A SUPPLEMENTAL ASSESSMENT OF THE MOHAWK WATERSHED

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November 2000

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EXECUTIVE SUMMARY

The following report summarizes information prepared for the Mohawk Watershed Partnership to help in the development of a conservation program for the Mohawk watershed, Oregon. It was intended to synthesize and complement multiple assessments of the watershed's condition that had already been completed by others, to fill selected data gaps, and to help provide the Partnership with a technical basis for prioritizing its near-term conservation activities.

Aquatic and terrestrial habitats within the Mohawk watershed have been substantially altered by a variety of human activities over the last 150 years, but native plants and animals that remain in the area provide important links to the past and conservation opportunities that extend beyond the watershed's boundaries. For example, the watershed's native run of spring chinook salmon became extinct in about 1910 but its streams continue to serve as the primary spawning areas for what appears to be the Willamette Basin's strongest remaining population group of fluvial (migratory) cutthroat trout. Similarly, only fragments remain of the bottomland forests that were once extensive along much of the lower Mohawk River, but these fragments and the potential for restoring additional areas of these forests have been identified as a conservation opportunity of statewide significance.

After summarizing information on the Mohawk watershed, we developed a general framework for prioritizing actions the Partnership might take to address concerns that include water quality, flooding, aquatic habitat, sustaining the watershed's native cutthroat trout (in the near term) and possibly reestablishing a run of spring chinook (over the long term). This framework, which identifies both the types of actions to be taken and the areas of the watershed within which they might first be concentrated, is given on the following page.

General framework for prioritizing conservation efforts by the Mohawk Watershed Partnership.

Action	Priority	Primary Emphasis Areas	Other opportunity areas
Work with landowners, as well as local and other agencies, to encourage improvements in land or water use practices within forest-lands, agricultural/grazing areas, and rural-residential areas. This action could include work toward: slowing or discouraging urbanization of the watershed; increasing streamflows through improved water management; ensuring that water diversions are screened to protect fish; controlling livestock access to streams, riparian areas, and wetlands; improving septic system maintenance and replacing failed systems; reducing sediment delivery and runoff from small rural roads, drive-ways, and other surfaces; adopting practices that assure cautious and proper use of yard or farm chemicals, including fertilizer; and continued improvements in forest practices.	very high to high	Mohawk River Corridor, and the Upper Mohawk, Cash, Cartwright, Parsons, and McGowan subwatersheds	Watershed-wide
Protect and restore bottomland forest, particularly along the mainstem Mohawk between Parsons Creek and the mouth.	high	Mohawk River Corridor	Lower Mill subwatershed
Improve riparian conditions in the watershed as a whole, emphasizing areas managed by the private, non-industrial landowners who are a primary focus of the Partnership's programs.	high	Upper Mohawk, Cartwright, Parsons, and McGowan subwatersheds	Watershed-wide
Compile the results of previous and ongoing inventories, then prioritize and fix unnatural barriers to fish migration.	high	Upper Mohawk, Cartwright, Parsons, and McGowan subwatersheds, plus the seasonal reservoir within the Shotgun Creek Recreation Site	Watershed-wide
Inventory, prioritize and fix erosion hazards associated with active and abandoned roads, and railroad grades, where this work has not already been completed.	high	Upper Mohawk, Cartwright, Parsons, and McGowan subwatersheds	Watershed-wide
Monitor stream temperatures in a systematic manner so that both cool water refuge and problem areas can be identified and incorporated into the Partnership's program	high	Mohawk River Corridor, and the Upper Mohawk, Cartwright, Parsons, and McGowan subwatersheds	Watershed-wide, including Mill Creek which is already on the Oregon 303(d) list for having water quality impaired by temperatures exceeding state standards
Increase aquatic habitat and channel complexity by placing large woody debris in streams, with an emphasis on responsive channel segments, areas of relatively cooler water, or (possibly) summer holding areas for adult spring chinook.	moderate to high	Mohawk River Corridor above Parsons Creek, and the Upper Mohawk, Cartwright, Parsons, and McGowan subwatersheds	Watershed-wide
Restore wetlands and other off-channel habitats, particularly along the mainstem Mohawk and lowland reaches of its tributaries.	moderate to high	Mohawk River Corridor, and the Cartwright, Parsons, and McGowan subwatersheds	Watershed-wide, including a recently formed pond on the western edge of the valley floor north of Black Canyon Creek

ACKNOWLEDGEMENTS

The information contained in this report reflects the efforts of a large number of individuals, although the author takes full responsibility for the analyses, interpretations, and recommendations given herein. A subconsultant, John Gabriel of Alsea Geospatial, Inc. (Corvallis, Oregon), played a central role in assembling spatial data used in our analyses and in assisting us in several analyses requiring the use of Geographic Information Systems (GIS) technology. Adam Quinn (Clearwater BioStudies, Inc.) helped interpret air photos, contributed several office-based analyses, and assisted the author in coordinating the activities of multi-agency crews that conducted field surveys of stream and riparian conditions within the Mohawk watershed during September 1999. Pat Thompson, a member of the Mohawk Watershed Partnership, helped administer a contract that was run through the East Lane Soil and Water Conservation District and offered multiple insights he had gained during many years spent in the watershed. Several other members of the Partnership also offered helpful insights and suggestions as this report was reviewed and finalized.

The project upon which this report was based was commissioned by the Mohawk Watershed Partnership, funded by the Bonneville Environmental Foundation, and assisted by a number of individuals both within and outside the watershed. Individuals who assisted our efforts on the project included, but were not limited to, representatives of the following entities:

- East Lane Soil and Water Conservation District
- Lane County
- McKenzie Watershed Council
- Oregon Department of Environmental Quality
- Oregon Department of Fish and Wildlife
- Oregon State University
- Oregon Water Resources Department
- U.S. Bureau of Land Management
- U.S. Environmental Protection Agency
- U.S. Fish and Wildlife Service
- U.S. Forest Service
- U.S. Geologic Survey
- U.S. Natural Resources Conservation Service
- Weyerhaeuser Company
- Willamette Industries

1. INTRODUCTION

The Mohawk Watershed Partnership (the Partnership) is a group of citizens who have worked together for more than three years to encourage voluntary actions that will improve environmental conditions in or along the Mohawk River and its tributaries. The group has a quarterly newsletter and has completed multiple tree planting, riparian fencing, public education, and other beneficial projects. Having proven their ability to work with private landowners and others to complete projects, the Partnership is now trying to develop a better understanding of existing conditions within the Mohawk watershed. Such an understanding will help the group focus resources on activities that are most likely to help conserve, improve, or restore locally and regionally important natural features within their watershed.

Several issues have been identified as being of particular interest to the Partnership and watershed residents. These include water quality, habitat for native fish and wildlife, flooding, natural communities that are unique or at risk, non-native or invasive species, effects of forest and grazing practices, and the implications of additional rural-residential development. Each issue reflects recognition that change is coming to the watershed and that there may be opportunities to achieve the Partnership's three primary goals:

- To encourage the development of a sustainable local economy that provides a healthy environment for people, fish and wildlife, and native vegetation in the watershed.

- To create incentives that promote personal change in activities affecting the health of the watershed.

- To develop common ground solutions and respect for divergent viewpoints.

The following report was commissioned by the Partnership and funded by the Bonneville Environmental Foundation. It was intended to (1) complement multiple assessments already completed on differing portions of the Mohawk watershed, (2) fill selected data gaps, and (3) help provide the Partnership with a technical basis for prioritizing its near-term conservation activities. Much of the information given here was acquired from entities that have worked with the Partnership for several years, including the Natural Resources Conservation Service

(NRCS), the Bureau of Land Management (BLM), the Weyerhaeuser Company, the Oregon Department of Fish and Wildlife, the McKenzie Watershed Council, and others. For additional information on the watershed, readers are referred to watershed analyses completed by Weyerhaeuser (1994), the BLM (1995), and the NRCS (1999).

2. STUDY AREA

The Mohawk watershed is located within the McKenzie subbasin, near the southern end of western Oregon's Willamette Basin (Figure 1). It covers an area of approximately 115,000 acres and ranges in elevation from about 450 to 3859 feet above sea level. The Natural Resources Conservation Service (1999) estimated that landuse within lowland areas[1] of the watershed is dominated by livestock grazing and other forms of agriculture (15,368 acres) but also includes most of the watershed's 2175 acres of varied types of rural development (rural-residential areas, recreational lands, and small acreage "hobby" farms). Upland areas[2] are dominated by private forestlands owned by Weyerhaeuser Company, Willamette Industries, and others (87,888 acres), interspersed with checker-boarded public forests managed by the Bureau of Land Management (27,034 acres) or Oregon Department of Forestry (707 acres). The general pattern of land use zoning within the watershed is shown in Figure 2.

The watershed has an interesting history of development, much of which has been described by Polley (1984), the Bureau of Land Management (BLM; 1995), and the McKenzie Watershed Council (1996). A brief summary of this history is given in Table 1. The Mohawk was once one of lowest elevation watersheds in the entire Willamette Basin to support a native run of spring chinook salmon. However, that run became extinct by about 1910 (Parkhurst et al. 1950), due probably to the combined effects of historic logging practices, modification of lowland habitats, and high harvest rates on adult fish returning from the ocean. Streams within the watershed have been altered by past activities but continue to serve as primary spawning areas for what appears to be the strongest population group of fluvial cutthroat trout in the entire Willamette Basin (Kostow et al. 1995).

[1] In this report, the term "lowlands" refers to the relatively flat land that borders and includes the lower and middle reaches of the Mohawk River and the lower valley reaches of many of its tributaries.

[2] The term "uplands", as used in this report, refers to the landscape (including streams) surrounding the lowlands.

