Lower Columbia River Estuary Plan

Lower Columbia River Estuary Program
Comprehensive Conservation and Management Plan

Artwork and Cover Design:
Manda Beckett, Portland, Oregon

Principal Writer:
Nancy Jerrick, Counterpoint Consulting, Portland, Oregon

Photographs:
Jim Douglas, Portland, Oregon

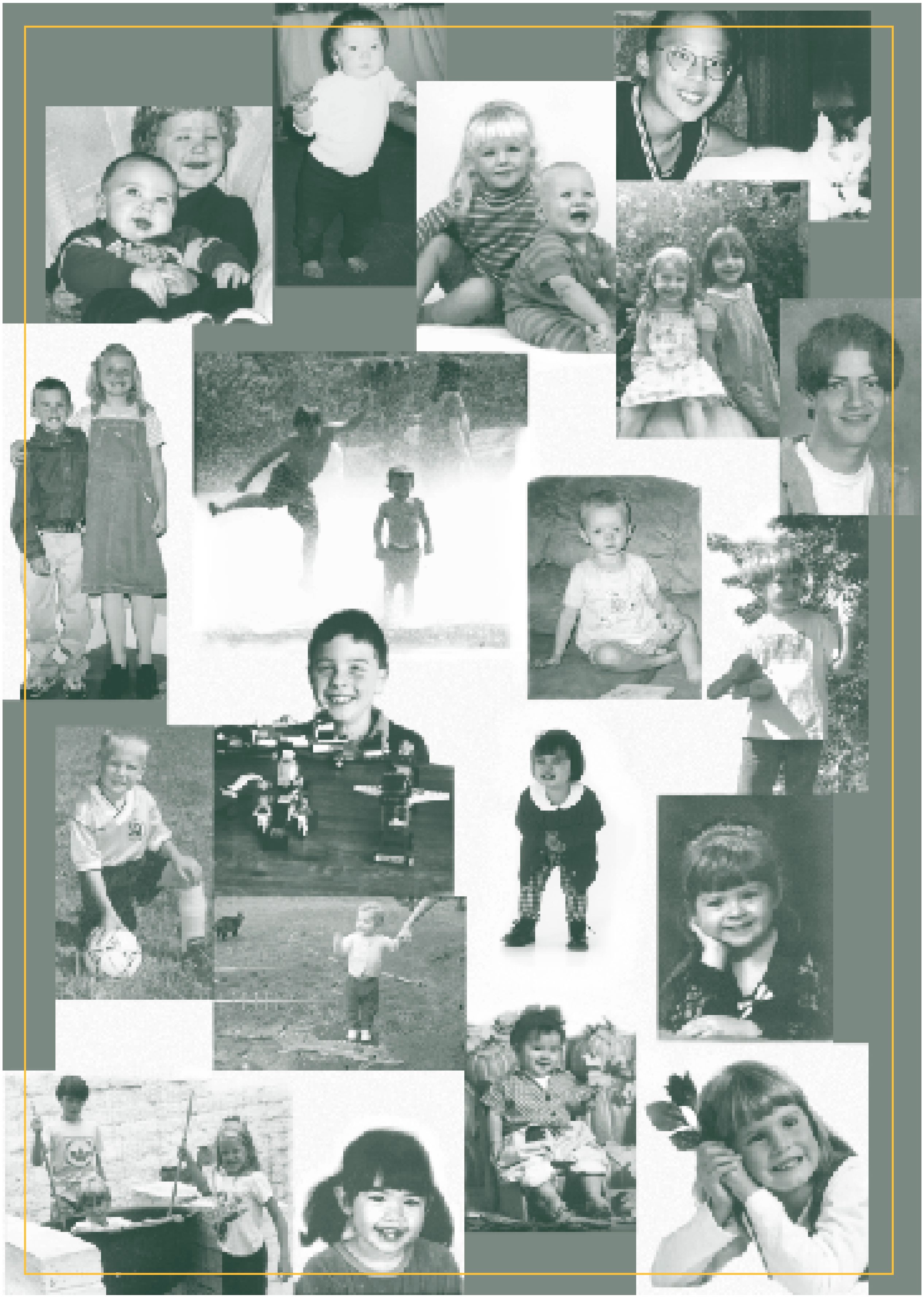
Estuary Program Director:
Debrah Richard Marriott

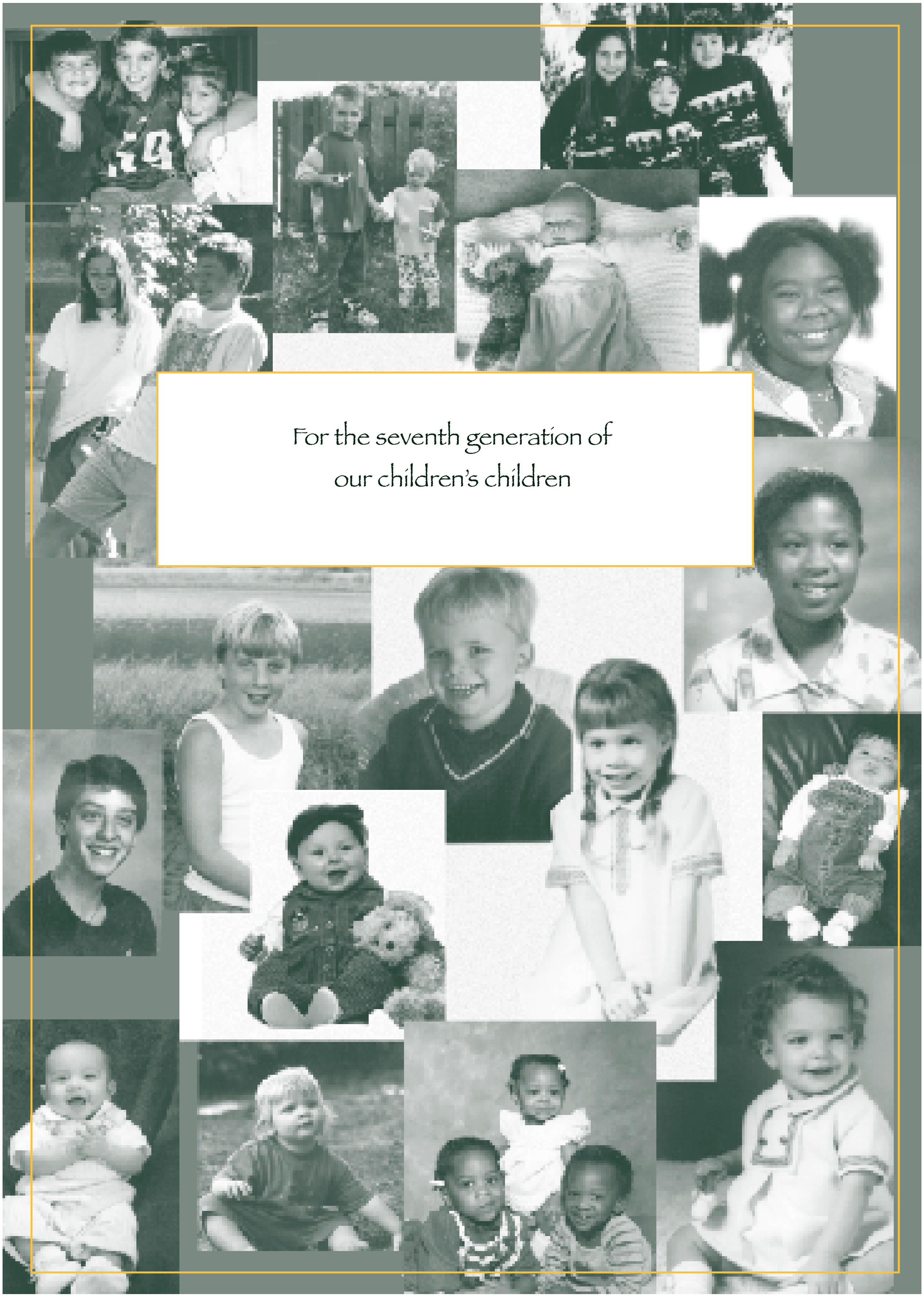
Management Committee Chair:
Glenn Vanselow

The Lower Columbia River Estuary Program is supported by the States of Oregon and Washington and the U.S. Environmental Protection Agency.

Eventually, all things merge into one,
and a river runs through it.

Norman Maclean





For the seventh generation of
our children's children

The Lower Columbia River Estuary Program

Comprehensive Conservation and Management Plan

Volume 1

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Executive Policy Advisor
Office of Governor Locke

Louise Solliday
Watershed Advisor
Office of Governor Kitzhaber

Sue Mauermann
Regional Director
Southwest Regional Office
Washington Department of Ecology

Langdon Marsh
Director
Oregon Department of
Environmental Quality

Erik Sten
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Local Government

Alphonse Halfmoon
Confederated Tribes of the Umatilla
Indian Reservation
Tribal Interests

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U.S. Environmental Protection Agency

Carl Dugger
Estuary Program Management Committee

Glenn Vanselow
Estuary Program Management Committee

Program Staff

Debrah Richard Marriott
Director

Nate Alexander
Office Manager

Bill Young
Intergovernmental Coordinator

Bruce Sutherland
Staff Scientist

Chris Hathaway
Natural Resource Specialist

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Oregon Division of State Lands
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(Iloba Odum)

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Oregon Department of Fish and Wildlife
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Andy Schaedel
Oregon Department of Environmental Quality
(Greg Pettit)

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Publisher, Chinook Observer

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Steve Morris
National Marine Fisheries Service
(Bruce McCain)

Jack Gakstatter
U.S. Environmental Protection Agency
(John Gabrielson)

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(Moses Dick Squeochs)

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Confederated Tribes of the Umatilla Indian Reservation
(Raphael Bill)

Eugene Greene
Confederated Tribes of the Warm Springs Reservation of Oregon
(Olney Patt, Jr.)

Jaime Pinkham
Nez Perce Tribe

Names in parentheses are alternate committee members

Public Involvement Work Group

Matt Winters, *Chair*
Washington Citizen-At-Large

Jon Graves
Marine Environmental Research Training School

Steve Harvey
Cowlitz-Wahkiakum Council of Governments

Tom Myrum
Washington Department of Water Resources

Jim Bergeron
Oregon State Extension - Clatsop County

Peter Birch
Washington Department of Fish & Wildlife

Jerome Arnold
Ecola Creek Awareness Project

Brad Witt
Oregon AFL-CIO

Greg Furher
U.S. Geological Survey

Darrel Buttice
Port of Portland

Mary Ruhl
Action Now and Science Work Group

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Northwest Pulp & Paper Association

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Washington Environmental Council

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Oregon Trout

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U.S. Department of Fish & Wildlife

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Longview Fibre Company

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U.S. Department of Fish & Wildlife

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Commercial Fishing

Galen May
Northwest Aluminum Company

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Port of Portland

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Clatsop Soil and Water Conservation Service

Andy Schaedel
Greg Pettit
Oregon Department of Environmental Quality

Jack Gakstatter
U.S. Environmental Protection Agency

Bruce McCain
National Marine Fisheries Service

Steve Purchase
Oregon Division of State Lands

Greg Furher
U.S. Geological Survey

Mark Siipola
U.S. Army Corps of Engineers

Chuck Henny
National Biological Service

Duncan Gilroy
Oregon Department of Health

Kathy Futornick
Port of Portland

Phil Barrett
Oregon Graduate Institute

Kathy Taylor
Columbia River Estuary Study Taskforce

Eldon E. Korpela
Salmon for All

Rick Vining
Washington Department of Ecology

Local Government Contacts

Sam Adams
City of Vancouver

Jerry Anderson
Wood Village

Joe Bakkensen
Clatsop County Commissioner

Paul Benoit
Director of Community Development, Astoria

Don Bradley
City of West Linn

Eddie Campbell
Multnomah County

Keith Chamberlain
City of North Bonneville

Larry Cole
City of Clatskanie

Norman Cuffel
Pacific County Commissioner

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City of Portland, Environmental Services

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City of Milwaukie

Linda Elliott
City of Cathlamet

Stan Finkelstein
Association of Washington Cities

Gordon Fultz
Association of Oregon Counties

Rosemary Furfey
METRO

Guy Graham
City of Gresham

Bill Gaffi
Unified Sewage Agency Washington County

Ken Galloway
County Forestry Department Hood River County

Janet Gillaspie
Association of Clean Water Agencies

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Assistant City Manager, Longview

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City Manager, Warrenton

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City of Hood River

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Clark County

Barbara Karnis
City of Woodland

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Public Works Department, Lake Oswego

Erik Kvarsten
City of Troutdale

Marian Lahav
Department of Community Preservation and Development, Vancouver

Charles Leeson
City Manager, Oregon City

Brian Little
City Manager, St. Helens

Patrick Lynch
Special Districts Association of Oregon

Dean Marriott
City of Portland, Environmental Services

Val Marty
City of Kalama

Mark McCrady
City of Longview

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City of West Linn

Chad Olsen
City of Rainier

Ronald Ozment
Wahkiakum County Commissioner

Paul Parker
Washington Association of Counties

Jack R. Peterson
Columbia County Commissioner

Doug Robertson
City Manager, Kelso

Scott Revell
Hood River County Planning and Community Development

Joel Rupley
Cowlitz County Board of Commissioners

Harpreet Sandhu
Skamania County Planning Department

Debra Smith
Mayor, City of Cascade Locks

Ed Smith
City of Castle Rock

Lisa Smith
City of Scappoose

Kathy Taylor
Columbia River Estuary Study Taskforce

Willie Tiffany
League of Oregon Cities

Jim Trick
Mayor, City of Ilwaco

Ginny Van Loo
Clackamas County

Roger Vonderharr
Mayor, City of Fairview

Alan Willis
Port of Portland

Cheryl Young
Columbia City

Preface

This *Comprehensive Conservation and Management Plan* provides a broad framework for managing and protecting the lower Columbia River and estuary. It is a guide for preserving and enhancing water quality and habitat, to be implemented by federal, state, local, and tribal governments; river users; environmental interests; and citizens of the region.

