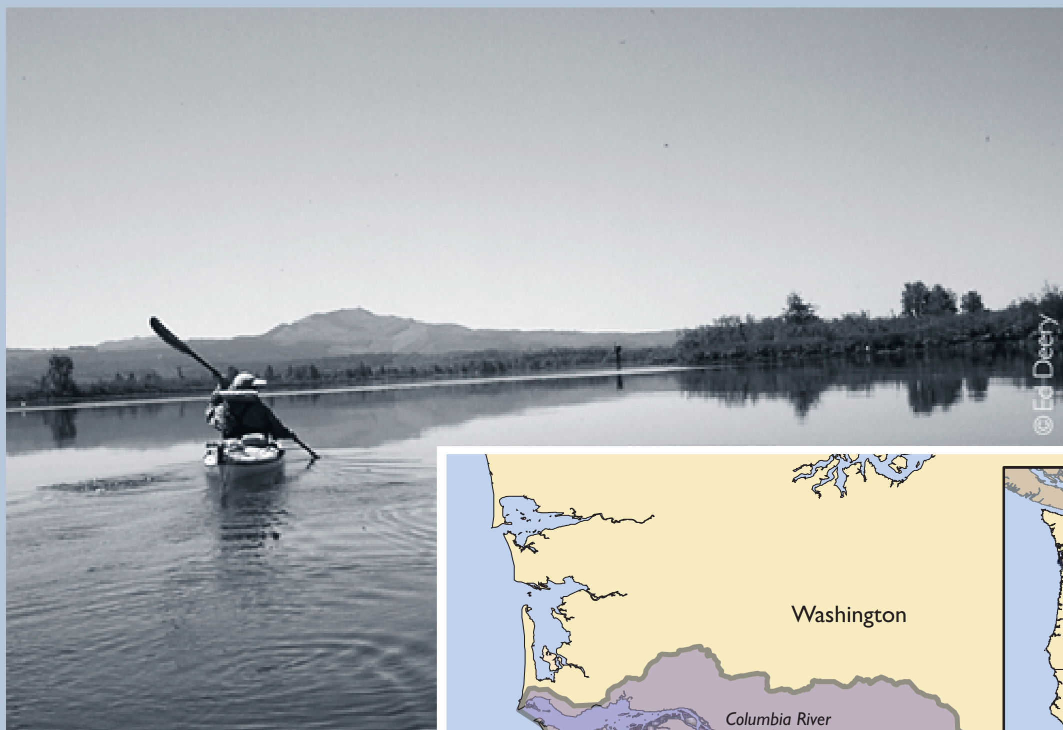
This document contains overall and specific condition of the Lower Columbia River Estuary Partnership from the National Estuary Program Coastal Condition Report. The entire report can be downloaded from ***http://www.epa.gov/owow/oceans/nepccr/index.html***

National Estuary Program Coastal Condition Report

Chapter 6: West Coast National Estuary Program Coastal Condition, Lower Columbia River Estuary Partnership

June 2007

Lower Columbia River Estuary Partnership



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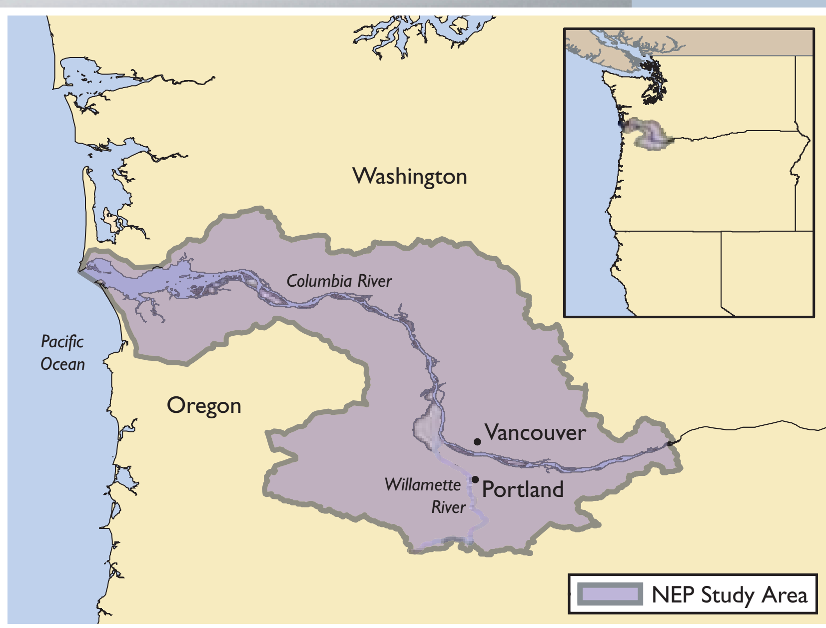

