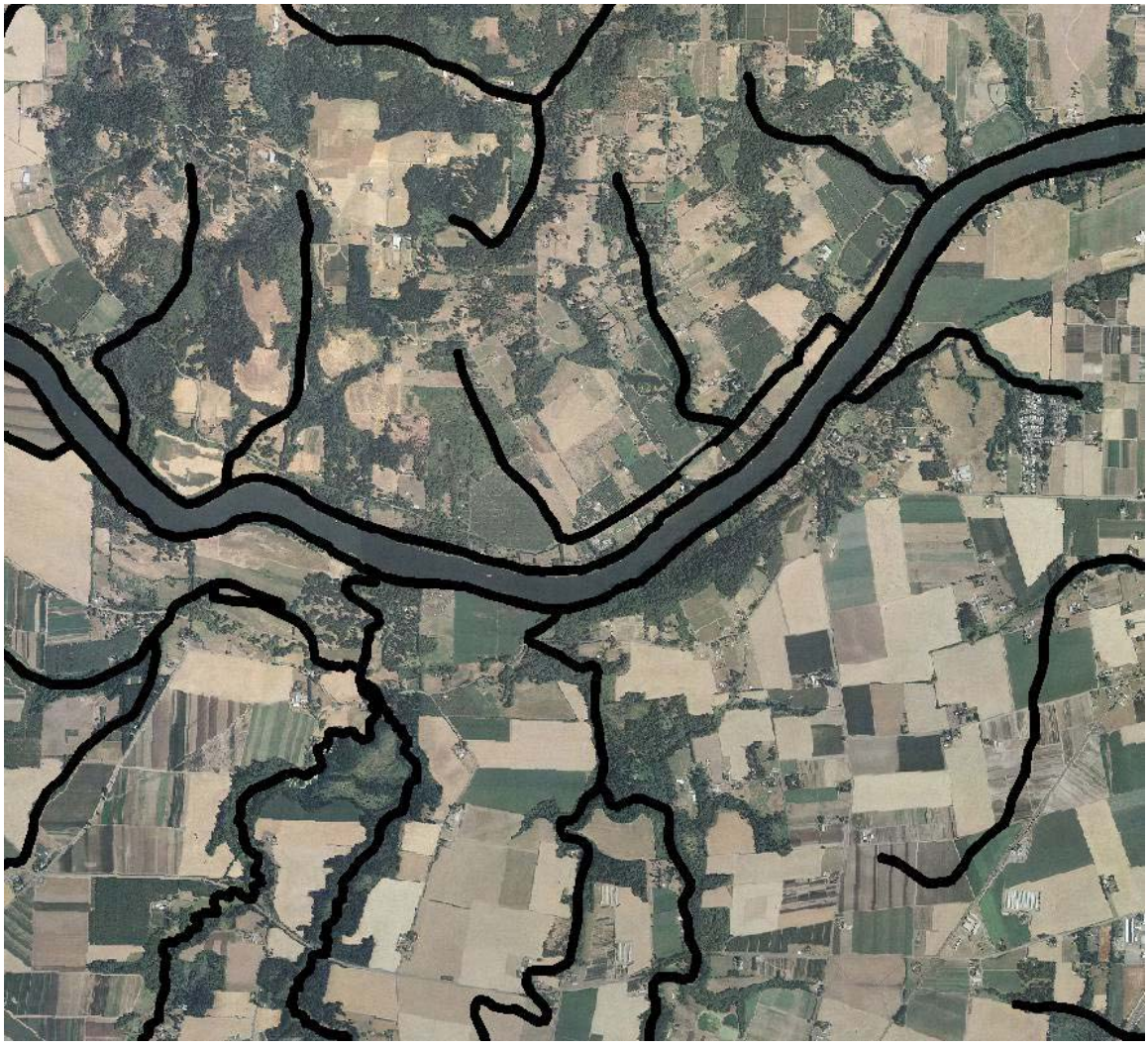
Figure 3. DMA boundaries in the Willamette Basin.



3.3 Riparian Areas and Stream Courses

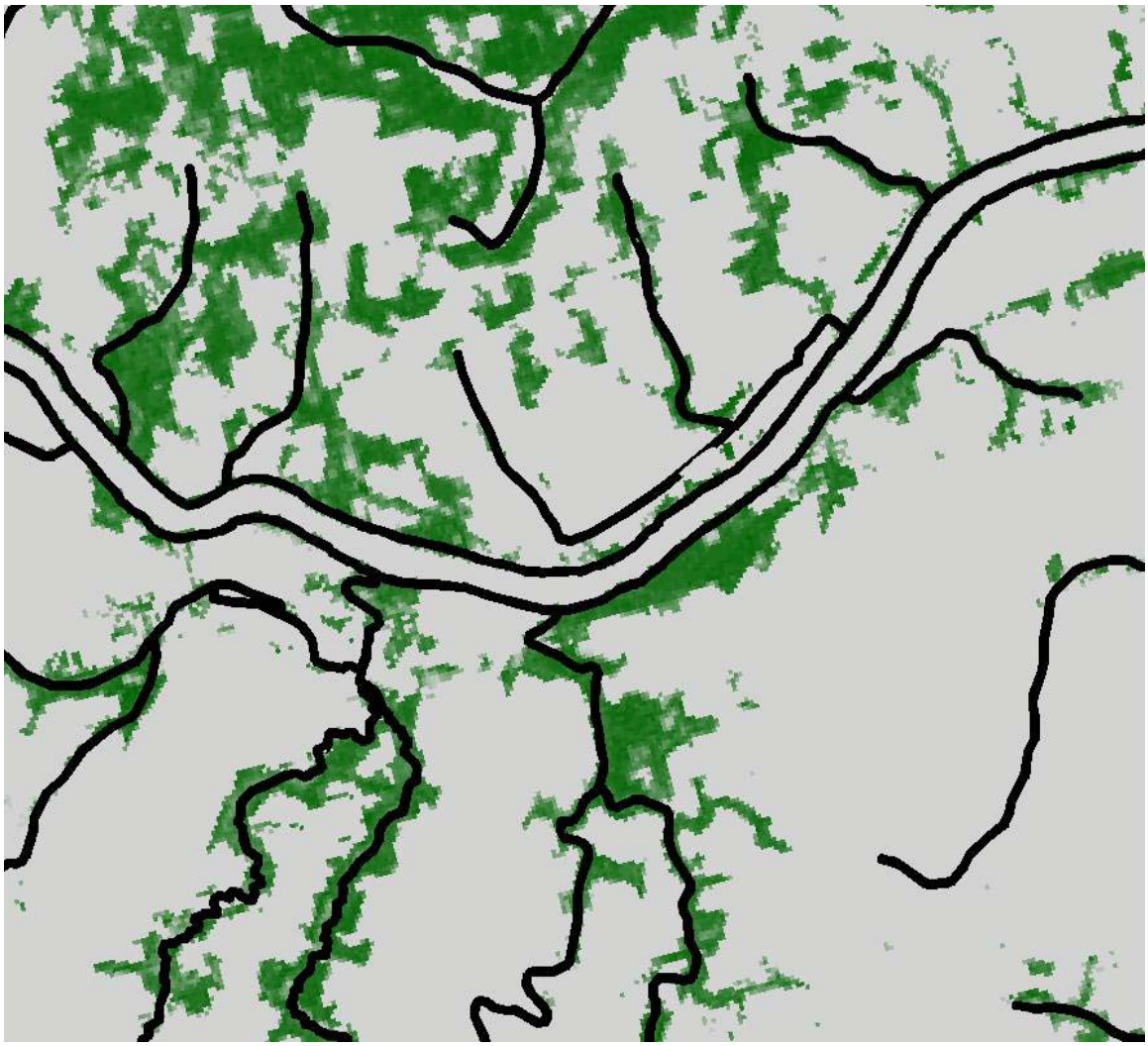
Thirty meter buffers were delineated around stream polylines using USGS's 1:100,000 resolution medium National Hydrography Dataset (NHD). Sixty meter buffers were delineated around polygonal NHD stream areas (see **Figure 4**). NHD stream areas represent streams wider than 50 feet. A wider buffer was used on larger streams to ensure a NLCD vegetation cell, rather than a water cell, would be captured inside the stream buffer zone. Areas inside the buffer zone classified by NHD as wetlands, ponds, lakes, water, or other non vegetated features were removed from consideration.

Figure 4. Aerial photograph with buffer zones depicted in black.



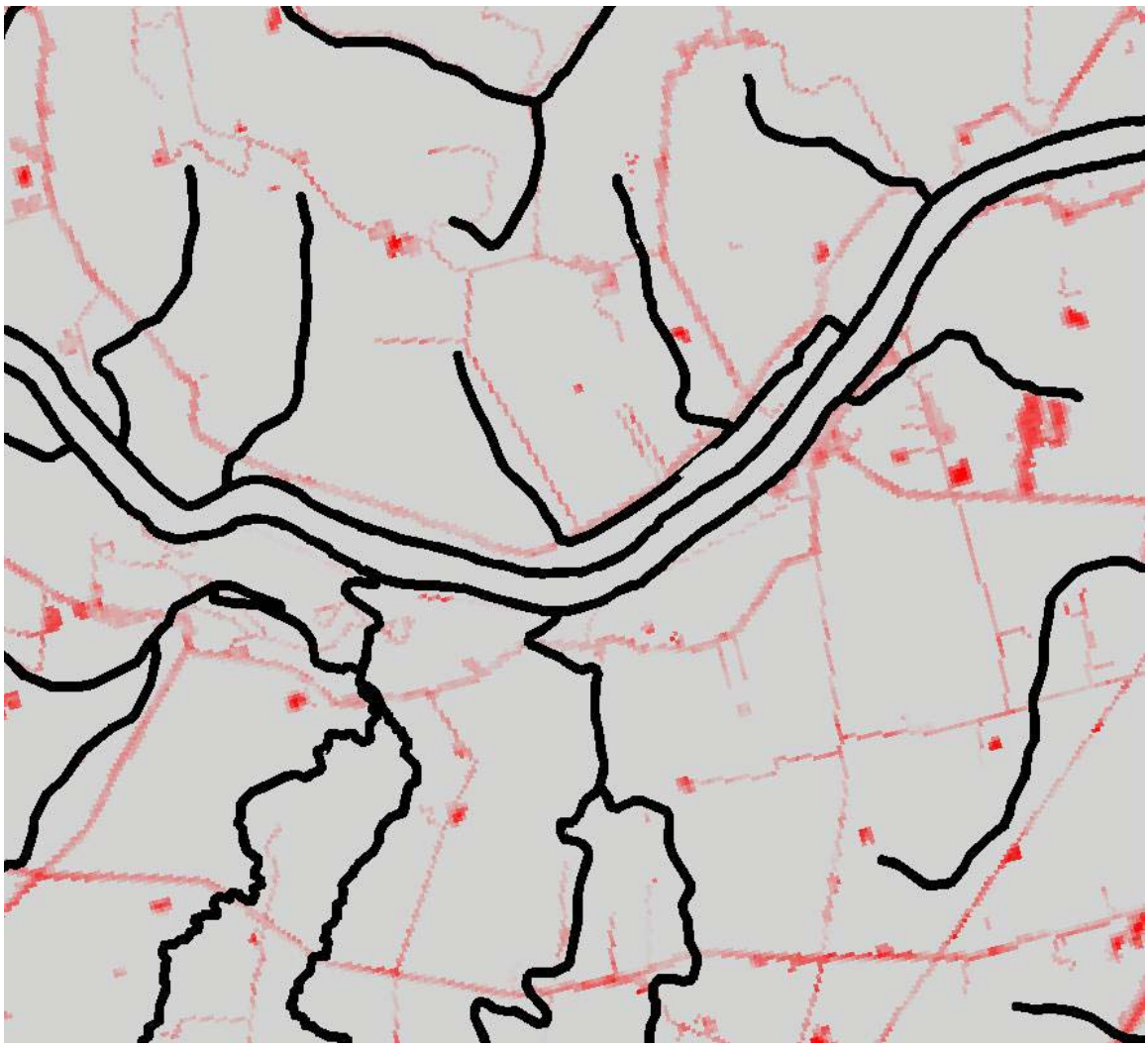
This study assumes most restoration projects will occur at sites with little or no vegetation cover. Using the 30 meter NLCD canopy cover data set shown in **Figure 5** (Huang et al 2001, Homer et al 2004), the number of acres having twelve percent or less canopy cover inside the stream buffer was quantified for each DMA. A canopy cover of twelve percent or less was used to set an upper and lower bound on the range of acres available for restoration projects. See **Section 6** for more information on upper and lower bounds.