As part of the National Estuary Program, the *Management Plan* focuses on the 146 miles of tidally influenced waters below Bonneville Dam. This river reach links ecosystems and economies north and south of the Oregon/Washington border, and east and west between the more heavily populated, wetter coastal valleys and mountains and the more sparsely populated, arid interior of the Columbia Basin. In addition to offering specific actions for the lower river and estuary, the plan provides a framework for coordinating the needs of the lower Columbia within broader, basin-wide considerations.

A diverse group of stakeholders participated on the Management Committee that prepared the *Management Plan*, with considerable input from the public. The plan is the product of a painstaking consensus process, which served not to dilute the decisions, but rather to create a better product. We tackled tough issues and make some bold decisions. The result is a plan that is ready for implementation, rather than requiring further debate.

The *Management Plan* defines specific actions for habitat, land use, and conventional and toxic pollutants. These actions will serve fish and wildlife habitat and water quality in three important ways: prevention of further loss, protection and enhancement of existing resources, and restoration where damage has already occurred. They focus both on solving existing problems and avoiding new ones. The goal is to achieve a net increase in water quality and habitat values.

The actions also address education and management. In our meetings with the public, we were told that education is key. Therefore, several actions call for the Estuary Program to provide hands-on education and technical and financial assistance to all parties as they work to implement this plan. Actions are also directed at both states and the federal agencies to increase consistency in setting standards, establishing regulations, and providing enforcement. Finally, the plan includes a long-term monitoring program so we can better identify problems and measure our progress.

This is an ambitious plan. Implementation of many actions can begin immediately. Success will not happen overnight, however. It will take years of diligence in many areas to see improvement. We will continually evaluate our efforts and adjust the plan to make sure it meets the river's needs. With the stewardship of all the citizens of the region, we can continue to enjoy the exemplary quality of life in the Pacific Northwest. We will be able to maintain the mutual regional goals of a vibrant economy and a healthy environment.

Glenn Vanselow, *Chair*
Lower Columbia River Estuary Program
Management Committee

Preface

The Lower Columbia River Estuary Program's *Comprehensive Conservation and Management Plan* is the work of the talented and highly dedicated members of the Management and Policy Committees. For 3 years, they have worked diligently, struggled tirelessly, and given much of themselves. The decisions did not always come easily, but after months and months of listening and learning, they make here a substantial contribution to the river and to future generations.

With completion of this *Management Plan*, we are well poised to solve problems in the lower Columbia River and estuary. Not only are the specific actions in place, they were developed in a collaborative process that will well serve their implementation. The goal has been to have the citizens guide this plan. We have often been frustrated by the size of the study area and the challenges posed by the range of cultural geography. The committee members worked very hard, using a number of innovative means, to make sure they were in fact listening to and representing all our citizenry. They took their role as representatives seriously, meeting with their constituents at critical milestones to seek guidance. While each wore a specific hat from 8:00 a.m. to 5:00 p.m., it was their 5:00 p.m. to 8:00 a.m. values that drove them. In all their public involvement efforts, the committee members never settled only for getting the public's review of their decisions; they asked for direction and guidance on issues still under debate. The plan they advance here reflects the struggles and the grace it takes to work collaboratively for a common good.

We were well served by every member, past and present. The Management Committee chair and vice-chair, Glenn Vanselow and Jim Bergeron, served as great role models in representing interests and working toward consensus. Like so many members, they gave generously of their time and energy. The faith and guidance of our facilitator, Carie Fox, made all the difference. We are indebted to Jessica Cogan and Jack Gakstatter from the U.S. Environmental Protection Agency, who were generous with their time, expertise, and resources. It is teamwork such as theirs that makes the National Estuary Program a model for dealing with any environmental issue. We appreciate the confidence and support of Marilyn Katz and Debora Martin of the U.S. EPA and Kate Kramer and the Western Center for Environmental Decision Making in helping us successfully integrate a risk ranking into our efforts. We are pleased to be on time with a quality *Management Plan* that was completed under budget, leaving program money available for additional grants and special projects. The program has benefited from a highly dedicated, talented, and fun staff.

We thank Governor John Kitzhaber of Oregon and Governor Gary Locke of Washington for their leadership in watershed management and effective government. That leadership will guide this plan and us through implementation.

To the many, many citizens beyond the committees—individual, municipal, and corporate—who joined us for workshops, participated in focus groups, gave us feedback, or planted trees: please know that this document reflects your work. We could not have done this without you.

And so, to the seventh generation of our children's children, we dedicate our work.

Debrah Richard Marriott, *Director*
Lower Columbia River Estuary Program

Mission

The mission of the Lower Columbia River Estuary Program is to preserve and enhance the water quality of the estuary to support its biological and human communities.

Values

We value the biological diversity and the economic, social and aesthetic benefits of the Lower Columbia River.

We acknowledge our differences and value our ability to come together to ensure the long term prosperity and sustainability of the river.

We are united into one community by the river. Its flow carries our history, our multiple cultures, our prosperity, and our future.

We value a common sense of stewardship toward the river by all people.

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4 Priority Issues

All things are connected. Whatever befalls the earth befalls the children of the earth.

Chief Seattle

The problems the Columbia River faces today are complex—the cumulative effects of many activities over many years. Current conditions in the Lower Columbia River Estuary must be well understood in order to determine appropriate and effective corrective actions. A key task for the Management Committee was to characterize the estuary and define the most significant concerns to be addressed.

The Bi-State Water Quality Program

The States of Washington and Oregon began discussing the possibility of nomination to the National Estuary Program in 1989. They recognized, however, that more data were needed to confirm the degradation of the lower river and estuary in order to support a nomination. They also acknowledged that while much ongoing activity was occurring in the Columbia Basin, the emphasis was generally above Bonneville Dam. Not much attention had been paid to the lower 146 river miles.

To provide the needed technical analysis for the lower river and estuary, the Lower Columbia River Bi-State Water Quality Program (Bi-State Program) was created in 1990 and continued until 1996. The program studied the lower part of the river from Bonneville Dam to the Pacific Ocean, a stretch of 146 river miles.

The Bi-State Program was a public/private partnership jointly administered by the Washington Department of Ecology and the Oregon Department of Environmental Quality and assisted by a Bi-State Steering Committee. Steering Committee members came from many groups with an active interest in the health of the river: environmentalists, industry, private citizens, public ports, local governments, fishing interests, Native American tribes, the Northwest Power Planning Council, and state and federal agencies dealing with environmental and natural resource issues. The program was financially supported by the citizens of Oregon and Washington, the Northwest Pulp and Paper Association, and the region's public ports. Private contractors and state and federal agencies conducted the studies. During its 6-year existence, the Bi-State Program invested over $5 million in its work.

The Bi-State Program assessed the health of the river by looking at how well the "beneficial uses" of the river are being met. Beneficial uses are defined in state laws and regulations and include water supply, agriculture, fish and wildlife, recreation, and commercial uses. The program focused on those beneficial uses that relate to the health of humans, fish, and wildlife.

The 6-year studies were conducted in four steps:

1990-1991: Existing Data were gathered and studied so researchers could start with a coherent picture of what was already known about the river and its problems.

1991-1993: Reconnaissance Surveys were broad preliminary studies designed to provide information about existing environmental conditions and pollutants of concern by sampling and analyzing water, sediment, and fish. These were the first environmental studies to examine the entire lower Columbia River broadly, rather than focusing on a particular type of pollution, beneficial use, or interest group.

1993-1996: Baseline Studies were specific studies suggested by the results of the reconnaissance surveys. They were designed to fill gaps in the information previously gathered. Three types of studies were performed: regular water testing over the course of a year ("ambient monitoring"), a close look at the impact of pollution on fish and wildlife health, and a preliminary look at possible human health risks associated with eating Columbia River fish.

1995-1996: Advanced Studies were in-depth studies of priority problems, based on the findings of all previous phases. They included a more detailed human health risk assessment and a study to identify pollutant sources.

These studies generated over 50 technical reports, which are summarized in an integrated technical report called The Health of the River 1990-1996.[1] Based on this work, the Bi-State Program identified four major problems in the study area that warranted further study and action:

- Toxic contaminants in sediment and fish tissue that affect the health of humans, fish, and wildlife
- Habitat loss or modification that affects fish and wildlife resources
- Water quality problems that affect the beneficial uses in parts of the lower river and estuary
- Overall declines in fish and wildlife health, including a number of threatened and endangered species

Based on the findings of the Bi-State Program, Oregon and Washington decided to nominate the Lower Columbia River Estuary for the National Estuary Program. The nomination was accepted, and in July 1995 the U.S. Environmental Protection Agency announced the Columbia River as one of the waterways accepted into the program.

[1] The Bi-State Water Quality Program reports are available from the Estuary Program office.

Estuary Program Priority Issues

The Management Committee carefully reviewed the technical studies conducted under the Bi-State Program from 1990-96. The studies provide the background for the technical elements of the *Management Plan*. Based on that assessment and supplementary information, the Management Committee identified seven priority issues of concern to the Lower Columbia River Estuary:

- Biological Integrity
- Impacts of Human Activity and Growth
- Habitat Loss and Modification
- Conventional Pollutants
- Toxic Contaminants
- Institutional Constraints
- Public Awareness and Stewardship

The seven priority issues are based on historic trends, current conditions, and projected future conditions. They include vision statements that define what a healthy lower Columbia River and estuary should look like, and objectives that describe what is needed to turn those visions into reality.

Identifying the priority issues was a complex and extremely important task, which required much work and attention from the Management Committee during its first year. Early identification was key, since the issues provide the overall framework for how best to protect and restore the lower river and estuary. In addition to using the technical findings of the Bi-State Program, the Management Committee held eight public meetings to confirm and help refine its choices.

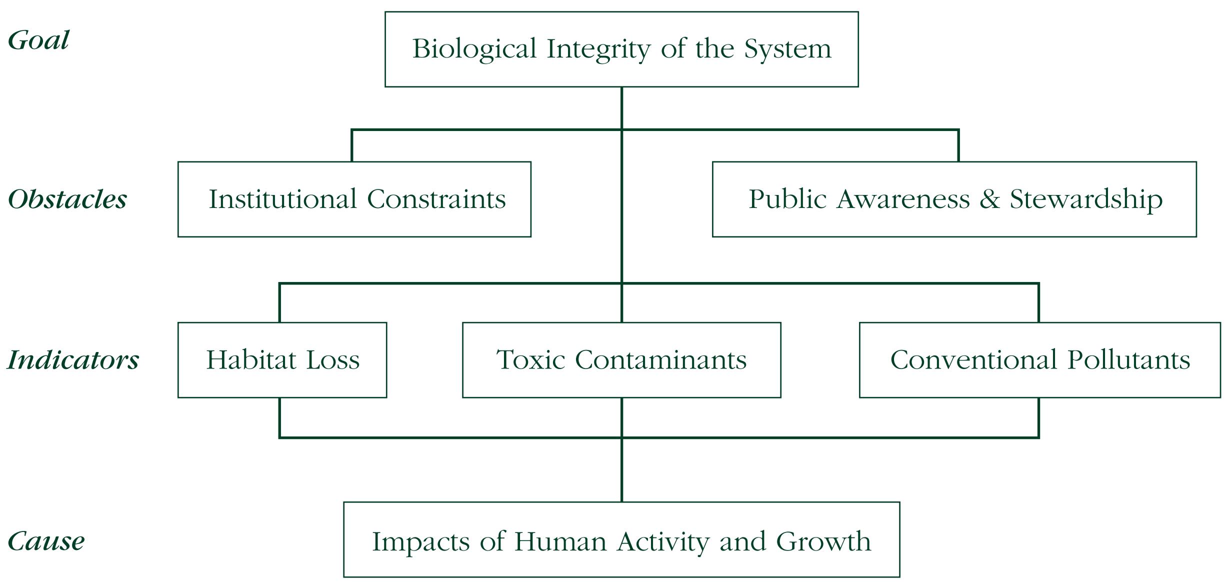
The priority issues enabled the Management Committee to continually focus on the overriding goals of the Estuary Program—goals such as preventing as well as reducing pollution, and increasing wetland acreage rather than merely stopping further loss. They provided a foundation from which the committee could examine related issues, discuss ideas, resolve differences, and propose actions.

The seven priority issues are interrelated. The Estuary Program's fundamental goal is to achieve a high level of **biological integrity** for the lower Columbia River and estuary. That integrity has been degraded by **human activity and growth** over the last hundred years. The degradation is evidenced by **habitat loss and modification**, **conventional pollutants** (such as elevated temperature, increased dissolved gas, bacteria, and sediment), and **toxic contaminants** in fish tissue and sediments. **Institutional constraints** from multiple jurisdictions and **lack of public awareness and stewardship** make protection of the river challenging.

Stated in terms of future management of the lower Columbia River and estuary, actions taken to lessen the impacts of human activity, such as controlling urban stormwater runoff, will also help address water quality problems. Similarly, actions that protect and restore habitat will help provide the conditions critical to maintain biological diversity. Better public awareness of the river ecosystem and the cause/effect relationships that affect it will bring greater political will to bear on managing growth and development, which will in turn affect all the other issues.