Background

The 4,300-mi^2 Lower Columbia River Estuary extends downstream from the Bonneville Dam at river mile 146 to the mouth of the Columbia River and into the Pacific Ocean to the 3-mile limit, which represents the point where coastal waters are no longer influenced by the plume of fresh water flowing into the ocean. This estuarine system contains a wide variety of habitats associated with marine, estuarine, and freshwater influences. These habitats range from open water to bottom sediments, tidal flats, and the riparian zone. The Lower Columbia River Basin drains approximately 18,000 mi^2, about 7% of the entire Columbia River Basin (LCREP, 1999).

The Lower Columbia River Estuary Partnership's (LCREP's) *Comprehensive Conservation and Management Plan, Volume 1* (LCREP, 1999) identifies many actions that can be conducted in the study area to improve water quality and habitat in the Lower Columbia River Estuary. The LCREP recognizes that many impacts in the study area are the result of problems or sources elsewhere in the Columbia River basin; therefore, efforts in the study area will be less effective if changes in the entire basin do not occur. For this reason, it is important not to separate the Lower Columbia River Estuary from the larger watershed. Although the LCREP's CCMP includes many actions that specifically address the study area, it also considers the impacts from the larger watershed and incorporates actions to address these impacts, where needed.

Environmental Concerns

The LCREP completed its CCMP for the Lower Columbia River Estuary in June 1999. The CCMP contains 43 specific actions to address 7 priority issues: biological integrity, impacts of human activity and growth, habitat loss and modification, conventional pollutants, toxic contaminants, institutional constraints, and public awareness and stewardship. As part of the planning process, a comparative risk assessment process helped prioritize the LCREP's activities and identified loss of habitat as the greatest risk to the health of the Estuary. Based on this assessment, the LCREP has chosen to direct much of its energy toward the protection and restoration of habitat.

Population Pressures

The population of the 11 NOAA-designated coastal counties coincident with the LCREP study area increased by 78.4% during a 40-year period, from 0.9 million people in 1960 to 1.6 million people in 2000 (Figure 6-19) (U.S. Census Bureau, 1991; 2001). This rate of population growth was one of the lowest for the West Coast NEPs and was much lower than the population growth rate of 100.3% for the collective NEP-coincident counties of the West Coast region. In addition, the LCREP study area's population density of 138 persons/mi^2 was the third-lowest density of the West Coast NEPs (U.S. Census Bureau, 2001). This estuary is not surrounded by the large metropolitan areas that are characteristic of some other West Coast NEPs, such as Puget Sound or the San Francisco Estuary.

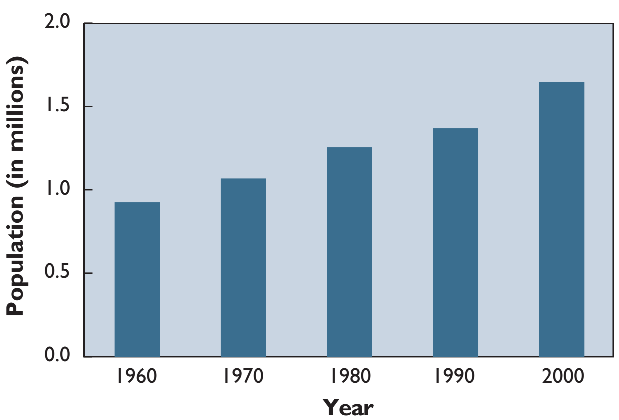

Figure 6-19. Population of NOAA-designated coastal counties of the LCREP study area, 1960–2000 (U.S. Census Bureau, 1991; 2001).

