OWEB Project Completion Report:

McKenzie-Willamette River Habitat Enhancement Action Planning and Implementation

Project # 200-093

Submitted to the Oregon Watershed Enhancement Board

By

John Runyon
Project Manager
McKenzie Watershed Council

April 10, 2002

C:\Projects\McKenzie\Confluence\ACTION\2002\OWEB 200-093 Project Completion Report.doc

Description of Project

The McKenzie-Willamette River Confluence area, which historically had extensive side channel areas and flood plain habitats, is a key to successfully restoring some flood plain function to the Willamette River system. The McKenzie Watershed Council, through their action planning process, identified restoration of the confluence area as the highest priority in the watershed. Previous studies, and the McKenzie Watershed Council's ongoing subbasin assessment, have identified the confluence area as having the potential to restore key refuge habitat (pools and side channels) for juvenile Upper Willamette River spring chinook salmon. Juvenile rearing habitat appears to be a strong limiting factor for chinook salmon production in the McKenzie River system. Since the McKenzie Watershed holds the only self-sustaining run of native chinook salmon in the upper Willamette River Basin, restoration of juvenile rearing habitat in the confluence area will be a key component of species recovery.

The confluence area has very valuable infrastructure in place, historically dynamic channel migration patterns, key fish and wildlife resources, and restoration potential, all of which requires very detailed habitat assessment, planning and engineering analysis to complete a successful project that enhances fish and wildlife habitat and accounts for flood protection requirements.

The value of the aquatic and flood plain habitats, complexity of the issues, the requirement to involve multiple interests, and the proximity of the gravel industry and residential areas created the need for sophisticated and detailed project planning for current and future projects. The goal of the project was to develop a comprehensive habitat enhancement and flood control plan that would guide project planning and land use decisions now and into the future (50 year or more). To help with the detailed planning, the project used the scientific foundation and information developed from the OWEB-funded fish and wildlife habitat assessment and the aggregate funded river hydraulic study. These studies provided essential information on fish / wildlife habitats and populations, river channel dynamics, erosion issues, and flooding problems.

List of Project Participants

The project oversight was provided by a steering committee comprised of representatives of the local aggregate industry, local landowners, state and federal agencies, environmental groups, and the McKenzie Watershed Council. This steering committee participated in the action planning process. Local consultants assisted with the project planning work. John Runyon, McKenzie Watershed Council, provided overall project management.

Project Steering Committee

Name	Organization
Chris Thoms	U.S. Army Corps of Engineers
Gary Lynch	Oregon Division of Geology & Mineral Industries
Jeff Ziller	Oregon Dept. of Fish and Wildlife
Randy Hledik	Wildish Land Company
John Alltucker	Eugene Sand and Gravel
George Staples	Delta Sand and Gravel
Rick Jefferies	Riveridge Golf Course
Bob Bumstead	McKenzie River Flyfishers
Jim Turner	National Marine Fisheries Service
Lori Warner	Oregon Division of State Lands
Karen Cholewinski	Green Island Farm
Bill Sage	Lan~~d~~e County Land Management
John Runyon	McKenzie Watershed Council
Jim Thrailkill	McKenzie Watershed Council

Project Consultants

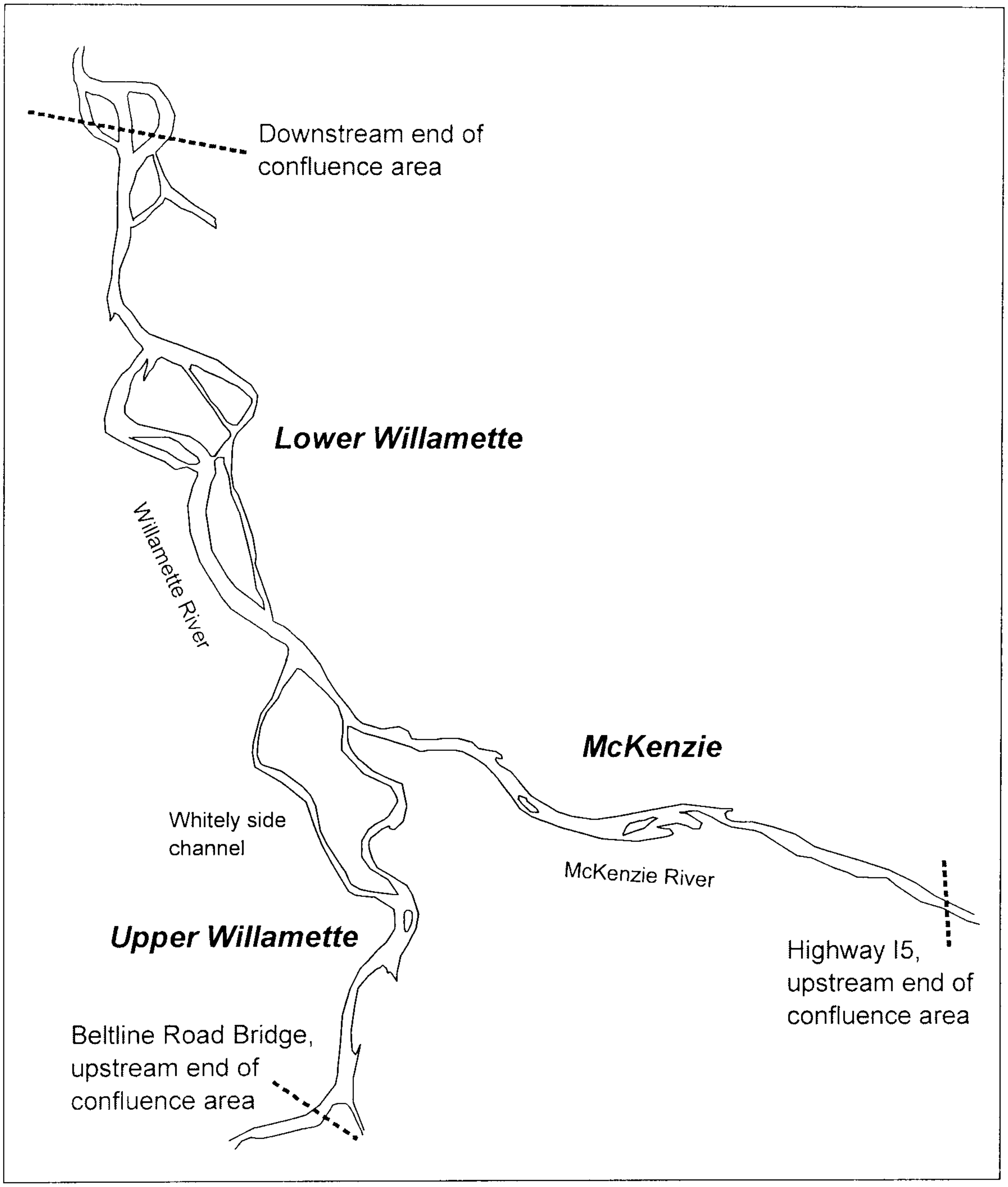
Name	Organization
John Gabriel	Alsea Geospatial
Chip Andrus	WaterWork Consulting
Dave Vesely	Pacific Wildlife Research

Methods

The local aggregate operators and the Oregon Concrete and Aggregate Producers Association (OCAPA) funded ($150,000) a geomorphic, hydrologic, and hydraulic study of the McKenzie-Willamette River confluence area for the purpose of developing a flood management plan. The hydraulic study provided the foundation for the riparian-aquatic assessment study funded by the Oregon Watershed Enhancement Board. The assessment evaluated historic and current habitat and developed principals for protecting or improving conditions for native fish and wildlife in the confluence area. The project area encompasses 11,123 acres of river channel, riparian and terrestrial habitats. The area includes the Willamette River downstream of river mile 178.2 (Beltline Road Bridge) to river mile 171.5 and the McKenzie River from its confluence with the Willamette River to the Interstate Highway 5 bridge (about 4 miles long). Included are the main channels of both rivers and off-channel areas that have connection to the main channels at any time. For purposes of the wildlife habitat, the study area includes land and water bodies within the historic flood areas of the two rivers (see map).

Both of these studies provided detailed and site-specific information on habitat features, fish and wildlife population status, water quality, hydraulic conditions, and habitat enhancement and flood protection opportunities. In addition to detailed reports, the studies provide GIS data layers describing the area and fish and wildlife habitat and populations.

This background information was used to guide the project and land use planning effort. Through a consensus-based process, the committee agreed to integrate habitat enhancement actions with flood-erosion control projects needed by the aggregate industry and other landowners. Because the aggregate industry is planning long-term actions involving extraction and pit reclamation, it was necessary to think about habitat enhancement over very long planning horizons of 50 years or more. Due to the complexity of the land uses and river channel dynamics, the planning was divided into short term (1 to 5 years), medium term (6 to 10 years) and long-term (11 years plus) planning horizons.


Downstream end of confluence area
Lower Willamette
Willamette River
McKenzie
Whitely side channel
McKenzie River
Upper Willamette
Highway I5, upstream end of confluence area
Beltline Road Bridge, upstream end of confluence area

Results

The McKenzie – Willamette River Confluence Project provides a model for protecting and enhancing fish and wildlife habitat while sustaining economic development.

The McKenzie-Willamette River Confluence Steering Committee has developed the foundation of good communication, mutual trust, and scientific information necessary to develop a long-term approach to resource management in the Confluence Area. Through a collaborative process, the Committee has made significant progress.

1. We have developed Committee consensus on the desired future for fish and wildlife habitat and land uses in the Confluence Area. Our *Land Use, Flood Control and Habitat Enhancement Guidelines* provide a framework for evaluating proposed actions and outline a vision for long-term habitat enhancement and economic sustainability. (**See Attached**)
2. Through the planning process, the Committee identified a number of short-term habitat improvement opportunities. Several of the high-priority projects were proposed for OWEB funding. These funded projects (**OWEB Project No.: 201-470, $151,781**), all on aggregate company lands, focus on improving salmonid and pond turtle habitats. (**See Attached Map**)

The Committee will continue to work within a framework of collaboration and consensus, providing a forum for discussion, communication, and coordinated actions in the Confluence Area. In the future, the Committee will focus on:

- Planning and implementing enhancement projects, including monitoring their effectiveness.
- Developing a detailed long-term habitat enhancement / flood protection plan.
- Integrating continued floodplain-mining activities into the long-term planning effort.
- Securing funding for project planning, management, implementation, and monitoring.

The Committee will take advantage of the participants shared knowledge and understanding and continue with the same stakeholder composition. The Committee's composition may change as members leave or it is necessary to add new representation. Members will be added by consensus of the full Committee.

The Committee will meet as needed, with the meetings focused on specific questions / projects. McKenzie Watershed Council will continue staff the process as a neutral convener and may provide:

- Facilitation of the committee
- Project management for grant-funded actions
- Coordination with other groups, landowner, and agencies
- Grant proposal preparation and administration
- Public / media outreach

Accounting of Expenditures and In-Kind Services

The attached table from the fiscal administrator, Cascade Pacific Resource Conservation and Development, provides the details on the expenditure of OWEB grant funds. In-kind services were provided by the members of the steering committee and their organization's staff. In-kind services included activities such as attendance at meetings and field tours, proposed project site visits, providing professional advice and information for the project, reviewing the consultants' work products, and interacting with the McKenzie Watershed Council. Accounting for time expenditures, by organization, is estimated as follows:

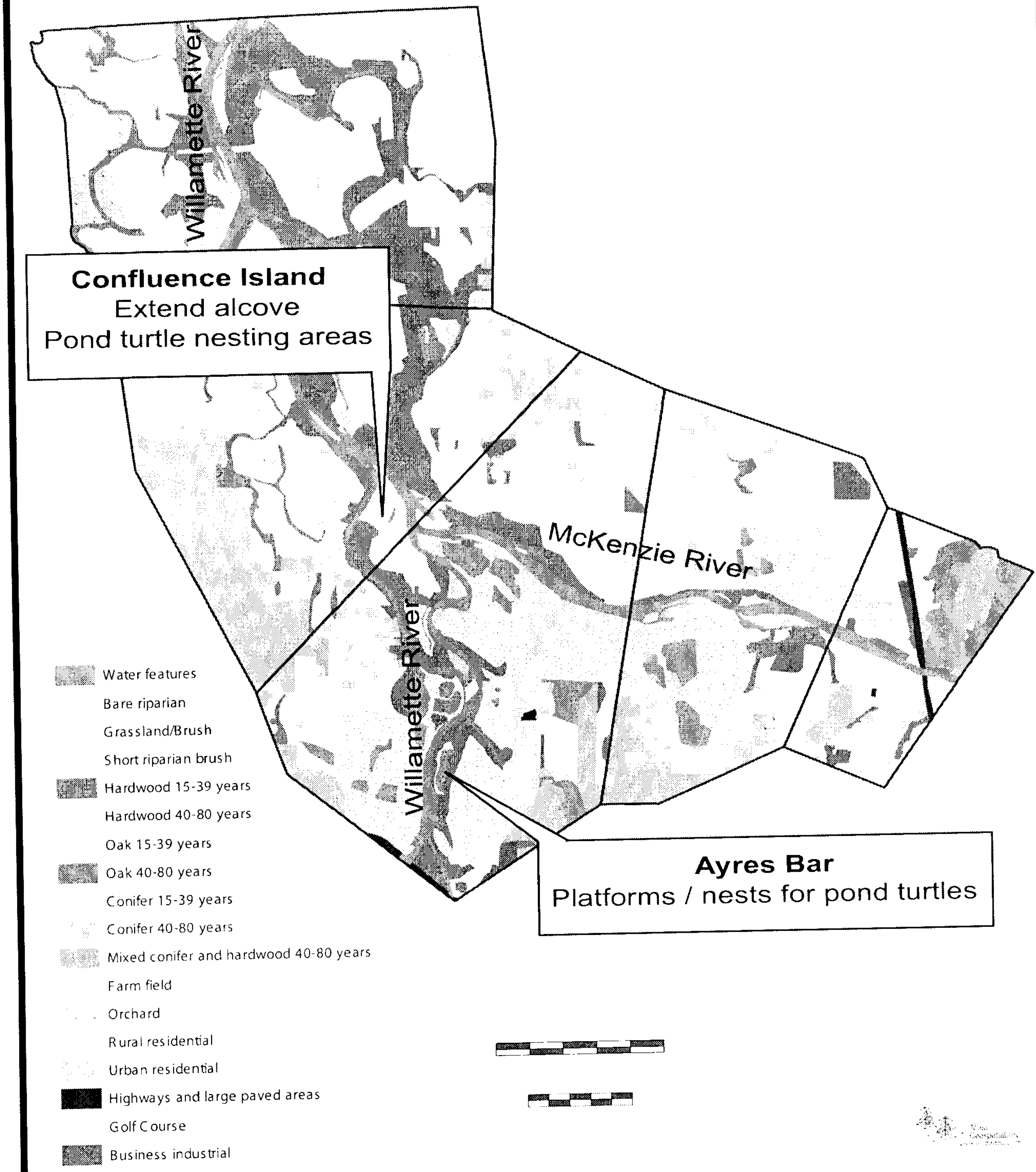
Participant	Type of In-Kind Services	Hours and Rate	Total
Local Aggregate Operators staff time and consultants (3 Staff and 1 Consultant)	Meeting time, consultants, site visits, project planning	220 hours@ $60/hr.	$13,200
McKenzie Flyfishers	Meeting time	80 hours @ $30/hr	$2,400
McKenzie Watershed Council Coordinator (BPA funding)	Meeting time, assistance with project admin.	100 hours @ $40/hr	$4,000
ODFW	Meeting time, consultants, site visits, project planning	100 hours @ $40/hr	$4,000
Oregon Department of Geology and Mineral Industries (2 Staff)	Meeting time, consultants, site visits, project planning	180 hours @ $40/hr	$7,200
Oregon Division of State Lands	Meeting time, consultants, site visits, project planning	100 hours @ $40/hr	$4,000
National Marine Fisheries Service	Meeting time, consultants, site visits, project planning	100 hours @ $40/hr	$4,000
Army Corps of Engineers	Meeting time, consultants, site visits, project planning	100 hours @ $40/hr	$4,000
			Total In-Kind Services: $42,800.00

Conclusions

The McKenzie-Willamette Confluence project is an innovative approach to long-term and integrated river channel and floodplain management. There are few models for success in this effort. While the Committee has developed the foundation for continued collaborative habitat enhancement and flood / erosion control actions in the Confluence Area, the process faces a number of challenges. These include:

- Using the current planning framework and Guidelines to build Committee consensus on specific long-term actions for habitat enhancement and land use following gravel extraction.
- Developing innovative approaches to the local, state and federal agency roles and coordination, including permitting processes and jurisdictional boundaries.
- Finding cooperative mechanisms to reduce bureaucratic "overhead" for the planning and permitting process.
- Refining an approach that gives landowners flexibility to achieve both economic and environmental goals.
- Developing regulatory flexibility to achieve goals.
- Developing landowner incentives and flexible permitting.
- Developing a cooperative and long-term organizational structure that provides landowners and government agencies with assurances that planned implementation, monitoring, and adaptive feedback will be successfully carried out in the future.
- Providing funding, staffing, and other resources to sustain this complex planning, implementation, and monitoring effort.
- Coordinating activities with local government agencies and other regional planning efforts.

Willamette-McKenzie River Confluence Proposed Habitat Enhancement Projects



Confluence Island
Extend alcove
Pond turtle nesting areas

Ayres Bar
Platforms / nests for pond turtles

LAND USE, FLOOD CONTROL AND HABITAT ENHANCEMENT GUIDELINES FOR THE CONFLUENCE AREA OF THE MCKENZIE AND WILLAMETTE RIVERS

McKenzie-Willamette Confluence Project Steering Committee

November 2001

LAND USE, FLOOD CONTROL AND HABITAT ENHANCEMENT GUIDELINES FOR THE CONFLUENCE AREA OF THE MCKENZIE AND WILLAMETTE RIVERS

McKenzie-Willamette Confluence Project Steering Committee

November 2001

Purpose

This document contains a set of parameters identified by landowners, regulatory agency officials and interested members of the public that can be used to guide land use, flood control and habitat enhancement activities in the vicinity of the confluence of the Willamette and McKenzie rivers near Eugene, Oregon. The guidelines are based on a comprehensive hydrologic analysis and biological evaluation of the two rivers and their associated fish and wildlife habitats. They reflect the historic, present and potential future dynamics of the river system, and recognize changing uses of adjacent land. The guidelines are intended to provide the basis for evaluating proposals pertaining to the protection, utilization or enhancement of the natural resources located in the Confluence Area.

Confluence Area

The Confluence Area encompasses both the Willamette and McKenzie River and surrounding floodplain habitats. The area includes the Willamette River downstream of river mile 178.2 (Beltline Road Bridge) to river mile 171.5 and the McKenzie River from its confluence with the Willamette River to the Interstate-Highway 5 bridge (about 4 miles long). Included are the main channels of both rivers and off-channel areas that have connection to the main channels at any time. For purposes of the wildlife habitat, the area includes land and water bodies within the historic flood areas of the two rivers. (See Figure A: Confluence Planning Area, and Figure B: Air Photo of the Confluence Area.)

Today a variety of land uses are found in the Confluence Area (See Figure C: Land Use Plan Designations). Highway bridges cross both rivers at the upper reaches of the confluence area. Adjacent to the north bank of the McKenzie River the major land uses are farming, sand and gravel mining and rural residential development. On the south side are found a regional park, a youth camp and sand and gravel operations. Urban development, including sand and gravel operations, governmental and business offices, and a golf course characterize the east side of the Willamette River. The west side of the Willamette is occupied by sand and gravel mining and semi-rural to urban residential development. Interspersed among these land uses are remnants of the natural ecosystem that continue to provide habitat to numerous species, as well as enjoyment to the general public.

Background

Through geologic time, dynamic channels and seasonal flooding created a diverse array of natural resources at the confluence of the Willamette and McKenzie Rivers. Flooding and meandering developed a riverine ecosystem characterized by a broad floodplain with braided steams, sloughs, wetlands, and multicanopied woods. Deep deposits of sand and

In order to obtain a comprehensive understanding of the locations vulnerable to future flooding, a hydrologic analysis was conducted. The hydrologic analysis estimates the 100-year instantaneous peak flow for the McKenzie River to be 89,900 cubic feet per second. The discharge estimated for the Willamette River at the confluence is 74,600 cubic feet per second. Using the hydraulic computer model UNET (Unsteady NETwork) an estimate was made of the flood-water surface profiles along the planning reaches of both rivers.

The analysis concludes that along most of the McKenzie River within the Confluence Area, the main channel in its current state is nearly large enough to contain the 100-year regulated flood. The Willamette River presents more challenges in terms of developing flood protection measures. Lateral erosion of the riverbanks will continue to be a problem for landowners along river reaches within the Confluence Area. (See Figure D: Map of Revetment and Bank Erosion Inventory.)

Habitat Characteristics

The confluence area includes some of the least altered and some of the most altered fish and wildlife habitat in the Willamette valley. Some alterations are local and some are a result of activities far upstream. Average annual peak flows are only 60% of normal for the McKenzie River and 30% of normal for the Willamette River due to upstream reservoirs. Decreased peak flows reduces the ability of a river to meander and create (or modify) off-channel features such as side channels, alcoves, and ponds. These off-channel features provide unique habitat for certain species of fish and wildlife.

Portions of the confluence area have also been intentionally channelized. What was previously a wide flood plain with multiple channels in the lower McKenzie River has been engineered into a single channel along the northern edge of the old flood plain. The area of channels and islands in the Willamette River from the McKenzie River confluence to Harrisburg in now only 20% of what existed in 1850. Large wood that choked the two rivers prior to European settlement is now mostly absent. About 20% of river banks in the confluence area are rip-rapped, further keeping the rivers from meandering

Both rivers are cool during the summer due to intensive groundwater inputs and flow supplementation from reservoirs. Neither river has any obvious water quality problems; nutrients are tightly cycled and man-made organic compounds and toxins are mostly absent. However, the Willamette River upstream of the McKenzie River suffers some chronic turbidity in spring and fall due to clay entrainment at a reservoir.

Fish sampling of highly altered and minimally altered habitat in the confluence area suggests fish communities are variable and change with the season. Rainbow and cutthroat trout caught in the McKenzie River and lower Willamette River were abundant along natural banks but mostly absent along rip-rapped banks that had fast-moving water. Rock barbs extending at right angles to rip-rapped banks mitigated the negative effects of alcoves at night. In contrast, northern pikeminnow have no access to introduced fish in the gravel ponds during low water where introduced fish are quite abundant. Bluegill and largemouth bass dominate the fish community in gravel ponds.

The bird community in the confluence area was monitored from January through May and found to be unusually diverse. The mosiac of human-influenced and natural habitat features supported 128 species. In June 2000 75 species of birds used the confluence area for nesting. Habitat types that were particularly attractive to birds were riparian woodlands, alcoves and ponds, inactive gravel mining areas, and shrubland.

Bare river substrate, now scarce due to the lack of high peak flows that would normally scour vegetation from the river's edge, is supplemented by bare areas at gravel operations and within seasonally-pond portions of grass-seed fields. Wading birds are particularly attracted to these areas without vegetation.

Adult western pond turtles have been found at many of the natural ponds and gravel ponds in the confluence area. However, we observed no younger turtles. Reproduction failure is suspected to be a major cause of western pond turtle decline in the Willamette valley. Raccoons, skunks, and small mammals raiding turtle nest sites probably contribute most to reproductive failure. Turtles usually nest at elevated sites supporting only sparse and short vegetation. However, introduced vegetation such as blackberry, grasses, and weeds have created a scarcity of such settings. (See Figure E: Map of Vegetation / habitat types.)