Figure 5. NLCD canopy cover. Darker shade of green indicates increased percent canopy density.



The twelve percent or less canopy cover criteria include areas like roads, buildings, and other impervious surfaces have no canopy cover in the total acres requiring restoration. Since most of this infrastructure would not be removed for restoration, these areas were excluded from consideration in the final total of acres for restoration. Using the NLCD impervious surface data set shown in **Figure 6** (Yang et al 2003, Homer et al 2004), the number of acres with no canopy cover was reduced by the corresponding percent of impervious surface in the same location. For example, if a two acre area has 50% impervious surface, there would be one acre available for restoration. The final number of acres available for restoration inside the buffer zone was adjusted using this method for each DMA.

Figure 6. NLCD impervious surface. Darker shade of red indicates increased percent impervious surface.



4 Best Management Practices and Cost Data

Many studies have examined the relationship between vegetated riparian conditions and multiple types of pollutant loading. Maintaining overstory riparian vegetation plays an important role in regulating water temperatures. Increased solar radiation is the largest source of stream temperature warming (Beschta 1997; Johnson and Jones 2000, Johnson 2004, ODEQ 2001, ODEQ 2006b, ODEQ 2008, and Poole and Berman 2001). For temperature, the approved TMDLs in the Willamette Basin require the restoration of riparian vegetation to meet the load allocations. Vegetated riparian buffers can also reduce bacteria concentrations (Coyne 1998; Dosskey 2002; Entry et al 2000; Sullivan et al 2007). Similarly, vegetated riparian buffers are effective at reducing nutrient and sediment loads in streams (Butler et al 2006; McKergo et al 2003; Muenz et al 2006; Parkyn et al 2005; Schoonover et al 2005).

The cost to install riparian buffers varies widely and can depend on a number of site specific conditions (number of plants, cost of materials, etc). Cost estimates for this study were derived using the average cost per acre compiled from multiple restoration projects in the Willamette Basin. The cost for each of these projects includes the cost of site preparation, plantings, materials, labor, project maintenance, and land rent over the contracted period (typically 15 years). This study assumes a rental agreement model (vs. fee simple purchase) because of availability of cost data and it appears to be the primary method utilized by agencies attempting to install BMPS on private land. This study primarily examines costs in the first contract period, although it is expected there will be ongoing rental fees beyond the initial contract.

Costs for riparian forest restoration are presented separately for urban and rural projects because municipalities managing their own programs reported higher restoration costs than federal programs implementing restoration primarily in rural areas. In addition, fencing and instream habitat improvement are additional best management practices (BMPs) often needed to successfully establish and protect riparian forest buffers. The costs to add fencing and improve instream habitat are described in **Section 4.3**. Uncertainty and an explanation of upper and lower bounds for cost estimates and BMP application can be found in **Section 6**.

4.1 Rural Riparian Forest Restoration Costs

Rural riparian forest restoration refers to restoration projects outside of urban growth boundaries. Cost estimates for these areas were based on restoration data from The Conservation Reserve Enhancement Program (CREP) and data from the National Resource Conservation Service (NRCS)

CREP is a voluntary land retirement program that helps agricultural producers protect environmentally sensitive land. CREP is administered by the USDA Farm Service Agency and combines resources from federal, state, tribal, and private sources to pay for protection measures. The Farm Service provided preliminary aggregated data (Loop 2008) from riparian restoration projects in rural Willamette Basin counties. An average cost for rural riparian forest establishment came to $4,695 per acre during the first contract period (with an average contract period of 15 years). Incentives and annual rental fees for subsequent contracts would average about $128 per acre plus inflation. This aggregate data compiles over 231 individual contracts totaling over 2,543 acres of restoration across the Basin (see **Table 2**). They represent the most recent contract data as of October of 2008. The dollars are nominal amounts as the payments are made over the contract period.

Table 2. Willamette Basin CREP statistics for non-urban counties (Loop 2008)

County	Total Acres Contracted	Total Installation Costs [1]	Total Rental and Maintenance Costs[2]	Average Installation Cost/Acre	Average Rental and Maintenance Cost/Acre	Total Average Cost/Acre
Benton	448.5	$1,051,798	$791,872	$2,345	$1,766	$4,111
Clackamas	82.8	$277,921	$131,274	$3,357	$1,585	$4,942
Columbia	389.9	$713,115	$648,247	$1,829	$1,663	$3,492
Lane	173.6	$545,124	$246,850	$3,140	$1,422	$4,562
Linn	336.9	$735,364	$542,874	$2,183	$1,611	$3,794
Marion	195.5	$836,947	$458,503	$4,281	$2,345	$6,626
Polk	539.1	$1,870,570	$1,302,233	$3,470	$2,416	$5,885
Yamhill	377.1	$1,090,059	$698,134	$2,891	$1,851	$4,742
All	**2,543.4**	**$7,120,898**	**$4,819,987**	**$2,800**	**$1,895**	**$4,695**

1. Includes State, Federal and estimated landowner contributions for site planning, site prep, installation, materials, and labor.
2. Includes base rental rate, incentive payments, and maintenance rate over life of the contract.

4.2 Urban Riparian Forest Restoration Costs

Urban riparian forest restoration refers to restoration projects at locations within an urban growth boundary. Cost estimates for these areas were based on Clean Water Service's Enhanced CREP Program. Clean Water Services is a water and sewer district in Washington County that serves Portland's suburban communities including Beaverton, Hillsboro, Tualatin, Tigard, and Forest Grove. The Enhanced CREP program is similar to CREP except that it provides additional money for installation, maintenance, rental

payments and incentive options to landowners. The enhancements were devised to increase participation in the program and were guided by input from local stakeholders (Clean Water Services 2005). Prior to implementing Enhanced CREP Clean Water Services performed a cost analysis and estimated the program would require $10,543 per acre during the first contract period (15 years) with incentive an annual rental fees of about $240 plus inflation for subsequent contracts (see **Table 3**) (Clean Water Services 2005). EPA advised ODEQ to use this estimate since it has received agency review, however, informal analysis and input from the program manager reveal average costs are actually greater (discussed below).

As of 2007 Clean Water Services has completed 55 riparian restoration projects totaling about 460 acres on both public and private land (Clean Water Services 2007). An informal analysis of this project data by Clean Water Services suggests the total average cost is $14,247 per acre (Clean Water Services 2007). The City of Portland also administers a watershed revegetation program. Since 1996, this program has revegetated more than 600 acres along 106 miles of stream (personal communication, Query, 2008). A specific cost analysis of Portland's program was not available but, the project manager indicated that average site preparation, plantings, maintenance and program costs run about $10,000-$15,000 per acre (personal communication, Allison, 2008). This is in line with values reported by Clean Water Services.

Table 3. Clean Water Services Enhanced CREP program costs (modified from Clean Water Services 2005).

Cost (Over 15 year Contract)	Average Installation Cost/Acre	Recurring Payments Cost/Acre	Total Cost/Acre
Labor	$2,436		$2,436
Payments (CREP, Rental, etc)		$2,139	$2,139
Sign up Incentive Payment		$137	$137
Installation Cost	$2,780		$2,780
Installation Maintenance Cost	$964		$964
Conservation Easements	$692		$692
Easement Stewardship	$72		$72
Cumulative Impact Bonus		$92	$92
Practice Incentive Payment		$912	$912
Water Rights Incentive		$319	$319
Total (15 year contract)	**$6,944**	**$3,599**	**$10,543**

4.3 Instream Habitat Improvement and Fencing Costs

When stream channels are heavily incised, lack large woody debris, or have unstable banks, additional instream improvement is often important for restoration success. Instream habitat work may include the placement of large woody debris and bed or bank material. Fencing is often required in agricultural land uses to protect the riparian plantings from forage or trampling by livestock.

The National Resource Conservation Service (NRCS) has developed cost estimates for instream habitat improvement and the installation of fencing. To improve instream habitat (NRCS practice 395), it will cost on average about $12,333 per acre in the Willamette Basin. To install about 635 feet of fencing (NRCS practice 382), it will cost about $6,307 per acre. 635 feet of fencing is enough to surround one acre of 100 foot riparian buffer. NRCS estimates are based on cost data from 2008.

4.4 BMP Application and Cost Summary

Table 4 describes how each BMP type was applied within each DMA class. *Percent acres restoration* refers to the percentage of the total acres being restored within each DMA class that would receive a particular BMP type. Since area with with no vegetation were considered in this analyses, 100% of the restoration acres require planting of riparian vegetation. Eight percent of restoration acres within county DMAs and private agricultural require fence installations. This fencing estimate is based on the percent of farms in the Willamette valley (see **Table 5**) that reported having cattle in the 2002 Census of Agriculture (NASS 2002).

Using the census data to estimate fencing needs assumes that farms needing riparian restoration would also be equally distributed among the general population of cattle farms in the valley. Because cattle are a known source of riparian degradation (Agouridis et al 2005, Kaufman et al 1983), and they sometimes use streams as a drinking water source, cattle may occur at a larger share of disturbed riparian sites than expected based on the normal distribution of cattle farms. It is very possible using the census figure might underestimate the actual need for fencing at restoration sites.

The Willamette Basin Rivers & Streams Assessment (ODEQ 2009) provided the basis for the percent of instream improvement needs by landuse. The assessment rated 246 sites in the Willamette Basin for streambed stability utilizing a probabilistic survey method. Streambed stability, also termed relative bed stability, is a good surrogate for instream improvement needs because wood volume, substrate type, and channel shape are factored into the final metric (Kaufman et al 1999). The assessment found that 61% of

stream miles in urban areas, 33% in agricultural areas, and 10% in forestry areas have "poor" streambed stability (as compared to "fair" or "good" streambed stability). We used these percentages to estimate the number of restoration acres that need habitat improvements. These ratings concur with a number of other studies that show stream habitat for urban and agriculture lands are highly degraded compared to forestry lands (Ebert et al 2000, Waite and Carpenter 2000, Wentz et al 1998). ODF, BLM, and USFS were the only State and Federal agencies assigned the 10% forestry stream improvement value because these agencies are primarily managing forests in the Willamette Basin.

Table 4. Average BMP type, cost, and percent acres applied within each DMA.

DMA Type	BMP Types Applied	Average Cost/Acre	Average Percent Restoration Acres
Agriculture	Rural Riparian Planting	$4,695	100%
	Instream Improvement	$12,333	33%
	Fencing	$6,308	8%
City	Urban Riparian Planting	$10,543	100%
	Instream Improvement	$12,333	61%
County	Urban Riparian Planting	$10,543	100%
	Instream Improvement	$12,333	61%
State	Rural Riparian Planting	$4,695	100%
	Instream Improvement (ODF only)	$12,333	10%
Federal	Rural Riparian Planting	$4,695	100%
	Instream Improvement (BLM and USFS only)	$12,333	10%
Private Forestry	Rural Riparian Planting	$4,695	100%
	Instream Improvement	$12,333	10%

Table 5. Cattle and farm statistics in Willamette Basin counties (NASS 2002).