NCA Indices of Estuarine Condition—Lower Columbia River Estuary

The overall condition of the Lower Columbia River Estuary is rated fair based on three of the indices of estuarine condition used by the NCA (Figure 6-20). The water quality and sediment quality indices are rated fair, and the fish tissue contaminants index is rated poor. Although data on the condition of the benthic community were collected for this estuary, the Lower Columbia River Estuary could not be rated using an index based on deviations from the expected species richness. Figure 6-21 provides a summary of the percentage of estuarine area rated good, fair, poor, or missing for each parameter considered. This assessment is based on data collected by ODEQ and the WSDE from 79 stations sampled in the LCREP estuarine area in 1999 and 2000. Please refer to Tables 1-24, 1-25, and 1-26 (Chapter 1) for a summary of the criteria used to develop the rating for each index and component indicator.

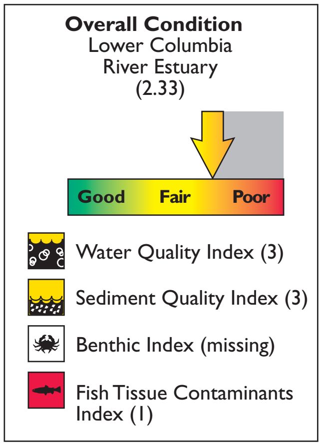

Figure 6-20. The overall condition of the LCREP estuarine area is fair (U.S. EPA/NCA).

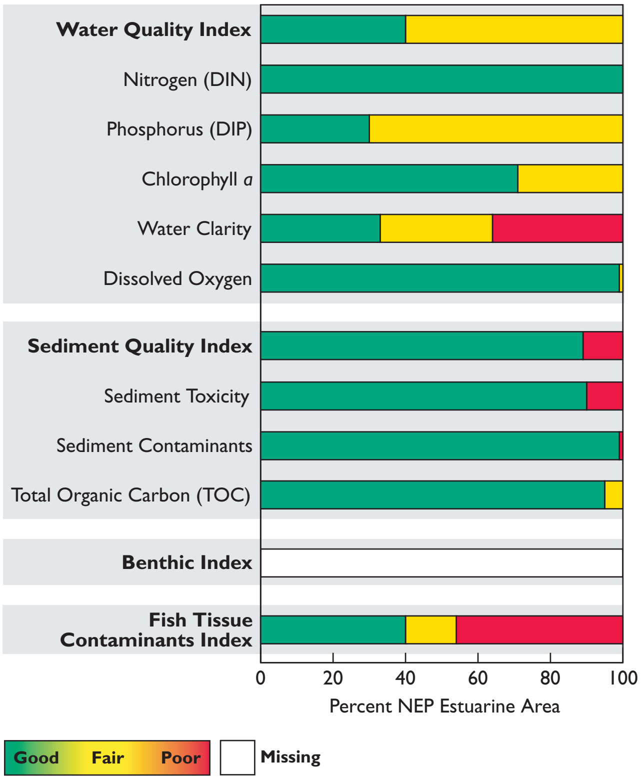

Figure 6-21. Percentage of NEP estuarine area achieving each ranking for all indices and component indicators — Lower Columbia River Estuary (U.S. EPA/NCA).

Water Quality Index

Based on NCA survey results, the water quality index for the Lower Columbia River Estuary is rated fair (Figure 6-22). This index was developed using NCA data on five component indicators: DIN, DIP, chlorophyll *a*, water clarity, and dissolved oxygen. Water quality was rated fair in 60% of the estuarine area due to limited water clarity and moderate DIP concentrations.

Dissolved Nitrogen and Phosphorus | The Lower Columbia River Estuary is rated good for DIN concentrations and fair for DIP concentrations. One-hundred percent of the estuarine area was rated good for DIN concentrations, and 70% of the estuarine area was rated fair for DIP concentrations.