Desired Future Condition

In a most general sense, the underlying long-term vision (50 years and more) for the Confluence Area is one in which the Willamette and McKenzie rivers and their environs retain what presently remains of the natural ecosystem, recapture or emulate where practical the natural biological and geological properties that have been lost, and fulfill the needs and enjoyment of future generations of people who live, work, recreate, or otherwise depend on the natural resources found in the area. This will only be possible through long-term collaborative and cumulative actions.

Returning the river and the surrounding floodplain to the condition that predates pioneer settlement of the area is problematic. Given the significant change that has occurred in more than a century of population growth, achievement of this condition would require an unprecedented effort, including removal of agricultural, residential, recreational, commercial, industrial, and public works structures. The resulting social and economic implications would be significant and, coupled with attendant financial costs and legal and political ramifications, make this alternative unrealistic. Furthermore, activities occurring both up and down stream beyond the Confluence Area have consequences that make a full return to pre-settlement condition difficult to obtain.

At the same time it remains necessary to recognize the importance of the agricultural, residential, recreational, commercial, industrial and public works land use activities occurring in the Confluence Area. Their continuation and protection from stream bank erosion and flooding should be taken into account when making decisions and setting policy for the area.

The guidelines contained in this document are intended to address both private ownership rights and broad public interests. As with the river system itself, the guidelines are dynamic in nature, recognizing that the scientific knowledge, social values and stakeholder interests that exist today will change with future generations. Therefore, this vision of the Confluence Area is intended as a direction, not as a destination. The planning timeframe considers actions over the short-term (one to six years), the transition period (six to 50 years) the long term (50 or more years).

Guidelines

A broad range of sometimes contradictory public and private interests are involved with human activity at the confluence of the Willamette and McKenzie rivers. The manner in which these interests are balanced, prioritized and regulated affects the condition of the natural environment, the livelihood of landowners, the economy of the local area, and the livability of the community in general.

It is important to keep in mind that time and timing are important elements regarding all aspects of conservation and development in the Confluence Area. In the short-term (from the present to 6 years from now) steps can be taken to preserve significant habitat, or to restore, enhance or emulate natural riverine conditions. Conversely, it is possible for development to occur on adjacent land, perhaps at the expense of certain habitat, with anticipation that in the long-term (6 to 50 or more years from now) the natural environment can be enhanced. Although care should be taken to avoid the inadvertent diminution or elimination of one habitat type for the sake of another, it may be necessary to prioritize habitat improvements that benefit one species over another. Consideration should be given to the values that deliberate change may create.

1) Improving Ecosystem Conditions

In regard to efforts aimed at improving the condition of the riverine and terrestrial ecosystem, the following protection and restoration actions will be studied for possible implementation:

- **Increase the width of the active river channels.** Historically the Willamette and McKenzie rivers flowed freely across comparatively wider and shallower channels than that to which they are confined today. While established rural and urban development constrains the expanse of the channel area available to river flows, portions of former channels remain undeveloped. The value and ramifications of integrating these abandoned channels with the active channel should be explored.

- **Excavate sand and gravel from deposits located below the ordinary high water lines of active river channels in a manner that does not exceed the depth of the river channels, and that results in conditions reflecting the historical character of the rivers.** The value and ramifications of reestablishing water flow into or through abandoned channels should also be explored, as well as should the creation of new side channels and alcoves.

- **Excavate sand and gravel deposits located above the ordinary high water lines of river channels to depths that fully utilize the available resource.** Sand and gravel excavations should be setback from the high water lines a minimum of 75 feet. Specific setbacks should be determined on a case-by-case basis, taking into consideration the following:
    - Floodway boundaries;
    - Historic river channel meander patterns;
    - Extent of riparian vegetation;
    - Stream bank stability;
    - Wildlife corridor connectivity;
    - Large wood recruitment potential;
    - Prevention of river channel capture; and
    - Reclamation opportunities

- **Excavate sand and gravel in a manner that does not adversely affect the quality or quantity of water in the rivers and associated aquifers.** Pit dewatering, storm water runoff, process water, sedimentation and turbidity are elements that should be controlled to avoid adversely impacting the biological and hydraulic character of the rivers, riverine habitat, and associated ground water.

- **Protect sand and gravel operations from stream bank erosion, flooding and river avulsion.** Where it is necessary to stabilize eroded stream banks, riprap revetments and bioengineering techniques should complement adjacent riparian conditions. Berms or dikes should be constructed in a manner that does not adversely affect water levels in river floodways.

- **Reclamation of sand and gravel pits should incorporate features that provide fish and wildlife habitat.** Mined-out pits can be designed to create a complementary diverse and complex mix of habitat types for a variety of species. The hydrologic and biologic potential for, as well as the legal liabilities associated with integrating reclaimed sand and gravel pits into the riverine ecosystem should be explored. Opportunities as well as risks associated with connecting river flows to mined-out pits should be addressed.

3) Continued Agricultural Land Uses

Agriculture is, and will continue to be, a major land use activity in the Confluence Area. The productive agricultural lands in the area support farm incomes and provide high quality habitat for fish and wildlife. Oregon Senate Bill 1010 establishes a process for the development of agricultural water quality management plans. A plan is under

5) Other Land Use Activities

As has been the case for the last 150 years, human activity will continue to influence the character of the Confluence Area. During the next 50 years the populations of Eugene, Springfield and Coburg are expected to continue to grow, increasing the interest in both preserving and converting natural areas and farmland. Similarly, community growth will generate demand for the sand and gravel deposited in the area, and as the resource is mined out, the gravel pits will be reclaimed for other uses. To address the evolution of land use in the Confluence Area, and direct it toward the stated vision, the following action is recommended.

- **Future development should incorporate the natural aspects of the rivers and their environs in a manner that protects and enhances their quality.** Built-up development such as houses, roads or other structures probably represents the most serious impediment to the long term function and recovery of the area, with the most significant consequences being the alteration of native vegetation, disturbance of wildlife habitat, hard surfacing of riverbanks to protect property, indiscriminate use of chemicals, and dumping of refuse into waterways. As existing land uses change to reflect future economic and social circumstances, consideration should be given to the environmental conditions that define this area.

6) Monitoring and Adaptive Management.

Because conditions in the Confluence Area will change over time, and because some of the actions recommended are experimental, it is important to monitor projects to evaluate whether they are achieving the desired future condition envisioned for the area. Furthermore, the proposed actions will be subject to revision as monitoring or other new information becomes available. Therefore the following is recommended.

- **Establish a system to monitor conditions in the Confluence Area, and evaluate the successes of projects designed to control floods and enhance habitat.** Seasonal surveys of fish and wildlife and bank erosion are encouraged, and a general review of these guidelines every five years or as changing conditions warrant, is appropriate.

7) The Role of Government Agencies

Local, state and federal agencies contribute to the achievement of the principles outlined in these guidelines. The ongoing partnership between Confluence Area landowners, the McKenzie Watershed Council, and state and federal agencies, has great potential to provide an innovative approach to collaborative natural resource problem solving. These agencies have an interest in improving interagency data collection and review, enhancing communication and collaboration, and in reducing duplication of effort to develop and implement a land use, flood control, and habitat enhancement plan that adheres with the spirit of the Oregon Plan for Salmon and Watersheds.

It is in the mutual interest of all government agencies to:

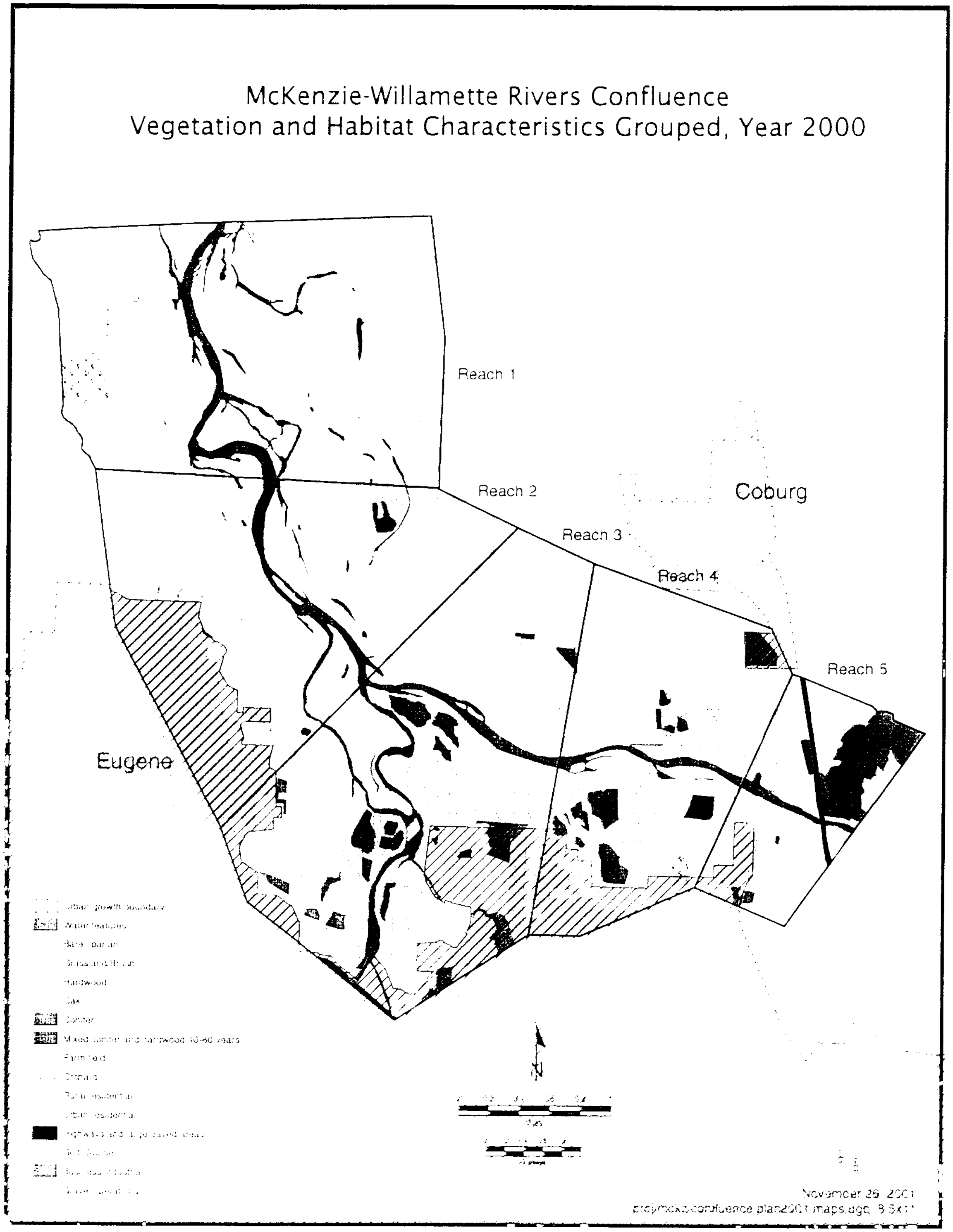
Figures

Figure B: Air Photo of the Confluence Area

Aerial View
McKenzie-Willamette River Confluence

September 17 2001
prj mckz confluence plan2001 maps aerial

Figure C: Map of Land Use Plan Designations



McKenzie-Willamette Rivers Confluence
Vegetation and Habitat Characteristics Grouped, Year 2000

Figure D: Map of Revetment and Bank Erosion Inventory

Figure E: Map of Vegetation / Habitat Types

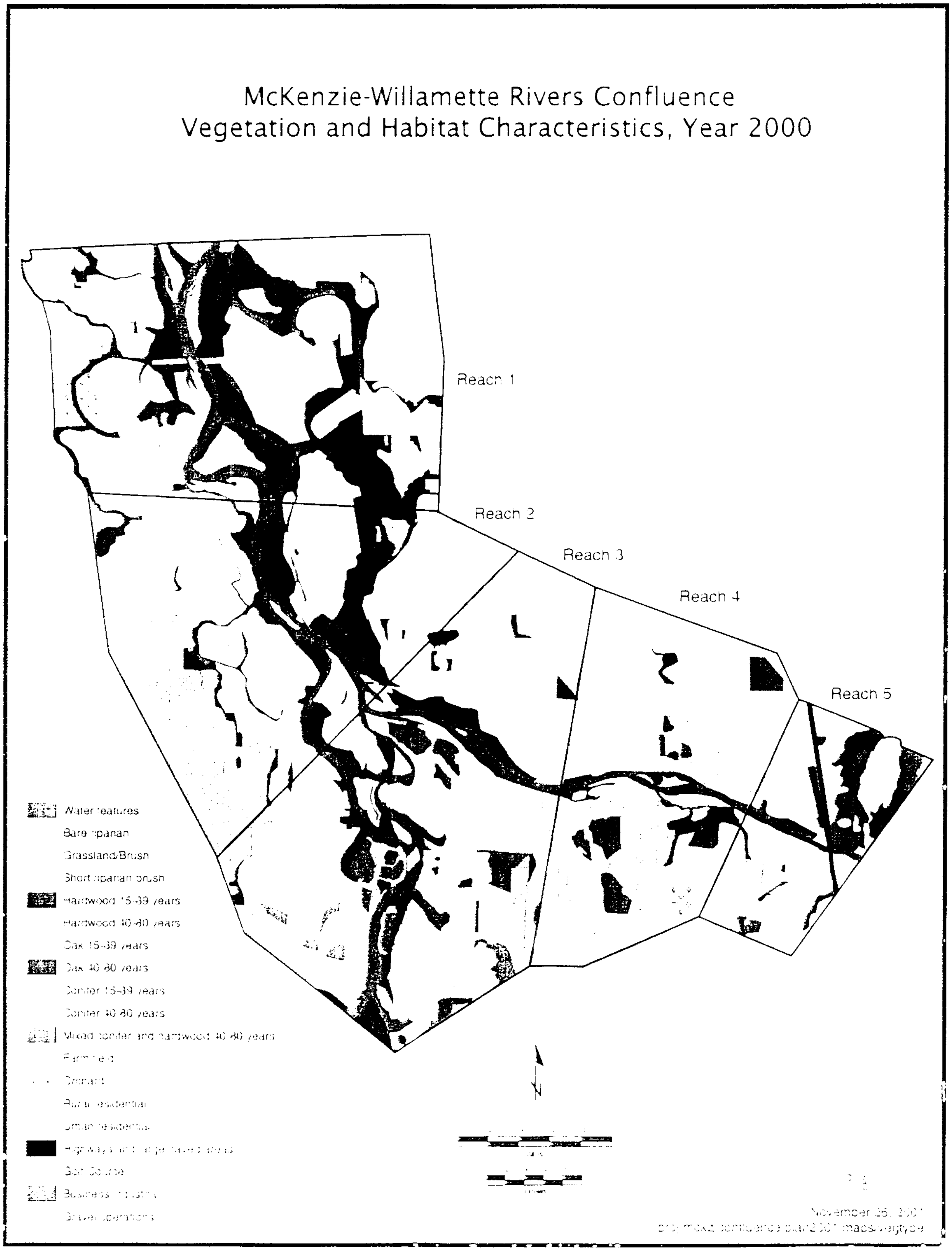
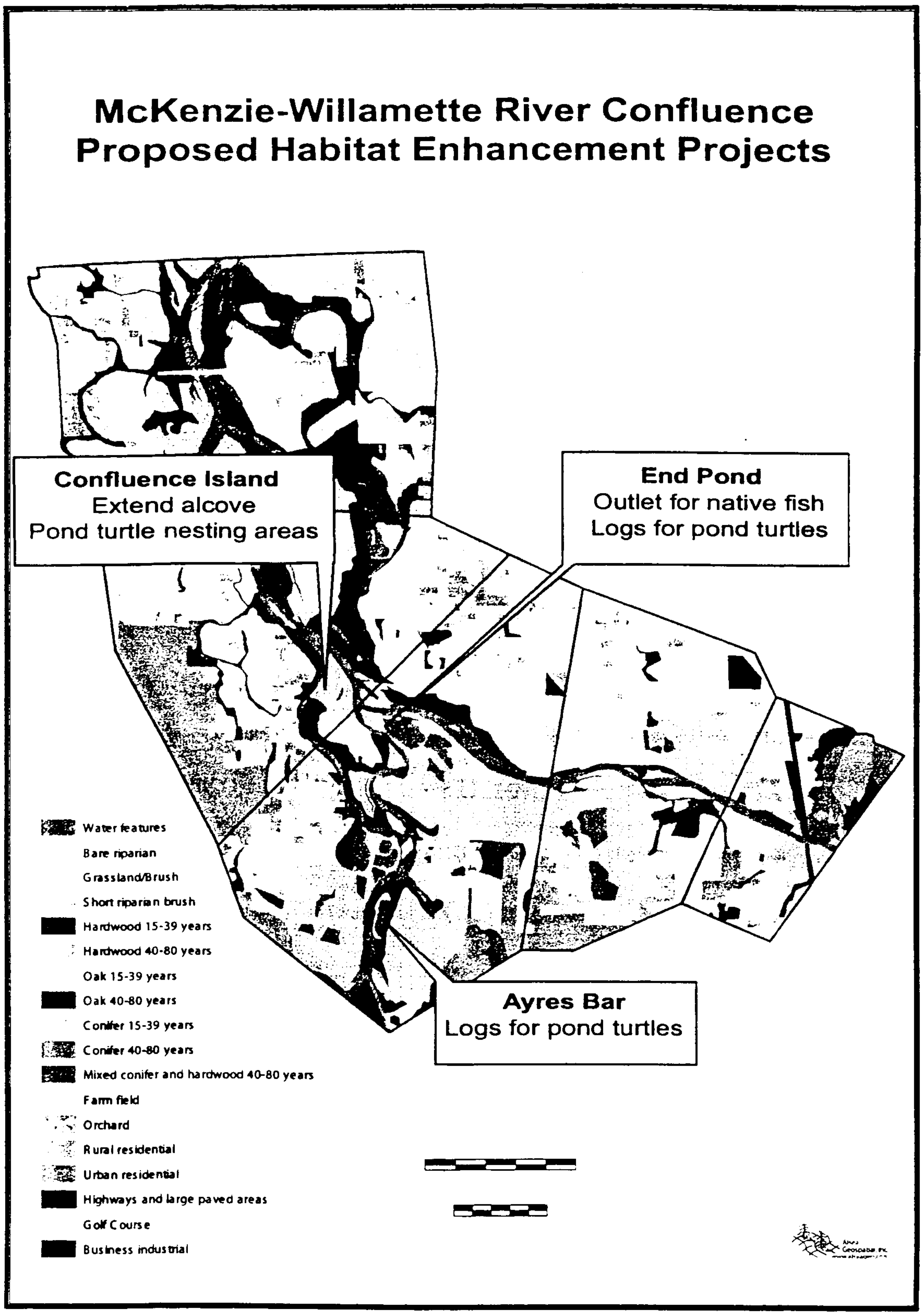


Figure F: Map of Proposed Short Term Habitat Enhancement Actions



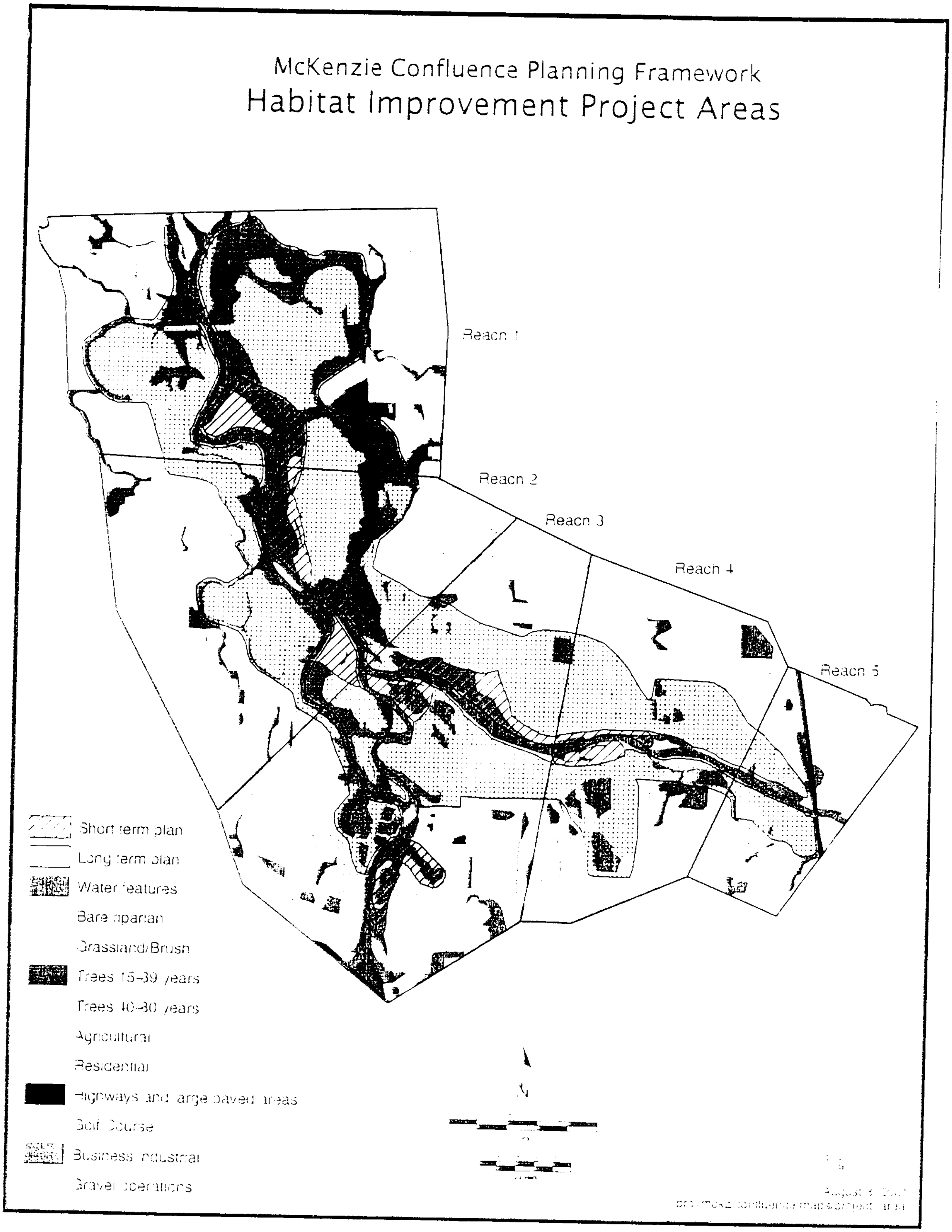
McKenzie-Willamette River Confluence Proposed Habitat Enhancement Projects

Confluence Island
Extend alcove
Pond turtle nesting areas

End Pond
Outlet for native fish
Logs for pond turtles

Ayres Bar
Logs for pond turtles

Figure G: Map of Proposed Short- and Long-Term Habitat Enhancement Opportunities



Appendix A: Oregon Plan Prescription

Prescription:
Seek the truth, learn, and adapt

Be humble

Start by obeying the law and living up to our commitments

Then, act voluntarily - the law may not be enough

Respect people - respect nature

Be patient

Build partnerships, make friends, and strengthen community

Strive to let rivers be rivers, and un-tame - a little - our watersheds

Share information - share the power to make decisions - share the responsibility to act