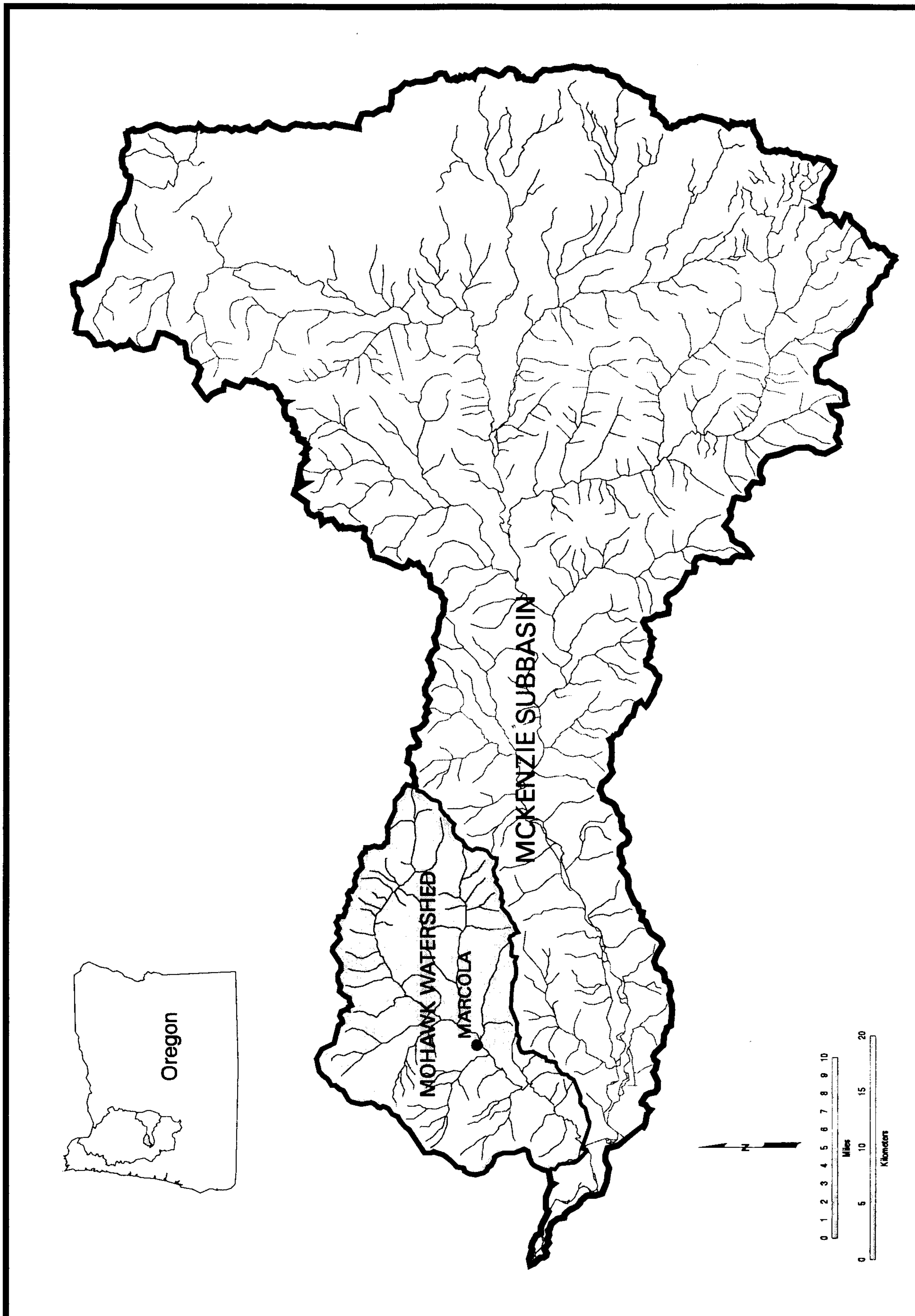

Figure 1. Location map for the Mohawk watershed, Oregon

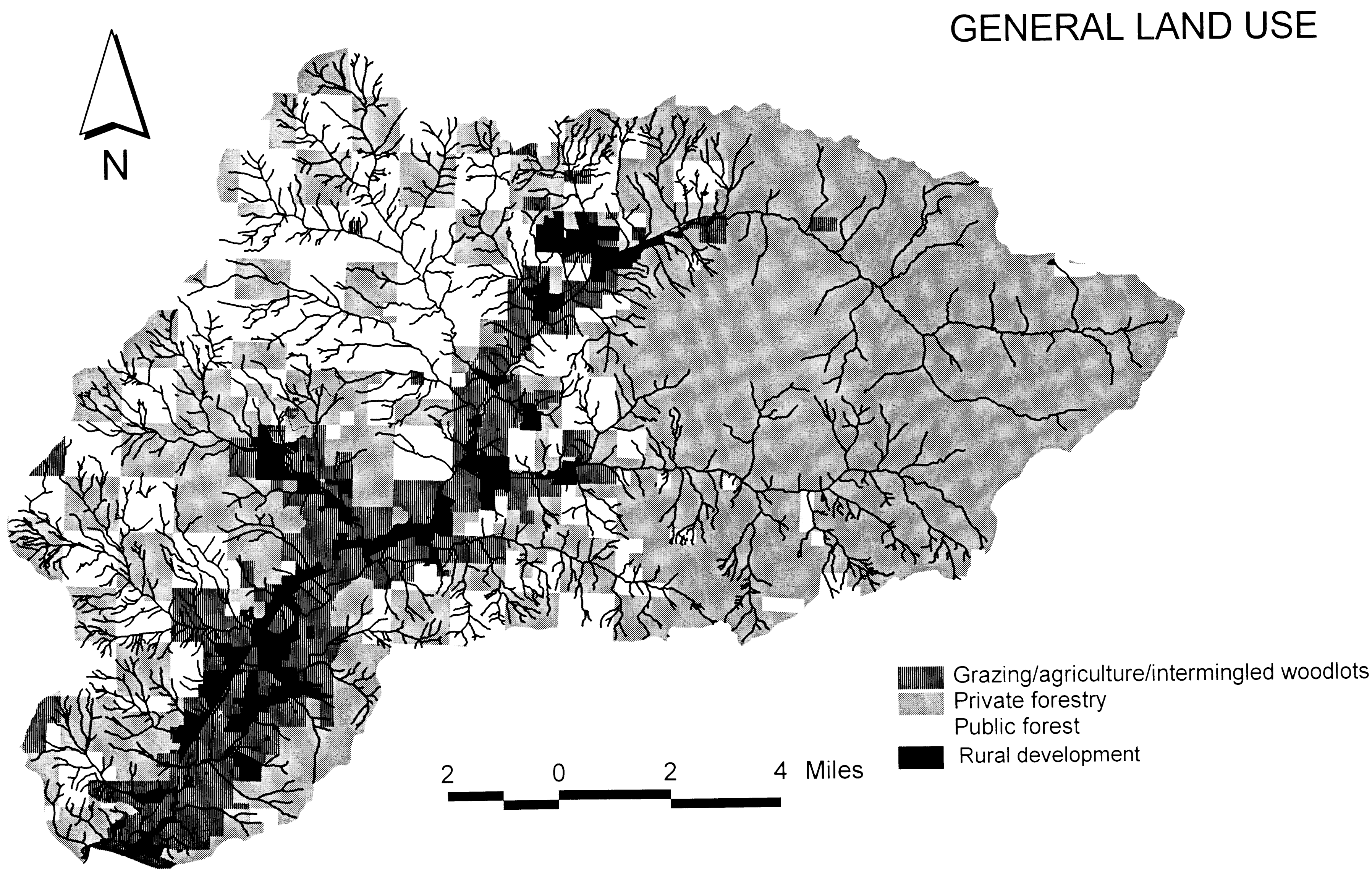

Figure 2. Landuse in the Mohawk watershed, Oregon.

Table 1. Selected events in the development of the Mohawk watershed, Oregon.

Year	Event
pre-contact	Kalapuya Indians in Mohawk Valley used low-intensity fire to maintain prairies and savannas
1846	First land claims staked in upper Willamette Valley
1850	Donation Land Act brings more emigrants to Oregon, 150 Euro-americans in Lane County
1854	General Land Office surveys the Mohawk watershed
1854	Small, water-powered sawmills begin operation at mouths of larger tributaries to serve local needs
1860	Claims filed for nearly all bottomland in the Mohawk Valley; farm development underway
1862	Homestead Act
1872	Oregon & California (O&C) Railroad reaches Mohawk Valley
1880	Areas along lower McGowan Cr. , Parsons Cr., Shotgun Cr. claimed for settlement
1885	First log drive down Mohawk River to McKenzie River
1894	First splash dam built on upper Mohawk River, others soon follow at other locations in watershed
1896	Southern Pacific (S&P) Railroad acquires O&C, bridges McKenzie River, starts logging boom
1896	Booth-Kelly Lumber Co. establishes mill on Mill Cr., industrial logging begins in the watershed
1900	Mature and old-growth forest dominates the Mohawk watershed
1900	Loggers use pole roads, chutes, splash dams, animals and steam power to move logs to mills
1900	S&P rail line reaches Booth-Kelly mill at Wendling on Mill Cr.
1906	Timber companies begin a period of railroad logging that will last for multiple decades
1908	Farmers file injunction, end splash damming because of flooding problems in their fields
1909	Most valuable timberlands in the watershed secured by private interests
1910	Expansive mills operating at Marcola, Wendling (Mill Cr.) and Mabel (mouth of Shotgun Cr.)
1910	Approximate year of last log drive down the Mohawk River
1910	Estimated time of extinction for spring chinook in the Mohawk
1915	Logging industry begins use of high-lead logging
1936	Mature/old growth stands of timber reduced by half to perhaps two-thirds in the watershed
1938	Bureau of Fisheries survey of Mohawk River found it "not a good salmon stream"
1950s	Most timber mills move south out of the watershed to Springfield, Oregon
1964	Major storm and flood (a 100 yr event) triggers watershed damage and timber salvage
1972	Large storm initiates dam-break flood of water and logs down the upper mainstem Mohawk
1980	Last of the original forest harvested along the upper Mohawk River
1993	About 3% of the watershed is in forest more than 80 years old; few patches of old-growth remain
1994	Federal Forest Plan causes shift to stronger resource conservation on BLM (formerly O&C) land
1995	Lowland streams, wetlands, riparian areas, and terrestrial habitats have long been altered
1996	Largest flood recorded on the Mohawk River since USGS gaging records began in 1936

Aquatic habitats found today within the Mohawk watershed reflect historic and ongoing interactions between natural or human-induced disturbances and the inherent ability of the watershed and its streams to recover from these disturbances. As elsewhere, patterns, types, and rates of disturbance have changed as the watershed has been developed, resulting in a shift away from the vegetative patterns (Figure 3), aquatic habitat conditions, and other landscape characteristics present prior to development. Stream channels have been simplified, riparian areas have been altered, and natural recovery processes are being impeded to varying degrees by ongoing activities. Watershed sediment yields and stream temperatures are elevated, natural accumulations and inputs of the woody debris responsible for the proper functioning of the aquatic ecosystem have been dramatically reduced, and historic floodplains and wetlands have been altered. These changes have, as in the case of spring chinook salmon, exceeded the adaptive capacities of some native species. A challenge faced by the Partnership and others in the watershed is deciding how and where to accommodate the needs of these native species for conditions closer (but not identical) to the historic condition while accounting for human needs, economic considerations, and pressure for additional rural-residential development in the area.

Some conservation opportunities within the watershed have already been identified by others and may ultimately become part of the Partnership's program. For example, Weyerhaeuser (1994), the Oregon Department of Fish and Wildlife (1996), and the McKenzie Watershed Council (1996) have placed a long-term priority on trying to re-establish a naturally reproducing spring chinook run in the Mohawk River. Areas of bottomland forest along the lower river below Marcola provide conservation opportunities that are of regional significance (Oregon Biodiversity Project 1998). Remnant or restorable wetland, savanna, or other natural communities within the watershed could contribute to voluntary private-public conservation efforts just getting underway as part of the Willamette Restoration Initiative (see Institute for the Northwest 1999).

