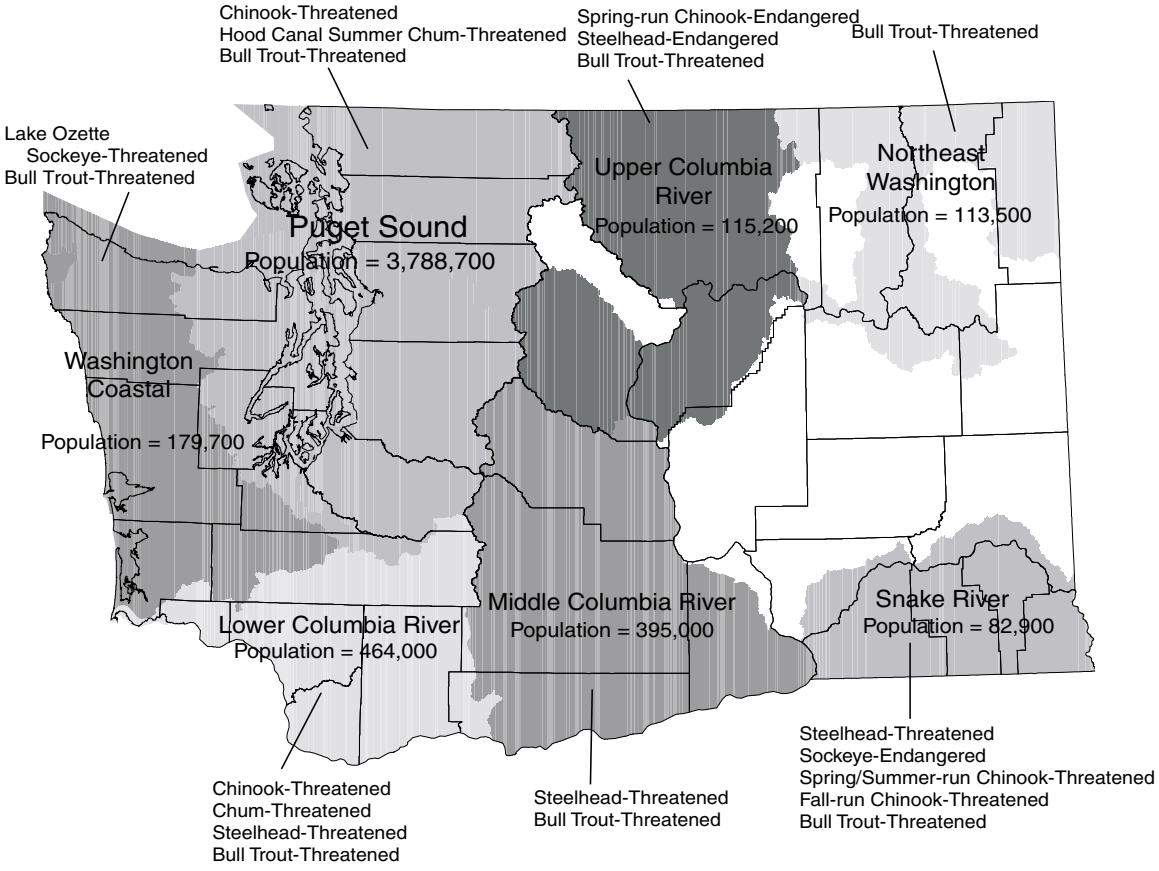
# Saving Salmon, Sustaining Prosperity

## An Introductory Handbook and Reference for the Puget Sound Region and Washington





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## What is this Handbook and why was it written?

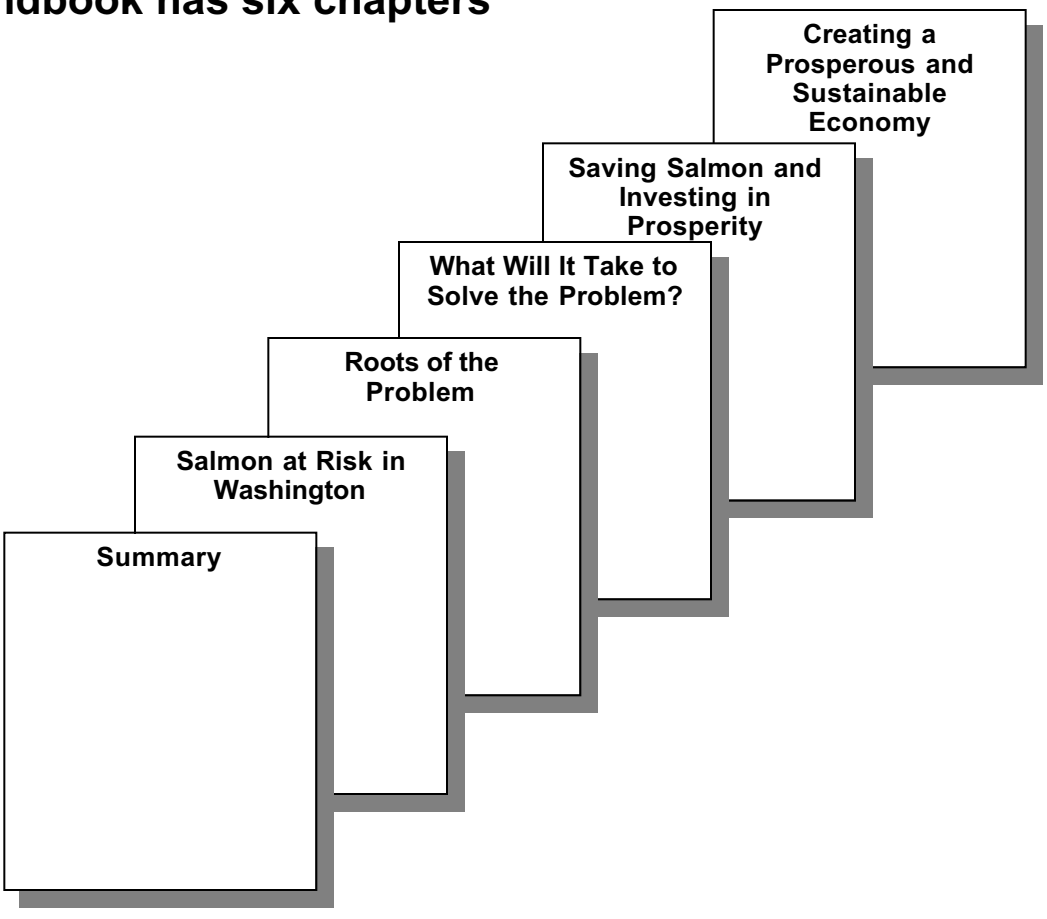
This report offers a quick summary of the economic data and issues associated with efforts to restore healthy salmon runs in the Puget Sound Basin and the rest of Washington.

Salmon populations have declined enough for some of the state's salmon runs to have gone extinct, and others to be listed as threatened or endangered under the federal Endangered Species Act. The listings have generated fear that taking the steps biologists say are needed to prevent salmon from extinction would impose extreme economic harm on taxpayers, business owners, workers, and property owners.

A closer look at the evidence, though, indicates that the reverse will be true. In many instances, saving salmon will result in money savings that exceed the initial costs. If taken efficiently and effectively, the steps needed to save salmon would enhance the value of the services taxpayers receive in return for their tax payments, improve business profits, generate new jobs, and enhance property values. In short, saving salmon will be a good investment for the economy and help communities, businesses, and citizens throughout Washington State adopt more environmentally and economically sustainable paths.

This report provides a summary of the evidence supporting these conclusions. It also contains information about the extent of the declines in salmon populations, a description of the factors contributing to these declines, and extensive endnotes and references pointing the interested reader toward more detailed information.

## This Handbook has six chapters



## Who prepared this Handbook?

This handbook was prepared by Matthew Martin, David Lindahl, Christina Halvorson, Anne Fifield, Ernie Niemi, and Ed Whitelaw, economists with ECONorthwest, under a grant provided through the Salmon Economics Project of the Center for Watershed and Community Health (CWCH), which is affiliated with the Mark O. Hatfield School of Government at Portland State University.

The Salmon Economics Project aims to provide accurate, objective, and easy-to-understand information about the potential costs and benefits associated with rebuilding healthy salmon populations. The Salmon Economics Project is an integral part of the CWCH's focus on developing new, effective approaches for building both strong economies and healthy environments.

The authors and CWCH gratefully acknowledge the financial support of the Ford Foundation, Brainerd Foundation, Lazar Foundation, and Harder Foundation, as well as the comments from reviewers. The authors are solely responsible for the content.

## Other, recent products from the Salmon Economics Project include these reports:

- *Salmon and the Economy: A Handbook for Understanding the Issues in Washington and Oregon.* This short "desk reference" offers a concise summary of how salmon and the economy interact. It compiles representative data on how urban development, timber harvest, agriculture, fish harvest, and dams harm salmon, explains the economic benefits the Pacific Northwest can expect if salmon populations and their habitat improve, and describes what it will cost to rebuild healthy salmon populations.
- *Saving Salmon, Saving Money: Innovative Business Leadership in the Pacific Northwest*. This report compiles evidence showing that 375 businesses and other organizations in Washington and Oregon have substantially reduced their needs for water, energy, hazardous materials and other inputs, by aggressively pursuing environmental efficiency.
- *Just Plain Good Business.* This report describes over $55 million in savings from case study examples of over 160 companies, all of whom have adopted sustainability measures to improve their environmental and economic performance.
- *Saving Salmon, Sustaining Agriculture.* This report is an assessment of the economic costs and benefits of adopting sustainable agricultural practices and increased irrigation efficiency.
- *Saving Salmon and Money Through Green Building Practices: Opportunities for the Pacific Northwest.* This report explains green building practices and provides case study examples where these practices have proven to be cost effective as well as environmentally sound.

Each of these reports can be found on-line at the Center for Watershed and Community Health website. Go to www.upa.pdx.edu/CWCH/.

## How should this Handbook be used?

Read the sections of the handbook that interest you. There are six chapters followed by a glossary listing some frequently used terms. If you want additional information, use these resources:

*Check out the references.* The handbook has a list of references for further information regarding the economics of salmon conservation.

*Contact the authors.* In Seattle, contact Matthew Martin. Phone: 206-622-2403. Email: martin@seattle.econw.com.

*Contact CWCH.* The Center for Watershed and Community Health at Portland State University is developing and implementing innovative proposals for improving the environment and the economy simultaneously. Phone: 503-725-8101. Email: cwch@pdx.edu. Website: www.upa.pdx.edu/CWCH/.

*Check the Salmon and Economy website:* www.SalmonAndEconomy.org, which provides an annotated bibliography of recent studies documenting the benefits as well as the costs of saving salmon. It also has links to governmental agencies overseeing salmon recovery and non-governmental organizations that recognize that saving salmon can generate economic benefits as well as costs.

# SUMMARY

## Puget Sound salmon populations are in trouble, primarily as a result of human activities

- Development has eliminated important salmon habitat, including wetlands and undisturbed streams. Urban areas increase stormwater flows that carry sediments and pollution into streams. Farming and logging create similar problems. As a result, watersheds with salmon and related species listed or proposed as threatened or endangered under the ESA cover 71 percent of Washington, including all of the Puget Sound.[1]

## Fixing the problem will require restoring lost salmon habitat

- Federal law mandates changes to restore salmon. Soon, new federal rules, called 4(d) rules, will go into effect to prevent activities harmful to salmon. We will have to restore salmon habitat and take action to prevent any further harm from human activities. Those who violate the rules and harm salmon face potential legal action.