Consider our children's needs - salmon and human

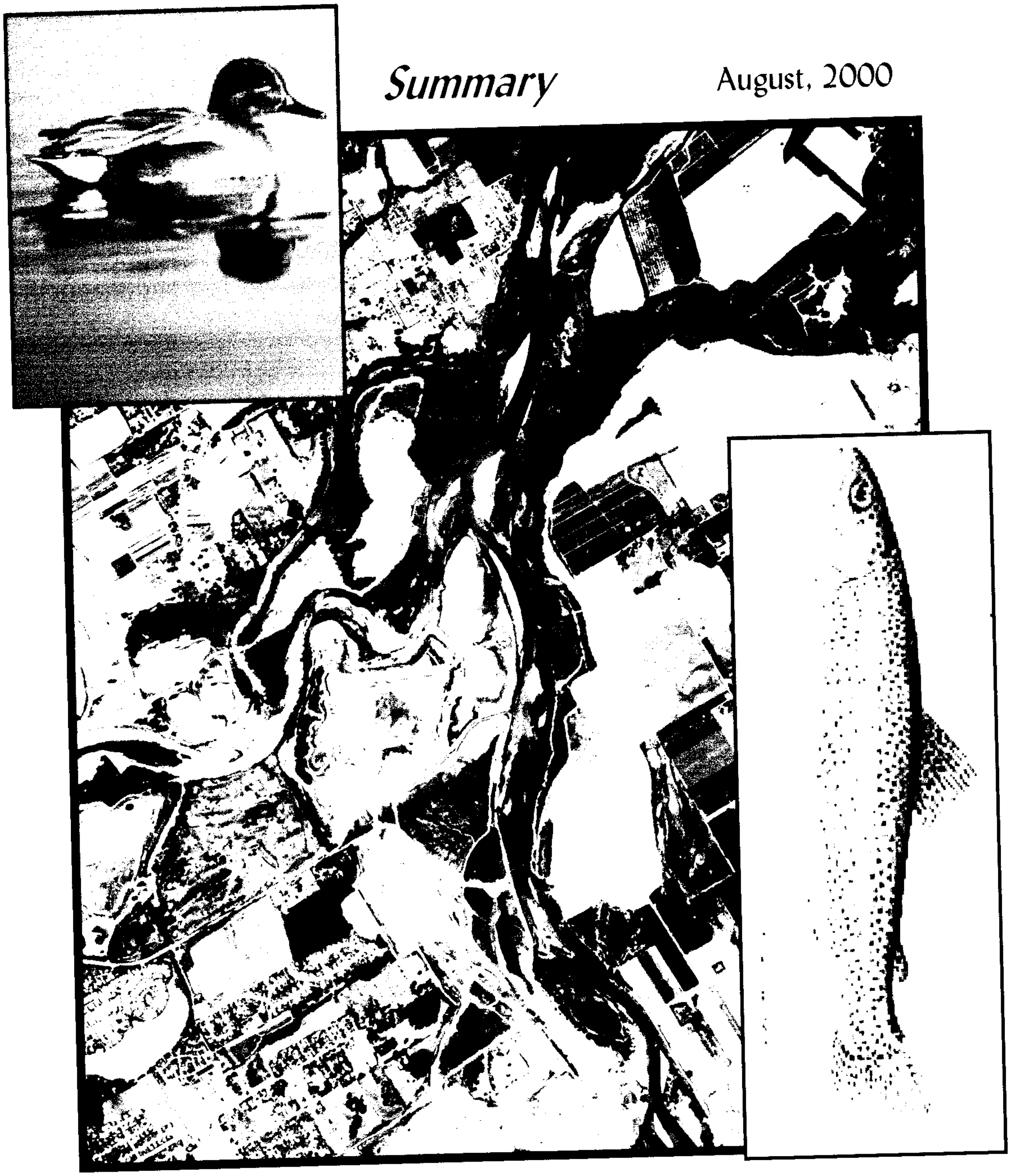
Never give up hope

F*rom: Year 2000 Update on the Oregon Plan for Salmon and Watersheds*

Biological Evaluation of the Willamette River and McKenzie River Confluence Area

Summary

August, 2000



Prepared for the Confluence Project Steering Committee
and the McKenzie Watershed Council

Prepared by Chip Andrus · *WaterWork Consulting*
John Gabriel · *Alsea Geospatial, Inc.*
Paul Adamus · *Adamus Resource Assessment, Inc.*

Introduction

Aerial photographs from 1944 show the McKenzie / Willamette confluence area as a maze of channels and ponds with a wide range of vegetation types and ages. Maps from 1910 illustrate the confluence area prior to conversion of higher terraces to farm land and show an even greater labyrinth of channels (Figure 1). The confluence area, as defined in this discussion, includes the Willamette River from the Beltline Road bridge in Eugene to a point about 4 miles downstream of the McKenzie River confluence, where the old McKenzie River channel intersects with the Willamette River. The confluence area also includes the McKenzie River downstream of the Highway I-5 bridge to its current confluence with the Willamette River (Figure 2).

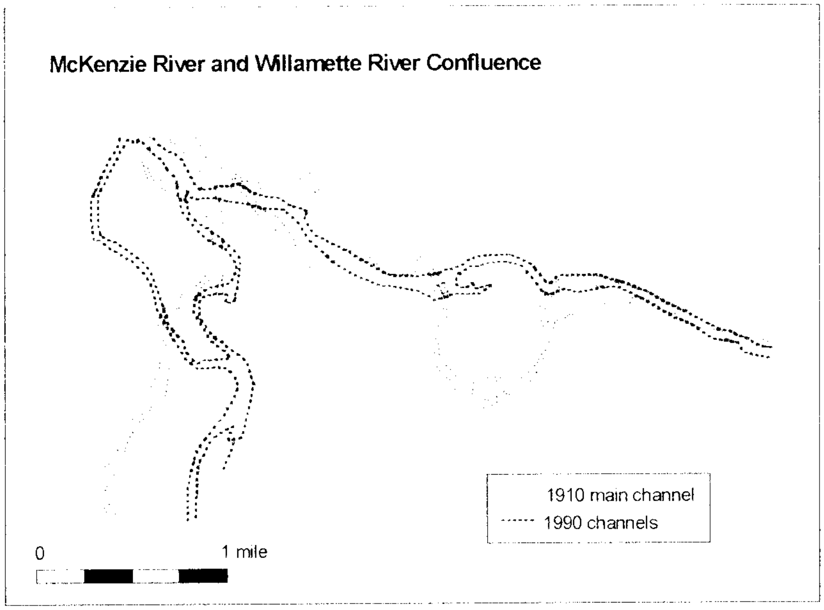
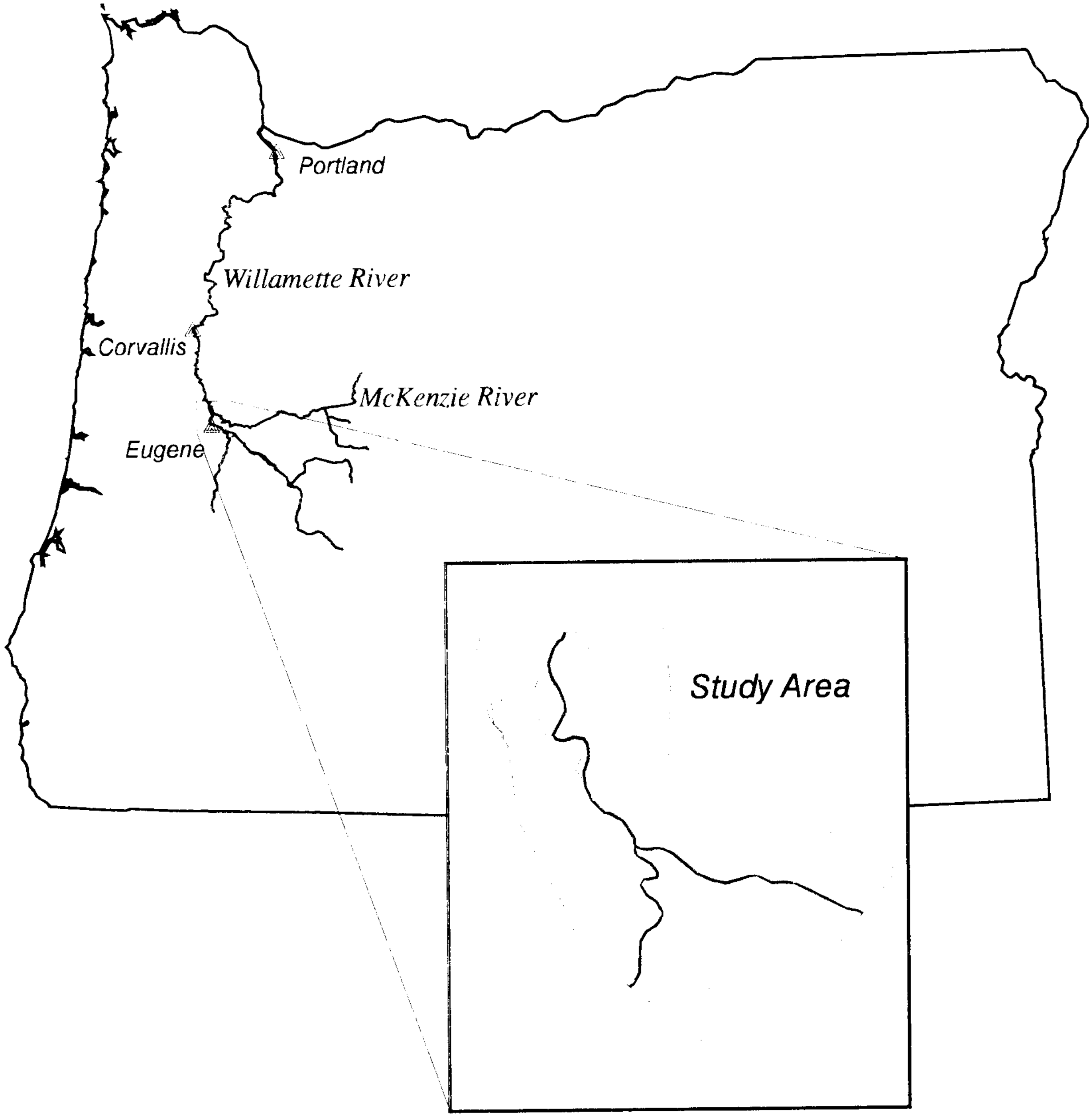


Figure 1. Channels of the Willamette River and McKenzie River near their confluence for 1910 and 1990. From Ligon (1991).

The confluence area has undergone many changes over the last 150 years, including log snagging to allow boat navigation, channelization, conversion of riparian forest to farm land and house sites, wastewater disposal, gravel extraction, and construction of upstream reservoirs that alter flow. Yet, the confluence area provides some of the best remaining habitat for fish and wildlife in the upper Willamette basin. It is also considered to have high potential for the restoration of many of the ecological functions that have been altered over the decades.

Interest in fish and wildlife in the confluence area heightened following high water in winter, 1996. The high water threatened or breached dikes surrounding some gravel extraction areas. As flows peaked, gravel operators responded by elevating or armoring dikes at various locations to prevent flooding of their operations. Required fill permits were not obtained prior to these activities and, due to a local shortage of large rock, concrete rubble was used to armor some threatened banks and local materials were used to elevate some dikes. Agencies that have



River Channel and Vegetation Study
McKenzie and Willamette River Confluence Area

ALSEA

www.ageospatial.com
/u2/mckz/confluence/scan/maps/riv2000_loc2.aml

August 24, 2000

FIGURE 2.

jurisdiction of fill activities responded with citations for some activities in 1996. Subsequently, a joint agreement was made to conduct a comprehensive study of fish and wildlife and flood susceptibility in the confluence area.

Out of this agreement came two studies. One study focused on the flood protection needs by gravel operators and was conducted by Northwest Hydraulics, Inc. with funding provided by the four gravel extraction companies in the confluence area. The other, summarized here, was a biological evaluation of the confluence area and it was funded by the Oregon Watershed Enhancement Board. The intent is to incorporate these two studies into a unified plan for restoring and protecting fish and wildlife habitat while providing appropriate levels of flood protection to gravel operations.

The biological study received oversight from the Confluence Steering Committee which consisted of representatives from the McKenzie Watershed Council, McKenzie River Flyfishers, Oregon Department of Fish and Wildlife, Corps of Engineers, Oregon Division of State Lands, National Marine Fisheries Service, Oregon Division of Geology and Mineral Industries, and the four effected gravel companies.

The biological evaluation in the confluence area had several objectives. One was to characterize current and historic river, land, and water conditions. Another objective was to describe the current status of fish, wildlife, and their habitat in the area using surveys of our own and information developed by others. A third objective was to identify restoration and protection principles that would be effective for improving fish and wildlife habitat in the confluence area.

River flow

Storage reservoirs constructed in the upper McKenzie River basin (during the 1960's) and Willamette River basin (1950's and 1960's) have decreased the frequency and magnitude of peak flows in the confluence area. Long-term annual peak flow information gathered at a gage near Vida (river mile 48), indicates that post-reservoir annual peak flows average only about 60% of those prior to reservoir construction (Figure 2). Furthermore, flows greater than the 1996 flood (30,900 cfs) occurred about four times per decade prior to reservoir construction. The 1996 flood was the highest flow on record for the 31-year period following completion of both reservoirs.

Peak flows have been muted even greater in the upper Willamette River basin. Records from a gage on the Middle Fork Willamette River at Jasper indicates that the annual peak flow after reservoir construction averaged only 30% of pre-reservoir values (Figure 3). The highest flow of record (94,000 cfs in 1910) was nearly four times greater than the highest flow for the post-reservoir period. The biological

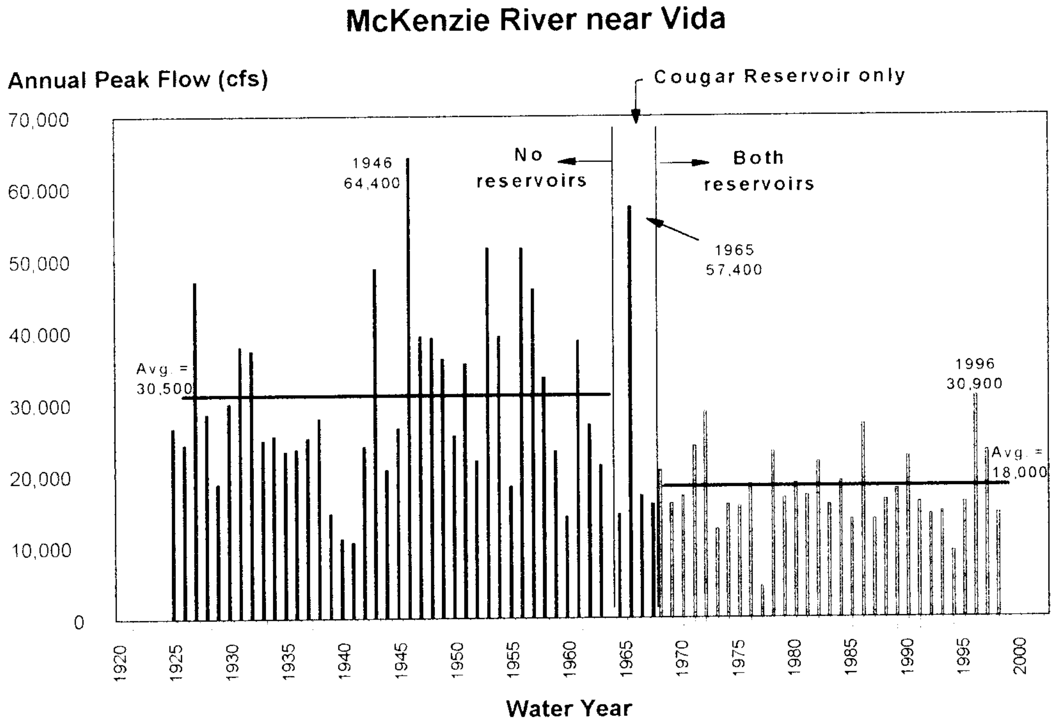


Figure 3. Annual peak flows for the McKenzie River near Vida before and after reservoir construction.

consequences of peak flow dampening in a river are indirect, yet potentially important. A decreased frequency of peak flows reduces the ability of a river to meander and create (or modify) off-channel features (Van Steeter and Pitlick 1998). These off-channel features include ponds, side channels, and alcoves (same as side channels but with only one end connected to the river at lower flows). Off-channel features provide unique habitat for certain species of fish and wildlife and so, without the process in place to create these features, the populations that depend on them would be expected also to decline.

Monthly flows for the McKenzie River and Willamette River have also been altered by upstream reservoirs. From July through January, average monthly flows for these rivers following construction of reservoirs has been greater than pre-reservoir flows. Reversely, because reservoirs are filled from February through June, monthly flows during this period have been lowered compared to historic conditions.

The biological consequences of lower monthly flows from late winter through early summer have not been evaluated for the Willamette River but could include the isolation of fish in off-channel features as they attempt to complete migrations. On the positive side, increased flow during the summer can improve water quality in rivers by diluting pollution, checking algal growth, and decreasing water temperature.

Suspended sediment

The amount of suspended sediment transported by a river depends on the supply of fine sediments available for transport and the energy available to move the sediment downstream. We looked for evidence that either sediment supply or energy has changed in the last century for the McKenzie and Willamette Rivers.

A comparison of data collected from 1948 to 1951 (pre-reservoir) by the Corps of Engineers and from 1991 to 1993 (post-reservoir) by the U.S.G.S. indicates that the relationship between daily sediment load and day flow is not different for the two time periods. This suggests that the net supply of sediment available for movement has not changed during the last 50 years. The no net change in sediment supply may be due to a number of factors. Roads were more numerous in 1991 than in 1948 yet built in a way that reduced sediment production. Bank hardening and channelization reduced bank sources of sediment and river meandering while urban runoff and farmer close to the river probably increases sedimentation.

However, as noted above, the dampening of peak flows at reservoirs has reduced the energy available to transport sediment. The suspended sediment vs. flow relationship was combined with actual daily flow data for the two time periods, and an estimate of annual sediment load was calculated. The results indicate that the current annual suspended load averages only 60% of that prior to reservoir construction. Consequently, depositions of fine sediments along the river are probably now less than before the reservoirs.

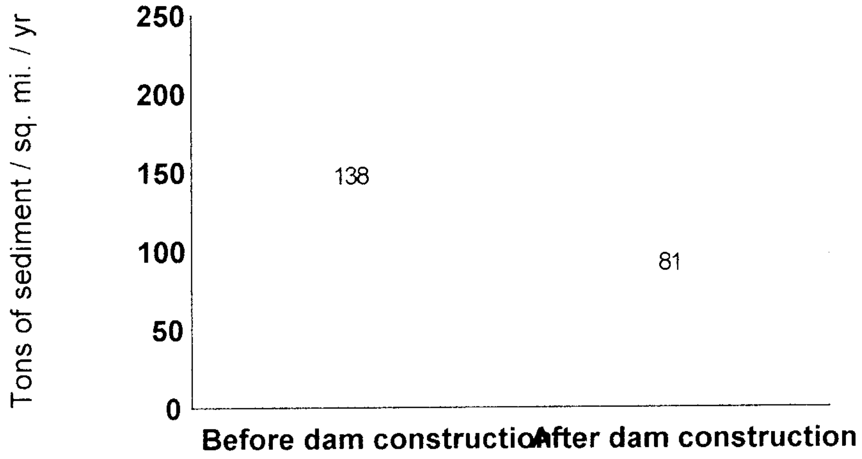


Figure 4. Modeled average unit annual load of suspended sediment for the McKenzie River at Coburg before dam construction (1940-1963) and after dam construction (1969-1998).

Bedload

Bedload includes that material ranging in size from larger sand particles to boulders that bump along the river bottom as it is being transported downstream by higher flows. The transport of this material is also determined by the amount of material available for transport.

While no measurements of bedload movement have ever been made for the lower McKenzie and upper Willamette Rivers, Ligon et al. (1995) indirectly demonstrated how the combination of dampened peak flows at reservoirs, intentional channelization, bank stabilization with riprap, and vegetation invasion of low-lying river bars has changed bedload composition along the McKenzie River. Using current and historic topographic maps, they determined that total wetted area of the McKenzie River decreased 28% and island perimeter decreased 41% from 1930 to 1990. They argued that by reducing peak flows and thereby curtailing the river's ability to meander, create new courses across the flood plain, undercut banks, and locally deposit excess bedload at mid-river locations, a river eventually forms into a single thread with few islands or other off-channel areas. In support of this theory, our surveys of substrate size along the lower McKenzie River indicated that cobble-sized material dominated the channel except in some off-channel features.

A lack of variability in substrate size in the main channel can limit spawning and rearing opportunities for fish, leaving only the option of migration into tributaries as a means for fish to find gravels of a proper size.

Channel morphology

Channel traces from 1850 from general land survey maps and compared to current conditions Gregory et al. (1998). They calculated that the area of channels and islands is now only 20% of what it was in 1850 for a segment of the Willamette River from the McKenzie River confluence to Harrisburg.

Aerial photographs from 1944 show the McKenzie River downstream of the Hwy I-5 bridge occupying a flood plain between one-half to one mile wide. In the upper one-half, the river had a single main channel with many high-water channels branching to the south and north. Further downstream, the river split into two major channels flowing parallel to each other at a distance of one-quarter mile (Figure 5). In addition, numerous small side channels dissected this lower delta. Currently the McKenzie River flood plain is about 900 feet wide.

The McKenzie River once flowed in a channel that paralleled the Willamette River and did not join up with the Willamette River until four miles downstream of the current confluence. By 1960, most of the lower McKenzie River had been diverted into its north channel and by-passed its lower section and instead flowed directly into the Willamette River. The "old" McKenzie channel plugged and now flows only during high water. Over the next 20 years the McKenzie was further channelized and in 1979 aerial photographs, the course of the river was about what it is today.

Most of the higher terraces next to the river had been converted to farm land by 1936. Yet, most of the bottom land was still vegetated with a variety of trees or was exposed gravel bars. A striking difference between channel conditions in the 1930's compared to today is the dominance of bare gravel. The large proportion of bare gravel in the active flood plain was likely a result of unfettered peak flows and a lack of intentional channelization. The river jumped back and forth across its flood plain over the decades, as evidenced by aerial photographs from 1944 and 1960.

Today, little bare gravel exists in the active flood plain of the confluence area. The two rivers are mainly a single thread, confined by riprap banks at many locations, and fringed by reed canary-grass in low areas. Reed canary-grass is a tall, dense grass introduced to Oregon for purposes of controlling soil erosion along ditches. Unfortunately, the grass has spread throughout the river system and now quickly invades most bare areas near the river. It commonly prevents reproduction of native vegetation and no practical tools are available to eradicate the grass. Other introduced species, such as Himalaya blackberry and Scotch broom, also readily occupy bare substrate along the river.

Banks of the main channels and major side channels within the confluence area are patchwork of natural and hardened banks, with the hardened banks (usually riprap) found mostly on the outside bends of curves in the channel. We conducted a survey of bank types throughout the confluence area and found that, overall, 12% of the Willamette River's banks and 25% of the McKenzie River's banks had riprap, barbs, or riprap and barbs. Barbs are rock structures that extend about 25 feet into the river at right angles to the bank. They are intended to provide fish with areas of slackwater that is usually missing along the outside bends of curves in

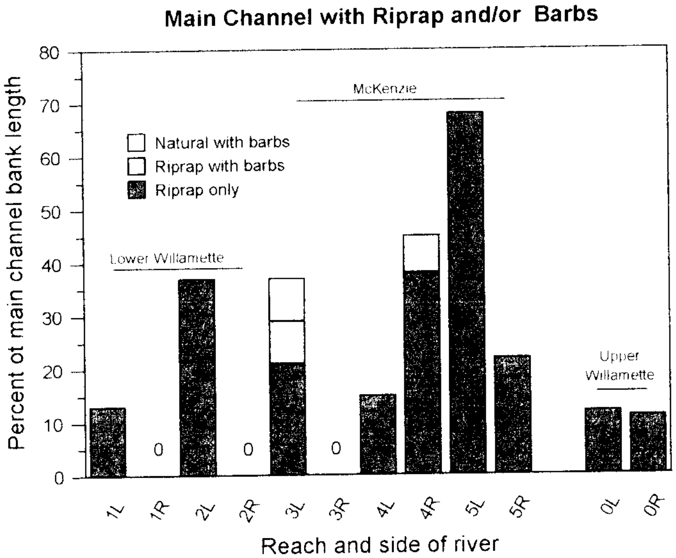


Figure 5. Percent of main channel banks with riprap and/or barbs by river reach and side of river.

rivers. Results for each of 6 reaches in the confluence area and for each river side are shown in Figure 5. Boundaries of the river reaches and bank hardening locations are shown in Figure 6.

