Streambank stabilization, streambank fencing, nuisance species control, riparian zone management

Stream Restoration Cost Estimates

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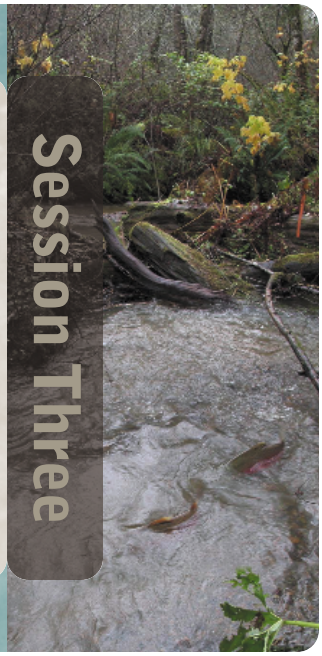
Session Three



ABSTRACT

The Wind River watershed in Washington State poses restoration challenges characteristic of Pacific Northwest watersheds, and is used here to exemplify the difficulties in estimating restoration costs on both small and large scales. This paper emphasizes the major influences on the cost of restoring the Wind River drainage, and the factors that can wreak havoc on cost estimation. Also discussed are the roles played by watershed analysis and stream surveys.

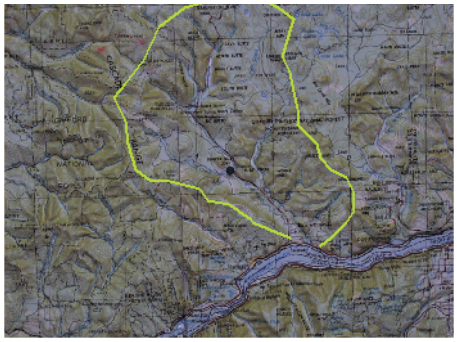
INTRODUCTION

The Wind River Watershed is located on the west slope of the Cascade Mountains in the Gifford Pinchot National Forest, Southwestern Washington State. The watershed contains 150,000 acres and drains into the Columbia River at river mile 155, approximately 10 miles upstream of Bonneville Dam (Figure 1). The Wind River ecosystem is a typical west-slope Cascade environment, with average annual precipitation ranges from less than 60″ per year in the southeast portion of the watershed to over 120″ per year in the west and northwest. Approximately 75% of the annual precipitation falls between November and March. Because the watershed lies in the western Cascades at elevations ranging from less than 100 feet to nearly 4,000 feet, both rain and snow are common during the winter months (Coffin 2001).

The predominant land management activity within the Wind River watershed has been timber harvest. Timber harvest within the basin began in the late 1800's. "Splash dams" were constructed on the main stem Wind River and tributaries to stockpile and transport logs down stream to the mills along the Columbia River. Riparian areas were targeted for harvest due to the large quantities of old growth timber and access to the stream (Figure 2).

The U.S. Forest Service (USFS) manages 89% of the land within the Wind River watershed. The Northwest Forest Plan Record of Decision categorizes the Wind River Basin as a Tier 1 Key Watershed that provides critical habitat for anadromous salmonids. Federal management will largely determine the quality of habitat in the Wind River watershed.

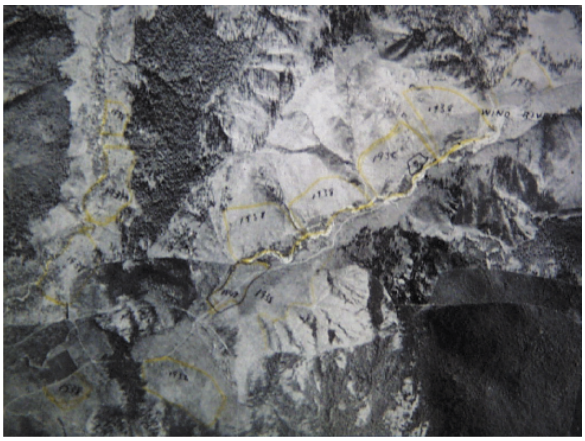
Figure 1. Wind River watershed, Skamania County, Washington