For the purposes of our work, we broke the Mohawk watershed into 19 subwatersheds ranging in size from 800 to 11,216 acres (Figure 4). These subwatersheds provided a logical basis for several examinations of current conditions and will ultimately provide a useful spatial framework for prioritizing conservation activities within the larger watershed. Recent analyses by Weyerhaeuser (1994), BLM (1995), and the NRCS (1999) identified many actions that would help improve aquatic conditions within differing portions of the Mohawk watershed. Spatial

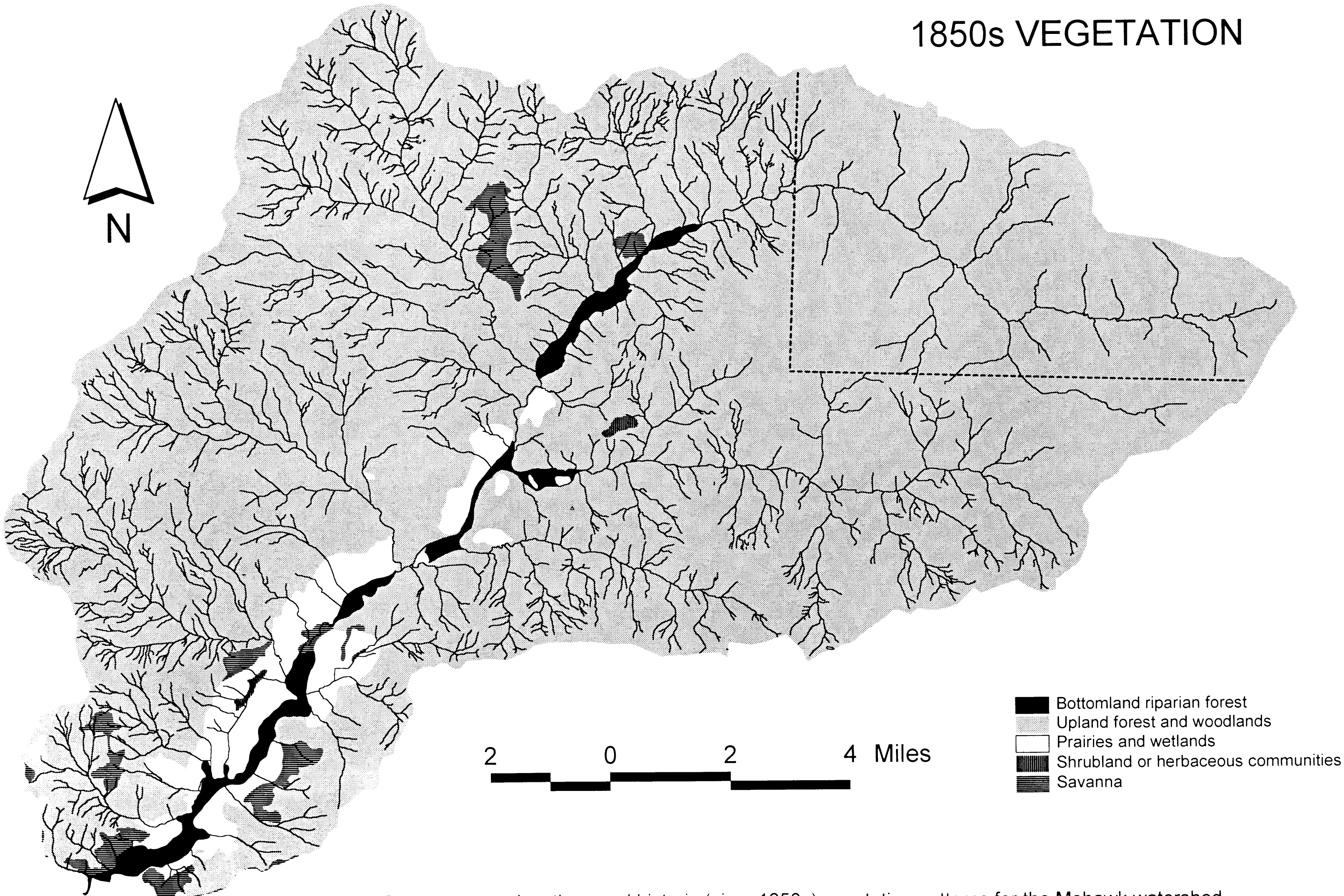

Figure 3. Current stream locations and historic (circa 1850s) vegetation patterns for the Mohawk watershed, Oregon. Data sources for vegetation mapping: The Nature Conservancy (Portland, OR) for most of the area and BLM (1995) for the northeastern portion of the watershed distinguished in the map by a dashed line.

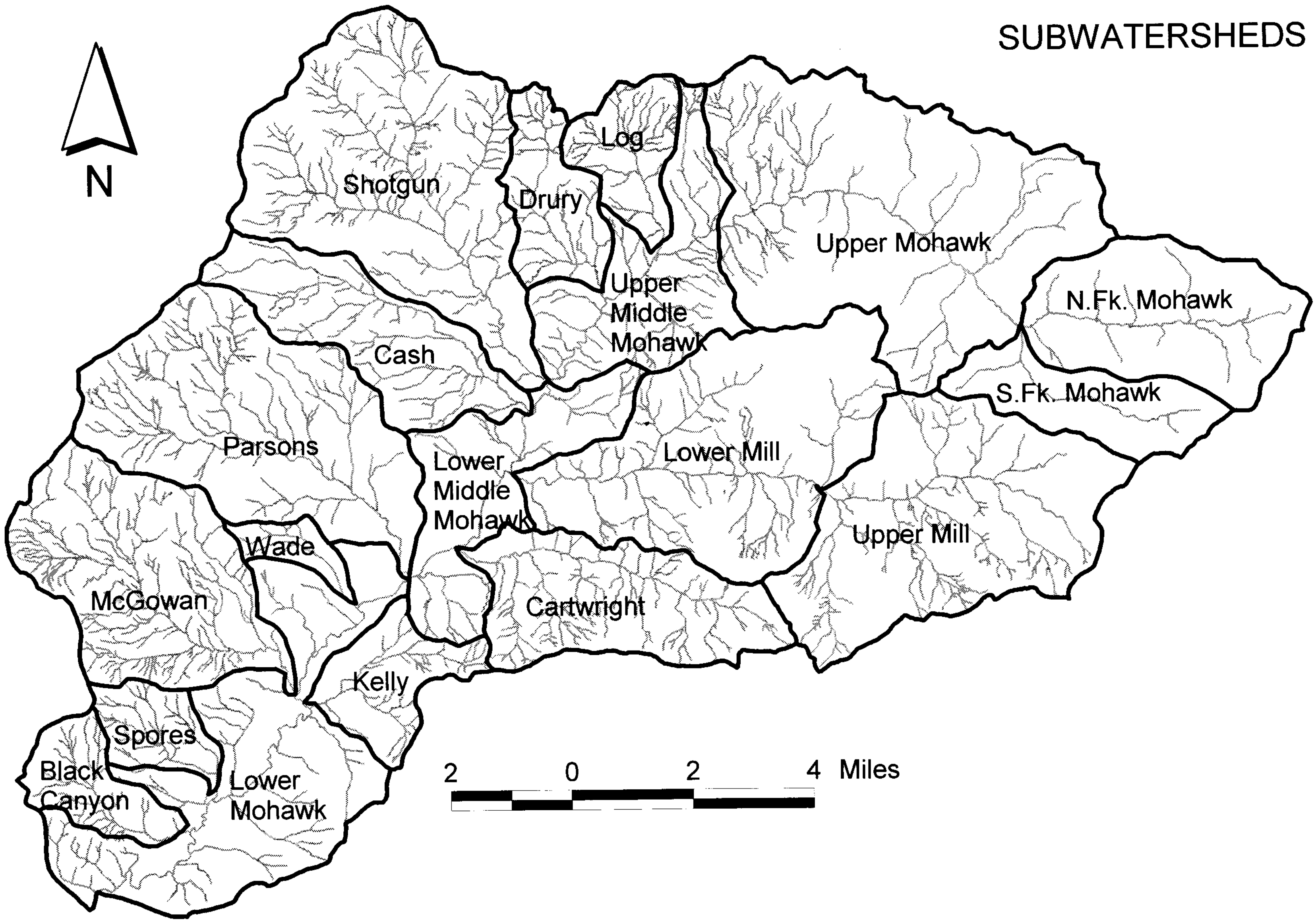

Figure 4. Subwatersheds of the Mohawk watershed, Oregon.

relationships between those three analyses and the 19 subwatersheds of the Mohawk are summarized in Table 2.

3. METHODS

We emphasized lowland portions of the watershed in many of our analyses because (1) these areas contain valuable resources worthy of conservation efforts, (2) they are owned by the small private landowners with whom the Partnership does most of its work, and (3) most upland areas are managed by public or private industrial landowners with resource specialists on staff. More broadly scaled analyses were included to help provide a watershed context for conservation activities that the Partnership may undertake as well as to include portions of the watershed where small private landowners are found outside the lowlands.

3.1. STREAMFLOWS AND WATER USE

3.1.1 Streamflows.

Mean monthly, annual peak, and annual 7-day low flows were plotted for the period of record (1936-97) for the U.S. Geologic Survey (USGS) gage site on the lower Mohawk River at Hill Road (No. 14165000). These plots gave an indication of the variations in flow affecting fish and other aquatic species in the watershed. Because historic flow data also provide a potential indicator of trends in a watershed's function, we used linear regression to test data from the USGS gage site for historic trends in mean monthly flows, annual peak flows, annual 7-day low flows, and the timing of annual maximum and minimum flows. Stream gage records, and thus our analysis, did not extend far enough back in time to capture any changes that might have been associated with extensive modifications to the Mohawk watershed that occurred prior to the mid-1930s.

Table 2. Subwatersheds of the Mohawk watershed and their previous inclusion in watershed assessments.

		Areas included in completed watershed assessments		
Subwatershed	Size (acres)	Weyerhaeuser (1994)	BLM (1995)	NRCS (1999)
N. Fk. Mohawk	5854	all	---	---
S.Fk. Mohawk	3143	all	---	---
Upper Mohawk	14616	all	lower portion	---
Upper Middle Mohawk	5058	eastern half	all	lower elevations
Lower Middle Mohawk	4762	eastern half	all	lower elevations
Lower Mohawk	9714	---	all	lower elevations
Upper Mill	10189	all	---	---
Lower Mill	10641	all	---	lower elevations
Cartwright	5584	---	---	lower elevations
Kelly	2423	---	all	lower elevations
Log	2156	---	all	lower elevations
Drury	2544	---	all	lower elevations
Shotgun	11216	---	all	lower elevations
Cash	4925	---	all	lower elevations
Parsons	10805	---	all	lower elevations
Wade	800	---	all	lower elevations
McGowan	7700	---	all	lower elevations
Spores	1562	---	all	lower elevations
Black Canyon	1948	---	all	lower elevations

3.1.2 Water Use.

Patterns of water use within the Mohawk watershed were examined by acquiring current water permit data from the Oregon Water Resources Department and scaling the volume of existing water use permits to the sizes of the drainage areas of the subwatersheds that support them. Assuming that permitted quantities are related to actual water use, this gave a general indication of where conflicts between consumptive water use and fish or other aquatic biota may be greatest in the watershed. Such areas may present particularly important opportunities to ease these potential conflicts by supporting water conservation activities, restoring watershed functions, or both.