## If we are smart about it, we can take advantage of opportunities that save salmon, promote prosperity, and ensure environmental sustainability

- Saving salmon presents an opportunity to improve. There are significant opportunities to adopt changes that save salmon and have other benefits. For example, a recent study found that 137 businesses in the Pacific Northwest have already saved $42 million from investments that are both salmon friendly and business smart.[2]
- Local governments can promote savings. Twelve communities saved 6.9 percent in the annual costs of public-sector services and 8.4 percent in overall housing costs by adopting development practices that limit impervious surfaces and control stormwater runoff. They also saved millions of dollars in road construction.[3]
- Future development can be smarter. For example, a 627 acre site in Issaquah will be developed under a plan approved by the City and environmental groups. The plan will preserve 388 acres of essential habitat and provide 71 acres of green space throughout the development.[4] In return, the 1,700 housing units alone will generate about $5 million annually in additional property taxes.[5]
- Farmers can adopt profitable and salmon friendly methods. One option is to plant fast growing hybrid poplars in essential riparian zones. Over a ten-year period, Washington farmers could expect an average annual net return of $300 per acre from selective harvesting of a grove.[6]
- Washingtonians are fooling themselves if they think they can forgo the effort to restore healthy salmon populations and still have a sustainable, prosperous economy. The plight of salmon serves as a warning that too many industries, offices, and households are abusing Washington's environmental and economic bounty by spilling toxic materials into streams, wasting energy and water, and needlessly pulling apart the ecological fabric that has made Washington such an attractive place to live and work. Yes, Washingtonians will have to incur costs to save salmon, but the costs of not saving them will be even greater.

# SALMON AT RISK IN WASHINGTON

## What Do Salmon Need?

Salmon begin life in freshwater streams, then move downstream to estuaries and the marine environment, and later return to their natal streams to spawn. Salmon are one of the few fish that require both fresh and marine water for survival, and at each life stage, their habitat needs change. Human activities have the greatest impact on salmon habitat in freshwater streams, as well as in estuaries and along shorelines. In freshwater streams, salmon need:

- **Cool Water.** Sufficient amounts of cool, clean water with high dissolved oxygen levels.
- **Riparian Habitat.** Salmon also need healthy stream corridors, with stable banks, tree and shrub cover to provide shading and shelter, and the right balance of pools, riffles, and other water environments.
- **Large Woody Debris.** Biologists have determined that it is especially important for streambeds to hold many large pieces of wood, which come from large trees falling into the stream. Juvenile salmon need an adequate supply of the small animals, called macroinvertebrates, and other sources of food.
- **Nutrients.** Most streams in which salmon spawn are relatively poor in nutrients, so the carcasses of the parent salmon indirectly provide valuable food for the next generation of fish. When fewer salmon return to spawn, fewer nutrients enter the system to nourish plants, animals, young salmon, and other fish.[7]
- **Gravel.** Salmon need gravel to lay their eggs in, but it must be the right size – fine sediment can smother salmon eggs and too-large gravel can prevent the fish from digging their nests (redds).

## The Extent of the Problem

River basins with salmon and related fish listed or proposed as threatened or endangered under the federal Endangered Species Act (ESA) cover 71 percent of Washington State and nearly all of western Washington.[8] In 1992, a joint state and tribal study examined Washington's 435 wild salmon and steelhead runs. Twelve runs were found in critical condition, 122 runs had stocks that were below expected levels (depressed), and one run was extinct.[9] The study found that of the Puget Sound's 209 salmonid runs, 93 were healthy; 55 are critical or depressed; 60 are of unknown status; and one is extinct.

Not only have salmon runs decreased in size, the actual salmon are shrinking. In the last century, Washington salmon returning from the Pacific Ocean have decreased in average size and age. Along the Pacific coast, today's chinook and chum salmon are about half the size of the fish in 1920, and coho sizes have dropped more than one-fourth in the last four decades.[10]

## Status of Wild Salmon and Steelhead Runs, 1992[11]

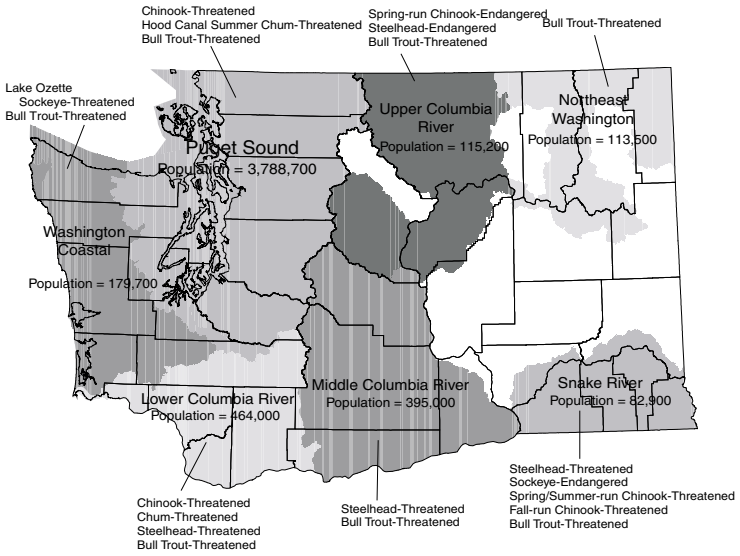
| Wild Salmon Runs[a] | Washington | Puget Sound |
|---|---|---|
| Total | 435 | 209 |
| Healthy | 187 | 93 |
| Critical or Depressed | 134 | 55 |
| Status Unknown | 113 | 60 |

[a] Includes salmon and steelhead only. Excludes non-anadromous salmonids, such as bull trout.

The close proximity of so many people to critical salmon habitat presents some unique challenges—and opportunities—for the conservation effort. While salmon runs are threatened throughout most of the state, there is a wide human population disparity between the Puget Sound and the other affected regions. The timber and agricultural industries have had to react to previous ESA listings, most famously the spotted owl. Taking corrective action to save salmon now, however, will also affect local governments, homeowners, developers, and industries in the Puget Sound area.

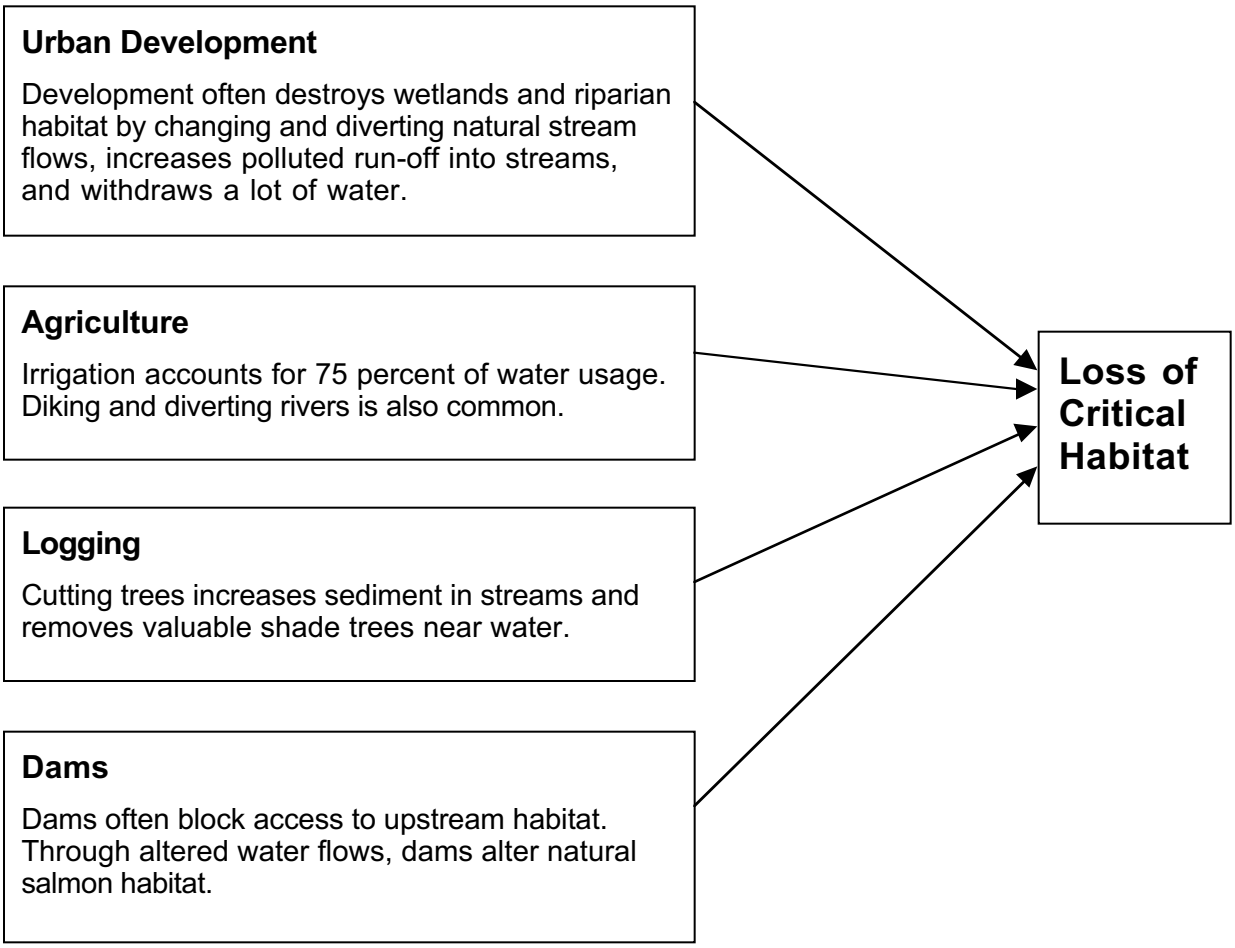
River basins with salmon and related fish listed or proposed as threatened or endangered cover 71 percent of the state of Washington.

## The Puget Sound region is the most densely populated portion of Washington[12]




Recently, the National Marine Fisheries Service finalized the 4(d) rules limiting activities that may be harmful to salmon. While similar rules have been adopted before for other species, never have they been put to use in such a highly urban environment. Local communities have been anticipating these rules and developing plans in response. These plans will affect nearly everyone in the Puget Sound, as well as many other parts of the state.

# ROOTS OF THE PROBLEM




## Loss of Habitat

Like any species, salmon populations cannot live without habitat that provides the food and shelter they need to survive and reproduce. Since salmon migrate during their lives, they need habitat in streams, estuaries, and marine systems. Because water flows downhill, upstream activities—including ones some distance from the stream itself—affect salmon streams. Land uses throughout the watershed influence the water quality, quantity, and structure of streams. When habitat declines, pollution, predation, disease, non-native species, and other threats pose greater risks to already-weakened salmon runs.