Most populations of salmonids that historically occupied the Wind River watershed are considered depressed (WDF *et al.* 1993). Shipherd Falls, which is 4.3 miles upstream from the historic mouth of the Wind River, was a natural barrier to all anadromous fish except steelhead (Bryant 1949); summer steelhead were dominant and numerous above this barrier. The U.S. Fish and Wildlife Service (USFWS *et al.* 1951) estimated the summer steelhead run size was 3,250 with an escapement of 2,500 spawning adults. The current number of wild summer steelhead spawning in the Wind River has been reduced to approximately 200 adults in recent years (Rawding 1997). In addition, a fall race of chinook that dominated the lower reach of the Wind River is depressed and composed of a substantial number of stray hatchery fish (WDF *et al.* 1993).

Anadromous fish losses have been attributed to adverse ocean conditions, the construction of Bonneville Dam, timber harvest, and rural development of the upper watershed (WDW *et al.* 1990). These activities in the upper watershed have severely impacted riparian areas and stream channels in several key steelhead sub watersheds. Poor upland, riparian, channel conditions cumulatively produce maximum water temperatures exceeding 24°C (75°F), risk of increased peak flows and increased sedimentation (USFS 1996).

Figure 2. 1944 U.S. Department of War aerial photograph of the Upper Wind River (river mile 20–25), Skamania County, Washington



Estimating Costs

Deciding where to spend allocated money to restore a watershed is critical. Stream surveys, sub-basin assessments and watershed analysis were used to evaluate limiting factors in the Wind River. Fish habitat and water quality have been negatively impacted by past riparian timber harvest, stream clean-outs, road building and regeneration harvest within the rain-on-snow zone. Alluvial reaches within the main-stem Wind River and tributaries, which contain the majority of steelhead spawning habitat, have been significantly impacted. Many of these reaches were disturbed over 80 years ago, yet habitat and water quality have not recovered and in some cases are getting worse.

In the Wind River, the USFS has taken a watershed approach to restoration. In 1992, the Wind River watershed was assessed and the USFS, USFWS and Underwood Conservation District (UCD) initiated cooperative habitat restoration projects in 1994. The Wind River Restoration Team (WRRT) was formed in 1994 in response to the decline of steelhead within the Wind River basin. The team includes technical specialists from the UCD, USFWS, Washington

Department of Fish and Wildlife (WDFW), U.S. Geological Survey (USGS), Washington Trout and the Yakama Nation. Acknowledging that watershed-scale restoration can only be successful if all stakeholders are involved, the UCD, in cooperation with Skamania County and the WRRT, facilitated the development of the Wind River Watershed Council in 1997. The group is comprised of representatives of landowners, businesses, logging companies, government agencies, conservation groups, schools, and others.

The restoration projects completed to date are products of stream surveys (1987–1998), a sub-basin assessment (1992) and watershed analysis (1996 and 2001) conducted by the USFS. Projects on private lands are products of stream surveys conducted by UCD and USFWS. The goals of these projects are to accelerate the recovery of water quality and fish habitat in which wild Wind River steelhead evolved. These goals will be achieved by utilizing a holistic, community-based watershed restoration approaches on both public and private lands. Past restoration efforts within the watershed have addressed degraded streams, riparian areas, and hill-slopes. An adaptive management strategy has permitted partners to build upon past successes in restoring degraded water quality and habitat within the Wind River sub-basin. On-going collection and analysis of biological, physical habitat, and water quality data will fill information gaps on private and public lands. This information is necessary to assess watershed processes and success of past restoration efforts and to identify future restoration needs. Coordination and education of land owners, the community, and other stakeholders is an important part of achieving restoration goals and preserving wild steelhead within the watershed.

