Dear Reader,

I am pleased to attach an electronic version of the Primer on Habitat Project Costs, a document created for the Puget Sound Shared Strategy by Evergreen Funding Consultants. The Primer is intended to help watershed leaders estimate the costs of habitat projects within their watersheds. Using simple techniques to translate project characteristics into likely cost ranges and to fine-tune estimates with secondary factors, the Primer provides an easy, consistent tool to estimate costs for habitat work in the watersheds and throughout the region.

The Primer is the result of dozens of interviews with restoration experts in the Puget Sound region, and we are very appreciative of all those that have contributed. The distillation of large quantities of information into an accurate, succinct, and easy-to-use publication has been a challenging task. We hope to continue to improve the Primer with future updates and would welcome comments on how to make the Primer as usable and as helpful to watershed planners as possible. Please send any comments or suggestions to Helena Wiley at hwiley@evergreenfc.com.

We hope that this product will help to further the goals of salmon recovery in Puget Sound.

Sincerely,

Jim Kramer, Executive Director
Puget Sound Shared Strategy

A Primer on Habitat Project Costs

SHARED STRATEGY
FOR PUGET SOUND
working with communities to restore salmon

Spring 2003

Prepared for the Puget Sound Shared Strategy
By Evergreen Funding Consultants

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Introduction

The purpose of this primer is to help watershed groups identify the costs of their salmon recovery strategies. Groups are currently working on plans to restore salmon populations in each of the 14 watersheds in the Puget Sound basin. As the plans are being assembled, they are becoming more specific in the actions proposed. A few of the plans have information on costs, but the methods used to compute costs vary widely. This primer is designed to give the groups working on these plans a simple, consistent tool to estimate costs.

Why worry about costs? In the next few years, attention will need to shift from planning to implementation of the salmon recovery strategies. Implementing the plans will be costly. Thinking about costs in the early stages of planning will ensure that (1) the plans are realistic about the costs and likelihood of funding for the recommended actions, and (2) funding sources are available when and where they are needed.

The primer focuses on a specific segment of the costs of salmon recovery: the capital costs of habitat acquisition and restoration projects. The cost estimates in the primer include construction, design, permitting, appraisal, basic monitoring (2 years), routine maintenance (2 years), reestablishing the site to prior conditions, and project management costs that are normally associated with implementing a capital project. More general administrative, enforcement, and long-term monitoring and maintenance costs are not included although they are likely to be warranted.

The primer was assembled by Evergreen Funding Consultants on contract to the Puget Sound Salmon Forum with funding provided through the National Fish and Wildlife Foundation. However, the real credit for the publication goes to the many habitat experts around Puget Sound who contributed their expertise on project costs. They are recognized individually in the Credits and Sources chapter.

HOW TO USE THE PRIMER:

The primer is designed to be used with draft watershed plans that have identified a number of projects to purchase and restore salmon habitat. It is best used to estimate the cost of a suite of restoration activities, and will be less accurate for individual projects.

1. The first step in using the primer is to divide the recommended projects from a watershed plan into the nine project categories used in the primer.

Many restoration projects will combine characteristics. For instance, a culvert replacement project may incorporate planting of the stream corridor upstream and downstream of the culvert. Projects with multiple characteristics should be costed based on the predominant restoration action. If there is more than one predominant action, the projects should be categorized and costed by their most expensive feature according to the following list.

LEAST EXPENSIVE	Fencing
	Riparian Planting
	Culvert Improvements
	Large Woody Debris/Engineered Log Jams
	Streambank Improvements
	Nearshore Restoration
	Floodplain Restoration
MOST EXPENSIVE	Estuary Restoration

Projects that combine acquisition and restoration should have each estimated separately and the totals combined.

2. The second step involves costing out categories of projects using the relevant primer chapter. Each chapter has the following information:

- A description of the project type;
- A level of cost predictability;
- The range in costs for the project type;
- The Most Important Factors used for calculating costs for the project type;
- A Calculating Costs table used to estimate cost ranges for projects with different characteristics;
- Other Important Factors used to fine-tune costs within estimated ranges;
- An example project to illustrate how the model is used;
- Sample restoration and land acquisition projects from around Puget Sound; and
- Sources for further information.

3. The last step is to combine the costs within each category with the costs of projects in other categories to get the overall cost of the proposed plan.

HOW NOT TO USE THE PRIMER:

The primer should not be used to calculate costs for individual projects, as a substitute for other costing methods such as estimates by engineers or land appraisers, or to determine the feasibility of projects. The primer is not intended to evaluate the appropriateness or feasibility of restoration actions.

ON FINE-TUNING AND COSTS ABOVE OR BELOW THE RANGES:

The tables in each chapter address the likely cost ranges for average project conditions. Fine-tuning factors can be used to determine whether the project in question is at the high or low end of the cost range. The "costs above or below range" information addresses projects that have costs that are so high or low that they should not be predicted using the methods described in the primer.

ON PRECISION AND ACCURACY:

A few types of habitat projects, like riparian planting and fencing projects, have been in wide use for years and have few variables that affect costs. These conditions result in greater predictability and precision in estimating costs. Other types, such as major floodplain and estuary restoration projects, are more experimental in nature and variable in characteristics, with costs that are much more difficult to predict. To account for differences in precision, the primer indicates the level of predictability for each category. Pay attention to this, and treat the results accordingly.

Because of the variability in the precision of the estimates and the inherent difficulty of generalizing about the costs of widely differing projects, there are bound to be cases where the cost estimates appear to be slightly off or even entirely wrong. Please keep track of these and let the authors know about them so that the next version of the primer is more accurate.

Thank you.

Dennis Canty, *President*
Neelima Shah, *Project Manager*
Helena Wiley, *Researcher and Writer*
Kim Engie, *Researcher and Writer*
EVERGREEN FUNDING CONSULTANTS

Land Acquisition

PROJECT DESCRIPTION:

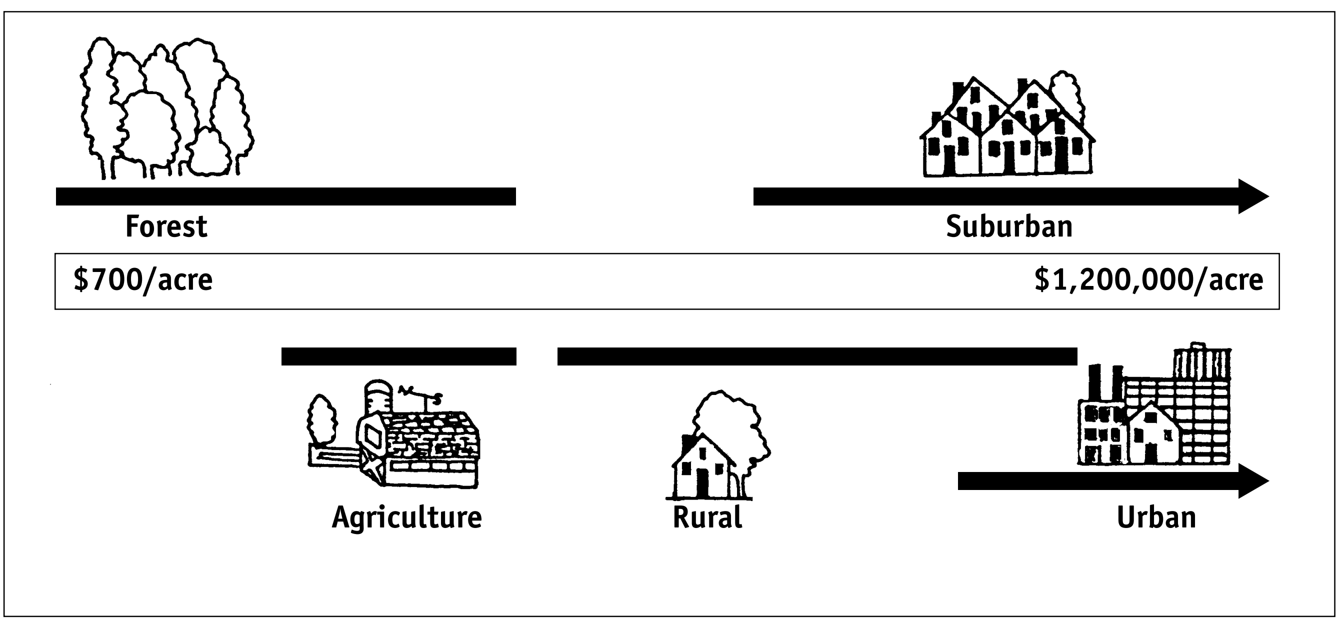
One of the most effective ways to protect high quality habitat is to purchase it. Land acquisition is a widely used tool for salmon conservation. In addition, acquisition is often the first step in major restoration projects used to secure the land for future improvements. Acquisition includes the outright purchase of property, known as fee-simple acquisition, and the purchase of specific rights to the property through a conservation easement. A cost estimating tool for conservation easements is included at the end of this section.

PREDICTABILITY OF COSTS:

Fair to Good. There is wide agreement among experts on the importance of development potential and the "highest and best use" of land in defining value. Rural land in large parcels is thought to be much more predictable than small urban and suburban lots that vary widely in cost.

COST RANGE:

Costs are given per acre. All the cost ranges in this section include appraisal, closing, commission, surveying, legal, and project management costs. Use the steps in this section to calculate an estimated cost in the following range. **COSTS ABOVE OR BELOW RANGE:** Highly sought after shoreline properties with lot sizes less than 1/2 an acre; timber value; parcels with functioning buildings (those likely to have an appreciable value).

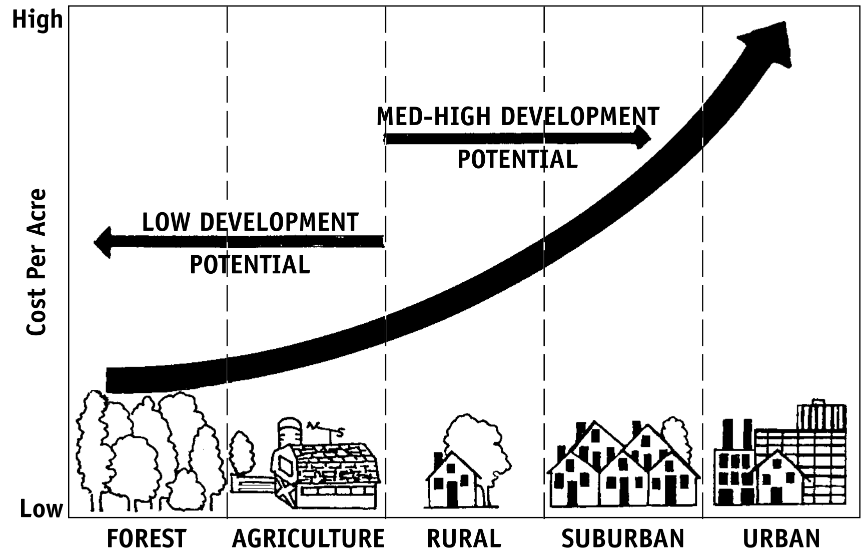


Timber Value The value of timber has a significant impact on the cost of land parcels. However, timber values are unpredictable and vary based on many site-specific factors. The value of timber on land parcels should be costed on a site-specific basis.

A. MOST IMPORTANT FACTOR: DEVELOPMENT POTENTIAL

Even though most parcels purchased for habitat conservation will never be developed, the cost of prospective acquisitions will be determined first and foremost by their potential for development. Parcels available for residential and commercial use are worth substantially more than those that have development restricted due to zoning or other regulations. Even among parcels that are available for residential and commercial use, there are substantial differences in the cost of land acquisition due to the intensity of use, with urban lots worth substantially more than rural residential parcels. Zoning is the simplest indicator of development potential and has a substantial impact on the cost of acquisition.

IMPACT OF ZONING ON COSTS



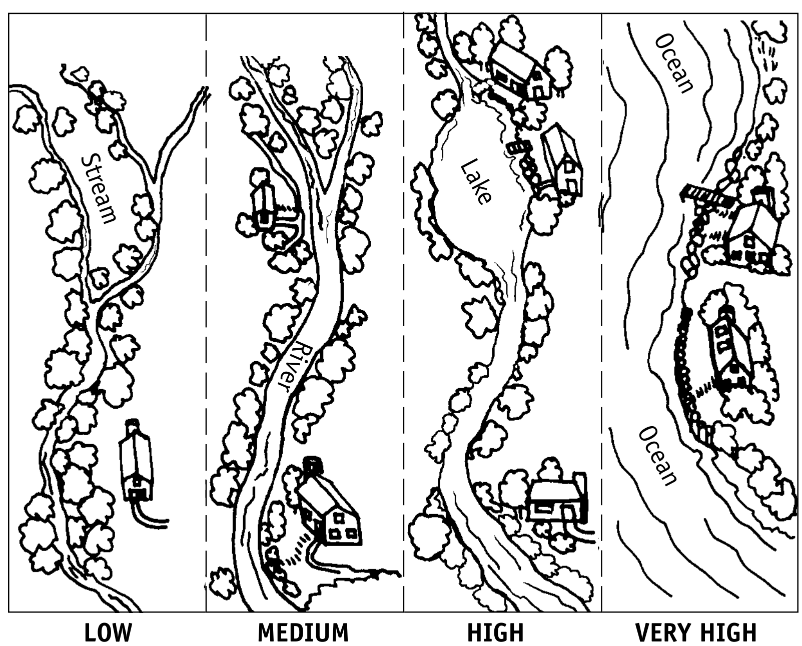
For other factors impacting the cost of parcels with medium-high development potential, go to **Step B.**
For factors impacting the cost of parcels with low development potential, skip to **Step C.**

B. PARCELS WITH MEDIUM-HIGH DEVELOPMENT POTENTIAL

B1. OTHER IMPORTANT FACTOR: AMENITY VALUE

Among developable parcels, waterfront property commands a premium in the marketplace. The extent of that premium is based on amenity value, with parcels bordering a small creek having a smaller premium than those on attractive lakes or Puget Sound shorelines. At the extreme are lots on highly sought-after shorelines like Lake Washington or San Juan Islands waterfront, many of which are so valuable and highly variable in cost that they are not estimated in this primer.

AMENITY VALUE



Exception: *Industrial estuaries with riverfront or marine access have medium amenity values because industrial use decreases the value.*

B2. CALCULATING COST FOR PARCELS WITH MEDIUM-HIGH DEVELOPMENT POTENTIAL:

Use the following table to calculate a cost range based on the amenity value and the zoning.

COST OF PARCELS: MEDIUM-HIGH DEVELOPMENT POTENTIAL ($/acre)

		AMENITY VALUE			
		LOW	**MEDIUM**	**HIGH**	**VERY HIGH**
ZONING	**RURAL RESIDENTIAL**	$5,000-$35,000	$24,000-$60,000	$60,000-$300,000	$300,000-$1,200,000
	SUBURBAN RESIDENTIAL	$60,000-$120,000	$120,000-$240,000	$300,000-$600,000	Unpredictable
	URBAN	$300,000-$600,000	$600,000-$1,200,000	Unpredictable	Unpredictable

NOTE: *Know of a project that does not fit these ranges? Please contact the authors with examples to improve future updates of the primer.*

B3. FINE TUNING COSTS FOR MEDIUM-HIGH DEVELOPMENT POTENTIAL PARCELS: LEVEL OF IMPROVEMENTS, PROXIMITY TO URBAN AREAS, AND SENSITIVE AREAS

Use the fine-tuning factors below to narrow the estimated cost range from the table above. Fine-tuning factors will push the cost up or down within the range determined above. The fine-tuning graphs can be used in combination: for example, if one indicates a high cost in the range and another indicates a low cost, estimate a cost that fits in the middle of the range.

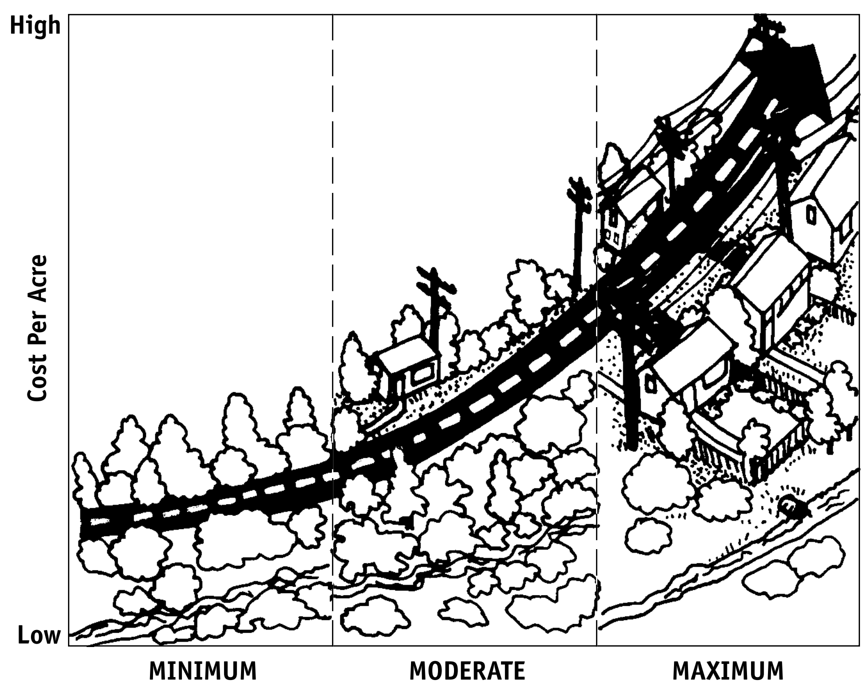
LEVEL OF IMPROVEMENTS/ACCESS

The level of improvements on a parcel will have a substantial impact on cost. Parcels with good road access and all utilities in place will be worth more than unimproved parcels with difficult access.

PROXIMITY TO URBAN AREAS

For rural residential parcels, proximity to the Tacoma/Seattle/Bellevue/Everett urban growth areas can have a major impact on value (see www.ocd.wa.gov/info/lgd/growth/maps/map_uga.tpl). Costs will be at the high end of the range for parcels within 10 miles of a metropolitan area, in the middle of the range for parcels 11-30 miles away, and at the low end of the range for parcels more than 30 miles from a metropolitan area.

IMPACT OF LEVEL OF IMPROVEMENT/ACCESS ON COSTS



SENSITIVE AREAS

The presence of sensitive areas such as wetlands, floodplains, or steep slopes will generally lower the value of a parcel due to the restriction these areas place on development potential. Where sensitive areas decrease the number of houses allowed on a parcel or make access and utility service very difficult, they can substantially reduce the value of the affected parcels. Parcels with minimal sensitive area coverage will cost more than parcels with substantial sensitive areas. For costing purposes, parcels with minimal sensitive areas (able to achieve at least 80% of the zoned density with simple access and utility service) will be at the high end of the range, those moderately affected by sensitive areas (able to achieve 50-80% of zoned density and/or with complicated access and utility service) will be in the middle of the range, and those with substantial sensitive areas (able to achieve less than 50% of the zoned density or with very difficult access or utility service) will be at the low end of the range.

C. PARCELS WITH LOW DEVELOPMENT POTENTIAL

C1. IMPORTANT FACTOR: PROXIMITY TO URBAN AREA

As with rural residential properties, agricultural and forest parcels vary in costs substantially based on their proximity to the Tacoma/Seattle/Bellevue/Everett urban growth area.

C2. CALCULATING COSTS FOR PARCELS WITH LOW DEVELOPMENT POTENTIAL

Use the following table to calculate a cost range per acre based on the distance from an urban area and zoning.

COST OF UNDEVELOPABLE LAND ($/acre)

PROXIMITY TO URBAN AREA	ZONING	
	FOREST	**AGRICULTURAL**
FAR 41+ MILES	$700-$1,800	$1,800-$2,400
MEDIUM 21-40 MILES	$1,800-$2,400	$2,400-$3,600
NEAR 0-20 MILES	$2,400-$4,800	$3,600-$4,800

NOTE: *Know of a project that does not fit these ranges? Please contact the authors with examples to improve future updates of the primer.*

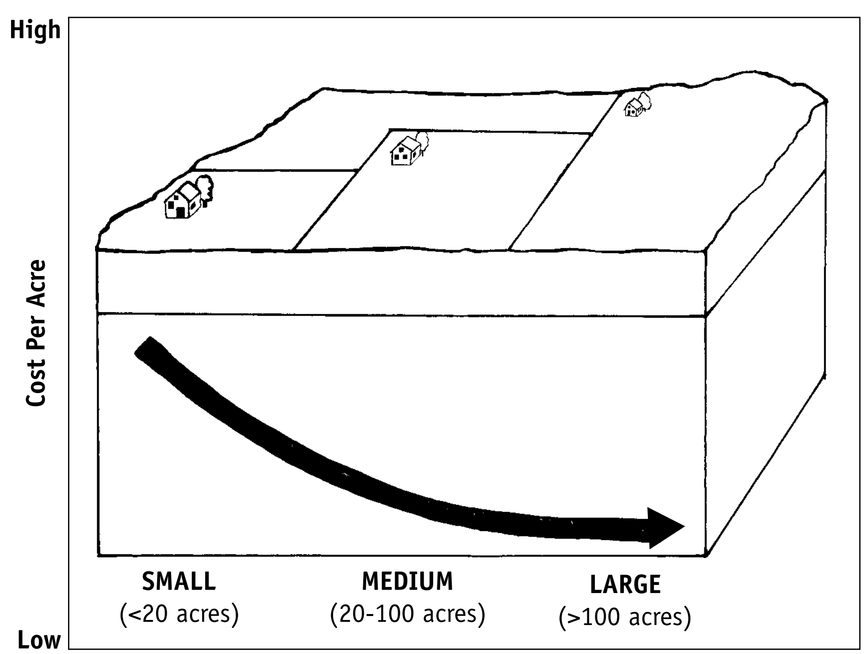
C3. FINE TUNING FOR LOW DEVELOPMENT POTENTIAL PARCELS:

PARCEL SIZE

Use the fine-tuning factor below to narrow the estimated cost range from the table above. The fine-tuning factor will push the cost up or down within the range determined above.