Water temperature

The upper Willamette River and McKenzie River are known for their cool water during the summer. Originating in the high Cascade Mountains and traveling much of their length through fractured volcanic rock, the supply of cooling groundwater to these rivers is abundant. Release of cool water from the lower depths of reservoirs in order to augment summer flow also contributes to river cooling, although it is unknown how far downstream this influence extends.

Gages were established by the EPA Research Laboratory within the Willamette River and its major tributaries during August, 1996 to detect downstream patterns of river warming in the Willamette River from the McKenzie River confluence to the Yamhill River. The maximum water temperatures for the Willamette River and McKenzie River were 64 deg F or cooler several miles upstream of their confluence (Figure 7). The McKenzie River was about 2 deg F cooler than the Willamette

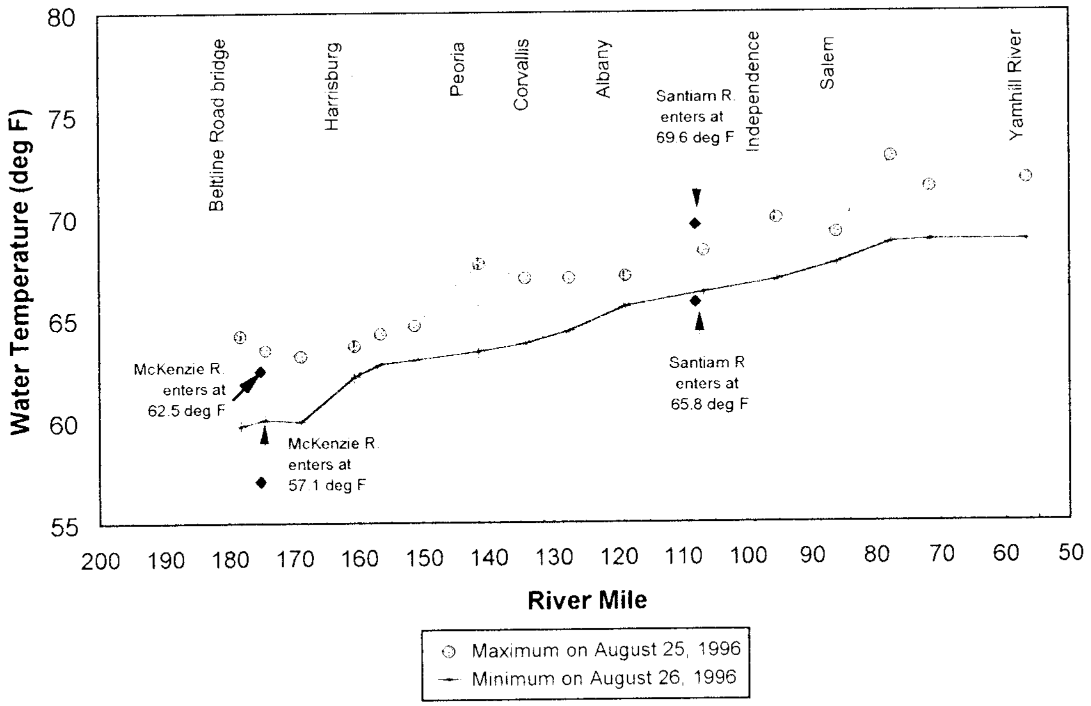
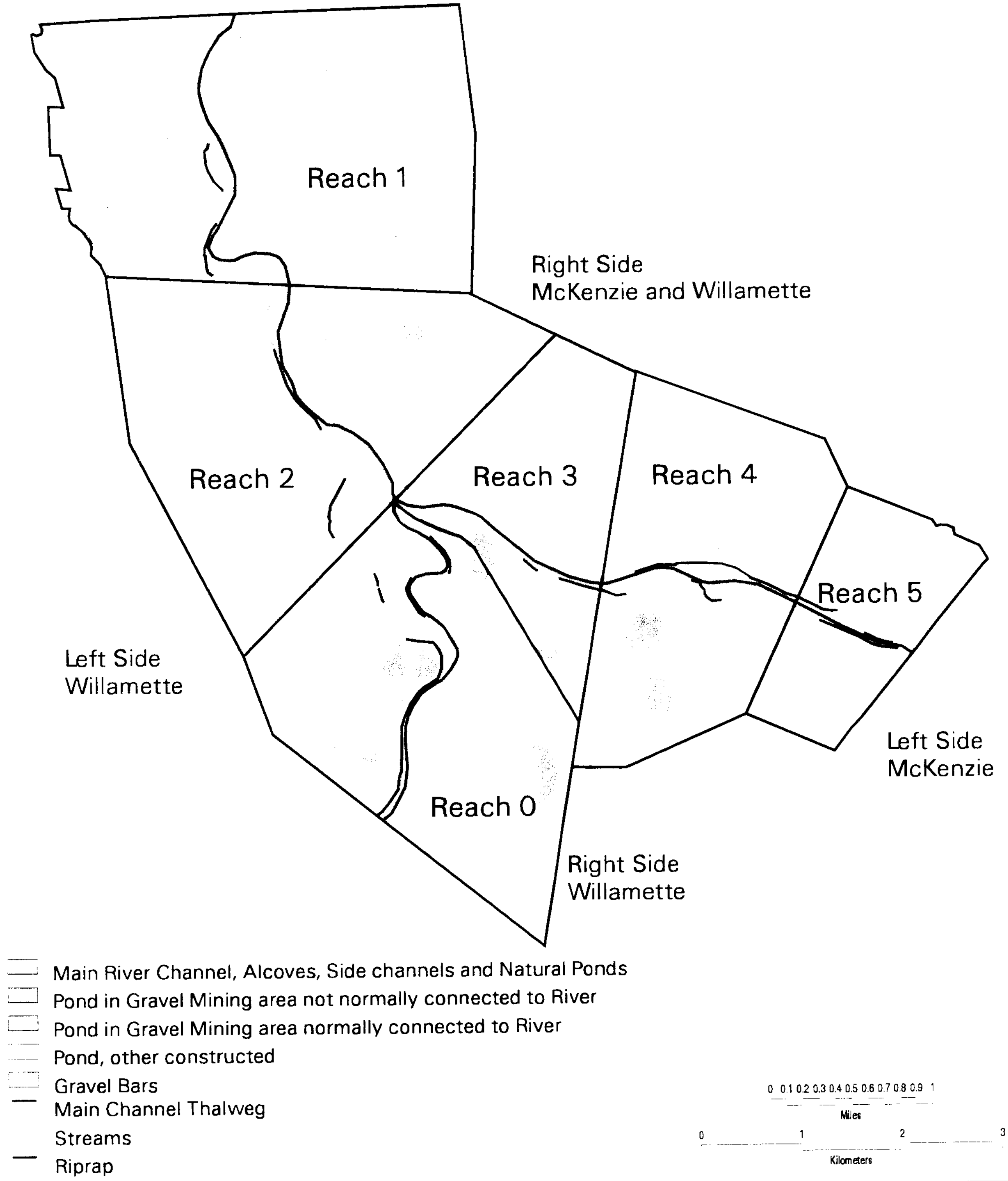


Figure 7. Water temperature trend for the Willamette River from the Mckenzie River confluence to the Yamhill River confluence.



River Channel and Water Features
McKenzie and Willamette River Confluence Area

ALSEA
Geospatial, Inc.

www.ageospatial.com
/u2/mckz/confluence/scan/maps/riv2000_rch2.aml

August 30, 2000

FIGURE 6.

The cool water from the combined rivers continued downstream to Harrisburg and then the Willamette River began to warm in a downstream direction, reaching 72 deg F at the Yamhill River confluence. Nighttime minimum temperatures of the McKenzie River were about 3 deg F cooler than maximum temperatures.

Water temperature data gathered by the EPA Research Laboratory in conjunction with an evaluation of other water characteristics in the Willamette River indicates that the McKenzie is slightly cooler than the upper Willamette River during winter and spring, as well as summer.

Other water characteristics

EPA Research Laboratory data indicated that phosphorus is cycled tightly in the McKenzie River and upper Willamette River with soluble reactive phosphorous concentrations less than 30 ug/L in both spring and summer. Nitrogen seems to be cycled tightly in the McKenzie River with levels of nitrate less than 0.09 mg/L-N, regardless of season. The upper Willamette has low nitrate levels in the summer but relatively high levels in winter and spring.

The sewage treatment plant with its outfall immediately upstream of the Beltline Road bridge, may be a source of this nitrogen. Yet, quarterly data collected by the City of Eugene at various points along the Willamette River within the city limits shows that the sewage treatment plant has only a small influence on nitrate and ortho phosphorus concentrations in the river. A variety of other water characteristics are tested by the city during their ambient river monitoring but none show a consistent increase downstream of the sewage treatment plant outfall, nor are the values suggestive of water quality problems. Testing of the sewage treatment plant effluent for a long list of organic compounds indicates that all are at non-detectable levels. The effluent is also tested regularly for a variety of toxic compounds and are consistently low.

Relatively high ammonium values in the upper Willamette River have been measured during the winter by the EPA Research Laboratory. Ammonium values in the McKenzie River were only 4% of McKenzie River values at the time, suggesting a point source of ammonium in the upper Willamette River. Effluent from the sewage treatment plant has an ammonia concentration of about 5 mg/L-N in the winter and could be the source. Quick uptake or conversion of ammonia and ammonium by aquatic organisms during the non-winter months may explain why such high values have not been observed during other times of the year.

The upper Willamette River is usually more turbid than the McKenzie River. This is supported by direct measurement and is visible in aerial photographs and when in the field for all but late summer months. For over a mile downstream of the confluence, moderately turbid water of the upper Willamette River main channel and the Whitely side channel remain segregated from the low turbidity water of the McKenzie River. Historic aerial photographs indicate that when the old McKenzie River channel flowed regularly, most of its water came from the McKenzie River. However, historic channel maps show both rivers feeding into the old McKenzie River channel in 1910. The current chronic turbidity of the upper Willamette River probably originates at Hills Creek Reservoir, a spot where a certain type of clay becomes suspended in the water.

Macroinvertebrates

The relative abundance and community structure of macroinvertebrates can provide a measure of the water quality in a river. Unlike direct measures of water characteristics, the structure of macroinvertebrate communities can reflect both episodic and chronic water degradation events. Samples are usually taken in the fall, a time when organisms have reached a steady-state, individual organisms are large, and species richness is greatest.

The only macroinvertebrate data available for the confluence area is that gathered each year by the City of Eugene. Samples were taken at two or three specific locations upstream of the sewage treatment plant outfall and four specific locations downstream of the outfall. Metrics were determined for evaluating community structure as shown below:

Table 1. Metrics determined for 1997 and 1998 macroinvertebrates sampled by the City of Eugene.

PRIMARY METRICS	POSITIVE INDICATORS	NEGATIVE INDICATORS
Total abundance (m2) Total taxa richness EPT Taxa richness %Dominant taxa Brillouin H Community Tolerance (HBI) EPT/Chironomidae Hydropsychidae/Trichoptera Baetidae/Ephemeroptera	Predator richness Scraper richness Shredder richness % Scrapers % Shredders % Intolerant taxa Intolerant taxa richness	%Collector-gatherer % Collector-filterer %Parasite %Oligochaeta %Tolerant molluscs %Tolerant crustacea - Gam %Tolerant mayflies %Tolerant caddisflies %Tolerant beetles %Tolerant dipterans %Simuliidae (blackfly) %Chironomidae (midge)

Most of these metrics indicated that macroinvertebrate communities downstream of the outfall were no different than upstream. Four metrics showed significant differences in one year but not the other. Overall macroinvertebrate abundance was greatest upstream of the outfall in 1998 but not in 1997. The percent of individuals consisting of collector and filterers (higher percentage suggests lower water quality) was greater downstream of the outfall in 1997 but not in 1998. In addition, the percent of individuals comprised of tolerant molluscs was high downstream of the outfall at two sites in 1998 but was low elsewhere in 1998 and throughout the study area in 1997. Tolerant organisms are those that are better adapted to withstand increases in water temperature, nutrients, and other water characteristics. Blackfly larvae were high at all four downstream sites in 1997 but not in 1998. These data suggest that the influence of the sewage treatment plant outfall has minimal or sporadic influence on the macroinvertebrate community in the Willamette River.

Land and water classes

We constructed a rectified land and water features mosaic of the study area using aerial photographs from April, 2000 and classified land and water features up to about 1 mile from the river. We next constructed buffers of 500 feet and 2640 feet (one-half mile) from the river edge. These buffers were allowed to wrap around the outermost extent of water features, whether they be side channels, alcoves, or the main channel.

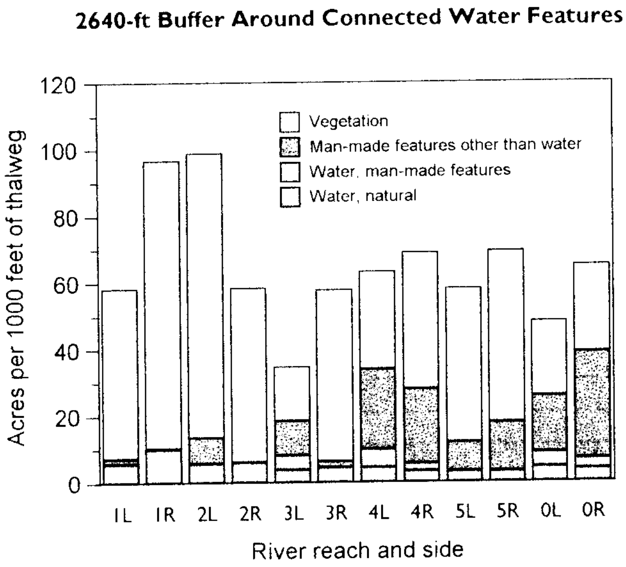


Figure 8. Major classes of land and water in the study area by reach and side of river.

Areas were determined for all features in each reach and side of stream and then normalized by dividing area by the length of the river thalweg for each reach. This allowed us to compare reaches, as well as river sides. Results are graphed in an upstream (1L to 5R) direction starting from the most downstream end of the study area (Reach 1) and continuing upstream to the Hwy I-5 bridge on the McKenzie River (Reach 5). Reach 0 is the Willamette River upstream of the McKenzie confluence to Beltline Bridge Road. A "L" indicates left bank facing downstream while "R" indicates right bank.

For a one-half mile buffering of connected water features, a majority of land in the reaches was vegetated (Figure 8). This included farmed land and orchards, as well as, natural vegetation. Man-made features were relatively rare in the lower Willamette (Reaches 1L to 2R) and along the right bank of the lowest reach in the McKenzie River (3R) with most of these features consisting of homes and their yards. The remainder of upstream reaches in the McKenzie and Willamette Rivers have a sizable component of man-made features, including gravel pits, gravel operations, residences, business/industrial areas, and highways. The relative area of natural water features was greatest in the lower Willamette reaches where the flow was greatest and constricting features such as riprap were least common (Figure 6 and 8).

Vegetation was mapped in broad types and age classes (Figure 9). Note that the left bank of Reach 3 is unusually small due to the partitioning of area at the confluence. Consequently, values derived for this slice of land should not be compared to other reaches and sides of river.

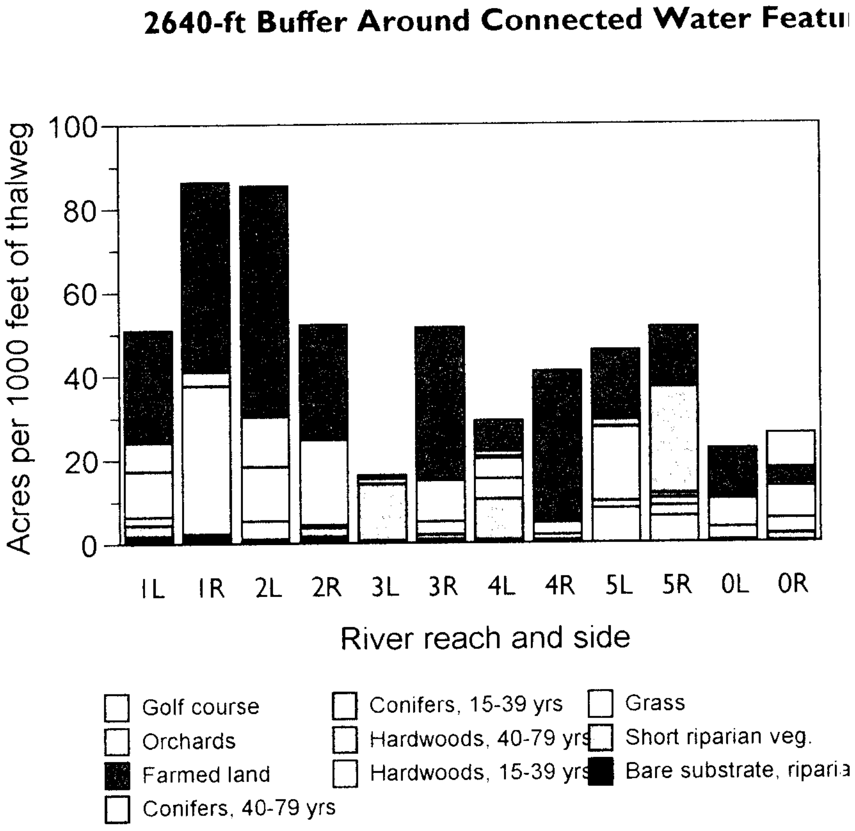


Figure 10. Vegetation classes within one-half mile of the river by reach and side of river.

Vegetation within one-half mile of the river edge was predominantly farm fields for the lower Willamette River and the north side of the McKenzie River. Hardwoods between 15-39 years were the most common tree type with older hardwoods only in the lower Willamette reaches and the left side of Reach 5 (dominated by Amitage Park). Conifers were scarce except on steep basalt slopes for the right side of Reach 5. The 1944 aerial photographs indicate that older conifers grew on the large islands near the confluence. Recent clearcuts at other spots in the study area also suggest that conifers were more common than they are today. Orchards were scarce in 2000 but common in 1944. Most of the orchards were converted to grass seed fields or to residential areas. Short riparian vegetation, consisting largely of willow and small ash trees, grew close to the river in low-lying areas that were annually flooded. Few areas of bare river substrate now exist. The 1944 photographs indicate a much wider area of substrate that was bared by high flows. The short riparian vegetation was set back accordingly.

Using diameter of dominant trees as a guide, many cottonwood trees near the river seemed to be of the same age (about 30 years old). Peak flow records from the Harrisburg gage on the Willamette River (about 10 miles downstream of the study area) indicated that the highest flow on record following reservoir construction occurred in 1972. If these cottonwood trees originated following this peak flow the trees would now be 28 years old.

Fish and their habitat

We used a number of data sets (this study, EPA, ODFW, and City of Eugene) to evaluate fish in the lower McKenzie River and the Willamette River. We also referred to published studies and the experience of local biologists to further understand fish and fish habitat relationships in the confluence area.

For the current study, we established 30 sites in the confluence area and boat electrofished the segments in September, 1999 (Figure 11). These sites included main channel reaches with natural banks (MN), riprap banks (MR), banks with riprap and barbs (MRB), alcoves (A), and both natural (PN) and gravel pit (PP) ponds near the river. We sampled most of these sites again in March, 2000. Some were skipped due to fast water which made electrofishing unreliable.

We also included a data set funded by the City of Eugene for which main channel fish communities were boat electrofished from the confluence of the Middle Fork and Coast Fork of the Willamette River, through the City of Eugene, and to the Beltline Bridge Road. This data set included 12 sites and field data was gathered in March, 2000. A third data set was from a research program established by the EPA Research Laboratory to evaluate main channel and alcove fish communities in the Willamette River from the McKenzie River confluence to Corvallis. These data include boat electrofishing results from 20 sites from March, 2000 and 54 sites from July, 1998. The sites from these three studies were all sampled at night by our team using the same crew chief, equipment, and techniques.

We also used seining data collected each year in August by the Oregon Department of Fish and Wildlife (Corvallis) from pools immediately downstream of riffles at 4 to 14 locations between the McKenzie River confluence and Harrisburg. These data were gathered each year from 1993 to the present.