The goals of restoration efforts in the Wind River have been to accelerate the recovery of riparian, in-stream habitat and water quality in which the steelhead evolved. The objectives to accomplish these goals are: reduce road densities, reforest, and rehabilitate riparian areas, flood plains, and stream channels. The USFS, USFWS, Bonneville Power Administration and UCD have made significant progress in restoring hydraulic processes and rehabilitation of critical habitat. Since 1992, approximately 100 miles of road have been stabilized or "storm-proofed", 35 miles have been decommissioned, 120 acres of flood plain have been reclaimed, 300 riparian acres have been planted and 3,000 pieces of large woody debris (LWD) have been placed back in 8 river miles of stream. In addition, the USFWS and UCD have initiated restoration on private lands with the implementation of two "demonstration" projects. One is a reforestation project along Martha Creek near Stabler, and the other is a riparian and channel rehabilitation project on the Wind River. Funding was recently secured to conduct additional projects in the privately owned portion of the watershed. These activities will assist landowners with riparian and channel restoration, slope stabilization and erosion control.

Stream Restoration Cost

For the purposes of this presentation, three types of restoration projects will be discussed: stream bank stabilization, channel rehabilitation and riparian reforestation. The majority of stream bank stabilization projects within the Wind River consist of constructing large woody debris revetments; log cribs, bank barbs and groins. Several projects have included rock groins or bank barbs and are included in cost estimates. Stream channel rehabilitation consists of a myriad of activities ranging from total channel reconstruction to reconstructing log jams that serve as channel slope grade controls to maintain or restore flood plain

connectivity. Riparian reforestation activities include planting conifers, hard woods and shrubs with conventional hand crews to transplanting whole trees and shrubs with heavy equipment.

Costs for bank stabilization on public lands within the Wind River range from approximately $46,000 to $222,000 per river mile. For channel rehabilitation, the USFS cost range from $41,000 to $137,000 per river mile with a mean of $86,000 per river mile. Riparian reforestation cost range from approximately $4,000 to almost $8,000 per mile, and with and average of $5,000 a river mile, or $110 per acre.

Major Factors Affecting Cost Estimation

• *Scope, treatment intensity and stream size:* Large projects tend to have lower cost per river mile. Planning, design, National Environmental Policy Act (NEPA) requirements, equipment mobilization cost on small bank stabilization projects (< 3,000´) can exceed implementation cost, which quickly drive up the cost per river mile. Large scale projects (1–9 river miles) absorb or significantly reduce the implementation to fixed cost ratio and are more efficient. Treatment intensity varies from site to site. Again using bank stabilization as an example, 200´ of bank may be treated with a single log jam/bank barb, while another site with 200´ of unstable bank may take a series of barbs and floodplain contouring to stabilize the site. The size of the stream can make a significant difference in the cost. Typically, planning, design, regulatory coordination and treatment intensity radically increase with stream size and are inversely proportional to stream order.

• *Access:* Access to the project site usually dictates the equipment type and labor intensity. In some areas where material such as large woody debris could not be hauled directly to a site, helicopters are typically used. Cost for heavy helicopters can cost upward of $8,000 an hour.

• *Material availability:* Although the USFS manages almost 90% of the watershed and the timber contained within it, obtaining the quantity and quality of large wood can be a challenge. Trees that are cut to put in the river are no different than those being cut to send to the mill; the same regulations apply to both.

• *Type of contract:* The type of contract can greatly influence the project cost. Hourly equipment rental (with operator) contracts are the cheapest; however the liability associated with the work greatly increases as well as the time and personnel it takes to direct the on the ground work. Construction contracts can cost up to 50% more than equipment rental contracts; however, the contractor assumes the responsibility.

• *Time:* The amount of time to complete the project is affected by all of the factors mentioned above. In addition, the permitting process (hydraulic permits, NEPA, endangered species consultation) can be very time consuming. For example, conducting the appropriate level of NEPA may take a year or more, especially if endangered species or significant cultural resources are involved.