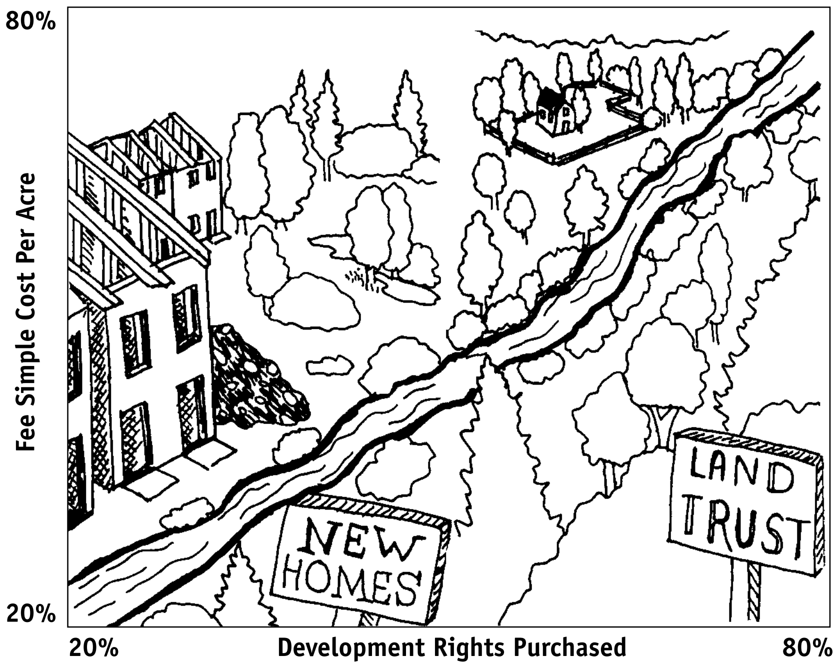
As the graph indicates, the per-acre cost of agricultural and forest land decreases dramatically with increasing parcel sizes. It may even be necessary, with parcels greater than 100 acres, to reduce the per-acre cost below the minimum in the appropriate range to reflect this substantial economy of scale.

IMPACT OF PARCEL SIZE ON COSTS



CONSERVATION EASEMENTS

COST OF CONSERVATION EASEMENTS



CONSERVATION EASEMENTS FOR MEDIUM-HIGH DEVELOPMENT POTENTIAL PARCELS:

For medium-high development potential parcels, the majority of land value is associated with the development potential of the parcel. Conservation easements tend to reduce the development potential within the area of the easement. In cases where an easement is purchased on part of a larger parcel, it may even decrease the development potential of the remaining unencumbered portion of the parcel. The cost of a conservation easement is usually directly proportional to the development rights purchased with the easement. Easements that have little impact on development potential often have low costs and those with major impacts can cost nearly as much as a fee simple purchase. Put another way,

<u>The cost of an easement equals the fee simple value of the property times the percentage of development rights purchased.*</u>

*In cases where the easement is for a portion of a lot, the percentage of development rights purchased should be calculated for the lot as a whole.

CONSERVATION EASEMENTS ON LOW DEVELOPMENT POTENTIAL PARCELS

On parcels with low development potential, the cost of a conservation easement is based primarily on the rights to farming and timber. Since the primer does not include a cost estimate for timber rights, the cost of conservation easements on low development potential parcels cannot be estimated using this tool.

SAMPLE PROJECTS

from around Puget Sound

SKAGIT CONSERVATION DISTRICT
Johnson Acquisition

Project involves the acquisition of 46 acres of stream front and floodplain land. The current use of the property includes cattle and lumber production. The property is 40 miles outside of Everett.
Acquisition Cost: $115,200 ($2,500/acre)

JAMESTOWN S'KLALLAM TRIBE
Jimmycomelately Acquisition

Project involves the acquisition of 5.7 acres of rural stream front property outside of Port Angeles. Property is being acquired in order to relocate stream to its natural historic floodplain.
Acquisition Cost: $157,000 ($27,543/acre)

TULALIP TRIBE
Qwuloolt Estuary

Project involves acquisition of 34 acres of suburban stream front property in the City of Marysville. The property, bisected by Allen's Creek in the Qwuloolt Estuary, is a critical piece in restoring an intertidal estuary. The site is accessible by a paved road.
Acquisition Cost: $2,200,000 ($64,700/acre)

KING COUNTY DNR AND PARKS
Site 1 Duwamish

Project involves the acquisition of 3.2 acres of urban land in Duwamish River Estuary. This industrial estuary located in the city of Seattle has been used for heavy industrial development, including concrete, glass, steel, and lumber factories.
Acquisition Cost: $1,726,000 ($539,375/acre)

EXAMPLE USING THE MODEL:

A watershed plan prioritizes acquisition of 2 parcels of land, 60 acres of forest and 80 acres of farmland along a mainstem river in Whatcom County.

Development Potential: Low (forest and agricultural)
Proximity to Urban Area: Far
Cost Range: $700-$1,800/acre (forest) and $1,800-$2,400 (agricultural)
Parcel Size: Medium
Adjusted Cost Range: $1,000-$1,500/acre (forest) and $2,000-$2,200/acre (agricultural)
Watershed Cost: $60,000-$90,000 (forest) and $144,000-$176,000 (agricultural)

ADDITIONAL RESOURCES:

Washington Environmental Council **http://www.wecprotects.org**

Cascade Land Conservancy **http://www.cascadeland.org**

The San Juan Preservation Trust **http://www.sjpt.org**

The Nature Conservancy **http://nature.org**

Land Trust Alliance **http://www.lta.org**

Fencing

PROJECT DESCRIPTION:

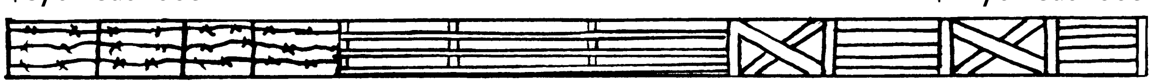
Fencing projects are commonly used to reduce livestock access to streams in agricultural areas. This chapter addresses projects in which fencing is the primary or only component. Fencing is a frequent element of other projects, but those projects should be costed-out using the chapters pertaining to their predominant or most expensive features.

PREDICTABILITY OF COSTS:

Excellent. Fencing projects are common and experts generally agree about the ranges in project costs and the factors that make projects more or less expensive.

COST RANGE:

Costs range from $3 to $12 per lineal foot. All the cost ranges in this section include construction, design, permitting, routine maintenance, reestablishing the site to prior conditions, and project management costs. More general administrative, enforcement, and long-term maintenance costs are not included. Use the steps in this section to calculate an estimated cost in the range.



A. MOST IMPORTANT FACTOR: MATERIALS

As illustrated in the graph and key below, the cost of materials is the most important factor in determining the cost of fencing projects.

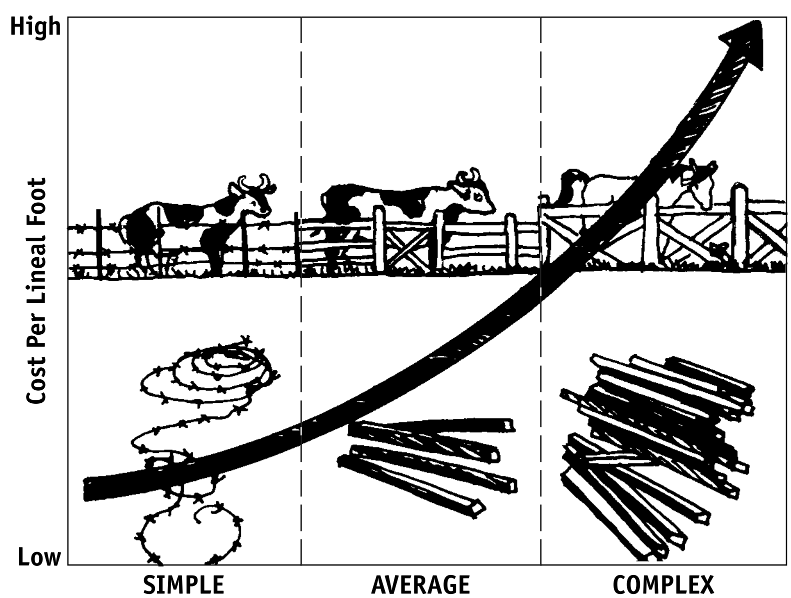
MATERIALS KEY:

SIMPLE = Barb or hog wire, no gates, few posts.

AVERAGE = Livestock fence, metal, wood corners, few gates, moderate number of posts.

COMPLEX = Split rail, primarily wood, multiple gates, many posts.

IMPACT OF MATERIALS ON COSTS



B. CALCULATING COSTS

Use the table below to estimate the costs of a fencing project based on the type of materials used.

COST OF FENCING PROJECTS ($/lineal foot)

MATERIALS	COST RANGE
SIMPLE	$1-4
AVERAGE	$5-8
COMPLEX	$9-12

NOTE: *Know of a project that does not fit these ranges? Please contact the authors with examples to improve future updates of the primer.*

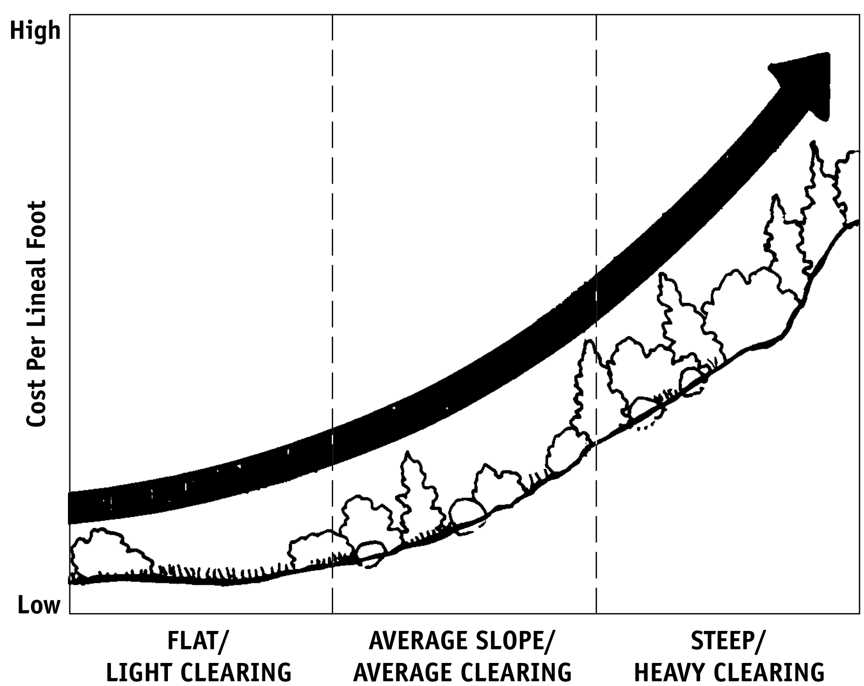
C. FINE TUNING: SITE PREPARATION AND LABOR

Use the fine-tuning factors below to narrow the estimated cost range from the table above. Fine-tuning factors will push the cost up or down within the range determined above. The fine-tuning graphs can be used in combination: for example, if one indicates a high cost in the range and another indicates a low cost, estimate a cost that fits in the middle of the range.

SITE PREPARATION

Higher site preparation costs result from having to clear vegetation from the fenceline and work on sloping land. Costs on flat pastureland will tend to be low.

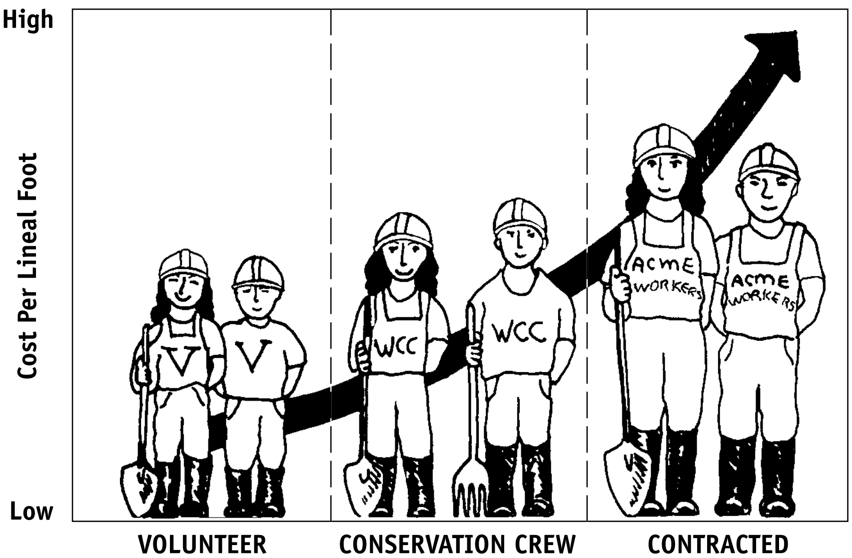
IMPACT OF SITE PREPARATION ON COSTS



LABOR

Because fencing projects rely heavily on manual labor, the costs of the labor force are a crucial consideration in overall project costs. The graph below indicates the three tiers of labor costs: those associated with volunteer labor, conservation corps crews, and agency or contracted crews, the most expensive alternative.

IMPACT OF LABOR ON COSTS



SAMPLE PROJECTS

from around Puget Sound

SKAGIT CONSERVATION DISTRICT
Wayne Johnson Restoration

Project includes 1,000 linear feet of barbwire fencing with H treated wooden posts. The area is currently used for lumber and cattle production.
Project Cost: $3,000 ($3/linear foot)

COWLITZ COUNTY
Abernathy Creek Riparian Restoration

Project includes 5,000 linear feet of wire fence and posts. Fencing along the creek will reduce further livestock disturbance.
Project Cost: $7,500 ($1.50/linear foot)

EXAMPLE USING THE MODEL:

A watershed plan identifies a need to install fencing along 3 different sections of a stream totaling 6,000 feet. The fences for these projects are built with barbwire, have wooden corner posts, metal line posts, and no top rail. The sites are fairly straight and the fence has only a few posts and gates. The sites are on an open field and do not require much site preparation. The Washington Conservation Crew is hired to build the fences and equipment is donated.

Materials: Average
Cost Range: $5-$8/lineal foot
Site Preparation: Flat/Light Clearing
Adjusted Matrix Cost Range: $5-$7/lineal foot
Labor: Conservation Crew
Adjusted Matrix Cost: $6/lineal foot
Watershed Cost (6,000 feet): $18,000

ADDITIONAL RESOURCES:

Washington State University Cooperative Extension **http://wawater.wsu.edu**

Washington Department of Fish and Wildlife **http://www.wa.gov/wdfw**

Washington Wildlife and Recreation Coalition **http://www.wildliferecreation.org**

Earthcorps **http://www.earthcorps.org/home/default.asp**

Riparian Planting

PROJECT DESCRIPTION:

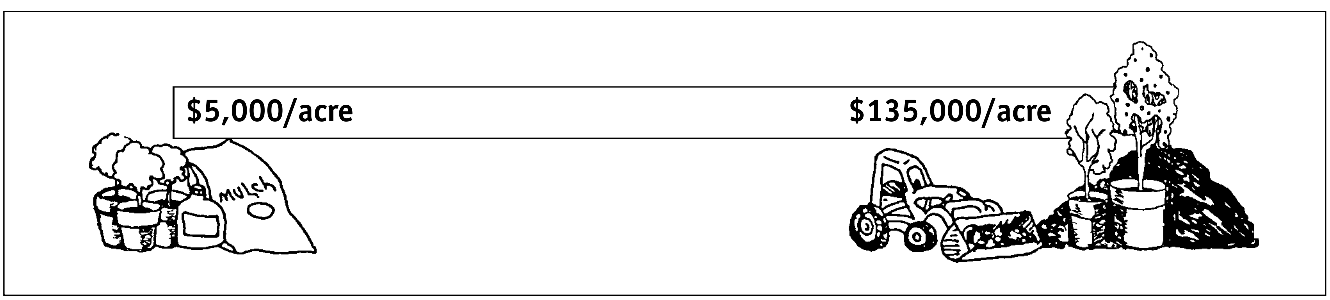
One of the most common habitat problems in the Puget Sound basin is the loss of the streamside and nearshore forests that bordered most rivers, streams, and coastlines before the settlement of this region. In response, many agencies and community groups have sponsored projects to plant trees and shrubs in upland riparian areas. This chapter addresses the costs of freestanding planting projects. Planting as a component of other restoration activities is included in the cost ranges for those projects in other sections of this primer.

PREDICTABILITY OF COSTS:

Very Good to Excellent. Riparian planting projects are common and relatively simple. Experts generally agree about the ranges in project costs and the factors that make projects more or less expensive.

COST RANGE:

Riparian planting project costs range from \$5,000 to \$135,000 per acre. All the cost ranges in this section include construction, design, permitting, basic monitoring (2 years), routine maintenance (2 years), reestablishing the site to prior conditions, and project management costs that are normally associated with implementing a capital project. More general administrative, enforcement, and long-term maintenance costs are not included. Use the steps in this section to calculate an estimated cost in the range. **COSTS ABOVE OR BELOW RANGE: Above:** Urban "landscaping" projects requiring mature trees and shrubs and intensive maintenance; **Below:** Seeding or hydro-seeding with native plant mix.



ESTIMATING ACREAGE

1 mile x 50 foot buffer = 6 acres (100% planted)
1 mile x 50 foot buffer = 1.8 acres (30% planted)

1 mile x 150 foot buffer = 18.2 acres (100% planted)
1 mile x 150 foot buffer = 5.5 acres (30% planted)

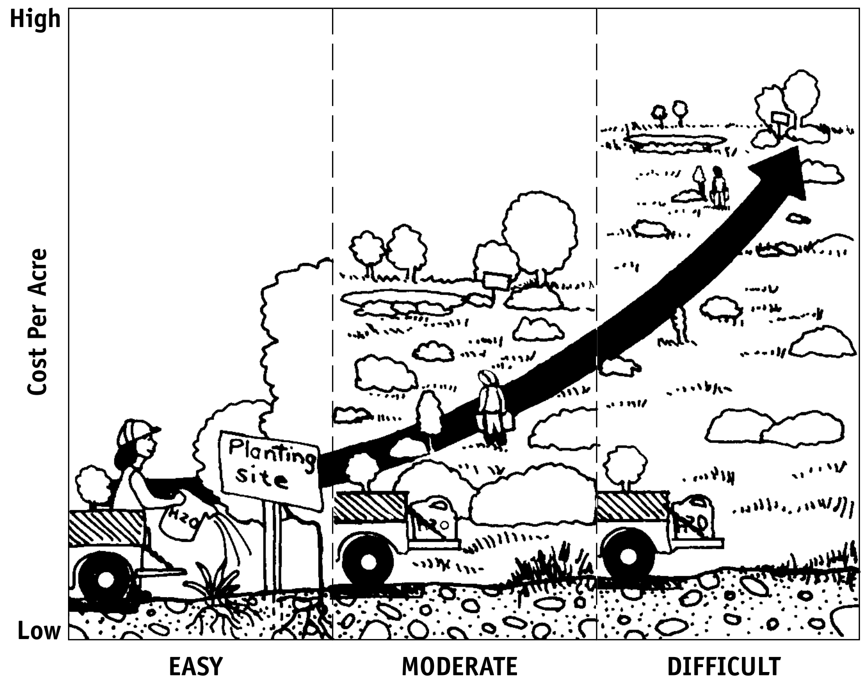
For planting along streams, double the acreage when both sides of the stream are planted.

A. MOST IMPORTANT FACTORS: SITE ACCESSIBILITY, MATERIALS AND SITE PREPARATION

SITE ACCESSIBILITY

Many planting sites are far from roads, and getting materials and planting crews to the site can add substantially to costs. After the planting project, poor access can also greatly increase the costs of maintenance. The graph illustrates the effect of accessibility on costs.

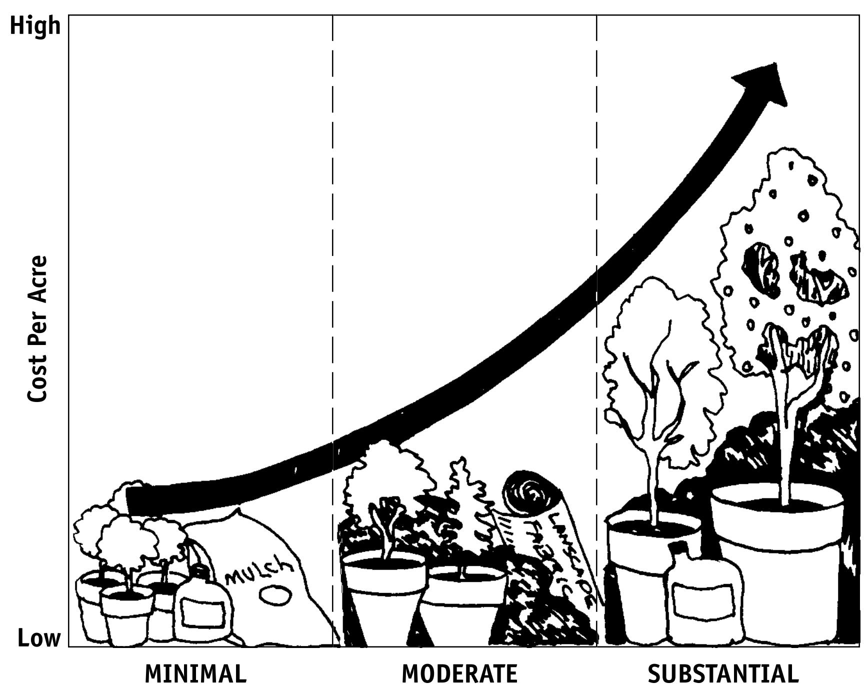
IMPACT OF SITE ACCESSIBILITY ON COSTS



MATERIALS

Materials for planting projects often come from the same commercial firms that supply plants for residential landscaping, and costs can vary greatly with the size and maturity of plants, the use of mulch and weedblock materials, and, after installation, the materials used to replant. It is also quite common for some materials to be donated or salvaged from construction sites, resulting in a substantial savings in total project costs.