The following discussions summarize the priority issues and the reasons they were selected for special attention. This is not an exhaustive presentation of all the problems associated with the Columbia River. In some cases, the kinds of information needed to draw definitive conclusions are either inconclusive, incomplete, or altogether lacking. The Estuary Program uses several "environmental indicators" that illustrate the problems that lead to the priority issues. The selected indicators are not an inclusive list. During its implementation phase, the Estuary Program will implement a long-term monitoring strategy to fill in the gaps and provide the data needed to assess river health more completely and track trends over time.[2]

Interrelationship of Priority Issues



[2] Chapter 6 provides a brief overview of the monitoring strategy. Volume 2 of the *Management Plan* includes the complete *Aquatic Ecosytems Monitoring Strategy*.

Biological Integrity

The biological integrity of a river system is an indicator of "wellness." It is defined as the capacity of the river system to support and maintain an integrated, adaptive community of plant and animal life. That community needs to be composed and organized in a way that is comparable to systems supported by natural waters in the region.

The Problem:

The populations of certain native species in the lower Columbia River and its tributaries have declined, and certain ecosystem functions are impaired.

Vision:

Integrated, resilient, and diverse biological communities are maintained and restored in the lower Columbia River and estuary.

Restoring and maintaining the biological integrity of the system is the ultimate goal of the Lower Columbia River Estuary Program. Because each of the other priority issues has significant impacts on biological integrity, actions taken to address them will contribute to this overall goal.

An underlying tenet of biological integrity is the maintenance of biological diversity at three levels: the individual level, the species level, and the ecosystem level. To sustain a biologically diverse community, the physical processes that support the system must be in balance. In the case of the Columbia River, good water quality and sufficient water quantity at the right times are keys to providing the aquatic environment necessary to support a diversity of native organisms. Diverse riverine habitat, including an abundance of functioning wetlands and riparian areas, are the other supports of this system.

Biological integrity is, in essence, the sum of all the parts of the natural system. When any of these parts is out of balance, biological integrity is threatened. Although a healthy system can adjust to significant disturbances, overall integrity is compromised once the scales tip too far, to the point where the system can no longer support the life cycles of some native species.

Tools to measure and define biological integrity are limited, and have not been extensively used in the Estuary Program study area. The river system is so large and observations regarding its condition are so varied that it is difficult to gain a full understanding of the status quo. Nevertheless, there is strong evidence to suggest that the biological integrity of the lower river and estuary is out of balance. The numerous causes for this imbalance are the direct result of human activities. They include dam construction and operation, urban development, dredging, agricultural and forestry practices, industrial discharges, loss of habitat, and population growth.

Concerns regarding biological integrity include:

- The ability of the river system to sustain native wildlife and fish populations has decreased. Numerous species are listed as threatened or endangered under the federal Endangered Species Act, including Columbia white-tailed deer, the American peregrine falcon, bald eagles, and twelve species of salmon and steelhead which use the lower river for some part of their life cycle (see page 23 in Chapter 2). Several species have become extinct in the study area, including the grizzly bear, grey wolf and California condor.
- Toxic contaminants, including pesticides, metals, PCBs, and dioxins, have been found in the flesh of fish, river otters, and mink and in the eggs of bald eagles and other fish-eating birds. Their presence may be linked to decreased reproductive rates in eagles, otters, and mink and to the dramatic decline in mink populations. Contaminated fish flesh may also represent a health threat to humans.
- Radical population shifts of species are occurring along the river. Populations of some non-indigenous species have substantially increased, including shad, Asian clams, Scotch broom, and nutria. This expansion depletes habitat and food needed by native populations. Some native species of waterfowl and marine mammals have also shown large population growth. These dramatic changes are a key indication of biological imbalance in the river.

Environmental Indicators

The Estuary Program developed a series of environmental indicator information sheets for the three priority issues related to habitat and pollutants. The information sheets are the basis for the discussions of environmental indicators in this chapter.[3]

Environmental indicators illustrate the types of problems in the river. Indicators that illustrate the threats to biological integrity include bald eagles, river otters, mink, and large scale suckers. The Estuary Program will develop additional information on these and other environmental indicators as the long-term monitoring plan is implemented. This will include a more comprehensive analysis of other plant and animal species that are potential indicators, and analysis of the impacts of non-indigenous species on native species and the ecosystem.

Salmonids are conspicuous in their absence from the discussion of environmental indicators. Clearly, the declining runs of salmon and steelhead are an indication of problems in the Columbia River. While the problems of other organisms described in this section can be pinpointed fairly narrowly, salmonids are transients in the lower river and estuary and are affected by a wide range of factors, some outside of the study area. Major efforts are underway in both Oregon and Washington to restore salmon and steelhead runs in the Columbia River Basin (see Chapter 6). The Estuary Program's role in these efforts will be to focus on factors that may affect salmonids in the lower river, rather than to address fish management issues. This will include protecting, enhancing and restoring critical in-river and riparian habitat; improving water quality; minimizing institutional constraints through improved coordination; and fostering a sense of river stewardship through education and outreach programs.

Bald Eagles

Why Are Bald Eagles Important to the Ecosystem? As a top predator, bald eagles play a key role in the food chain and are a good indicator of environmental health. Bald eagles are especially susceptible to habitat changes, human disturbance, and toxic contaminants, which can accumulate in their tissues throughout their long lives. Because eagles primarily consume fish that live in the river, their health is an excellent indication of water quality.

3 The environmental indicator information sheets are available from the Estuary Program office.

Where Are Bald Eagles Found? Bald eagles are mostly found in areas of open water, mudflats, and marsh habitats where they do most of their foraging. For perching and nesting, they require large trees with sufficiently high sturdy branches. These are usually coniferous stands bordering the estuary and on river islands.

What Is the Problem? Resident bald eagles in the lower Columbia River have unusually low reproductive rates.

What Are the Specific Concerns? Bald eagle populations in the lower Columbia River are fairly large and seem to be relatively stable at the present time. Their reproductive rate, however, is unusually low compared to other eagle populations. This poorer success rate is likely due to eggshell thinning caused by DDE (a metabolite of DDT). Other contaminants, including dioxins, furans, and PCBs, have been found at concentrations exceeding levels known to impair reproductive success. Habitat loss and modification have also limited eagle populations, and diminish the eagle's ability to deal with environmental stresses such as contaminants and human encroachment.

What Are the Sources of Toxic Contaminants in Lower Columbia River Bald Eagles? The ingestion of contaminated fish and waterfowl is the immediate source of toxic contaminants, which move through the food chain from multiple original sources. The sources of PCBs, pesticides, metals, and dioxins/furans are described under the "Toxic Contaminants" issue later in this chapter.

River Otters

Why Are River Otters Important to the Ecosystem? River otters are a top predator and play a key role in the food chain in many riverine environments. They are good indicators of environmental health because they are especially susceptible to habitat changes and human disturbance. Since river otters primarily consume resident fish, they provide an excellent indication of water quality, particularly accumulations of toxic contaminants in the lower levels of the food chain. They also consume amphibians, insects, birds, and small mammals. They are opportunistic feeders and will feed on whatever is most available.

Where Are River Otters Found? Otters generally inhabit the lower portions of streams, rivers, and estuaries, but are found throughout the Columbia River system. They are scarce in heavily populated areas and polluted areas. Critical habitat for river otters in the lower Columbia River are sloughs and tidal creeks associated with willow-dogwood and Sitka spruce habitats. Otter dens are usually within 10 meters of the water. Otters tend to use existing formations such as logjams, manmade structures, or structures made by other animals such as beaver, rather than make their own dens.

What Is the Problem? PCBs, pesticides, dioxins, furans, and some metals have accumulated in the tissues of river otters living in the lower Columbia River.

What Are the Specific Concerns? Data on population trends and general health are not extensive enough to accurately assess the current status of river otter populations in the lower Columbia River. The data do, however, indicate that populations have declined over the past 20 years. Monitoring has found elevated levels of DDE (a metabolite of DDT) and PCBs in the livers of otters in the lower river, compared with other otter populations in the Northwest. The impacts of these elevated levels are not well understood, but there is evidence that male sexual development is impaired. This may in turn affect the overall health of the population and may be causing a population decline. Levels of metals and dioxins/furans are also elevated, with unknown impacts. In addition, major losses of otter habitat have occurred on the lower river, which almost certainly has caused a decrease in the population.

What Are the Sources of Toxic Contaminants in Lower Columbia River Otters? The ingestion of contaminated fish and other river-associated organisms is the main source of toxic contaminants, which move through the food chain from multiple original sources. The sources of pesticides, PCBs, metals, and dioxins/furans are described under the "Toxic Contaminants" issue later in this chapter.

Mink

Why Are Mink Important to the Ecosystem? Mink are a top predator and play a key role in the food chain in many riverine environments. They are potentially good indicators of environmental health because they are especially susceptible to habitat changes and human disturbance. Unlike otters, mink are also grown commercially, and quite a bit of information is therefore available about their sensitivity to contaminants. Since they consume resident river fish and other potentially contaminated organisms, their health provides an indication of the accumulation of toxic contaminants in the lower levels of the food chain. Mink are opportunistic predators and will feed on whatever is most available. Common food items besides fish include small mammals, birds, amphibians, crustaceans, insects, and reptiles. The importance of each prey item varies with the location.

Where Are Mink Found? Mink are found immediately adjacent to streams or rivers, where there is abundant woody debris for cover and shallow pools for foraging. The dens are usually within 10 meters of the water, preferably cavities in tree roots or rocks.

What Is the Problem? Mink in the lower Columbia River have elevated levels of PCBs and other contaminants in their livers.

What Are the Specific Concerns? Mink populations in the lower Columbia River are not well understood. Mink exist throughout the Columbia River system and in western Oregon and Washington, but recent data in the lower river are scarce because so few animals have been found. Information on population trends and general health is not available. The rate of mink harvest by commercial trappers has declined significantly over the past 20 years, but many variables besides the health of the populations could be the cause of this decline.

Limited monitoring data show elevated levels of PCBs in various mink tissues. Mink are known to be very susceptible to dioxins, but somewhat tolerant of DDT and DDE. The impacts of the elevated PCB levels and other contaminants found in the lower river are not understood well enough to make definitive conclusions. However, there is evidence that the mink population has declined significantly in recent years, and toxic contaminants may be part of the cause. A significant loss of habitat in the lower river is also a factor in the apparent population decline.

What Are the Sources of Toxic Contaminants in Lower Columbia River Mink? The ingestion of contaminated fish and other river-associated organisms is the main source of toxic contaminants, which move through the food chain from multiple original sources. The sources of PCBs, pesticides, metals, and dioxins/furans are described under the "Toxic Contaminants" issue later in this chapter.

Large Scale Suckers

Why Are Large Scale Suckers Important to the Ecosystem? Large scale suckers are an important part of the bottom-feeding community in the lower river. They feed almost entirely on organisms associated with bottom vegetation, including plankton, aquatic insect larvae, worms, and clams. Monitoring of lower Columbia River backwater areas indicates that contaminated sediments settle in these areas. Because suckers sieve through the bottom sediment for food, they take up sediment-borne contaminants. Consequently, they can be an indicator of sediment contamination. Suckers are important prey for a number of carnivorous fish, birds, and mammals, including bald eagles and river otters.

Where Are Large Scale Suckers Found? Juvenile suckers are found in shallow pools and backwater areas associated with mud and cobble substrates. Adult suckers are found primarily in the main river drift, but probably feed in backwater areas where food is more abundant.

What Is the Problem? Large scale suckers in the lower Columbia River have elevated levels of PCBs, dioxins, and pesticides in their flesh.

What Are the Specific Concerns? Large scale sucker populations in the lower Columbia River are apparently thriving. They are generally abundant throughout the Columbia River system and in western Oregon and Washington. Concentrations of PCBs and dioxins above reference levels have been found in large scale sucker flesh at several locations. Some metals and pesticides have also been detected. Consumption of suckers that have bioaccumulated toxic contaminants results in even greater concentrations of the toxic contaminants in the organisms that prey on them, such as eagles and otters.

What Are the Sources of Toxic Contaminants in Lower Columbia River Suckers? The ingestion of contaminated sediments and sediment-associated organisms (such as worms, clams, and plankton) is the immediate source of toxic contaminants. These contaminants have settled in the sediments and moved through the food chain from multiple original sources. The sources of PCBs, pesticides, metals, and dioxins/furans are described under the "Toxic Contaminants" issue later in this chapter.

Impacts of Human Activity and Growth

Human activity over the past 100 years has significantly affected natural systems. Individuals today are less aware of the impacts their activities have on the natural environment than their forebears, and are often less physically connected to the river. The pressures of human activity and growth are evidenced in each of the other issues. Toxic pollutants are discharged into the river; land use practices cause runoff of contaminants and alter natural flood control processes; political boundaries do not recognize natural systems such as watersheds; habitat is modified and destroyed. The biological integrity of the river and estuary is compromised as a result.

The impact of human activity over time and into the future is a core consideration that needs constant attention. Significant concerns include:

- Habitats, including wetlands, are lost. Wetlands provide critical habitat for a large variety of organisms.
- Pollutants accumulate in the ecosystem, impacting the food chain, water quality, and sediment.
- The biological integrity of the river system is disturbed, as indicated by decreased biodiversity and the significant number of threatened and endangered species. Estuarine habitats, particularly wetlands, are critical to the juvenile stages of many salmon populations. Loss of key estuary habitats limits the ability of these populations to recover.
- Wastewater disposal and treatment systems tend to malfunction or perform poorly with increased loads, increasing the opportunities for discharging untreated wastes.