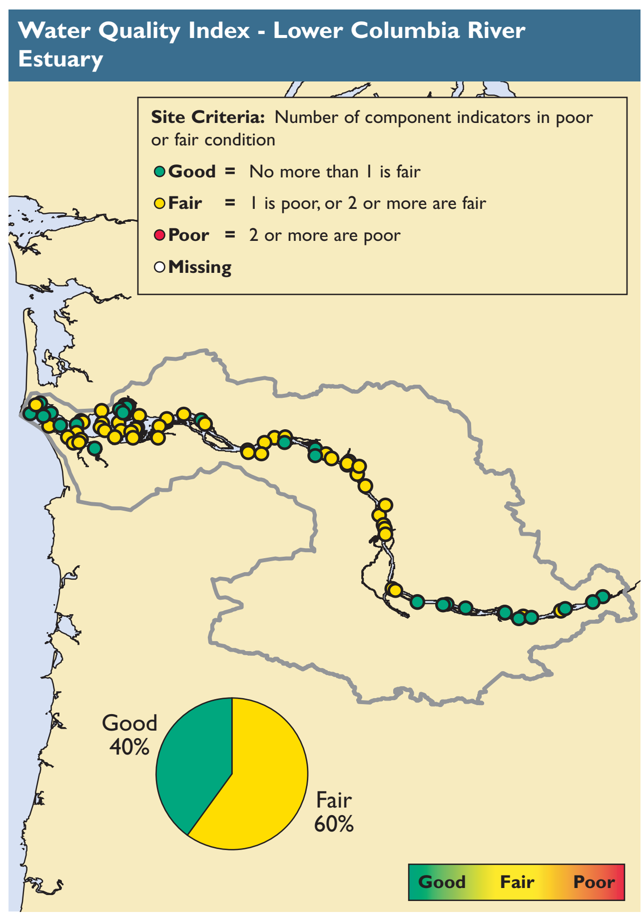

Figure 6-22. Water quality index data for the Lower Columbia River Estuary, 1999–2000 (U.S. EPA/NCA).

Coho salmon are found in the Lower Columbia River Estuary (Oregon Department of Fish and Wildlife).

Chlorophyll a | Chlorophyll *a* concentrations in the Lower Columbia River Estuary are rated good. Approximately 29% of the estuarine area was rated fair for this component indicator, with the remaining 71% of the area rated good. None of the LCREP's estuarine area was rated poor for chlorophyll *a* concentrations.

Water Clarity | Water clarity in the Lower Columbia River Estuary is rated poor. Approximately 35% of the estuarine area was rated poor for water clarity, and an additional 31% of the area was rated fair.

Dissolved Oxygen | Dissolved oxygen conditions in the Lower Columbia River Estuary are rated good, with 99% of the estuarine area rated good for this component indicator. Although conditions in the Estuary appear to be good for dissolved oxygen, measured values reflect daytime conditions, and some areas of the Estuary may still experience hypoxic conditions at night.

Sediment Quality Index

The sediment quality index for the Lower Columbia River Estuary is rated fair, with 11% of the estuarine area exceeding thresholds for one or more of the three component indicators: sediment toxicity, sediment contaminants, or sediment TOC (Figure 6-23).

Sediment Toxicity | The Lower Columbia River Estuary is rated poor for sediment toxicity, with 10% of the estuarine area rated poor for this component indicator.

Sediment Contaminants | The Lower Columbia River Estuary is rated good for sediment contaminant concentrations, with only 1% of the estuarine area rated poor for this component indicator and none of the area rated fair.

Total Organic Carbon | The Lower Columbia River Estuary is rated good for sediment TOC. Ninety-five percent of the estuarine area was rated good for this component indicator, and 5% of the area was rated fair. None of the LCREP's estuarine area was rated poor for sediment TOC concentrations.