	All Counties	Benton	Clackamas	Columbia	Lane	Linn	Marion	Multnomah	Washington	Yamhill
Cattle Farm Acres	155,015	6,200	25,040	9,505	22,150	26,875	24,600	2,520	11,090	16,265
Total Farm Acres	1,899,449	130,203	215,210	62,398	234,807	385,589	341,051	34,329	130,683	196,298
Percent Farm Acres with Cattle	8%	5%	12%	15%	9%	7%	7%	7%	8%	8%

4.5 Other Studies and Cost Data

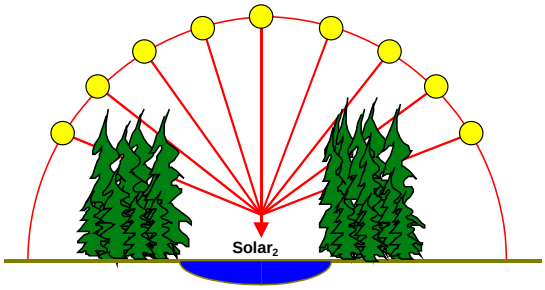
A literature review of other efforts to estimate restoration costs for Oregon streams are as follows. A study by Seedang et al (2008) determined the cost effectiveness of reducing stream temperatures in the upper mainstem Willamette River by restoring riparian vegetation and hyporheic flow. The total cost for restoring riparian shading came to 2.68 million dollars with an average cost of $3,000 per acre. The total cost for restoring hyporheic flow came to 4.28 million dollars with an average cost of $2,547 per acre. A study in the Tualatin Basin by Knoder (1995) estimated it would cost $118,400 to restore riparian and instream habitat on Gales Creek ($6,000 per mile) and $542,750 to restore Dairy Creek ($21,000 per mile). A restoration project along 300 meters of Beaver Creek in the Coast Range was documented by Bishaw et al (2002) to cost $4346.29.

5 TMDL Load Allocations and Solar Radiation Load

Solar radiation modeling was completed to estimate the pollution load reduction resulting from restoration. Solar radiation is the largest flux in a stream's heat budget and therefore is the largest source of temperature increases (Brown 1969, DEQ 2001, DEQ 2006b, DEQ 2008, Johnson 2004). The amount of solar radiation received at the stream surface is measured in kilocalories per day. One kilocalorie is the amount of energy required to heat up one gram of water by one degree Celsius. The temperature load allocations in the Willamette Basin TMDLs are generally expressed as the amount of solar radiation that a stream receives when system potential vegetation is present. System potential vegetation refers to the vegetation which can grow and reproduce on a site given the natural plant biology, site elevation, soil characteristics, climate, and nature disturbance regime. Because the amount of solar radiation blocked by vegetation was not modeled at every location in the TMDLs, *effective shade* curves were used as the basis for the load allocations. Effective shade curves are defined as the amount of total daily solar radiation load divided by the amount of solar radiation load blocked by vegetation with a certain height and density, and the stream is of a certain width and aspect. The effective shade concept is illustrated in **Figure 7** and **Figure 8.**

Figure 7. Effective shade defined.

Solar$_1$ – Potential daily direct beam solar radiation load adjusted for julian day, solar altitude, solar azimuth and site elevation.



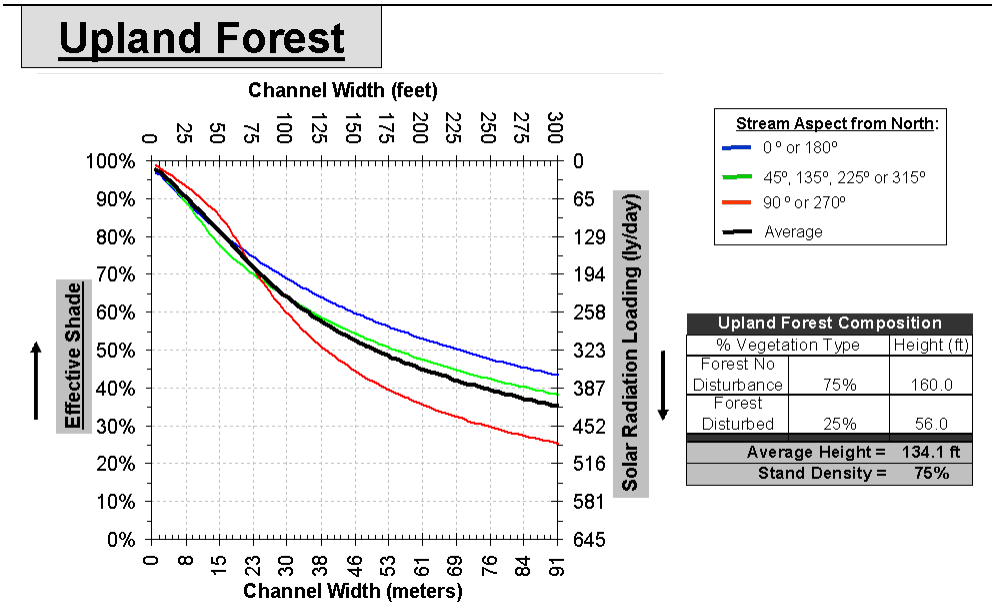
$$\text{Effective Shade} = \frac{(\text{Solar}_1 - \text{Solar}_2)}{\text{Solar}_1}$$

Where,

Solar$_1$: Potential Daily Direct Beam Solar Radiation Load

Solar$_2$: Daily Direct Beam Solar Radiation Load Received at the Stream Surface

Figure 8. Example of an effective shade curve for upland forest (ODEQ 2006b).



The modeling for this study uses the system potential vegetation described in the Willamette Basin TMDL (DEQ 2006b). Effective shade and solar radiation load were modeled with the mathematical model Heat Source version 8.0.4. Heat Source simulates open channel hydraulics, flow routing, heat transfer, effective shade, and stream temperatures (Boyd and Kasper, 2003). The model predicted effective shade and the total solar radiation load blocked by riparian restoration at locations where there is opportunity for restoration. Effective shade and solar load results are reported in **Section 7**. Modeling

nearly all of streams in the basin took significant computing resources and time. To make the task manageable with the resources available, a few assumptions were made in the absence of collecting basin wide data. Those assumptions are listed below.

Stream Width	Stream width was not known at every location so it was estimated using the stream's Strahler order (SO). Stream width was estimated for each Strahler order from randomly selecting different streams and measuring the width from an aerial photo in GIS. There was limited field data available for validation. (SO = 1, width = 1m), (SO = 2, width = 3 m), (SO = 3, width = 10 m), (SO = 4, width = 25 m), (SO = 5, width = 60 m), (SO = 6, width = 120 m), (SO = 7, width = 180 m), (SO = Unknown, width = 25 m)
Vegetation	**Site potential vegetation types, shown in Table 5, was extracted from page C-33 in the Willamette Basin TMDL Appendix C. The system potential vegetation codes were cross walked to the appropriate NLCD landcover code and applied basinwide. Not all TMDL system potential vegetation types were used. The designation of areas with no vegetation corresponds to the lower bound GIS data set. The system potential vegetation density was adjusted for developed areas based on the intensity of the development.**
Model Period	**The solar radiation loads represent the solar radiation load received on August 1st.**
Topography	Topographic shade was not factored into the load reductions.

Table 6. **Site potential vegetation attributes used in the Heat Source model.**

2001 NLCD Land Cover Type	NLCD Code	TMDL Site Potential Vegetation	Height (m)	Density (0 - 1)	Overhang (m)
Unknown	N/A	No Change	0.0	0.00	0.0
Open water	11	No Change	0.0	0.00	0.0
Perennial Ice/Snow	12	No Change	0.0	0.00	0.0
Developed, Open Space (<20%)	21	Forest –Mature Hardwood	20.4	0.75	3.1
Developed, Low Intensity (20%-49%)	22	Forest –Mature Hardwood (Adjusted)	20.4	0.55	3.1
Developed, Medium Intensity (50%-79%)	23	Forest –Mature Hardwood (Adjusted)	20.4	0.40	3.1
Developed, High Intensity (80%-100%)	24	Forest –Mature Hardwood (Adjusted)	20.4	0.10	3.1
Barren Land	31	Forest –Mature Hardwood	20.4	0.75	3.1
Deciduous Forest	41	Forest –Mature Hardwood	20.4	0.75	3.1
Evergreen Forest	42	Forest –Mature Coniferous	48.8	0.75	4.9
Mixed Forest	43	Forest –Mature Mixed Conifer-Hardwood	27.4	0.75	3.3
Scrub/Shrub	52	Prairie- Grassland	1.0	0.75	0.0
Grassland/Herbaceous	71	Prairie- Grassland	1.0	0.75	0.0
Pasture/Hay	81	Forest –Mature Hardwood	20.4	0.75	3.1
Cultivated Crops	82	Forest –Mature Hardwood	20.4	0.75	3.1
Woody Wetlands	90	Forest –Mature Hardwood	20.4	0.75	3.1
Emergent Herbaceous Wetland	95	Prairie- Grassland	1.0	0.75	0.0

6 Uncertainty

A ground survey of specific site needs as well as riparian and instream conditions throughout the basin would provide the most precise cost estimate. However, such a comprehensive survey would require a sizeable on-the-ground data collection effort over an extended period of time. Such an effort was infeasible given this project's schedule and resources. Thus, to participate in the EPA's Clean Watersheds Needs Survey, ODEQ implemented a GIS and statistical -based analysis that provides information for the entire basin and meets the EPA's data needs. Since any GIS and statistical-based approach contains a level of uncertainty, we report a lower and upper bound for the final cost estimate to account for the potential variability and uncertainly. These bounds should be viewed as the range in which the final costs should fall between.

Table 7 and **Table 8** show the values used for the lower and upper bounds and the methods for deriving those bounds. Most of the bounds were calculated as the upper and lower 95% confidence interval. This metric calculates the bounds that contain 95% of the distribution of observed values. Because the federal government prohibits the release of raw data used for CREP or NASS, data are only available as an average value aggregated by county only. So while the average values were derived with a large set of raw data, the standard deviation and 95% confidence interval are derived from the aggregated data. This tends to generate large standard deviations because of the small number of observations (n). When it was not possible to calculate the 95% confidence interval, a 15% margin of safety was used instead. This value is based on best professional judgment and field experience of restoration experts.

In addition, we believe it is unlikely that every landowner would be willing to accept rental and incentive payments at prices described in this study (if at all). Anecdotal evidence suggests that CREP payments may already be too low to encourage restoration efforts on agricultural lands. Payments likely need to be higher to encourage participation. Also, reliance on land rental agreements is not going to garner participation from every landowner. Other methods and programs will need to be considered to facilitate restoration efforts.

Table 7. Upper and lower bound BMP costs.

BMP Type	Average Cost/Acre	Lower Bound	Upper Bound	Notes
Urban Riparian Planting	$10,543	$8,962	$12,124	+/- 15% Margin of Safety
Rural Riparian Planting	$4,695	$3,964	$5,426	95% Confidence Interval, n = 8, Table 2
Instream Improvement	$12,333	$10,483	$14,183	+/- 15% Margin of Safety
Fencing	$6,308	$5,362	$7,254	+/- 15% Margin of Safety

Table 8. Upper and lower bound BMP application percentages.

BMP Type	Average	Lower Bound	Upper Bound	Notes
Riparian Planting	100%	85%	100%	- 15%
Instream Improvement - Agricultural	33%	23%	43%	95% Confidence Interval, n = 16 (ODEQ 2009)
Instream Improvement – Forestry (ODF, Private Forest, BLM, USFS)	10%	5%	15%	95% Confidence Interval, n = 9 (ODEQ 2009)
Instream Improvement Urban (Cities, Counties inside UGB)	61%	47%	75%	95% Confidence Interval, n = 43 (ODEQ 2009)
Fencing -Agricultural	8%	6%	10%	95% Confidence Interval, n =9 Table 4

Table 9 shows the average, upper and lower bounds for GIS derived values. The average value represents the total number of acres inside the stream buffer with zero percent canopy cover. The upper bound represents the area with twelve percent or less canopy cover. The mean absolute difference (MAE) found when correlating field measured Oregon tree canopy densities to the NLCD canopy cover dataset was about twelve percent (Huang et al 2001). In simpler terms, this means areas measured in the field with no vegetation (zero percent canopy cover) would on average have a potential error of plus or minus 12% canopy cover in the NLCD data. It is not possible to assume a NLCD canopy cover of -12% so the lower bound was calculated as the difference in the number of acres from zero to + 12% canopy cover. The difference was then subtracted from the average for each DMA to find the lower bound.