The Problem:

The impacts of land use practices and population growth in the lower Columbia River and its tributaries, if not addressed, will result in further loss of fish and wildlife habitat, degraded water quality, and diminished quality of life.

Vision:

Land uses and land development practices, including results of past practices and population growth, are managed in a way that enhances the quality of life of the biological and human communities in the lower Columbia River and estuary.

Objectives:

- *Human activities, including land use practices, will not adversely affect natural systems.*
- *Cumulative impacts of development and human activity will be considered in planning efforts and programs.*
- *Development practices will conserve land.*
- *Enforcement of existing rules and laws will provide the basis to support voluntary efforts.*
- *Water quality and floodplain functions will be restored and maintained through habitat management.*

- The roofs, driveways, and streets of residential development reduce the land's ability to absorb and filter rainwater. The resulting erosion and contaminated runoff harm habitat and impair water quality.
- Land modification blocks animal migration routes, destroys nesting and rearing sites, and changes the habitat so much that it is unusable to some species. The continuous presence of humans and their pets may even interfere with plant and animal communities normally able to adapt to some physical changes in the landscape.
- Commercial and industrial development contributes to air and water pollution. It also often uses large land areas and typically increases stormwater runoff problems. Traffic to and from commercial and industrial sites, and the increased human activity associated with the sites, can drive wildlife from neighboring habitat areas.
- Some agricultural and forest practices contribute to degradation of water quality and habitat: the spreading of fertilizers and pesticides, the presence of domestic and farm animals in or near streams, poor crop rotation, certain planting and harvesting methods, timber cutting near streams, and road building.
- Development in floodplains can cause pollution and excessive runoff, and can result in property damage during high water.

Human population growth and activity will continue to occur. The effects of this growth, combined with past and present activities, could place significant additional stress on natural systems. If not addressed, the adverse effects already documented will intensify, resulting in:

- Increased loss of fish and wildlife habitat. Each increment lost is more critical than the last.
- The release of more toxic and conventional pollutants to the Columbia River as a result of increased waste streams.
- Increased pollutant discharges and property damage during flooding.
- Diminished opportunities to enjoy and use the Columbia River because of pollution from wastewater treatment, stormwater, and other non-point sources.
- Continued damage to the biological integrity of the ecosystem. Weakened integrity makes it even more difficult for the system to absorb future impacts.
- Impaired quality of life for humans, fish, and wildlife.

The issue is how to manage human population growth to protect the integrity of the lower Columbia River and estuary. The effectiveness of land use planning will determine the extent to which sensitive areas and critical habitat can be sustained. Appropriate land use and development practices can reduce the stress placed on the Columbia River's natural systems.

Habitat Loss and Modification

Habitat is critical to sustaining fish and wildlife populations. Changes in habitat directly affect a species' ability to forage and reproduce successfully. Some species may not survive habitat modifications.

Certain land and water management practices along the lower Columbia River during the last century have caused major losses and modifications of upland, wetland, and instream habitat. These practices include hydropower generation, dredging, agriculture, logging, channel alteration, and urban expansion. Development activity within the floodplain and loss of natural flood storage capacity have also affected habitat.

The depletion of fish and wildlife resources caused by habitat loss also directly affects the economic, recreational, and aesthetic uses of the river. For example, the decline of salmon and steelhead populations has resulted in lost revenues and recreational opportunities because of diminished commercial and sport fishing. Regulations in place today, the Endangered Species Act listings, and voluntary efforts to protect and restore habitat in both Oregon and Washington have begun to slow the losses, but losses still occur.

The Problem:

The lower Columbia River and its tributaries have been modified by human activities that have negatively affected the habitat of certain fish and wildlife.

Vision:

Habitat in the lower Columbia River and estuary supports self-sustaining populations of plants, fish, and wildlife.

Objectives:

- *There will be no further loss or degradation of overall habitat values.*
- *Habitat management will focus on maintaining the biological integrity of the entire system.*
- *Native species will be protected and enhanced, when appropriate, and adverse effects of non-native species will be reduced.*
- *Habitats necessary for healthy populations of plants, fish, and wildlife will be protected.*
- *Future developments will protect or enhance habitat for native plants, fish, and wildlife.*
- *Important habitat already lost will be recovered, and impaired habitat will be enhanced and restored.*

Concerns related to habitat loss and modification include:

- A comparison of habitat types along the lower river between the 1880s and 1991 shows large losses of wetlands, including marshes and forested wetlands, with accompanying increases in urban and developed land and open water.
- Habitat losses and modifications have had a major impact on the ability of salmon and steelhead populations to sustain themselves. Native salmon populations in the Columbia River have declined dramatically in the last century. Fish harvesting, hydropower, ocean conditions, and the presence of hatcheries are also factors in the decline.

- Several species that live in or depend on the habitats associated with the lower Columbia River and estuary are listed as threatened or endangered. (See page 23)
- The loss of habitat also results in important human losses of aesthetic, cultural, and scientific values.
- Development, diking, filling, damming, dredging, and many other activities that have provided economic growth to the area have resulted in loss of fish and wildlife habitat.
- In addition to affecting habitat, the loss of natural flood storage capacity resulting from development activity within the floodplain has contributed to increased flooding and subsequent property damage.

Environmental Indicators

Wetlands are one environmental indicator of habitat loss and modification. The lower river contains a wide variety of habitat types associated with marine, estuarine, and freshwater influences. These range from open water, to bottom sediments, to tide flats, to the riparian zone. Because of the critical role wetlands play in the estuarine ecosystem, they were selected to illustrate the degradation of the river system.

Wetlands

What Are Wetlands? Wetlands are transitional areas between terrestrial and deep-water habitats where the water table is at or near the land surface, or the land is covered by shallow water. Wetlands can be vegetated or non-vegetated, and are classified on the basis of their hydrology, vegetation, and soil type.

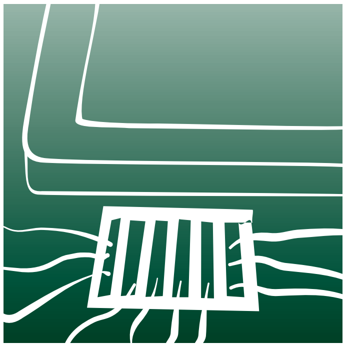
Why Are Wetlands Important to the Ecosystem? Wetlands provide important stopover, feeding, and breeding habitat for migratory waterfowl and shorebirds. They also provide critical breeding, rearing, and feeding habitat for native fish and wildlife, including a number of threatened and endangered species. About half of commercially harvested Pacific Ocean fish and shellfish species depend on tidal wetlands for food, spawning, or nursery habitat during some stage of their lives. In addition, wetlands perform important hydrologic functions, including flood control, erosion and storm damage reduction, water quality maintenance, and water supply. Wetlands also support numerous recreational opportunities, including boating, birding, and fishing.

What Is the Problem? Wetland habitat in the lower Columbia River has been substantially reduced. Historical evidence indicates that since 1870, more than half of estuarine wetlands have been lost as a result of diking, draining, filling, dredging, and flow regulation. Since 1948, certain types of wetland habitats in the lower 46 miles of the river have decreased as much as 75 percent, while barren land and open water areas have increased substantially.

What Is the Specific Concern? The loss of wetland habitat is believed to be one of the causes of declining salmon runs. It also may have significant impacts on other wetland-dependent organisms such as bald eagles, otters, minks, osprey, waterfowl, and a variety of estuarine fish and crustaceans.

What Are the Causes of Wetlands Losses in the Lower Columbia River?

- ***Development:*** Development is the largest single cause of wetlands loss. Harmful activities include diking and draining former wetlands to create farmland; filling wetlands so permanent structures can be built; and building instream structures such as tide gates, piers, jetties, and bridges that change river hydraulics and sedimentation. In addition, development activities in floodplains alter natural runoff and water movement patterns, causing significant wetland loss.
- ***Dredging and Damming:*** Navigation channels and drainage channels are dredged to ensure that water drains more rapidly and spreads out less. This causes formerly wet areas to dry out and diminishes wetland habitat. Dredging also requires disposal of massive quantities of sediments, which creates new islands, fills many former wetlands, and changes shoreline sediment types. Dam operation on the mainstem and major tributaries of the Columbia River has substantially reduced peak river flows and flooding; as a result, lands that were formerly wet for part of the year are no longer wet at all. Dredging may also alter the important transfer of food and nutrients, which are key to supporting wetland and other habitat types, into and out of the system.
- ***Flow Diversion:*** Flow diversion for purposes such as irrigation and industrial use decreases minimum low flows. This in turn dries out areas that had formerly been wet year round.



Conventional Pollutants

Water quality standards have been established to protect the most sensitive beneficial uses of the river: recreation (water contact) and support of salmon and steelhead populations. Conventional pollutants for which standards exist include:

- Temperature
- Total dissolved gas
- Turbidity
- Fecal coliform bacteria
- Dissolved oxygen

Most conventional pollutants meet established standards. However, the standards for temperature and total dissolved gas are commonly exceeded in the lower Columbia. Bacteria, pH, and dissolved oxygen concentrations occasionally exceed standards. This means that full protection is not currently being provided, at a time when salmon and steelhead populations are under stress and human water contact activities are increasing.

Concerns regarding conventional pollutants include:

- The water temperature standard is often exceeded in late summer and fall when river flows are low. Water temperatures are frequently high enough to be harmful to native cold-water species of fish and other organisms. This is of particular concern for salmonids.
- Total dissolved gas concentrations frequently exceed standards in the river during spring and summer months. Aquatic organisms may develop gas bubble disease, which can be fatal. This has caused extensive mortalities in downstream migrating juvenile salmonids.

The Problem:

At times, certain water quality standards established to support aquatic life, protect human health, and for aesthetic purposes are not met in the lower Columbia River and its tributaries.

Vision:

In the lower Columbia River and estuary, temperature, turbidity, bacteria, dissolved oxygen, total dissolved gas, and other conventional pollutants are controlled to levels that protect the health of fish, wildlife, and humans.

Objectives:

- *Riparian and wetland vegetation will be maintained or reestablished as appropriate to protect the natural functions of estuarine areas, the mainstem of the river itself, and tributaries of the lower Columbia River to reduce conventional pollutants.*
- *Conventional pollutants from all sources will be prevented or reduced, and the Clean Water Act will be fully implemented with respect to conventional pollutants.*
- *Monitoring will be implemented and maintained to show long-term trends in conventional pollutants.*
- *Stream functions, including seasonal flows, fish and wildlife habitat, spawning beds, and groundwater recharge, will be maintained and enhanced.*

- Turbidity and sedimentation adversely affect salmon and steelhead by smothering their redds (egg nests) and destroying existing and potential spawning and rearing habitat. In addition, toxic contaminants found in sediments of the lower river were probably transported there as part of the suspended solids load. These toxics are then ingested by bottom-feeding organisms and passed up the food chain, ultimately affecting the top predators.
- Fecal coliform bacteria concentrations at some locations occasionally exceed human health standards, resulting in possible increased risk of disease from water contact.
- Water withdrawals in some Columbia River tributaries have interfered with the production of resident and migratory salmonid fishes. Lower flows reduce instream habitat and can cause increased water temperature and decreased oxygen levels.
- Violations of the dissolved oxygen and pH standards may be related to high temperature and high nutrient inputs from Willamette River sources or may result from stagnation in backwater areas. These high nutrient levels can stimulate the growth of algae; however, excessive algal growth has not been a significant problem to date. Although dissolved oxygen levels are sometimes below standards, they are not yet considered a serious problem.

Environmental Indicators

Primary environmental indicators for conventional pollutants include temperature, total dissolved gas, turbidity and suspended solids, and fecal coliform bacteria.

Other conventional pollutants of possible concern include dissolved oxygen, pH, and nutrients. Low dissolved oxygen concentrations associated with high pH levels have occasionally been measured in backwater areas in the lower river, where warm waters and sufficient nutrient availability have stimulated algal growths. Low dissolved oxygen can be a problem for sensitive aquatic species such as salmonids. More data are needed to determine whether this is a significant issue.

Temperature

Why Is Water Temperature Important? Many Northwest aquatic species are very sensitive to water temperature, particularly salmonids and some amphibians. Water temperatures that exceed a species' tolerance level can cause increased metabolic activity and abnormal growth, and can lead to stress and decreased resistance to disease and predation. Increased temperatures may also make juvenile fish more subject to predation by species that favor warmer waters.

What Is the Problem? Water temperatures in the lower river are frequently high enough during the summer and fall to be harmful to native cold-water species of fish and other organisms.

What Is the Standard for Water Temperature? The standard, which was set to protect salmonid fish, establishes a range of temperatures that should not be exceeded. The existing standard for Oregon ranges from 50 to 68º Fahrenheit (10 to 20º Celsius), depending on the river basin and species being protected. The specific standard for the lower Columbia River is 68° F (20° C) for the average daily maximum temperature over a 7-day period. Washington's comparable standard for class A waters, which include the lower Columbia River, is that temperatures are not to exceed 68° F (20° C) in more than 15 percent of the samples taken over a 7-day period.

What Is the General Condition of the Lower Columbia River? The 68º temperature standard is exceeded in the late summer and fall when river flows are low. Temperatures routinely reach 72° F (22° C) and above during late summer.

What Are the Specific Concerns? The lower Columbia provides critical habitat for juvenile salmonids, which are particularly sensitive to elevated temperatures.

What Are the Sources of High Temperatures in the Lower Columbia River?