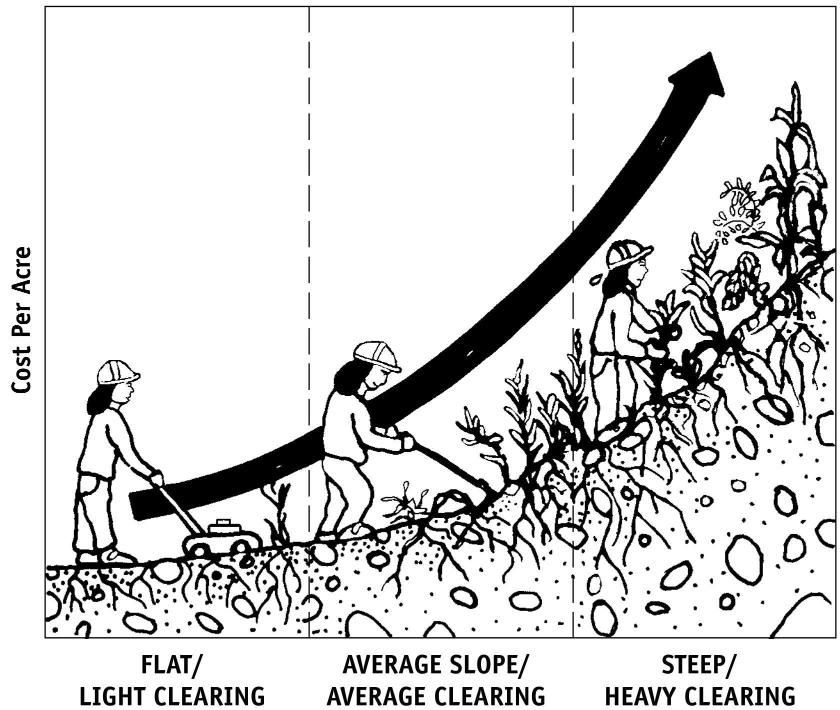
IMPACT OF MATERIALS ON COSTS



SITE PREPARATION

Many planting projects require clearing and grading work to prepare the site for planting. In the most costly scenario, the presence of invasive species such as blackberry, knotweed, and reed canary grass in steep gradient areas can result in total project costs that are double or triple those of projects on minimal gradient sites without invasive species.

IMPACT OF SITE PREPARATION ON COSTS



B. CALCULATING COSTS FOR RIPARIAN PLANTING PROJECTS:

First, use the following table to estimate the influence of materials and site accessibility on the cost of riparian planting projects.

IMPACT OF SITE ACCESSIBILITY AND MATERIALS ON COSTS

		SITE ACCESSIBILITY		
		EASY Easily accessible by vehicle, water source available	**MODERATE** Site partially accessible by vehicle	**DIFFICULT** Very limited access, no vehicle access
MATERIALS	**MINIMAL:** Bare Roots; *Weed block:* mulch, cardboard or none; Most materials donated.	Low Cost	Medium Cost	Medium Cost
MATERIALS	**MODERATE:** 1-5 gallon size plants; *Weed block:* landscape fabric, mulch; Combination of donated & purchased materials.	Low Cost	Medium Cost	High Cost
MATERIALS	**SUBSTANTIAL:** 5 gallon and greater size plants; *Weed block:* landscape fabric and mulch; Majority of materials purchased.	Medium Cost	Medium Cost	High Cost

Next, use the following table to identify a cost range based on site accessibility and materials (low, medium, high cost) established in the previous step and the level of site preparation shown below.

COST OF RIPARIAN PLANTING PROJECTS ($/acre)

		LEVEL OF SITE PREPARATION		
		FLAT/ LIGHT CLEARING	**AVERAGE SLOPE/ AVERAGE CLEARING**	**STEEP/ HEAVY CLEARING**
MATERIALS/SITE ACCESSIBILITY	**LOW COST**	$5,000-$25,000	$20,000-$50,000	$60,000-$100,000
	MEDIUM COST	$10,000-$35,000	$45,000-$65,000	$70,000-$120,000
	HIGH COST	$30,000-$50,000	$55,000-$80,000	$100,000-$135,000

NOTE: *Know of a project that does not fit these ranges? Please contact the authors with examples to improve future updates of the primer.*

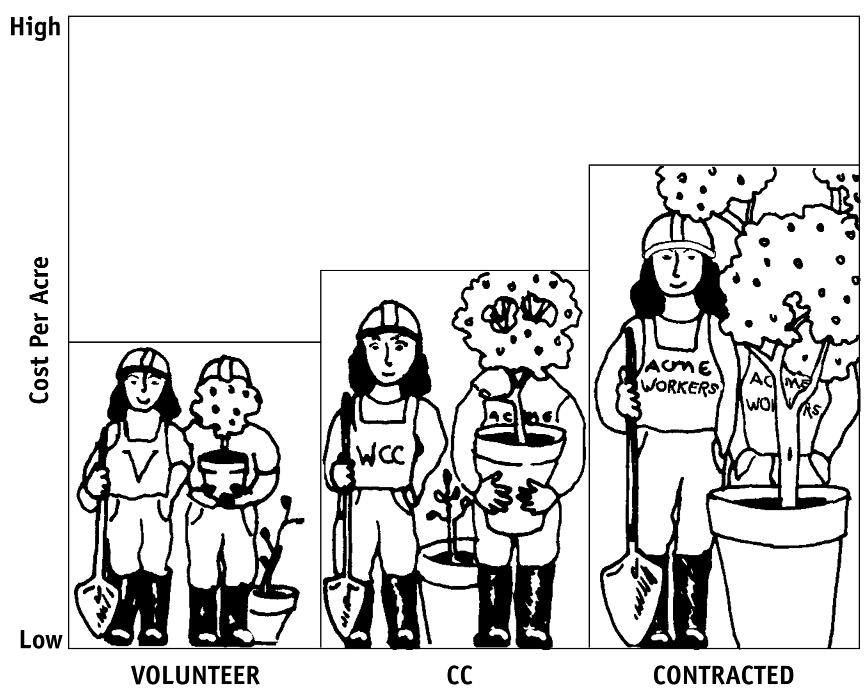
C. FINE TUNING COSTS ON PLANTING PROJECTS: LABOR, DESIGN/PERMITS, AND MAINTENANCE

Use the fine-tuning factors below to narrow the estimated cost range from the table above. Fine-tuning factors will push the cost up or down within the range determined above. The fine-tuning graphs can be used in combination: for example, if one indicates a high cost in the range and another indicates a low cost, estimate a cost that fits in the middle of the range.

LABOR

Being among the simplest restoration projects, planting projects lend themselves to less skilled labor, including the use of volunteers and conservation corps crews. Because planting requires a great deal of manual work, use of these labor sources can dramatically decrease the cost of a project. The graph indicates the difference in costs among projects done by volunteers, by conservation corps crews, and by agency staff or contractors - the most expensive option.

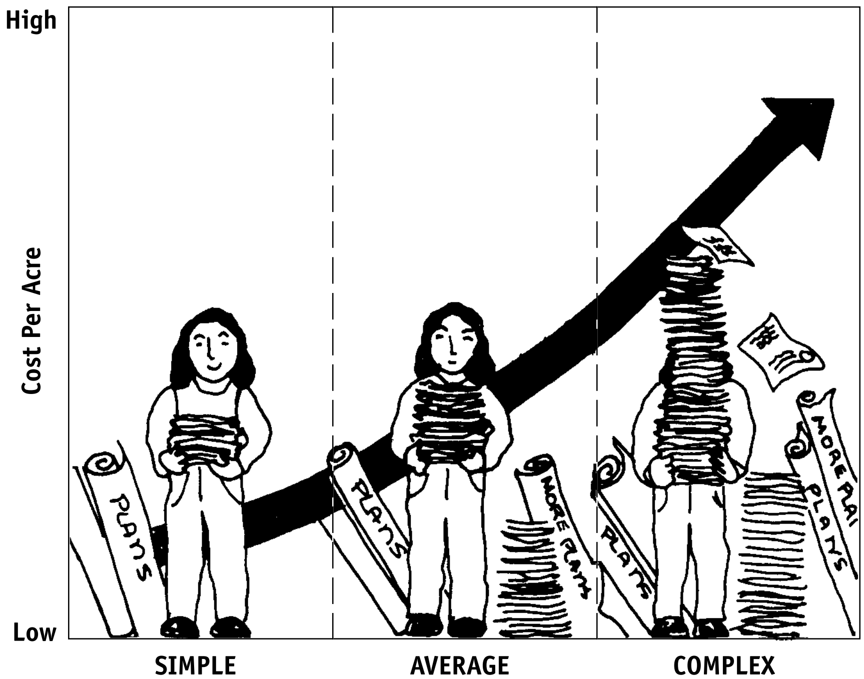
IMPACT OF LABOR ON COSTS



DESIGN/PERMITTING

Occasionally, riparian planting projects will need detailed planting plans for permitting or funding proposals. The addition of professional fees or staff costs to develop planting plans can substantially increase overall project costs.

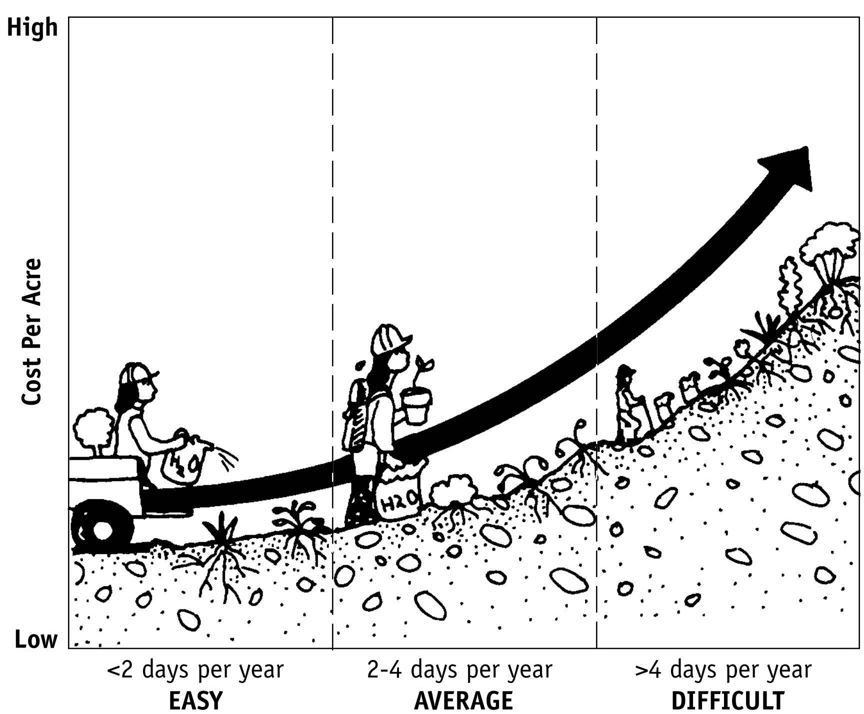
IMPACT OF DESIGN/PERMITTING ON COSTS



MAINTENANCE

All the cost ranges in this section include 2 years of maintenance (some replacement of plants and periodic weeding and watering). Maintenance costs will vary with greater frequency of maintenance, lower plant survival, and the level of difficulty in getting water to the planting site. Longer term maintenance will probably be needed, but costs vary widely and are therefore not predicted.

IMPACT OF MAINTENANCE ON COSTS



EXAMPLE USING THE MODEL:

A watershed plan identifies a need for riparian planting on 4 different streams totaling 6 acres of stream bank. Each project requires removing extensive amounts of reed canary grass and blackberries on a steep gradient, requiring a significant amount of handwork. The site is inaccessible by tractor. Bare root conifers are used - some donated and some purchased. Most of the work is done by the Washington Conservation Crew. There are minimal permit requirements and simple planting plans are used. Maintenance occurs 2-3 times per year.

Site Accessibility: Difficult
Materials: Minimal
Site Preparation: Steep/Heavy Clearing
Cost Range: $70,000-$120,000/acre
Labor: Conservation Crew
Design/Permitting: Simple
Maintenance: Average
Adjusted Cost Range: $90,000/acre
Watershed Cost (6 acres): $540,000

ADDITIONAL RESOURCES:

Washington State University Cooperative Extension **http://wawater.wsu.edu**

Washington Department of Fish and Wildlife **http://www.wa.gov/wdfw**

Washington Wildlife and Recreation Coalition **http://www.wildliferecreation.org**

Puget Sound Water Quality Action Team **http://www.wa.gov/pswqat**

Washington Native Plant Society **http://www.wnps.org**

Earthcorps **http://www.earthcorps.org**

SAMPLE PROJECTS

from around Puget Sound

ASOTIN CONSERVATION DISTRICT
Asotin Creek Riparian Tree Propagation

The goal of this project is to reduce water temperature in the Asotin Creek Watershed over the next 10 years. Project involves planting of conifers on 10-foot centers and riparian trees on 6-foot centers.
Project Cost: $29,900/acre

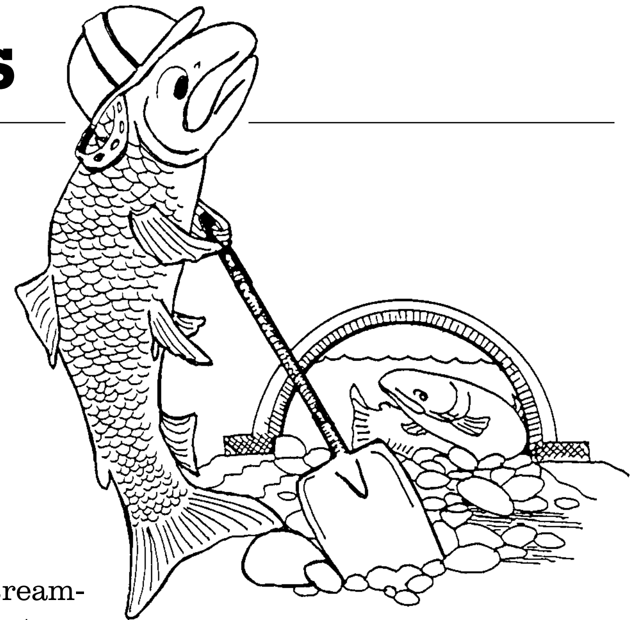
SOUTH PARK HABITAT FOR HUMANITY WETLANDS

The project involves restoration of wetlands in an industrial area involving heavy clearing and small, low cost materials.
Project Cost: $100,000/acre

COUGAR MOUNTAIN CONIFER UNDERPLANTING

The project involves planting of bare root conifers with minimal invasive removal and site preparation, and easy site accessibility.
Project Cost: $6,000/acre

Culvert Improvements



PROJECT DESCRIPTION:

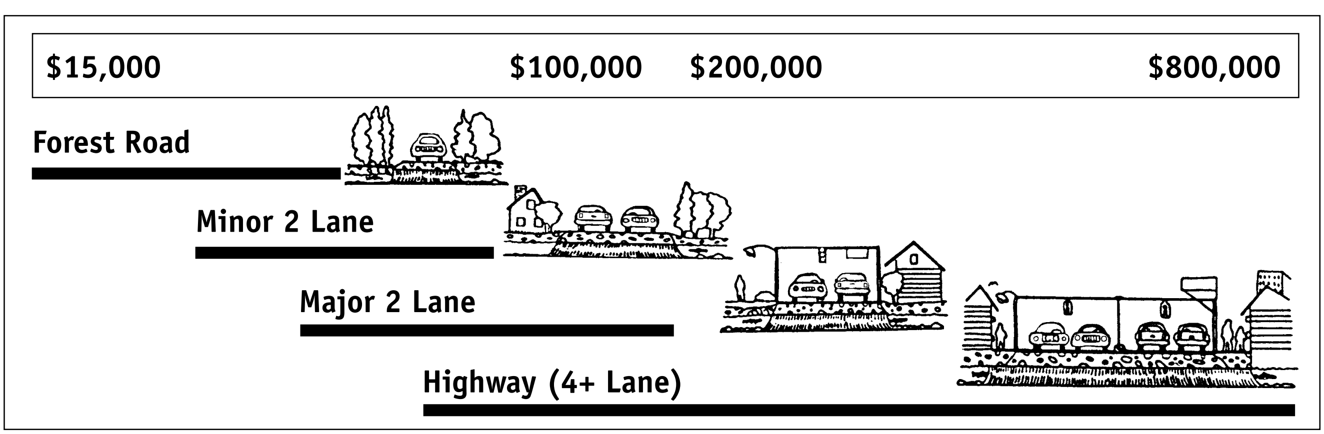
One of the most common types of restoration projects is the replacement of culverts. Culverts are used to allow streams to pass under roadways. Many culverts on Puget Sound streams were installed decades ago when lower streamflows and less concern about fish passage led to the use of smaller culverts than are the current standard. Additionally, many culverts have caused stream erosion at their downstream ends, resulting in them being perched above the current streambed. These small culverts impede upstream and downstream salmon migration and restrict salmon use in otherwise promising habitat areas. The typical culvert project replaces the undersized culvert with a culvert of larger diameter and rebuilds the road segment over the culvert. Depending on the complexity of the project, upstream and downstream channel habitat may need to be restored, and traffic may need to be routed around the culvert during construction.

PREDICTABILITY OF COSTS:

Very Good to Excellent. Experts generally agree about the main cost factors that make culvert improvement projects more or less expensive, and there are many examples of culvert replacement projects on which to base cost estimates.

COST RANGE:

Costs are given for total projects. All the cost ranges in this section include construction, design, permitting, basic monitoring (2 years), routine maintenance (2 years), reestablishing the site to prior conditions, and project management costs that are normally associated with implementing a capital project. More general administrative, enforcement, and long-term maintenance costs are not included. Use the steps in this section to calculate an estimated cost in the following range. **COSTS ABOVE OR BELOW RANGE: Above:** Projects on Interstate highways in metropolitan areas. **Below:** Removals without any replacement on roads to be decommissioned.

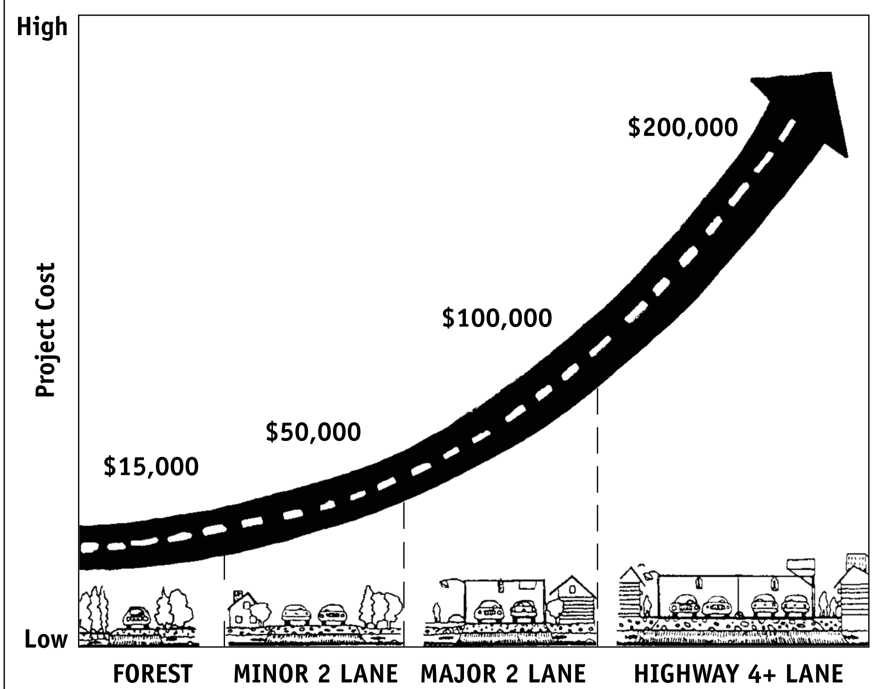


A. MOST IMPORTANT COST FACTORS: TYPE OF ROAD AND SIZE OF WATERWAY

TYPE OF ROAD

Larger roads require larger and more substantial culverts. Design, engineering, and permitting costs also tend to be greater with culvert projects on highways and major arterials. The graphic illustrates the effect of road type on total culvert project costs.