Figure 3 provides an example of common access and material availability issues. This is Wind River at river mile 24, where work on three river miles of stream has been completed this year. Riparian areas were thinned and then hauled or yarded directly into the river. Approximately 2,000 trees were then used to install grade controls, construct logjams, and reconstruct meanders at a cost of $65,000 a river mile.

Figure 4 shows a project that took place in an area that was experiencing channel

Figure 3. The Mining Reach riparian and stream channel restoration project, Skamania County, Washington

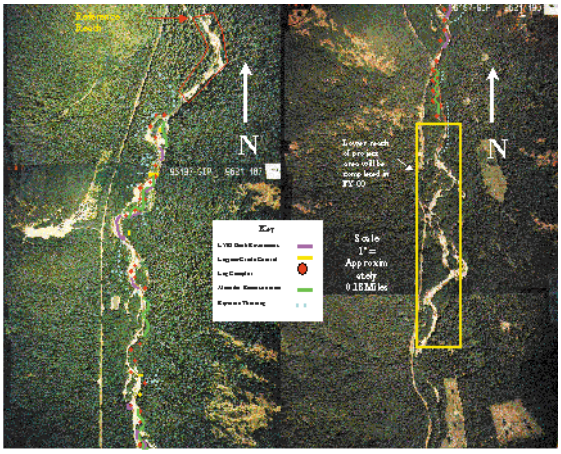
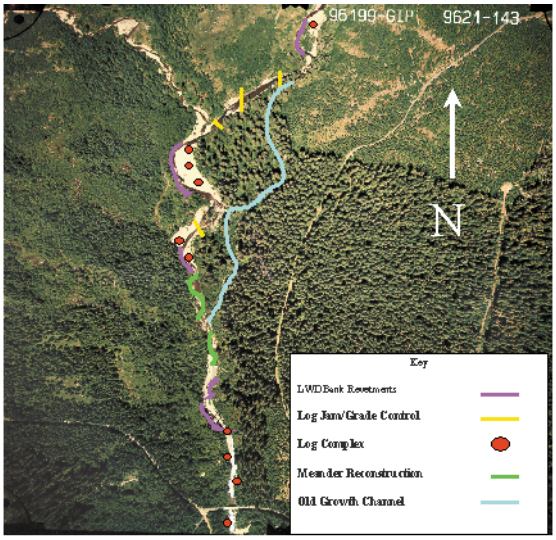


Figure 4. Trout Creek restoration, Wind River watershed, Skamania County, Washington



down-cutting. The damage was the result of three historical actions. First, all of the timber alongside the creek was cut, and then the upper watershed was logged. The cumulative effects of these actions decreased bank stability and are thought to have increased peak flows. Finally, the proverbial straw that broke the camel's back — logjams that were thought to be migration barriers to steelhead were removed, which resulted in down-cutting or incision and subsequent lateral migration of the stream channel. The project area contained very young stands of trees; therefore there was little onsite material available for construction. Trees were salvaged from a wind blown stand of trees 20 miles away, stockpiled nearby and then a helicopter was used to fly the trees to the project site. The difficulties involved in importing the trees to the site almost tripled the cost per river mile compared to the previous example. Restoration cost for rehabilitation of this project ranged between $140,000 and $150,000 per river mile.

Refining Cost Estimates

Table 1 shows a range of cost for restoration. For planning, design, and NEPA, costs range from $21,000 to $110,000 per river mile. The mean is about $70,000 for the planning phase.

Material acquisition and material transportation to project sites can become one of the most expensive components of stream restoration. Trees and LWD have been primarily used for restoration in the Wind River. Boulders and rock have also been used in certain circumstances. Obviously projects with ample on-site material cost significantly less than projects that involve extensive haul distances or helicopter transport. For material transport equipment, the use of a helicopter greatly increases the cost, to at least $64,000 per river mile and often as much as $150,000 per river mile. If material can be ground transported to the site, the cost can drop down to as low as $17,000 a river mile. These costs do not reflect the cost of trees. If purchasing trees is necessary, the material costs may exceed $145,000/ river mile.