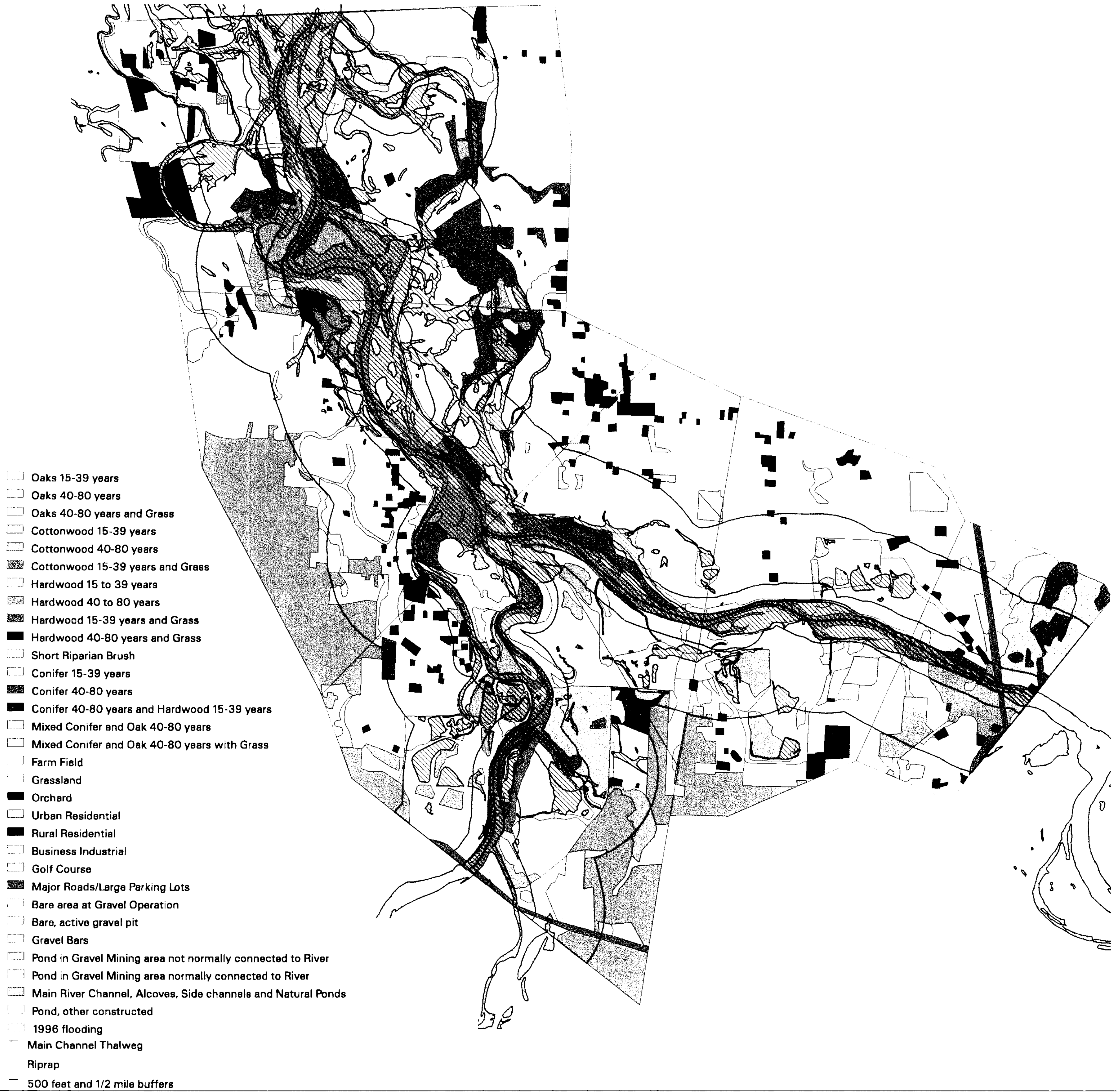


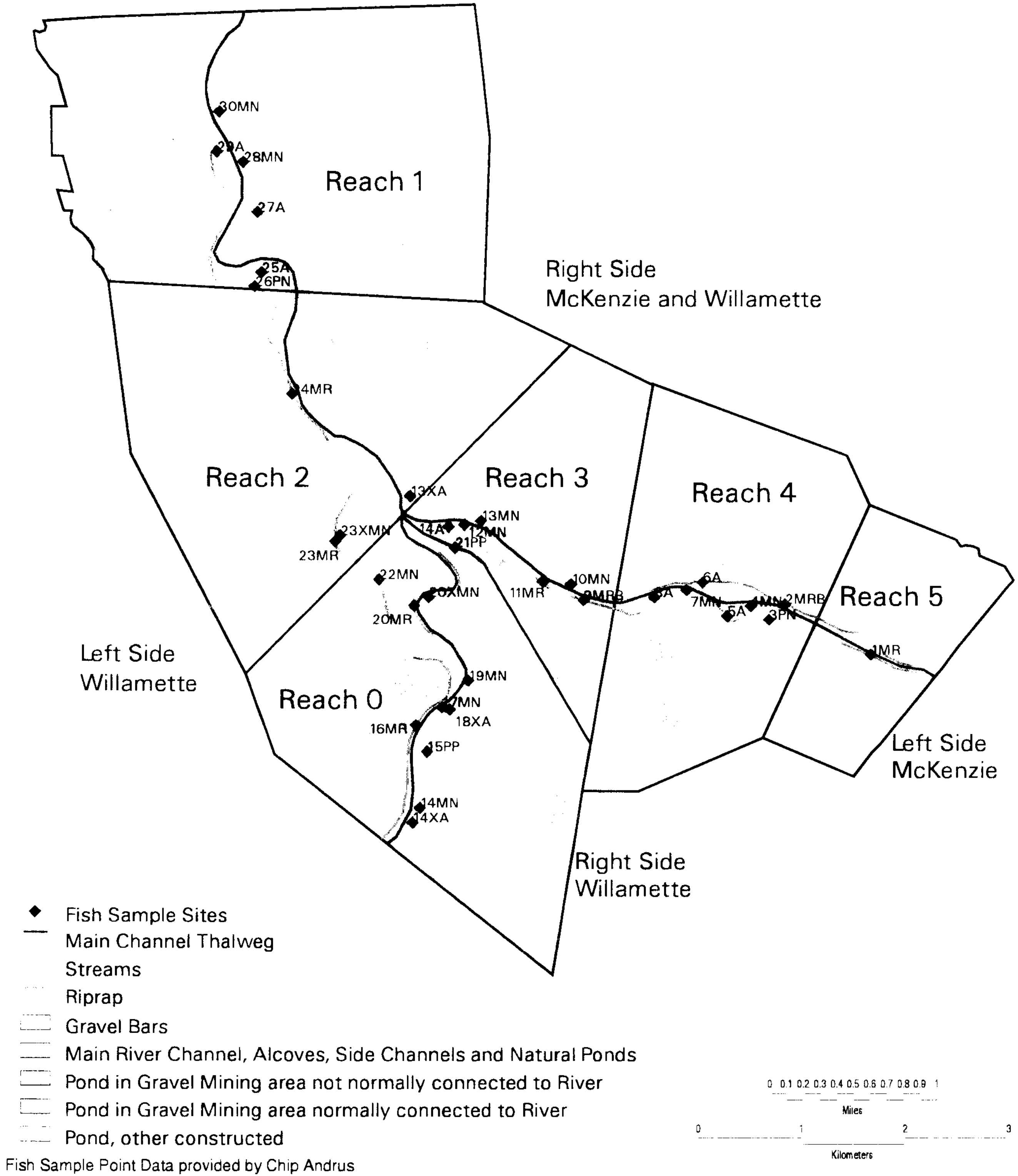
FIGURE 9.

River Channel and Vegetation Characteristics
McKenzie and Willamette Confluence Area

ALSEA
Geospatial, Inc.
www.ageospatial.com

Source Flood Data: OSU Fish and Wildlife Dept: Modified by Chip AndruS
August 28, 2000

/u2/mckz/confluence/scan/maps/riv2000.aml



Fish Sample Point Data provided by Chip Andrus

Fish Sample Sites
McKenzie and Willamette River Confluence Area

ALSEA

www.ageospatial.com

August 28, 2000

/u2/mckz/confluence/scan/maps/riv2000_fish.aml

Figure 11.

No fish sampling method provides an unbiased portrayal of fish communities in a river. Boat electrofishing, the method we used in our sampling, has the benefit of being effective in a wide variety of habitat types and over a wide range of fish sizes. Yet, it has its limitations. The electrical field does not extend to the bottom of the river when water depth is greater than 7 feet and this often results in an undercount of those fish which normally reside at the bottom of the water column. Very fast water can also complicate boat electrofishing by providing little time to net fish. Large numbers of stunned fish in the water can overwhelm the netter. Furthermore, swirling eddies at the bank edge frustrate attempts to keep the boat facing downstream.

We have minimized bias through site selection and sampling technique but have concerns about underepresenation of fish that find cover under rocks (dace and sculpin), juvenile lamprey that rear within fine sediments, and largemouth bass that are often spooked by the leading edge of the electrical field. Boat electrofishing effectiveness decreases with fish size, especially for fish less than 3 inches long. As a result, we have limited our reporting to only those fish 2.4 inches (60 mm) and longer. Limited seining of the lower McKenzie River by Oregon Department of Fish and Wildlife in late April, 2000 indicated that young-of-the-year chinook salmon were common at some locations. These fish were about 60 mm long in late April and so would have been less than 40 mm long in March the time when we onducted our boat electrofishing. We did not catch any of these fish, because either the fish were too small or they had not yet moved downstream into lower reaches of the McKenzie River.

Seining also has inherent bias. Catches can be successfully brought to shore only where a debris-free beach of gravel or small cobbles exists. Seining is best suited for shallow areas with lower velocity flow. The river bottom must be free of large objects such as wood and shopping carts. Furthermore, seining success his highly dependent on the skills of those who operate the nets.

In the following discussion, sampling results are expressed in two fish size classes. "Small" fish are those between 2.4 and 7.9 inches (60-200 mm) long and "large" fish are greater than 7.9 inches. We thought this size class distinction was important because it corresponded with maximum fish size and transitions in diet for some species.

Overall fish community composition

The number of fish genera encountered at a site can be an indicator of its suitability to provide a range of habitat conditions for fish. Presumably, sites with more genera of fish have a greater diversity of habitat features and conditions. Results from our sampling indicates that genera abundance of large fish in March was greatest at main channel sites. Differences among reaches and habitat types were small, except that gravel pit ponds and alcoves between Harrisburg and Corvallis averaged fewer genera . Genera abundance of small fish was greater than for large fish in March. Sites with natural banks had the fewest genera, especially those located in the McKenzie River. Sites from the Springfield bridge to the McKenzie confluence, both main channel segments and alcoves, had the highest genera of small fish in March.

Genera abundance of large fish was about the same for September and March but small fish genera decreased for most habitat types in September. This decrease in the number of genera was most pronounced at sites with riprap or riprap with barbs. Alcoves had the greatest diversity of small fish in September for both the McKenzie River and the Willamette River downstream of the confluence. Gravel pit ponds saw a decrease in genera for both large and small size classes during the summer.

Three-spine stickleback were found only at one site during the study; three fish were captured in a natural pond next to the McKenzie River. Stickleback were once common in the Willamette Valley but now appear to be uncommon and declining (personal communication, Stan Gregory, Oregon State Univesity, Corvallis and Paul Shearer, Oregon Department of Fish and Wildlife, Corvallis).

Fish assemblages were divided into four groups; salmonids, scrapers, "other" native, and introduced. Salmonids included juvenile chinook salmon, cutthroat trout, rainbow trout, and mountain whitefish. A single large bull trout (also a salmonid) was seined by the Oregon Department of Fish and Wildlife in the McKenzie River near the confluence last year but none have been encountered during other studies. Fishermen have not reported catching bull trout in the confluence area. Scrapers included fish that feed by scraping periphyton from rocks. These were predominantly largescale suckers with some mountain suckers and chiselmouth. Other native fish included northern pikeminnow (formerly called northern squawfish), peamouth, redside shiner, dace, scuplin, sand roller, and three-spine stickleback. Introduced fish were predominantly bluegill and largemouth bass with some crappie, yellow bullhead, pumpkinseed, carp, goldfish, and green sunfish.

In March, large salmonids were the most abundant in the McKenzie River for natural and riprapped main channel sites (Figure 12). Large salmonids catches in the Willamette River were lower and somewhat uniform among segments. Many of the large trout we caught this time of year had spawning colors which suggested that a number of large trout might have already moved upstream to spawn. The Mohawk River basin, a lower tributary of the McKenzie River, is heavily used by trout for spawning. Natural banks had greater catches of large salmonids than riprapped banks except for the single riprapped site in the McKenzie River. Here, a long glide with moderate water velocity, moderate depth, and a cobble/gravel substrate provide high quality conditions for trout and their food supply.

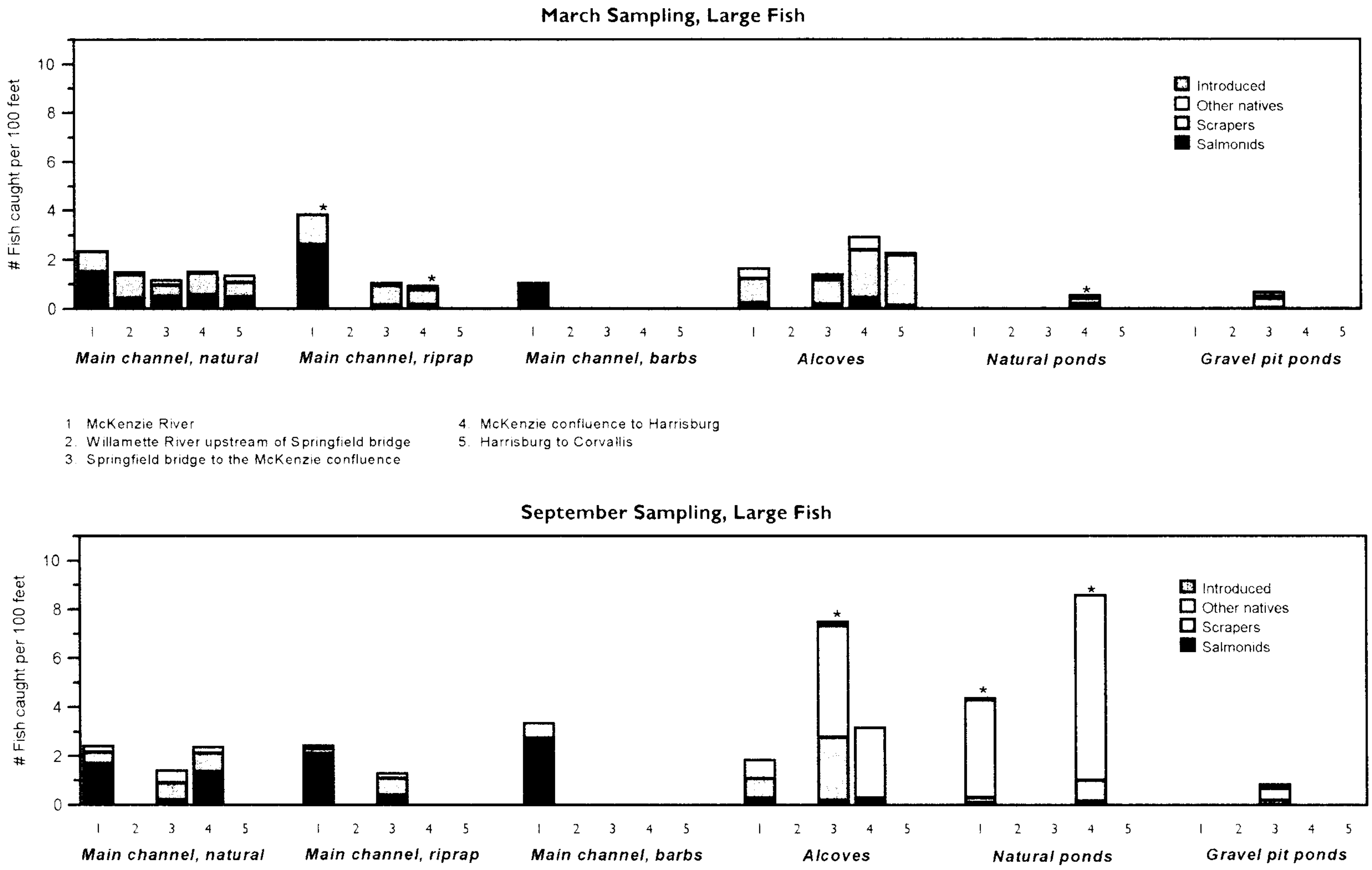


Figure 12. Large fish community structure for March and September sampling. Includes electrofishing results from this study, City of Eugene study, and EPA study. Bars with an asterisk indicates that only one site was sampled and therefore, results are less reliable than the other bars which have replication.

The density of large salmonids at McKenzie main channel sites with barbs was not much different than elsewhere in the McKenzie main channel. However, in September, the barbs had higher densities of large salmonids than natural or riprapped banks. The barbs were particularly attracted to large rainbow trout. Most fish near barbs were caught in the relatively slack water downstream of the barbs.

Catches of large salmonids were higher in September than in March. Large salmonids, mostly cutthroat trout, were found at low densities in alcoves and natural ponds for both seasons, yet were present in gravel ponds only in March.

Large scrapers were common in main channel segments, except for main channel segments with barbs. Large scrapers were abundant within alcoves, with Willamette alcoves downstream of the confluences having the highest densities. Tthe Environmental Protection Agency Research Laboratory conducted during summer, 1998 and found that few large scrapers use alcoves during the day but they enter alcoves at night in large numbers. Both natural ponds and gravel pits had large scrapers, although densities were relatively low.

"Other" large native fish were found mostly in alcoves and natural ponds during September but were mostly absent from all features in March. Northern pikeminnow belong to this group and have a diet that includes small fish. Their use of alcoves is probably a reflection of the large number of small fish within alcoves.

Large introduced fish were absent from main channel sites and natural ponds for both seasons and infrequently found in alcoves during September. Gravel pits had large largemouth bass during both seasons. Individual bass we caught sometimes exceeded four pounds. We checked several large largemouth bass for gut contents but the guts were empty and so we could not determine what they had been eating.

Small salmonids were most abundant in March within the McKenzie River (Figure 13). Densities were greatest at main channel sites with barbs. Small salmonids were considerably more abundant in March than in September. Salmonids present during September were mostly large fish. Small salmonid abundance during March within the Willamette River did not vary much between upstream and downstream sites.

Small scrapers were uncommon at main channel sites but abundant in alcoves, especially in September. Small scrapers were also abundant in natural ponds during September but uncommon within gravel pit ponds. Small "other" fish had their highest densities at sites with barbs in March and were predominantly redside shiner. Yet, they were uncommon at these sites in September, possibly due to predation by the high density of large salmonids. Small "other" fish in the Willamette River were common at riprap sites downstream of the McKenzie confluence during March but were mostly absent in September. Small "other" were found within alcoves and natural ponds at high densities for both seasons. Lesser densities

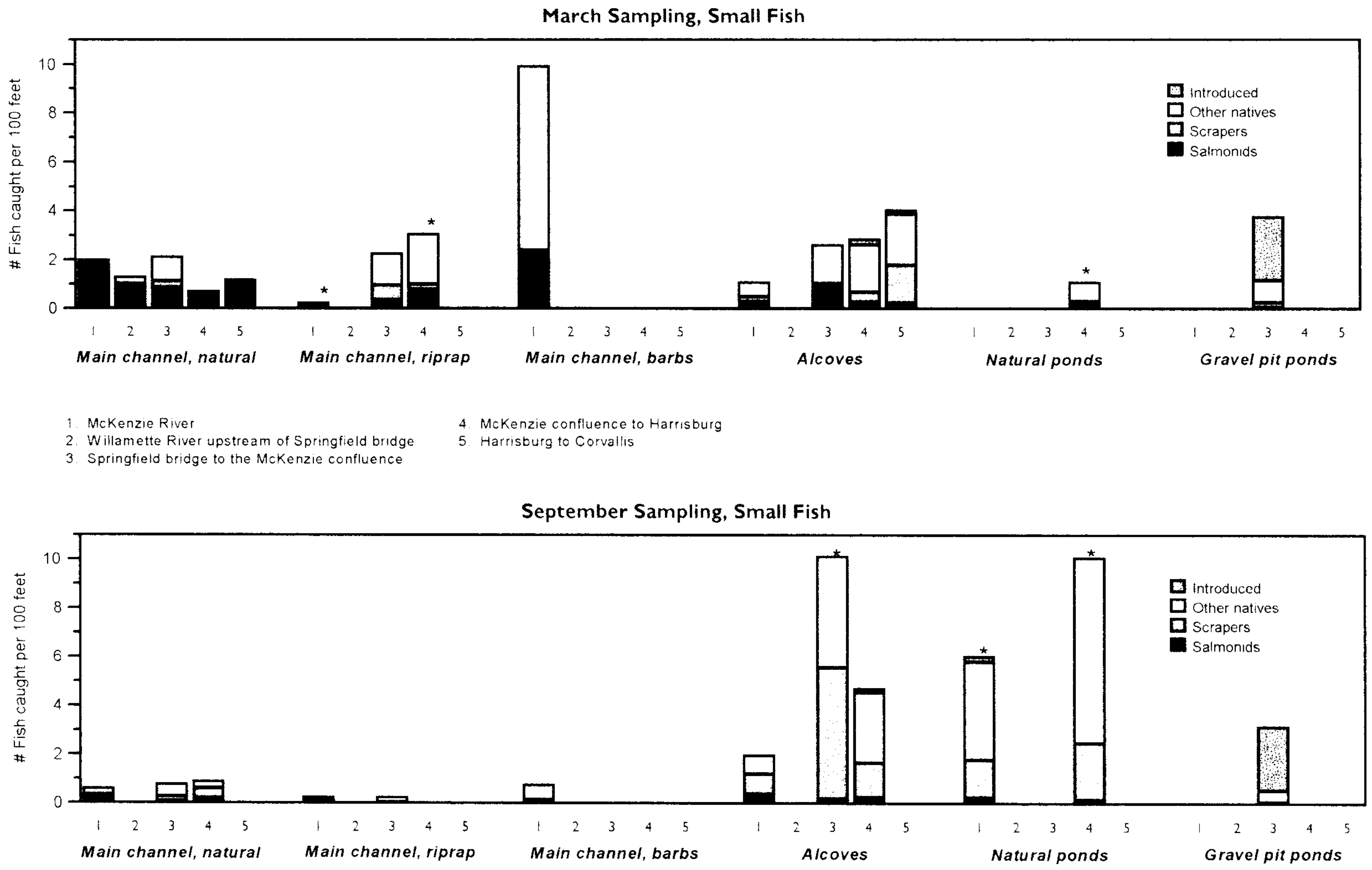


Figure 13. Small fish community structure for March and September sampling. Includes electrofishing results from this study, City of Eugene study, and EPA study. Bars with an asterisk indicates that only one site was sampled and therefore, results are less certain than the other bars which have replication.

were found in gravel pits.

Small introduced fish dominated gravel pits during both season. The decline of trapped salmonids and other native species from March to September suggests that these ponds, in their current form, do not benefit native fish. Likely factors that make gravel ponds unfavorable to native fish include high water temperature, low nighttime dissolved oxygen, lack of suitable food, predation by largemouth bass, and competition for food by small introduced fish.

Overall, the combined data sets indicated highly specialized uses of habitat based on fish group and size classes. Generally, natural banks supported higher densities and a greater diversity of native fish than did riprap banks. The high seasonal use of barbs was intrigueing in that the barbs probably mimic a type of habitat that is no longer present in the rivers. Possibly, large trees with rootwads previously provided this habitat type in which low velocity flow is adjacent to high flow (for effective feeding) and many crevasses exist to avoid predation. Large wood is now nearly absent from the McKenzie River and Willamette River.

Alcoves and natural ponds provide a specialized habitat that support high densities of native fish. While introduced fish are sometimes found in alcoves, they are usually found in only small numbers. These off-channel features are not common today probably due to channelization and reduction of peak flows. Aerial photographs from 1944 show a much higher density of off-channel features than exist today. If alcoves and natural ponds are indeed the nurseries of many native fish then their decline has likely affected the reproductive succes of the native species using these features.

The McKenzie River stands out as exceptional for salmonids, in spite of its highly altered state. Prior to channelization, the McKenzie River probably supported even greater population of salmonids. The loss of complex habitat features (braided main channels, side channels, gravel bars, large wood) is obvious when comparing 1944 to current aerial photographs. Nevertheless, the McKenzie River probably still has great potential for recovery of this lost potential.

Salmonid community composition

Salmonids in the McKenzie River and Willamette River have become high profile, largely due to the federal listing of the spring Chinook salmon that still spawn in the upper McKenzie River. In addition, fly fishermen highly value the wild rainbow trout and cutthroat trout. Consequently, the following provides a more detailed examination of the salmonid community in the study area.

Naturally-reared salmonids in the confluence area include spring chinook, rainbow trout, cutthroat trout, and mountain whitefish. There are also hatchery fish that include fall chinook (discontinued recently, but there is still natural rearing of a small number of residual fish), steelhead, and a hybrid rainbow trout. Only one hatchery rainbow was encountered (it was diseased) and only a few hatchery steelhead (near Corvallis in March) were caught during the studies. A number of hatchery-reared chinook salmon were caught as evidenced by a clipped adipose fin. Another group of juvenile hatchery chinook are not marked and cannot be distinguished from naturally-reared juvenile chinook. This group of fish are unfed fry from eggs of hatchery spawners that are released into upriver reservoirs. While intended to provide a source of food for bull trout and angling opportunities within reserviors, Oregon Department of Fish and Wildlife monitoring has indicated that a number of these juvenile chinook move out of the reservoirs and reside in downstream waters.

Therefore, the unmarked juvenile chinook salmon we encountered are probably a mixture of fish with wild and hatchery genes. Naturally-reared fish include both truly wild fish (if they still exist) and fish with hatchery parentage. Overall, about one-third of the juvenile chinook we caught in March had a clipped adipose fin. Only one juvenile chinook caught in the McKenzie River had a clipped adipose fin while over 40% of chinook in the Willamette River upstream of the confluence had a clipped adipose fin. None of the juvenile chinook we caught in September and none of those seined by Oregon Department of Fish and Wildlife in August (Willamette River between the McKenzie River confluence and Harrisburg) had a clipped adipose fin. This suggests that hatchery-reared juvenile chinook salmon move downstream of Corvallis (probably to the Columbia River) sometime betwen late spring and late summer. Radiotagging of hatchery chinook salmon in the McKenzie River and Willamette River by Shreck et al. (1984) support this theory.