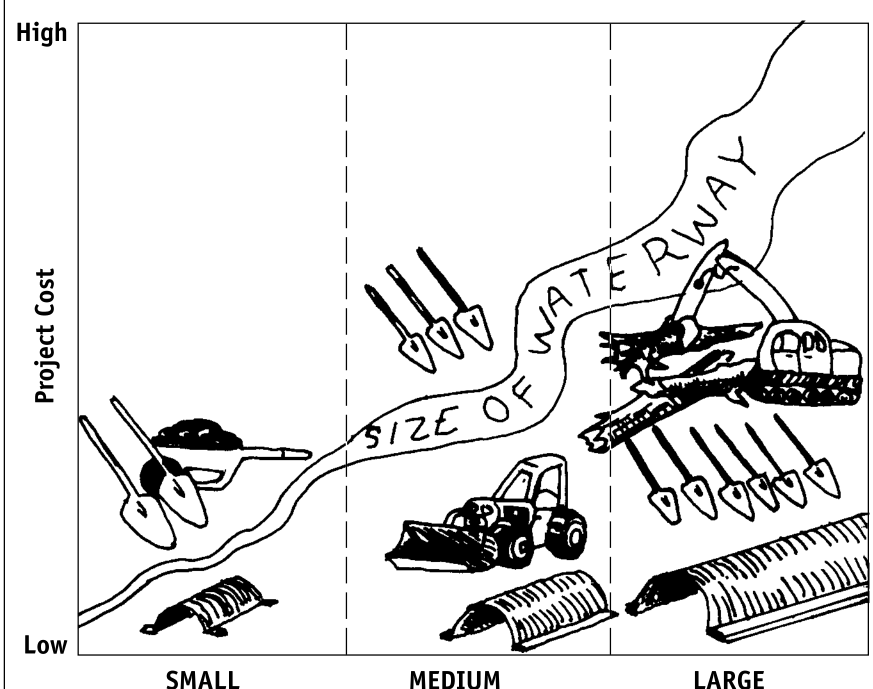
IMPACT OF ROAD TYPE ON COSTS



SIZE OF WATERWAY

The second crucial factor in estimating the costs of culvert projects is the size of the waterway. Larger rivers and streams require bigger culverts, and their greater power drives higher engineering, design, construction, and permitting costs. For purposes of this primer, waterway size is determined by the width of the channel downstream of the culvert at the high water mark.

IMPACT OF SIZE OF WATERWAY ON COSTS



B. CALCULATING COSTS:

Use the following table to calculate a cost range for culvert improvement projects based on the road type and size of waterway.

COST OF CULVERT REPLACEMENTS ($/project)

		ROAD TYPE			
		FOREST ROAD	**MINOR 2 LANE**	**MAJOR 2 LANE**	**HWY 4+ LANES**
SIZE OF WATERWAY	**SMALL:** Tributary 0-10 feet wide	$15,000-$40,000	$50,000-$100,000	$100,000-$200,000	$200,000-$350,000
	MEDIUM: Tributary 10-20 feet wide	$50,000-$100,000	$140,000-$240,000	$200,000-$350,000	$300,000-$450,000
	LARGE: Tributary or small mainstem 20-30 feet wide	$80,000-$150,000	$180,000-$280,000	$250,000-$450,000	$600,000-$800,000

NOTE: *Know of a project that does not fit these ranges? Please contact the authors with examples to improve future updates of the primer.*

BRIDGES: *In general, bridges are used to remedy fish passage barriers on streams over 20 feet wide. In cases where project cost estimates for bridges are already available, they should be used. When these estimates are not available, double or triple the cost of a culvert replacement to estimate the cost of a bridge.*

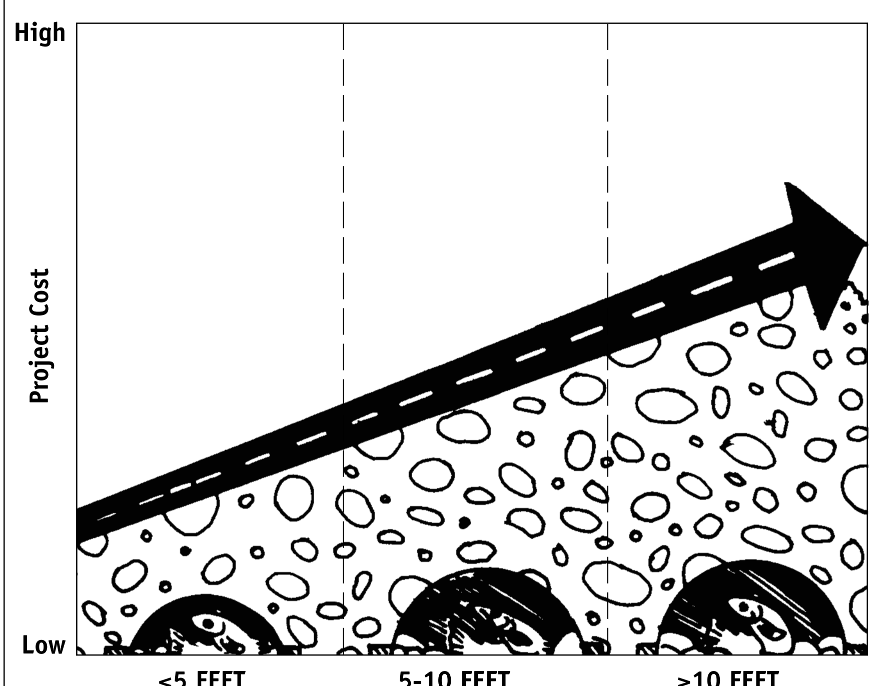
C. FINE TUNING COSTS FOR CULVERT IMPROVEMENTS: FILL HEIGHT

Use the fine-tuning factor below to narrow the estimated cost range from the table above. The fine-tuning factor will push the cost up or down within the range determined above.

FILL HEIGHT

Fill height refers to the distance between the culvert and the road. Where the culvert is well below the road, total project costs can increase significantly with the extent of fill to be removed and replaced. Larger culverts are needed to support greater amounts of fill. For the purposes of fine-tuning, fill height less than five feet will push costs to the low end of the range; projects with fill height greater than ten feet will have costs in the high end of the range.

IMPACT OF FILL HEIGHT ON COSTS



EXAMPLE USING THE MODEL:

A watershed plan identifies 4 undersized culverts that need replacement. They are on similar sized creeks that are between 10 and 20 feet wide. The creeks run perpendicular to US 101, crossing at four different points. The streambeds are all far below the road, and replacements will require extensive excavation. Since the culverts are on a major highway, traffic diversion and safety are important concerns.

Size of Waterway: Medium
Road Type: Highway
Cost Range: $300,000-$450,000
Fill Height: >10 feet
Adjusted Cost Range: $450,000
Watershed Cost (4 culvert replacements): $1,800,000

ADDITIONAL RESOURCES:

Washington State Department of Transportation **http://www.wsdot.wa.gov**

Washington State University Cooperative Extension **http://wawater.wsu.edu**

Washington Department of Fish and Wildlife **http://www.wa.gov/wdfw**

Puget Sound Water Quality Action Team **http://www.wa.gov/pswqat/index.htm**

SAMPLE PROJECTS

from around Puget Sound

CITY OF KENNEWICK
Lower Amon Creek Culvert Replacement

The goal of the project is to improve fish passage by replacing two 30-inch culverts with a 6-foot bottomless pipe arch. The culvert is located on the Lower Amon Creek, a tributary 15-feet wide on a forest maintenance road.
Project Cost: $80,000

KITSAP COUNTY PUBLIC WORKS
Olalla Valley Road Tributary to Olalla Creek

Project involves replacing a culvert under Olalla Valley Road, a major 2-lane rural county road with heavy traffic. The culvert is on Olalla Creek, a tributary with a stream width of 15-feet.
Project Cost: $350,000

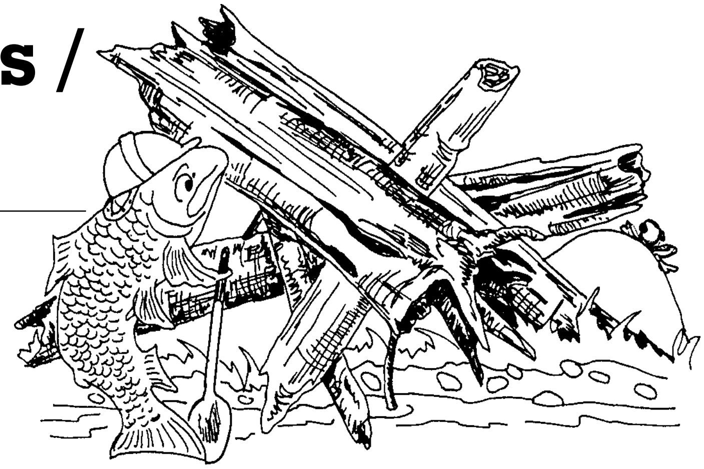
QUINAULT INDIAN NATION
South Fork Salmon River Culvert

Project involves replacement of a 72-inch culvert located on a forest service road that provides access to the Quinault Indian Nation. The culvert is on a 30-foot wide tributary to the Mainfork Salmon River.
Estimated Project Cost: $148,000

KITSAP COUNTY
Barker Creek Culvert (Barker Creek Road)

Project involves replacement of an undersized culvert on Barker Creek Road, a minor 2 lane residential access road. The culvert will be replaced with a 3-sided concrete box culvert on Barker Creek, a tributary 14-feet wide.
Project Cost: $201,900

Engineered Log Jams / Large Woody Debris



PROJECT DESCRIPTION:

A common technique used in habitat restoration is the placement of trees and stumps into a stream to create pools and refuge areas for salmon and other fish and wildlife species. This technique replicates the natural process of streamside trees falling into the stream or river. Wood placement projects are divided between Large Woody Debris (LWD) projects, which tend to be smaller in size and on smaller streams, and Engineered Log Jams (ELJs) that tend to be bigger, more heavily engineered, and on larger rivers.

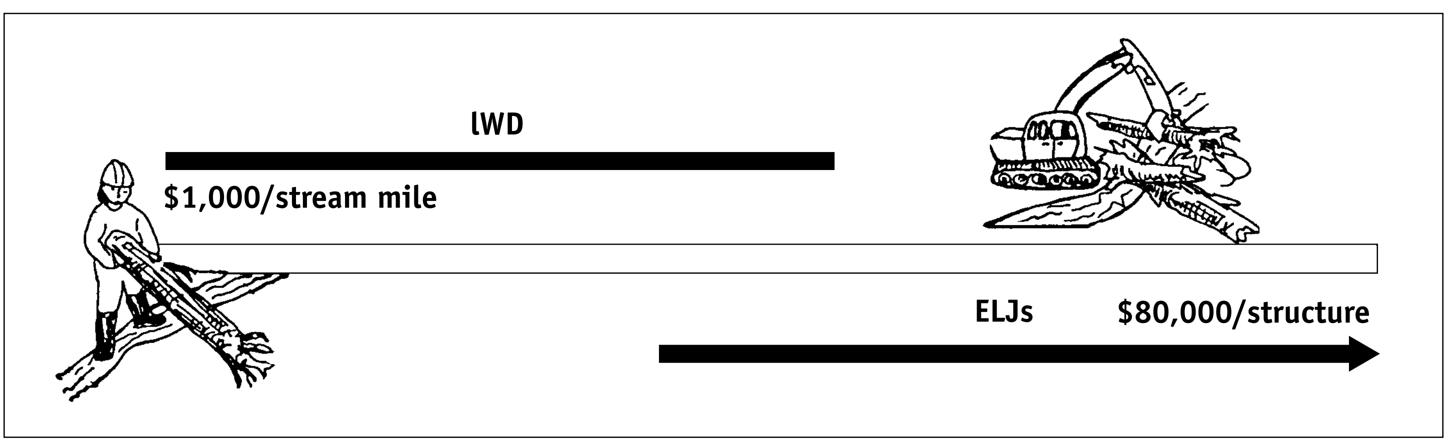
The techniques presented in this chapter are for projects that use wood to enhance instream habitat. Those that use trees and stumps to reinforce streambanks from erosion should be costed using the Streambank Improvement chapter.

PREDICTABILITY OF COSTS:

Good to Very Good. Experts generally agree about the main factors that make these projects more or less expensive. Predictability of total costs would be improved with more consistency in reporting of costs.

COST RANGE:

Costs are given per stream mile for smaller projects and per structure for larger projects. All the cost ranges in this section include construction, design, permitting, basic monitoring (2 years), routine maintenance (2 years), reestablishing the site to prior conditions, and project management costs that are normally associated with implementing a capital project. More general administrative, enforcement, and long-term maintenance costs are not included. Use the steps in this section to calculate an estimated cost in the following range. **COSTS ABOVE OR BELOW RANGE: Above:** Extremely challenging permitting. **Below:** Onsite or donated materials, placement by volunteers, non-populated reach.

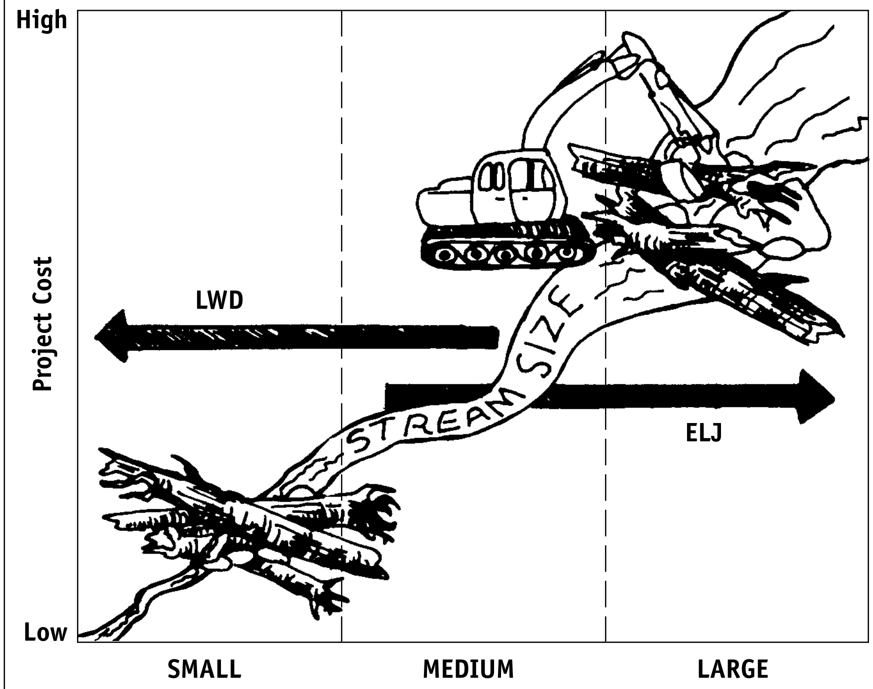


A. MOST IMPORTANT FACTOR: SIZE OF WATERWAY

All of the costs of wood placement projects – design, materials, permitting, and labor – tend to increase in direct proportion to stream size. While there are qualifying factors, projects on large mainstem rivers tend to be much more expensive than those on small tributaries.

Size of Waterway	Mean Annual Flow in CFS at Site	Example
Small	1-100 CFS	Clover Creek, Pierce County
Medium	100-2,000 CFS	South Fork Nooksack River, Whatcom County
Large	2,000+ CFS	Green River, King County

IMPACT OF SIZE OF WATERWAY ON COSTS



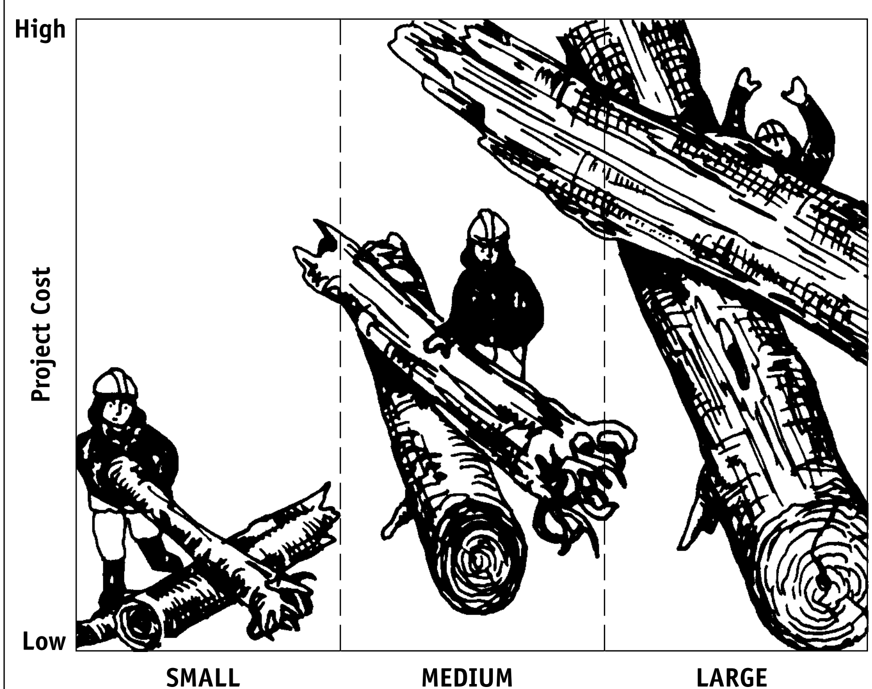
Find mean annual flows for waterways in Washington State at http://www.usgs.gov/

B. OTHER IMPORTANT FACTORS: MATERIALS AND TRANSPORTATION COSTS

MATERIALS

The trees, stumps, and other materials used in these projects vary greatly in size, and larger materials are substantially more expensive. It is assumed in this model that all materials are purchased.

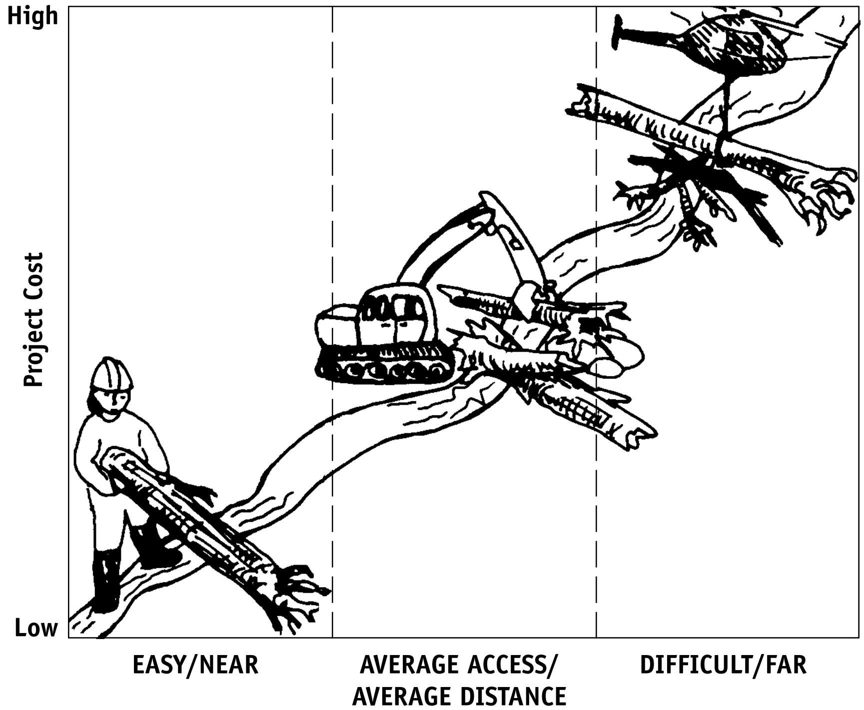
IMPACT OF MATERIAL SIZE ON COSTS



TRANSPORTATION

Transportation costs are also a substantial cost of wood placement projects. Transportation costs vary based on site accessibility and the distance to the materials source. Easy road access and a local source of materials (0-7 miles away) will result in a less expensive project, while sites with distant material sources (20+ miles) and difficult site access will have high costs.

IMPACT OF TRANSPORTATION ON COSTS



C. CALCULATING COSTS:

First, use the following table to estimate the influence of material size and transportation on the cost of wood placement projects.

MATERIALS		TRANSPORTATION		
		EASY/NEAR 0-7 mile	**AVERAGE ACCESS/ AVERAGE DISTANCE** 7-20 mile	**DIFFICULT/FAR** 20+ mile,
	SMALL: (0-12") diameter	Low Cost	Medium Cost	High Cost
	MEDIUM: (13-24") diameter	Low Cost	Medium Cost	High Cost
	LARGE: (25-36") diameter	Medium Cost	High Cost	High Cost

Next, use the following table to identify a cost range based on the materials/transportation costs established in the previous step (low, medium, high cost) and the size of the waterway shown below. Note that the smaller projects (generally LWD) are estimated by stream mile and larger ones (generally ELJs) by structure.

COST OF ELJs AND LWD ($/stream mile or $/structure)

STREAM SIZE (CFS)		TRANSPORTATION & MATERIAL REQUIREMENTS		
		LOW COST	**MEDIUM COST**	**HIGH COST**
	SMALL: 1-100	$10,000-$30,000*	$20,000-$50,000*	$20,000-$40,000
	MEDIUM: 100-2,000	$20,000-$50,000*	$15,000-$45,000	$40,000-$70,000
	LARGE: 2,000+	$10,000-$20,000	$40,000-$60,000	$60,000-$80,000

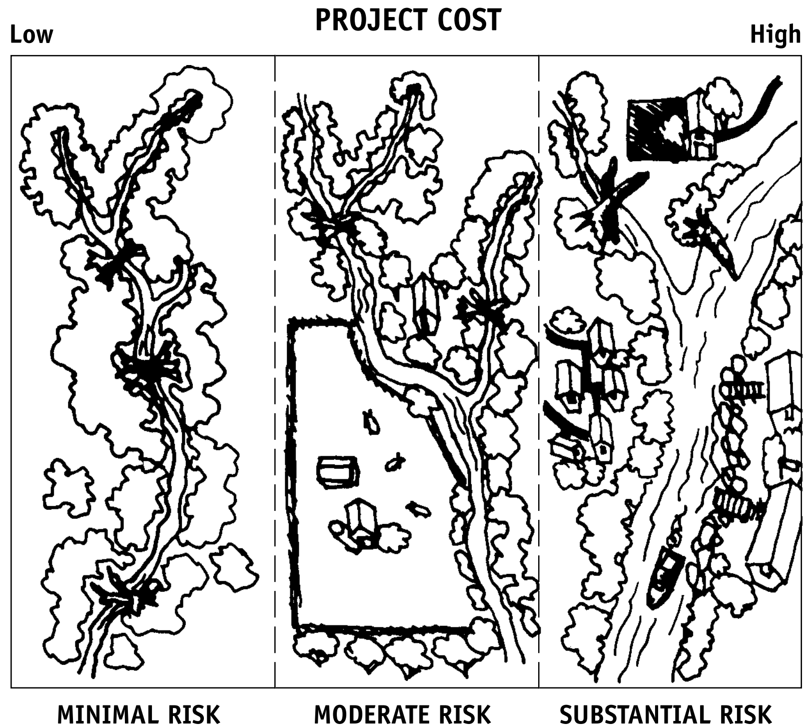
*Ranges given by per stream mile (assuming 100-400 pieces per stream mile.) All other cells ranges given per structure.
All costs ranges assume purchased material.