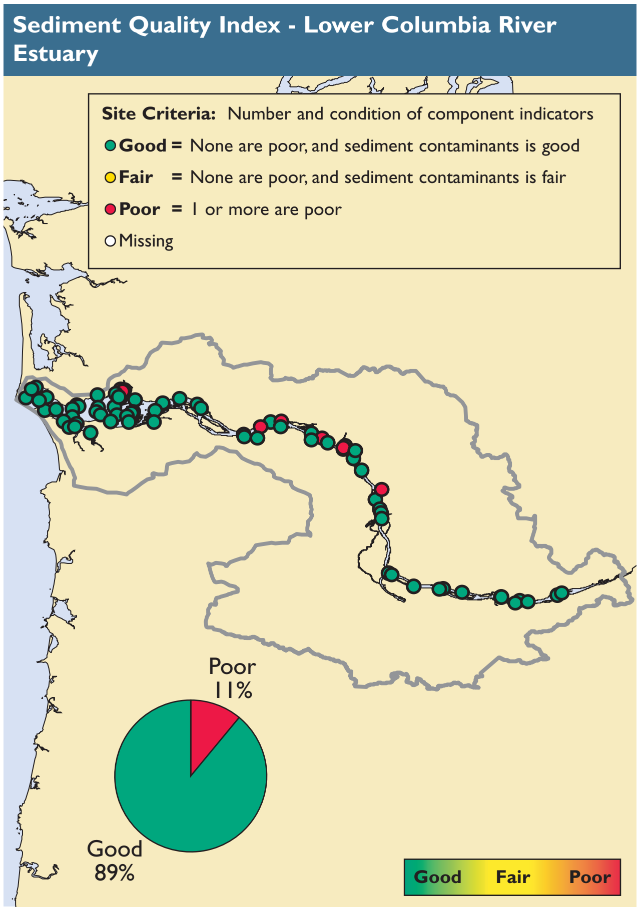

Figure 6-23. Sediment quality index data for the Lower Columbia River Estuary, 1999–2000 (U.S. EPA/NCA).

Benthic Index

The condition of the benthic invertebrate community in the Lower Columbia River Estuary currently cannot be rated using an index based on deviations from the expected species richness. This conclusion was based on 75 benthic samples taken in the LCREP estuarine area, of which 29 samples were collected in the side embayments in 1999 and 46 were taken in the main stem of the Columbia River in 2000. The NCA approach requires a significant regression between salinity and the log of species richness; however, this relationship was not significant in the Lower Columbia River Estuary ($r^2 = 0.03$, $p > 0.10$). The lack of a significant regression was not due to an inadequate range in salinity because salinity for the Estuary ranged from 0.04 to 31.3 ppt. Species richness was low in the Estuary, averaging only 6.0 species per sample over all the samples and 4.4 species per sample in the samples collected along the main stem of the Columbia River. It is possible that stressors (e.g., dredging of the channel) or naturally low diversity in the Estuary obscured any simple relationship between salinity and species richness; however, when samples collected within 99 feet of the shipping channel were removed from the regression analysis, the regression relationship improved, but was still not significant due to the wide range of species richness values at freshwater sites. EPA was unable to provide a relative benthic index assessment for the Lower Columbia River Estuary using the NCA survey data, and additional data analysis will be required to find an alternate approach for the Estuary.

Fish Tissue Contaminants Index

The fish tissue contaminants index for the Lower Columbia River Estuary is rated poor. Forty-six percent of all stations sampled where fish were caught exceeded the EPA Advisory Guidance values using whole-fish contaminant concentrations and were rated poor (Figure 6-24). For populations that consume whole fish, these risk calculations are appropriate. The contaminants found in fish tissues at elevated concentrations in the Lower Columbia River Estuary most often included total PCBs, DDT, DDD, DDE, and mercury.

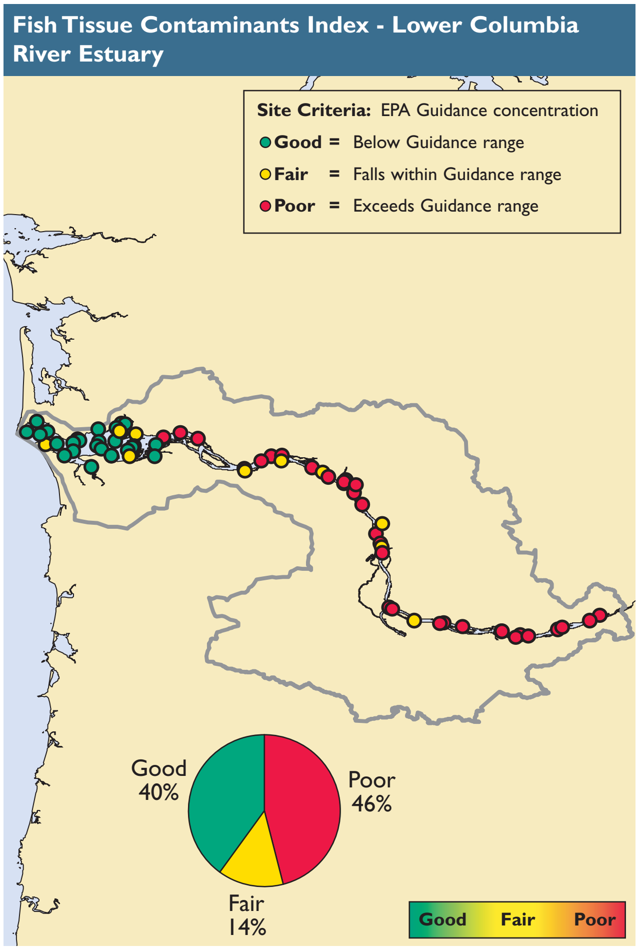

Figure 6-24. Fish tissue contaminants index data for the Lower Columbia River Estuary, 1999–2000 (U.S. EPA/NCA).