3.2. STREAM CHANNELS

3.2.1 Channel Changes.

Historic channel modifications caused by the use of many of the watershed's streams as transportation networks for logs have been summarized by Polley (1984), Weyerhaeuser (1994), and BLM (1995). However, little has been written about modifications to the watershed's lowland channels that may have had more to do with draining wet areas, reducing stream access to floodplains, or protecting property threatened by bank erosion, than with transporting logs. We examined the oldest air photos available (1:15,000-scale 1936 black-and-white images from the US Army Corps of Engineers) as well as recent photos acquired from the BLM (1:12,000-scale 1995 color images) to identify major changes of course or other changes in channel features discernable along the lower mainstem Mohawk River or its lowland tributaries. Dramatic changes apparent in the photos were confirmed to the degree possible by on-the-ground inspection then transferred to digital maps.

Lowland channels we surveyed during late summer in 1999 (see Section 3.6) were examined for past downcutting, for areas where streambanks were armored with rock (e.g., rip-rap) to protect property, and for the presence of sidechannel areas that reflect aquatic habitat complexity. We calculated the percentage of the total length of these channels that had been modified with riprap as an index of the degree to which this type of activity has affected lowland streams in the watershed. The abundance of sidechannels was expressed as a percentage of total wetted channel area and examined from the perspective that these types of features are a naturally common and important component of aquatic habitat in lowland areas.

3.2.2 Responsive Stream Reaches.

Unconfined low-gradient (<2%) stream channels tend to provide depositional zones for sediment and woody material from upstream areas, are sensitive to cumulative effects, and often provide the most complex and dynamic habitats for aquatic species when in good condition. They also provide the preferred habitats of many aquatic species. We mapped the watershed's low-gradient channels, and the degrees to which they are laterally confined by hillslopes, natural terraces, or deep channel incision, to show how these areas are distributed within the Mohawk watershed. Information sources included previous watershed assessments by Weyerhaeuser (1994) and BLM (1995) as well as USGS 7.5-minute topographic maps, recent air photos, and limited ground-truthing.

3.3. RIPARIAN AREAS, WETLANDS AND FLOOD-PRONE LANDS

3.3.1. Riparian Conditions.

Prior to this study, Weyerhaeuser (1994), BLM (1995), and NRCS (1999) had assessed recent riparian conditions within the Mohawk watershed. We briefly summarized their information on streamside vegetation in both upland and lowland areas, then supplemented it by interpreting lowland riparian conditions from 1:15,000-scale 1936 air photos from the US Army Corps of Engineers and 1:12,000-scale 1995 photos from the Bureau of Land Management. Sections of the lower mainstem Mohawk River and its lowland tributaries that were included in one or more sets of interpretations we made are shown in Figure 5.

3.3.1.a. <u>Changes in the spatial extent of bottomland forest</u>. Because the bottomland forest along the lower Mohawk has been recognized as part of a regionally important conservation opportunity, we used the 1936 and 1995 air photos to map changes that have occurred in the spatial distribution of this forest along the Mohawk between McGowan Creek and the mouth. This section of river does not cover all of the historic nor current distribution of what is now a fragmented forest, but does include a major portion of what is left. For each of the two photo years, our mapping involved transferring delineations of forest and river locations from individual

EVALUATION OF STREAMSIDE CONDITIONS

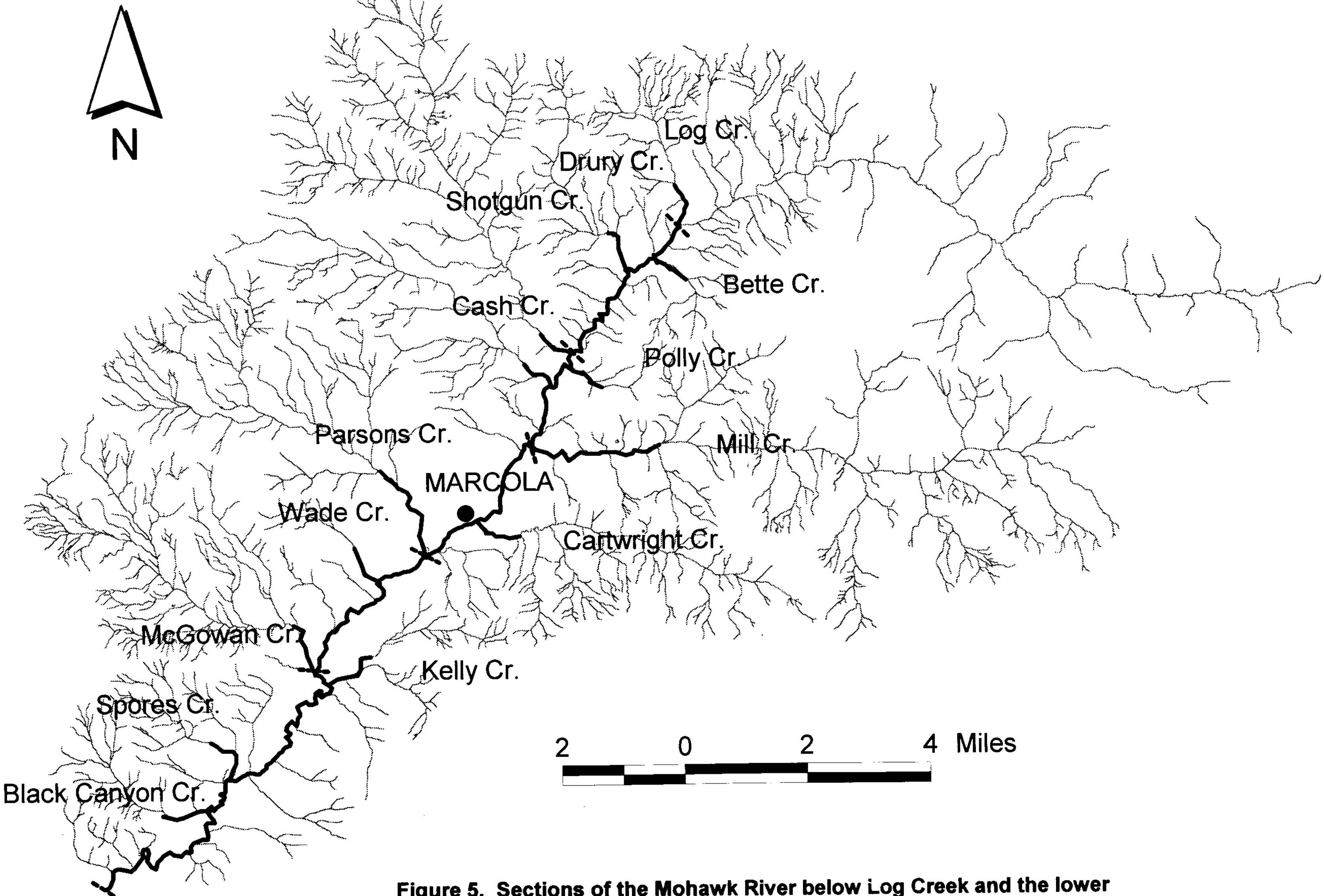

Figure 5. Sections of the Mohawk River below Log Creek and the lower sections of tributaries for which streamside conditions were evaluated.

photos to a common base map, with two and preferably three horizontal control points matched per pair of adjacent photos. Forest of variable density (including sparse) was included. Mapping results were then converted to a common scale and inspected for changes that occurred between 1936 and 1995 in the distribution of bottomland forest along this section of river. The magnitude of these changes was then considered in the context of changes from the historic (1850s) forest condition suggested by the map (see Figure 3) that The Nature Conservancy constructed from 1850s GLO surveys.

3.3.1.b. Fragments of bottomland forest that could be high priorities for protection.
We delineated dense patches of bottomland forest larger than one acre in size on 1:12,000-scale 1995 color air photos of the Mohawk River between Log Creek and the mouth. The sizes of dense forest patches along each of the specific sections of the mainstem mapped in Figure 5 were then determined using SigmaScan digital measurement software. Resultant data were summarized to document opportunities to protect these fragments as possible starting points for restoring larger portions of the historic forest.

3.3.1.c. Assessment of lowland riparian forest widths and streamside conditions. The air photos were also used to assess widths of streamside forests and, where possible, to interpret the extent of severe bank erosion problems. Interpretations we made from the 1936 photos were of the lengths of streambanks along specific sections of the mainstem Mohawk River below Shotgun Creek that were bordered by bands of streamside trees 0-50, 50-100, 100-150, or >150 feet wide. These riparian widths include those that available science suggests will perform a variety of beneficial functions ranging from bank stabilization to water quality control and to the creation and maintenance of fish and wildlife habitat (Figure 6). Similar photo-based interpretations of streamside forest widths, covering sections of the mainstem below Log Creek and lowland reaches of named tributaries to the mainstem (see Figure 5), were made from the 1995 air photos. These interpretations of recent conditions also included lengths of streambank that lacked any continuous buffer of trees and, along the mainstem, lengths of eroding cutbanks that were severe enough to be distinguishable in the photos.

All interpretations of streamside forest width and areas of severe bank erosion made from the 1995 photos were delineated on the photos and provided to the Partnership as a means of helping to identify sites for potential riparian restoration projects.