Table 9. Upper and lower bound GIS derived data.

GIS Data Type	Average	Lower Bound	Upper Bound	Notes
No Vegetation (excluding impervious)	95,138 acres	93,985 acres	96,291 acres	+/- acres based on 12% Oregon MAE (Huang et al 2001)
Impervious Area Removed	3,159 acres	3,154 acres	3,164 acres	

7 Results

According to this analysis, approximately 96,000 acres could be restored in the Willamette Basin. The total restoration cost estimate during the first 15-year contract period is on average around 900 million dollars with a range between 600 million to about 1.2 billion dollars. Subsequent contracts would have average annual rental fees of about 13 million dollars in 2008 dollars. **Table 10** through **Table 12** shows the range in restoration cost based on the average, upper, and lower bound values. BMPs percentage (**Table 7**) and BMP cost (**Table 8**) account for the most variation in the results while the GIS metrics (**Table 9**) contribute the least variation. Approximately 18.6 billion kilocalories per day of solar radiation would be blocked in late July through early August once the vegetation reached maturity. **Figure 9** through **Figure 11** shows the increase in effective shade that would result from the restoration. The majority of the large effective shade increases from restoration occur in agricultural land uses. Additional metrics are broken-down by DMA in **Table 13** through **Table 22**.

Table 10. Variation in total restoration cost using lower bound GIS metrics.

	Costs at Lower Bound	Costs at Average	Costs at Upper Bound
BMPs at Lower Bound	$593,948,408	$701,055,855	$808,163,302
BMPs at Average	$757,534,352	$893,914,709	$1,030,295,066
BMPs at Upper Bound	$859,137,175	$1,013,447,631	$1,167,758,088

Table 11. Variation in total restoration cost using average GIS metrics.

	Costs at Lower Bound	Costs at Average	Costs at Upper Bound
BMPs at Lower Bound	$599,730,493	$707,888,178	$816,045,862
BMPs at Average	$764,943,567	$902,666,575	$1,040,389,583
BMPs at Upper Bound	$867,460,804	$1,023,275,282	$1,179,089,759

Table 12. Variation in total restoration cost using upper bound GIS metrics.

	Costs at Lower Bound	Costs at Average	Costs at Upper Bound
BMPs at Lower Bound	$605,512,578	$714,720,500	$823,928,422
BMPs at Average	$772,352,782	$911,418,441	$1,050,484,100
BMPs at Upper Bound	$875,784,433	$1,033,102,932	$1,190,421,431

Table 13. Acres of restoration for each DMA type.

DMA Type	Total Riparian Acres	Average		Upper/Lower Bound (Deviation from Average)	
		Potential Restoration Acres	Percent of Riparian Available for Restoration	Potential Restoration Acres	Percent of Riparian Available for Restoration
Agricultural	105,439	72,065	68%	+/- 446	+/-0.4%
City	15,795	5,758	36%	+/- 24	+/-0.2%
County	6,507	2,414	37%	+/- 12	+/-0.2%
Federal	103,906	5,500	5%	+/- 361	+/-0.3%
Private Forestry	87,316	8,899	10%	+/- 301	+/-0.3%
State	5,328	503	9%	+/- 8	+/-0.2%
All	**324,290**	**95,138**	**29%**	**+/- 1,153**	**+/-0.4%**

Table 14. Restoration cost estimates for each DMA type.

DMA Type	Lower Bound Total Costs	Average Total Costs	Upper Bound Total Costs
Agriculture	$437,032,814	$668,010,994	$888,275,131
City	$71,928,727	$104,022,436	$131,604,438
County	$30,135,568	$43,615,827	$55,223,590
Federal	$19,658,874	$31,779,865	$42,838,166
Private Forest	$33,475,402	$52,753,889	$69,489,110
State	$1,717,023	$2,483,564	$2,990,995
All	**$593,948,408**	**$902,666,575**	**$1,190,421,431**

Table 15. Restoration cost estimates for each DMA type using all lower bound values.

DMA Type	Riparian Planting Cost	Habitat Improvement Cost	Fencing Cost	Total Cost	Percent of Total Cost
Agriculture	$241,312,305	$172,679,316	$23,041,193	$437,032,814	73.6%
City	$43,678,289	$28,250,439	$0	$71,928,727	12.1%
County	$18,299,643	$11,835,925	$0	$30,135,568	5.1%
Federal	$17,312,664	$2,346,210	$0	$19,658,874	3.3%
Private Forest	$28,968,941	$4,506,461	$0	$33,475,402	5.6%
State	$1,665,852	$51,171	$0	$1,717,023	0.3%
All	**$351,237,693**	**$219,669,522**	**$23,041,193**	**$593,948,408**	**100%**

Table 16. Restoration cost estimates for each DMA type using all average values.

DMA Type	Riparian Planting Cost	Habitat Improvement Cost	Fencing Cost	Total Cost	Percent of Total Cost
Agriculture	$338,346,347	$293,297,639	$36,367,008	$668,010,994	74.0%
City	$60,705,228	$43,317,208	$0	$104,022,436	11.5%
County	$25,453,247	$18,162,580	$0	$43,615,827	4.8%
Federal	$25,820,736	$5,959,129	$0	$31,779,865	3.5%
Private Forest	$41,779,179	$10,974,710	$0	$52,753,889	5.8%
State	$2,359,869	$123,695	$0	$2,483,564	0.3%
All	**$494,464,607**	**$371,834,961**	**$36,367,008**	**$902,666,575**	**100%**

Table 17. Restoration cost estimates for each DMA type using all upper bound values.

DMA Type	Riparian Planting Cost	Habitat Improvement Cost	Fencing Cost	Total Cost	Percent of Total Cost
Agriculture	$393,448,608	$442,226,519	$52,600,004	$888,275,131	74.6%
City	$70,100,377	$61,504,061	$0	$131,604,438	11.1%
County	$29,415,379	$25,808,211	$0	$55,223,590	4.6%
Federal	$31,802,029	$11,036,137	$0	$42,838,166	3.6%
Private Forest	$49,917,311	$19,571,799	$0	$69,489,110	5.8%
State	$2,771,944	$219,052	$0	$2,990,995	0.3%
All	**$577,455,648**	**$560,365,779**	**$52,600,004**	**$1,190,421,431**	**100%**

Table 18. Solar radiation load metrics from full restoration.

DMA Type	Current Solar Radiation Load (Gigacalories/day)	Solar Radiation Load after Restoration (Gigacalories/day)	Decrease in Solar Radiation Load after Restoration (Gigacalories/day)	Portion of Total Solar Load Reduction
Agriculture	20.18	7.23	12.94	70%
City	9.44	7.19	2.25	12%
County	3.41	2.48	0.93	5%
Federal	2.09	1.79	0.30	2%
Private Forest	4.05	1.95	2.09	11%
State	0.74	0.63	0.11	1%
All	39.90	21.28	18.62	100%

Percents may not calculate as presented due to rounding.

Restoration along Johnson Creek in Portland. Photo by Ryan Michie.

Figure 9. Increase in effective shade after restoration of system potential vegetation.

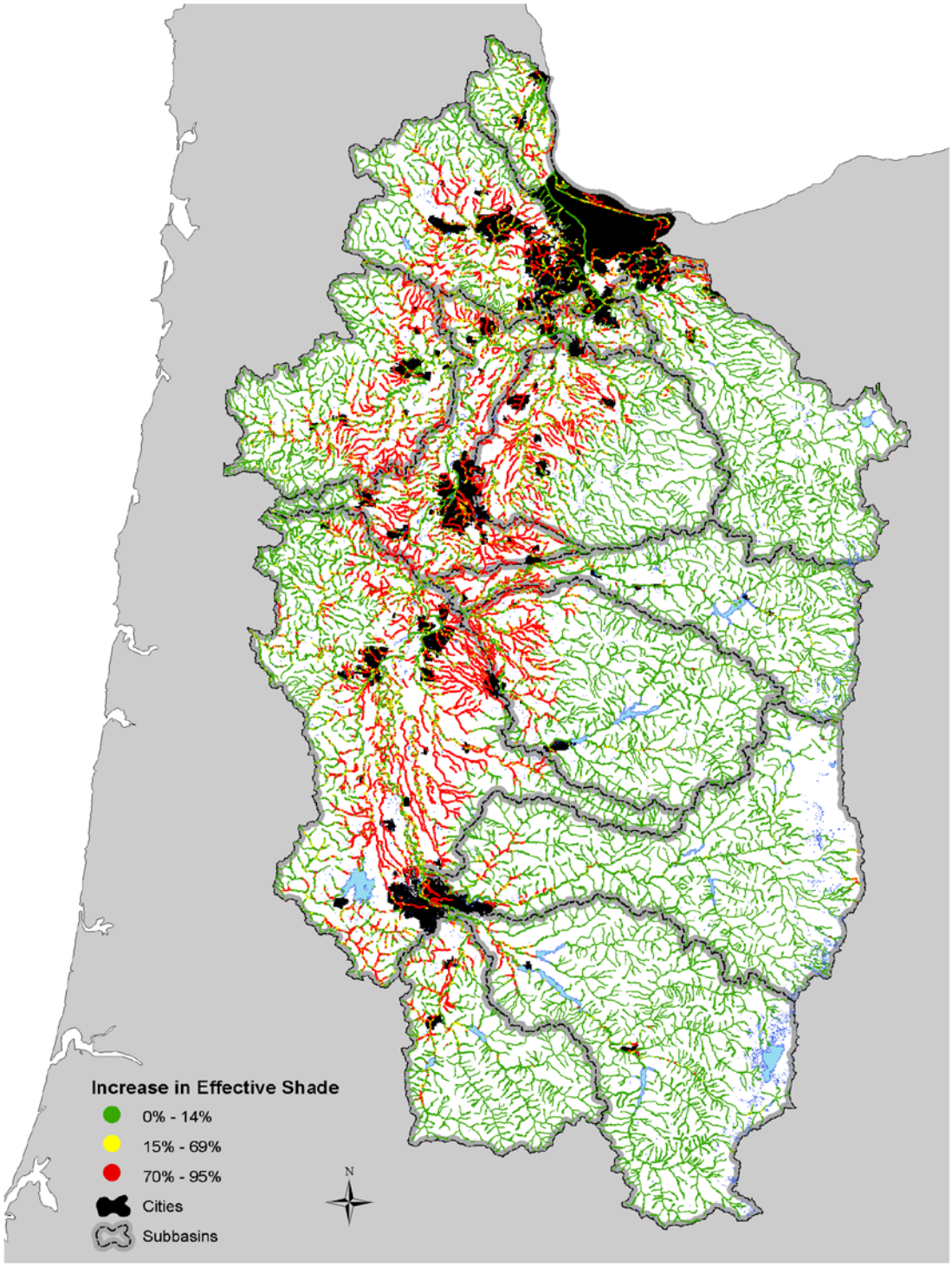


Figure 10. Increase in effective shade after restoration of system potential vegetation (N. Willamette Basin).