Astoria Bridge (LCREP).

Lower Columbia River Estuary Partnership

HIGHLIGHT

Habitat Protection and Restoration in the Lower Columbia

The floodplain of the Lower Columbia River Estuary historically contained extensive and diverse wetland and riparian habitats critical to fish and wildlife; however, the impacts of development over the past 150 years have significantly altered this complex system. Although the Estuary still provides essential habitat for a great number of freshwater and saltwater fish, numerous shellfish, a variety of marine and water-dependent land mammals, and over 175 species of birds, it is a very different area from the one explored by Lewis and Clark (ANEP, 2001a; LCREP, 2006). Loss of wetland habitat is one of the greatest problems being addressed by the LCREP. Evidence indicates that more than one-half of the wetland areas in the Estuary have been lost since 1870 as a result of diking, draining, filling, dredging, and flow regulation. Forested marshes in the lower 46 miles of the Lower Columbia River have decreased as much as 75%, whereas barren lands and open water areas have increased substantially (ODEQ, 2000).

The LCREP has made habitat restoration and protection a top priority. The Partnership's CCMP (LCREP, 1999) presents six actions specifically directed toward habitat protection and restoration, and several other actions involve a habitat element. The LCREP is working to establish a coordination structure to ensure that projects are developed using the best available scientific information and prioritized according to the life-cycle needs of endangered species, such as salmon and other native organisms.

Since 1999, the LCREP's habitat restoration program has funded 22 projects, resulting in the protection of more than 1,200 acres and the restoration of more than 850 acres. The program has also spent $2.7 million to leverage nearly $9 million in restoration funding with over 50 partners throughout Oregon and Washington, resulting in 4,600 total acres protected or restored in the Lower Columbia River Estuary (LCREP, 2005b). Some examples of these restoration projects are discussed in the following sections.

Reconnecting historic floodplains to regular tidal wetting, such as seen on this 80-acre parcel, is one of the habitat restoration techniques used by partners of the LCREP (Columbia Land Trust).

Scappoose Bay Conservation Plan and Restoration Projects

The LCREP worked with The Wetlands Conservancy to conduct an inventory of naturally valuable habitat within the 8,960 acres of the Scappoose Bay Bottomlands. Partnering with the Scappoose Bay Watershed Council, the LCREP allocated grant funding to remove multiple fish barriers, install fish-friendly bridges, and fence stream riparian areas. The planning area for these activities covers 200 acres of cattle farmland (The Wetlands Conservancy, 2004).

Grays Bay Area Conservation/Restoration Projects

Partnering with the Columbia Land Trust, the LCREP funded a multi-level restoration effort with grant funding from the EPA Watershed Initiative and the Bonneville Power Administration. At 5 different sites, the project resulted in the conservation of 880 acres of floodplain, the reconnection of 500 acres of historic floodplain, the restoration of 300 acres of salmon habitat, and the enhancement of 3 miles of riparian habitat (CREST, 2006).

Strategic Prioritization for Habitat Restoration

As a next step in the Partnership's habitat restoration program, the LCREP has initiated an effort with partners and interested parties to develop a focused Strategic Habitat Restoration Plan, which will detail the most ecologically beneficial locations for restoration and describe the most appropriate types of restoration strategies to undertake in those areas. Beginning in 2006, the LCREP will employ this tool in the restoration project selection process, which will identify project value based on its significance to the Columbia River ecosystem. Ultimately, projects selected through this framework will provide greater cumulative benefits to the entire system, while adaptive management and effectiveness monitoring of these projects will ensure continued progress and improvements to the system's health over the long term (Evans et al., 2006).

Replacing undersized, non-performing culverts, such as the one seen here on Honeyman Creek, allows for full fish passage and tidal influence in tributary streams. The photo on the left is a pre-restoration representation, whereas the photo on the right is after restoration (Scappoose Bay Watershed Council [left] and the LCREP [right]).