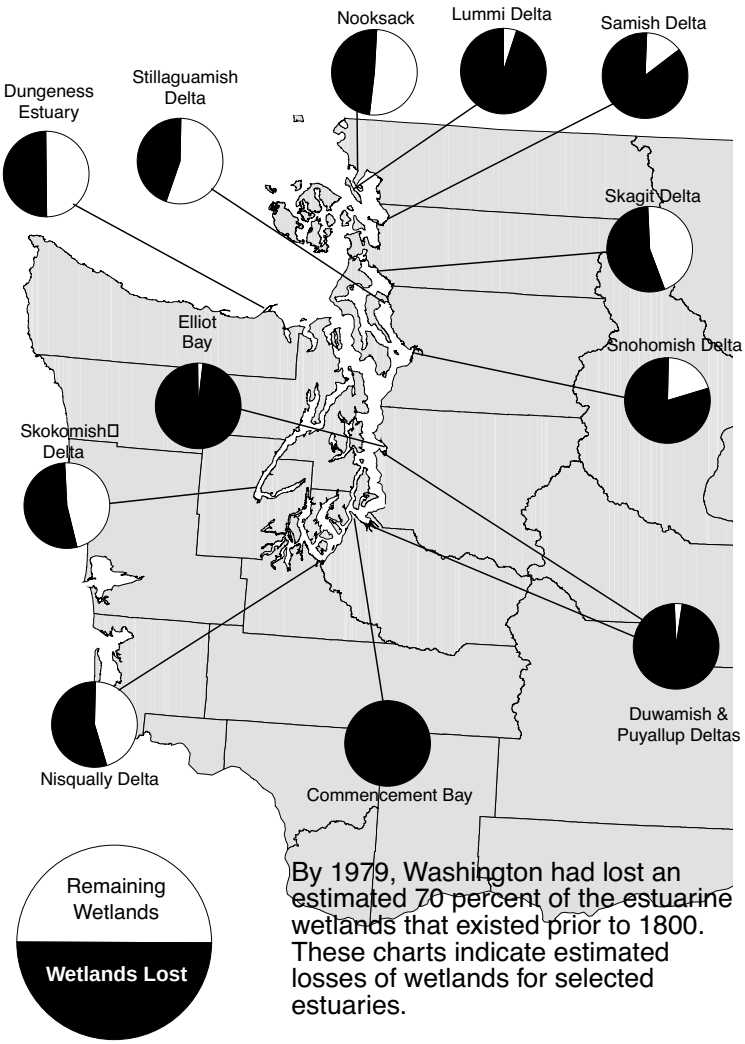
# Urban Development

A 1995 study found that human activities have modified nearly 800 miles, or one-third, of Puget Sound's shoreline. In central Puget Sound, where the population is concentrated, this figure rises to more than half.[13] Stream habitat is no better, with culverts blocking fish access to more than 3,000 miles of potential spawning habitat.[14]

## Loss of Riparian Habitat and Wetlands

The removal of nearby vegetation and other habitat changes can destabilize streambeds, increase sediment, and raise temperatures in the stream, which hurts salmon and their eggs. In recent years as many as 30 percent of stream monitoring stations in Puget Sound showed excessive temperatures.[15] Wetlands filter pollutants, replenish groundwater supplies, reduce flooding, and provide key habitat for fish, birds, and other wildlife. Overall, more than 70 percent of tidal wetlands in the Puget Sound have been destroyed, mainly as a result of urbanization, development of ports, and industrial use. About 500-1,000 acres of freshwater wetlands are filled each year in the Puget Sound region. [16]

### Most Wetlands in Puget Sound Are Gone[17]




By 1979, Washington had lost an estimated 70 percent of the estuarine wetlands that existed prior to 1800. These charts indicate estimated losses of wetlands for selected estuaries.

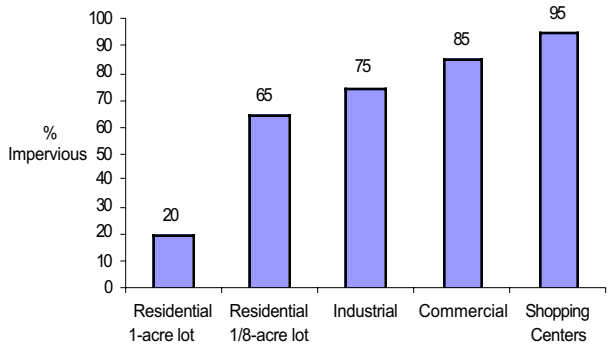
## Water Withdrawals

Though agriculture is the largest water user statewide, communities in western Washington are starting to feel the squeeze of limited water availability from increases in industrial and domestic use, which are the second and third highest users of water, respectively.[18] Water withdrawals are especially harmful to salmon when streams are at seasonally low levels in the late summer and early fall.

## Impervious Surfaces

Research shows that in undisturbed forests in the Puget Sound region, less than one percent of rainfall runs off the surface of the land. On impervious surfaces like the roads and roofs found in urban areas, however, 84 percent of rainfall becomes surface runoff, which conveys sediment, oil, metals, trash, and other pollutants from the land into streams. A recent study of 22 watersheds in the Puget Sound lowlands found levels of imperviousness ranging from less than 5 percent in undeveloped areas to more than 45 percent in highly urbanized watersheds. Additional research found roads, parking lots, and other transportation features often account for more than 60 percent of total impervious surface in suburban Puget Sound.[20]

**Impervious Surface by Land Use[19]**




## Pesticides, Fertilizers, Sediment, and Other Pollutants

When impervious surfaces increase with urban development, more pesticides, fertilizers, sediment, and other pollutants enter streams. In the Puget Sound basin, pesticide use in urban areas, at over 1 million pounds annually, is more than triple the region's agricultural use.[21] And the region's failure rate for septic systems is about 3.5 to 5 percent, representing 14,000 to 20,000 systems discharging untreated wastes into the basin.[22] Studies show that chemical exposure in the polluted bays near Seattle and Tacoma impairs the growth, survival, and immune systems of young coho salmon.[23] Many of these areas also are unsafe for humans.

## Culverts

Culverts, which channel streams under roadways or other structures, can constrict streams and block salmon from migrating to upstream habitat. About 80 percent of the culverts in the Puget Sound basin block fish passage.[24]

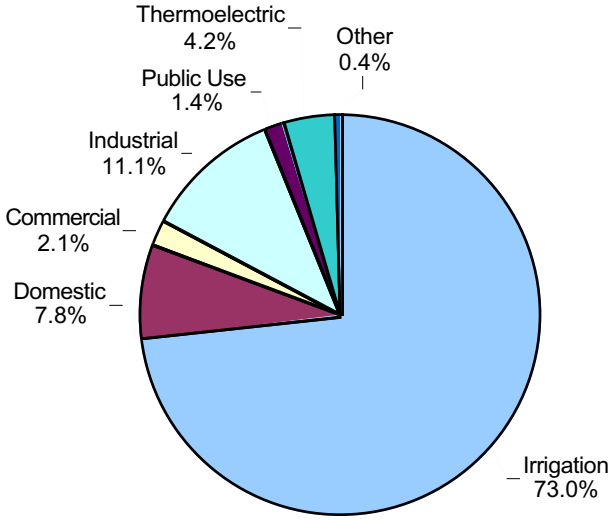
## Logging

On the west slope of the Cascade Range, clearcutting a single acre, along with the accompanying road construction, results in 3.5 tons of additional sediment per year for about 25 years, clogging the streams where salmon live.[25] About three-quarters of culverts in western Washington forests block or impede fish migration.[26] Cutting streamside vegetation removes the protective shade that keeps streams cool enough for salmon and helps maintain the high dissolved oxygen levels they need. Studies of streams west of the Cascades show maximum temperatures exceeding 20° Celsius (potentially stressful for salmon) in 70 percent of streams and exceeding 25° Celsius (potentially deadly) in 20 percent of streams.[27]

## Agriculture

In the lowlands surrounding Puget Sound, diking and diverting rivers in agricultural regions is a major factor in the decline of salmon habitat.[28] Of the 8.8 billion gallons of water used in Washington every day, three-quarters is for irrigation. Withdrawals for irrigation reduce the amount available in streams for salmon, especially during dry summers when water levels are already low. Statewide, agricultural activities are the most common pollution source for streams, lakes, estuaries, and other surface waters.[29]

**Distribution of Water Use in Washington State[30]**



# Dams

Dams block or delay the movement of young salmon migrating downstream towards the Puget Sound as well as adult salmon heading upstream to spawn. Dams are hazardous for young salmon, which are injured or killed passing through turbines and over spillways. The reservoirs behind dams raise water temperatures, silt levels, and the risk of being eaten. They also change river flows, often leaving insufficient flows below the dams. The counties surrounding Puget Sound contain about 400 dams. Almost no sizeable rivers in the state remain without dams, except a few on the Olympic Peninsula.[31] Nine dams alone in the Puget Sound region block salmon access to more than 200 miles of streams with considerable areas for spawning.[32]

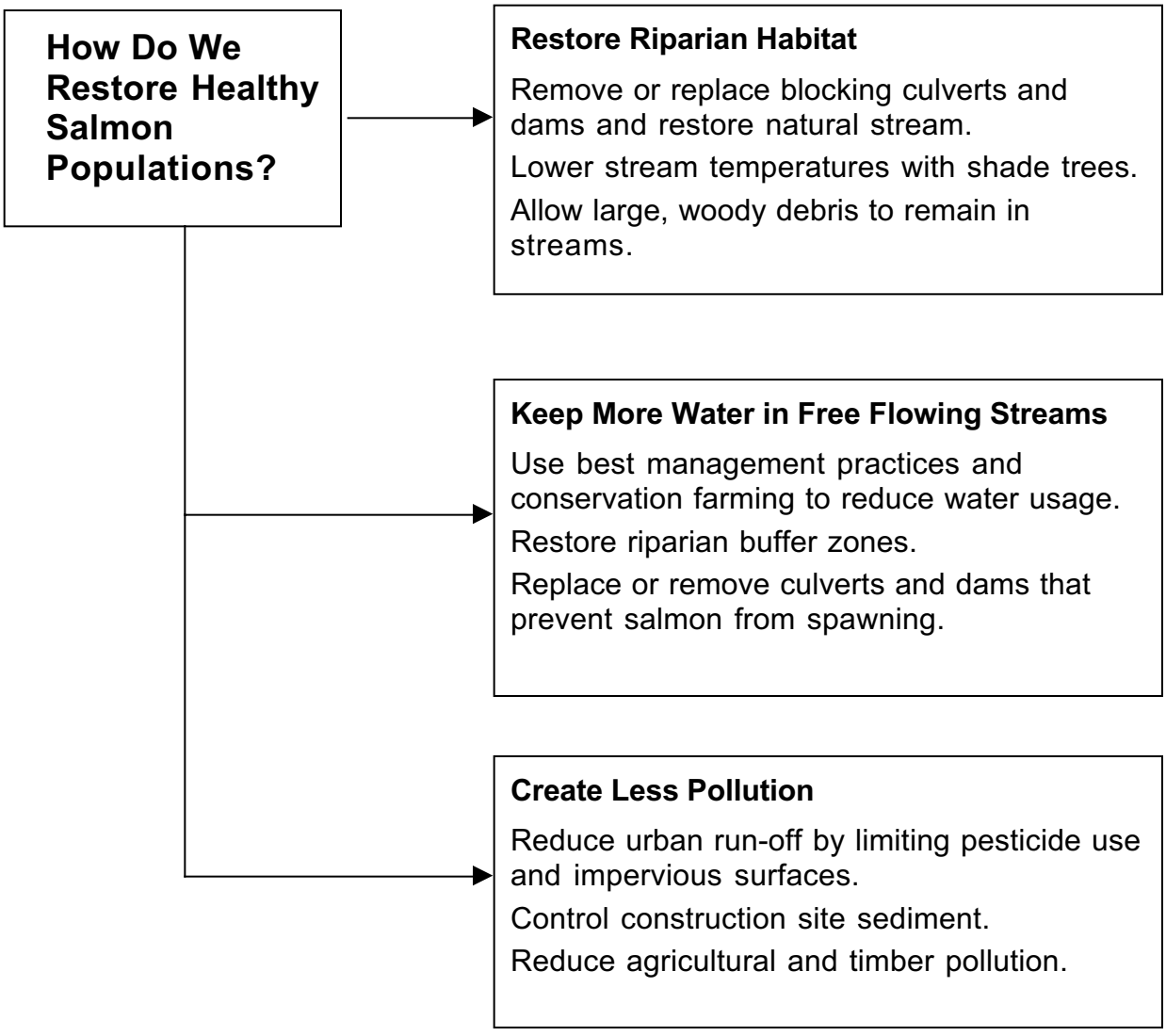
**Dams in Puget Sound by County, 1999[33]**

| County | Public | Private | Total[a] | Total Storage Capacity (acre-feet) |
|---|---|---|---|---|
| Clallam | 7 | 11 | 18 | 48,499 |
| Island | 4 | 6 | 10 | 484 |
| Jefferson | 2 | 2 | 4 | 3,758 |
| King | 62 | 33 | 95 | 1,127,246 |
| Kitsap | 10 | 14 | 24 | 9,116 |
| Mason | 4 | 12 | 16 | 963,676 |
| Pierce | 20 | 30 | 50 | 670,375 |
| San Juan | 6 | 45 | 51 | 11,914 |
| Skagit | 5 | 15 | 20 | 173,036 |
| Snohomish | 22 | 27 | 49 | 223,771 |
| Thurston | 4 | 25 | 29 | 71,348 |
| Whatcom | 15 | 19 | 34 | 2,258,896 |
| TOTAL | 161 | 239 | 400 | 5,562,119 |

[a] Number of dams includes those regulated by federal or state agency.