E. FINE-TUNING COSTS FOR WOOD PROJECTS: RISK AND WOOD DENSITY

Use the fine-tuning factors below to narrow the estimated cost range from the table above. Fine-tuning factors will push the cost up or down within the range determined above. The fine-tuning graphs can be used in combination: for example, if one indicates a high cost in the range and another indicates a low cost, estimate a cost that fits in the middle of the range.

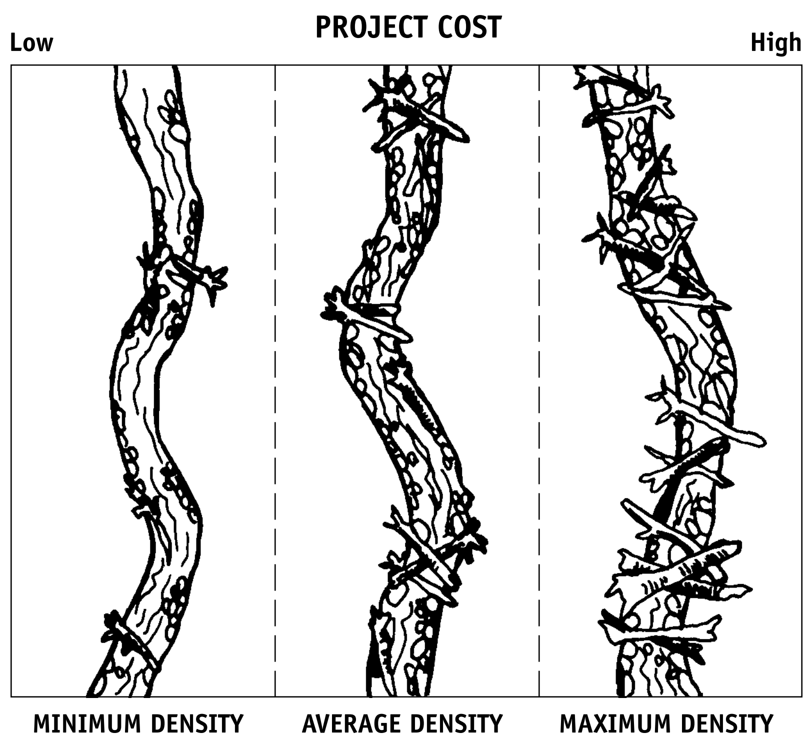
RISK

Logs and stumps placed in streams can create hazards by trapping floaters and boaters, jamming downstream culverts, and changing channel and flood-plain characteristics resulting in potential flooding and erosion threats. All of these issues can be overcome by careful design and engineering but at additional cost. Costs will tend to be highest in heavily used rivers and those bordered by rural and suburban communities, and lowest in smaller, more remote streams.



WOOD DENSITY

These projects also vary a great deal by the number of trees and stumps used or wood density. Average wood density is 200-300 pieces per mile or 50-80 pieces per structure. Projects with lower than average wood density will have costs in the low end of the range; higher than average wood density will have high end costs.



EXAMPLE USING THE MODEL:

A watershed plan recommends three engineered logjams to address the lack of structural complexity in a major tributary (800cfs). Each jam consists of roughly 60 pieces of wood. Wood pieces range in size from 18-24 inches in diameter and access to the river is limited in some areas by forested terrain. The materials source is within a few miles. The projects are in a sparsely populated rural area and there is little river use.

Waterway Size: Medium
Materials: Medium
Transportation Costs: Average Access/Average Distance
Cost Range: $15,000-$45,000 per structure
Risk: Minimal
Wood Density: Average
Adjusted Cost Range: $20,000-$30,000 per structure
Watershed Cost (3 projects): $60,000-$90,000

ADDITIONAL RESOURCES:

US Forest Service **http://www.fs.fed.us/rm/RRR/index.shtml**

Snohomish County Public Works
http://www.co.snohomish.wa.us/publicwk/swm/reports/salmonwatch/salmon1.pdf

University of Washington, Center for Streamside Studies
http://depts.washington.edu/cssuw/Publications/FactSheets/elwdc.pdf

Washington Department of Fish and Wildlife **http://www.wa.gov/wdfw**

SAMPLE PROJECTS

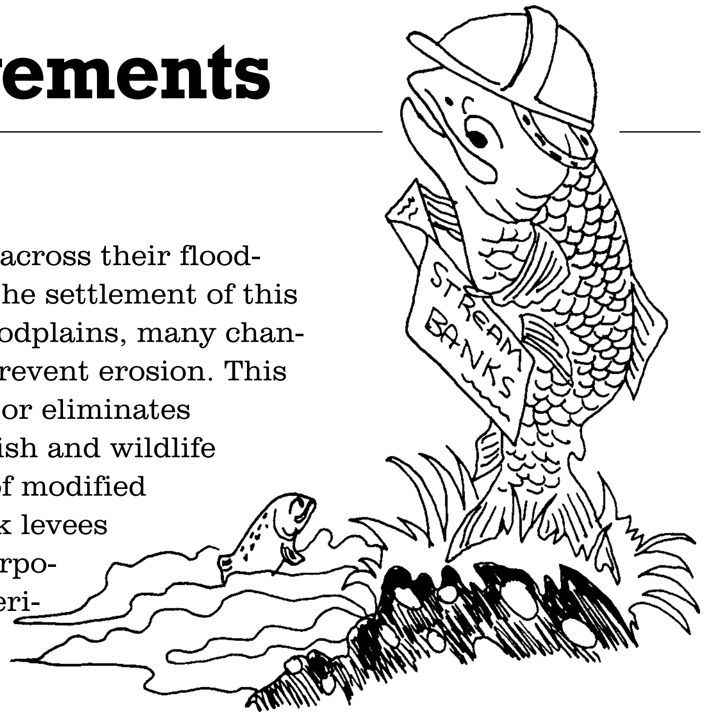
from around Puget Sound

WASHINGTON TROUT
North Fork Stillaguamish River
Project involves implementation of Phase II of the North Fork Stillaguamish Engineered Logjam Project and placement of 3 engineered logjams.
Project Cost: $202,510 ($67,503/structure)

LOWER ELWHA KLALLAM TRIBE
Elwha River Engineered Logjams
Project involves restoration of the river's most important remaining spawning & rearing site for salmon through placement of 300 pieces of wood for 5 structures at the head of the Elwha River.
Project Cost: $180,961 ($36,192/structure)

UMATILLA CONFEDERATED TRIBE
Large Woody Debris Placement in South Fork Touchet River
Project involves the placement of whole trees with rootwads and large woody debris in 7 miles of the South Fork Touchet River to increase floodplain stabilization and number of pools.
Project Cost: $269,000 ($38,571/stream mile)

Streambank Improvements



PROJECT DESCRIPTION:

In their natural condition, rivers tend to move across their floodplains, cutting new banks and channels. With the settlement of this region and farming and development in the floodplains, many channels have been reinforced with rock banks to prevent erosion. This practice stabilizes the streambank but reduces or eliminates streamside vegetation that provides essential fish and wildlife habitat. In order to restore the habitat values of modified streambanks, many agencies are replacing rock levees with streambank restoration projects that incorporate trees, logs, shrubs, and other natural materials. Often these projects are undertaken because the previous erosion control method has failed.

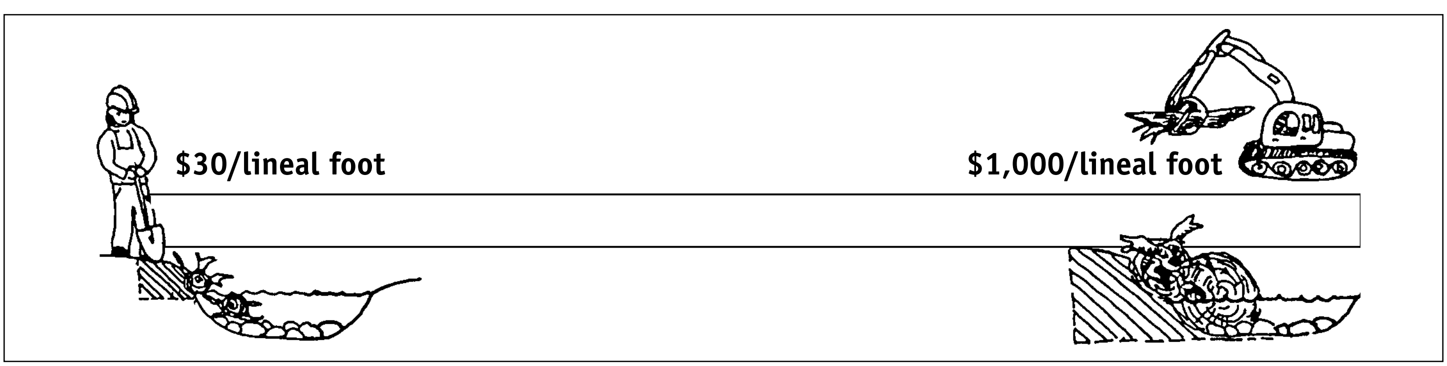
This chapter addresses the cost of streambank improvements. Work to place logs and stumps in the river to promote channel diversity is covered in the chapter on Large Woody Debris and Engineered Log Jams. Projects that include reconnection of river elements through the setback of levees are included in the Floodplain Restoration section. Projects that consist of planting only should be costed using the Riparian Planting chapter.

PREDICTABILITY OF COSTS:

Good. Streambank improvement projects are fairly common in the Puget Sound area. The wide variability in materials used, site characteristics, and design options results in some difficulties in predicting costs.

COST RANGE:

Costs range from $30-1,000 per lineal foot of streambank. All the cost ranges include construction, design, permitting, basic monitoring (2 years), routine maintenance (2 years), reestablishing the site to prior conditions, and project management costs that are normally associated with implementing a capital project. More general administrative, enforcement, and long-term maintenance costs are not included. Use the steps in this section to calculate an estimated cost in the range. **COSTS ABOVE OR BELOW RANGE: Above:** Projects with a focus on erosion control for protection of roads or other human infrastructure. **Below:** Volunteer labor in area above high water mark.

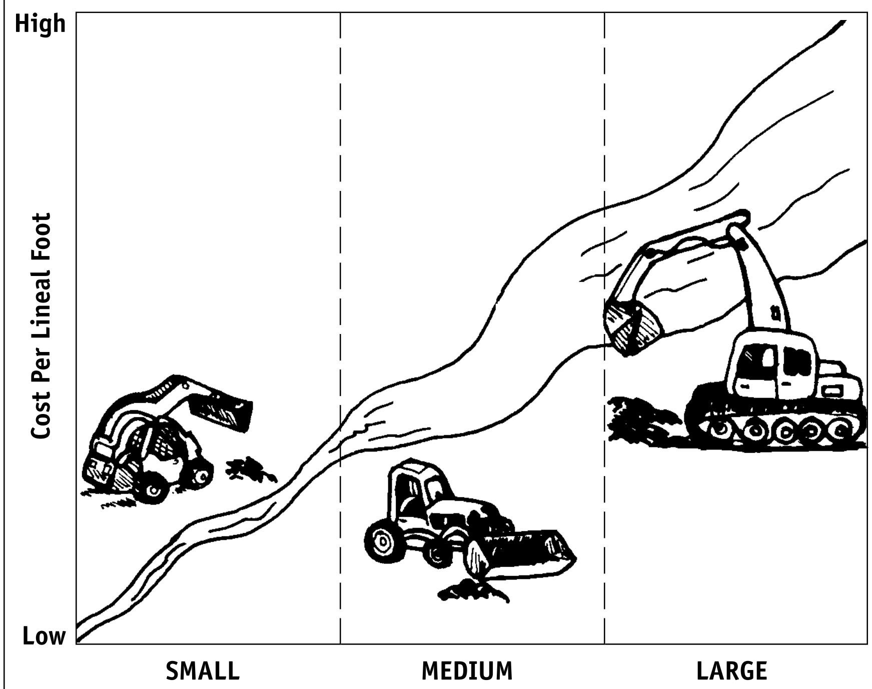


A. MOST IMPORTANT COST FACTOR: SIZE OF WATERWAY

Because these projects tend to be placed on erosion-prone streambanks, the erosive power of the stream or river is a crucial issue. More powerful rivers will require larger and more stable materials to anchor the streambank and more complicated design and engineering. Use the following graph and table to describe the size of river or stream where the projects will be located.

Size of Waterway	Mean Annual Flow in CFS at Site	Example
Small	1-100 CFS	Clover Creek, Pierce County
Medium	100-2,000 CFS	South Fork Nooksack River, Whatcom County
Large	2,000+ CFS	Green River, King County

IMPACT OF SIZE OF WATERWAY ON COSTS

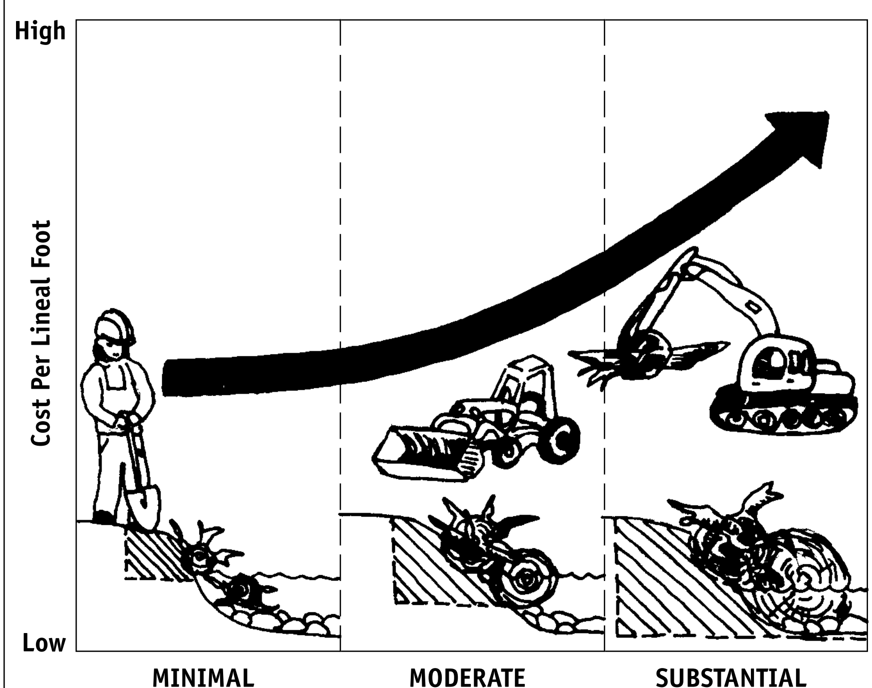


Find mean annual flows for waterways in Washington State at http://www.usgs.gov/

B. OTHER IMPORTANT COST FACTOR: EXTENT OF EXCAVATION

In the simplest streambank projects, the bank is intact and will need minimal regrading before logs and stumps are placed and trees and shrubs planted. However, many streambank projects require more substantial excavation to remove existing riprap, relocate levees or revetments, or provide a streambank profile that can accommodate plants and natural materials. Extensive excavation, meaning the reconstruction of the entire slope, requires heavy equipment, better access, and a place to stockpile or dispose of materials, all of which can be costly. The graph illustrates the relationship between degree of excavation and cost.

IMPACT OF EXTENT OF EXCAVATION ON COSTS



C. CALCULATING COSTS

Using the information on the degree of excavation and size of waterway, estimate the cost ranges per lineal foot of streambank from the following chart.

COST OF STREAMBANK IMPROVEMENTS ($/lineal foot)

		SIZE OF WATERWAY		
		SMALL	**MEDIUM**	**LARGE**
EXTENT OF EXCAVATION	**MINIMAL**	$30-$60	$60-$150	$150-$400
	MODERATE	$60-$100	$150-$250	$400-$700
	SUBSTANTIAL	$100-$200	$250-$500	$700-$1,000

NOTE: *Know of a project that does not fit these ranges? Please contact the authors with examples to improve future updates of the primer.*

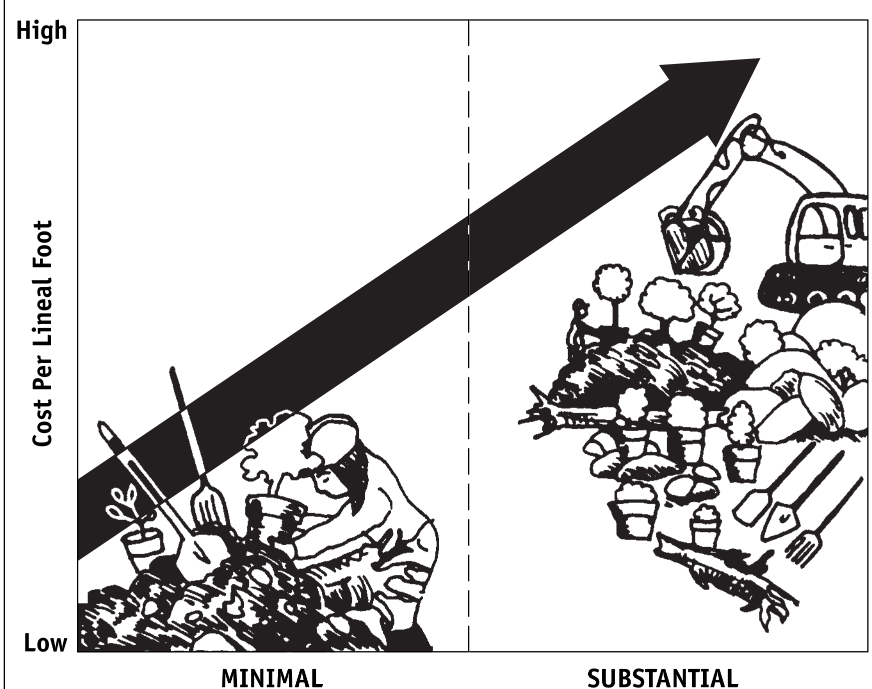
D. FINE-TUNING COSTS FOR STREAMBANK IMPROVEMENTS: MATERIALS AND PERMITTING

Use the fine-tuning factors below to narrow the estimated cost range from the table above. Fine-tuning factors will push the cost up or down within the range determined above. The fine-tuning graphs can be used in combination: for example, if one indicates a high cost in the range and another indicates a low cost, estimate a cost that fits in the middle of the range.

MATERIALS

As with planting and large woody debris projects, the size of and type of materials can have a substantial impact on costs of streambank projects. At the high end are large logs (>24" in diameter), large root wads, large toe rock, and larger plants (> 5 gallon sizes), all of which are purchased. The low end includes smaller and donated materials.

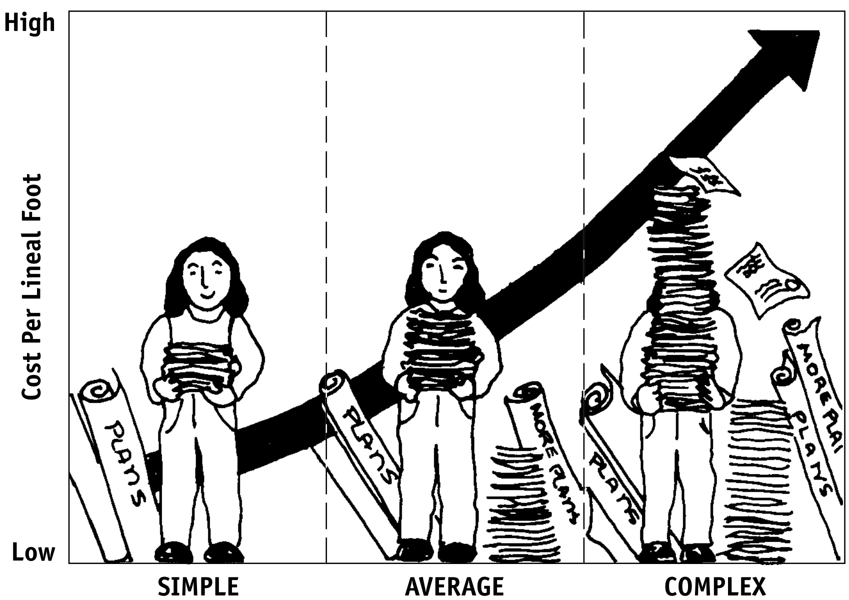
IMPACT OF MATERIALS ON COSTS



PERMITTING

Streambank projects can be challenging to permit, particularly the larger ones that involve substantial in-the-water excavation. Almost all of these projects will require federal 404 and state HPA permits, and any wrinkle in the permitting process can have a substantial impact on overall project costs. While permitting problems may be hard to predict, projects on key salmon-bearing rivers, upstream of crucial roads or culverts, or where adjoining property is developed are more likely to have higher permitting costs. Risk due to erosion and flooding concerns can also increase permitting costs.

IMPACT OF PERMITTING ON COSTS



EXAMPLE USING THE MODEL:

A watershed plan identifies a river reach needing bank enhancement. Priorities include two sections of bank, a 200' and a 500' stretch, along two similar tributaries to the main channel. Excavation costs will be high in both cases, because enhancements will include excavating rootwads into the bank to create habitat and reconstructing the entire slope. The permitting costs are high, because both tributaries adjoin residential areas with erosion concerns.