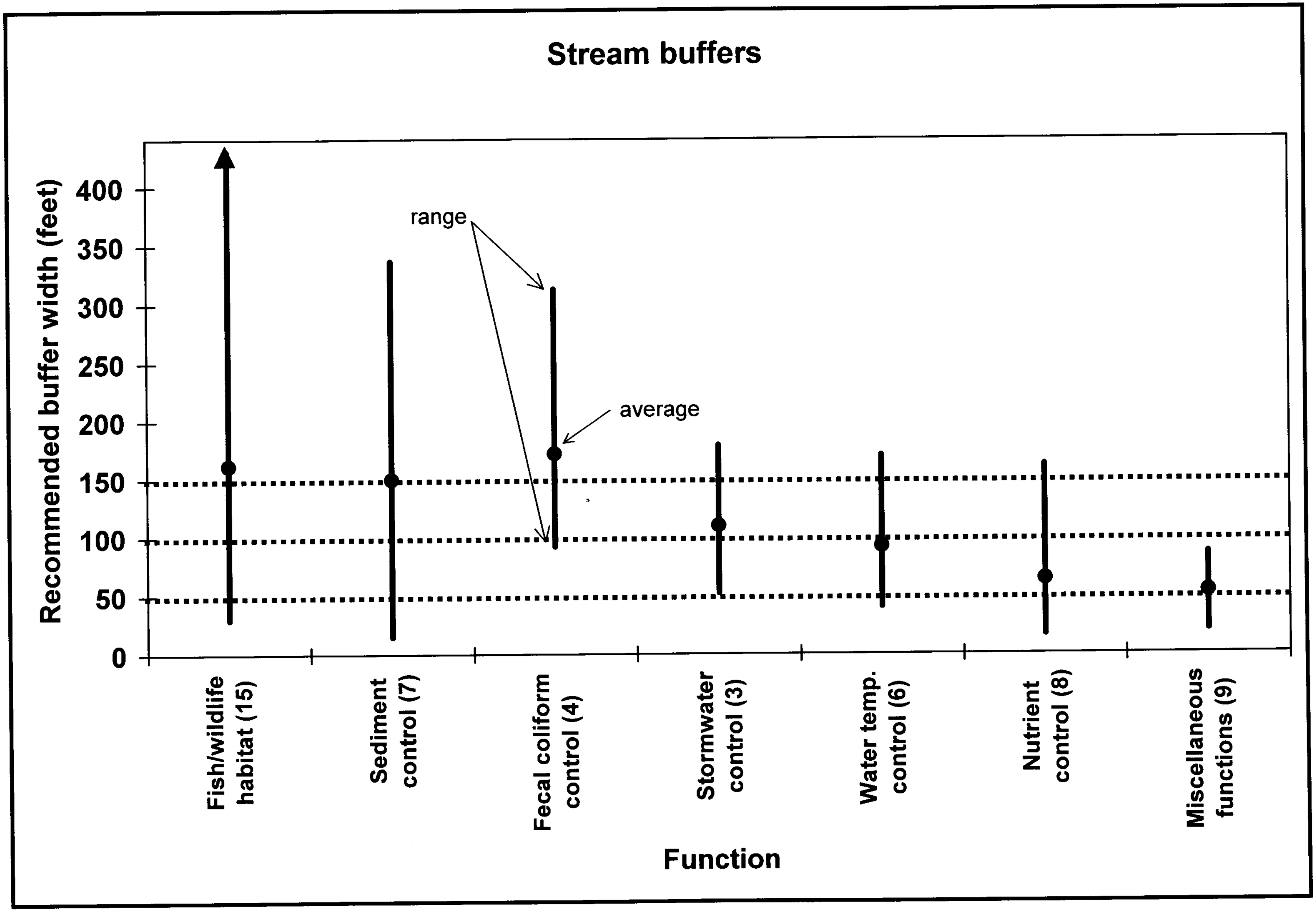

Figure 6. Riparian buffer widths recommended for different functions along streams. Ranges and averages of widths recommended by multiple studies (numbers in parentheses) are shown for specific functions. Source: Metro (1997).

3.3.1.d. **<u>Landuse patterns near streams</u>.** Landuses near streams influence riparian conditions and the options available to improve these conditions. We used the 1995 air photos to identify dominant landuses within or adjacent to the riparian area along each river and stream section mapped in Figure 5. This was done by delineating variable length segments of each bank within each section into four use categories: forest/woodland, agriculture/grazing, rural residential, or road/railroad/utility corridor. For each river or stream section, we calculated the percent of total bank length classified into each of the four categories, to provide an indication of the kinds of conservation opportunities that may be available and to identify how adjacent landuse varies along the river and among the lower sections of its tributaries. Ground-level observations were then used to validate a subsample of our interpretations for each section, and to clarify what kinds of conditions or restoration constraints might be associated with each type of landuse.

We also examined near-stream changes in landuse that have occurred over the past half-century along the mainstem and lowland segments of named Mohawk tributaries below Shotgun Creek by comparing the 1936 and 1995 air photos. Selected results of those examinations were then summarized for this report.

3.3.2. Riparian Protection Rules.

Riparian buffer width requirements vary with land ownership and landuse within the Mohawk watershed. We reviewed available information on regulations or management guidance in place during 1999 and developed a simple chart that depicts this variation.

3.3.3 Wetlands and Flood-Prone Areas.

Recent information on wetlands and flood-prone areas within the Mohawk watershed was readily available to us in the form of National Wetlands Inventory (NWI) maps from the U.S. Fish and Wildlife Service (USFWS) and Geographic Information System (GIS) data on hydric soils and flood-prone areas available from NRCS (1999). We acquired this information, then mapped the combination of NWI wetlands, hydric soils, and flood-prone areas as a first-cut at identifying potential wet areas within the watershed. We also analyzed the degree of overlap between land zoned for three basic use types (rural development, agriculture, and forestry) and potential wetland or flood-prone areas. This analytical effort, supplemented by abbreviated interpretations of color 1:12,000-scale 1995 air photos and several days of ground-truthing within the Mohawk Valley, yielded preliminary information on several issues and possible conservation opportunities that relate to existing as well as potentially restorable wet areas in the watershed.

3.4 SUBWATERSHED SENSITIVITY AND FOREST STANDS

We used GIS, information from Weyerhaeuser (1994) and BLM (1995), and spatial data readily available from public sources, to map three general indices of watershed sensitivity to disturbance and two indices of forest stand conditions among each subwatershed of the Mohawk. Indices of watershed sensitivity included percent steep (>65%) slopes, percent ancient (deep-seated) landslides, and percent of subwatershed in the rain-on-snow zone (1500-3500 ft; BLM (1995)). Percent steep slopes and percent rain-on-snow zone were determined using a 30-meter digital elevation model, while percent ancient landslides was measured directly off maps from the Weyerhaeuser (1994) and BLM (1995) watershed assessments. The two indices of forest stand conditions, both based on existing interpretations of satellite imagery, were "percent of forest not clearcut from 1972-95" derived from spatial data developed by Cohen et al. (1998) and "percent of forest in older (~60+ yr) stands in 1995[1]" based on a combination of digital data from the Laboratory for Applications of Remote Sensing in Ecology in Corvallis, Oregon and the Cohen et al. (1998) data. Ground-level stand data would have been better than interpretations from satellite imagery but were unavailable to us for the entire watershed.

The maps we developed provide context for the work the Partnership will be doing, which is focused largely in the lowlands but affected by conditions in upland forests. They also give a general indication of how patterns of watershed disturbance caused by forestry activities might relate to variation in the relative sensitivity of upslope areas within the Mohawk's subwatersheds.

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[1] Spatially explicit data on forest vegetation that a regional computer model interpreted from 1988 satellite imagery were used to identify "older" stands of conifers in the watershed, then adjusted for those stands harvested between 1988 and 1995. Areas of forest the regional model classified as conifer dominated stands about 80 years or more old in 1988 and not harvested by 1995 were grouped together in what we termed "older" forest stands in the Mohawk watershed. Discussions with local foresters familiar with recent ground-based stand age data for the watershed suggest that the true age of these "older" stands was actually about 60 years or older. It is our understanding that the regionally calibrated model tends to overestimate the age of conifer stands in the Mohawk watershed because it interprets multiple characteristics of stand structure, not actual tree age, and tree growth in the watershed is more rapid than the regional average.

3.5. ELEVATED SEDIMENT YIELDS

Sources of elevated sediment yields from upland areas of the Mohawk watershed, primarily active forest roads, were reviewed in analyses completed by Weyerhaeuser (1994) and BLM (1995). We briefly summarized some of that information for this report and supplemented it by using maps developed by Polley (1981) to measure the lengths of old, abandoned railroad grades present in the watershed.

The assessment of the lower Mohawk watershed by NRCS (1999) identified fine sediments as a potential water quality problem but provided little analysis of lowland sources. It was beyond the scope of our work to conduct a detailed evaluation of sediment sources in the watershed's lowlands, but we did make and summarize multiple field observations of specific problem areas.

3.6. FISH HABITAT

During September 1999, we surveyed 47 pre-selected reaches of streams in the Mohawk watershed using a modified version of the latest ODFW aquatic inventory protocols (Moore et al. 1997). The specific protocols used are given in Appendix A. The intent was to (1) supplement pre-existing data, (2) obtain information on stream conditions in lowland and other areas that accounted for responses to the 1996 flood (the largest recorded at the USGS gage on the lower Mohawk), and (3) help identify opportunities for protecting high-quality habitats or for improving those of lesser quality. All fieldwork was coordinated and conducted by our staff with field support from NRCS and USFWS personnel. Survey reaches (Figure 7) had been selected in advance from candidates throughout the watershed by using a systematic process strongly weighted toward the mainstem Mohawk River below Log Creek and tributary streams that had not recently been examined by ODFW or Weyerhaeuser Company.

Aquatic habitat and riparian data from our stream surveys were summarized and incorporated into a spatially-linked database that also included previous survey data for reaches within the watershed that had been collected by ODFW, Weyerhaeuser, BLM, and the EPA (Figure 7). The database included available information on channel size and gradient, watershed setting (upland or lowland), and (where available) values for multiple parameters for which we intended to compare measured conditions to habitat benchmarks. As in all of our efforts, upland stream reaches were defined as those in forestlands surrounding the Mohawk Valley, while lowland