- ***Changes in Flow Patterns and Channel Morphology:*** Actions or developments that have slowed river flow or exposed more open water to the sun (such as dams, siltation, and channel modifications) usually result in higher temperatures or changes in seasonal temperature patterns.
- ***Water Impoundments:*** Water impounded through such means as artificial ponds, diked impoundments for waterfowl, and other shallow bodies of water becomes warm and is discharged into the river.
- ***Loss of Streamside Vegetation:*** The riparian zones of many of the Columbia's tributaries have been altered by agricultural practices, forestry practices, urban development, and industrial activities. These activities decrease protective vegetative cover and cause subsequent increased warming of the waters from solar radiation.
- ***Irrigation:*** Water that is diverted or withdrawn for irrigation and other uses is usually warmer when it returns to the receiving stream because it has been exposed to increased solar radiation.
- ***Groundwater Withdrawals:*** The extensive use of groundwater for irrigation, drinking water, and other commercial purposes can decrease the amount of cold water recharge to stream systems.
- ***Domestic and Industrial Discharges:*** Treated domestic waste, industrial discharges, and other water uses may also contribute to the overall temperature increase.

Total Dissolved Gas

What is Total Dissolved Gas? Total dissolved gas is a measurement of the amount of nitrogen and oxygen gas dissolved in water. Water is saturated when it can hold no more dissolved gas under normal atmospheric conditions. Concentrations exceeding 100 percent (known as supersaturation) can occur when gas is forced into the water under pressure; this can happen when water spills over a dam and plunges to depth.

Why Is Total Dissolved Gas Important to the Ecosystem? Like the air we breathe, water must have sufficient dissolved gas in the right proportions for aquatic life to survive and remain healthy. Concentrations in excess of the water quality standard of 110 percent saturation adversely affect aquatic life and can cause death.

What Is the Problem? Total dissolved gas concentrations frequently exceed standards in the river during spring and summer months.

What Is the Standard for Total Dissolved Gas? Oregon and Washington both have a standard of 110 percent saturation for the protection of aquatic life. Concentrations above this level are known to be harmful to fish and other forms of aquatic life.

What Is the General Condition of the Lower Columbia River? During spring and summer months, total dissolved gas concentrations in the river frequently exceed 110 percent saturation. Supersaturation is highest below the dams and only gradually dissipates as the water moves downstream.

What Are the Specific Concerns? Aquatic organisms exposed to supersaturation can develop gas bubble disease. Symptoms of the disease include gas bubbles in the blood, lateral line, and intestinal tract; loss of swimming ability; reduced growth; and ruptured swim bladders. The disease can result in death.

What Are the Sources of Excess Total Dissolved Gas in the Lower Columbia River?
Excess total dissolved gas concentrations in the lower river are almost exclusively the result of water spilling over Bonneville Dam and other dams upstream from it. Because of the configuration of some of the dams, the spills can drive atmospheric gases into solution, resulting in supersaturation of gases in the river.

Turbidity and Suspended Solids

What Are Turbidity and Suspended Solids? Turbidity is a measure of the amount of suspended material in the water, based on the material's refractory characteristics. Total suspended solids is a measure of the amount of organic and inorganic suspended material in the water. This is determined by filtering the water and measuring the dried residue. The two measurements are related, but there is not a direct correlation.

Why Are Suspended Materials in the Water Important? Suspended sediment in streams plays an important role in how some chemicals move through the environment. It also affects what ultimately happens to the chemicals. Some contaminants attach to suspended particles, travel downstream with them, and settle in distant locations. Suspended solids also decrease water clarity, inhibit photosynthesis, and decrease food production. In addition, excessive suspended solids eventually settle out and may fill or smother important spawning and rearing habitat.

What Is the Problem? Turbidity and suspended solids levels in the lower Columbia River are elevated and may be adversely affecting aquatic life.

What Are the Standards for Turbidity and Suspended Solids? Washington and Oregon have standards for turbidity. The Oregon turbidity standard states that concentrations cannot increase to a level that is 10 percent above the standard outside of a defined mixing zone, or more than 10 percent relative to a control point immediately upstream of the source. In general terms, turbidity should not be raised more than 10 percent above the natural background level of the stream. Washington's standard is the same, except in rivers with low background turbidity. In these streams, turbidity concentrations should not increase more than five turbidity units. There are no standards for suspended solids.

What Is the General Condition of the Lower Columbia River? Turbidity and suspended solids concentrations in the lower river are somewhat elevated, but not excessive, compared to other rivers in the region. Turbidity has remained mostly unchanged throughout the historical sampling period. Concentrations increase downstream from Bonneville Dam.

What Are the Specific Concerns? Toxic contaminants at levels of concern have been found in the sediments of the lower river. These contaminants, which originated from upstream sources, were probably transported there as part of the suspended solids load.

What Are the Sources of Suspended Solids in the Lower Columbia River?

- ***Stormwater Runoff:*** Excessive precipitation during storm events leads to greatly increased runoff and subsequent increased levels of suspended particles from urban and rural lands. This runoff enters the lower Columbia River by way of its tributaries.
- ***Land Alteration:*** Construction of residential and commercial structures, road building, logging, and agricultural activities expose lands to possible erosion and landslides during rainy periods.
- ***River and Stream Alterations:*** Activities affecting stream beds or banks and activities affecting riparian areas along tributary streams may increase the possibility that high flows will trigger increased erosion. Turbidity and suspended solid concentrations increase as a result.

Dams, on the other hand, trap suspended sediments and decrease or alter their downstream distribution.

- ***Irrigation Returns:*** Waters withdrawn for irrigation purposes may erode soils and return those materials to local waterways and, eventually, to the Columbia River.
- ***Photosynthetic Activity:*** Algal blooms resulting from increased nutrients and/or sunlight can increase the suspended solids load.

Fecal Coliform Bacteria

What Are Fecal Coliform Bacteria? "Fecal coliform" refers to the group of bacteria associated with the feces of warm-blooded animals, including livestock and humans.

Why Are Fecal Coliform Bacteria Important? They constitute one of three bacteria commonly used to indicate possible contamination from human or animal waste. The others are Escherichia coli (E. coli) and Enterococcus spp.

What Is the Problem? Fecal coliform bacteria concentrations at some locations in the lower Columbia River occasionally exceed health standards.

What Is the Standard for Fecal Coliform Bacteria? A standard exists to protect the health of humans who come in contact with the water. It refers to the number of bacterial colonies found by filtering 100 millimeters (ml) of water through a membrane filter and incubating the filter for a specified period of time. The Washington standard, based on fecal coliform concentrations, is 100 colonies per 100 ml (based on a geometric mean of all samples with more than 10 percent exceeding 200 colonies per 100 ml). The new Oregon standard, which has replaced the old fecal coliform standard, is 126 E. coli per 100 ml (based on 30-day log mean with a single exceedance value of 406 E. coli per 100 ml). The Washington and Oregon standards are not directly comparable because they measure different bacteria, but are thought to provide similar protection. For consistency, Washington's standard is used in this discussion, since most of the Estuary Program's data are for fecal coliform.

What Is the General Condition of the Lower Columbia River? The lower Columbia River shows minimal affects of fecal coliform. During high periods of runoff, however, fecal coliform levels occasionally rise above the standard, especially downstream from urban areas.

What Are the Specific Concerns? Since the lower Columbia River is used extensively for water contact recreation, any violations of standards may indicate a possible health hazard. Although no disease outbreaks have been directly linked to the study area, opportunities for human exposure do exist.

What Are the Sources of Fecal Coliform Bacteria in the Lower Columbia River?

- ***Combined Sewer Overflows:*** Many existing older sewage systems have combined storm and sanitary sewers. During high rainfall periods, the sewer can become overloaded and overflow, bypassing the treatment system. As it discharges to a nearby stream or river, untreated sewage enters the river system.
- ***Treatment Plant Failure:*** During intense rainfall periods, sewage treatment plants may fail, discharging untreated wastes into nearby streams. Unexpected mechanical breakdowns may also cause wastes to spill into nearby waters.
- ***Livestock/Agriculture:*** Agricultural practices that can contribute to fecal coliform contamination include allowing animal wastes to wash into nearby streams during rain events and allowing livestock to water in streams.

- ***Urban Runoff:*** Runoff from roads, parking lots, and yards can carry animal wastes, toxic chemicals, and other pollution to streams through storm sewers.
- ***Wildlife:*** Coliform bacteria can come from the feces of any warm-blooded animal. Large numbers of wildlife can therefore cause contamination of water bodies. This is especially likely during the wet season, when the wastes may wash into streams and rivers.
- ***Failing Septic Tank Systems:*** Individual home septic tanks, especially if not placed in appropriate areas, can become overloaded during the rainy season and allow untreated human wastes to flow into drainage ditches and nearby waters.

Toxic Contaminants

The presence of toxic contaminants in the environment has implications for fish, wildlife, and humans. Many of these toxins work their way up the food chain by accumulating in the flesh of living organisms, and can have both cancerous and non-cancerous human health effects. They can also affect the human immune system and lead to developmental abnormalities.

Toxic contaminants have been found in water, sediments, and biota (living plants and animals) of the lower Columbia River. They include PCBs (polychlorinated biphenyls), dioxins and furans, PAHs (polynuclear aromatic hydrocarbons), pesticides (particularly DDT and its metabolites), and arsenic. Some of these toxins come from current discharge sources. Others, such as PCBs, DDT, and a number of pesticides, are no longer used or discharged into the river, but persist in the environment from past practices.

These toxic contaminants are impairing wildlife health in and near the river. Contaminants detected in fish tissue have also prompted human health advisories. People who consume large quantities of fish for subsistence, social, or cultural reasons are more likely to be affected by the contamination than average consumers. Health advisories may also affect the sport and commercial fishing industry if the public assumes that all fish in the river, rather than only certain species and locations, are contaminated at levels of concern.

The Problem:

Some toxic and/or bioaccumulative contaminants are at levels considered unsafe (or unhealthy) in the lower Columbia River and its tributaries for certain wildlife species and may also cause human health effects.

Vision:

Toxic contaminants are not present at levels that impair the health or threaten the future well-being of the lower Columbia River and estuary and the populations they support.

Objectives:

- *The goals of the Clean Water Act, and the requirements of the Endangered Species Act recovery measures that relate to toxic contaminants, will be met.*
- *Toxic contaminants discharged to the river that are bioaccumulative or that persist in the environment will be eliminated or minimized to the greatest extent practicable through pollution prevention and technology.*
- *Toxic contaminants that do not bioaccumulate or persist in the environment will be controlled to safe levels.*
- *Naturally occurring chemicals that reach toxic levels as a result of human activity will be reduced to safe levels.*
- *Locations of elevated contamination will be identified, and contaminated hotspots will be removed, treated, or contained.*
- *Effects of toxic contaminants and long-term trends in toxic concentrations will be monitored.*

Concerns regarding toxic contaminants include:

Water

- Some pesticides have been detected at concentrations exceeding safe levels for both aquatic life and human health in the Willamette and Yakima Rivers. Both are tributaries to the Columbia River.

Sediment

- The majority of sediment samples from the lower Columbia show metals levels corresponding to background (average) levels in the Columbia River. Samples from a few locations, however, show concentrations of metals that may be harmful to humans and aquatic life.
- Dioxins and furans have been found in some sediment samples from the lower Columbia at levels that may be harmful to humans, fish, and wildlife.

Biota

- PCBs, dioxins, furans, pesticides, and some metals have accumulated in the tissue of river otters. One-year-old males are experiencing delayed development and abnormalities that may be associated with some of these contaminants.
- DDE (a metabolite of DDT), PCBs, and dioxins and furans have been found at unsafe levels in the eggs of bald eagles. The productivity of lower Columbia River eagles is well below levels of other eagle populations in the area.
- The mink population is at historically low levels. Contaminants found in the tissues of lower Columbia River mink have been measured at levels that may cause reproductive failures. Changes and losses in habitat have also contributed to the decline in mink population.
- Toxic contaminants have been detected in fish tissue. The Washington and Oregon health agencies recommend that women of reproductive age, pregnant or nursing women, and children limit their consumption of lower Columbia River fish because of the potential for human developmental effects. The Oregon Health Division issued a health advisory in 1993 concerning black crappie and carp in the Columbia Slough, based on detectable levels of PCBs. The Oregon Health Division is also evaluating a draft advisory for fish in the Willamette River, based on levels of methyl mercury. Other health advisories have been issued for other areas in the Columbia River Basin.
- PAHs are widely distributed in the environment and are common in runoff from urban areas. It is believed that PAHs may affect the health of fish and other organisms. Sampling and analysis of the impact on the Columbia River is ongoing.
- Several toxic chemicals exceed water quality standards for the protection of aquatic life in areas of the lower Columbia River. Arsenic, DDE, dioxin, and PCB levels in some fish species exceed criteria at various sites from Bonneville Dam to the mouth of the river. DDE, DDT, dioxin, and lead standards are exceeded in the Columbia Slough. A total maximum daily pollutant load for dioxin was established for the lower Columbia River because the compound exceeded water quality standards. Although discharge limits were met in 1996, dioxin is still present in sediment and fish flesh because of its highly persistent and bioaccumulative nature.
- Although chlorine was not identified in the Bi-State Study as a significant problem in the lower river, it is highly toxic to aquatic life in its residual form. Chlorine may also combine with constituents in the water to form toxic chlorinated hydrocarbons. Since most wastewater treatment facilities disinfect their effluent with chlorine, this highly toxic chemical is still impacting aquatic life in the study area. The Management Committee felt that the use of chlorine for disinfection purposes should be added to the list of concerns.

Environmental Indicators

Environmental indicators for toxic contaminants include pesticides, metals, PCBs, and dioxins/furans. For many toxic contaminants, there are insufficient data to adequately assess their effects on the lower Columbia River ecosystem. Much more work is needed in this area. A more comprehensive assessment of toxic contaminants in the water column, sediments, and tissues is a key part of the monitoring strategy.