Size of Waterway: Medium
Extent of Excavation: Substantial
Cost Range: $250-$500 per lineal foot
Materials: Average
Permitting: Complex
Adjusted Cost Range: $350-$500 per lineal foot
Watershed Cost (2 projects): $70,000-$100,000 (200') and $175,000-$250,000 (500')

SAMPLE PROJECTS

from around Puget Sound

NORTH OLYMPIC SALMON COALITION
East Fork Chimacum Extension
1,300 feet of bank reconfigured to add floodplain margin. Anchored logs added to bank and native plantings.
Project Cost: $63,800 ($48/lineal foot)

KING COUNTY DNR & PARKS
Narita Levee Repair
Over-steepened levee regraded over 400 feet of the Green River bank to enhance bank stability. Flood bench created and site replanted.
Project Cost: $150,539 ($376/lineal foot)

NORTH YAKIMA CONSERVATION DISTRICT
Buchanan Ranch Restoration Project
4,620 feet of bank at mouth of Wenas Creek running through a cattle ranch. Fencing, re-meandering, and reconstruction to allow access to floodplain. Includes rootwads, rock vanes, and planting.
Project Cost: $296,904 ($64/lineal foot)

KING COUNTY DNR & PARKS
White Swan Levee Repair
Entire bank including riprap excavated out to create steps in slope. 7-layer geogrid system used to stabilize bank of Green River over 50 feet. Planting of native shrubs and trees.
Project Cost: $48,580 ($970/lineal foot)

ADDITIONAL RESOURCES:

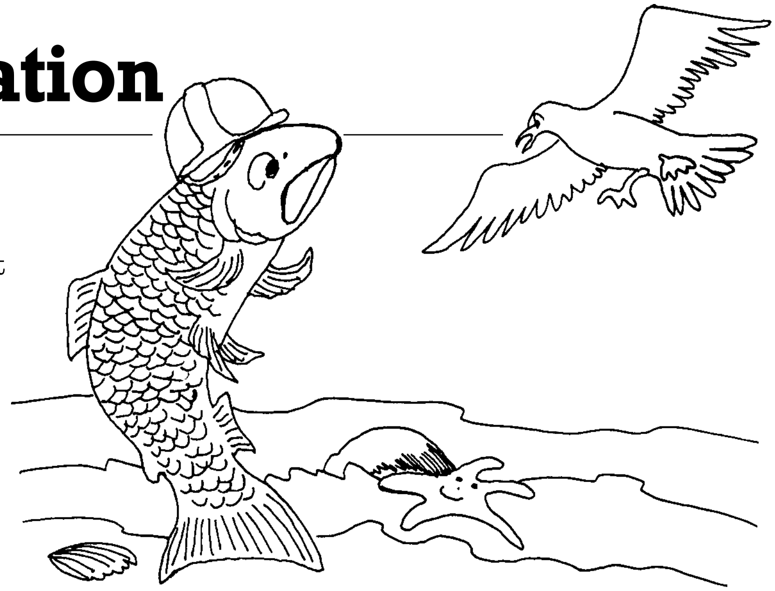
King County's guide to Bank Stabilization **http://dnr.metrokc.gov/wlr/biostabl**

Robbin Sotir & Associates, Soil Engineering Consultants **http://www.sotir.com**

Washington Department of Fish and Wildlife **http://www.wa.gov/wdfw**

Washington State University Cooperative Extension **http://wawater.wsu.edu**

Nearshore Restoration



PROJECT DESCRIPTION:

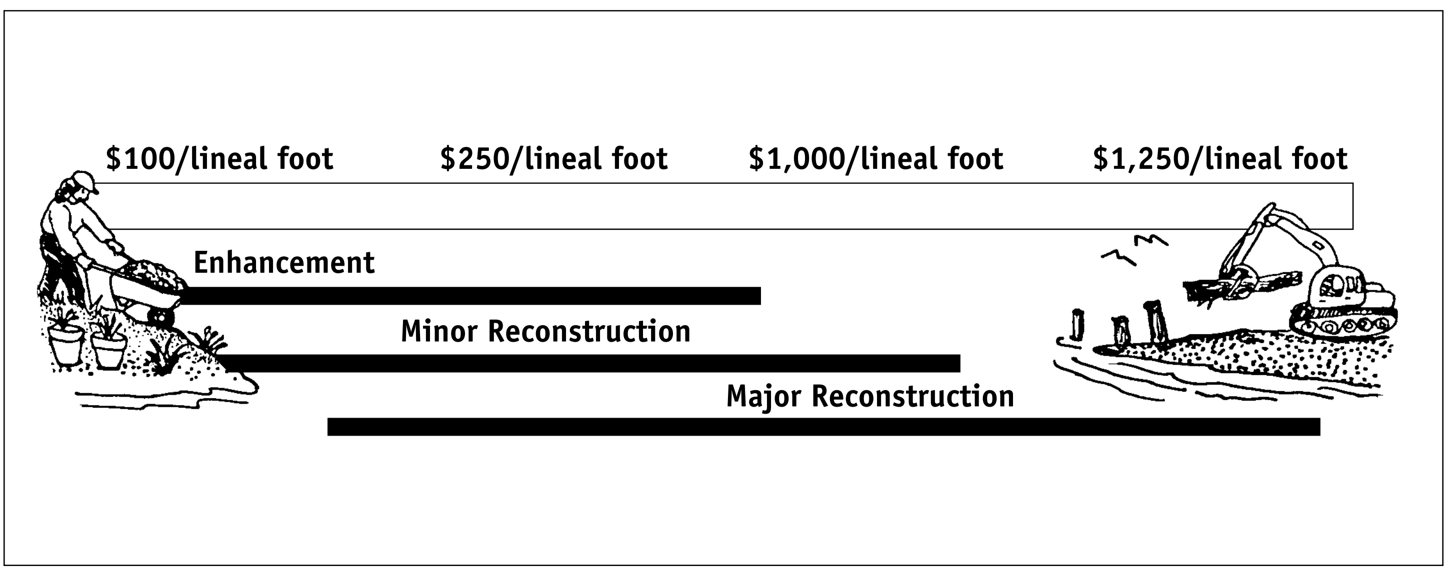
Recent studies indicate that marine habitat along the shores of Puget Sound is vital to salmon and other fish and wildlife species. Because marine shorelines are so popular as homesites and have been used for a wide range of industrial purposes, much of this habitat has been lost or degraded. In response, many agencies and organizations are proposing projects to remove bulkheads, reconfigure beaches, and add natural sediments, wood, and plants to recreate the historic nearshore characteristics.

PREDICTABILITY OF COSTS:

Fair. The fact that few projects have been completed and they range widely in scale limits the predictability of nearshore restoration work. As more nearshore projects are completed in the region, practices and designs will become more predictable as will costs.

COST RANGE:

Costs are given per lineal foot. All the cost ranges include construction, design, permitting, basic monitoring (2 years), routine maintenance (2 years), reestablishing the site to prior conditions, and project management costs that are normally associated with implementing a capital project. More general administrative, enforcement, and long-term maintenance costs are not included. Use the steps in this section to calculate an estimated cost in the following range. **COSTS ABOVE OR BELOW RANGE: Above:** No natural sediment source; Capping or removal of contaminated marine sediments; Highly urban area bulkhead removal with city infrastructure. **Below:** Small planting projects using handwork.



A. MOST IMPORTANT COST FACTOR: PROJECT COMPLEXITY

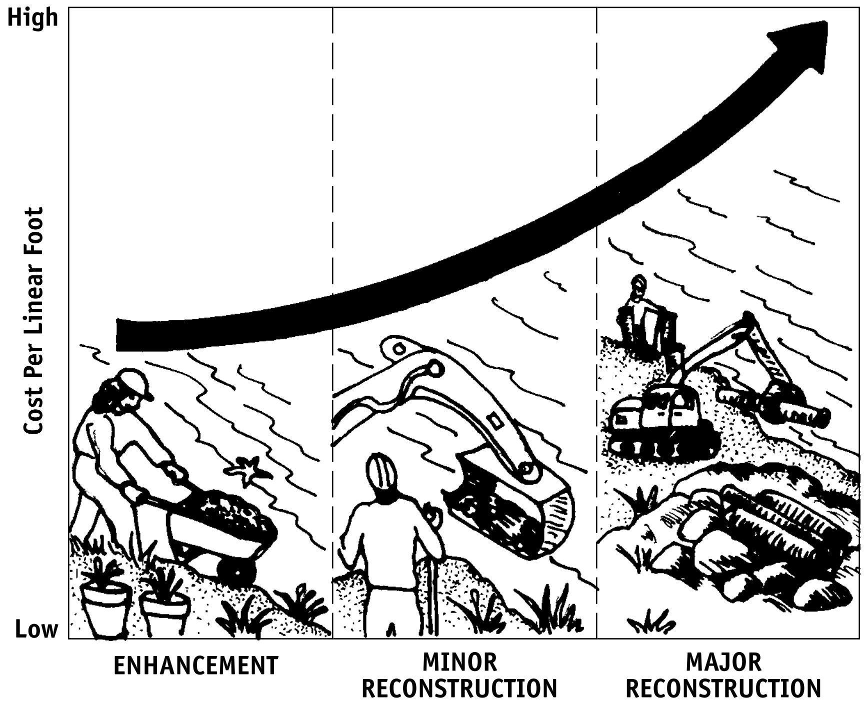
Nearshore restoration projects can be divided into three categories that differ in costs:

ENHANCEMENT: Characterized by the addition of natural sediments or gravels and plants to a beach or subtidal area. Some equipment use, minimal grading work and skilled labor needs.

MINOR RECONSTRUCTION: Characterized by the removal of small bulkhead structures and some recontouring of the beach combined with replanting. Addition of natural sediments, minimal use of LWD and boulders, heavy equipment use, and skilled labor.

MAJOR RECONSTRUCTION: Characterized by substantial reconstruction of the beach with removal of major bulkheads and fill. Replacement with natural materials (logs, rootwads, boulders, and plants), large amounts of heavy equipment, and skilled labor.

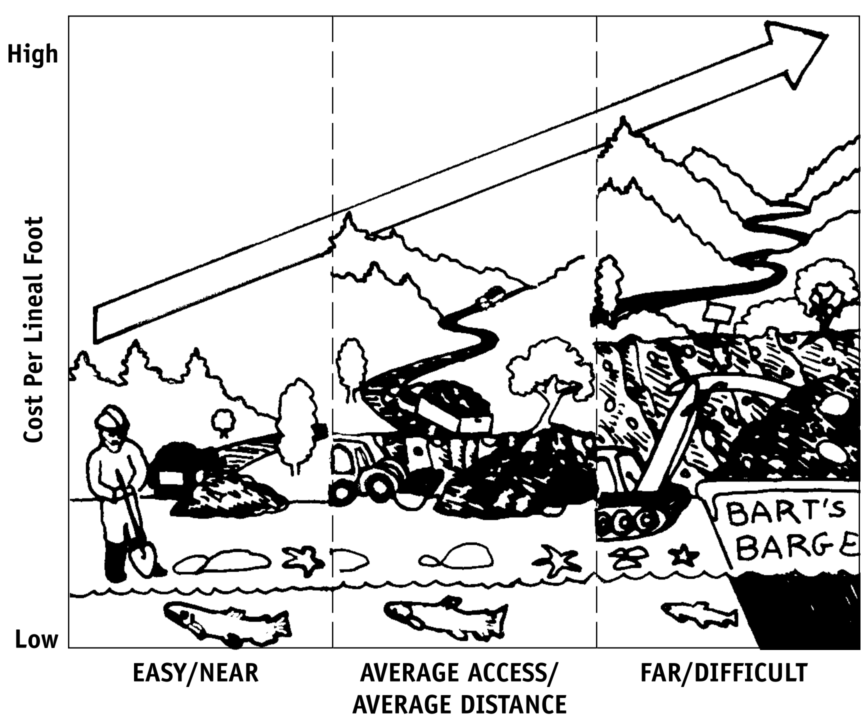
IMPACT OF PROJECT COMPLEXITY ON COSTS



B. OTHER IMPORTANT COST FACTOR: TRANSPORT

The cost of nearshore projects will depend on how far materials need to be carried to or from the project site and how difficult the site is to access from land or water. For cost estimation, projects with disposal sites 0-7 miles away and easy access for crews and equipment will have low transport costs. Projects that have difficult access from the water or roads or have long distances to material sources or disposal sites (20+ miles) will have high costs.

IMPACT OF TRANSPORT ON COSTS



C. CALCULATING COSTS: PROJECT COMPLEXITY AND TRANSPORT COSTS

Find an approximate cost range in the matrix below based on the transport costs and the project complexity:

COST OF NEARSHORE RESTORATION ($/lineal foot)

		TRANSPORT COSTS		
		EASY/NEAR	**AVERAGE ACCESS/ AVERAGE DISTANCE**	**FAR/DIFFICULT**
PROJECT COMPLEXITY	**ENHANCEMENT**	\$100-\$150	\$150-\$250	\$200-\$600
PROJECT COMPLEXITY	**MINOR RECONSTRUCTION**	\$125-\$250	\$200-\$500	\$300-\$1,000
PROJECT COMPLEXITY	**MAJOR RECONSTRUCTION**	\$200-\$600	\$300-\$1,000	\$1,000-\$1,250

NOTE: *Know of a project that does not fit these ranges? Please contact the authors with examples to improve future updates of the primer.*

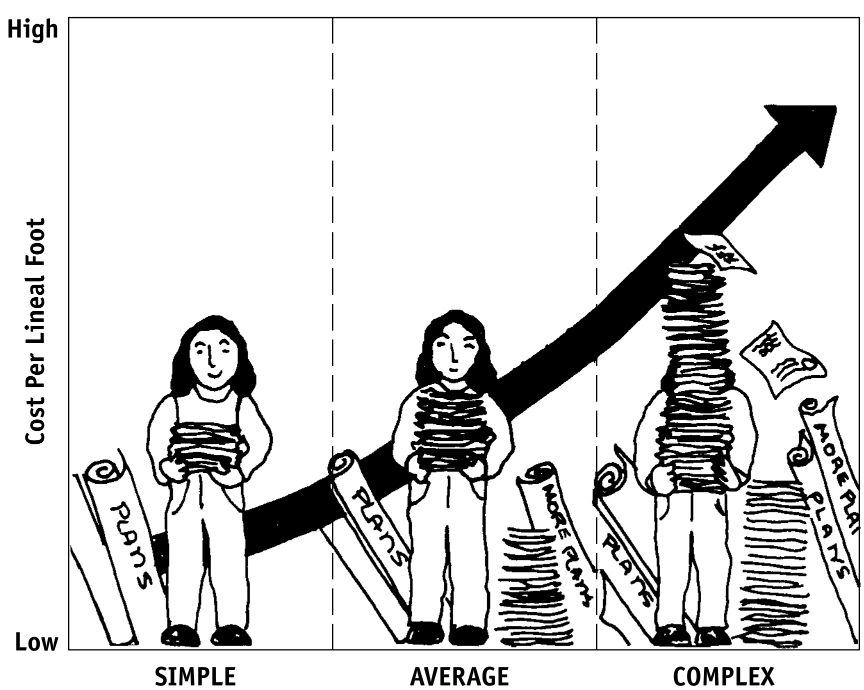
D. FINE-TUNING COSTS FOR NEARSHORE PROJECTS: DESIGN/PERMITTING AND OVERALL PROJECT SIZE

Use the fine-tuning factors below to narrow the estimated cost range from the table above. Fine-tuning factors will push the cost up or down within the range determined above. The fine-tuning graphs can be used in combination: for example, if one indicates a high cost in the range and another indicates a low cost, estimate a cost that fits in the middle of the range.

DESIGN/PERMITTING

Because few of these projects have been implemented, design and permitting costs can vary tremendously, accounting for 15-60% of total project cost. Projects in very active shorelines (strong tidal currents, major longshore drift, heavy wave action) will have higher design and permitting costs than those in less active shoreline areas. Permitting costs will also be determined by shoreline land use, with developed shorelines requiring more careful and costly analysis.

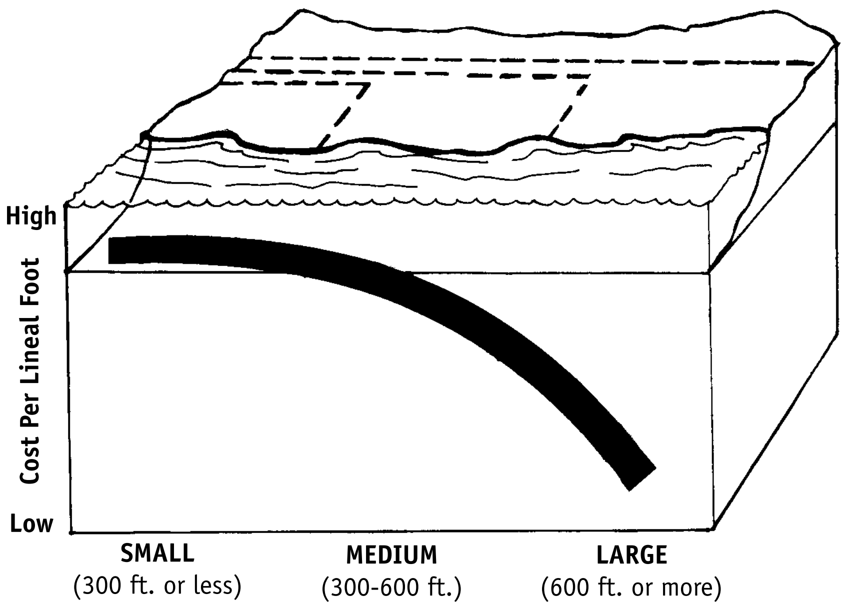
IMPACT OF DESIGN/PERMITTING ON COSTS



OVERALL PROJECT SIZE

Because the costs of design, transport, and permitting tend to be high for nearshore projects of any size, the larger projects tend to be substantially cheaper in per foot cost than smaller projects due to an economy of scale. For cost estimation, consider any project smaller than 300 feet of shoreline as small, 300 to 600 feet medium, and greater than 600 feet large.

IMPACT OF PROJECT SIZE ON COSTS



EXAMPLE USING THE MODEL:

A watershed plan recommends four projects to remove riprap bulkheads, reconfigure the shoreline, and replant native vegetation. Substantial excavation will be required. The disposal site for the riprap is more than 20 miles away. The project sites are not easily accessible by road, and equipment and materials will need to be barged in and out. Design and permitting is expected to be difficult, and the total length of the projects is estimated at 1,400 feet.

Project Complexity: Major Reconstruction; ***Transport:*** Far/Difficult; ***Cost Range:*** $1,000-$1,250/lineal foot; ***Design/Permitting:*** Complex; ***Project Size:*** Large; ***Adjusted Range:*** $1,100-$1,200/lineal foot; ***Watershed Cost (all four projects):*** $1,540,000-$1,680,000.

SAMPLE PROJECTS

from around Puget Sound

ISLAND COUNTY MARINE RESOURCE COMMITTEE
Maylor's Marsh Nearshore Restoration

Major Reconstruction project involving 2,200 feet of bulkhead removal (riprap and planks), regrading of tidal channels and the shoreline for forage fish benefit, and tide gate removal.
Project Cost: $617,700
(Estimated: $280/lineal foot)

BLOMQUIST RESIDENCE
Hood Canal

Minor Reconstruction/Enhancement project involving the restoration of 95 feet of beach through the anchoring of large wood with ecology blocks and/or cables and adding a gravel mix to existing shoreline. Good site access.
Project Cost: $15,500
($165/lineal foot)

BAUM RESIDENCE
Budd Inlet, Olympia

Major reconstruction of 250 feet of a steep bluff through invasive control, excavation to remove a wood bulkhead, and replacement with riprap bulkhead, soil nails, and live willow stakes. Also includes planting and an irrigation system. Transport costs include lowering drill rig by boom truck off bluff.
Project Cost: $160,000
($627/lineal foot)

ADDITIONAL RESOURCES:

Puget Sound Nearshore Project **http://www.wa.gov/wdfw/hab/psnerp**

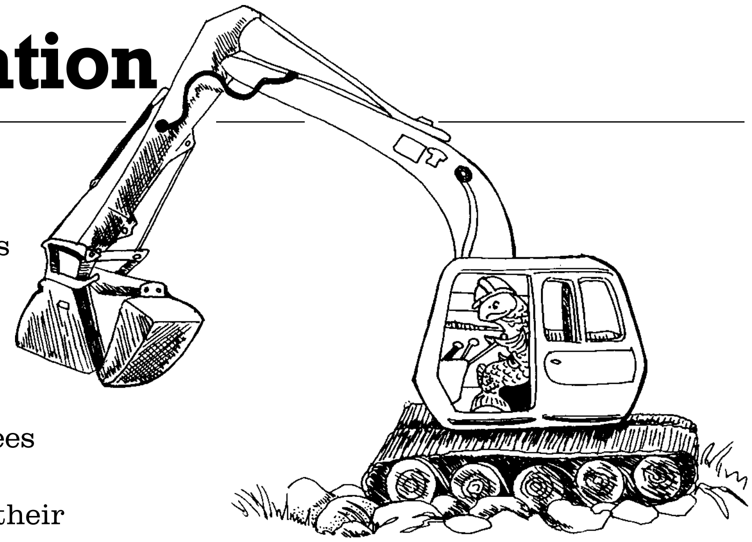
Washington State Department of Natural Resources **http://www2.wadnr.gov/nearshore/index.asp**

Puget Sound Water Quality Action Team **http://www.wa.gov/pswqat/Programs/Habitat.htm**

Northwest Straits Commission **http://www.nwstraits.org**

Washington State Department of Ecology Publication **http://www.ecy.wa.gov/biblio/0006012a.html**

Floodplain Restoration



PROJECT DESCRIPTION:

The settlement of the Puget Sound basin has been concentrated in the floodplains of the major rivers of the regions. With settlement has come the straightening and reinforcement of stream channels to reduce erosion and carry floodwaters downstream. The levees and revetments installed on many rivers to accomplish this have walled-off rivers from their floodplains and isolated tributaries and side channels on the floodplains that formerly provided refuge areas and spawning habitat for fish and wildlife. Many organizations and agencies are now taking steps to improve habitat by restoring the connections between rivers and floodplains and rebuilding floodplain tributaries and side channels.