Catches of large salmonids were dominated by mountain whitefish in March at main channel sites with natural banks and at one McKenzie River site with rippap (Figure 14). Unlike most riprapped segments of the river, the flow at this site does not have a high velocity. Mountain whitefish did not use sites with barbs or any of the off-channel features. Strangely, most mountain whitefish were gone in September. This was probably not due to the water temperature since maximum temperatures rarely exceed 64 deg F. Cutthroat trout were more numerous than rainbow trout, except at McKenzie River sites with barbs in March. There, the two species of trout where were co-dominate.

Large cutthroat and rainbow trout caught at Willamette River main channel sites during September were considerably less numerous upstream of the McKenzie River confluence than downstream. Immediately downstream of the McKenzie River, Willamette River sites with natural banks had densities of large trout similar to the McKenzie River. Large trout were mostly absent between Harrisburg and Corvallis in September.

Large salmonids were found in off-channel features at low densities and, within alcoves, they usually occupied the downstream ends of alcoves. Here, they probably have good opportunities to feed at the interface between still alcove water and the swift main channel.

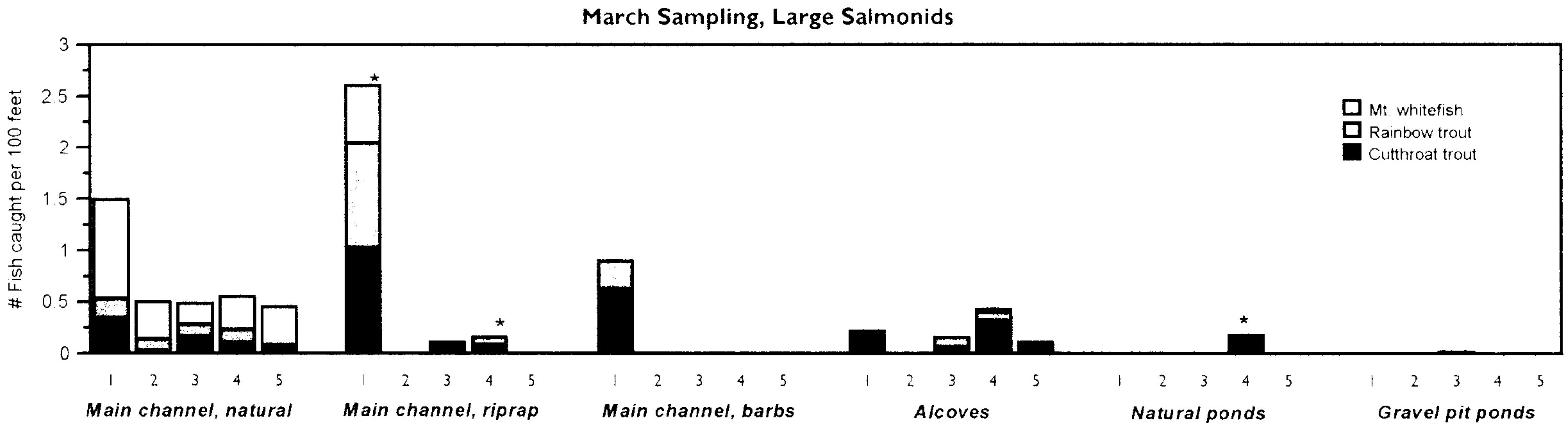
A few large cutthroat trout were found in the gravel pits during March but they were absent in September. In contrast, natural ponds supported large cutthroat trout throughout the summer.

As with large salmonids, small salmonids were dominated by mountain whitefish at main channel sites with natural banks (Figure 15). Values were highest for the Mckenzie River and sites upstream (upstream of Springfield) and downstream (Harrisburg to Corvallis) of the confluence area. Small mountain whitefish were rarely found at riprap sites, sites with barbs, or within off-channel features. In September, the small mountain whitefish were mostly absent at all sites.

Small cutthroat trout and rainbow trout were uncommon at all sites and particularly in September. Pool seining in the lower Willamette River by the Oregon Department of Fish and Wildfe in August (1993 to the present) also indicated that small trout were scarce. This coincides with findings by Moring et al. (1988) who demonstrated that cutthroat trout found in the Willamette River basin usually spend the first two years of their lives in tributaries and then move downstream to larger rivers.

Juvenile chinook salmon were found at high densities only at McKenzie River sites with barbs. There, they were found in the slackwater immediately downstream of a barb. Higher numbers of juvenile chinook salmon were also found at a riprap site downstream of the confluence and within several alcoves upstream of the confluence. Juvenile chinook salmon were uncommon in September at all sites with alcoves having the highest densities.

Seining of deep pools by Oregon Department of Fish and Wildlife locateds directly downstream of riffles (1993 to the present) indicated that juvenile chinook salmon were not particularly abundant in August. The average catch was only 5 fish per set. These sites were located between the McKenzie confluence and Harrisburg. These results, along with the scarcity of juvenile chinook caught in a trap at the mouth of the McKenzie River in 2000, suggests that densities of these fish are not high in the confluence area. Nevertheless, there is potential that the night electrofishing we conducted, the pool seining by Oregon Department of Fish and Wildlife, and the fish trap resulted in an undercount of juvenile chinook. Seining of juvenile chinook in the Deschutes River during the summer proved to be superior to boat electrofishing in a study conducted by Oregon Department of Fish and Wildlife (personal communication, Jeff Ziller, ODFW, Springfield).



1. McKenzie River
2. Willamette River upstream of Springfield bridge
3. Springfield bridge to the McKenzie confluence
4. McKenzie confluence to Harrisburg
5. Harrisburg to Corvallis

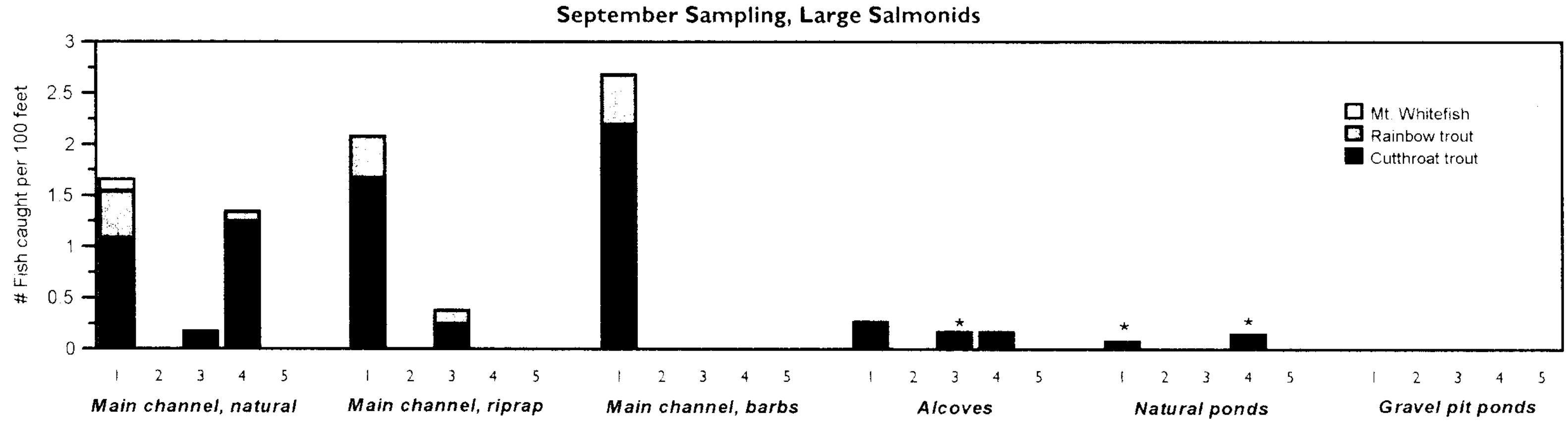
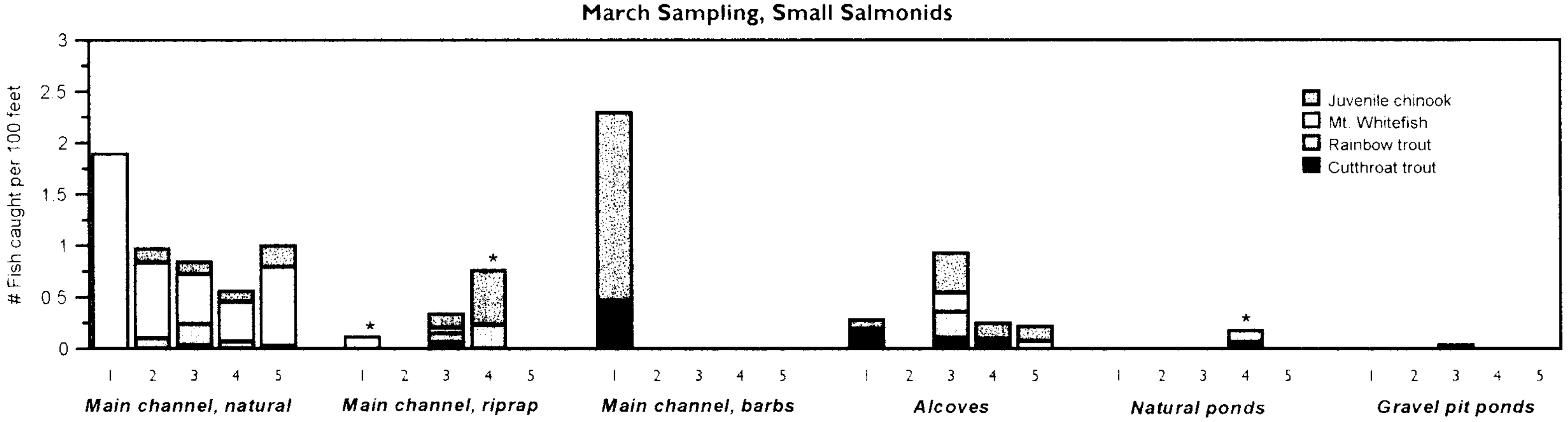


Figure 14. Large salmonid community structure for March and September sampling. Includes electrofishing results from this study, City of Eugene study, and EPA study. Bars with an asterisk indicates that only one site was sampled and therefore, results are less reliable than the other bars which have replication.


March Sampling, Small Salmonids

1. McKenzie River
2. Willamette River upstream of Springfield bridge
3. Springfield bridge to the McKenzie confluence
4. McKenzie confluence to Harrisburg
5. Harrisburg to Corvallis

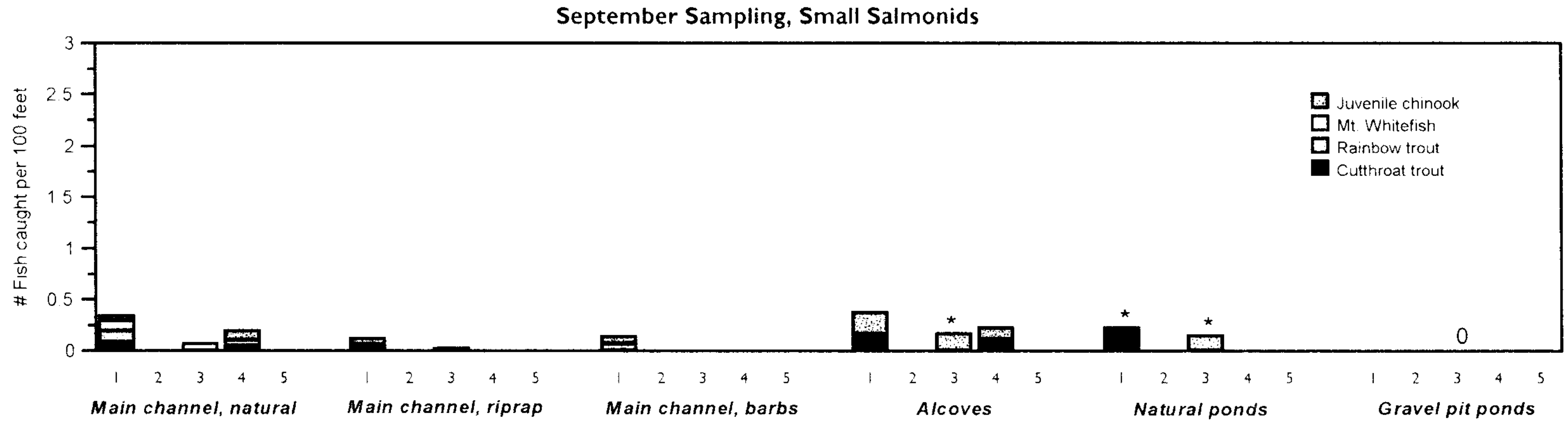

September Sampling, Small Salmonids

Figure 15. Small salmonid community structure for March and September sampling. Includes electrofishing results from this study, City of Eugene study, and EPA study. Bars with an asterisk indicates that only one site was sampled and therefore, results are less certain than the other bars which have replication.

Overall, the salmonid community in the study area various widely with season and according to the age class of the fish. The dominance of main channel sites by mountain whitefish in March was unexpected, as was the preferred use of barbs by both large trout and juvenile salmon. However, juvenile salmon did not use the barbs in September, possibly because of the large densities of large trout that used these areas. Trout use of the Willamette River upstream of the confluence is low in September yet the reasonsfor this are not clear. The upper Willamette River is quite cold with maximum values only several degrees higher than the McKenzie River.

Ambiant water quality measurements upstream and downstream of Eugene indicate no obvious decline in parameters that would influence fish. Furthermore, fish and macroinvertebrate monitoring upstream and downstream of the sewage treatment plant outfall and at a major stormwater outfall did not lead to a conclusion of habitat degradation. Nevertheless, the food supply of fish may be influenced by stormwater and other discharges throughout the Willamette River reach from Springfield through Eugene but this needs further evaluation.

Relative fish abundance and specific habitat features

We measured water depth and velocity and categorized vegetation and bank type at each main channel site. At alcove sites, we measured water depth, nighttime dissolved oxygen, and nighttime water temperature, as well as estimating the area of alcove with floating or submerged large wood and the length of bank with overhanging vegetation.

Correlations between selected groups of fish and habitat features were examined. We found no combinations with a significant correlation except that small native fish in September were inversely correlated to water depth at main channel sites that had natural banks. Nevertheless, the relative abundance of small native fish in the main channel during September was quite low and so the relationship is of no practical consequence.

We were surprised about the lack of correlation between fish and basic parameters such as water depth and velocity. At a micro-site scale, these factors often lead to segregation of fish species and size class. The variability of fish among even similar sites can be quite high. A greater sample size with better precision when measuring the habitat variables may be needed to isolate correlations between fish abundance and habitat features. Considering this, we believe that by presenting the results by river segments (1to 5, Figures 12-15) and site type we have extracted as much useful information as possible.

Other studies provide additional insight into the specific habitat needs of certain fish.

It has been shown that juvenile chinook salmon prefer moderatel flows with a gravel or cobble substrate. They also prefer sites with deep water (for protection) adjacent to shallow water (for feeding). Rivers with braided main channels and many side channels readily provide these features. Large wood accumulations in the current are also preferred by juvenile chinook salmon because of the many crevasses and the justiposition of slow and fast water. The habitat needs of these fish during winter have been less studied because of difficulties locating fish when flows are high. Yet, they seem to prefer the river edge and off-channel features where they can get out of the high flow.

Outer anomalies

During the studies we kept track of outer anomalies, including disease, infection, parasites, injuries, missing body parts, and other deformities. Most outer anomalies occurred among largescale sucker greater than 11.8 inches (300 mm) long. Less than 1% of smaller-sized fish had outer anomalies. Fish greater than 11.8 inches long, excluding largescale sucker, had an outer anomaly rate of about 5%. Salmonids were relatively free of outer anomalies with cutthroat trout having no anomalies.

Outer anomaly rates of largescale sucker greater than 11.8 inches long varied widely by season and reach. Furthermore, rates were different between alcoves and main channel sites. Outer anomaly rates were about 50% in September for largescale sucker caught at main channel and alcove sites within the McKenzie River and Willamette River upstream of the confluence. Rates were considerably lower (< 10%) for the Whitely side channel and Willamette River downstream of the confluence.

In contrast, outer anomaly rates among largescale sucker greater than 11.8 inches long were low in March, except within Willamette River alcoves between Beltline Road bridge and the confluence where they averaged nearly 50%. Anomaly rates were low within alcoves of the McKenzie River and the Willamette River downstream of the confluence.

Largescale sucker anomaly rates for Willamette River in March decreased from the confluence of the Coast Fork and Middle Fork, through Eugene, and down to the McKenzie River confluence. Rates were higher in the McKenzie River (average about 30%) and intermediate in the Whitely side channel and downstream of the confluence. Outer anomaly rates in March averaged less than 10% for McKenzie River alcoves in March, while they were about 50% the previous September.

It is unclear why outer anomaly rates among largescale sucker are so high, even in the McKenzie River. There may be a migration of stricken largescale sucker from lower reaches of the Willamette River to cooler upstream waters in order to find an environment that is less conducive to the spread of disease and parasites. However, recent studies by the EPA Research Laboratory of tagged healthy largescale sucker indicate that they have very localized home ranges.

Restoration principles for fish and their habitat

The information summarized above provides information about how conditions for fish might be improved in the confluence area. One thing we know is that the concept of "high quality" fish habitat can be complicated when the fish community includes many species with specialized habitat preferences. What is good habitat for large trout may be a death trap to small fish that try to share the same area with these predatory trout. What is preferred habitat for a three-spine stickleback would probably cause a mountain whitefish to starve. Since society generally assigns a higher value to salmonids than to other native fish, it often assumed that what is good for salmonid is also good for fish in general. This concept, if pursued to the extreme, could actually lead to river simplification over time since, for some salmonids their abundance is not directly tied to the presence of off-channel features. An alternative concept that could be pursed is that of providing a wide range of habitat types, roughly in proportion to what the fish evolved with. Historical accounts indicate that the McKenzie River and Willamette River contained more off-channel areas, shallow areas, and site channels that would tend to segregate species and size classes of fish.

The following is a discussion of habitat restoration and protection principles that seem to apply to the confluence area based on our study and studies conducted in similar settings.

- *Look for opportunities to increase the width of the active channel.*

  The active channel width of both rivers in the confluence area has been reduced over the last century in order to minimize river meandering and to extract gravel from floodplain areas. As a result, only a remnant of the once-many side channels, alcoves, and natural ponds remain. Restoration that leads to a varied and complex channel would be particularly helpful for young-of-the year chinook salmon and the many other native fish that breed and rear in backwater areas.

  Increasing the width of the active channel could occur in several ways. One, would be to breach dikes at spots along the river and construct a side channel that wound through shallow mined areas. Of course, this would not work well where abandoned deep pits were present, since bedload carried by the side channel would be lost to the pit. Another way of increasing the width of the active channel would be to excavate the upstream end of old side channels that are now plugged, thereby allowing the river to occupy these reaches. Peak flows are now too diminished by reservoir operations for the river to accomplish this by itself. Since a number of side channels were intentionally plugged decades ago, it may take an equally intentional action to get them unplugged. There is a chance that opened side channels would plug again soon after they were cleared, but designing the side channel inlet so that it funnels flow in the winter may help it become self-cleaning.

Opening the inlet of the old McKenzie channel would be one of the most comprehensive actions for expanding the active channel of the river. It would add a number of miles of wetted channel to the confluence area. However, a gravel mine is currently located in the middle of the old channel and other adjacent landowners may be troubled by the prospect of the McKenzie River again taking over this route.

- *Keep upper Willamette River water segregated from McKenzie River water.*

  For reasons yet unknown, the Willamette River upstream of the confluence has few salmonids compared to the McKenzie River during the summer. Currently, flow from the McKenzie River does not mix with the Willamette River until a mile downstream of the current confluence. This segregation of McKenzie water along the east half of the channel extends the zone of good water conditions for salmonids into the Willamette River.

  Actions intended to increase channel complexity should probably be designed to maintain or expand segregation of the two rivers. For example, if the inlet of the old McKenzie River channel were ever opened, it should be designed to receive only McKenzie River water rather than a combination of the two rivers.

- *Excavate new alcoves and side channels, where appropriate.*

  Peak flow dampening at reservoirs has left the Willamette and McKenzie Rivers with limited power to create new alcoves and side channels. Intentional construction of these features in appropriate locations could help benefit channel complexity and provide more habitat for fish that seek out these features.

  An alcove was constructed near Corvallis by a gravel company several years ago and the EPA Research Laboratory monitored water characteristics and fish communities in the alcove over the next year. The constructed alcove was immediately occupied by native fish and was particularly attractive to salmonids at various times during the following year. It had no water quality problems that would limit its use by fish. An important feature of this constructed alcove was that fine sediments were readily scoured away during high flows, thereby maintaining its depth and width for the next summer. Constructing the alcove at an acute angle to the river helped ensure that high flows would keep it scoured.

- *Provide year-round connection of low-lying gravel ponds to the main channel.*

  Our sampling indicated that two gravel ponds located in low-lying areas near the river trapped native fish when flows were high. The pits have no connection with the main channel at low flow so these native fish become trapped until the next high flows occur. Gravel ponds invariably become stocked with largemouth bass and bluegill, whether the landowner chooses to or not. Predation of native fish by large largemouth bass, combined with warmer water, is probably the reasons we found so few native fish in September.

  Providing a year-round connection of gravel pits to the main channel may solve several problems. First, the opening allows native fish to leave the pit if predation pressure becomes high or water quality diminishes. Second, the opening may allow large northern pikeminnow to move into the pits and feed on small exotic fish. The scarcity of introduced fish in natural alcoves may be a result of northern pikeminnow predation.

  Year-round connection of near-river gravel ponds has been recently tried at one site near Harrisburg and two sites near Corvallis. The connections have been at the downstream end of the pond. Initial results indicate that fish readily move out of gravel pits through these openings.

- *Find and protect the last remaining populations of three-spine stickleback.*

  Our studies and those conducted by others suggest that three-spine stickleback are rapidly dissappearing from the Willamette River valley. We found only one small population during our sampling in 1999 and 2000. These stickleback were in a natural pond on private land. Other small populations may exist in the confluence area and it may make sense to find them so that other river restoration activities do not end up destroying these sites. Stickleback we have found over the years were in alcoves or natural ponds, usually in water less than

3 feet deep, and where reeds grow in thick bunches.

- *Protect or establish large trees close to river channels or off-channel features.*

  Large trout were often found in small pockets of slow water that adjoined faster water. These microsites probably provided the trout with a place to rest from the current but also good visibility of passing food. Large trees growing at the edge of the river often provided the small bank indentations that created these pockets of slow water. Our analysis of current vegetation along channels in the study area indicate a scarcity of large trees compared with conditions in 1944.

  A long-term restoration stratgey could include conversion of reed canarygrass and blackberries to trees along the edges of the river. Sites where the river is slowly meandering into the bank would be most appropriate for converting areas of introduced plants to native trees.

- *Where riprap is a must, add rock barbs.*

  Salmonids in the McKenzie River were particularly attracted to riprap banks that had barbs. Large trout inhabitated the slow water immediately downstream of the barbs during September and juvenile chinook salmon occupied these same locations in March.

  Where riprap is a necessity in the confluence area, the addition of barbs can create some very useful habitat. During our sampling we noticed that the longer barbs (20 feet extending into the channel) attacted more fish than did shorter barbs.

Wildlife and their habitats

The purpose of the wildlife study was to quantify the current characteristics of riparian and aquatic ecosystems of the confluence area, by surveying seasonal assemblages of birds and other wildlife and to compare with historic conditions. Yet, little systematic, quantitative data exists to describe the structure of wildlife habitat as it existed in the confluence area over a century ago. From anecdotal accounts of early land surveyors, we do know there existed a nearly continuous floodplain corridor of willow, ash, cottonwood, and red cedar. This corridor reportedly had a width of between 1 and 3 km. Farther from the river, there existed wet prairie with scattered oak and ponderosa pine.

Shrub communities along rivers in the Willamette basin are now dominated by introduced species such as Himalayan blackberry and Scotch broom. The homogeneous thickets which they form provide habitat to but a few wildlife species, and create an impediment to movements of larger mammals.