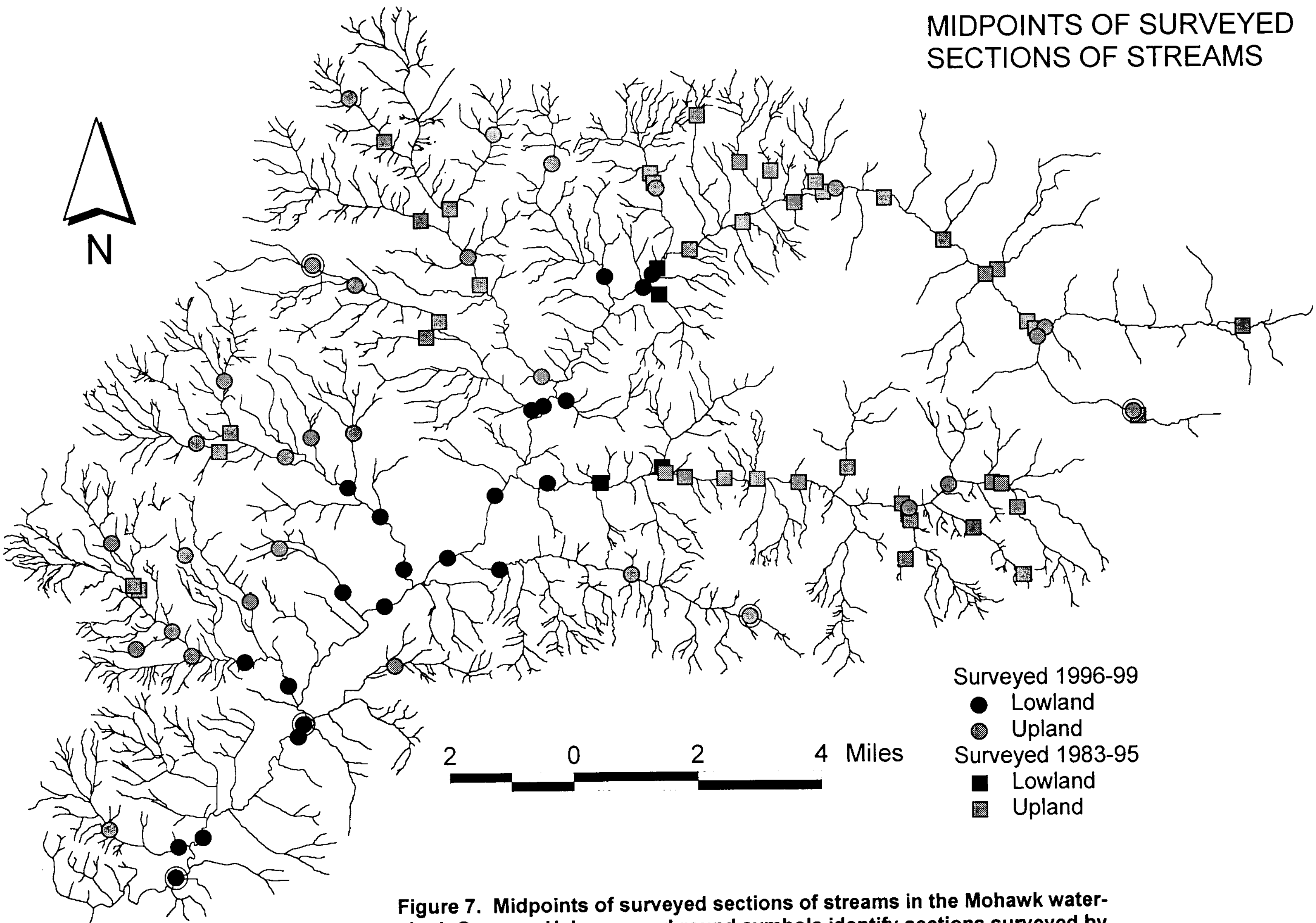


Figure 7. Midpoints of surveyed sections of streams in the Mohawk watershed, Oregon. Halos around round symbols identify sections surveyed by the EPA during the 1996-99 period.

reaches included sections of the Mohawk River downstream from approximately the Log Creek confluence and the low-gradient lower segments of valley tributaries that were dominated by grazing, agricultural, rural residential, or mixed landuses. Stream data were also stratified into groups of information collected either before or after the 1996 flood, due to concern that habitat changes caused by that event may have made pre- and post-flood data not entirely comparable across the watershed.

3.6.1. Benchmark Analysis.

We used the basic approach recommended in the most recent Oregon Watershed Assessment Manual (OWEB 1999) to evaluate the quality of stream and riparian conditions along surveyed reaches within the Mohawk watershed. Reach-specific values for each of six important stream characteristics were compared to habitat benchmarks summarized in Table 3 and Figure 8. The benchmarks used include measures of quality for each of the following habitat elements: channel condition, pools, sediment, large woody debris, and riparian condition. Multiple additional habitat benchmarks from OWEB (1999) were compared to data from surveyed reaches in the Mohawk system, but were not a focus of our analysis.

Each habitat benchmark represents “good” conditions for most stream reaches and provides a standard against which to objectively classify specific locations with respect to a given habitat feature at the time they were surveyed. It should be noted, however, that not all reaches may be capable of meeting or exceeding all of the benchmarks because the inherent potential of reaches varies due to natural variations in their geomorphic and ecological settings.

Results of our benchmark analysis were expressed in terms of the percentages of reaches surveyed in 1999 that met multiple habitat benchmarks, and the percentages of stream reaches in upland and lowland settings that met or failed to meet specific habitat benchmarks. The spatial distributions of reaches surveyed by us or by others that met, failed to meet, or lacked data suitable for comparison to each specific habitat benchmark, were then mapped using a GIS. This helped identify areas within the watershed that exhibited good (“met benchmark”) or less than good (“did not meet benchmark”) habitat conditions.

Table 3. Habitat benchmark conditions evaluated for each reach surveyed in the Mohawk watershed during 1999.

	Benchmark condition*	Source
Riparian conditions		
Shade**	>80% of potential shade (see Figure 8)	modified from WFPB (1997)
Potential large woody debris ***	>300 riparian trees having diameters of 20"+ /1000 ft of stream, or >200 riparian trees having diameters of 35"+/1000 ft of stream	modified from OWEB (1999)
Stream channel		
Streambank erosion	<10%	NMFS & USFWS (1996)
Pools		
Pool frequency	<7 channel widths/pool	OWEB (1999)
Large woody debris (LWD)		
LWD	>60 total pieces/1000 ft of stream, or >9 key pieces/1000 ft of stream ****	OWEB (1999)
Fine sediments		
Percent surface fines in riffles	volcanic parent material: <8% sedimentary parent material: <10% <1.5% gradient streams: <12%	OWEB (1999) OWEB (1999) OWEB (1999)

* condition considered to represent "good" habitat

** calculated as 80% of site potential (based on channel width and assumed tree heights of 150 ft for upland reaches and 100 ft for lowland reaches)

*** only conifers counted toward potential LWD along upland reaches, but both conifers and hardwoods counted along lowland reaches

**** counts of total pieces include all LWD larger than a minimum size threshold, typically 6 in. by 10 ft; key LWD included all pieces larger than 2 ft by 33 ft

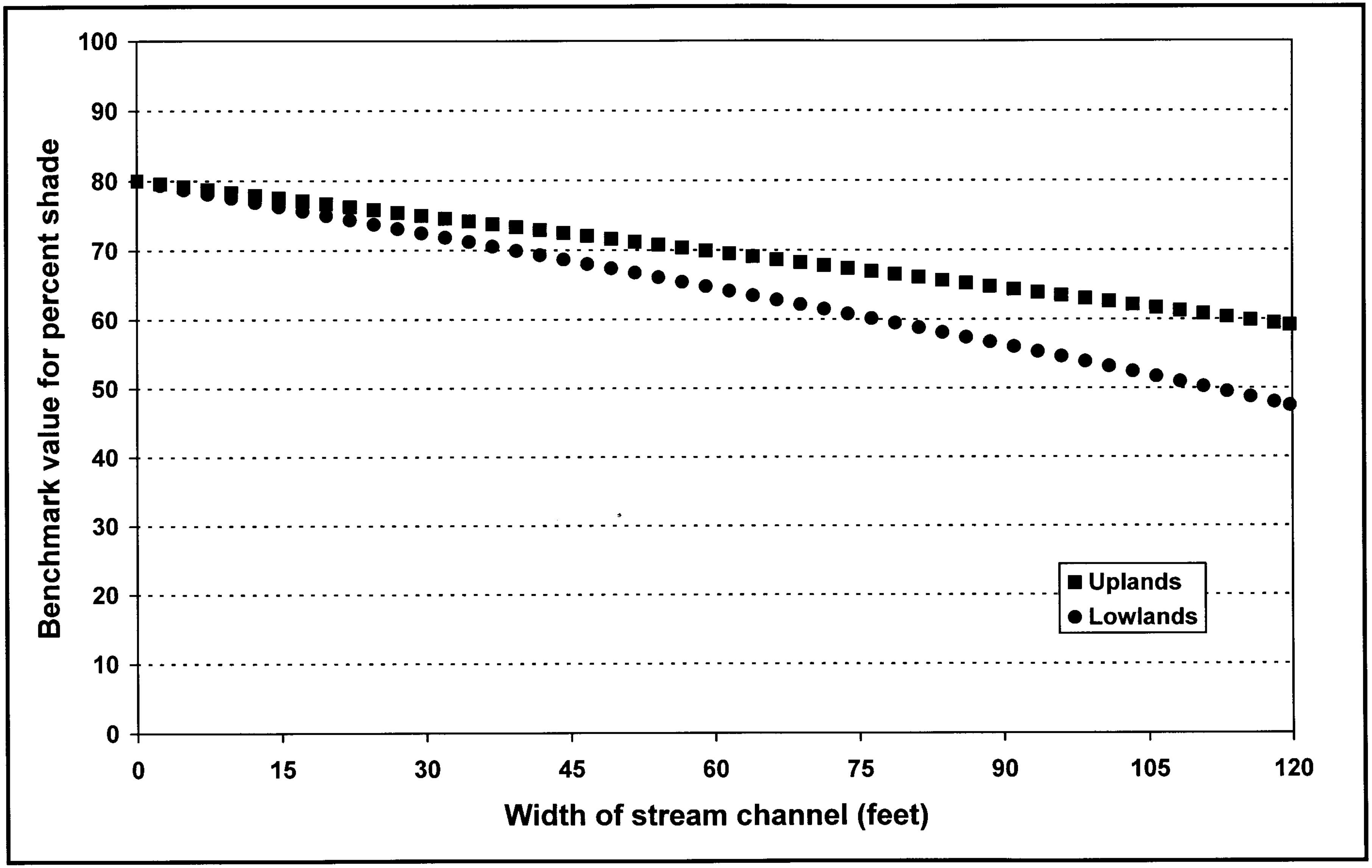


Figure 8. Benchmark values for stream shade along upland and lowland reaches in the Mohawk watershed. Values are 80% of calculated site potentials based on channel widths and tree heights of 150 ft for uplands and 100 ft for lowlands.

3.6.2. Comparisons to 1938 River Survey.

In 1938, the Bureau of Commercial Fisheries conducted a river survey that included evaluations of riverbed substrates and counts of large, deep pools along most of the mainstem Mohawk. We combined the results of recent counts of these pools made along the mainstem by us and by others, then compared them to the 1938 counts to assess changes.

3.7. UNNATURAL BARRIERS TO FISH MIGRATION

Road culverts installed improperly along streams, small dams constructed to divert or pond water, and severe streamflow depletion from water withdrawals can block fish migrations. We summarized what has or is being done to identify these problems in the watershed and progress that has been made toward fixing them.

3.8. WATER QUALITY

Continuously recorded stream temperature data and other water quality information collected within the Mohawk watershed were acquired from ODEQ, Weyerhaeuser, BLM, ODFW, the Partnership, and the McKenzie Watershed Council. Stream temperatures recorded during summer were then summarized and used to map locations that either met or did not meet the State temperature standard (peak 7-day average maximum $<64^{o}$F) established to protect the watershed's coldwater species like salmon or trout. Data on water quality parameters other than temperature were subjected to a "red flag" analysis as outlined in the Oregon Watershed Assessment Manual (OWEB 1999). Turbidity data collected by the McKenzie Watershed Council at multiple stations during two storm events in the winter of 1998-99 were also examined.

3.9. FISH

Information on fish native to the Mohawk watershed was summarized from a variety of recent and historic sources in order to build interest, provide context, and help identify potential priorities for the Partnership's program. Particular attention was paid to the life histories and habitat needs of the watershed's cutthroat trout and of the spring chinook that are becoming the focus of possible reintroduction efforts. Factors limiting these species within the Mohawk system were identified by comparing known habitat needs to existing conditions within the system.