Lower Columbia River Estuary Partnership Indicators of Estuarine Condition

The LCREP has developed a set of six environmental indicators that attempt to provide accessible information about the health of the Lower Columbia River Estuary. These indicators are considered key measures of the Estuary's ecological integrity and are meant to be a step in the process of relaying important information about the estuarine system to policy makers and the public. The LCREP's environmental indicators are the following:

- Habitat (loss, opportunity, protection and conservation, restoration, net change)
- Biotic integrity (native species assessment)
- Land use (land-use changes, riparian integrity)
- Water quality (concentrations of toxic contaminants and convention pollutants, temperature, and dissolved oxygen)
- Stewardship (children's educational and field programs, volunteer monitoring, and restoration)
- Appreciation (park visitors, recreational and shellfish permits, membership in environmental non-governmental organizations).

The LCREP's indicators were carefully chosen based on a number of factors. Each indicator had to be a measurable and quantifiable value, be understandable to the public, have sufficient historical records to show trends, relate to the overall condition of the Estuary, allow for an assessment of present conditions and a prediction of future trends, provide sufficient facts to support goal-setting and program management, and provide targets and endpoints for the restoration of the Estuary.

Water and Sediment Quality

In 2004 and 2005, the LCREP partnered with USGS and the ODEQ to monitor water quality at three fixed stations along the Lower Columbia River and the Willamette River. Selected water samples were analyzed for a variety of parameters, including nutrients, chlorophyll *a*, suspended sediment, total coliforms, trace elements, and a variety of chemical contaminants (LCREP, 2006). Water quality sampling using semipermeable membrane devices (SPMDs) was also conducted in the Lower Columbia River and its tributaries during 2003 and 2004. SPMDs are used to mimic the accumulation of contaminants in the fatty tissues of fish. During this study, concentrations of dieldrin and PCBs commonly exceeded human health criteria; DDT compound concentrations exceeded the criteria less frequently; and PAH concentrations were below the criteria (Johnson and Norton, 2005). Additional SPMD samples were collected in 2005. More information about the LCREP's water quality monitoring efforts is available at http://www.lcrep.org.

Water temperatures and dissolved oxygen concentrations are also monitored in the Lower Columbia River Estuary. Cool (68 degrees Fahrenheit or less) water temperatures in the Estuary are essential for native aquatic species, which experience stress as temperatures rise. Average and maximum summer water temperatures have increased by approximately 4 degrees since 1938. In 2002, measured dissolved oxygen concentrations in the Estuary were above Washington's and Oregon's state standard of 8 mg/L (LCREP, 2005a).

Habitat Quality

Habitats in the LCREP study area have been changing over time, and the acreage of developed land and open water in the Lower Columbia River Estuary has increased substantially since the 1880s. At the same time, the areal extents of the Estuary's tidal swamps and marsh habitat have decreased by 77% and 57%, respectively. Although the average tree cover in most of the study area (the region near Longview, WA, was excluded from this analysis) decreased from 46% to 24% between 1972 and 2000, the amount of area with thick, dense canopy tree cover has increased since 1986 (LCREP, 2005a).

The LCREP and its partners have undertaken several measures to monitor, assess, and map habitats in the Estuary. The Partnership's habitat status monitoring program was established to create a long-term data set used to assess the status and trends of the Estuary's aquatic habitats (LCREP, 2006). The Lower Columbia River and Estuary Ecosystem Classification System is under development by the LCREP, USGS, and the University of Washington to delineate the Estuary's different landscape structures and guide habitat monitoring efforts (Simenstad et al., 2005). Field work has also been combined with satellite images, digital aerial photos, bathymetry, LIght Detection And Ranging (LIDAR), and high-resolution hyperspectral images to develop detailed and comprehensive habitat maps and habitat data layers (LCREP, 2006).

Living Resources

Approximately 24 threatened and endangered species of plants, fish, animals, and birds can be found in the Lower Columbia River Estuary. Although populations of some of these species (e.g., bald eagles) are slowly recovering, others (e.g., chinook salmon) are not. The number of occupied bald eagle nests along the Columbia River has been increasing slowly since 1978; however, the productivity of those nests located below river mile 60 remains low due to significant contaminant concentrations (e.g., DDE, PCBs, and dioxins) found in the egg shells collected from this portion of the Estuary. During the past hundred years, the number of chinook salmon returning to spawn in the Estuary has decreased from a range of 450,000–550,000 fish to an average of 100,000 salmon. Although a variety of factors (e.g., hydropower operations, harvest, ocean conditions) contributed to this population decline, habitat loss and degradation is cited as the leading cause. Since reaching a low of 25,000 returning fish in 1999, chinook salmon returns have improved slightly (LCREP, 2005a).