# WHAT WILL IT TAKE TO SOLVE THE PROBLEM?

The basic needs for a healthy salmon population requires, among other things, restoring lost riparian habitat, providing more and freer-flowing water for upstream activities, and putting less pollution into surface waters. Although this sounds easy, in practice it has proven difficult, especially for the Puget Sound where the unique issues of urbanization are not completely understood. The last part of this chapter summarizes some ways to be smarter about development in the future.



# Salmon Recovery Needs

Efforts to protect and restore dwindling salmon runs should address the problems identified in the previous chapter. This section summarizes some of the major changes needed to respond to these problems. If done correctly, correcting past mistakes to promote healthy salmon populations will also help to make our future activities more environmentally sustainable.

## Restore Riparian Habitat

Often, restoring habitat means removing or replacing culverts and restoring natural stream flow that has been straightened or diverted. For example, a joint public and private effort will remove the Goldsborough Dam near the town of Shelton and owned by the Simpson Lumber Company. The lumber company will save the expense of repair and upkeep on the dam, while in its place, a 2,000 foot stretch of the stream will be regraded and landscaped, restoring access to 14 miles of upstream salmon habitat.[34] Other goals of restoration should include:

A joint effort to remove the Goldsborough Dam will restore access to 14 miles of salmon habitat.

- **Lower stream temperatures.** Shade from nearby trees keeps streams from getting so warm that salmon cannot survive. Research on streams west of the Cascades found maximum stream temperatures in 70 percent of the streams exceeded 20° Celsius, deemed potentially stressful for salmon, and 25° Celsius (potentially lethal) in 20 percent of the streams.[35]
- **More large wood in streams.** Research has shown that, when large trees fall into a stream, they provide important habitat for salmon. Surveys in Oregon's Coast Range, though, indicate that only 17–23 percent of stream miles have a "desirable" number of pieces of large wood.[36] A similar shortage is likely in Washington.

## Keep More Water in Free Flowing Streams

Regenerating riparian zones will have little impact without sufficient water flow. Salmon migrating upstream to spawn face obvious difficulties if stream levels are too low. Likewise, juveniles migrating to the ocean need water to complete the journey before their transformation to saltwater fish is complete.

*More Water*

- **Reduce Urban Water Use.** A recent study by Seattle Public Utilities indicated that more than 31 million gallons of water could be conserved each day during the high-use summer months if consumers implemented cost-effective technologies, such as low-flow toilets, efficient showerheads, and efficient clothes washers[37]

In the Seattle area, 31 million gallons of water could be conserved each day during the summer months.

- **Conservation Farming.** Irrigators divert about 6.3 million acre-feet (maf) of water from streams in Washington,

roughly three-fourths of total water withdrawals.[38] Irrigators return to streams about one-half of what they withdraw. No-till farming and other conservation practices reduce the need for irrigation.

- **Reduce electrical use.** Efforts to reduce the amounts of electricity we use allow more water to flow over salmon ladders. New houses and industrial facilities can be built with energy and money saving devices. With conservation, removing unneeded dams might be possible.

*Free Flowing Streams*

- **Unblock fish passage.** One study in western Washington found three of every four culverts in forested areas block or impede fish movement.[39] These need to be removed or replaced. Dams block 55 percent of the salmon habitat and 33 percent of the total stream miles in the Columbia Basin.[40] In Puget Sound, nine dams alone have blocked access to an estimated 201 miles of streams with substantial spawning areas.[41]

> Three of four culverts block or impede fish movement. These need to be removed or replaced.

- **Change stream channels.** In the Puget Sound lowlands, the diking and diversion of streams and rivers in agricultural areas is the most cited cause for salmon habitat reduction.[42] Urban areas tend to channel streams underground or through concrete embankments. Where possible, natural stream banks need to be restored.

## Create Less Urban Pollution

Urban use of pesticides, about 1.1 million pounds per year, is more than three times greater than agricultural use in the Puget Sound area.[43] Pesticides used on lawns and gardens often end up in streams, where concentrations frequently exceed water-quality standards.[44]

- **Reduce sediment and other pollutants.** Urban lands deliver harmful chemicals to streams. A recent study found that nine of ten urban streams examined in King County contained diazinon, a chemical linked to home lawn care.[45] Developing plans, voluntary or otherwise, to reduce the use of these chemicals is essential as many important salmon runs traverse urban property.

> A recent study found that nine of ten urban streams examined in King Country contained diazinon, a chemical linked to home lawn care.

- **Limit impervious surfaces or control and treat run-off naturally.** Seattle is working on a pilot project that narrows and curves an existing street and installs detention swales to contain and filter stormwater. When finished, it will permit more soil infiltration than before, reducing urban pollution into local streams.[46]

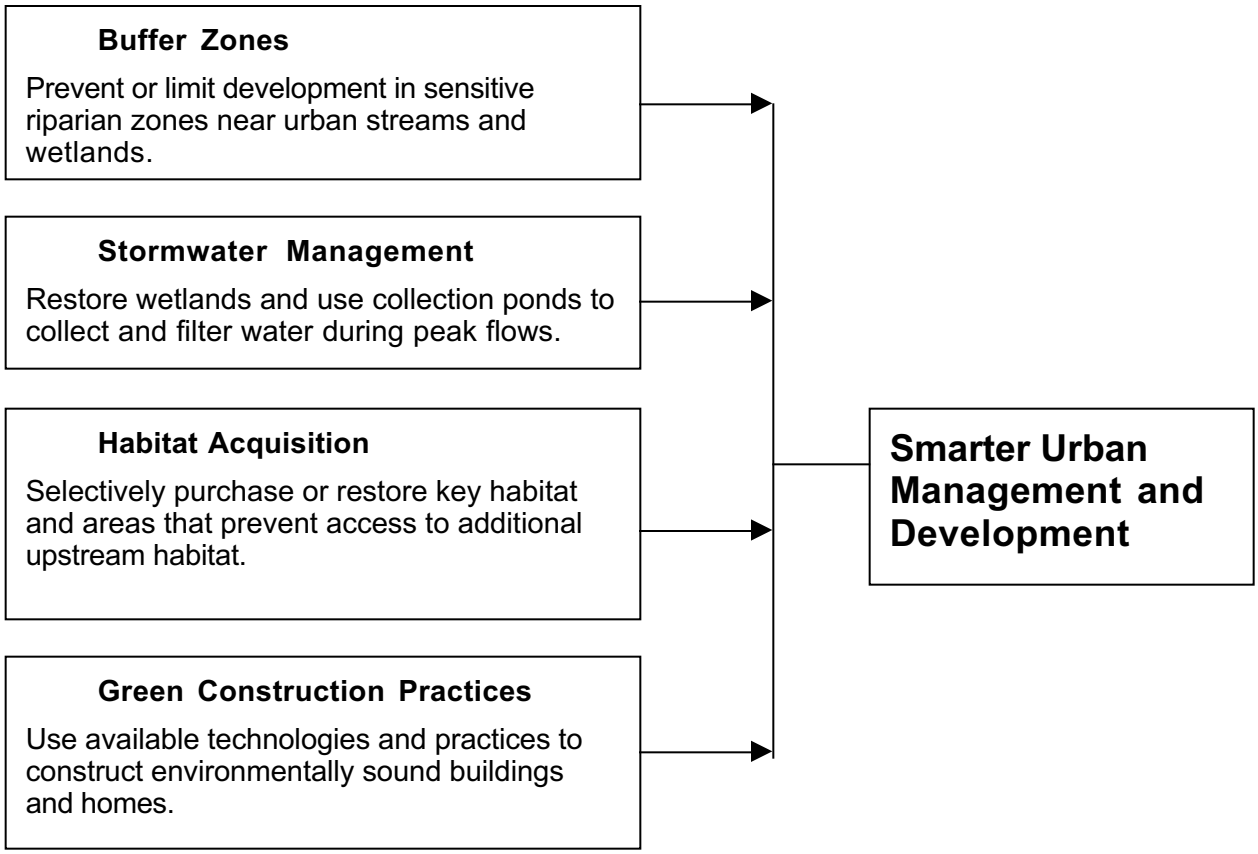
## Reduce Agricultural and Timber Pollution

Up to 64 percent of sediment found in streams comes from cropland, pasture, and rangeland.[47] The highest pesticide concentrations often occur in streams draining from agricultural areas.[48] Restoring riparian zones and creating silt pools help filter water before it reaches streams. Integrated pest management, which seeks to

reduce agricultural pesticide use through natural means, is gaining increasing attention as a way for farmers to reduce their use of expensive chemicals.

Research in the western Cascades shows that clearcutting one acre, with the associated roads, causes sedimentation to increase by 3.5 tons per year for about 25 years.[49] Large-scale clearcutting also increases the risk of landslides Reduced clearcutting, especially on steep slopes or land near critical stream habitat, is the easiest may to reduce chemicals or run-off from timber lands.

## Smarter Urban Management and Development




The urban environment of the Puget Sound is a new aspect to endangered species recovery efforts. Previous plans to save endangered species like the spotted owl, for instance, have centered primarily on rural activities, such as logging and farming. However, the plans being developed to save salmon in the Puget Sound must address urban activities to be successful. This section provides some brief descriptions of some steps that may be taken in the salmon recovery effort. Adopting environmentally smarter development practices is necessary for sustainable development.

- **Buffer Zones**. Some jurisdictions are considering buffers in the range of 50-300 feet wide, depending on the size and sensitivity of the water body. Potential policies applied in this zone could include ordinances restricting development, protecting native plants and forest cover, requiring structural setbacks from the stream edge, and limiting impervious surfaces.[50]

- **Stormwater Management.** Limiting polluted stormwater is a major challenge for urban areas. Collection ponds, restoration of wetlands, and smart building practices that allow for more pervious surfaces can help attenuate peak flows.
- **Habitat Acquisition and Restoration.** Habitat acquisition and restoration should focus on improving habitat needed to address key shortcomings in Puget Sound watersheds, such as insufficient estuarine habitat and barriers to fish migration.
- **Green Building and Construction Practices.** Green building encompasses practices that improve building performance while also reducing stress on the environment. These practices can be grouped into five categories:

  **1) Energy-saving practices** reduce the amount of energy used for heating and lighting. Particularly innovative techniques include furnaces equipped with clock thermostats, skylights for closets and dark hallways, and triple-glazed windows.