This chapter addresses the costs of two types of floodplain restoration. The simpler of the two, the floodplain tributary reconnection, involves improving connections and habitat on tributary streams that flow across the floodplain and connect to the river in one place. The more complicated cases, termed side channel reconnections, are side channels and oxbows that connect at an upstream and downstream point and carry part of the flow of the entire river. Projects that consist of planting only should be costed using the Riparian Planting chapter.

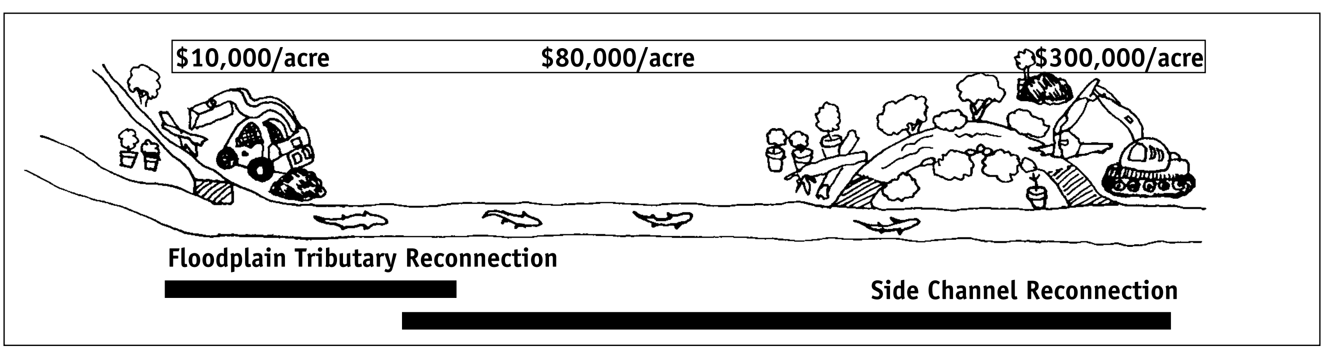
PREDICTABILITY OF COSTS:

Fair. Floodplain restoration costs are among the most variable and difficult to predict of any project type addressed in this primer. Expert opinion varies on which factors are most responsible for differences in project costs. More systematic record keeping with consistent parameters would encourage greater predictability for these projects.

COST RANGE:

Costs are given per acre. All the cost ranges include construction, design, permitting, basic monitoring (2 years), routine maintenance (2 years), reestablishing the site to prior conditions, and project management costs that are normally associated with implementing a capital project. More general administrative, enforcement, and long-term maintenance costs are not included. Use the steps in this section to calculate an estimated cost within the following range.

COSTS ABOVE OR BELOW RANGE: Above: Major reconnection projects on extremely large or energetic river like the Lower Skagit. **Below:** Hand work to allow connection of small wetland to small stream; Projects only involving planting.



For discussion of floodplain tributary reconnection, simple reconnections of wetlands or tributaries via a single connection to the main channel, go to **step A.** *For discussion of side channel reconnection, projects involving two connections to the main channel, go to* ***step B.***

A. FACTORS AND COST CALCULATION FOR FLOODPLAIN TRIBUTARY RECONNECTION

A1. MOST IMPORTANT FACTORS: EXTENT OF EARTHMOVING AND MATERIALS

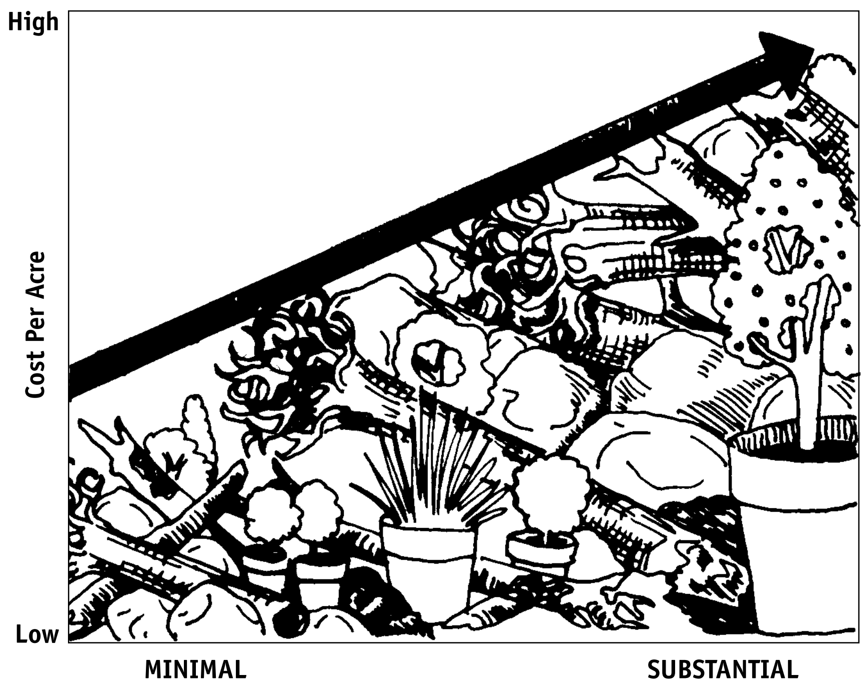
EXTENT OF EARTHMOVING

The most common problems with floodplain tributaries are poor connections between the tributary and the mainstem river and straightening of the tributary channel. Connections are often through undersized culverts, and floodgates are occasionally used to prevent backwater flooding. The remedies tend to be expensive, often requiring substantial excavation in rock levees and revetments. Reconfiguring a straightened channel is also expensive and may involve heavy equipment and stockpiling and disposal of materials. In the cost table, minimal earthmoving costs are for conditions where the connection and tributary channel require little work – a few days of equipment work and little or no off-site disposal (0-250 yds^3/acre). Substantial earthmoving costs apply when a levee or revetment needs to be excavated or an entire channel segment needs to be reconfigured (5,000-50,000 yds^3/acre).

MATERIALS

Earthmoving is commonly followed by the rebuilding of the floodplain channel with rock, logs, stumps, and plants. The materials for this work can be an important element of total project costs. In the table and graph, low material costs apply to those projects where the channel work is not extensive, the use of large logs, rock, and stumps is minimal, and most of the cost is for plants. At the high end, large quantities of expensive materials – big rocks, logs, and stumps – will be required.

IMPACT OF MATERIALS ON COSTS



A2. CALCULATING COSTS FOR FLOODPLAIN TRIBUTARY RECONNECTION

Considering the extent of earthmoving and materials, find the appropriate cost range in the table below.

COST OF FLOODPLAIN TRIBUTARY RECONNECTION ($/acre)

		EXTENT OF EARTHMOVING		
		MINIMAL	**MODERATE**	**SUBSTANTIAL**
MATERIALS	**MINIMAL**	$5,000-$10,000	$10,000-$20,000	$30,000-$40,000
	MODERATE	$10,000-$20,000	$20,000-$30,000	$40,000-$60,000
	SUBSTANTIAL	$30,000-$40,000	$40,000-$60,000	$60,000-$80,000

Estimating Acreage *For floodplain restoration projects, use the footprint of the construction site as the acreage amount.*

NOTE: *Know of a project that does not fit these ranges? Please contact the authors with examples to improve future updates of the primer.*

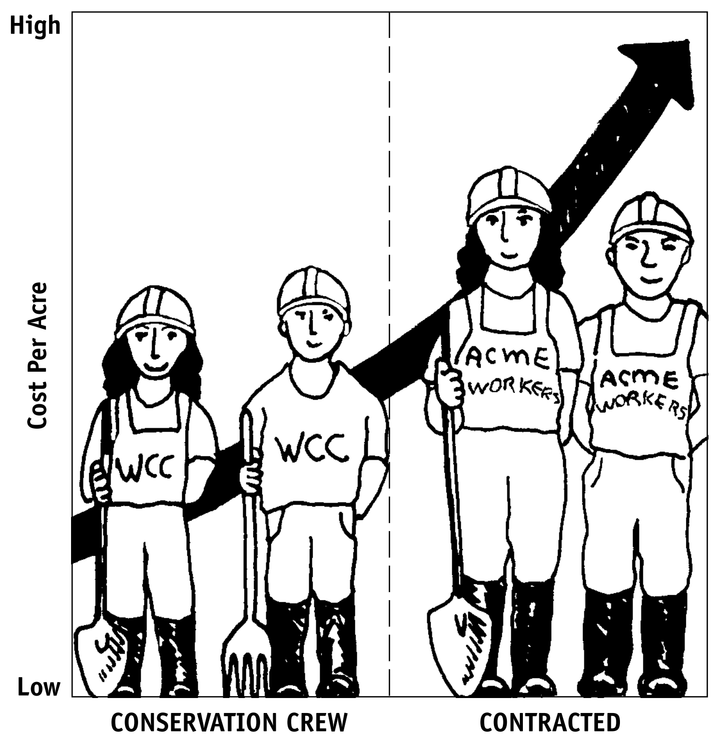
A3. FINE-TUNING COSTS FOR FLOODPLAIN TRIBUTARY RECONNECTION: LABOR

Use the fine-tuning factor below to narrow the estimated cost range from the table above. The fine-tuning factor will push the cost up or down within the range determined above.

LABOR

The smallest of these projects are at a scale and complexity where less skilled manual labor can be used for major elements of the project. Use of conservation corps and similar crews can result in costs at the low end of the ranges given.

IMPACT OF LABOR ON COSTS



B. FACTORS AND COST CALCULATION FOR SIDE CHANNEL RECONNECTION

B1. MOST IMPORTANT FACTORS: RIVER/STREAM ENERGY AND EARTHMOVING

RIVER/STREAM ENERGY

Because side channel restoration projects connect at the upstream and downstream end to divert a portion of the river's flow into the channel, the power or energy of the river or stream is a key factor in driving design, construction, and permitting costs. High-energy rivers, those with high velocities and streamflows, will require projects with larger and more robust materials, more complicated design and engineering, and costlier construction techniques. Use the following table to categorize rivers and streams by energy. When in doubt, note that lower energy rivers are placid in appearance, while high-energy rivers often have waves or rapids.

RIVER/STREAM ENERGY	EXAMPLE
LOW	Snohomish River near mouth
MEDIUM	Nisqually River, mainstem Nooksack River
HIGH	Sauk River, Middle Fork Snoqualmie River, North Fork Nooksack River

KEY: RIVER/STREAM ENERGY

L=1st order tributary, low volume, rapidly flowing.

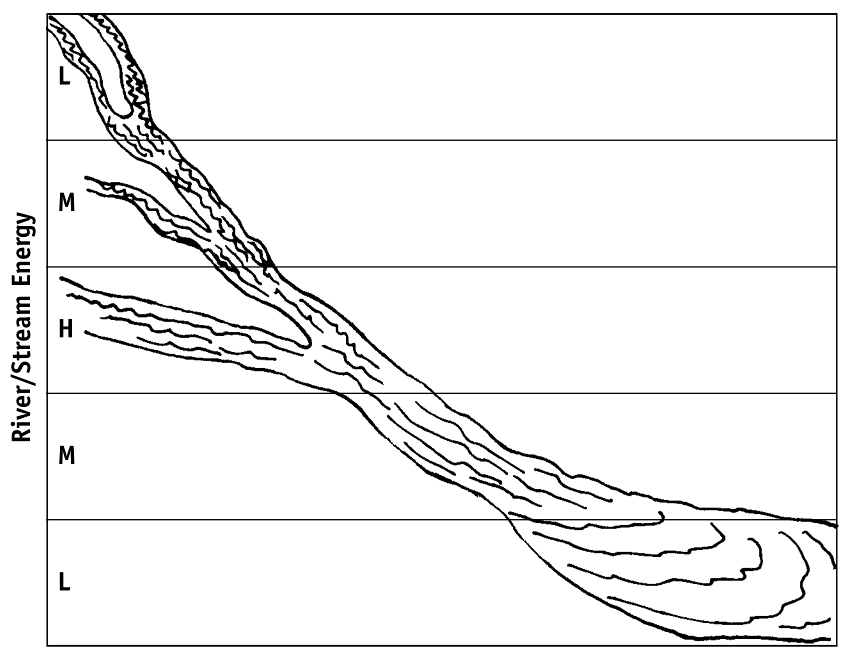
M=2nd order tributary with some gradient. Pools and riffles.

H=Energetic 2nd and 3rd order streams, small mainstem rivers. High volume with multiple tributaries contributing to flow, moderate gradient. Eddies, standing waves, pools and riffles.

M=3rd or 4th order mainstem rivers. Small riffles, low gradient.

L=4th or 5th order mainstems or estuaries. Large volume, minimal gradient, placid.

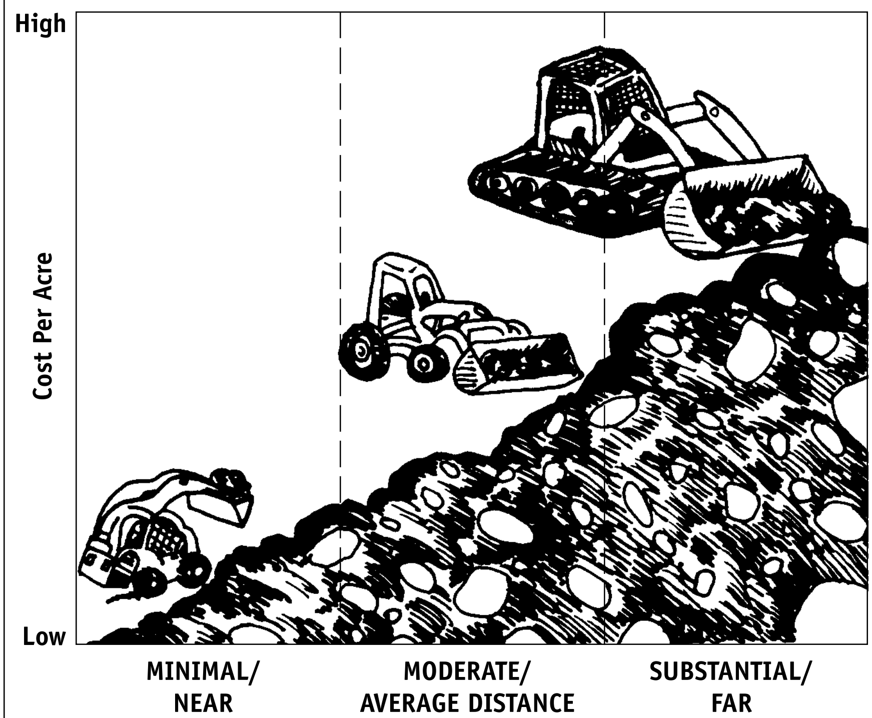
RIVER/STREAM ENERGY



EXTENT OF EARTHMOVING

Earthmoving costs tend to be substantially higher for side channel projects than for floodplain tributary restoration. These projects often include substantial modification or total removal of riverfront levees, the construction of levees elsewhere in the floodplain, and major excavation of side channels. In the table and graph below, high earthmoving costs will result from major changes to levees and channels that involve extended use of heavy equipment, relocation or removal of large quantities of material including levee setbacks (50,000-400,000 yds^3/acre), and distant sources for materials or disposal sites (over 20 miles away). Projects with existing side channels, no levee removal, minor excavation (50-500 yds^3/acre) at the connections and local disposal sites (less than 7 miles away) will have low costs.

IMPACT OF EXTENT OF EARTHMOVING ON COSTS



B2. CALCULATING COSTS FOR SIDE CHANNEL RECONNECTION

Considering waterway energy and extent of earthmoving, find the appropriate cost range in the table below.

COST OF SIDE CHANNEL RECONNECTION($/acre)

		ENERGY OF WATERWAY		
		LOW	**MEDIUM**	**HIGH**
EXTENT OF EARTHMOVING	**MINIMAL/ NEAR**	$20,000-$40,000	$40,000-$70,000	$60,000-$90,000
	MODERATE/ AVERAGE DISTANCE	$40,000-$60,000	$70,000-$100,000	$100,000-$200,000
	SUBSTANTIAL/ FAR	$60,000-$100,000	$130,000-$200,000	$200,000-$300,000

Estimating Acreage *For floodplain restoration projects, use the footprint of the construction site as the acreage amount.*

NOTE: *Know of a project that does not fit these ranges? Please contact the authors with examples to improve future updates of the primer.*

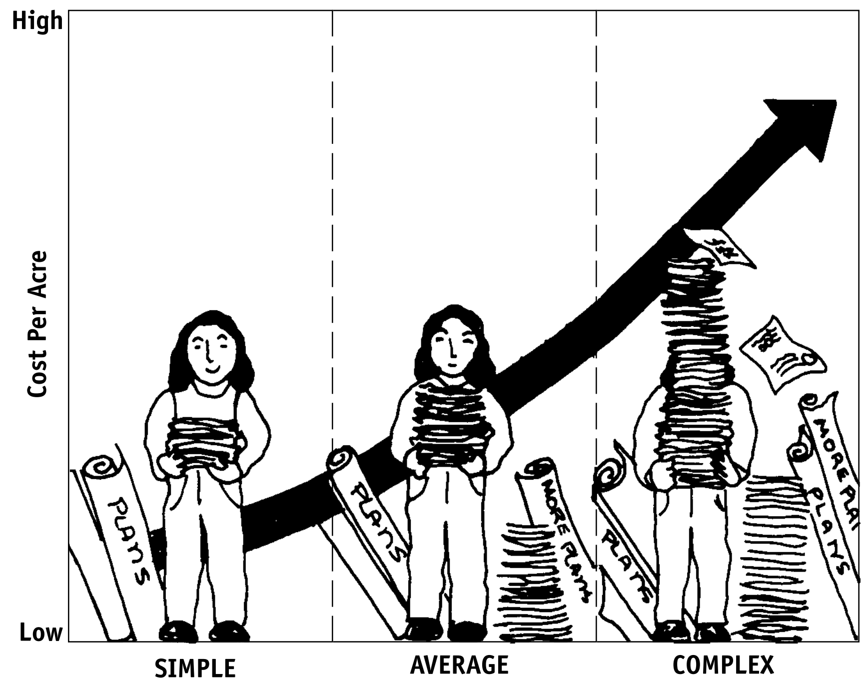
B3. FINE-TUNING COSTS FOR SIDE CHANNEL RECONNECTION: PERMITTING AND MATERIALS

Use the fine-tuning factors below to narrow the estimated cost range from the table above. Fine-tuning factors will push the cost up or down within the range determined above. The fine-tuning graphs can be used in combination: for example, if one indicates a high cost in the range and another indicates a low cost, estimate a cost that fits in the middle of the range.

PERMITTING

Although permitting costs can be highly variable for all restoration projects, it is particularly so with larger projects like most side channel restorations. Most involve an in-water component and will need the full suite of state and federal permits. Permitting costs will tend to be higher when the land adjoining the side channel has roads or structures on it and when the floodplain is along an important salmon-bearing river- both factors that result in complexity.

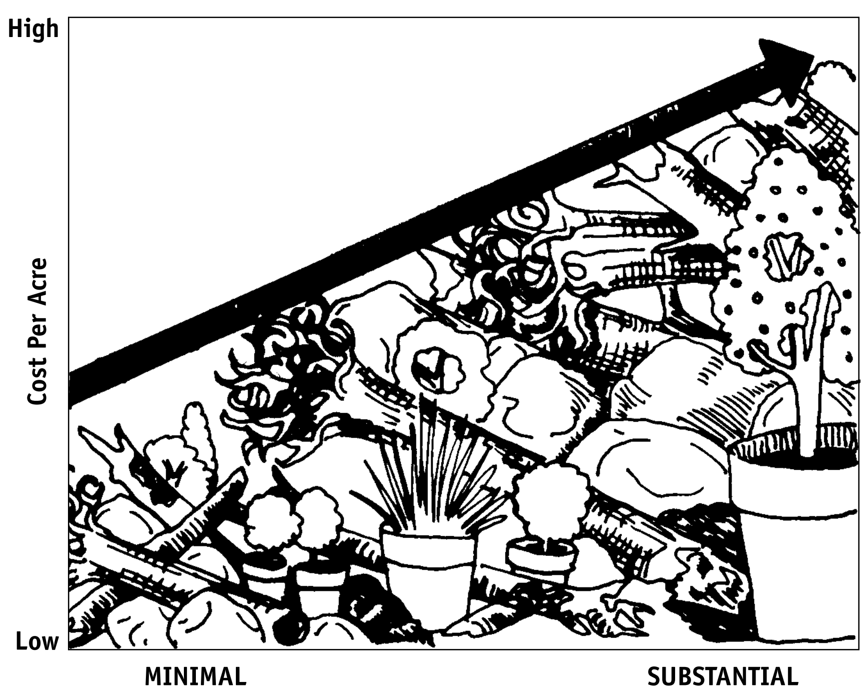
IMPACT OF PERMITTING ON COSTS



MATERIALS

Once the earthwork is completed and the new side channel and river connections are in place, the channel, levee, and other features will need to be restored. This often involves the placement of rock, logs, and root wads and the planting of trees and shrubs along the new channel. The cost of these materials tends to be dwarfed by earthmoving costs on side channel projects but can be an important secondary consideration. High project costs will result from use of expensive materials – large logs, root wads, and rock - as well as more mature and larger plants.