At least 81 invasive species (e.g., American shad, purple loosestrife, Chinese mystery snail, Eastern snapping turtle, nutria) have been introduced to the Lower Columbia River Estuary since the mid-1880s. The majority of these species originated in North America, and domestic shipping is most likely an important vector for the introduction of new species to the Estuary. The rate at which new species are discovered has increased from one every five years between the 1880s and the 1970s to one every five months since 1994. Although this rate of increase can be attributed to more new species being introduced to the Estuary, an increasing number of improved surveys to monitor invasive species has also contributed to the growing number of species detected. For example, an invasive species survey conducted at 134 stations in the LCREP study area during 2002 and 2003 identified 269 aquatic species. Twenty-one percent of these were invasive species, and the origins of another 45% of the identified species were unknown (Sytsma et al., 2004; LCREP, 2005a).

Toxic contaminants have been detected in the fatty tissues of fish and wildlife living in the Lower Columbia River Estuary, and interim health advisories have been issued for dioxins, PCBs, and pesticides in the fatty tissue of all fish in the Estuary (LCREP, 2005a; U.S. EPA, 2005a). Starting in 2005, the LCREP and NOAA began testing juvenile salmon tissue and stomach contents for concentrations of chemical contaminants. The resulting data will be used to assess the effects of toxic contaminants on the survival and productivity of the Estuary's juvenile salmon and to assist with the development of three models designed to identify contaminant sources; describe potential modes and routes of transport, exposure, and uptake; and analyze the possible effects on survival and productivity of listed salmon species (LCREP, 2006).

Environmental Stressors

The LCREP uses the percentage of the study area's impervious surface and the number of innovative stormwater management projects implemented as indicators of estuarine condition. Between 2000 and 2005, the amount of impervious cover in the LCREP study area has increased significantly. Innovative stormwater management projects have been implemented in the study area, especially in the Portland and Vancouver areas (LCREP, 2005a). These projects are highlighted in the LCREP's *Lower Columbia River Field Guide to Water Quality Friendly Development*, which provides local examples of different stormwater management techniques and is available online at http://www.lcrep.org/fieldguide.

Current Projects, Accomplishments, and Future Goals

Monitoring the Estuary to track its condition over time and to develop a better understanding of the highly complex ecosystem is another critical element of the LCREP. During the development of its CCMP, the LCREP and a highly dedicated group of monitoring organizations spent almost two years developing the *Lower Columbia River Estuary Plan, Volume 2: Aquatic Ecosystem Monitoring Strategy for the Lower Columbia River-Information Management Strategy* (LCREP, 1998). The Monitoring Strategy of this report lays out a phased-in approach to implementing a comprehensive monitoring plan for the Lower Columbia River Estuary. Special projects have been initiated to enhance understanding of the Estuary, with attention paid to addressing the monitoring needs of salmon restoration.

Data management is another focus of the LCREP's current efforts. Currently, there is no single place where one can go to find all the existing information about the Lower Columbia River Estuary. The Information Management Strategy of this report (LCREP, 1998) lays out a multi-phase approach for improving access to and management of data. An example of progress is the availability of technical data regarding the condition of the Estuary, including data from the Bi-State Water Quality Study, is available online at http://www.lcrep.org.

The LCREP has also focused its resources on developing educational programs for the area's students and volunteer opportunities for residents. Since 2000, the Partnership has developed more than 50 different field-based Columbia River education curricula for more than 32 school districts and assisted with classroom programs, field trips, and on-river trips for more than 45,000 students. The Partnership has also provided over 8,000 volunteers the opportunity to help plant more than 11,000 native trees and shrubs at 18 habitat restoration sites (LCREP, 2005a).

Conclusion

Based on data from the NCA estuarine survey, the overall condition of the Lower Columbia River Estuary is rated fair. The LCREP has been working collaboratively with many other organizations to monitor the ecosystem; educate the public; and assess, protect, and restore the extensive and diverse habitats that comprise the Lower Columbia River Estuary. These efforts have had positive effects in several areas of estuarine health (e.g., bald eagle population increases, acreage of restored habitat); however, other areas (e.g., water temperature increases, toxic contaminant concentrations in fish tissue) remain a concern.