  **2) Water-saving practices** cut down on water use both indoors and outdoors. Green buildings use low-flow showerheads, aerating faucets and high-efficiency washers and recycle gray water for outdoor use.

  Green Building and Construction Practices:

  1. Energy Saving
  2. Water Saving
  3. Pollution-Reducing
  4. Run-off Reducing
  5. Forest-Conserving

  **3) Pollution-reducing practices** limit the use of toxic building materials, such as particleboard and cabinetry made with formaldehyde glues. In landscape designs, using native instead of exotic plants decreases the need for fertilizers and pesticides.

  **4) Runoff-reducing practices** limit stormwater that surges into streams, primarily by retaining it on-site and reducing the amount of impervious surface on the property. Techniques include on-site drainage ponds and rainwater catchments.

  **5) Forest-conserving practices** lower demand for new timber and other natural resources. They include advanced framing systems that use less timber, salvage used timber, and use timber from sustainably-harvested forests.

# SAVING SALMON AND INVESTING IN PROSPERITY

The Puget Sound region will be going through an experimental recovery in the midst of a thriving urban economy. The application of the ESA in the Puget Sound is the broadest in the statute's 26-year history in terms of geography and the effect on the population.[51]

But many fear that the recovery will be too costly for the region. However, there is already substantial evidence that opportunities to save salmon can also be opportunities to do other things in ways that are cost-efficient economically and environmentally sustainable. If we miss those opportunities and wait until it's too late, however, saving salmon may require more than finding mutually beneficial opportunities.

## Economic Principles for Benefit and Cost Analysis

In September, 1998, 78 economists sent a letter to the governor's of four Pacific states and the premier of British Columbia outlining important economic issues to consider when evaluating salmon recovery alternatives.[52] They presented six principles that need to be considered to understand the full range of economic consequences for saving salmon. The first two principles are the most important as they address the two primary areas of analysis.

**Six Principles for Considering the Economics of Saving Salmon**

- *Benefits as well as Costs*
- *Positive as well as Negative Impacts on Jobs*
- *Distribution of Consequences and Fairness*
- *Rights and Responsibilities*
- *Uncertainty and Sustainability*
- *More than just Salmon Conservation*

1. **Benefits as well as Costs.** Salmon conservation will generate economic benefits as well as economic costs. Consider them both to understand the full effect on the value of the goods and services derived from streams, forests and other resources. The first principle is the most important. Too often the costs of salmon conservation receive attention without a proper understanding of the related benefits.
2. **Positive as well as Negative Impacts on Jobs.** Salmon conservation will have both positive and negative impacts on job opportunities. Consider them both to understand the full impact on workers, their families and their communities.

The remaining four principles offer guidance in the application of the first two principles.

3. **Distribution of Consequences and Fairness.** Those who enjoy the benefits or positive job impacts of salmon conservation will not necessarily be the same as those who bear the costs or negative job impacts. Consider the

full distribution of economic consequences to understand who wins, who loses and the fairness of the distribution.

4. **Rights and Responsibilities.** With salmon conservation, property owners and resource users will behave differently than they otherwise would have. Consider whether these changes represent infringement on their rights or enforcement of their responsibilities.
5. **Uncertainty and Sustainability.** Salmon conservation decisions unavoidably will be based on information insufficient to guarantee the outcome. Consider the potentially high costs that might materialize from decisions that increase the probability of undesirable outcomes that are irreversible (such as extinction) or extremely difficult to reverse.
6. **More than just Salmon Conservation.** Salmon conservation will have a variety of ecological and economic consequences, such as changes in the quality of stream water used for other purposes, that may be peripheral to the salmon themselves. Consider the full set of consequences derived from salmon-conservation efforts.

The remainder of this chapter addresses some of the more important economic issues regarding salmon restoration by applying these six economic principles. Occasionally, where a clear example of one of the principles emerges, the text will indicate which principle is being applied.

## Harvest and Marine Activities

Successful salmon-recovery efforts will yield more fish for harvest by the commercial fishing industry and others. Research estimates that increased supplies of fish to the commercial fishing industry would be worth about $5-70 per fish, depending on the species and method of harvest.[53] However, the total value to recreational fishers is the amount anglers are willing to pay to fish for the salmon. Economists typically break this value into two parts. One is the amount anglers actually spend. In most cases, though, anglers are willing to spend more than they actually do. The difference, called consumer surplus, is the amount the angler's willingness to pay exceeds what they actually pay. Anglers' total willingness to pay—the sum of their expenditures plus their consumer surplus—to catch a salmon or steelhead in recent years has been about $190 per fish.[54]

**Potential Impacts on Jobs and Other Variables from Increased Fish Catch**

| | Impact per 1,000 Fish[a] |
|---|---|
| *If Fish Are Caught Commercially…* | |
| Jobs | 1.5 |
| *If Fish Are Caught Recreationally…* | |
| Anglers' Expenditures | $79,510 |
| Jobs | 4.0 |
| Anglers' Consumer Surplus[b] | $108,900 |

[a] Estimates based on multiple assumptions. Actual impacts may vary. See references for details.

[b] Value of fish to anglers minus costs of catching them.

If the salmon harvest were increased to a level that allowed more commercial activity, fishermen would experience more job opportunities and business. The recreational fishing industry would also experience a net gain in employment.

## Real Estate, Development, and Property Owners

Salmon recovery is tied inextricably to land and property. Developers, landowners, architects, contractors, and others involved in the real estate industry will see the effects of salmon recovery in their planning, design, development, and property management activities. Yet, while many may see only the costs of these changes, most businesses and landowners will not suffer noticeable financial losses; in fact, many have the opportunity to experience increases in land value and property income.

### Salmon recovery is consistent with other forms of land use regulation

- **The real estate industry has always adjusted to land use management policies.** Buffer zones, reduction of impervious surfaces, construction site practices, and other actions to recover salmon are similar or nearly identical to existing regulations and practices. Washington's Growth Management Act of 1990 is a model for the rest of the nation, and landowners and the real estate industry have adjusted their practices in conjunction with its implementation. Salmon recovery efforts will be no different—what investors and landowners value most are well-defined laws and guidelines. As specific policies are developed and implemented, buyers, sellers, developers, and tenants will adjust accordingly.

> As specific policies are developed, buyers, sellers, developers, and tenants will adjust accordingly. Over time, many of the initial adjustment costs will fade away.

- **Most urban properties are valued based on density, not parcel size.** One of the biggest fears to property owners is that the creation of a riparian buffer zone will reduce the value of their real estate by reducing the amount of land that can be developed. The value of most commercial land, and urban residential land, however, is based on the amount of buildable area (i.e., per square foot) and not on the size of the parcel. So a 5-acre lot zoned for office development at a Floor to Area (FAR) ratio of 0.25 may, in fact, be less valuable than a 3-acre lot with a FAR of 0.5. If a buffer zone reduces or eliminates development in certain areas, it may have little effect, no effect, or a positive effect, depending on how development densities are increased on other parts of the property or in other areas.

- **Salmon recovery may decrease the value of some properties and increase the value of others.** Riparian buffer zones, which limit developed uses along salmon-bearing waterbodies, may reduce the value of some waterfront and other properties where the use is significantly curtailed. This is an example of the third economic principle at work. However, such zones also create greenbelts that can have a value-enhancing impact on adjacent properties. A recent study of

> A recent study … found that homes adjacent to natural areas yielded an average $11,000 price premium.

housing sales in Portland found that homes adjacent to natural areas yielded an average $11,000 price premium.[55]

- **Property prices are an effective means of encouraging the right behavior to recover salmon.** Certain activities in specific locations are most harmful to salmon. For instance, tract development adjacent to a salmon-spawning stream will have more of an impact, and be subject to stronger recovery efforts, than developments in less critical habitat. Property values will reflect both the potential costs of these efforts and act as a regulating mechanism to where development occurs.

## Saving salmon makes economic sense for landowners

- **Green building and development practices are good for the bottom line.** They are happening regardless of formal salmon recovery efforts. These practices provide a way for environmentally sustainable development that is also good for business. The report entitled *"Saving Salmon and Money Through Green Building Practices"* provides numerous examples of these practices in action. See the box to the right for examples.
- **Homeowners buying green buildings can get more house for their money.** Fannie Mae, a national mortgage-finance company, is testing "green mortgage" programs throughout the United States. The notion is simple. If you expect to pay less for electricity, gas, or water, you have more to spend on the house, and you qualify for a larger or cheaper mortgage. Green mortgages capture these long-run energy savings in the initial mortgage, effectively raising the purchase price.

**Examples of Green Building:**

**King Street Center, Seattle, Washington.** Opened in 1999, this eight-story 327,000 square-foot office building uses just 28 percent of the energy allowed by existing energy codes. An on-site rainwater system supplies 60 to 80 percent of water used for flushing toilets in the building.[56]

**Seventh Generation Systems Sustainable Technology Center, Friday Harbor, San Juan Island, Washington.** This 17,000 square foot commercial development, uses state-of-the-art green building technology. As a result, this development saves $32,000 a year—the equivalent of two months' free rent for all its tenants. Electricity costs were reduced 83 percent, and sewer and water costs were reduced 69 percent.[57]

**Build a Better Kitsap Home, Hansville, Washington.** The Build a Better Kitsap program is run by the Home Builders Association of Kitsap County. There is also a program in Clark County, Washington. This 2,400 square-foot home meets the programs highest "3-Star" criteria and is expected to save $750/year in heating costs.[58]

# Businesses

Saving salmon may require businesses to alter the amount of pollution and waste they create, diminish their energy use, and generally adopt more environmentally sound practices. Often these will impose up-front costs on businesses. In many cases, however, firms will reap savings from lower operational costs in return. This is simply an application of the first and sixth economic principles discussed earlier in the chapter.

## Opportunities to Reduce Waste and Energy and Water Use

### Examples of Businesses Saving Money[59]

| Company | Type of Program | Savings |
|---|---|---|
| Boeing Commercial Airplane Group | Energy conservation | $92,000 per year |
| Water Wells & Sons Viewmont Orchards | Energy conservation, micro-irrigation | $55,000 per year |
| Sound Ford Auto Body Shop | Paint conservation and computer tracking system | $84,000 per year |

A recent study found that 137 businesses in the Pacific Northwest have already saved over $42 million between 1992-1999 by making sound business and environmentally smart investments. Private firms were able to recoup their initial costs through reduced energy or water needs or waste disposal savings in an average of four years.[60] Another study of over 160 firms found the average payback period to be just 1.9 years.[61]

If just 25 percent of firms in Washington and Oregon were to make investments into sustainability, the savings to firms would increase to over $1 billion.[62] Salmon would benefit from lower energy demand, making it possible to eliminate the electric generating dams that are most damaging to salmon habitat.

> If 25 percent of firms were to make environmentally sound investments, the savings could increase to over $1 billion.