Pesticides

What Are Pesticides? Pesticides are chemicals that repel, kill, or prevent or regulate the growth of unwanted biological organisms. These chemicals, which include herbicides and fungicides, are used to control fungi, weeds, insects, plant diseases, and small animals, mainly mice and rats.

Why Are Pesticides Important to the Ecosystem? Pesticides not only target unwanted pests, they also kill desirable organisms, either directly or by contaminating their food source. Pesticides can also accumulate in the food chain and cause adverse health effects in animals and humans. Because they are generally designed to be persistent, pesticides, their residues, and breakdown products can remain in the environment for long periods. Because they are also designed to affect living organisms, they may accumulate in flesh, and their impacts may be magnified as they are transferred up the food chain. Newer pesticides are generally much less persistent and less likely to bioaccumulate than earlier organochlorine pesticides, such as DDT. However, much more research is needed on the newer generation of pesticides to understand their possible impacts on the environment.

What Is the Problem? Pesticides have been found in sediments and fish tissue samples in the lower Columbia River.

What Are the Standards for Pesticides? State standards exist for some pesticides where sufficient data exist. For pesticides where data are limited, guidance values have been established. For the protection of aquatic life, the standards and guidance values are based on concentrations that cause no observable effect. For the protection of humans, the level is based on the risk of one additional cancer case in 1 million people. A wide variety of pesticides are in use, and new ones continue to be developed. Their toxic impacts on organisms are highly variable, and the standards and criteria for each are unique. The following table provides examples of some of the concentration standards.

Pesticide Concentration Standards

COMPOUND	FRESH WATER AQUATIC LIFE	HUMAN FISH CONSUMPTION
Aldrin	3.0 ug/liter (acute)	0.079 ng/liter
Chlordane	2.4 ug/liter (acute)	0.46 ng/liter
Dieldrin	2.5 ug/liter (acute)	0.076 ng/liter
DDT	1.1 ug/liter (acute)	0.024 ng/liter
DDE*	1,050 ug/liter (acute)	—
Mirex	0.001 ug/liter (chronic)	—
** a guidance value*	*ug = microgram*	*ng = nanogram*

What Is the General Condition of the Lower Columbia River? Monitoring on the lower Columbia River has shown there are trace concentrations of some toxic organics in the water and in fish tissue. The most common pesticide found in the water column of the lower river is the herbicide atrazine, which is used extensively in the Willamette Valley. Atrazine concentrations found in the lower Columbia River are well below U.S. EPA criteria. The most common pesticides found in fish tissue are no longer in use. They include the organochlorine pesticides DDT and its metabolites DDE and DDD and, to a lesser extent, dieldrin and aldrin. The organochlorine pesticides chlordane and mirex were also found in otter and mink livers. Standards for many of the newer pesticides are still needed.

What Are the Specific Concerns? Fish tissue samples have shown sufficiently high concentrations of DDT and its metabolites DDE and DDD to be of concern for people who consume large amounts of fish. As a result, the Oregon and Washington Health Departments have issued fish consumption recommendations. There is also evidence that DDT and its derivatives may be responsible for thinning of bald eagle eggshells and reduced reproductive capabilities of mink and river otters. While concentrations of atrazine in the lower Columbia are well below levels of concern, levels found in the Willamette River are a possible concern.

What Are the Sources of Pesticides in the Lower Columbia River?

- **Stormwater Runoff:** Stormwater runoff accounts for much of the pesticides found in the water, animal flesh, and sediments in the lower river. Sources include agricultural runoff associated with crops and animal feedlots, and pest and weed control applications associated with roadways and residential, governmental, and commercial facilities. Specific sources include direct disposal in storm drains and sewer systems; leaking landfills and hazardous waste sites; erosion of contaminated soils; contaminated groundwater; and fallout from rain, fog, and dust.
- **Application Processes:** Pesticides can enter the river directly through application to lakes, streams, and estuaries, and indirectly from drifting spray from aerial and land-based applications.
- **Spills:** Industrial, agricultural, and household spills, as well as improper storage, can introduce pesticides to the river.
- **Irrigation:** Irrigation runoff and return flows of pesticide-laced water into tributary streams and rivers are also likely sources.

Metals

What Are Metals? Metals are elements such as lead, copper, iron, and zinc that occur naturally in the environment in trace amounts. They are used extensively in manufacturing and industry. Depending on the characteristics of the metals, they can be dissolved in the water column, deposited in sediments, or both.

Why Are Metals Important to the Ecosystem? Trace amounts of these elements are normally a necessary part of existence and are not harmful to aquatic life or humans. When some metals exceed background levels, however, they can become toxic and even lethal. Some metals can also be transferred up the food chain and bioaccummulate in predators.

What Is the Problem? Concentrations of metals that may be harmful to humans and aquatic life have been detected in sediments and fish tissue in the river.

What Are the Standards for Metals? There are state standards for each of the 16 metals normally monitored. There are values for fresh and marine waters and fish flesh. For aquatic life, the values are based on levels that produce no observable effects. For human consumption, the values are based on an increased cancer risk of one in 1 million. The metals of possible concern in the lower Columbia River are arsenic, cadmium, copper, chromium, lead, and mercury. The concentration standards for these metals are shown below.

Metals Concentration Standards

METAL	FRESH WATER AQUATIC LIFE	HUMAN FISH CONSUMPTION
Arsenic	—	140 ng/liter (inorganic form)
Cadmium	1.1 ug/liter (chronic)**	10 ug/liter (fish & water)
Lead	3.2 ug/liter (chronic) **	50 ug/liter (fish & water)
Mercury	0.012 ug/liter (chronic)	146 ng/liter
Chromium*	11.0 ug/liter (chronic)**	—
Copper	12.0 ug/liter (chronic)**	—
**trivalent & hexavalent forms*	***dependent on water hardness*	*ug = microgram* *ng = nanogram*

What Is the General Condition of the Lower Columbia River? The concentrations of most metals in the water column are generally well below the standards. Arsenic is persistently detected in the lower river at higher levels than in the major tributaries, but is not above standards. In sediments, high metals concentrations are present in a few locations, and levels in some fish species are elevated above background levels.

What Are the Specific Concerns? There are a number of concerns regarding metals in the lower Columbia River:

- Elevated levels of cadmium and chromium in the kidneys and livers of river otters may be related to inhibited sexual development in males.
- Elevated levels of mercury, lead, and cadmium occur in bald eagle egg tissue.
- Levels of mercury and arsenic are elevated in some fish tissue and could affect humans who consume the fish.
- Elevated concentrations of arsenic, cadmium, and copper occur in some backwater sediments, although the significance of this is unclear without further study.

What Are the Sources of Metals in the Lower Columbia River?

Stormwater Runoff: Runoff causes metals that are either dissolved in the water or attached to particulate matter to enter streams and rivers. Runoff may come from urban areas such as streets, roads, and parking lots, or other areas such as landfills, contaminated sites (from surface and subsurface drainage), and abandoned mines. Runoff can also contaminate groundwater.

Natural Sources: Metals from rock and soil may be naturally introduced by dissolving in the water column.

Industry: Metals may be discharged from mining or manufacturing processes, either directly to the river or through sewage treatment facilities.

PCBs

What Are PCBs? PCBs, or polychlorinated biphenyls, comprise a family of manmade colorless and odorless chemicals. Because of their insulating and nonflammable properties, PCBs were widely used as coolants and lubricants in transformers, capacitors, and other electrical equipment. Banned from production in the United States in 1976, PCBs found today are from historical use or spills.

Why Are PCBs Important to the Ecosystem? Because of their stable properties, PCBs persist in the environment for long periods. They have low water solubility, but accumulate in sediments and biological matter. Bottom-feeding fish ingest PCBs, which move up the food chain to accumulate in higher concentrations in the fatty tissues of predators. PCBs are carcinogenic and can cause reproductive problems in humans and other organisms.

What Is the Problem? PCBs have been found in fish flesh in the lower Columbia River at levels that may affect humans and other organisms that consume fish.

What Is the Standard for PCBs? The standard based on human health risk is designed to protect against the risk of one additional cancer in a population of 1 million individuals. Oregon's standard is 0.079 parts per trillion (ppt), and Washington's standard is 1.0 ppt. There are also chronic toxicity standards for the protection of organisms. The standard for freshwater aquatic life in both Oregon and Washington is 14 ppt, and the standard for marine life is 30 ppt.

What Is the General Condition of the Lower Columbia River? Samples of fish tissue taken at various sites have elevated levels of PCBs. The reproductive capabilities of bald eagles and mink appear to be affected by high levels of bioaccumulative contaminants such as PCBs.

What Are the Specific Concerns? Recent fish tissue samples have PCBs at levels high enough to adversely affect wildlife and humans who consume large amounts of contaminated fish. As a result, the Oregon and Washington Health Departments have issued fish consumption recommendations.

What Are the Sources of PCBs in the Lower Columbia River?

- **Past Disposal Practices:** Past practices allowed used and worn out transformers, capacitors, hydraulic fluid, carbonless copy paper, plasticizers, and flame retardants to be taken to landfills. These materials then leaked into the groundwater and ultimately entered the river system.
- **Leaks and Spills:** Leaks from transformers and other electrical equipment may reach the water.
- **Dust Control:** In the past, PCB-contaminated oil was commonly sprayed on roads for dust control. This material ultimately leached into streams and rivers.

Dioxins and Furans

What Are Dioxins/Furans? Polychlorinated dibenzodioxins (dioxins) and dibenzofurans (furans) comprise a group of chemical compounds that exhibit similar chemical, physical, and toxicological properties. They are created by the chemical interaction of chlorinated compounds with organic matter. The chlorine atoms attach themselves in various ways to produce 75 dioxin isomers and 135 furan isomers.

Why Are Dioxins/Furans Important to the Ecosystem? Dioxins/furans are widespread in the environment and persist over long periods of time. The compounds have been measured in air, soil, sediments, meat, milk, fish, vegetables, and human biological samples. Some of the dioxin/furan compounds have strong toxic effects because of their ability to attach to fatty tissues. Even in trace amounts, they have been linked to cancer and other health effects in laboratory animals.

Of the numerous forms of these compounds, 17 are toxic. TCDD (2,3,7,8-tetrachlorodibenzo-p-dioxin), commonly called dioxin, is the most toxic and is considered by the Environmental Protection Agency to be a probable human carcinogen. A less toxic form, 2,3,7,8-tetrachlorodibenzofuran, has also been found in fish flesh.

What Is the Problem? Dioxins and furans have been detected in sediments and fish tissue samples in the lower Columbia River at levels that may be harmful to humans, fish, and wildlife.

What Are the Standards for Dioxins/Furans? Oregon and Washington have adopted a water quality standard of 0.013 parts per quadrillion for 2,3,7,8 TCDD. This standard is based on human health risk and is designed to protect against the risk of one additional cancer in a population of 1 million individuals. It applies to both fish consumption and drinking water. There are no standards for the other dioxin and furan compounds. There is also a guidance value for the protection of aquatic organisms that establishes a level at which there is no observable effect.

What Is the General Condition of the Lower Columbia River? Concentrations of TCDD exceeding the standard have been found in sediments and in the tissues of organisms in the lower river. Based on these findings, Oregon and Washington established waste discharge limits for TCDD for the known sources of dioxin at that time: the bleached pulp mills. The discharge limits were met in 1996. Because TCDD is long-lived and bioaccumulative in the environment, however, elevated levels of TCDD in sediments and tissues of organisms will continue to be found.

What Are the Specific Concerns? The concentrations of dioxins/furans found in sediments and fish tissue are believed to be one of the factors contributing to the poor reproductive performance of bald eagles and mink. In addition, humans who consume large amounts of fish may face increased risk of cancer. It is not known whether the concentrations are affecting other aquatic organisms.

What Are the Sources of Dioxins/Furans in the Lower Columbia River?

- **Industrial Processes:** A number of manufacturing processes use chlorine compounds or chlorine gas to bleach or disinfect. Chlorine is also used in electrolytic processes. Industrial sources include the pulp and paper industry, wood-treating facilities, and herbicide and pesticide manufacturers. The waste discharges from such sources could introduce dioxins/furans to the river.
- **Combustion:** The incomplete combustion of fuels from vehicles, wood stoves, fireplaces, and municipal incinerators results in the aerial deposition of dioxins.
- **Runoff:** Urban/industrial storm drains and combined storm overflows that discharge urban runoff can carry aerially deposited dioxins, pesticides, and herbicides to the river.
- **Past Management Practices:** Past waste management practices that allowed untreated or insufficiently treated wastes to enter directly into the river are in part responsible for present-day accumulations of dioxins/furans in sediments. These sediments can be re-suspended when disturbed by dredging or floods and transported downstream.

Institutional Constraints

Effective natural resource management is extremely difficult in a system as large and diverse as the lower Columbia River and estuary. Over 160 agencies and organizations have jurisdiction or exert influence over management of the lower Columbia River. A variety of policies, laws, plans, and regulations are in place. The problems are complex, and decision-making processes are complicated and time-consuming. As a result, management efforts are often hindered by a lack of coordination and consistency, and natural resources may not receive the protection they need.

The issues affecting natural resource protection can be considered in three general groups:

- Organizational and institutional factors
- Decision-making factors
- Ecosystem management factors

Organizational and Institutional Factors

The agencies and organizations involved with management of the lower Columbia River include 19 federal, 22 state, 14 regional agencies and organizations; 37 local governments; 14 port districts; 4 treaty tribes; and 44 non-governmental organizations. Each has a different jurisdiction, constituency, and purpose. Efforts at coordination are made more difficult because few, if any, are specifically charged with identifying overlaps in programs or gaps in provided services. The few that have an oversight role are often not empowered to prompt change when they identify such gaps or overlaps. This kind of fragmented approach is contrary to the need for comprehensive solutions to complex problems that do not recognize political or jurisdictional boundaries.