4. RESULTS

4.1 STREAMFLOWS AND WATER USE

4.1.1. Streamflows.

Patterns of variation in streamflows, both seasonal and between years, have a profound influence on fish and other aquatic animals within a watershed. Relatively consistent, seasonal changes in flow influence the timing of important life history events (e.g., migration, reproduction) while less predictable changes associated with major floods or droughts can affect their habitats or abundance for extended periods of time.

Streamflows in the Mohawk River follow seasonal patterns typical of western Oregon. Flows are generally highest during late fall through winter, but drop to very low levels during summer, partly because the headwaters retain little to no snow beyond early spring (Figure 9). Mean river flows vary among months by a factor of 30 and annual peak and lowest flows have on occasion varied by a factor of more than 600. Peak flow during the 1996 flood (13,500 cfs) was the largest recorded at the Mohawk gage during a period of record that began in 1936. Annual 7-day low flows, which provide a reasonable approximation of those likely to constrain fish populations when habitat area is most restricted, have been between 15 and 30 cfs during most years. An instream flow of 20 cfs at the Mohawk gage was established in 1962 as the minimum needed for the maintenance of fish and wildlife resources. Annual 7-day low flows measured at the gage fell below this minimum during 20 of 51 years in which flows were measured, and have averaged 21.5 cfs.

Our regression-based trend analyses did not detect any statistically significant patterns of change in mean flows for individual months, in annual peak flows, in annual 7-day low flows, or in the timing of annual peak and low flows at the Mohawk gage, between 1936 and 1997. This does not necessarily mean that there have not been changes in flow patterns in Mohawk River

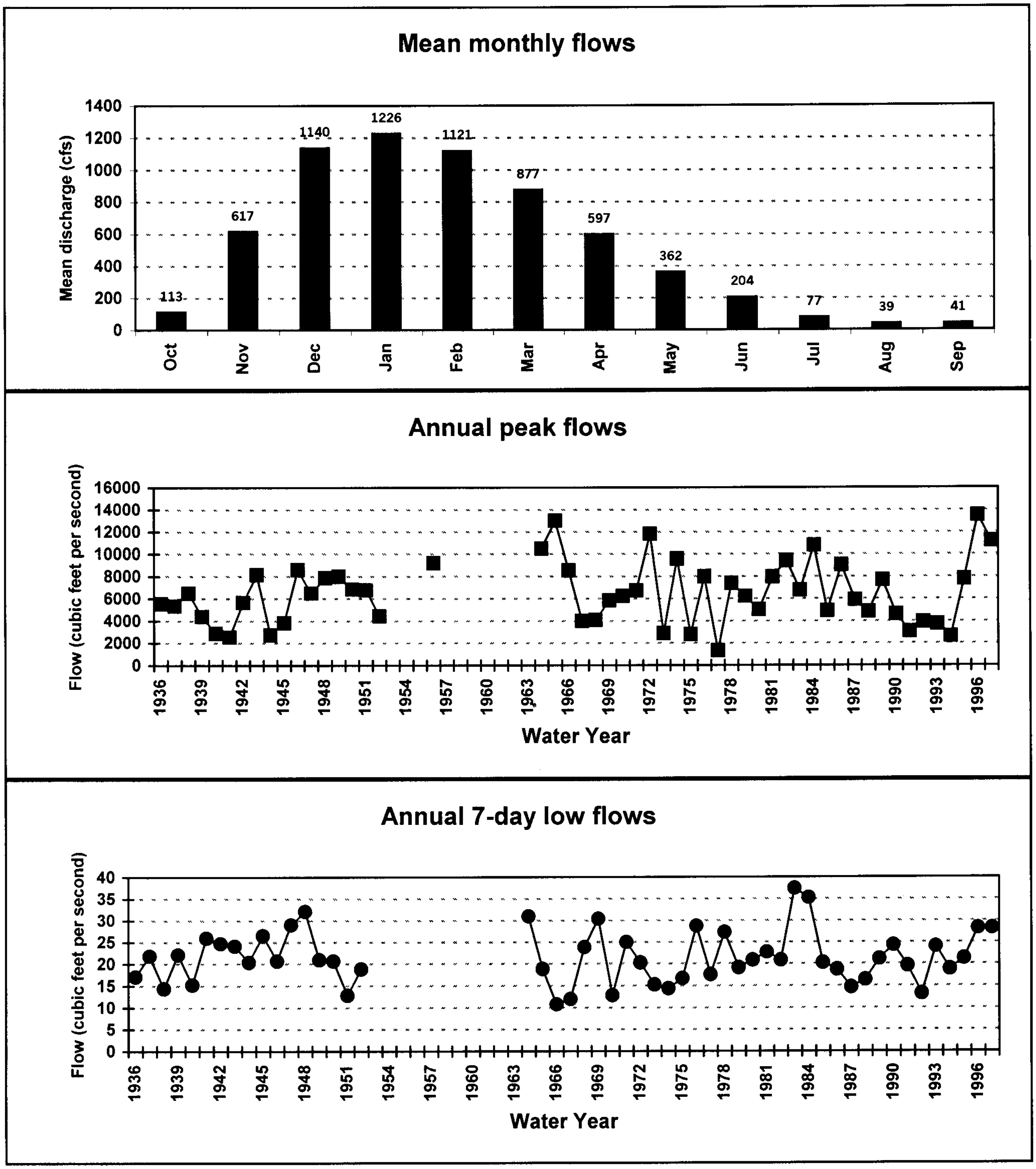


Figure 9. Mean monthly (top), annual peak (middle), and 7-day low flows (bottom) for the Mohawk River near Springfield, Oregon, USGS gage no. 14165000, water years 1936-97.

tributaries over this time period, only that if there have been such changes they were not evident in our analyses of data collected near the lower end of the entire watershed. In fact, watershed analyses by Weyerhaeuser (1994) and the BLM (1995) concluded that land management activities have had effects on peak streamflows, at least at the scale of subwatersheds and tributaries within the watershed. BLM (1995) attributes such increases to a variety of factors including roads that are hydrologically connected to streams, soil compaction, removal of riparian vegetation, losses of floodplain and wetland function due to reduced large woody debris, active channelization and channel incision (down-cutting), and forest removal in rain-on-snow zones.

4.1.2. Water Use.

Water diverted from streams during periods of low flow reduces available aquatic habitat and can increase stream temperatures. Such influences can be of particular significance in low elevation watersheds like the Mohawk, where base flows are naturally low and each increment of diverted water adds to the risk that habitat downstream will not meet the needs of native salmonids or other sensitive aquatic species.

A total of 163 surface water rights were valid in the Mohawk watershed during late 1999 and they had the potential to allow diversions totaling 57.4 cfs (OWRD 1999). This volume of rights substantially exceeds the average 7-day low flow for the Mohawk River gage near Springfield (21.5 cfs) and the instream flow identified as the minimum necessary for supporting fish and wildlife (20 cfs). Water rights in the watershed have increased by a factor of 10 over the last several decades, from 5.4 cfs in 1966 (Hutchinson et al. 1966), but it is not clear what proportion of these rights are being exercised, if actual water use has increased at this rate, or if all of the many rural-residential diversions within the watershed are linked to valid rights. There has been no clear trend of decreasing low flows at the Mohawk gage that would suggest flows in the lowest portions of the river are declining, although localized declines in streamflow within some ungaged areas of the watershed have surely occurred.

The potential intensity of water use across the entire Mohawk watershed, as reflected by valid water rights, averages 0.33 cfs/mi^2. Several subwatersheds tributary to the Mohawk River have the potential for greater water diversion and use than this watershed-wide average condition (Figure 10). These subwatersheds include Cash, Upper Mill, Lower Mill, Cartwright, and Wade.

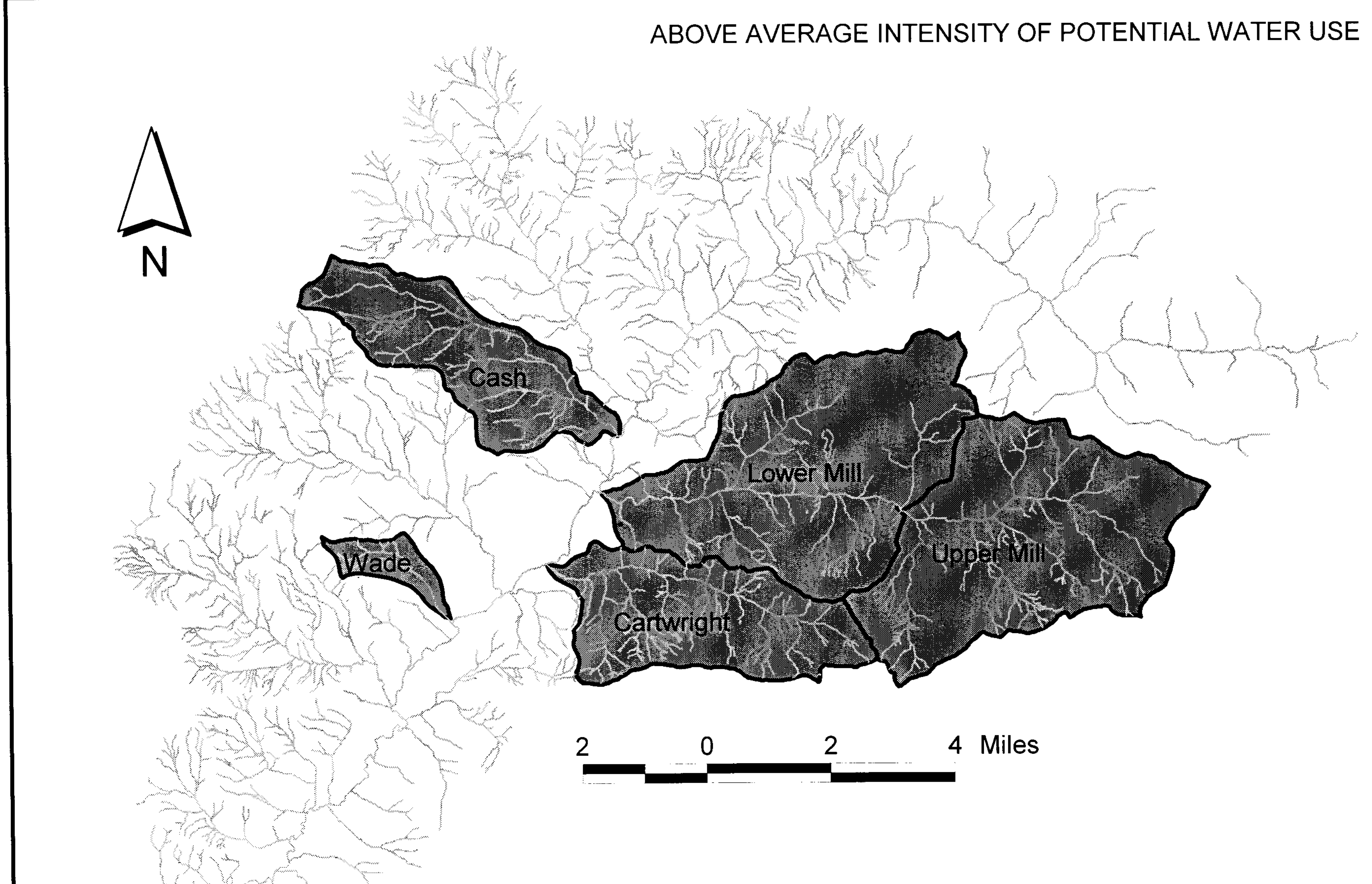


Figure 10. Subwatersheds having above average intensity of potential water use (surface water rights >0.33cfs/mi^2) in the Mohawk watershed, Oregon. Data source: OWRD (1999).