IMPACT OF MATERIALS ON COSTS



EXAMPLE USING THE MODEL:

In order to address a river segment that has been channelized and leveed, a watershed plan recommends reconnection of three side channels on a high-energy river. Each site will involve breaching a levee in two places to allow the main channel to flow over part of the floodplain. The project sites are on pastureland. Adjoining cropland will require a new levee to be built further away from the river. Permitting complexity is expected to be average and materials costs are likely to be high due to extensive restoration needed. The total size of the three projects is estimated at four acres.

Type of Project: Side Channel Reconnection
Extent of Earthmoving: Substantial
River Energy: High
Cost Range: $200,000-$300,000/acre
Permitting: Average
Materials: Substantial
Adjusted Range: $250,000-$275,000/acre
Watershed Cost (4 acres): $1,000,000-$1,100,000/acre

ADDITIONAL RESOURCES:

Washington Department of Fish and Wildlife **http://www.wa.gov/wdfw**

King County Surface Water Engineering & Environmental Services
http://ldnr.metrokc.gov/WTD/swees/cip.htm

SAMPLE PROJECTS

from around Puget Sound

Side Channel Reconnections:

KING COUNTY DNR & PARKS
Raging River Preston Reach Levee Removal
Removal of 1,300 feet of levee to open connections to floodplain and wetland. Project includes invasive control and planting.
Project Cost: $250,000
(Estimated: $167,560/acre)

KING COUNTY DNR & PARKS
Porter Levee
2 levee breaches allow the reconnection of a side channel on the left side of the Green River. Project includes installation of large woody debris and planting.
Project Cost: $190,000
(Estimated: $126,000/acre)

SEATTLE CITY LIGHT
Powerline Channel
Connection of abandoned slough by excavation of 1.8 acres of off-channel habitat on the Upper Skagit. Project includes the placement of spawning gravel in excavated pond.
Project Cost: $345,000
(Estimated: $186,116/acre)

Floodplain Tributary Reconnections:

KITSAP CONSERVATION DISTRICT
Gamble Creek Restoration
Project involves re-meandering 350 feet of creek, allowing access to 1-acre of floodplain, installing rootwads, logs, and gravel.
Project Cost: $73,200.
(Estimated: $14,640/acre).

KING COUNTY WATER & LAND RESOURCES
O'Grady Park Stream Restoration
Project involves the reconstruction of 1,100 feet of stream corridor to allow for flooding and meandering over a benched migration zone. Includes the addition of large woody debris, boulders, and native vegetation.
Project Cost: $222,000
(Estimated: $54,000/acre)

Estuary Restoration

PROJECT DESCRIPTION:

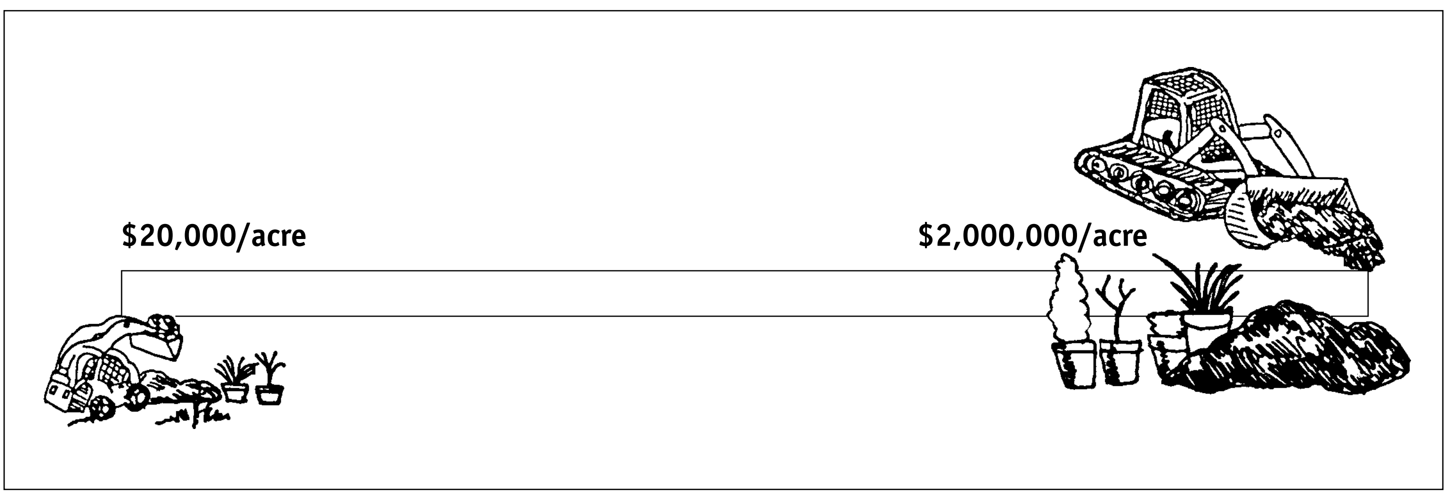
Salmon migrate through the estuaries at the mouths of the major rivers of Puget Sound as juveniles and adults. Because much of the early settlement in the region occurred in these lower river segments, much estuarine habitat has been filled and developed. This loss of habitat is thought to be a major limiting factor in salmon recovery, and many of the watershed plans are likely to have recommendations for removing fill and dikes and reclaiming estuary habitat.

PREDICTABILITY OF COSTS:

Fair. Data is limited for estuary restoration projects, because relatively few projects have been documented to date. Experts point to the lack of design standards as the reason for less predictable costs. Increased predictability is likely as more projects are implemented.

COST RANGE:

Costs range between $20,000 and $2,000,000 per acre. All the cost ranges include construction, design, permitting, basic monitoring (2 years), routine maintenance (2 years), reestablishing the site to prior conditions, and project management costs that are normally associated with implementing a capital project. More general administrative, enforcement, and long-term maintenance are not included. Use the following steps to calculate an estimated cost in this range. **COSTS ABOVE OR BELOW RANGE: Above:** Capping or removal of contaminated marine sediments. **Below:** Invasive control or planting only.

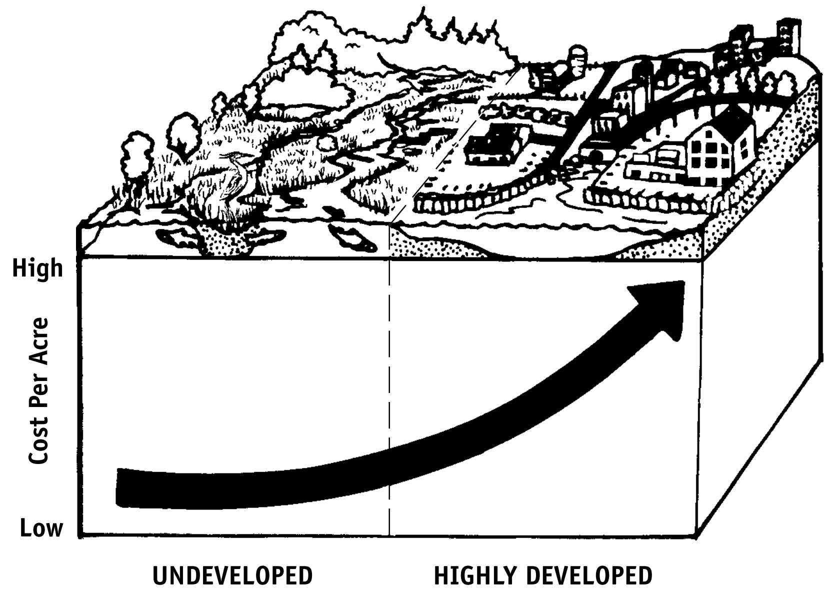


A. MOST IMPORTANT COST FACTOR:

SITE LAND USE

Site land use refers to what activities occurred on the site prior to restoration. Undeveloped sites like pastureland will offer less hindrance to excavation and will cost less. Projects on developed sites with utilities, roads, and/or buildings will involve more difficult excavation and may involve re-routing of roads or utilities. As shown in the graph, cost per acre increases with land use intensity. Contamination is a related factor to prior land use intensity, but will be covered in Step D.

IMPACT OF SITE LAND USE ON COSTS

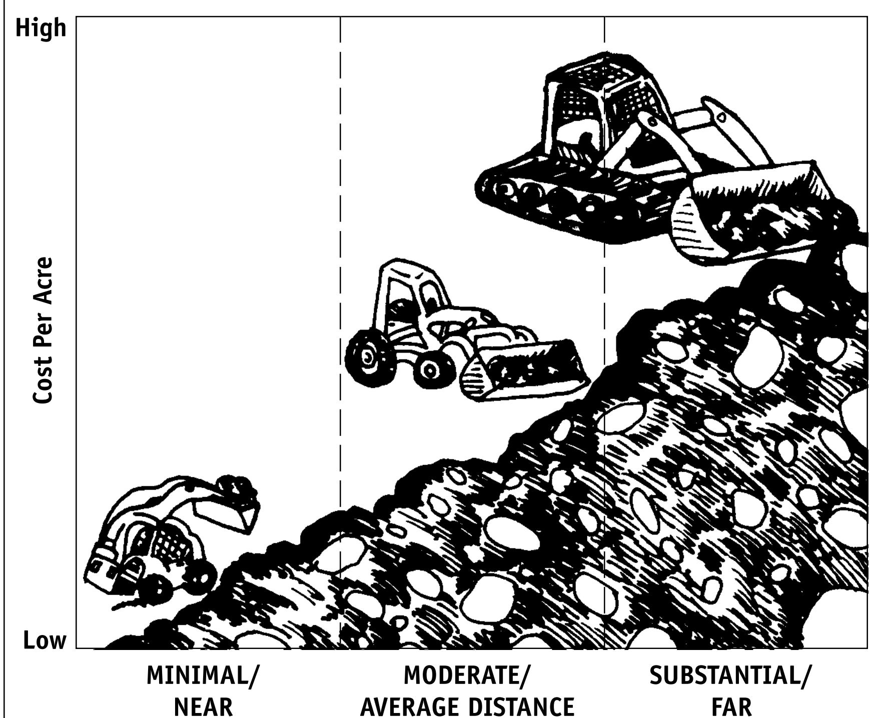


B. OTHER IMPORTANT COST FACTOR:

EXTENT OF EARTHMOVING

Earthmoving costs are a significant cost in estuary restoration. These projects often include removal of estuarine dikes, the construction of setback dikes, or major excavation of entire estuarine sites. High earthmoving costs will result from major changes to sites that involve extended use of heavy equipment, removal of large quantities of material (50,000-400,000 yds^3/acre), and distant sources for materials or disposal sites (over 20 miles away). Projects involving the removal of dikes with no setbacks or only minor excavation (50-500 yds^3/acre) with on-site or local disposal (less than 7 miles away) will have low costs.

IMPACT OF EXTENT OF EARTHMOVING ON COSTS



C. CALCULATING COSTS: SITE LAND USE AND EXTENT OF EARTHMOVING

Use the table below to find the appropriate cost range based on site land use and extent of earthmoving:

COST OF ESTUARY RESTORATION ($/acre)

		SITE LAND USE		
		UNDEVELOPED No stuctures, utilities, or roads	**SOMEWHAT DEVELOPED** Few small structures, utilities, or roads	**HIGHLY DEVELOPED** Major structures, utilities, roads
EXTENT OF EARTHMOVING	**MINIMAL/NEAR:** 0-7 miles	$20,000-$40,000	$70,000-$150,000	$400,000-$900,000
	MODERATE/ AVERAGE: 7-20 miles	$40,000-$60,000	$150,000-$450,000	$900,000-$1,200,000
	SUBSTANTIAL/FAR: 20+ miles	$60,000-$80,000	$450,000-$1,000,000	$1,000,000-$3,000,000

NOTE: *Know of a project that does not fit these ranges? Please contact the authors with examples to improve future updates of the primer.*

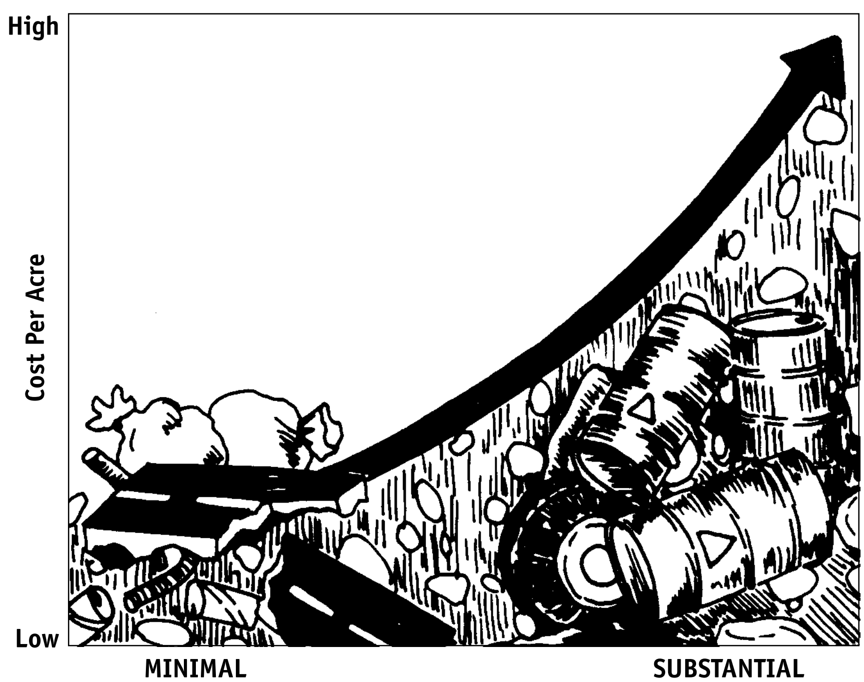
D. FINE-TUNING COSTS FOR ESTUARY PROJECTS: CONTAMINATION AND PLANTING/ INVASIVE CONTROL

Use the fine-tuning factors below to narrow the estimated cost range from the table above. Fine-tuning factors will push the cost up or down within the range determined above. The fine-tuning graphs can be used in combination: for example, if one indicates a high cost in the range and another indicates a low cost, estimate a cost that fits in the middle of the range.

CONTAMINATION

Contaminated fill is a common problem for estuary projects in urban and industrial areas and occurs, but less frequently, even when the filled area has been used for farming. Disposal costs, permitting, and design considerations increase substantially with the degree of contamination. At their most extreme, costs for addressing site contamination are unpredictably high.

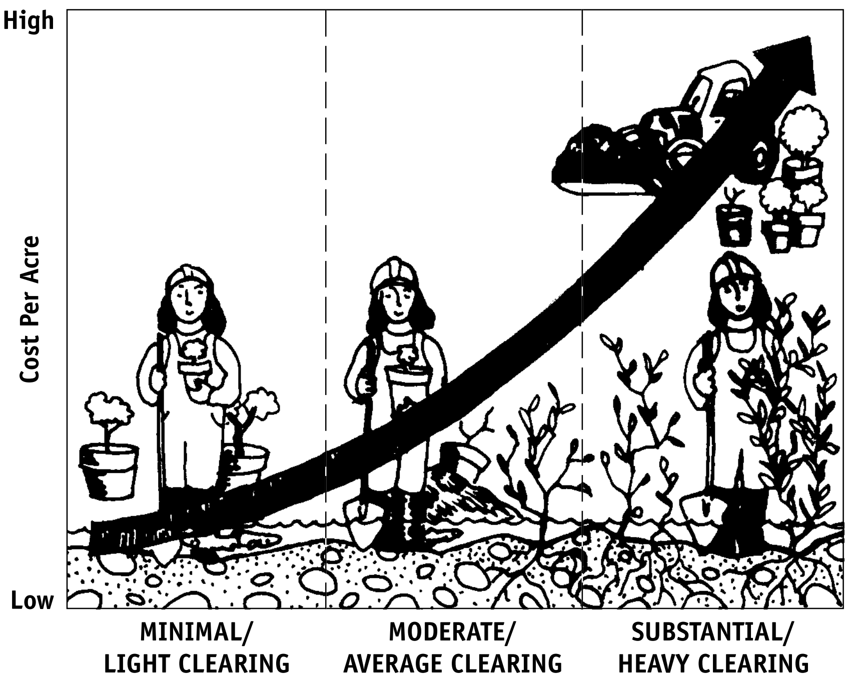
IMPACT OF CONTAMINATION ON COSTS



PLANTING AND INVASIVE CONTROL

After excavation work in estuarine areas, planting of native species is often used to restore the original ecosystem conditions and to stabilize sediments. Tidal influence in estuaries can require specific planting plans and analyses that can be costly. As with riparian planting projects, detailed designs, larger and more unusual materials, and the intensity of planting all drive costs. Invasive plants may also be a significant problem in estuary areas; where control is necessary, it will lead to substantially higher costs.

IMPACT OF PLANTING/INVASIVE CONTROL ON COSTS



EXAMPLE USING THE MODEL:

A watershed plan identifies an estuarine area which was filled for urban use but has been acquired for restoration. Priorities include excavation of 3 one-acre sites currently under parking lots and abandoned roads. Extent of earthmoving will be high due to complete excavation of each site and a disposal site 20 miles away. The sites have low contaminant levels. Planting costs will be minimal, because watershed planners are relying on tidal influx of seeds to establish themselves once this estuary has been excavated.

Site Land Use: Somewhat developed; ***Extent of Earthmoving:*** Substantial; ***Matrix Cost Range:*** \$450,00-\$1,000,000/acre; ***Contamination:*** Minimal; ***Planting:*** Minimal; ***Adjusted Range:*** \$450,000-\$600,000/acre; ***Watershed Cost (3 sites each 1 acre):*** \$1,350,000-\$1,800,000.

SAMPLE PROJECTS

from around Puget Sound

**PORT OF BREMERTON
Sinclair Inlet Estuary
Restoration Phase 2**

In a somewhat to highly developed urban/industrial area, restoration of 1.7 acres of estuary and 1,600 feet of shoreline through fill removal, gravel placement, and planting.
Project Cost: \$885,817
(Estimated: \$442,000/acre)

**WDFW and ACOE
Deep Water Slough
Levee Project**

In a somewhat developed area, removal of 14,000 feet of dike, construction of 8,300 feet of setback and repair of 10,000 feet of dike in Lower Skagit.
Project Cost: \$2,149,993
(Estimated: \$191,247/acre)

**SYKOMISH INDIAN TRIBE
Skykomish River Estuary
Nalley Island Levee
Removal**

In undeveloped agricultural area, project involves removal of 6,600 feet armoring, riprap and berm to allow re-flooding of pastureland.
Project Cost: \$254,600
(Estimated: \$33,611/acre)

**COLUMBIA LAND TRUST
Lower Columbia River
Estuary Deep River**

In an undeveloped area, project involves removal of 16,000 feet of dike to restore tidal function to floodplain.
Project Cost: \$467,322
(Estimated: \$25,428/acre)

ADDITIONAL RESOURCES:

Washington Department of Fish and Wildlife **http://www.wa.gov/wdfw**

Lower Columbia River Estuary Partnership **http://www.lcrep.org**

NOAA National Strategy **http://restoration.nos.noaa.gov/welcome.html**

Credits and Sources

Tim Abbe, Herrera Environmental Consultants
Brian Bair, Wind River
Mike Barber, Washington Department of Fish & Wildlife
Gary Bell, Washington Department of Fish & Wildlife
Peggy Bill, Cascade Land Conservancy
Pieter Bohen, Earthcorps
Mason Bowles, King County
Randy Brake, Pierce County
Bob Brandow, Washington Department of Natural Resources
Martha Bray, Skagit Land Trust
Pat Cagney, Army Corps of Engineers
Tom Cowan, Northwest Straits Commission
Dick Dadisman, Kitsap County
Monica Daniels, Kitsap County
Tom Dean, People for Puget Sound
Tracy Drury, Geo Engineers
Steve Dubiel, Earthcorps
Troy Fields, Mid-Sound Fisheries Enhancement Group
Jim Fox, Salmon Recovery Funding Board
Roger Fuller, Nature Conservancy
Bill Garrott, Army Corps of Engineers
Perry Gayaldo, NOAA Fisheries Service
Noel Gilbrough, Army Corps of Engineers
Michael Hagen, Hagen Consulting
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Mike McHenry, Lower Elwha Klallam Tribe
Fiona McNair, Mid-Sound Fisheries Enhancement Group
Dave Montgomery, University of Washington

Credits and Sources

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Tom Murdock, Adopt a Stream Foundation
Doug Myers, Puget Sound Water Quality Action Team
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Ken Nelson, City of Kennewick
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Jon Peterson, Washington Department of Transportation
Scott Porter, Quinault Indian Nation
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Monte Reinders, Jefferson County
Faith Roland, King County
Gordon Roycraft, Kitsap County
Jeff Rudolph, Pierce County
Tim Seifert, San Juan Preservation Trust
Ann Seiter, Jamestown S'Klallam Tribe
Bruce Sexauer, Army Corps of Engineers
Hugh Shipman, Washington Department of Ecology
John Small, Anchor Environmental, L.L.C.
Carey Smith, Pacific Coast Joint Venture, USFWS
Mike Spillane, Herrera Environmental Consultants
Pat Stevenson, Stillaguamish Tribe
Tom Stowe, Stowe Appraisals
Alison Studley, Skagit Fisheries Enhancement Group
Han Timmers, Timmers Appraisal Services
Randy Van Hoy, Ducks Unlimited
Colin Wagoner, Ridolfi Engineers
Jaques White, People for Puget Sound

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Design: Natalie Kosovac, Natfly Productions