## Better Marketing Potential

Consumers have shown a growing preference for environmentally safe products and services. From a business perspective, salmon friendly products offer a chance to establish a market niche while practicing good stewardship. The commitments by Home Depot and Lowe's to phase-out wood products from old-growth forests and efforts by MacMillan Bloedel, Willamette Industries, and other timber producers to phase out environmentally harmful practices, show that firms producing and retailing salmon-friendly products can gain a market advantage.

# Local Governments and Communities

Saving salmon will impose some budgetary costs on communities trying to comply with the new rules. In return, they can expect to reap many fiscal and natural amenity benefits that are associated with salmon recovery. In fact, there is growing evidence that investment in community projects to save salmon will provide for greater prosperity in the future.

## Investment to Save Salmon

Local governments will shoulder much of the financial burden of saving salmon. One survey reported that Washington residents would be willing to pay $30 to $97 annually per household to save salmon.[63] That compares favorably to a report that estimates the cost to local communities to be about $79 per Puget Sound household annually, in constant dollars.[64] Some examples of current efforts include:

> Washingtonians say they are willing to pay $30 to $97 annually per household to save salmon.

- **Cedar River Habitat Conservation Plan.** Seattle owns over 90,000 acres in this watershed, which supplies most of the city's drinking water. Under a plan to preserve and restore the watershed, Seattle expects to spend about $90 million over 50 years, which amounts to about $3.33 per city resident and $1.38 per person in the service area.
- **Saving Salmon Eggs.** Seattle's City Light utility spends about $500,000 to $2 million each year to maintain water levels in the Skagit River to protect salmon eggs. This is about one dollar per person in the service area. The project returns about 30,000 additional salmon to spawn each year, for a cost of about $17 to $67 per reproducing fish.

## Cost Savings for Local Governments

The first principle of salmon economics reminds us to consider benefits as well as costs. A comprehensive salmon-conservation program will also offer opportunities for cost savings to local communities. Preventative measures offer the best chance to avoid potentially costly cleanup and restoration.

- **Savings from reducing impervious surfaces.** Twelve communities in a Delaware watershed saved an average of 6.9 percent in annual public services costs and 8.4 percent in overall housing costs through smart development that limited impervious surfaces and stormwater run-off.[65]

> Twelve communities saved an average of 6.9 percent in annual public services costs by limiting impervious surfaces and stormwater run-off.

- **Savings from sediment reductions.** Salmon restoration would reduce excess sediment that clogs channels, exacerbates floods, and causes other damage. Each ton prevented will reduce damage by about $3.66.[66] Eliminating sediment from construction sites, for example, could save $109 per acre.[67]
- **Savings from reduced water usage.** Seattle residents could save as much $20 million annually by following best management practices to reduce water use, maintaining higher water levels in streams.[68]

- **Savings from clean watersheds.** Residents of Salem, Oregon save about $15-30 per person annually because its watershed delivers water so clean that it requires minimal treatment.[69] These savings could be sought through other salmon restoration efforts.
- **Increased tax revenue from smart development.** Recently, Intracorp finalized a plan to develop a 627 acre site in Issaquah in cooperation with local government and environmental concerns. The plan will leave 388 acres of essential habitat forested and provide 71 acres of green space throughout the development.[70] The 1700 housing units will generate about $5 million in additional taxes for the city.[71]

### Improved Quality of Life for Residents

The salmon recovery efforts will provide many non-market services and amenities that improve the quality of life in the region (the sixth economic principle). Surveys continually show the importance of the regions natural qualities to residents.

By living amid high-quality natural-resource amenities, workers in the PNW, in effect, receive a *second paycheck*—denominated in access to scenic vistas, outdoor recreation opportunities, and the like—that augments the first paycheck earned through work and investments.[72] The approximate size of the *second paycheck* is indicated by the fact that workers generally would not relocate elsewhere in the U.S. unless they received 10–15 percent increase in wages.[73]

Furthermore, in response to a bigger second-paycheck many businesses will chose to locate where there is a growing pool of productive workers and expanding consumer markets.[74] In this way, saving salmon acts as an investment in our economic prosperity.

### Additional Benefits for Residents

By saving salmon, residents of Puget Sound would receive several monetary and natural amenity benefits, such as:

1. Higher disposable incomes from energy and water savings.
2. Lower tax bills for stormwater management.
3. Cleaner water for drinking and recreational use.
4. More green spaces near homes and developed areas.
5. Longer salmon fishing seasons as salmon runs increase.
6. New employment opportunities.

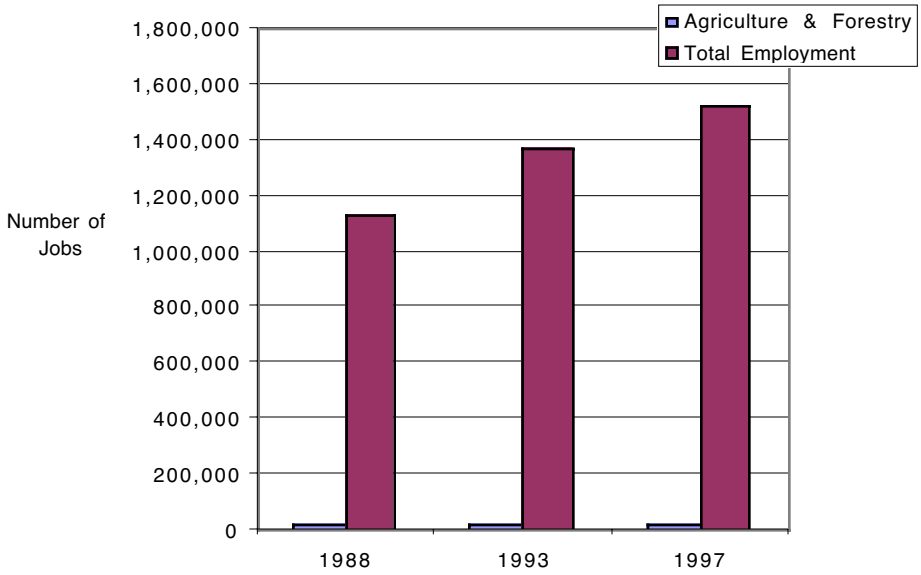
# Agriculture and Forestry

At this point in time, it is unclear exactly how the final 4(d) rules for salmon will affect farmers and timber companies. However, farmers will most likely have to create riparian buffer zones around streams and limit water consumption and soil erosion. The timber industry will need to further limit soil erosion, road building, and clear-cutting. In any case, there are new methods or alternatives available to these industries that are both good for salmon and good for business.

## Addressing Job Concerns

One of the chief concerns about salmon restoration has been the potential impact on jobs, chiefly in the farming and timber industries. Timber harvest and employment have decreased throughout the 1990s, as has agricultural production in the area.[75] These are long term trends, though, and should not be blamed on salmon restoration.

### Puget Sound Employment Growth, 1988-1997[76]




However, the second economic principle discussed earlier in this chapter states there will be positive and negative impacts on jobs and saving salmon could cause some additional workers in these industries to become unemployed. These workers will need the support provided by unemployment insurance and job retraining programs so that they may find employment in expanding industries. Saving salmon will also create jobs, but the new jobs will be in other industries.

Additionally, consider the size of these industries relative to total employment. The total number of ***new*** jobs created in the region over the last five years has exceeded ***total*** employment in the timber and agriculture sectors in any year.

The total number of ***new*** jobs in the region over the last five years has exceeded ***total*** employment in the timber and agriculture sectors in any year.

## New Agricultural Practices

Farmers may face some short-term costs while transitioning to conservation methods of farming, including planting new crops and learning new farming methods. However, in many cases the changes will increase the profitability of agricultural land in the future while ensuring the environmental sustainability of farming.

### No-Till Farming

No-till farming involves drilling seeds into unplowed fields, even if there is leftover material (like corn stalks) from the previous crop. The residue left in the field helps retain soil and moisture. When compared to conventional tillage practices, no-till farming reduces costly soil erosion by as much as 95 percent. [77]

> No-till methods lower the total cost of growing wheat by an average of 10 percent per bushel and reduce costly soil erosion by as much as 95 percent.

A recent study of Pacific Northwest farmers found that no-till methods also lowered the total cost of growing wheat by an average of 10 percent per bushel. The cost savings come from not having to replace eroded topsoil and less field preparation.[78]

The same study noted that fewer farmers have adopted no-till practices in the Northwest compared to the rest of the country, partly from fear of short-term loss, despite the fact that these methods have been used successfully in parts of the state for years.[79]

### Profitable Riparian Buffers

Creating a riparian buffer zone requires about six acres per mile of streamside.[80] The cost to the farmer is the net profit that could have been extracted from those acres. If the acres were used for wheat production, for example, a farmer who uses conventional tilling and harvests 60 bushels per acre could lose a net profit of up to $220 per acre, depending on the price of wheat.[81]

> Over ten years, farmers could expect an average annual net return of at least $300 per acre from a grove of hybrid poplars.

However, it makes sense that farmers will look for the next best alternative to make the land profitable (recall the fourth principle). Fast growing hybrid poplars are one option. Over ten years, farmers could expect an average annual net return of at least $300 per acre from selective harvesting of a grove.[82] Additionally, farmers can get grants to plant buffers with trees, lowering the initial cost and increasing the net benefit.[83] Other options include land swaps or land sales to trusts or conservation groups.

### Reduced Pesticide Use

Integrated Pest management (IPM) is a farming method that takes advantage of natural pest controls. At the Geis Farm near Moses Lake, WA, for example, the owners have developed wildlife habitats in areas that are hard to farm. They try to encourage beneficial insects that prey on unwanted pests, reducing the need, and the cost, of using harmful pesticides.[84] The adoption of conservation tilling and riparian buffer zones will also limit the amount of pesticides that enter streams and help protect farmers against legal action under the 4(d) rules and the Clean Water Act.

### Reduced Water Use

Surface irrigation is the most common and least efficient of possible methods used in the Washington. Typically, less than half, and sometimes as little as one-fifth, of all water diverted is actually used by crops. However, reducing agricultural water diversions will impose costs on farmers, either through new irrigation equipment purchases or altered crops. One solution is buy water rights from farmers, who might then use the proceeds to buy more efficient irrigation equipment or grow new crops. Recent research indicates that a regional program to increase stream flows in this manner would cost no more than $4 per Washington resident annually and may cost as little as 46 cents.[85]

A regional program to increase stream flows would cost no more than $4 per Washington resident annually and may cost as little as 46 cents.

### Salmon Safe Certification

Besides helping salmon, programs like the Pacific Rivers Council's "Salmon-Safe" program have the added benefit of creating a niche market where consumers are willing to pay a premium for products that, in this case, do not harm salmon. The market for environmentally sound foods is growing at 20 percent annually.[86]

## New Timber Practices

The new 4(d) rules will likely expand the location and width of riparian buffer zones around streams so that trees may provide shade and create pools where salmon can rest and feed under fallen trees. Preventing timber harvest in buffer zones imposes a cost on landowners.[87] However, the timber industry has already seen restrictions for conservation purposes. Logging practices have also changed in response to consumers, who increasingly want to buy ecologically sound products.

As a result, the cost to the timber industry for saving salmon is the incremental cost related to any ***new*** changes in logging practices related to salmon restoration. As with agriculture, timber landowners will seek to minimize these losses by employing their land in alternative ways. Some options include marketing products to the growing market for environmentally sound products, swapping salmon sensitive land for lands with fewer logging restrictions, growing alternative products such as mushrooms and berries, and receiving payment from a public land trust for not logging in essential salmon habitat areas. Additionally, tax credits to small landowners will help to alleviate some of the costs associated with the buffer zones.[88]

The cost to timber industry for saving salmon is the incremental cost related to any ***new*** changes in logging practices related to salmon restoration.