Vegetation has been changed in other ways (Benner and Sedell 1997). Bottomland trees that existed in pre-settlement times averaged much larger than current trees. Floodplains contained extensive accumulations of fallen logs and branches. For example, within the channel of the upper Willamette River there were approximately 550 snags per kilometer of channel, or 1 per 1.6 m (5.2 ft.) of channel. Currently, there is about 1 downed tree per 300-400 m (about 1 per quarter-mile)(Sedell and Froggatt 1984). In pre-settlement times, large numbers of dead trees remained standing for long periods, providing habitat to many hole-nesting species. The ground under the tree canopy in places was scoured clean of herbaceous vegetation due to frequent floods and constant shifting of channels. Backwater sloughs that intermittently connected to or disconnected from the mainstem river, as gravel deposition patterns shifted, were common. At one time, perhaps many sloughs contained a profusion of submersed aquatic plants that grew well to great depth in relatively clear water, as opposed to the present condition, where many sloughs are overrun by species tolerant of turbid or nutrient-rich waters. The extensive variety of aquatic plants provided a prolonged source of food to ducks, which by some accounts were present more extensively and in numbers at least tenfold greater than they are currently. Borders of sloughs were characterized by a variety of native sedges, rushes, and grasses, whereas currently, nearly all sloughs are bordered by nearly monotypic stands of reed canarygrass (*Phalaris arundinacea*).

Perhaps few if any wildlife species have disappeared from the region entirely as a direct consequence of the major changes that have occurred in the bottomland ecosystem (Gullion 1951). Nonetheless, populations of many bottomland species have likely declined as bottomland forests have been removed and sloughs altered. To some degree, the ponds created from upland by gravel operations may have unintentionally and partially offset the loss (by drainage and channelization) of some natural wetlands, but with further loss of bottomland forest being one consequence. Also, populations of several farmland and urban-associated species probably have increased in the Confluence area in recent decades as the associated land uses have proportionately increased.

Methods used to evaluate wildlife

We conducted a 6-month survey of birds, amphibians, and reptiles in the confluence area in order to provide data for informing decision-makers about possible future habitat restorations and enhancements Project resources were limited such that the survey is best characterized as a reconnaissance-level survey, rather than an intensive survey intended to identify every spot used by any or all species.

Instead of surveying wildlife directly, we could have simply assessed the *habitat* (basically, the land cover) at various units within the Confluence, perhaps using habitat assessment protocols employed by Eugene-Springfield's "Goal 5" Natural Resources Inventory, or Habitat Evaluation Procedures (HEP) used by wildlife agencies in NEPA assessments (e.g., ODFW 1997). However, such habitat approaches do not specify for which species they are assessing the habitat. They also assess habitat only for a narrow list of presumed "indicator" species (Adamus 1995). Thus, we chose to undertake the more costly task of assessing wildlife use of habitats directly with field surveys, but supplemented that data collection with assessments of habitat suitability for <u>all</u> terrestrial vertebrate species based on satellite imagery (1992 Thematic Mapper).

<u>Wintering and migrating birds</u>

We used "area count" protocols to inventory birds during the months of January through May (the wintering and migration periods). We divided the accessible part of the project area into 24 survey units and divided each unit into as many as 4 subunits depending on its general land cover (river, forest & slough, fields & residential). We visited most units 8 times during the January-May period; a few units were visited less often due to inundation of dirt access roads and delays in gaining permission for access. During each of the 8 periods it took about 4 days to survey all subunits; whenever possible these days were consecutive. Birds were identified and counted primarily by sight as the observer drove and walked through accessible parts of the unit, taking the same route and stopping at the same places each time. No attempt was made to standardize the time spent searching per unit because this varied depending on the numbers of birds present; however, we did record the total minutes of observation time each visit, as well as weather and water conditions. The biweekly frequency of visits to each unit was likely sufficient to detect most bird species that use the site regularly, except for a few species that may occur as rare vagrants or only during the autumn.

To help characterize the birds that spend part of the winter in the area, we also obtained and digitized observational data from parts of the Eugene Christmas Bird Count (CBC), 1992-1999. This is an informal survey conducted by birders once annually sometime between late December and early January. A fraction of the Eugene CBC has included the confluence area, and birders have annually been given permission to survey Delta Sand & Gravel and Eugene Sand & Gravel properties.

Nesting birds

During the usual breeding season for most species (June), we together made two visits to 121 points spread out somewhat evenly within the same units covered by the wintering-migration surveys, as well as in a few additional locations. Points were spaced at intervals of at least 200 meters (656 ft.), and geographic coordinates (accurate to within about 10 feet, using a GPS instrument) were determined for each point. At each point we identified birds by song (primarily) and sight during a standard 5-minute period. Birds noted beyond a 50-meter (164 ft.) radius of each point were tallied separately and incidentally. The point counts began at 5 A.M. and lasted until about 10 A.M. and 5 consecutive days were required to cover all 121 points each time. Presence of a species at the same point on both survey dates is highly suggestive of breeding and strong ties to a particular local habitat. We did not search for nests or conduct nocturnal surveys for owls.

Reptiles and amphibians

During bird survey visits to each subunit, we scanned all water bodies with binoculars for evidence of Western Pond Turtle, and walked a substantial part of the shoreline of each slough and pond at least once during February-March to check for Red-legged Frog. However, to accommodate the bird surveys most areas were visited during the cooler early morning hours, at which time many reptiles and amphibians are hiding. In addition, we attempted to survey reptiles and amphibians (especially salamanders) by use of cover boards. Two standard-sized, weathered boards were placed in each unit and were turned over during each visit to check for hiding reptiles and amphibians.

Habitat characterizations

We noted the various habitat types observed in each of the wintering & migration survey subunits, photographed the subunits, and mapped their habitat types approximately. Also, while conducting the nesting bird surveys we estimated the percent of the surrounding 50-meter circle that was comprised of various habitat types, based on visual estimation. Our surveys covered all major habitat types in the Confluence area, but did not include some habitats prevalent elsewhere in Lane County, e.g., extensive oak woodlands, conifer forest, large wetlands, reservoirs, small streams.

Modeled habitat suitability

In addition to field surveys, we assessed habitat over the entire project area using satellite imagery that had been classified according to land cover type. The satellite imagery divides the project area into thousands of squares (pixels), each 30 x 30 meters (about 0.2 acre). Image analysts at the Forest Sciences Laboratory, Oregon State University, assigned each pixel to one of about 30 land cover classes based on its condition in spring and summer of 1992. The USEPA then used species models developed by Adamus and others (2000) to assign a score to each pixel, on a 0 (unsuitable habitat) to 10 (best habitat), for each species. After obtaining these species-pixel scores from the USEPA, we summed and mapped species richness (weighted by habitat suitability) for birds, mammals, and amphibians and reptiles. In other words, to "weight" the species richness by habitat suitability, we simply summed the habitat suitability scores of all species predicted to occur occur within a pixel, based on its land cover, adjacency to other land cover types, and geography.

Wintering and migrating birds

A total of 128 species of birds was detected among the 24 survey units during the 8 January-May visits (Table 2). All the species we found are ones that have been found before in the Eugene-Springfield area, and most are found in many other parts of the Willamette Valley as well.

Table 2. Bird species observed during winter and spring surveys.

# of units = number of survey areas (of 26) where species was observed anytime, January- May.
Unit ID of maximum units = place where most birds seen on one date (see Wildlife Map A).
# of periods = number of visits when species seen anywhere in Confluence area (i.e., frequency)
Period when max. = calendar period when most individuals of the species were seen in any unit.

Period 1: January 11 – 17
Period 2: January 25 - February 3
Period 3: February 9 – 21
Period 4: February 28 – March 9
Period 5: March 13 – 21
Period 6: March 30 – April 12
Period 7: April 18 – May 2
Period 8: May 16 – 31

Max. per Period = most individuals seen on any one date, summed among all units

Species	# of units	Unit ID(s) of maximum units (see Wildlife Map A)	# of periods	Period(s) when max.	Max. per Period
American Bittern	1	14	1	7	1
American Coot	4	3A	6	4	62
American Crow	24	19	8	2	379
American Goldfinch	21	5	5	8	64
American Kestrel	8	15	6	2; 3	3
American Pipit	9	6	4	6	59
American Robin	26	22	8	5	323
American Wigeon	14	20	8	5	183
Anna's Hummingbird	3	18; 20; 22	4	5	2
Bald Eagle	9	1; 3; 5; 7; 10	7	5; 6	8
Barn Swallow	11	6	3	8	25
Belted Kingfisher	17	9	8	6	12
Bewick's Wren	19	15	8	4	13
Black-capped Chickadee	23	13	8	6	77
Black-headed Grosbeak	22	1A	2	8	135
Black-throated Gray Warbler	6	15	2	7	9
Blue-winged Teal	1	8	1	8	9
Brewer's Blackbird	10	19	8	3	100
Brown Creeper	14	15	6	7	22
Brown-headed Cowbird	21	15	4	8	66
Bufflehead	4	8	7	1	19
Bullock's Oriole	2	6	1	8	3
Bushtit	15	19	7	5	42
California Quail	17	13	6	8	79
Canada Goose	23	8	8	3	568
Cassin's Vireo	5	9B; 10	1	7	7
Cedar Waxwing	20	18	2	8	174
Chipping Sparrow	4	21	3	6	9
Cliff Swallow	7	8	3	8	116

Species	# of units	Unit ID(s) of maximum units (see Wildlife Map A)	# of periods	Period(s) when max.	Max. per Period
Common Merganser	12	5	8	3	35
Common Raven	10	11	4	2	29
Common Snipe	12	9	7	2	49
Common Yellowthroat	24	11; 13; 16	3	8	70
Cooper's Hawk	1	22	1	4	1
Dark-eyed Junco	22	9	6	2	160
Double-crested Cormorant	17	5	8	1	61
Downy Woodpecker	18	17; 20	8	6	21
Dunlin	2	8	3	4	15
European Starling	26	22	8	6	223
Fox Sparrow	21	18	8	1	41
Gadwall	11	12	7	3	87
Glaucous-winged Gull	5	1	3	4; 5	3
Golden-crowned Kinglet	16	12	6	2	38
Golden-crowned Sparrow	24	5	7	7	209
Great Blue Heron	24	1	8	5	44
Great Egret	2	1; 16	3	2; 3; 4	1
Great Horned Owl	6	1	6	7	5
Greater Scaup	1	1	1	7	6
Greater White-fronted Goose	1	9	1	6	4
Greater Yellowlegs	9	1A	4	6	33
Green-winged Teal	14	8	7	1	229
Hairy Woodpecker	8	16; 17	5	5	9
Hammond's Flycatcher	1	15	1	7	1
Hermit Thrush	3	15; 20; 22	3	5; 6; 7	1
Hooded Merganser	4	9B; 22	5	5	9
House Finch	16	18	8	8	58
House Sparrow	6	18	7	8	13
Hutton's Vireo	3	10	3	6	2
Killdeer	20	1; 1A	8	8	47
Lazuli Bunting	10	9B	1	8	22
Least Sandpiper	2	9	4	6	40
Lesser Goldfinch	4	3	3	2	12
Lesser Scaup	3	5	3	3	5
Lincoln's Sparrow	14	5	7	6; 7	17
Long-billed Dowitcher	2	6	1	6	10
MacGillivray's Warbler	5	2; 3A; 15; 16; 22	2	8	8
Mallard	23	3A	8	5	184
Marsh Wren	1	6	5	3; 4; 6	2
Mew Gull	3	8	3	5	80
Mourning Dove	23	10	6	8	98
Mute Swan	1	3A	5	3; 4; 5; 8	3
N. Rough-winged Swallow	3	11	2	7	9
Northern Flicker	24	11	8	5	37
Northern Mockingbird	1	17	1	6	1
Northern Pintail	4	9; 12	3	3	6

Species	# of units	Unit ID(s) of maximum units (see Wildlife Map A)	# of periods	Period(s) when max.	Max. per Period
N. Rough-winged Swallow	6	3	3	7	26
Northern Saw-whet Owl	2	13; 15	2	6; 7	1
Northern Shoveler	4	6; 8	6	3; 5	6
Orange-crowned Warbler	16	15	6	7	48
Osprey	15	14	4	8	22
Pacific-slope Flycatcher	5	15	2	8	6
Pied-billed Grebe	13	3A	7	2; 3	10
Pileated Woodpecker	7	1A	6	7	5
Pine Siskin	6	16	5	2	10
Purple Finch	9	6; 16	2	8	10
Red-breasted Nuthatch	5	22	3	7	5
Red-breasted Sapsucker	7	1A; 16; 17	5	5	8
Red-tailed Hawk	22	1; 1A; 6	8	6	20
Red-winged Blackbird	12	3	6	4	58
Ring-billed Gull	3	8	3	3; 4	6
Ring-necked Duck	7	16	5	6	54
Ring-necked Pheasant	4	13	5	6	7
Rock Dove	3	1; 1A	6	1; 2	300
Ruby-crowned Kinglet	21	22	6	3	52
Ruddy Duck	2	6	3	2	2
Rufous Hummingbird	13	2; 5; 11; 14; 15; 16; 19	3	7	14
Savannah Sparrow	13	9B	6	6	26
Sharp-shinned Hawk	4	1A; 6; 15; 19	4	3	2
Short-eared Owl	1	11	1	2	1
Song Sparrow	26	12	8	8	223
Spotted Sandpiper	10	1; 19	5	8	19
Spotted Towhee	25	5	8	8	79
Steller's Jay	14	16	7	6	38
Swainson's Thrush	13	13	2	8	54
Townsend's Warbler	2	15	1	7	4
Tree Swallow	23	1	4	6	366
Turkey Vulture	20	1A	6	7	76
Varied Thrush	10	6	6	4	13
Vaux's Swift	6	11	2	7	60
Violet-green Swallow	24	5	4	7	790
Warbling Vireo	5	12; 15	2	8	10
Western Grebe	1	5	5	2 - 6	1
Western Kingbird	1	17	1	6	1
Western Meadowlark	1	22	1	7	1
Western Scrub-Jay	25	16; 20	8	6	85
Western Tanager	3	19	2	7	4
Western Wood-Pewee	15	13; 19	2	8	44
White-crowned Sparrow	21	21	7	1	50
White-throated Sparrow	1	18	1	4	1
Willow Flycatcher	2	1A	1	8	3
Wilson's Warbler	19	1	3	8	90

Species	# of units	Unit ID(s) of maximum units (see Wildlife Map A)	# of periods	Period(s) when max.	Max. per Period
Winter Wren	15	15	8	7	13
Wood Duck	21	14; 16	8	5	57
Yellow Warbler	19	10	2	8	89
Yellow-breasted Chat	1	11	1	8	1
Yellow-rumped Warbler	19	10	6	6	45

By seasonal period, species richness and bird abundance varied across the entire project area as follows:

	Number of species, all units surveyed	Number of individuals, all units surveyed
Period 1: January 11 – 17	52	2322
Period 2: January 25 - February 3	61	2472
Period 3: February 9 – 21	61	2847
Period 4: February 28 – March 9	80	2386
Period 5: March 13 – 21	73	3250
Period 6: March 30 – April 12	92	3686
Period 7: April 18 – May 2	90	3608
Period 8: May 16 – 31	76	3259

It is not possible to make absolute comparisons among units because they encompassed different acreages and survey time could not be meaningfully standardized. Another way of comparing the survey units is to weight the species richness by the relative scarcity of the species that were found. Using this method, a unit that contained many species that were found only in a few other units and on a few dates was scored higher than a unit that contained mainly species that were widespread temporally and spatially in the project area. By weighting species richness accordingly, the units were scored on a relative scale of 0 to 1.

Nesting birds

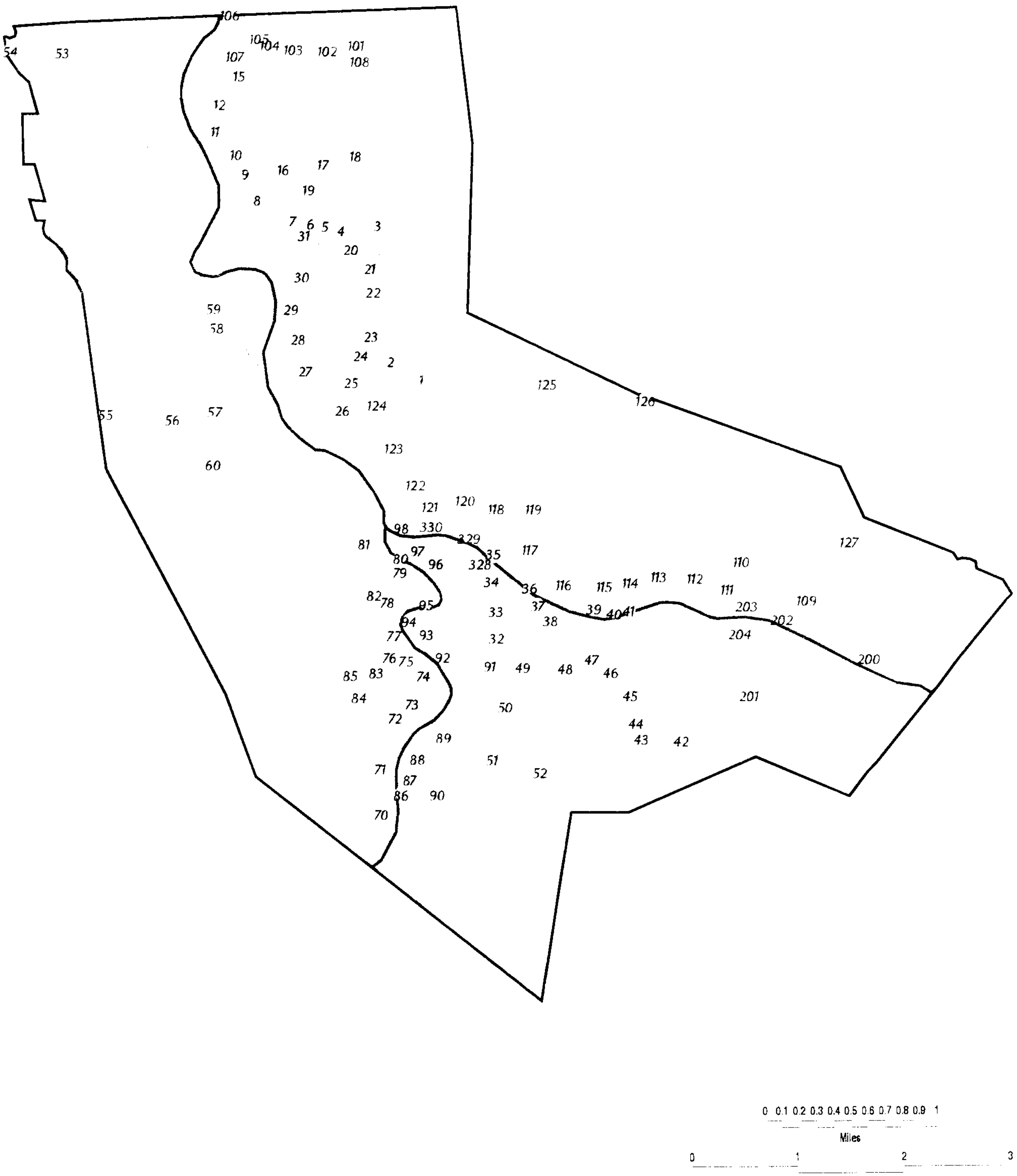
A total of 75 species of birds was detected among the 121 survey points during the two June visits (Table 3, Figure 16). This represents more than half of the species that may currently nest in the Eugene-Springfield area (Adamus and Larsen, in preparation). Of the 75 species we found, populations of 25 (one-third) are believed to have declined in western Oregon-Washington lowlands generally, based on national breeding bird survey data, 1968-1996 (see Table below). Nests we found were: Bald Eagle (1 nest), heron (2 rookeries with multiple nests), Turkey Vulture (2 nests), and multiple nests of Osprey, Great Horned Owl, and Red-tailed Hawk.

None of the many species we found is restricted to the confluence area; all occur in other parts of Lane County, and most, commonly so. Although we surveyed weedy fields, during the nesting season we did not find rare grassland species (Western Meadowlark, Grasshopper Sparrow, Vesper Sparrow, Northern Harrier) that nest in drier weedy fields elsewhere in Lane County.

Table 3. Bird species observed during June breeding season surveys.

Species (listed from most to least widespread) * = may be declining in region, see text	% of points at which species found
Song Sparrow *	91
American Robin	76
Black-headed Grosbeak	76
Cedar Waxwing	72
Western Wood-Pewee *	72
Spotted Towhee	62
Brown-headed Cowbird *	60
American Goldfinch * (may include some Lesser Goldfinch)	59
Tree Swallow *	57
European Starling	47
Yellow Warbler	47
Mourning Dove *	46
Western Scrub-Jay	43
Swainson's Thrush	42
Common Yellowthroat	39
Warbling Vireo	29
California Quail	28
Killdeer *	28
Willow Flycatcher *	27
Bewick's Wren	26
Black-capped Chickadee	24
Lazuli Bunting *	24
Great Blue Heron	21
American Crow	19
Brown Creeper	19
House Finch	18
Mallard	16
Northern Flicker	16
Red-winged Blackbird	16
Violet-green Swallow	16
Spotted Sandpiper	14
Steller's Jay	13
Barn Swallow *	10
Turkey Vulture	10
Bullock's Oriole *	9

Species (listed from most to least widespread) * = may be declining in region, see text	% of points at which species found
Rufous Hummingbird	9
Orange-crowned Warbler *	8
Osprey	8
Belted Kingfisher	7
Red-tailed Hawk	7
Wood Duck	7
Brewer's Blackbird	6
Red-breasted Sapsucker	6
Bushtit *	5
Pileated Woodpecker	4
Vaux's Swift *	4
Band-tailed Pigeon *	4
Canada Goose	4
Common Merganser	4
Great Horned Owl	4
MacGillivray's Warbler *	4
Pacific-slope Flycatcher *	4
Green Heron	3
House Sparrow	3
Savannah Sparrow	3
Yellow-breasted Chat	3
Downy Woodpecker	2
Ring-necked Pheasant *	2
Western Tanager	2
Bald Eagle	1
Chipping Sparrow *	1
Cliff Swallow *	1
Hairy Woodpecker	1
House Wren	1
Lesser Goldfinch *	1
Purple Finch *	1
American Kestrel *	<1
Black-throated Gray Warbler	<1
Blue-winged Teal	<1
Eastern Kingbird (probable vagrant)	<1
N. Rough-winged Swallow	<1
Olive-sided Flycatcher	<1
Pied-billed Grebe	<1
White-crowned Sparrow *	<1
Wilson's Warbler *	<1



Bird Nest Site Data provided by Paul Adamus
OSU Fish and Wildlife

Breeding Bird Nest Sites
McKenzie and Willamette River Confluence Area

ALSEA

www.ageospatial.com
/u2/mckz/confluence/scan/maps/riv2000_nests.aml

August 28, 2000

FIGURE 16

Bird species-habitat associations

The following associations of bird species with particular habitats were noted. Species are listed in habitats where they were found most often, though some species use (or even depend on) multiple habitats. Boldfaced species probably breed in the confluence area. Other listed species were noted only during migration or winter. The location of selected birds are shown in Figure 17.