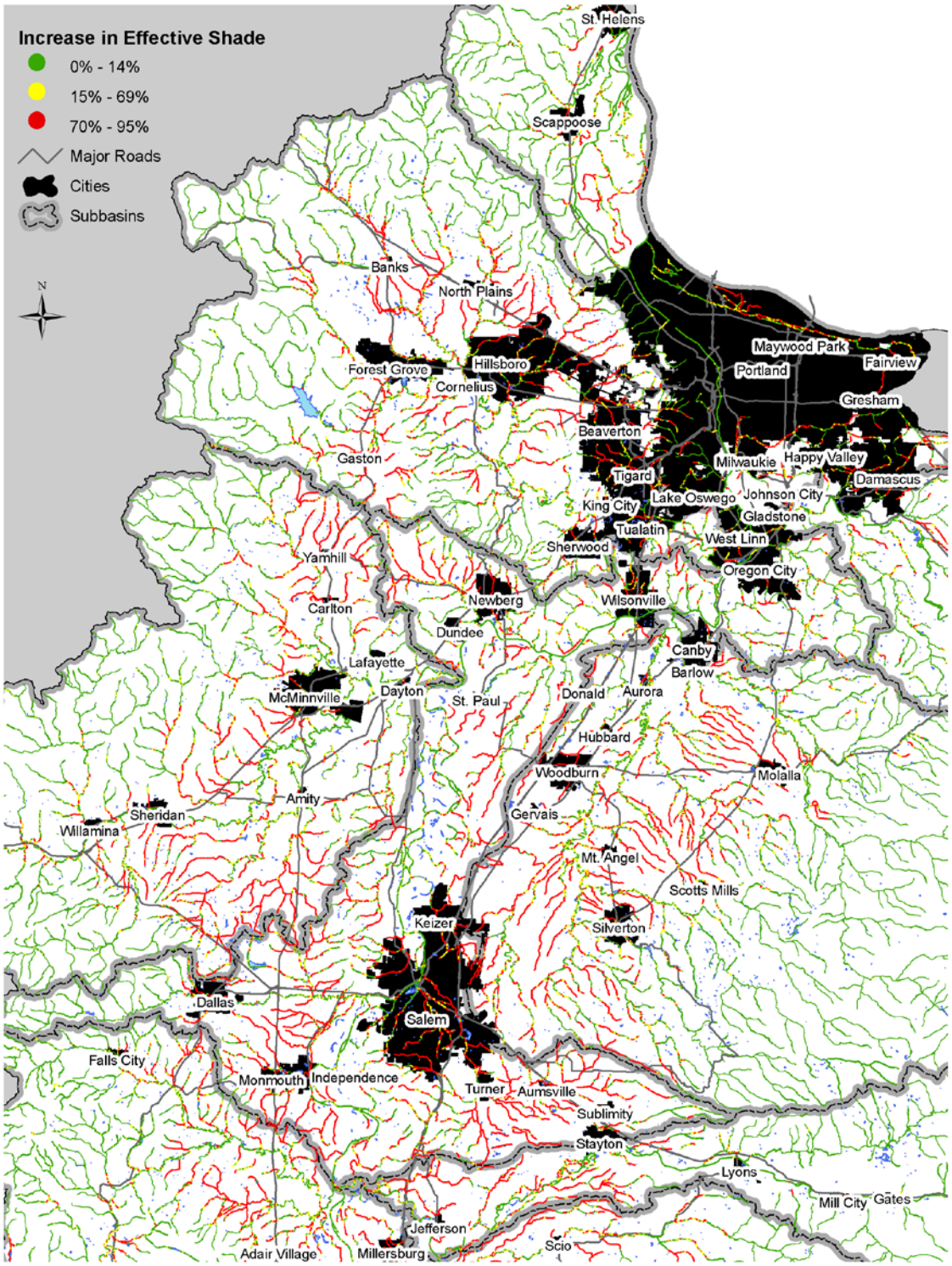


Figure 11. Increase in effective shade after restoration of system potential vegetation (S. Willamette Basin).

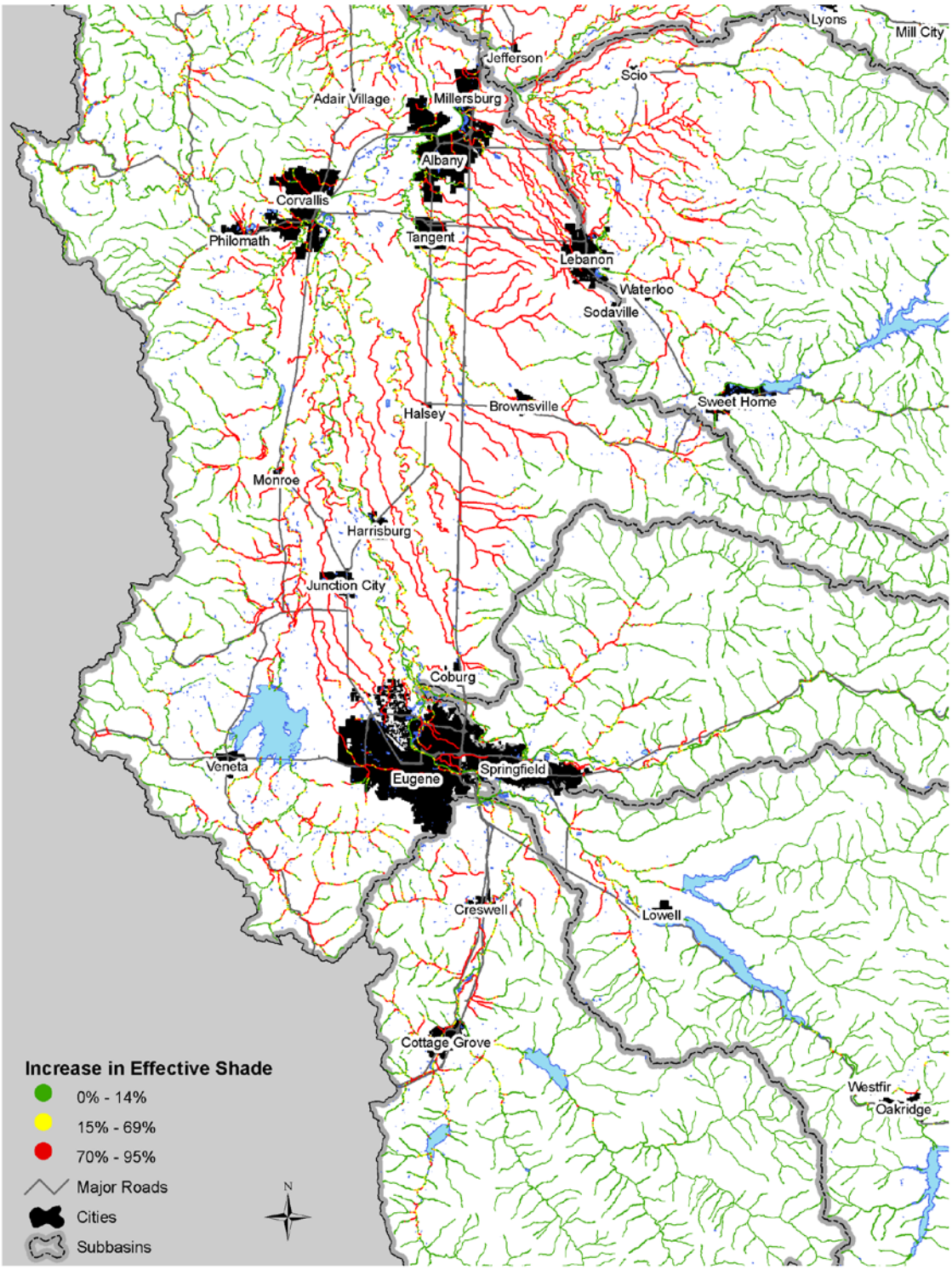


Table 19. Total restoration cost estimates for each DMA.

DMA Type	DMA	Average Potential Restoration Acres (+/- Upper and Lower Bound Deviation)		Lower Bound Total Cost	Average Total Cost	Upper Bound Total Cost
Agriculture	Oregon Dept. of Agriculture	72,065	(+/- 446)	$437,032,814	$668,010,994	$888,275,131
City	City of Adair Village	0	(+/- 0)	$0	$0	$0
City	City of Albany	219	(+/- 3)	$2,703,587	$3,953,809	$5,057,274
City	City of Amity	4	(+/- 0)	$45,196	$65,089	$82,004
City	City of Aumsville	31	(+/- 0)	$382,799	$551,284	$694,555
City	City of Aurora	5	(+/- 0)	$65,255	$93,977	$118,400
City	City of Banks	10	(+/- 0)	$127,330	$183,373	$231,029
City	City of Barlow	0	(+/- 0)	$0	$0	$0
City	City of Beaverton	130	(+/- 0)	$1,625,159	$2,340,455	$2,948,705
City	City of Brownsville	47	(+/- 0)	$584,842	$842,254	$1,061,144
City	City of Canby	22	(+/- 0)	$275,445	$396,679	$499,770
City	City of Carlton	24	(+/- 0)	$298,601	$430,027	$541,784
City	City of Coburg	6	(+/- 0)	$79,205	$114,066	$143,710
City	City of Cornelius	5	(+/- 0)	$64,251	$92,530	$116,577
City	City of Corvallis	165	(+/- 2)	$2,036,894	$2,976,841	$3,805,194
City	City of Cottage Grove	44	(+/- 1)	$540,232	$791,228	$1,013,510
City	City of Creswell	25	(+/- 0)	$316,010	$455,098	$573,371
City	City of Dallas	81	(+/- 0)	$1,011,218	$1,463,970	$1,854,105
City	City of Damascus	198	(+/- 1)	$2,472,195	$3,571,435	$4,513,620
City	City of Dayton	4	(+/- 0)	$55,574	$80,035	$100,835
City	City of Detroit	0	(+/- 0)	$0	$0	$0
City	City of Donald	0	(+/- 0)	$0	$0	$0
City	City of Dundee	8	(+/- 0)	$104,844	$150,989	$190,229
City	City of Durham	1	(+/- 0)	$12,080	$17,397	$21,918
City	City of Estacada	54	(+/- 0)	$674,565	$971,467	$1,223,937
City	City of Eugene	411	(+/- 0)	$5,147,106	$7,420,826	$9,359,816
City	City of Fairview	77	(+/- 0)	$963,570	$1,391,691	$1,758,432
City	City of Falls City	16	(+/- 0)	$193,924	$283,296	$361,983
City	City of Forest Grove	8	(+/- 0)	$104,676	$150,748	$189,926
City	City of Gaston	6	(+/- 0)	$80,125	$115,392	$145,380

Table 19. Total restoration cost estimates for each DMA.

DMA Type	DMA	Average Potential Restoration Acres (+/- Upper and Lower Bound Deviation)	Lower Bound Total Cost	Average Total Cost	Upper Bound Total Cost
City	City of Gates	6 (+/- 1)	$64,251	$103,901	$145,228
City	City of Gervais	4 (+/- 0)	$45,224	$65,129	$82,055
City	City of Gladstone	38 (+/- 0)	$472,912	$685,077	$868,181
City	City of Gresham	65 (+/- 0)	$818,020	$1,181,880	$1,493,841
City	City of Halsey	12 (+/- 0)	$148,645	$214,069	$269,703
City	City of Happy Valley	76 (+/- 0)	$953,190	$1,372,727	$1,729,478
City	City of Harrisburg	22 (+/- 0)	$280,159	$403,469	$508,324
City	City of Hillsboro	234 (+/- 1)	$2,923,179	$4,229,834	$5,354,364
City	City of Hubbard	6 (+/- 0)	$81,464	$117,320	$147,810
City	City of Idanha	26 (+/- 1)	$320,166	$473,138	$611,285
City	City of Independence	45 (+/- 0)	$563,835	$812,000	$1,023,027
City	City of Jefferson	8 (+/- 0)	$101,942	$150,829	$195,089
City	City of Johnson City	4 (+/- 0)	$48,209	$69,428	$87,471
City	City of Junction City	19 (+/- 0)	$241,604	$347,943	$438,368
City	City of Keizer	64 (+/- 0)	$805,271	$1,159,702	$1,461,092
City	City of King City	13 (+/- 0)	$166,277	$239,462	$301,694
City	City of Lafayette	5 (+/- 0)	$65,730	$94,660	$119,260
City	City of Lake Oswego	39 (+/- 0)	$481,784	$697,854	$884,278
City	City of Lebanon	103 (+/- 1)	$1,289,287	$1,869,650	$2,371,793
City	City of Lowell	0 (+/- 0)	$0	$0	$0
City	City of Lyons	4 (+/- 0)	$50,720	$73,044	$92,027
City	City of Maywood Park	0 (+/- 0)	$0	$0	$0
City	City of McMinnville	80 (+/- 0)	$994,843	$1,436,730	$1,815,177
City	City of Mill City	23 (+/- 0)	$293,691	$422,955	$532,875
City	City of Millersburg	122 (+/- 0)	$1,523,720	$2,196,740	$2,770,627
City	City of Milwaukie	30 (+/- 0)	$378,336	$544,856	$686,456
City	City of Molalla	18 (+/- 0)	$231,783	$333,800	$420,550
City	City of Monmouth	23 (+/- 0)	$294,304	$423,839	$533,989
City	City of Monroe	18 (+/- 0)	$226,259	$325,845	$410,527
City	City of Mt. Angel	5 (+/- 0)	$67,292	$96,910	$122,095

Table 19. Total restoration cost estimates for each DMA.