The Problem:

The large number of agencies/governments in the study area, with their different missions, responsibilities, policies, procedures, and priorities, complicates the efforts to protect and improve the health of the lower Columbia River and its tributaries.

Vision:

A coordinated, integrated network exists among all levels of government and other interested organizations that effectively and efficiently protects and manages the lower Columbia River and estuary.

Objectives:

- *There will be improved coordination among governments and agencies of governments.*
- *Duplication of responsibility or overlapping jurisdictions will be identified, evaluated, and addressed to ensure the most effective and efficient protection of the resource.*
- *Areas of conflict, or potential conflict, will be identified and resolved between, among, or within governments or agencies of governments.*

While some agencies and organizations are attempting to work together to develop a common vision and management strategy for the river, a number of constraints exist:

- Effective natural resource management depends on clear statutory authority and precise and implementable regulations. The Columbia River is governed by a host of different laws administered by different agencies, none of which focus on the river as a whole. Regulatory authority is often limited or inconsistent.
- The decision-making cycles of most government processes conflict with the longer timeframe needed to address many environmental issues. Problems requiring long-term solutions may be neglected in favor of those that appear easy to resolve or produce immediate results.
- Multiple issues compete for limited funding, and priorities are not always clearly set. Decisions are sometimes made in highly charged public or political arenas, which can compromise the objectivity of the decision-making process.
- The lower Columbia River and estuary encompasses diverse cultures, with multiple perspectives and needs. Disparate groups tend to work separately to accomplish individual interests, rather than focus on a common goal.

Concerns related to these organizational and institutional factors include:

- Several dozen different jurisdictions are responsible for activities that affect water quality, fish, wildlife, and habitat in the lower Columbia River. Lack of coordination among jurisdictions adds to project costs (in terms of both dollars and time) and often results in competing plans.
- Multiple resource management plans exist for anadromous fish, and there is continued court jurisdiction over some fish issues. As a result, decision-making and subsequent action are slowed or prevented.
- Washington and Oregon have different water quality standards, and regulatory review processes neither correspond nor dovetail. This can make the permitting process confusing and time-consuming. As a result, economic opportunities may be lost or diminished, and resources may not receive the protection they need.
- There is a lack of shared knowledge among agencies and across levels of government regarding other jurisdictions' structures, responsibilities, schedules, and contact points.
- Jurisdictions are often unable to pursue needed work because of insufficient funding. Pressures on budgets at all government levels make a long-term coordinated approach both more difficult to accomplish and more critically needed.
- Some interested parties may be underrepresented because of poor coordination and a lack of common understanding about the decision-making process. As a result, key issues are often raised in an untimely manner, adding to plan or project costs.

Decision-Making Factors

Decision-making about natural resource management is complex, affected by numerous environmental, social, and economic conditions. Multiple and often competing questions must be considered:

- Are there conflicting environmental and biological needs or benefits?
- What are the immediate and long-term economic impacts?
- What are the social values, preferences, and needs at this time?
- What limitations does the decision place on future generations?
- What level of knowledge is needed?
- What level of scientific uncertainty is acceptable?
- Are sufficient financial resources available?

These factors would make the decision-making process difficult even in a constant world. The process is made even more challenging by continually changing values and perceptions over time. Public views and public policy are influenced by cultural and social values, the state of the economy, and political forces. Changes can be gradual and relatively easy to absorb, or more sudden and disruptive, making them difficult to manage.

The limits of science pose another problem in decision-making. Scientific knowledge is rarely sufficient to enable decisions to be made with absolute certainty. In addition, science alone does not determine policy, and must be considered in the context of other public values; while science may be able to solve problems, it cannot dictate which problems to solve. An informed citizenry is also crucial to scientifically based decisions. Science is useful in setting policy only to the extent that the public understands and accepts its findings as valid.

Another critical factor in the decision-making process is the need to monitor and measure the success of management actions. Measurable outcomes help determine if efforts are producing the desired results, if adjustments are needed, and where subsequent time and funding should be focused. The results of many actions are not easy to measure—for example, those intended to improve habitat or increase public knowledge. Without establishing clear connections between actions and effects, however, the results can be questionable, and the public can lose faith in the management planning process.

Finally, current approaches to burden of proof and cumulative impacts affect the decision-making process. The burden of proof most often lies with regulatory agencies, who generally deny projects only if they can prove without doubt that the project would adversely affect the environment. Agencies are also not required to consider the cumulative impacts of activities and projects. These approaches tend to favor project approval. It may be more appropriate in some cases to place the burden of proof on the project proponent to demonstrate that the proposed action will *not* have unreasonable or irreversible adverse impacts on lower Columbia River and estuary resources.

Ecosystem Management Factors

The complexity of the biological system is another major factor affecting resource management. The lower Columbia River and estuary is a diverse ecosystem, a transition zone between salt and fresh water that provides habitat for a wide variety of plants, fish, and wildlife. Complexity in biological systems is good because such systems are more likely to be stable and self-sustaining. The more complex a system is, however, the less evident the effects of our actions are. As a result, we do not always consider cumulative impacts. Nevertheless, each incremental change, whether visible or not, affects the biological system and almost always reduces its complexity. Each small encroachment makes it less likely that we will ever be able to restore the Columbia River ecosystem to a healthy state. The biological system must be viewed as an integrated whole, with each component dependent for its existence on all the other components.

The diversity of the lower Columbia River and estuary also means it offers many uses: environmental, economic, recreational, commercial, and aesthetic. Perhaps because it supplies so much, we have come to think of it as an inexhaustible source that can serve all of our purposes. Yet, the evidence indicates otherwise. We have to make choices about which uses are the most important to us and how much of each use the river can support. We must then manage the river to ensure that these uses will continue to exist. This requires coordination, cooperation, and a shared vision for the river and the broad community it serves.[4]

[4] The "Base Program Analysis" in Volume 3 is a more extensive analysis of some of the factors that have traditionally inhibited cohesive and coordinated environmental protection.

The Problem:

Citizens are not now fully aware of their ability and responsibility to protect and improve the health of the lower Columbia River and its tributaries.

Vision:

Everyone participates in maintaining and protecting the lower Columbia River and estuary.

Objectives:

- *A network is maintained to provide information about activities that impact the water and habitat quality in the lower river and estuary.*
- *Every individual knows what lifestyle practices improve or impair water and habitat quality.*
- *Continuing education teaches us about the complexity of the Columbia River as a system and provides us with an evolving knowledge base to understand the system and make environmentally sound decisions.*
- *Every individual is a trustee of the river.*

Public Awareness and Stewardship

Citizens are an integral part of a natural community; we need to develop and maintain a common concern for the well-being of that community. This concern is expressed as a commitment to environmental stewardship.

Human culture once centered upon and directly depended on water bodies. Although well over half of the nation's population still lives within 100 miles of a coast or significant river, our connection with these waters for sustenance and livelihood is less apparent than it was for our forebears. It is harder today to see how many of our daily lifestyle choices have direct impacts on our water resources. Our actions on land, even miles from the river, can have negative impacts on the health of the river. Fertilizer spread on lawns in urban areas drains to the Columbia River. The construction of miles of pavement for new shopping areas outside urban boundaries, and the roads to take us there, results in more heavy metals and toxic chemicals entering the river. The choice of bleached white paper adds dioxin to the water. Often, we do not see the links or we may not know the consequences or alternatives. We feel less connected to natural systems and, as a result, feel less direct responsibility for their care. Many people do not have a strong sense they belong to an "estuary community" or a "Columbia River community."

This lack of connection is compounded because it is very difficult to see the system as a whole. Interest groups tend to organize around a single issue, interest, or place; there has not been a group that promotes the health of the estuary system as a whole. People often look to institutions, not individuals, for answers.

The problems we face today are multi-faceted, the result of multiple actions that accumulate to degrade habitat and pollute water. At one time, point sources of pollution, such as major discharges from manufacturing plants, were considered the major contributor. Now we must address significant non-point sources, coming from numerous places and actions. This means that all of us need to assess our activities and choices, understand their impacts, and make adjustments.

Concerns related to public awareness and stewardship include:

- The processes necessary to keep the lower Columbia River and estuary healthy are not well understood. Citizens are unclear about the actions they should take to protect and restore it. As a result, people tend to focus on single issues, often to the detriment of the river as a whole.
- People feel that individual actions will do little to affect such a large river.
- People do not believe their comments are really heard or acted upon. As a result, they are reluctant to spend the time and effort required to participate in a collaborative stewardship process.

If we are not successful in changing our attitudes, significant adverse effects will result:

- A continuing lack of knowledge about the estuary's biological and human systems will make it impossible for citizens to make decisions that will help restore it and keep it healthy.
- People will be unlikely to develop a stewardship ethic unless they have a sense of place that makes them feel they own and belong to an estuary community.
- People will not participate and take action unless they believe their participation matters.

Most people want to protect the environment and leave it in a better condition for their children. With better factual information and a greater understanding of the connections, we can make more environmentally sound decisions and help shape responsible environmental policy.

From Vision to Action

The seven priority issues form the foundation of the *Management Plan*. The problems in the lower river and estuary and the severity of those problems helped the Management Committee define the guiding principals it would use throughout the planning process. The principles, vision, and objectives developed for each issue provided a frame of reference for defining specific actions. The Management Committee worked hard to ensure the actions are **SMART:** **S**pecific, **M**easurable, **A**chievable, **R**esponsive, and **T**rackable. Each selected action addresses one or more of the priority issues, and all are aimed at achieving the Estuary Program's fundamental goal: a high degree of biological integrity for the lower Columbia River and estuary.

The 43 actions are presented in Chapter 5. They are the important next steps for the future of the lower Columbia River and estuary.

Glossary

Algal growths: Growths of microscopic aquatic plants.

Alluvial: Relating to clay, silt, sand, gravel, or similar material deposited by running water.

Ambient: Refers to overall conditions surrounding a place or thing. For example, ambient monitoring refers to routine water quality monitoring.

Anadromous: Describes fish that are born in fresh water, migrate to the sea, and return to fresh water to spawn (reproduce). Examples include salmon, sturgeon, shad, smelt, and steelhead.

Aquatic: Living in or around water.

Arsenic: A naturally occurring chemical element, currently used primarily in the production of pesticides and wood preservatives. In some areas, levels of arsenic are increasing in groundwater because of seepage from hazardous waste sites. In sufficient quantities, arsenic is highly toxic to fish, wildlife, and humans.

Basin: An area of land drained by a river and its tributaries.

Bathymetry: The measurement of water depths in water bodies.

Beneficial uses: The specific uses of a river by people and wildlife, defined by state laws and regulations, and protected by state agencies. Oregon and Washington's defined beneficial uses for the lower Columbia River are: public and private drinking water supply, irrigation, stock watering, fish migration and spawning, other fish wildlife and aquatic plant uses, wildlife usage, preservation of significant and unique habitats, water contact sports, fishing and hunting, aesthetic quality, hydroelectric power, navigation and transportation, marinas and related commercial activity, and commercial fishing.

Benthic: Bottom-dwelling or substrate-oriented; at or in the bottom of a body of water.

Best Management Practice (BMP): A practice or combination of practices that are determined to be the most effective and practical means of controlling point and non-point source pollutants at levels compatible with environmental quality goals.

Bioaccumulative: Contaminants that accumulate in the tissues of individual organisms.

Bioassay: A laboratory test using live organisms to measure biological effects of a substance, factor, or condition.

Biodiversity: The number and abundance of species found within a common environment. This includes the variety of genus, species, ecosystems, and the ecological processes that connect everything in a common environment.

Biological integrity: The capacity of the river system to support and maintain an integrated, adaptive community of plant and animal life.

Biota: All living organisms that exist in a region.

Bis (2-ethyl hexyl) phthalate: A common plasticizer used in a wide variety of industrial processes.

Carcinogenic: Capable of causing or inciting cancer.

Chronic toxicity: Measured as the concentrations of toxics that cause long-term sublethal effects such as impaired growth or reproduction.

Clean Water Act: The 1973 Federal Water Pollution Control Act and Amendments are concerned with the pollution of surface water and groundwater and basically call for fishable and swimmable water everywhere. Permits are required for discharges into waters. The law provides for pretreatment standards, plans involving non-point source pollution, and effluent limitations to effectuate the statutory purpose.

Environmental Protection Agency Cluster Rule: An integrated, multi-media regulation to control the release of pollutants to air and water from the pulp and paper industry. The Cluster Rule sets new baseline limits for releases of toxics and non-conventional pollutants.

Columbia River Basin: All tributaries and their watersheds that drain into the Columbia River along its entire 1,200-mile length. The Columbia River Basin drains approximately 259,000 square miles.

Combined Sewer Overflow (CSO): Untreated overflow from commingled sanitary and storm sewers.

Confluence: The place where two or more streams or rivers meet.

Conventional Pollutants: Constituents or characteristics of the water that occur naturally but become problematic to aquatic organisms and humans due to human activity or, in some cases, natural events. Examples include high water temperatures and high levels of total dissolved gas.

Crustaceans: Invertebrates (animals without backbones) of the phylum Arthropoda, including amphipods, shrimps, crabs, barnacles, and other animals that have segmented bodies, jointed legs, and hard external shells.