Labor costs are typically access-driven. Depending on the site, labor cost can range from $17,000 per mile if access is limited or drop to $112 per river mile if access to sites is not restricted. Riparian planting and thinning is typically the most labor intensive

Table 1. Typical restoration costs

Item	High end (cost/river mile)	Low end (cost/river mile)	Reasonable mean (cost/river mile)
Plan, design & NEPA	$110,040	$21,833	$68,880
Materials (trees)	$64,900	$14,747	$20,566
Mobilization	$8,200	$1,333	$2,777
Equipment	$122,000	$17,333	$20,800
Labor	$17,167	$112	$5,000
Riparian planting/ maintenance	$7,646	$3,893	$5,512
Instream structure maintenance	$24,640	$4,760	$5,600
Total	**$354,593**	**$64,011**	**$129,135**

aspect of stream restoration. Riparian planting, which is arguably always needed in conjunction with streambank stabilization, runs $4,000 to $7,000 per river mile.

Maintenance of riparian and in-stream improvements are important. Monitoring of plant survival and growth plots in riparian areas along the Wind River and tributaries have shown that mortality of newly planted trees can approach 60%. Vegetation management is needed to control the competing vegetation and browse from ungulates. Streams are dynamic and some level of maintenance of in-stream structures must also be maintained. Unfortunately, it is rare for most projects to receive sufficient funding for adequate monitoring or maintenance.

Another issue that can greatly affect the cost of the project is whether the equipment is rented hourly or included in a construction contract. A typical hourly equipment rental contract may include the hiring of a timber faller, a tracked excavator, and bulldozer with operators. The work is directed by the designer. In contrast to hourly equipment rentals, construction contracts require extensive, detailed plans ("blueprints") for the contractor to follow. Cost for construction contracted in-stream work can significantly increase cost due to the extent of design specifications, site and contract preparation. In addition, site variances are typically the norm and not the exception which can wreak havoc with the best designs. Site variances can never be fully anticipated and typically lead to costly modifications. Experience has demonstrated that construction type contracts can cost over seven times that of equipment rental contracts and the results can be less than acceptable.

Table 2 provides examples of three projects: Trout Creek, which is approximately one river mile; Panther Creek, which is about 2/10ths of a river mile; and the Mine Reach, which totaled approximately 3 river miles. Looking at cost per river mile, there are some significant differences between the three projects. Trout Creek was the most expensive, because material access was limited to the project sites. Heavy helicopters were needed

Table 2. Project budgets: Trout Creek, Panther Creek and Mine Reach

Trout Creek 30208	Unit	Unit cost	Days/acres/logs	Cost	
Plan, design & NEPA	per acre	393	100	$39,300	
Excavator	per day	1300	16	$20,800	7.8125
Dozer	per day	820		$0	
Riparian thinning	per acre	900		$0	
Labor crew	per day	600	15	$9,000	
Planting	per acre	110	3	$330	
Helicopter	per log	333	125	$41,625	heavy helicopter $7,500/day
Log haul	per log	115	125	$14,375	$4.5/log/mile rootwads attached
Move in/out	in & out	8000	1	$8,000	
Materials	bulk	4000	1	$4,000	
Rig	per month	220	1	$220	
Total cost				$137,650	
Cost/rm	river mile	1.1		$137,650	
Panther Creek 30508	**Unit**	**Unit cost**	**Days/acres/logs**	**Cost**	
Plan, design & NEPA	per acre	393	10	$3,930	21833
Excavator	per day	1300	2.4	$3,120	12 sticks per day
Dozer	per day	820		$0	
Riparian thinning	per acre	900		$0	
Labor crew	per day	600	1	$600	
Planting	per acre	110	0.2	$22	
Helicopter	per log	333	0	$0	
Log haul	per log	115	28	$3,220	

Table 2. Project budgets: Trout Creek, Panther Creek and Mine Reach (cont'd.)