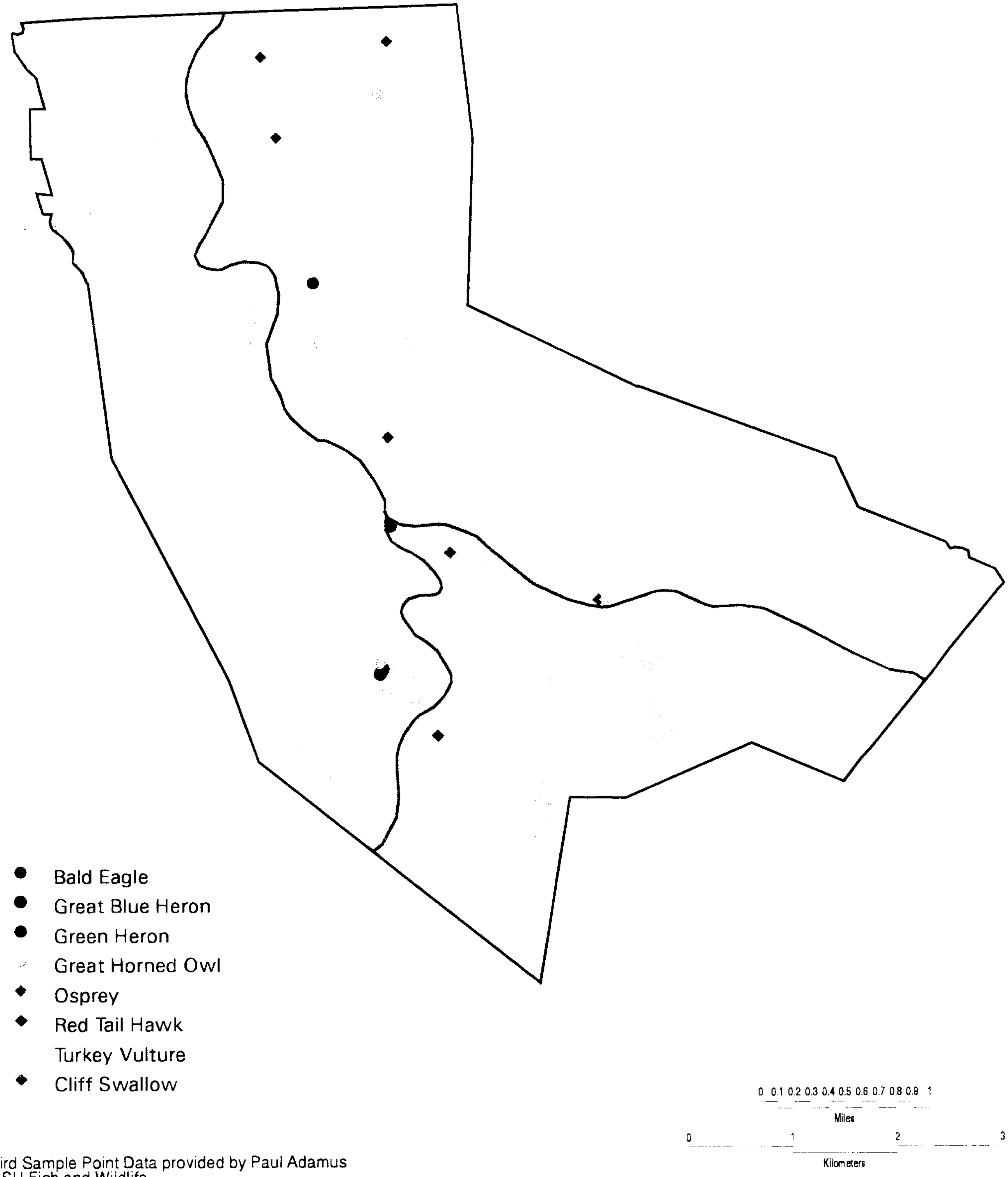
CHANNELS: Double-crested Cormorant, **Great Blue Heron** (shoreline, bars), **Green Heron, Wood Duck** (margins), **Mallard, Common Merganser, Spotted Sandpiper** (gravel bars and revetments), **Osprey, Bald Eagle, Belted Kingfisher.**

GRAVEL PIT PONDS and/or FLOODPLAIN SLOUGHS: **Pied-billed Grebe** (weedy edges), Western Grebe (deeper pits), Double-crested Cormorant, American Bittern (if dense grassy vegetation, especially cattails), **Great Blue Heron**, Great Egret, **Green Heron, Mute Swan** (Dodson Slough only)**, Canada Goose**, Greater White-fronted Goose, **Wood Duck,** Green-winged Teal, **Mallard**, Northern Pintail, Blue-winged Teal, Northern Shoveler, Gadwall, American Wigeon, Ring-necked Duck, Lesser Scaup, Greater Scaup, Bufflehead, Hooded Merganser, **Common Merganser**, Ruddy Duck, **Osprey, Bald Eagle, Killdeer** (shoreline), American Coot, Greater Yellowlegs, Common Snipe (weedy edges), Dunlin (especially puddles and muddy shores), Least Sandpiper (puddles and muddy shores), Long-billed Dowitcher (puddles and muddy shores), Ring-billed Gull (mud flats and plowed fields), Glaucous-winged Gull, Mew Gull (mud flats and plowed fields), **Belted Kingfisher, Tree Swallow** (wooded edge), **Marsh Wren** (if cattails present), **Common Yellowthroat** (weedy edges), **Red-winged Blackbird** (weedy or shrubby edges).

OPEN LAND: Green-winged Teal, **Mallard**, American Wigeon, **Turkey Vulture, Red-tailed Hawk, American Kestrel, Ring-necked Pheasant, California Quail, Killdeer** (bare areas), Ring-billed Gull (bare flats in winter), **Mourning Dove**, Short-eared Owl (large weedy fields), **American Crow** (orchards, row crops), Common Raven, Western Kingbird, **American Robin** (row crops, orchards, mint fields), Varied Thrush, American Pipit, **European Starling, Common Yellowthroat, Savannah Sparrow, Western Meadowlark** (large weedy fields with scattered shrubs), **Lesser Goldfinch, American Goldfinch.**

WOODLAND: **Bullock's Oriole** (edge, with tall trees), **Cassin's Vireo** (with natural shrub understory), **Turkey Vulture, Bald Eagle** (tall cottonwoods), Sharp-shinned Hawk, Cooper's Hawk, **Red-tailed Hawk** (near fields), **Band-tailed Pigeon** (cottonwoods), **Great Horned Owl, Northern Saw-whet Owl** (conifers), **Red-breasted Sapsucker, Downy Woodpecker, Hairy Woodpecker** (large trees), **Northern Flicker, Pileated Woodpecker** (large cottonwoods), Olive-sided Flycatcher (snags in open), **Western Wood-Pewee**, Hammond's Flycatcher, **Pacific-slope Flycatcher**, **Tree Swallow** (edges near water), **Steller's Jay** (conifers or cottonwoods), **Black-capped Chickadee** (especially maples and conifers), Red-breasted Nuthatch (conifers), **Brown Creeper** (large trees), **Bewick's Wren, House Wren**, Winter Wren, Golden-crowned Kinglet (especially in conifers), Ruby-crowned Kinglet, **Swainson's Thrush** (shrub understory), Hermit Thrush (natural shrub understory), **Cedar Waxwing** (near edges), Hutton's Vireo, **Warbling Vireo** (cottonwoods), Yellow-rumped Warbler (especially near sloughs), Black-throated Gray Warbler, Townsend's Warbler (conifers), **MacGillivray's Warbler** (natural shrub understory in larger wet woodlands), Wilson's Warbler, **Western Tanager** (near conifers), **Black-headed Grosbeak, Chipping Sparrow** (near conifers or orchards), Purple Finch (especially ash woods), Pine Siskin.

OPEN SHRUBS (blackberry, willow, and/or cottonwood plantations): **Rufous Hummingbird, Willow Flycatcher** (especially along water), Eastern Kingbird (along water), **Bushtit, Bewick's Wren, Swainson's Thrush**, Varied Thrush (especially near woodland), **Western Scrub-Jay**, Northern Mockingbird, **Orange-crowned Warbler, Yellow Warbler** (especially willow), **Common Yellowthroat** (scattered in wet fields),



Bird Sample Point Data provided by Paul Adamus
OSU Fish and Wildlife

Bird Sample Sites
McKenzie and Willamette River Confluence Area

ALSEA
www.ageospatial.com
/u2/mckz/confluence/scan/maps/riv2000_birds.aml

August 29, 2000

FIGURE 17

Yellow-breasted Chat (extensive dry shrub thickets), **Spotted Towhee**, **Lazuli Bunting** (orchards and scattered dry shrubs), Fox Sparrow (blackberry thickets), **Song Sparrow**, Lincoln's Sparrow (wet weedy fields), **White-crowned Sparrow** (weedy fields), Dark-eyed Junco, **Brown-headed Cowbird** (especially snags near willows).

BANK CUTS (from river channel erosion or gravel extraction): **Belted Kingfisher, Cliff Swallow, Northern Rough-winged Swallow.**

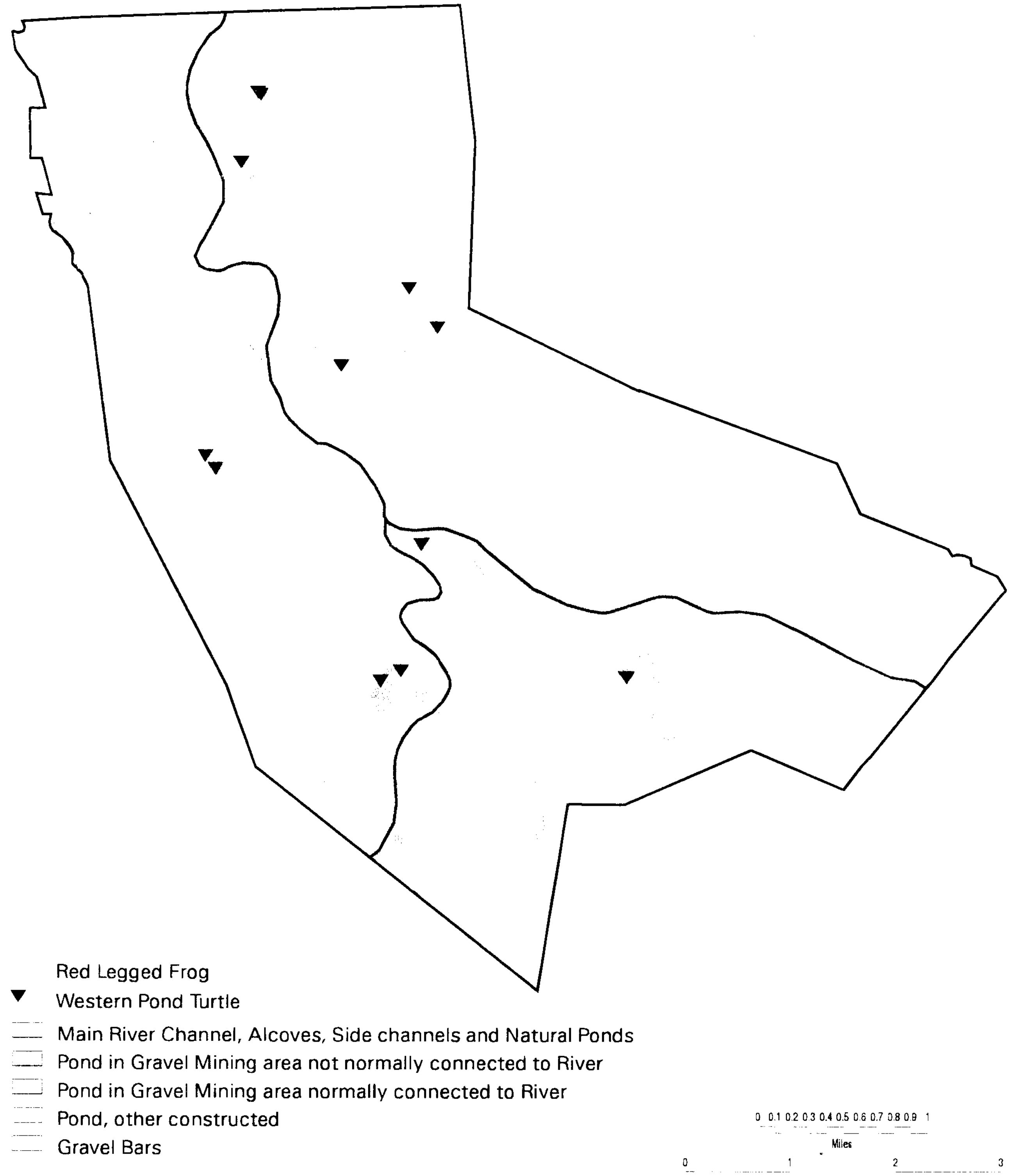
HUMAN STRUCTURES and/or YARDS: **Canada Goose, Wood Duck, Osprey**, **Rock Dove, Anna's Hummingbird, Violet-green Swallow, Tree Swallow, Cliff Swallow, Barn Swallow, Vaux's Swift, Brewer's Blackbird, House Finch, House Sparrow**

Reptiles and amphibians

Western Pond Turtle: Although not legally designated as endangered or threatened, this species is of interest to natural resource agencies because it apparently has declined throughout the Willamette Valley. Nevertheless, we discovered these turtles in 7 of our 24 survey units (Figure 18). As found elsewhere by other researchers (Holland 1994, Cowie 1997, Holte 1998), we found basking turtles in sunny ponds (both natural and former gravel pits) that contained partly submerged logs or boulders, and water year-round. These ponds typically were surrounded by lands that had been partly cleared of trees for gravel mining or agriculture, but which contained moderately dense areas of grass or other short plants which provide cover to young turtles.

Red-legged Frog: This is another species which, although not legally designated as endangered or threatened in Oregon, is of interest to natural resource agencies because it apparently is declining rapidly throughout the Willamette Valley. We found this frog in 2 of our 24 survey units, but it is likely that intensive surveys focused just on this species would discover it in additional units. Like the turtle, this species favors ponds, particularly ponds with extensive native herbaceous plants along the edge, and willow thickets or woodland nearby with substantial amounts of downed logs. Red-legged frog eggs and larvae are eaten by many species of fish, as well as the introduced bullfrog.

Others: Bullfrogs – noted predators of native amphibians – were heard at 2 of the 24 sites, and undoubtedly would have been found at more had the sampling protocol specifically targeted this species. Pacific Tree frog was heard at virtually all units. Long-toed Salamander was noted under our cover boards at one unit, and Ensatina (another salamander) was found in 3 units. Somewhat surprising to us was a lack of any observations of snakes, and discovery of only one lizard (Northern Alligator Lizard) in a single unit. This may partly reflect the time of day of our surveys. Finally, we note that we were particularly alert for Foothill Yellow-legged Frog, a species more common in California but known currently to be at only one location in the Willamette River Basin. However, we found none.



Wildlife Sample Point Data provided by Paul Adamus
OSU Fish and Wildlife

Wildlife Sample Sites
McKenzie and Willamette River Confluence Area

ALSEA

www.ageospatial.com

August 28, 2000

/u2/mckz/confluence/scan/maps/riv2000_amph.aml

Figure 18

Wildlife habitat restoration principles

Analysis of the field data suggests that management and restoration of wildlife habitat in the confluence area should focus on riparian woodlands, floodplain sloughs, inactive gravel-mined lands, and shrublands. These are discussed below.

Riparian woodland management

Riparian woodlands are the forested areas along the rivers and sloughs. In the confluence area, they are primarily vegetated with black cottonwood, with intermixed Oregon ash, big-leaf maple, and rarely, ponderosa (valley) pine. Of the various Confluence habitats, riparian woodlands supported the widest variety of wildlife. They are the only habitat that supports nesting Bald Eagles and Great Blue Herons. Riparian woodlands are one of four ecosystems highlighted as conservation priorities for land birds in western Oregon (the others are Grassland-Savanna, Oak Woodland, and Chaparral, none of which now occur extensively in the confluence area)(Altman 2000).

If they desire, landowners can maintain and improve riparian woodlands on their property by considering the following:

- Avoid or minimize the conversion of riparian woodlands to other land uses. In particular, avoid or minimize loss of woodlands in any of the following situations:
  - woodlands covering the largest contiguous areas
  - woodlands with interspersed conifer trees
  - woodlands with large-diameter (>52 inch) trees and high, closed canopies, e.g., "gallery forest"
  - woodlands with native shrub understories (not Himalayan blackberry)
  - woodlands that host the following nesting bird species (none are endangered): Band-tailed Pigeon, MacGillivray's Warbler, Pileated Woodpecker, Hairy Woodpecker, Red-eyed Vireo. These species may indicate higher riparian quality in the Confluence area.

- Don't cut (or allow employees to cut) cottonwood trees for lumber or firewood, even if the trees or their limbs have fallen or are dying, or are washed up on the bank of a channel or pond. Over a dozen wildlife species depend on dead wood, and there can never be enough standing and downed dead wood for wildlife needs. Data we collected suggest the scarcity of dead wood in the Confluence area is one factor that most limits wildlife. Standing or downed dead wood closest to rivers and sloughs is of particular importance (Steel and others 1999).

- Create conditions favorable for long term re-establishment of cottonwoods in some of the floodplain areas where they once occurred, especially in areas adjoining existing large tracts of older cottonwood. Restoring cottonwoods (and other woody vegetation) may not be desirable everywhere it is feasible to do so if it results in replacing inactive, shallowly-flooded gravel pits. Such habitats are also of high value to a diversity of wildlife species. A discussion of cottonwood regeneration is included in Table 3.

- Minimize visits to areas in the vicinity of Bald Eagle nests and heron rookeries during the times in early spring when these species are nesting.

Floodplain slough management

These water bodies, which are flooded annually by the river, provide crucial habitat to 2 of the rarest wildlife species – Western Pond Turtle and Red-legged Frog, as well as to one-third of the birds we observed. The presence of one or more of the following species in a floodplain slough over many weeks (especially if in relatively large numbers), is often an indicator of good habitat quality in the Confluence area: American Bittern, American Wigeon, Green-winged Teal, Hooded Merganser, Wood Duck, Green Heron, Belted Kingfisher, Marsh Wren.

Development-related alterations to floodplain sloughs are closely reviewed by several government agencies, but the habitat quality of floodplain sloughs can nonetheless be degraded indirectly and severely by excessive sediment runoff (turbidity), spent lead shot, and excessive growths of some highly invasive plant species. If they desire, landowners can maintain and improve floodplain sloughs on their property by considering the following:

- Use all means possible to keep sediment runoff and chemicals from reaching sloughs.

- Don't automatically assume it is best to connect every isolated slough to a river, or disconnect every connected slough from its river. From a wildlife perspective there are advantages to having each, and an appropriate goal at a landscape scale may be to maintain a variety of sloughs, both connected and isolated, and ones that hold water year-round as well as ones that hold water only seasonally. Isolated sloughs (those with no year-round connection to a river) potentially suffer water quality problems due to poor water exchange rates, and provide little or no habitat for most native fishes. However, they may provide the best habitat for rare turtles and frogs, and support large and diverse aquatic plant and invertebrate populations. Among the best habitats are isolated sloughs that mostly or completely dry out in late summer but which are flooded annually by a river and hold water until at least mid-June.

- Place a few scattered piles of untreated waste lumber, tree trunks, or boulders in each slough so they protrude above the water surface during late spring and summer, providing resting habitat for turtles and frogs.
- Attempt to minimize the spread of reed canarygrass. This invasive plant chokes out native sedges and rushes that provide better conditions for most wildlife species. Although difficult, controlling reed canarygrass can sometimes be accomplished by mechanically breaking up existing stands and maintaining water depths of at least 2 feet above the tops of existing plants during at least 2 consecutive growing seasons. This frequently is impractical and long-term control remains elusive.
- When possible, minimize public access to sloughs, especially during the winter when disturbance-sensitive waterfowl populations are present. Post signs around sloughs and water-filled gravel pits requesting that no fish be introduced, because fish (especially warm water species) can eliminate populations of sensitive frogs and aquatic salamanders, as well as reducing numbers of aquatic invertebrates that feed young waterfowl.
- If possible, lay out any future farm or mining roads so they stay at least 100 feet away from floodplain sloughs, or otherwise do not contribute sediment to sloughs via dust or runoff during highest flows.

Inactive gravel-mined land management

Inactive gravel-mined lands typically contain either stagnant water (seasonal or permanent) or extensive weedy and shrubby vegetation. Because of local land use trends, both of these habitats would otherwise be even more diminished or rare in the Confluence area were it not for the presence of inactive gravel-mined lands. Thus, at a landscape scale, inactive gravel-mined lands contribute importantly to the region's wildlife diversity.

If they desire, landowners can maintain and improve inactive gravel lands that contain gravel pits (excavations) by considering the following:

For gravel pits (excavations):

- When possible, for maximizing waterbird habitat maintain water levels at a depth of less than 4 feet in all pits. Where legal and feasible, pump or otherwise completely drain flooded pits for at least 3 consecutive days annually in order to maintain their habitat productivity and kill non-native fish. Draining should occur in late summer or early fall to minimize damage to amphibians and to provide habitat for shorebirds that are migrating then.

- When the property contains multiple abandoned pits, if possible manage their hydrology such that a variety of water depths are present, e.g., one pit with many scattered seasonal puddles (necessary for shorebirds), another with a few acres of 3-4 foot depths (for Western Grebe), another with intermediate depths.
- If possible, avoid or minimize the frequency of sudden changes in water levels, e.g., more than one vertical foot per day.
- When economically feasible, reshape side slopes of pits to a more natural contour (see guidelines from Oregon Division of State Lands).
- Create flat sand or gravel bars that extend into the water. These provide good resting habitat for gulls and shorebirds, especially in larger flooded pits,
- In active pits containing Cliff Swallow colonies, Kingfisher burrows, or Killdeer nests, if possible time the excavations near the colony or nests to avoid the May-nesting July period.
- When it is necessary to return inactive gravel-mined lands to active status, consider transplanting to another inactive site some of the native wetland plant communities and amphibians that had colonized the site being activated.
- Plus, see suggestions given above under "Floodplain sloughs."

When gravel lands contain extensive weedy and shrubby areas, landowners can maintain and improve these by considering suggestions in the following section on Shrublands.

Shrubland and weed field management

Inactive gravel-mined lands contain some of the largest areas of shrubland and weed field in the Confluence area. But extensive shrublands valuable to wildlife are also present along farm roads, within riparian corridors, where pastures have been abandoned, and as plantations of cottonwood, hybrid poplar, or Christmas trees. The highest quality shrublands in the Confluence area are those that are contain native shrub species instead of just Himalayan blackberry or Scotch broom. Native shrublands with interspersed patches of weeds consistently support large numbers of sparrows during the winter and the following species during the nesting season: Ring-necked Pheasant, Yellow-breasted Chat, Willow Flycatcher, Orange-crowned Warbler, Lazuli Bunting.

If they desire, landowners can maintain and improve shrubland and weed field habitats by considering the following:

- Whenever possible, avoid removal or disturbance of naturally-established, sapling-sized cottonwood stands. These are increasingly rare in the region and hold the key to maintaining the future richness of wildlife.
- In appropriate settings on bare soil, encourage the planting and growth of willow, cottonwood, ash, and other native tree and shrub species, rather than letting Himalayan blackberry or Scotch broom take hold. When planting native shrubs or trees, plant them in a naturally irregular, staggered, open manner rather than in straight rows, and leave occasional gaps and small openings where herbaceous weeds (important to wintering sparrows and other species; ODFW 2000) can grow.
- When feasible, align new farm and mining roads along the edge of wooded tracts, rather than through them. Roads and clearings in woodlands speed the spread of Himalayan blackberry or Scotch broom, to the detriment of native shrubs that are more useful to wildlife.
- When not too detrimental to agricultural operations, plant or otherwise allow patches or lines of shrubs (hedgerows) and weedy herbaceous plants to become established amid agricultural fields.
- Keep puddles in weed fields and cultivated fields nearly bare of vegetation and don't connect or drain them. Winter and springtime puddles, when not choked with plants, are very important to shorebirds (Killdeer, Dunlin, and others).

Fish, wildlife, and flood protection

(To come)