Cumulative impacts: The combined environmental impacts that accrue over time and space from a series of similar or related individual actions, contaminants, or projects. Although each action may seem to have a negligible impact, the combined effect can be severe.

DDD: See DDT.

DDE: See DDT.

DDT (Dichloro-diphenyl-trichloroethane): The first chlorinated hydrocarbon insecticide (pesticide). DDT collects in the fatty tissue of some animals and was responsible for eggshell thinning and reproductive failure in eagles. The U.S Environmental Protection Agency banned registration and interstate sale of DDT in 1972 because of its persistence in the environment and accumulation in the food chain. In the environment, DDT breaks down to form DDD and DDE, which are also toxic.

Diking: A method of artificially changing the direction of a course of water or confining water.

Dioxin: A chlorinated organic compound that is widespread and persistent in the environment, some forms of which are highly toxic to fish, wildlife, and humans.

Dissolved oxygen (DO): Oxygen dissolved in water; necessary for the life of fish and most other aquatic organisms. The measurement of dissolved oxygen can be an important indicator of the condition of a water body.

Dredging: The removal of sediments from a river, estuary, or ocean, usually for navigation or docking purposes.

Ecology: The interrelationships of living things to one another and to their environment, or the study of these interrelationships.

Evolutionary Significant Unit (ESU): A population or group of populations that is considered distinct (and hence a "species") for purposes of conservation under the Endangered Species Act. To qualify as an ESU, a population must: 1) be reproductively isolated from other conspecific (of the same species) populations, and 2) represent an important component in the evolutionary legacy of the biological species.

Ecosystem: A community of organisms in a given area together with their physical environment and its characteristic climate.

Effluent: Wastewater discharged into a body of water from point sources.

Endangered Species: A plant or animal that is in danger of extinction throughout all or a significant portion of its range, as identified in accordance with the Endangered Species Act of 1973.

Endangered Species Act: A federal act to protect plant and animal species whose continued existence is in jeopardy. When species are listed under the Act as threatened or endangered, certain actions must be taken for their conservation.

Enhancement: Making changes or improvements to habitat to replace functions or values lost or damaged.

Environmental Indicators: Conditions or occurrences that indicate the health or degradation of the environment.

Erosion: Wearing away of rock or soil by the gradual detachment of soil or rock fragments by water, wind, ice, and other mechanical and chemical forces. Human activities can greatly speed this detachment.

Estuary: The area where the fresh water of a river meets the salt water of an ocean. In the National Estuary Program, this definition is extended to include the tidally influenced waters of the river.

Fecal Coliform: Bacteria associated with the feces of warm-blooded animals, including livestock and humans.

Fertilizers: Material added to the soil to supply chemical elements needed for plant nutrition.

Fill: Soil, sand, and debris deposited in aquatic areas, such as wetlands, to create dry land, usually for agricultural or commercial development purposes.

Flip lips: A structure added to the sloping surface of a spillway to change the downward direction of flow and "flip" it outward. This minimizes deep plunging of water, thereby reducing gas supersaturation and minimizing gas bubble disease in both juvenile and adult migrating fish. Also called spill flow detectors.

Floodplain: The area along a stream or river that is subject to flooding.

Food chain: An arrangement of the organisms of an ecological community according to the order of predation in which each uses the next (usually lower) member as a food source.

Furan: A chlorinated organic compound closely related to dioxin.

Gas bubble disease: A potentially fatal disease affecting fish, triggered by exposure to elevated levels of dissolved gas when water is spilled over dams.

Groundwater recharge: Replenishment of water that circulates in underground aquifers.

Habitat: Places where plants and animals live, feed, find shelter, and reproduce.

Infiltration: The downward movement of water from the atmosphere into soil or porous rock.

Instream water rights: Rights that establish flow levels to stay in a stream on a month-by-month basis, and are usually set for a certain stream reach and measurement at a specific point on the stream. Instream water rights have a priority date and are regulated in the same way as other water rights.

Lower Columbia River Basin: All tributaries and their watersheds that drain into the Columbia River from its mouth to river mile 146. It is larger than the Lower Columbia River Estuary Program study area because it includes the entire watersheds of the tributaries, beyond the waters that are tidally influenced. The Lower Columbia River Basin drains approximately 18,000 square miles, about 7 percent of the entire Columbia River Basin.

Lower Columbia River Estuary Program Study Area: Those portions of the Columbia River and its tributaries that are tidally influenced. The study area extends from the Pacific Ocean to Bonneville Dam at river mile 146. It also includes near-coastal waters from the mouth of the Columbia to the 3-mile limit, to the extent that those waters are influenced by the plume of fresh water flowing out of the Columbia River to the sea. The study area covers approximately 4,300 square miles. It is also referred to as the lower Columbia River and estuary.

Macro-invertebrates: Invertebrates large enough to be seen with the naked eye (i.e., most aquatic insects, snails, and amphipods).

Mainstem: The main course of a stream or river.

Marsh: A wetland where the dominant vegetation is non-woody plants such as grasses and sedges, as opposed to a swamp, where the dominant vegetation is woody plants and trees.

Metabolite: The product of the physical and chemical processes by which foodstuffs are synthesized into complex elements, complex substances are transformed into simple ones, and energy is made available for use by an organism.

Metadata: Information about data, such as their source, sampling protocol, and standards.

Metals: A group of elements found in rocks and minerals that are naturally released to the environment by erosion, as well as generated by human activities. Certain metals, such as mercury, lead, zinc, and cadmium, are of environmental concern because they are released into the environment in excessive amounts by human activity and can produce toxic effects.

Mitigation: Measures taken to reduce the severity of impacts resulting from an action or practice.

Morphology: The form and structure of a stream or river.

Mouth: The place where a stream or river enters a larger body of water (e.g., the ocean).

Native species: Species that are indigenous to the local region and have evolved to thrive in local conditions.

Natural flood storage capacity: The natural capacity of lands surrounding a river to absorb floodwaters and excess runoff.

National Estuary Program (NEP): A federal program established in 1987 by amendments to the Clean Water Act and administered by the U.S. Environmental Protection Agency. The NEP's primary goal is "to protect estuaries of national significance that are threatened by degradation caused by human activity." The NEP employs community-based environmental planning, designating primary responsibility for program development and implementation to the local community.

Non-indigenous species: Species not naturally growing or living in a particular area. Their introduction and expansion can destroy or deplete habitat and food needed by native populations. Also referred to as exotic or non-native species.

Non-point source pollution: Pollution entering waterways from broad land areas as a result of the way the land is used—for example, runoff from agricultural practices, construction and road-building, logging, and urban development.

National Pollutant Discharge Elimination System (NPDES) permit program: A provision of the Clean Water Act that prohibits discharge of pollutants into waters of the United States unless a special permit is issued by U.S. EPA, a state, or another delegated agency.

Nutrients: Essential chemicals needed by plants and animals for growth. Enriched nutrient loads from sewage, land runoff, and atmospheric deposition can result in excessive growth of algae and lead to degradation of water quality.

PAHs (Polycyclic or polynuclear aromatic hydrocarbons): A class of complex organic compounds, some of which are persistent and cause cancer. These compounds are formed from the combustion of organic material and are ubiquitous in the environment. PAHs are commonly formed by forest fires and by the combustion of gasoline and other petroleum products. They often reach the environment through atmospheric fallout and highway runoff.

Particulate matter: Material composed of minute separate particles.

PCBs (polychlorinated biphenyls): A group of manufactured colorless and odorless chemicals made up of carbon, hydrogen, and chlorine. Because of their insulating and nonflammable properties, PCBs were widely used as coolants and lubricants in transformers, capacitors, and other electrical equipment. Banned from production in the United States in 1976, PCBs found today are from historical use or spills. PCBs are suspected of causing cancer in humans and other animals.

Performance standards: Standards based on meeting certain desirable outcomes through flexible methods.

PBTs (persistent bioaccumulative chemicals): Toxic and long-lasting substances that can build up in the food chain to levels that can be harmful to human and ecological health. Many of these substances are man-made and have been in existence for a relatively short period. A few, such as mercury and cadmium, are naturally occurring.

Pesticides: Pesticides include herbicides, insecticides, fungicides, and rodenticides that are used to control unwanted plants, insects, fungi, or rodents, respectively. Most of these chemicals are manufactured and are not found naturally in the environment.

pH: Measure of the negative logarithm of the hydrogen ion concentration to determine the acidity or alkalinity of water. Water of pH 7 is neutral; lesser values are acidic; higher values (pH 14 maximum) are alkaline.

Plankton: Microscopic plants and animals that drift with currents.

Plume: An elongated column or cloud of water or suspended sediment.

Point source pollution: A source of pollutants from a single point of conveyance, such as a pipe. For example, the discharge from a sewage treatment plant or a factory is a point source.

Radionuclides: Decayed products of radioactive materials.

Redds: Nests made in gravel (particularly by salmonids), consisting of a depression that is created and then covered.

Restoration: Returning a damaged habitat, as nearly as possible, to its condition prior to being damaged.

Riparian zone: The land bordering a stream or river, and the vegetation typical of those borders.

Riprap: Large rocks, broken concrete, or other structure used to stabilize streambanks and other slopes.

Riverine: On or near the banks of a river.

River mile: The mile marking a particular point along or in a river, measured from the mouth of a river to its source.

Rock barbs: Rock structures placed in a stream that alter flow to protect streambanks and create new aquatic and riparian habitats.

Runoff: Water from precipitation, snowmelt, and agricultural or landscape irrigation that runs off the land into water bodies.

Salmonid: Fish of the family Salmonidae, including salmon, trout, chars, whitefish, ciscoes, and grayling.

Sanitary Sewer Overflow (SSO): Overflow resulting from a municipal sanitary sewer system exceeding its capacity, due to unintended inflow and infiltration of storm water.

Sediment: Mud, sand, silt, clay and other particles that settle on the bottoms of waterways.

Self-sustaining: Species able to reproduce and rear successfully in their natural habitats and survive the remainder of their life stages.

Sensitive species: Those species that 1) have appeared in the Federal Register as proposed for classification and are under consideration for official listing as endangered or threatened species, or 2) are on an official state list, or 3) are recognized as needing special management to prevent their being placed on a federal or state list.

Slough: A channel through a marsh or mudflat.

Spawn: The act of reproduction of fish, which includes egg laying and fertilization, and sometimes nest building (e.g., salmon).

Stewardship: Taking care of the earth for ourselves and others; sharing knowledge and enthusiasm about that care with others.

Stormwater: Surface water resulting from all natural forms of precipitation.

Substrate: Material that forms a stream or lake bed (silt, sand, gravel, cobble, etc.).

Supersaturation: Water is supersaturated when concentrations of dissolved gas exceed 100 percent. This can occur when gas is forced into the water under pressure, such as when water spills over dams and forces gas into the water.

Suspended solids: Solid inorganic and organic materials that remain suspended in the water column.

Synergistically toxic: Chemicals that become toxic as they mix with other chemicals.

303(d) lists: State-compiled lists of stream segments that do not meet water quality standards.

They are called 303(d) lists after the section of the Clean Water Act that makes the requirement.

Tidal wetlands: Wetlands that have a direct connection to or are influenced by the ocean's tides. For the purposes of the *Management Plan*, tidal wetlands are defined as wetlands below river mile 46.

Tide flats: Flat areas of land exposed during low tides.

Tide gate: A structure designed to allow drainage of diked areas while preventing their inundation by the ocean's tides.

Threatened species: A plant or animal species likely to become endangered throughout all or a specific portion of its range within the foreseeable future, as identified in accordance with the Endangered Species Act of 1973.

Total dissolved gas: A measurement of the amount of nitrogen and oxygen gas dissolved in water. Water is saturated when it can hold no more dissolved gas under normal atmospheric conditions.

Total Maximum Daily Loads (TMDLs): Allocated measures that ensure compliance with water quality standards for 303(d)-listed water bodies.

Toxic chlorinated hydrocarbons: Toxic compounds resulting from the mixing of chlorine, carbon, and water.

Toxic: Poisonous, carcinogenic, or otherwise directly harmful to life.

Tributary: A stream or river feeding a larger body of water.

Tributylitin: An organic compound used as an additive in many marine anti-foulant plants to prevent algal and barnacle growth. Tributylitin is highly toxic to many marine organisms.

Turbidity: A measure of the amount of suspended material in the water, based on the material's refractory characteristics.

Urban growth boundaries: Generally state-wide, land use planning programs that mark the separation between rural and urban land. They are intended to encompass an adequate supply of buildable land that can be efficiently provided with urban services (such as roads, sewers, water lines, and street lights) to accommodate the expected growth during a specific time period.

Waste load allocations: The portion of a receiving water's loading capacity that is allocated to existing or future point source discharges.

Water column: The layer of water between surface and bottom sediments; the moving mass of water contained by a stream or river bed. The water column contains dissolved and particulate matter and provides habitat for plankton, fish, and marine mammals.

Watershed: A geographic area within which all surface water drains to a particular body of water.

Wetland: An area that is saturated by a surface of groundwater and subsequently is characterized by a prevalence of vegetation that is adapted for life in saturated soil conditions.

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Historical Photographs

Page 12 - Fish net seining. Earl Moore photo, Oregon Historical Society, #OrHi GI 7185 #390-D

Page 143 - The Rapids, Upper Cascades. Charles E. Watkins photo, Oregon Historical Society, #OrHi 21089 #1100B

In memory of Terry Husseman

whose vision and commitment inspires us still.
Terry served as Deputy Director of the Washington Department of Ecology
and was a founding member of the Estuary Program Policy Committee.
In large part, it was Terry's vision and guidance for a two-state comprehensive
environmental program that shaped the Estuary Program.
He is missed.