Using computer simulations of timber growth and habitat conditions, researchers at the University of Washington concluded that, if landowners invest in management practices designed to improve habitat, rather than do nothing, long-run logging levels can be ***increased*** 9 percent. Furthermore, they concluded that the logged timber would be more valuable.[89]

# CREATING A PROSPEROUS AND SUSTAINABLE ECONOMY

What will the Puget Sound economy look like ten or twenty years after the 4(d) rules go into effect? Clearly, we will be doing some things differently and probably all of us will be more aware of how our actions affect salmon.

One thing we can say with confidence – ***the sky will not fall***. That is, the net cost to saving salmon will not ruin the economy. In fact, we can expect the regional economy to continue to grow over the long run, but in a more environmentally and economically sustainable manner.

Additionally, we can make some other statements about the economics of saving salmon:

- **The costs are often overstated.** Correcting the mistakes of the past will require additional resources. However, reports of massive job losses, for example, do not consider the relative size of affected industries or the strength of the regional economy.
- **Postponing the effort will only increase the costs**. Besides, federal law requires that we make the effort now, instead of imposing greater costs on future generations.
- **Saving salmon will often provide savings through investment opportunities.** As we get smarter about saving salmon, we will find more opportunities where doing the right thing for salmon is also cost efficient. Local communities and businesses can find opportunities to both save salmon and invest in prosperity.
- **Saving salmon will also provide some important non-market benefits.** Saving salmon will provide additional clean water, recreation opportunities, and other natural amenities that are valuable to residents.

There is much more to the story. This handbook is only an introduction to the maze of interactions between salmon and the economy, including the uniqueness of saving salmon in an urban environment. The effort will be most successful where efforts to save salmon take advantage of environmentally sound investment opportunities, whether as communities or business enterprises.

Most importantly, we have nothing to fear as the region becomes more involved in the salmon effort. In fact, it will help us build a more prosperous and sustainable economy.

# SALMON GLOSSARY

**Anadromous** – Fish that hatch in freshwater, mature in saltwater, and return to freshwater to spawn (lay eggs).

**Critical habitat** – The ecosystem elements that must be present and properly functioning to assure the continued existence of a particular species, as designated by NMFS or FWS.

**Endangered species** – A species in danger of becoming extinct within the foreseeable future in all or a significant portion of its range.

**ESA** – The Endangered Species Act of 1973, as amended. The federal law establishing policies for the protection and recovery of declining species.

**Escapement** – Fish that have survived being caught in all fisheries and compose a spawning population.

**ESU** – Evolutionarily Significant Unit. A population or group of populations of salmon that is substantially reproductively isolated from other populations and contributes substantially to the ecological and genetic diversity of the biological species.

**FWS** – The U.S. Fish and Wildlife Service. With NMFS, the federal agency responsible for implementation of the Endangered Species Act.

**4(d) Rule** – Protective regulations issued by NMFS or FWS upon finalizing the listing of a species as 'threatened.' The rules are tailored to particular species and areas, and they can take the place of the broad restrictions on take defined in Section 9 of the ESA.

**HCP** – Habitat Conservation Plan. To obtain a permit for incidental take, landowners can negotiate an HCP with NMFS or FWS, specifying covered activities and how their effects will be minimized or mitigated in a specific area.

**Incidental take** – Take of a listed species that results from, but is not the purpose of, carrying out an otherwise lawful activity conducted by a federal agency or other party.

**NMFS** – The National Marine Fisheries Service. With FWS, the federal agency responsible for implementation of the Endangered Species Act.

**Smolt** – A juvenile salmonid that is undergoing physiological changes to migrate from freshwater to saltwater.

**Take** – Of a threatened or endangered species, includes "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or to attempt to engage in such conduct," according to the ESA.

**Threatened species** – A species that is likely to become endangered in the foreseeable future in all or a significant portion of the species' range.

**Watershed** – A basin including all the water and land areas that drains to a common body of water.

# REFERENCES


[1] ECONorthwest with data from the Bonneville Power Administration.

[2] Goodstein, Eban, Bob Doppelt, and Karin Sable. 2000. *Saving Salmon, Saving Money: Innovative Business Leadership in the Pacific Northwest*. Center for Watershed and Community Health, Portland State University. January.

[3] Burchell, Robert W., William Dolphin, and Harvey S. Moskowitz. 1995*. Impact Assessment of DELEP CCMP versus Status Quo on Twelve Municipalities in the DE-LEP Region*. Report #95-06 of the Delaware Estuary Program.

[4] Seattle Daily Journal of Commerce, July 18, 2000

[5] ECONorthwest, using average assessed value and property tax rates for the city of Issaquah.

[6] Central Oregon Agricultural Research Center "Hybrid Poplar Production in Central Oregon". (see http://dwp.bigplanet.com/polargroup/nss-folder/demonstrationprojects/1madras.htm).

[7] T.C. Bjornn and D. W. Reiser. 1991. "Habitat Requirements of Salmonids in Streams" In *Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats*. Edited by W.R. Meehan. Special Publication 19. Bethesda, Maryland: American Fisheries Society.

Bilby, R.E., B.R. Fransen, P.A. Bisson, and J.K. Walter. 1998. "Response of Juvenile Coho Salmon (Oncorhynchus kisutch) and Steelhead (Onchorhynchus mykiss) to the Addition of Salmon Carcasses to Two Streams in southwestern Washington, U.S.A." *Can. J. Fish. Aquat. Sci*. 55: 1909-1918.

[8] ECONorthwest with GIS data from Bonneville Power Administration and National Marine Fisheries Service.

[9] Washington Department of Fisheries, Washington Department of Wildlife, and Western Washington Treaty Indian Tribes. 1993. *1992 Washington Salmon and Steelhead Stock Inventory*.

Washington Department of Fish and Wildlife. 1999. *Washington Salmon Recovery and the State's Fisheries*, May.

[10] Washington State Department of Natural Resources. 1998. *Our Changing Nature: Natural Resource Trends in Washington State*. pp. 60-61.

[11] Washington Department of Fisheries, Washington Department of Wildlife, and Western Washington Treaty Indian Tribes. 1993. *1992 Washington Salmon and Steelhead Stock Inventory*.

Washington Department of Fish and Wildlife. 1999. *Washington Salmon Recovery and the State's Fisheries*, May.

[12] Map data from the Washington Department of Fish and Wildlife.

[13] Puget Sound Water Quality Action Team. 1998. *Puget Sound Update: Sixth Report of the Puget Sound Ambient Monitoring Program*.

[14] Puget Sound Water Quality Action Team. 2000. *Status and Trends of Key Indicators of Puget Sound's Health*.

White, Jacques. 1997. *The Loss of Habitat in Puget Sound.* People for Puget Sound. March.

[15] Puget Sound Water Quality Action Team. 2000. *Status and Trends of Key Indicators of Puget Sound's Health*.

[16] White, Jacques. 1997. *The Loss of Habitat in Puget Sound.* People for Puget Sound. March.

Washington State Department of Natural Resources. 1998. *Our Changing Nature: Natural Resource Trends in Washington State*. pp. 46-47.

[17] Washington State Department of Natural Resources. 1998. *Our Changing Nature: Natural Resource Trends in Washington State*.

[18] Solley, W.B., R.R. Pierce, and H.A. Perlman. 1998. *Estimated Use of Water in the United States in 1995*. U.S. Department of the Interior, U.S. Geological Survey. U.S. Geological Survey Circular. 1200.

[19] Arnold, C.L. Jr. and C.J. Gibbons. 1996. "Impervious Surface Coverage: The Emergence of a Key Environmental Indicator." *Journal of the American Planning Association* 62 (2): 243-258.

[20] Christopher W. May, Applied Physics Laboratory, College of Ocean and Fishery Sciences, University of Washington. 1998. "The Cumulative Effects of Urbanization on Small Streams in the Puget Sound Lowland Ecoregion," *Puget Sound Research*.

[21] Bortleson, Gilbert and David Davis. 1997. *Pesticides in Selected Small Streams in the Puget Sound Basin, 1987-1995*. US Department of the Interior, US Geological Survey, Washington State Department of Ecology. Fact Sheet. 067-97. June.

Voss, F.D., S.S. Embrey, and J.C. Ebbert. 1999. *Pesticides Detected in Urban Streams During Rainstorms and Relations to Retail Sales of Pesticides in King County, Washington*. U.S. Geological Survey. USGS Fact Sheet. 097-99. April.

[22] White, Jacques. 1997. *The Loss of Habitat in Puget Sound.* People for Puget Sound. March.

[23] Casillas, E., Stein, J. E., et. al. 1993. "Effects of Estuarine Habitat Quality on Juvenile Salmon: I. Chemical Contaminant Exposure and II. Altered Growth and Immune Function," in Proceedings, Coastal Zone 93, Eighth Symposium on Coastal and Ocean Management, New Orleans. July 19-23.

White, Jacques. 1997. *The Loss of Habitat in Puget Sound.* People for Puget Sound. March..

[24] Puget Sound Water Quality Action Team. 2000. *Status and Trends of Key Indicators of Puget Sound's Health*.

White, Jacques. 1997. *The Loss of Habitat in Puget Sound.* People for Puget Sound. March.

[25] Grant, G.E. and A.L. Wolff. 1991. "Long-Term Patterns of Sediment Transport After Timber Harvest, Western Cascade Mountains, Oregon, USA." Presented at Sediment and Stream Water Quality in a Changing Environment: Trends and Explanation in Vienna. IAHS. 203.

[26] Forest Practices Advisory Committee on Salmon and Watersheds. 1999. *Fish Passage Restoration*, Version 2.0, September.

[27] Forest Ecosystem Management Assessment Team. 1993. *Forest Ecosystem Management: An Ecological, Economic, and Social Assessment*. Forest Service, Fish and Wildlife Service, National Marine Fisheries Service, National Park Service, Bureau of Land Management, and Environmental Protection Agency. 794-478. July.

[28] Staubitz, W.W., G.C. Bortleson, S.D. Semans, A.J. Tesoriero, and R.W. Black. 1997. Water-Quality Assessment of the Puget Sound Basin, Washington,

Environmental Setting and Its Implications for Water Quality and Aquatic Biota. U.S. Geological Survey. Water-Resources Investigations Report. 97-4013.

[29] Washington State Department of Natural Resources. 1998. *Our Changing Nature: Natural Resource Trends in Washington State*. p. 37.

[30] Solley, W.B., R.R. Pierce, and H.A. Perlman. 1998. *Estimated Use of Water in the United States in 1995*. U.S. Department of the Interior, U.S. Geological Survey. U.S. Geological Survey Circular. 1200.

Public use includes water for firefighting, street washing, and other municipal needs. Other includes water for livestock and mining.

[31] Washington State Department of Natural Resources. 1998. *Our Changing Nature: Natural Resource Trends in Washington State*. pp. 40-41.

[32] S.P. Cramer & Associates, Inc. 1999. Status of Chinook Salmon and their Habitat in Puget Sound. Coalition of Puget Sound Businesses. June.

[33] Office of Dam Safety, Washington State Department of Ecology.

[34] "Owner, State, U.S. Agree to Split Stream-Repair Cost," *Seattle Times*, August 3, 2000.

[35] Forest Ecosystem Management Assessment Team. 1993. *Forest Ecosystem Management: An Ecological, Economic, and Social Assessment*. Forest Service, Fish and Wildlife Service, National Marine Fisheries Service, National Park Service, Bureau of Land Management, and Environmental Protection Agency. 794-478. July.