DMA Type	DMA	Average Potential Restoration Acres (+/- Upper and Lower Bound Deviation)	Lower Bound Total Cost	Average Total Cost	Upper Bound Total Cost
City	City of Newberg	53 (+/- 0)	$661,927	$953,266	$1,201,006
City	City of North Plains	5 (+/- 0)	$57,360	$82,606	$104,074
City	City of Oakridge	46 (+/- 1)	$571,033	$834,420	$1,066,458
City	City of Oregon City	68 (+/- 0)	$859,088	$1,237,206	$1,558,737
City	City of Philomath	24 (+/- 0)	$296,062	$432,438	$552,465
City	City of Portland	1,107 (+/- 2)	$13,858,417	$19,994,889	$25,237,676
City	City of Rivergrove	2 (+/- 0)	$27,703	$39,897	$50,265
City	City of Salem	740 (+/- 1)	$9,273,671	$13,371,453	$16,866,747
City	City of Sandy	6 (+/- 3)	$43,215	$114,468	$210,022
City	City of Scappoose	24 (+/- 0)	$295,615	$425,727	$536,368
City	City of Scio	21 (+/- 0)	$263,922	$380,085	$478,864
City	City of Scotts Mills	5 (+/- 0)	$59,313	$85,419	$107,618
City	City of Sheridan	40 (+/- 0)	$502,289	$723,367	$911,359
City	City of Sherwood	41 (+/- 0)	$520,006	$748,880	$943,503
City	City of Silverton	26 (+/- 0)	$328,843	$473,580	$596,657
City	City of Sodaville	0 (+/- 0)	$0	$0	$0
City	City of Springfield	69 (+/- 1)	$856,268	$1,245,200	$1,583,997
City	City of St. Helens	50 (+/- 0)	$623,539	$899,991	$1,136,415
City	City of St. Paul	2 (+/- 0)	$23,212	$33,428	$42,116
City	City of Stayton	44 (+/- 1)	$537,638	$786,326	$1,005,867
City	City of Sublimity	11 (+/- 0)	$141,530	$203,824	$256,794
City	City of Sweet Home	53 (+/- 1)	$655,007	$952,945	$1,212,750
City	City of Tangent	59 (+/- 0)	$730,530	$1,060,101	$1,345,729
City	City of Tigard	109 (+/- 1)	$1,366,035	$1,976,442	$2,501,633
City	City of Troutdale	19 (+/- 0)	$241,548	$347,862	$438,267
City	City of Tualatin	63 (+/- 0)	$787,750	$1,134,470	$1,429,301
City	City of Turner	43 (+/- 0)	$538,307	$775,238	$976,710
City	City of Veneta	0 (+/- 0)	$0	$0	$0
City	City of Waterloo	0 (+/- 0)	$5,301	$7,634	$9,618
City	City of West Linn	89 (+/- 1)	$1,102,085	$1,599,211	$2,030,009

Table 19. Total restoration cost estimates for each DMA.

DMA Type	DMA	Average Potential Restoration Acres (+/- Upper and Lower Bound Deviation)		Lower Bound Total Cost	Average Total Cost	Upper Bound Total Cost
City	City of Westfir	13	(+/- 1)	$157,768	$239,261	$316,627
City	City of Willamina	16	(+/- 0)	$196,519	$283,015	$356,566
City	City of Wilsonville	93	(+/- 0)	$1,168,039	$1,686,156	$2,129,424
City	City of Wood Village	8	(+/- 0)	$98,706	$142,150	$179,093
City	City of Woodburn	82	(+/- 0)	$1,031,167	$1,485,024	$1,870,959
City	City of Yamhill	12	(+/- 0)	$152,578	$219,734	$276,840
County	Benton County	340	(+/- 4)	$4,218,743	$6,145,648	$7,831,093
County	Clackamas County	351	(+/- 4)	$4,359,124	$6,346,054	$8,081,360
County	Columbia County	51	(+/- 0)	$640,890	$926,990	$1,172,963
County	Lane County	212	(+/- 2)	$2,639,447	$3,830,220	$4,862,237
County	Linn County	408	(+/- 1)	$5,104,669	$7,363,488	$9,292,336
County	Marion County	312	(+/- 0)	$3,913,475	$5,643,984	$7,120,896
County	Multnomah County	99	(+/- 1)	$1,234,939	$1,789,534	$2,268,528
County	Polk County	121	(+/- 0)	$1,512,728	$2,178,539	$2,744,709
County	Washington County	381	(+/- 0)	$4,771,172	$6,876,973	$8,671,530
County	Yamhill County	139	(+/- 0)	$1,740,354	$2,514,388	$3,177,964
Federal	BLM	626	(+/- 21)	$2,357,384	$3,711,770	$4,885,285
Federal	BPA	0	(+/- 0)	$0	$0	$0
Federal	USACE	47	(+/- 1)	$155,735	$220,137	$258,032
Federal	USCG	0	(+/- 0)	$0	$0	$0
Federal	USFS	4,206	(+/- 335)	$15,070,998	$24,932,928	$34,298,202
Federal	USFWS	621	(+/- 5)	$2,074,757	$2,915,030	$3,396,648
Forestry - Private	Oregon Dept. of Forestry	8,899	(+/- 301)	$33,475,402	$52,753,889	$69,489,110
Forestry - State	Oregon Dept. of Forestry	100	(+/- 3)	$380,115	$594,583	$777,736
State	Oregon Dept. of Fish and Wildlife	66	(+/- 1)	$218,889	$311,270	$366,974
State	Oregon Dept. of State Lands	7	(+/- 0)	$23,979	$33,413	$38,615
State	Oregon Parks and Recreation	224	(+/- 3)	$743,380	$1,051,505	$1,233,322
State	State of Oregon (general)	105	(+/- 1)	$350,660	$492,794	$574,348
		95,138	**(+/- 1153)**	**$593,948,427**	**$902,666,588**	**$1,190,421,429**

Table 20. Restoration cost estimates for each DMA using all lower bound values.

DMA Type	DMA	Potential Restoration Acres	Riparian Planting Cost	Habitat Improvement Cost	Fencing Cost	Total Cost
Agriculture	Oregon Dept. of Agriculture	71,619	$241,312,305	$172,679,316	$23,041,193	$437,032,814
City	City of Adair Village	0	$0	$0	$0	$0
City	City of Albany	216	$1,641,737	$1,061,850	$0	$2,703,587
City	City of Amity	4	$27,445	$17,751	$0	$45,196
City	City of Aumsville	31	$232,452	$150,347	$0	$382,799
City	City of Aurora	5	$39,626	$25,629	$0	$65,255
City	City of Banks	10	$77,320	$50,010	$0	$127,330
City	City of Barlow	0	$0	$0	$0	$0
City	City of Beaverton	130	$986,868	$638,291	$0	$1,625,159
City	City of Brownsville	47	$355,142	$229,700	$0	$584,842
City	City of Canby	22	$167,262	$108,183	$0	$275,445
City	City of Carlton	24	$181,324	$117,277	$0	$298,601
City	City of Coburg	6	$48,097	$31,108	$0	$79,205
City	City of Cornelius	5	$39,016	$25,235	$0	$64,251
City	City of Corvallis	162	$1,236,892	$800,002	$0	$2,036,894
City	City of Cottage Grove	43	$328,053	$212,179	$0	$540,232
City	City of Creswell	25	$191,895	$124,115	$0	$316,010
City	City of Dallas	81	$614,056	$397,162	$0	$1,011,218
City	City of Damascus	197	$1,501,226	$970,969	$0	$2,472,195
City	City of Dayton	4	$33,747	$21,827	$0	$55,574
City	City of Detroit	0	$0	$0	$0	$0
City	City of Donald	0	$0	$0	$0	$0
City	City of Dundee	8	$63,666	$41,178	$0	$104,844
City	City of Durham	1	$7,336	$4,745	$0	$12,080
City	City of Estacada	54	$409,625	$264,939	$0	$674,565
City	City of Eugene	410	$3,125,549	$2,021,557	$0	$5,147,106
City	City of Fairview	77	$585,122	$378,448	$0	$963,570
City	City of Falls City	15	$117,759	$76,165	$0	$193,924
City	City of Forest Grove	8	$63,564	$41,112	$0	$104,676
City	City of Gaston	6	$48,656	$31,470	$0	$80,125
City	City of Gates	5	$39,016	$25,235	$0	$64,251

Table 20. Restoration cost estimates for each DMA using all lower bound values.

DMA Type	DMA	Potential Restoration Acres	Riparian Planting Cost	Habitat Improvement Cost	Fencing Cost	Total Cost
City	City of Gervais	4	$27,462	$17,762	$0	$45,224
City	City of Gladstone	38	$287,173	$185,739	$0	$472,912
City	City of Gresham	65	$496,738	$321,282	$0	$818,020
City	City of Halsey	12	$90,264	$58,381	$0	$148,645
City	City of Happy Valley	76	$578,819	$374,371	$0	$953,190
City	City of Harrisburg	22	$170,125	$110,034	$0	$280,159
City	City of Hillsboro	233	$1,775,083	$1,148,096	$0	$2,923,179
City	City of Hubbard	6	$49,469	$31,996	$0	$81,464
City	City of Idanha	26	$194,419	$125,747	$0	$320,166
City	City of Independence	45	$342,385	$221,449	$0	$563,835
City	City of Jefferson	8	$61,904	$40,038	$0	$101,942
City	City of Johnson City	4	$29,275	$18,934	$0	$48,209
City	City of Junction City	19	$146,712	$94,891	$0	$241,604
City	City of Keizer	64	$488,996	$316,275	$0	$805,271
City	City of King City	13	$100,971	$65,306	$0	$166,277
City	City of Lafayette	5	$39,914	$25,816	$0	$65,730
City	City of Lake Oswego	38	$292,560	$189,223	$0	$481,784
City	City of Lebanon	103	$782,912	$506,375	$0	$1,289,287
City	City of Lowell	0	$0	$0	$0	$0
City	City of Lyons	4	$30,799	$19,921	$0	$50,720
City	City of Maywood Park	0	$0	$0	$0	$0
City	City of McMinnville	79	$604,112	$390,731	$0	$994,843
City	City of Mill City	23	$178,342	$115,349	$0	$293,691
City	City of Millersburg	121	$925,270	$598,450	$0	$1,523,720
City	City of Milwaukie	30	$229,742	$148,594	$0	$378,336
City	City of Molalla	18	$140,749	$91,034	$0	$231,783
City	City of Monmouth	23	$178,715	$115,590	$0	$294,304
City	City of Monroe	18	$137,395	$88,865	$0	$226,259
City	City of Mt. Angel	5	$40,863	$26,429	$0	$67,292
City	City of Newberg	53	$401,951	$259,976	$0	$661,927
City	City of North Plains	5	$34,831	$22,528	$0	$57,360

Table 20. Restoration cost estimates for each DMA using all lower bound values.