Panther Creek 30508	Unit	Unit cost	Days/acres/logs	Cost	
Move in/out	in & out	500	1	$500	
Materials	bulk	500	0.01	$5	
Rig	per month	220	0.05	$11	
Total cost				$7,478	
Cost/rm				$41,544	
Mine Reach 30408	**Unit**	**Unit cost**	**Days/acres/logs**	**Cost**	
Plan, design & NEPA	per acre	393	280	$36,680	
Excavator	per day	1300	50	$65,000	35 sticks per day
Dozer	per day	820	32	$26,240	skid 55 sticks/day
Riparian thinning	per acre	900	20	$18,000	88 trees/day
Labor crew	per day	600	10	$6,000	
Planting	per acre	110	250	$27,500	
Helicopter	per log	333	0	$0	
Log haul	per log	115	0	$0	
Move in/out	in & out	500	2	$1,000	
Materials	bulk	4000	1	$4,000	
Rig	per month	220	2	$440	
Total cost				$184,860	
Cost/rm	river miles	3		$61,620	

to stockpile logs near the project sites which were placed with an excavator. The helicopter could have been used to do the placement, but it would have raised the cost from $333 per log to over $1,100 per log. In contrast the Mine Reach restoration project utilized on-site materials acquired from second growth riparian stands of timber, which dramatically reduced project cost.

The NEPA analysis for many of the projects used as examples in this presentation were grouped to reduce costs and may not reflect typical cost for projects on a similar scale. Individually, any one of these projects

could have NEPA cost up to $60,000 or $110,000 per river mile.

LARGER SCALE COST ESTIMATES

Can we estimate river work on a watershed scale? On a watershed scale, it is definitely possible to estimate costs for river work. However, good stream survey data and watershed analysis or assessments are essential for prioritizing projects and estimating costs on a watershed scale. Without knowledge of existing watershed conditions and a sense of project priorities, cost estimates would be baseless and serve little utility.

Planning projects on the watershed level can lead to incremental cost savings relative to NEPA, consultation and design, as in the project examples discussed above. However, before projects are lumped into a single NEPA document for the sake of cost savings, considerable public outreach and forethought should go into the decision. For instance, restoration for three different streams that added up to about seven river miles was combined into one NEPA document which substantially reduced cost and increased efficiency. However, if one of the stream segments or a portion of the project was controversial and then appealed, it would have resulted in a delay of the other two projects. Therefore the cost savings of grouping projects should be weighed with the potential risk.

Can we estimate costs on Evolutionarily Significant Unit (ESU), state, or regional scales? This is less likely. Gross generalizations could be made to approximate restoration cost per region. However, the differences in limiting factors and treatment methods would differ radically from region to region and ESU to ESU. For instance, addressing limiting factors on the west side of the Cascade Mountains may predominantly involve culvert removals for fish passage, riparian and channel rehabilitation. Whereas on the east side of the Cascades, limiting factors associated with cattle grazing, irrigation diversions and sediment runoff from cultivation are addressed. Cost could be extrapolated from watersheds within each ESU. However, the cost range would be so large that cost estimation on an ESU or regional scale may be of little use or may over or underestimate the cost which would undoubtedly under serve the resource and potentially squander taxpayer money.

CONCLUSION

The best way to maintain confidence in cost estimates on large scales is to only make approximations at the fifth field watershed level or lower. This limits the area of interest to around 250,000 acres, where it is still possible to take into account the specific conditions in the watershed. In addition, it is important to have funding for the projects that will span several years, allowing time for project planning and environmental permitting. It is possible, however, that standardized costs estimated for large areas (watersheds and greater) may never be appropriate, and that working from the individual conditions at each restoration site may be the only way to develop reasonable estimates of project costs.

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