[36] State of Oregon. 1997. *Oregon Coastal Salmon Restoration Initiative-Oregon's Plan for Conservation and Restoration of Anadromous Salmonids in Coastal River Basins*. National Marine Fisheries Service. August.

[37] Seattle Public Utilities. May 1998. *Water Conservation Potential Assessment: Executive Summary*.

[38] An acre-foot of water is the amount that would cover one acre of land one foot deep, or about 326,000 gallons. Solley, W.B., R.R. Pierce, and H.A. Perlman. 1998. *Estimated Use of Water in the United States in 1995*. U.S. Department of the Interior, U.S. Geological Survey. U.S. Geological Survey Circular. 1200.

[39] Forest Practices Advisory Committee on Salmon and Watersheds. 1999. *Fish Passage Restoration*, Version 2.0, September.

[40] National Research Council. 1996. *Upstream: Salmon and Society in the Pacific Northwest*. Washington, D.C.: National Academy Press.

[41] S.P. Cramer & Associates, Inc. 1999. *Status of Chinook Salmon and their Habitat in Puget Sound*. Coalition of Puget Sound Businesses. June.

[42] Staubitz, W.W., G.C. Bortleson, S.D. Semans, A.J. Tesoriero, and R.W. Black. 1997. *Water-Quality Assessment of the Puget Sound Basin, Washington, Environmental Setting and Its Implications for Water Quality and Aquatic Biota*. U.S. Geological Survey. Water-Resources Investigations Report. 97-4013.

[43] Bortleson, G.C. and D.A. Davis. 1997. *Pesticides in Selected Small Streams in the Puget Sound Basin, 1987-1995*. U.S. Geological Survey. USGS Fact Sheet. 067-97.

[44] Voss, F.D., S.S. Embrey, and J.C. Ebbert. 1999. *Pesticides Detected in Urban Streams During Rainstorms and Relations to Retail Sales of Pesticides in King County, Washington*. U.S. Geological Survey. USGS Fact Sheet. 097-99. April.

[45] Robert Matzner and Estella Waldman. 1999. "Water Resources Assessment for Diazinon." Environmental Protection Agency Memorandum, May 10.

[46] Sam Bennett. “Green Building Takes to the Streets” *Seattle Daily Journal of Commerce*, March 6, 2000.

[47] Washington County Soil and Water Conservation District and Small Acreage Steering Committee. 1999. *Managing Streamside Areas with Buffers: Tips for Small Acreages in Oregon*. Fact Sheet 5. January.

[48] Ewing, R.D. 1999. *Diminishing Returns: Salmon Decline and Pesticides*. Oregon Pesticide Education Network. February.

Wentz, D.A., B.A. Bonn, K.D. Carpenter, S.R. Hinkle, M.L. Janet, F.A. Rinella, M.A. Uhrich, A. Laenen, and K.E. Bencala. 1998. *Water Quality in the Willamette Basin, Oregon, 1991-95*. U.S. Geological Survey Circular 1161.

[49] Grant, G.E. and A.L. Wolff. 1991. “Long-Term Patterns of Sediment Transport After Timber Harvest, Western Cascade Mountains, Oregon, USA.” Presented at *Sediment and Stream Water Quality in a Changing Environment: Trends and Explanation* in Vienna. IAHS. 203.

[50] L. L. Osborne and D. A. Kovacic, “Riparian Vegetated Buffer Strips in Water-quality Restoration and Stream Management,” *Freshwater Biology* 29: 243-258.

[51] Sam Howe Verhovek. “An Expensive Fish” *The New York Times*, March 16, 1999.

[52] Whitelaw, E.W. and others. 1998. “A Letter from Concerned Economists to Governors Kitzhaber, Knowles, Locke, and Wilson, and Premier Clarke Regarding the Economic Issues of Salmon Recovery.” Eugene, OR: September 9.

[53] Niemi, E., E. Whitelaw, M. Gall, and A. Fifield. 1999. *Salmon, Timber, and the Economy*. ECONorthwest for Pacific Rivers Council. October.

[54] Niemi, E., E. Whitelaw, M. Gall, and A. Fifield. 1999. *Salmon, Timber, and the Economy*. ECONorthwest for Pacific Rivers Council. October.

[55] Margot Lutzenhiser and Noelwah Netusil, forthcoming, “The Effect of Open Spaces on a Home’s Sales Price.” *Contemporary Economics Policy.*

[56] King County Department of Natural Resources. (see http://dnr.metrokc.gov/dnradmin/press/990618kf.htm).

[57] Rocky Mountain Institute. 1997. *Green Developments* CD-ROM.

[58] Build a Better Kitsap program (see www.kitsaphba.com/bbk.html).

[59] Goodstein, Eban, Bob Doppelt, and Karin Sable. 2000. *Saving Salmon, Saving Money: Innovative Business Leadership in the Pacific Northwest*. Center for Watershed and Community Health, Portland State University. January.

[60] Goodstein, Eban, Bob Doppelt, and Karin Sable. 2000. *Saving Salmon, Saving Money: Innovative Business Leadership in the Pacific Northwest*. Center for Watershed and Community Health, Portland State University. January.

[61] Doppelt, B. and Watson, L. 2000. *Just Plain Good Business: The Economic and Environmental Benefits of Sustainability as Exemplified by One Hundred Sixty Case Examples*. Center for Watershed and Community Health.

[62] Goodstein, Eban, Bob Doppelt, and Karin Sable. 2000. *Saving Salmon, Saving Money: Innovative Business Leadership in the Pacific Northwest*. Center for Watershed and Community Health, Portland State University. January.

[63] Washington Department of Fish and Wildlife. 1996. *Opinion Survey*. Washington Department of Fish and Wildlife.

Olsen, D., J. Richards, and R.D. Scott. 1991. “Existence and Sport Values for Doubling the Size of Columbia River Basin Salmon and Steelhead Runs.” *Rivers* 2 (1): 44-56.

Number of households from U.S. Department of Commerce, Bureau of the Census. 1998. *Statistical Abstract of the United States, 1998,* 118th Edition. Washington, D.C.: National Technical Information Services.

[64] ECONorthwest, using data from Department of Community Trade and Economic Development. 1999. “Local Government Fiscal Assessment” Draft Statewide *Strategy to Recover Salmon*, 1999.

[65] Burchell, Robert W., William Dolphin, and Harvey S. Moskowitz. 1995*. Impact Assessment of DELEP CCMP versus Status Quo on Twelve Municipalities in the DE-LEP Region*. Report #95-06 of the Delaware Estuary Program.

[66] Ribaudo, M.O. 1986. *Reducing Soil Erosion: Offsite Benefits*. U.S. Department of Agriculture, Economic Reearch Service. Agricultural Economic Report. 561. September.

Niemi, E., E. Whitelaw, M. Gall, and A. Fifield. 1999. *Salmon, Timber, and the Economy*. ECONorthwest for Pacific Rivers Council. October.

[67] ECONorthwest, with data from Spence, B.C., G.A. Lomnicky, R.M. Hughes, and R.P. Novitzki. 1996. *An Ecosystem Approach to Salmonid Conservation*. ManTech Environmental Research Services Corp. TR-4501-96-6057.

[68] Regional savings and costs were estimated by applying the per capita savings to the regionwide population, and applying the per gallon cost to all gallons saved.

[69] Niemi, E., E. Whitelaw, and M. Gall. forthcoming. *The Economic Consequences of Waterborne Soil: Salem and the North Santiam River*. ECONorthwest.

[70] Seattle Daily Journal of Commerce, July 18, 2000

[71] ECONorthwest, using average assessed value and property tax rates for the city of Issaquah.

[72] Whitelaw, W.E. and E. Niemi. 1989. “The Greening of the Economy.” *Old Oregon* 68 (3): 26-27.

[73] Greenwood, M.J., G.L. Hunt, D.S. Rickman, and G.I. Treyz. 1991. “Migration, Regional Equilibrium, and the Estimation of Compensating Differentials.” *The American Economic Review* 81 (5): 1382-1390.

[74] Power, T.M. and others. 1995. *Economic Well-Being and Environmental Protection in the Pacific Northwest*. Economics Department, University of Montana. December.

[75] Niemi, E., E. Whitelaw, M. Gall, and A. Fifield. 1999. *Salmon, Timber, and the Economy*. ECONorthwest for Pacific Rivers Council. October.

[76] County Business Pattern (see http://www.census.gov/epcd/cbp/view/cbpview.html). Data include the 12 counties in the Puget Sound region.

[77] Veseth, R. 2000. “Economic Erosion Control Under Furrow Irrigation” in *Pacific Northwest Conservation Tillage Handbook Series* 14, March. (see http://pnwsteep.wsu.edu/Tillage_Handbook/chapter9/090488.htm).

[78] Young, D., Hinman, H., and R. Veseth. 2000. “PNW Economics Research Shows No-Till Profitability” in *Pacific Northwest Conservation Tillage Handbook Series* 14, March (see http://pnwsteep.wsu.edu/Tillage_Handbook/chapter10/101400.htm).

[79] WSU Cooperative Extension Publications, “Economic Case Studies of Eastern Washington and Northern Idaho No-Till Farmers,” Pub. No. EB-1885 and EB-1886. (see http://farm.mngt.wsu.edu/onlinepub.html).

[80] USDA, National Agroforestry Center. “A Riparian Buffer Design for Cropland, Riparian #4.” (see http:www.libfind.unl.edu/nac/pubs/afnotes/rip-4/)

[81] ECONorthwest, using data from Washington Agricultural Statistics Reports (see http://www.nass.usda.gov/wa).).

[82] Central Oregon Agricultural Research Center “Hybrid Poplar Production in Central Oregon”. (see http://dwp.bigplanet.com/polargroup/nss-folder/demonstrationprojects/1madras.htm).

[83] “U.S. Means Business in Saving Salmon, State Farmers Wanted” Seattle Post-Intelligencer, April 10,1999.

[84] Sustainable Agricultural Research and Education-Western Region. 2000. “Sustainable Agriculture…Continuing to Grow: Proceedings of the Farming and Ranching for Profit, Stewardship & Community Conference” Portland, Oregon, March 7-9.

[85] Jaeger, William K. “Increasing Stream Flows to Sustain Salmon in the Pacific Northwest: an Economic and Policy Assessment,” manuscript.

[86] The Hartman Group, “Food and the Environment: A Consumer’s Perspective (Phase 1: summer 1996; Phase 2: Winter 1997).

[87] Schillinger, R. and T. Helvoigt. 1998. *Impact on Industrial Timberland Value of "No-Touch" Buffer Zones Along Waterways in Western Washington*. May.

Brown, G. and L. Steel. 1994. “Economic Impact of Alternative Riparian Management Zone Policies on Selected Fisheries.” In *Washington Forest Landscape Management Project-Progress Report*. Edited by A.B. Carey and C. Elliot. Report No. 1. U.S.D.A. Forest Service, State of Washington Department of Fish and Wildlife, and Washington State Department of Natural Resources. Pgs. 129-142.

[88] “Who Will Be Affected by the Salmon Ruling and How” Seattle Post-Intelligencer, March 16, 1999.

[89] Lippke, B.R., B.B. Bare, R.A. Woods, W. Xu, and M. Mendoza. 1999. *Economic and Environmental Impact Assessment of Forest Policy Changes in Western Washington*. CINTRAFOR, College of Forest Resources, University of Washington. Special Paper 27. January.