DMA Type	DMA	Potential Restoration Acres	Riparian Planting Cost	Habitat Improvement Cost	Fencing Cost	Total Cost
City	City of Oakridge	46	$346,757	$224,277	$0	$571,033
City	City of Oregon City	68	$521,676	$337,412	$0	$859,088
City	City of Philomath	24	$179,782	$116,280	$0	$296,062
City	City of Portland	1,105	$8,415,441	$5,442,976	$0	$13,858,417
City	City of Rivergrove	2	$16,823	$10,881	$0	$27,703
City	City of Salem	739	$5,631,381	$3,642,290	$0	$9,273,671
City	City of Sandy	3	$26,242	$16,973	$0	$43,215
City	City of Scappoose	24	$179,511	$116,105	$0	$295,615
City	City of Scio	21	$160,265	$103,657	$0	$263,922
City	City of Scotts Mills	5	$36,017	$23,295	$0	$59,313
City	City of Sheridan	40	$305,012	$197,277	$0	$502,289
City	City of Sherwood	41	$315,770	$204,235	$0	$520,006
City	City of Silverton	26	$199,688	$129,155	$0	$328,843
City	City of Sodaville	0	$0	$0	$0	$0
City	City of Springfield	68	$519,964	$336,305	$0	$856,268
City	City of St. Helens	50	$378,640	$244,899	$0	$623,539
City	City of St. Paul	2	$14,095	$9,117	$0	$23,212
City	City of Stayton	43	$326,477	$211,160	$0	$537,638
City	City of Sublimity	11	$85,944	$55,587	$0	$141,530
City	City of Sweet Home	52	$397,749	$257,258	$0	$655,007
City	City of Tangent	58	$443,610	$286,920	$0	$730,530
City	City of Tigard	109	$829,516	$536,518	$0	$1,366,035
City	City of Troutdale	19	$146,678	$94,869	$0	$241,548
City	City of Tualatin	63	$478,356	$309,393	$0	$787,750
City	City of Turner	43	$326,884	$211,423	$0	$538,307
City	City of Veneta	0	$0	$0	$0	$0
City	City of Waterloo	0	$3,219	$2,082	$0	$5,301
City	City of West Linn	88	$669,235	$432,851	$0	$1,102,085
City	City of Westfir	13	$95,803	$61,964	$0	$157,768
City	City of Willamina	16	$119,335	$77,184	$0	$196,519
City	City of Wilsonville	93	$709,285	$458,754	$0	$1,168,039

Table 20. Restoration cost estimates for each DMA using all lower bound values.

DMA Type	DMA	Potential Restoration Acres	Riparian Planting Cost	Habitat Improvement Cost	Fencing Cost	Total Cost
City	City of Wood Village	8	$59,939	$38,767	$0	$98,706
City	City of Woodburn	82	$626,170	$404,997	$0	$1,031,167
City	City of Yamhill	12	$92,652	$59,926	$0	$152,578
County	Benton County	336	$2,561,806	$1,656,937	$0	$4,218,743
County	Clackamas County	347	$2,647,052	$1,712,072	$0	$4,359,124
County	Columbia County	51	$389,177	$251,714	$0	$640,890
County	Lane County	210	$1,602,788	$1,036,658	$0	$2,639,447
County	Linn County	407	$3,099,780	$2,004,889	$0	$5,104,669
County	Marion County	312	$2,376,434	$1,537,041	$0	$3,913,475
County	Multnomah County	98	$749,910	$485,030	$0	$1,234,939
County	Polk County	121	$918,595	$594,133	$0	$1,512,728
County	Washington County	380	$2,897,266	$1,873,906	$0	$4,771,172
County	Yamhill County	139	$1,056,820	$683,535	$0	$1,740,354
Federal	BLM	605	$2,040,033	$317,351	$0	$2,357,384
Federal	BPA	0	$0	$0	$0	$0
Federal	USACE	46	$155,735	$0	$0	$155,735
Federal	USCG	0	$0	$0	$0	$0
Federal	USFS	3,871	$13,042,139	$2,028,859	$0	$15,070,998
Federal	USFWS	616	$2,074,757	$0	$0	$2,074,757
Forestry - Private	Oregon Dept. of Forestry	8,598	$28,968,941	$4,506,461	$0	$33,475,402
Forestry - State	Oregon Dept. of Forestry	98	$328,944	$51,171	$0	$380,115
State	Oregon Dept. of Fish and Wildlife	65	$218,889	$0	$0	$218,889
State	Oregon Dept. of State Lands	7	$23,979	$0	$0	$23,979
State	Oregon Parks and Recreation	221	$743,380	$0	$0	$743,380
State	State of Oregon (general)	104	$350,660	$0	$0	$350,660
		93,985	**$351,237,705**	**$219,669,529**	**$23,041,193**	**$593,948,427**

Table 21. Restoration cost estimates for each DMA using average values.

DMA Type	DMA	Potential Restoration Acres	Riparian Planting Cost	Habitat Improvement Cost	Fencing Cost	Total Cost
Agriculture	Oregon Dept. of Agriculture	72,065	$338,346,347	$293,297,639	$36,367,008	$668,010,994
City	City of Adair Village	0	$0	$0	$0	$0
City	City of Albany	219	$2,307,357	$1,646,452	$0	$3,953,809
City	City of Amity	4	$37,984	$27,104	$0	$65,089
City	City of Aumsville	31	$321,717	$229,567	$0	$551,284
City	City of Aurora	5	$54,843	$39,134	$0	$93,977
City	City of Banks	10	$107,013	$76,361	$0	$183,373
City	City of Barlow	0	$0	$0	$0	$0
City	City of Beaverton	130	$1,365,839	$974,617	$0	$2,340,455
City	City of Brownsville	47	$491,521	$350,733	$0	$842,254
City	City of Canby	22	$231,493	$165,186	$0	$396,679
City	City of Carlton	24	$250,954	$179,072	$0	$430,027
City	City of Coburg	6	$66,566	$47,499	$0	$114,066
City	City of Cornelius	5	$53,999	$38,532	$0	$92,530
City	City of Corvallis	165	$1,737,219	$1,239,621	$0	$2,976,841
City	City of Cottage Grove	44	$461,743	$329,485	$0	$791,228
City	City of Creswell	25	$265,585	$189,513	$0	$455,098
City	City of Dallas	81	$854,341	$609,629	$0	$1,463,970
City	City of Damascus	198	$2,084,212	$1,487,223	$0	$3,571,435
City	City of Dayton	4	$46,707	$33,328	$0	$80,035
City	City of Detroit	0	$0	$0	$0	$0
City	City of Donald	0	$0	$0	$0	$0
City	City of Dundee	8	$88,114	$62,875	$0	$150,989
City	City of Durham	1	$10,153	$7,245	$0	$17,397
City	City of Estacada	54	$566,927	$404,540	$0	$971,467
City	City of Eugene	411	$4,330,632	$3,090,193	$0	$7,420,826
City	City of Fairview	77	$812,161	$579,531	$0	$1,391,691
City	City of Falls City	16	$165,325	$117,971	$0	$283,296
City	City of Forest Grove	8	$87,973	$62,775	$0	$150,748
City	City of Gaston	6	$67,340	$48,052	$0	$115,392
City	City of Gates	6	$60,634	$43,267	$0	$103,901

Table 21. Restoration cost estimates for each DMA using average values.

DMA Type	DMA	Potential Restoration Acres	Riparian Planting Cost	Habitat Improvement Cost	Fencing Cost	Total Cost
City	City of Gervais	4	$38,008	$27,121	$0	$65,129
City	City of Gladstone	38	$399,796	$285,281	$0	$685,077
City	City of Gresham	65	$689,719	$492,160	$0	$1,181,880
City	City of Halsey	12	$124,926	$89,143	$0	$214,069
City	City of Happy Valley	76	$801,094	$571,633	$0	$1,372,727
City	City of Harrisburg	22	$235,456	$168,013	$0	$403,469
City	City of Hillsboro	234	$2,468,439	$1,761,395	$0	$4,229,834
City	City of Hubbard	6	$68,465	$48,855	$0	$117,320
City	City of Idanha	26	$276,113	$197,025	$0	$473,138
City	City of Independence	45	$473,866	$338,135	$0	$812,000
City	City of Jefferson	8	$88,020	$62,808	$0	$150,829
City	City of Johnson City	4	$40,517	$28,911	$0	$69,428
City	City of Junction City	19	$203,052	$144,891	$0	$347,943
City	City of Keizer	64	$676,777	$482,925	$0	$1,159,702
City	City of King City	13	$139,745	$99,717	$0	$239,462
City	City of Lafayette	5	$55,241	$39,418	$0	$94,660
City	City of Lake Oswego	39	$407,252	$290,602	$0	$697,854
City	City of Lebanon	103	$1,091,087	$778,563	$0	$1,869,650
City	City of Lowell	0	$0	$0	$0	$0
City	City of Lyons	4	$42,627	$30,417	$0	$73,044
City	City of Maywood Park	0	$0	$0	$0	$0
City	City of McMinnville	80	$838,444	$598,286	$0	$1,436,730
City	City of Mill City	23	$246,828	$176,128	$0	$422,955
City	City of Millersburg	122	$1,281,970	$914,771	$0	$2,196,740
City	City of Milwaukie	30	$317,966	$226,890	$0	$544,856
City	City of Molalla	18	$194,798	$139,002	$0	$333,800
City	City of Monmouth	23	$247,343	$176,496	$0	$423,839
City	City of Monroe	18	$190,156	$135,689	$0	$325,845
City	City of Mt. Angel	5	$56,554	$40,355	$0	$96,910
City	City of Newberg	53	$556,306	$396,961	$0	$953,266
City	City of North Plains	5	$48,207	$34,399	$0	$82,606

Table 21. Restoration cost estimates for each DMA using average values.

DMA Type	DMA	Potential Restoration Acres	Riparian Planting Cost	Habitat Improvement Cost	Fencing Cost	Total Cost
City	City of Oakridge	46	$486,949	$347,471	$0	$834,420
City	City of Oregon City	68	$722,006	$515,199	$0	$1,237,206
City	City of Philomath	24	$252,361	$180,076	$0	$432,438
City	City of Portland	1,107	$11,668,581	$8,326,307	$0	$19,994,889
City	City of Rivergrove	2	$23,283	$16,614	$0	$39,897
City	City of Salem	740	$7,803,289	$5,568,164	$0	$13,371,453
City	City of Sandy	6	$66,801	$47,667	$0	$114,468
City	City of Scappoose	24	$248,445	$177,282	$0	$425,727
City	City of Scio	21	$221,809	$158,276	$0	$380,085
City	City of Scotts Mills	5	$49,849	$35,570	$0	$85,419
City	City of Sheridan	40	$422,141	$301,226	$0	$723,367
City	City of Sherwood	41	$437,030	$311,850	$0	$748,880
City	City of Silverton	26	$276,371	$197,209	$0	$473,580
City	City of Sodaville	0	$0	$0	$0	$0
City	City of Springfield	69	$726,672	$518,529	$0	$1,245,200
City	City of St. Helens	50	$525,215	$374,776	$0	$899,991
City	City of St. Paul	2	$19,508	$13,920	$0	$33,428
City	City of Stayton	44	$458,883	$327,443	$0	$786,326
City	City of Sublimity	11	$118,947	$84,877	$0	$203,824
City	City of Sweet Home	53	$556,118	$396,827	$0	$952,945
City	City of Tangent	59	$618,652	$441,449	$0	$1,060,101
City	City of Tigard	109	$1,153,409	$823,034	$0	$1,976,442
City	City of Troutdale	19	$203,005	$144,857	$0	$347,862
City	City of Tualatin	63	$662,052	$472,418	$0	$1,134,470
City	City of Turner	43	$452,412	$322,826	$0	$775,238
City	City of Veneta	0	$0	$0	$0	$0
City	City of Waterloo	0	$4,455	$3,179	$0	$7,634
City	City of West Linn	89	$933,264	$665,946	$0	$1,599,211
City	City of Westfir	13	$139,627	$99,633	$0	$239,261
City	City of Willamina	16	$165,161	$117,854	$0	$283,015
City	City of Wilsonville	93	$984,004	$702,152	$0	$1,686,156

Table 21. Restoration cost estimates for each DMA using average values.

DMA Type	DMA	Potential Restoration Acres	Riparian Planting Cost	Habitat Improvement Cost	Fencing Cost	Total Cost
City	City of Wood Village	8	$82,956	$59,195	$0	$142,150
City	City of Woodburn	82	$866,627	$618,396	$0	$1,485,024
City	City of Yamhill	12	$128,232	$91,502	$0	$219,734
County	Benton County	340	$3,586,467	$2,559,182	$0	$6,145,648
County	Clackamas County	351	$3,703,419	$2,642,635	$0	$6,346,054
County	Columbia County	51	$540,971	$386,019	$0	$926,990
County	Lane County	212	$2,235,233	$1,594,987	$0	$3,830,220
County	Linn County	408	$4,297,171	$3,066,317	$0	$7,363,488
County	Marion County	312	$3,293,706	$2,350,278	$0	$5,643,984
County	Multnomah County	99	$1,044,333	$745,201	$0	$1,789,534
County	Polk County	121	$1,271,348	$907,191	$0	$2,178,539
County	Washington County	381	$4,013,252	$2,863,721	$0	$6,876,973
County	Yamhill County	139	$1,467,342	$1,047,046	$0	$2,514,388
Federal	BLM	626	$2,939,588	$772,182	$0	$3,711,770
Federal	BPA	0	$0	$0	$0	$0
Federal	USACE	47	$220,137	$0	$0	$220,137
Federal	USCG	0	$0	$0	$0	$0
Federal	USFS	4,206	$19,745,981	$5,186,947	$0	$24,932,928
Federal	USFWS	621	$2,915,030	$0	$0	$2,915,030
Forestry - Private	Oregon Dept. of Forestry	8,899	$41,779,179	$10,974,710	$0	$52,753,889
Forestry - State	Oregon Dept. of Forestry	100	$470,888	$123,695	$0	$594,583
State	Oregon Dept. of Fish and Wildlife	66	$311,270	$0	$0	$311,270
State	Oregon Dept. of State Lands	7	$33,413	$0	$0	$33,413
State	Oregon Parks and Recreation	224	$1,051,505	$0	$0	$1,051,505
State	State of Oregon (general)	105	$492,794	$0	$0	$492,794
		95,138	**$494,464,615**	**$371,834,966**	**$36,367,008**	**$902,666,588**

Table 22. Restoration cost estimates for each DMA using all upper bound values.

DMA Type	DMA	Potential Restoration Acres	Riparian Planting Cost	Habitat Improvement Cost	Fencing Cost	Total Cost
Agriculture	Oregon Dept. of Agriculture	72,512	$393,448,608	$442,226,519	$52,600,004	$888,275,131
City	City of Adair Village	0	$0	$0	$0	$0
City	City of Albany	222	$2,693,806	$2,363,468	$0	$5,057,274
City	City of Amity	4	$43,680	$38,324	$0	$82,004
City	City of Aumsville	31	$369,961	$324,593	$0	$694,555
City	City of Aurora	5	$63,067	$55,333	$0	$118,400
City	City of Banks	10	$123,060	$107,969	$0	$231,029
City	City of Barlow	0	$0	$0	$0	$0
City	City of Beaverton	130	$1,570,656	$1,378,049	$0	$2,948,705
City	City of Brownsville	47	$565,229	$495,915	$0	$1,061,144
City	City of Canby	22	$266,207	$233,563	$0	$499,770
City	City of Carlton	24	$288,587	$253,198	$0	$541,784
City	City of Coburg	6	$76,548	$67,161	$0	$143,710
City	City of Cornelius	5	$62,096	$54,481	$0	$116,577
City	City of Corvallis	167	$2,026,874	$1,778,321	$0	$3,805,194
City	City of Cottage Grove	45	$539,856	$473,654	$0	$1,013,510
City	City of Creswell	25	$305,412	$267,959	$0	$573,371
City	City of Dallas	81	$987,607	$866,498	$0	$1,854,105
City	City of Damascus	198	$2,404,223	$2,109,397	$0	$4,513,620
City	City of Dayton	4	$53,711	$47,124	$0	$100,835
City	City of Detroit	0	$0	$0	$0	$0
City	City of Donald	0	$0	$0	$0	$0
City	City of Dundee	8	$101,328	$88,902	$0	$190,229
City	City of Durham	1	$11,675	$10,243	$0	$21,918
City	City of Estacada	54	$651,942	$571,995	$0	$1,223,937
City	City of Eugene	411	$4,985,597	$4,374,219	$0	$9,359,816
City	City of Fairview	77	$936,646	$821,786	$0	$1,758,432
City	City of Falls City	16	$192,813	$169,169	$0	$361,983
City	City of Forest Grove	8	$101,166	$88,760	$0	$189,926
City	City of Gaston	6	$77,438	$67,942	$0	$145,380
City	City of Gates	6	$77,357	$67,871	$0	$145,228

Table 22. Restoration cost estimates for each DMA using all upper bound values.

DMA Type	DMA	Potential Restoration Acres	Riparian Planting Cost	Habitat Improvement Cost	Fencing Cost	Total Cost
City	City of Gervais	4	$43,707	$38,348	$0	$82,055
City	City of Gladstone	38	$462,445	$405,736	$0	$868,181
City	City of Gresham	66	$795,709	$698,132	$0	$1,493,841
City	City of Halsey	12	$143,660	$126,043	$0	$269,703
City	City of Happy Valley	76	$921,223	$808,255	$0	$1,729,478
City	City of Harrisburg	22	$270,764	$237,560	$0	$508,324
City	City of Hillsboro	235	$2,852,054	$2,502,310	$0	$5,354,364
City	City of Hubbard	6	$78,732	$69,078	$0	$147,810
City	City of Idanha	27	$325,607	$285,678	$0	$611,285
City	City of Independence	45	$544,925	$478,102	$0	$1,023,027
City	City of Jefferson	9	$103,916	$91,173	$0	$195,089
City	City of Johnson City	4	$46,592	$40,879	$0	$87,471
City	City of Junction City	19	$233,501	$204,867	$0	$438,368
City	City of Keizer	64	$778,265	$682,827	$0	$1,461,092
City	City of King City	13	$160,700	$140,994	$0	$301,694
City	City of Lafayette	5	$63,525	$55,735	$0	$119,260
City	City of Lake Oswego	39	$471,019	$413,259	$0	$884,278
City	City of Lebanon	104	$1,263,358	$1,108,434	$0	$2,371,793
City	City of Lowell	0	$0	$0	$0	$0
City	City of Lyons	4	$49,019	$43,008	$0	$92,027
City	City of Maywood Park	0	$0	$0	$0	$0
City	City of McMinnville	80	$966,872	$848,305	$0	$1,815,177
City	City of Mill City	23	$283,841	$249,034	$0	$532,875
City	City of Millersburg	122	$1,475,802	$1,294,826	$0	$2,770,627
City	City of Milwaukie	30	$365,647	$320,809	$0	$686,456
City	City of Molalla	18	$224,010	$196,540	$0	$420,550
City	City of Monmouth	23	$284,434	$249,554	$0	$533,989
City	City of Monroe	18	$218,671	$191,856	$0	$410,527
City	City of Mt. Angel	5	$65,035	$57,060	$0	$122,095
City	City of Newberg	53	$639,728	$561,279	$0	$1,201,006
City	City of North Plains	5	$55,436	$48,638	$0	$104,074

Table 22. Restoration cost estimates for each DMA using all upper bound values.

DMA Type	DMA	Potential Restoration Acres	Riparian Planting Cost	Habitat Improvement Cost	Fencing Cost	Total Cost
City	City of Oakridge	47	$568,059	$498,399	$0	$1,066,458
City	City of Oregon City	68	$830,277	$728,461	$0	$1,558,737
City	City of Philomath	24	$294,276	$258,189	$0	$552,465
City	City of Portland	1,109	$13,443,092	$11,794,584	$0	$25,237,676
City	City of Rivergrove	2	$26,774	$23,491	$0	$50,265
City	City of Salem	741	$8,984,236	$7,882,511	$0	$16,866,747
City	City of Sandy	9	$111,870	$98,152	$0	$210,022
City	City of Scappoose	24	$285,701	$250,666	$0	$536,368
City	City of Scio	21	$255,071	$223,792	$0	$478,864
City	City of Scotts Mills	5	$57,324	$50,294	$0	$107,618
City	City of Sheridan	40	$485,444	$425,915	$0	$911,359
City	City of Sherwood	41	$502,566	$440,937	$0	$943,503
City	City of Silverton	26	$317,815	$278,842	$0	$596,657
City	City of Sodaville	0	$0	$0	$0	$0
City	City of Springfield	70	$843,731	$740,266	$0	$1,583,997
City	City of St. Helens	50	$605,323	$531,093	$0	$1,136,415
City	City of St. Paul	2	$22,433	$19,682	$0	$42,116
City	City of Stayton	44	$535,785	$470,082	$0	$1,005,867
City	City of Sublimity	11	$136,784	$120,010	$0	$256,794
City	City of Sweet Home	53	$645,983	$566,767	$0	$1,212,750
City	City of Tangent	59	$716,816	$628,913	$0	$1,345,729
City	City of Tigard	110	$1,332,519	$1,169,114	$0	$2,501,633
City	City of Troutdale	19	$233,447	$204,820	$0	$438,267
City	City of Tualatin	63	$761,331	$667,970	$0	$1,429,301
City	City of Turner	43	$520,254	$456,456	$0	$976,710
City	City of Veneta	0	$0	$0	$0	$0
City	City of Waterloo	0	$5,123	$4,495	$0	$9,618
City	City of West Linn	89	$1,081,304	$948,705	$0	$2,030,009
City	City of Westfir	14	$168,654	$147,973	$0	$316,627
City	City of Willamina	16	$189,929	$166,638	$0	$356,566
City	City of Wilsonville	94	$1,134,258	$995,166	$0	$2,129,424

Table 22. Restoration cost estimates for each DMA using all upper bound values.

DMA Type	DMA	Potential Restoration Acres	Riparian Planting Cost	Habitat Improvement Cost	Fencing Cost	Total Cost
City	City of Wood Village	8	$95,396	$83,697	$0	$179,093
City	City of Woodburn	82	$996,585	$874,375	$0	$1,870,959
City	City of Yamhill	12	$147,461	$129,378	$0	$276,840
County	Benton County	344	$4,171,307	$3,659,785	$0	$7,831,093
County	Clackamas County	355	$4,304,615	$3,776,746	$0	$8,081,360
County	Columbia County	52	$624,790	$548,173	$0	$1,172,963
County	Lane County	214	$2,589,918	$2,272,319	$0	$4,862,237
County	Linn County	408	$4,949,653	$4,342,683	$0	$9,292,336
County	Marion County	313	$3,793,014	$3,327,882	$0	$7,120,896
County	Multnomah County	100	$1,208,353	$1,060,175	$0	$2,268,528
County	Polk County	121	$1,461,996	$1,282,713	$0	$2,744,709
County	Washington County	381	$4,618,975	$4,052,556	$0	$8,671,530
County	Yamhill County	140	$1,692,774	$1,485,191	$0	$3,177,964
Federal	BLM	647	$3,509,331	$1,375,954	$0	$4,885,285
Federal	BPA	0	$0	$0	$0	$0
Federal	USACE	48	$258,032	$0	$0	$258,032
Federal	USCG	0	$0	$0	$0	$0
Federal	USFS	4,541	$24,638,019	$9,660,183	$0	$34,298,202
Federal	USFWS	626	$3,396,648	$0	$0	$3,396,648
Forestry - Private	Oregon Dept. of Forestry	9,200	$49,917,311	$19,571,799	$0	$69,489,110
Forestry - State	Oregon Dept. of Forestry	103	$558,685	$219,052	$0	$777,736
State	Oregon Dept. of Fish and Wildlife	68	$366,974	$0	$0	$366,974
State	Oregon Dept. of State Lands	7	$38,615	$0	$0	$38,615
State	Oregon Parks and Recreation	227	$1,233,322	$0	$0	$1,233,322
State	State of Oregon (general)	106	$574,348	$0	$0	$574,348
		96,291	**$577,455,648**	**$560,365,778**	**$52,600,004**	**$1,190,421,429**

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Restoration in an urban setting along the headwaters of Tryon Creek in Portland. Photo by Ryan Michie.