These subwatersheds, and others as well, may be good candidates for enhancing late season streamflows through improved water management or other means.

4.2. STREAM CHANNELS

4.2.1. Channel Changes.

Historic logging practices that used streams to transport logs to mills damaged many riparian areas and simplified numerous stream channels in the Mohawk watershed. Known locations of historic dams that pulsed torrents of water down stream channels for this purpose, or that stored logs that were transported in this way within the watershed, are mapped in Figure 11. What is apparent from the map is that a sizeable portion of the drainage network within the watershed was affected by these practices, particularly when one considers that the mapping is almost surely incomplete. Streams known to have been simplified by these practices, and at some locations even scoured down to bedrock, include the Mohawk River itself, Shotgun Creek, Mill Creek, Cartwright Creek, and Parsons Creek.

Although not particularly well documented, early development of lowland areas within the Mohawk Valley involved the channelization or rerouting of some streams once associated with wetland areas or extensive floodplains. These stream channels would have provided highly desirable aquatic habitats, protective (refuge) areas for native fish during floods, and a high degree of floodwater detention in their natural state. Whether the largest of these streams were modified to allow more efficient transportation of logs, to help drain areas for agricultural development, or both, may have varied with location.

Two examples of historic stream rerouting that were evident in 1936 air photos of the Mohawk Valley are shown in Figure 12. Cartwright Creek, which now follows a rather straight route as it enters the Mohawk River from the east, once followed a less direct and considerably more sinuous route to a confluence with the mainstem that was almost two-thirds of a mile farther downriver. Field reconnaissance of this area suggests that more than a mile of the kind of unconfined, low-gradient stream channel that is highly productive for a variety of aquatic species when in good condition was replaced with a much shorter, deeply incised (downcut) channel less capable of providing high-quality habitats.

A second example of historic rerouting of a lowland stream was seen in 1936 air photos of lower Wade Creek. Notes taken by General Land Office (GLO) surveyors in 1854 refer to the area

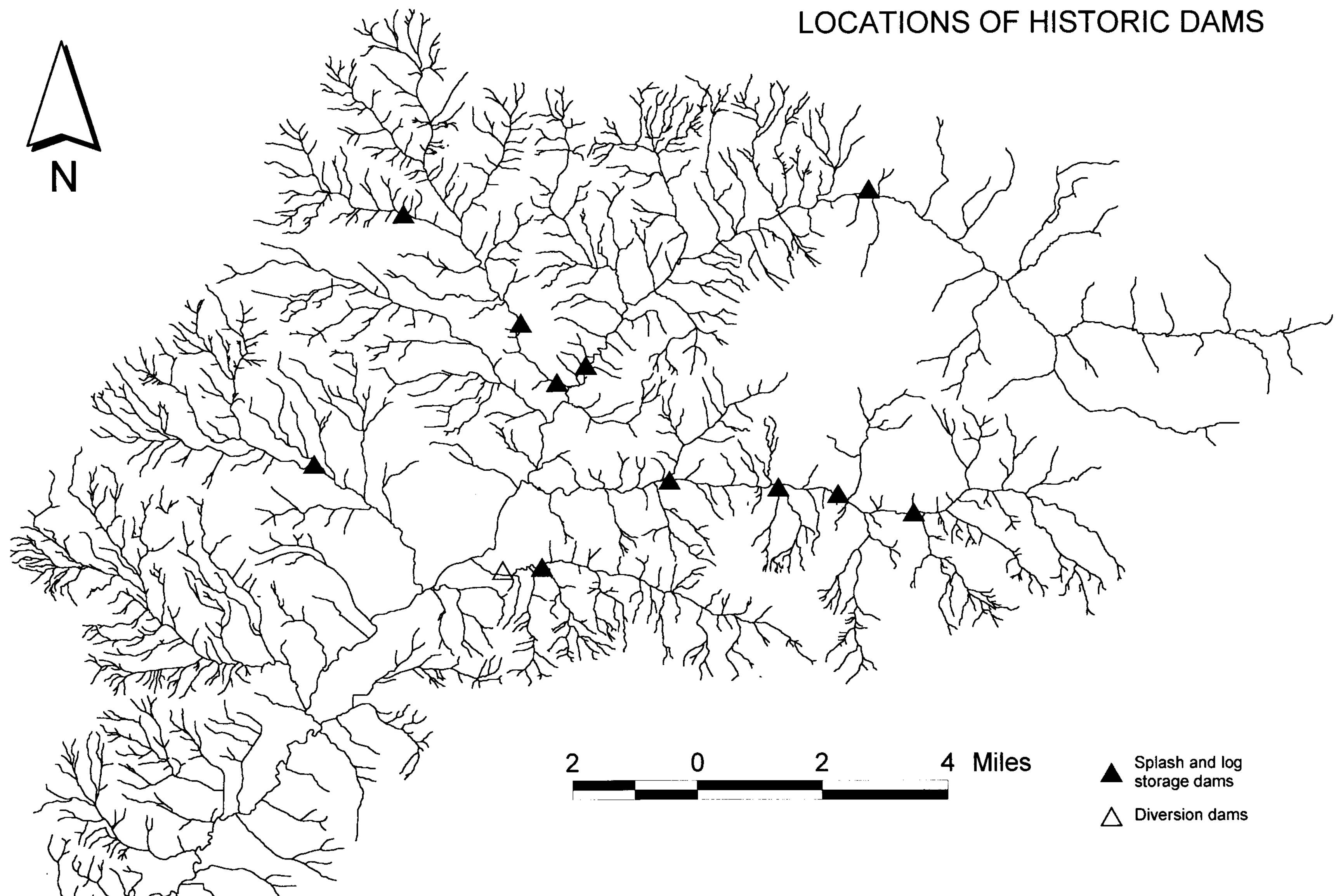


Figure 11. Locations of historic dams in the Mohawk watershed, Oregon.

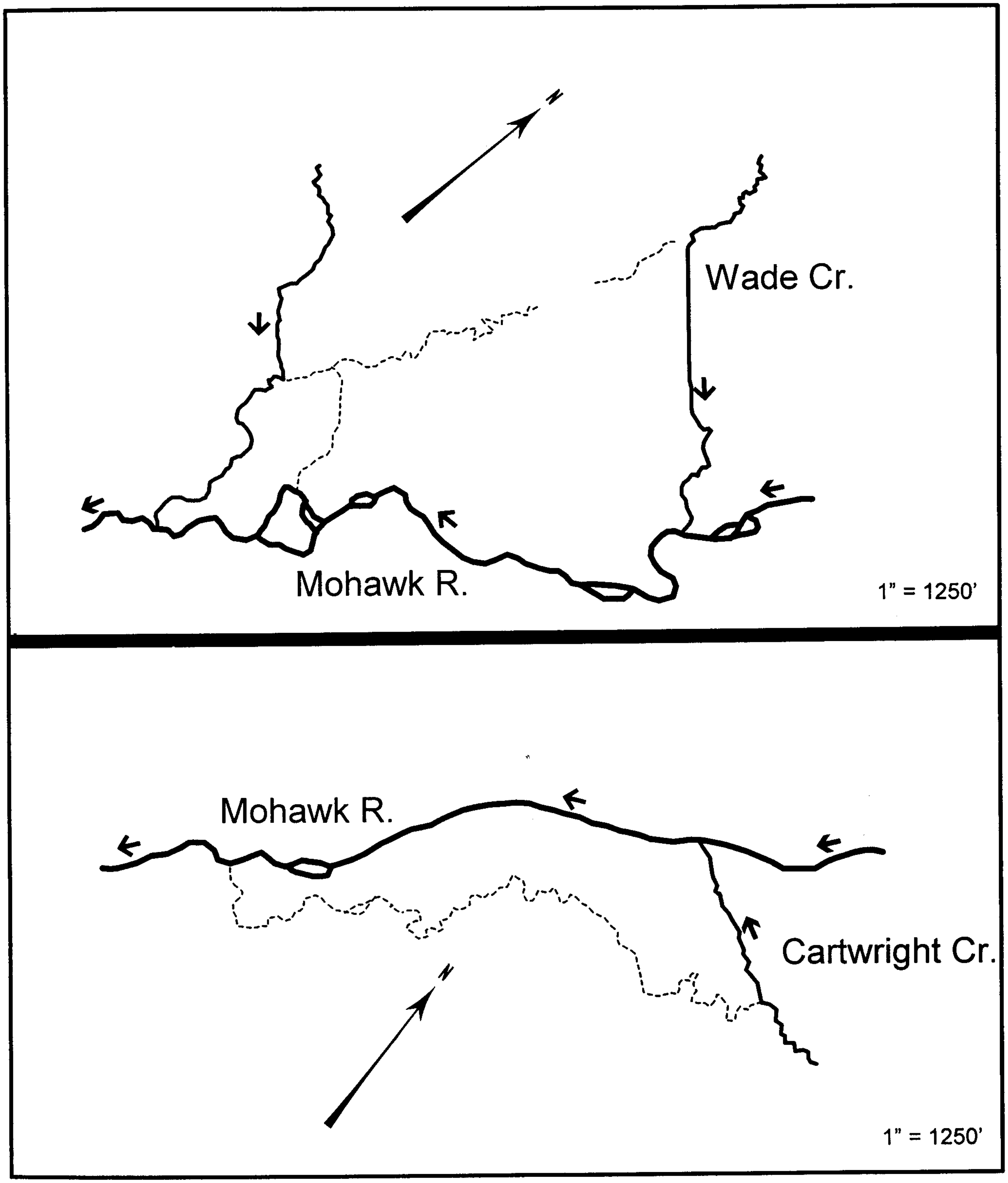


Figure 12. Historic channel changes evident in 1936 air photos of lower Cartwright (bottom) and Wade Creek (top). Primary stream channels in 1936 are shown as bold lines and those that were apparently abandoned prior to 1936 when the primary channels were straightened are marked as dashed lines.

surrounding lower Wade Creek as a “brushy swamp” and a map made of the area at that time shows Wade Creek disappearing into a wetland with no clearly defined channel to the main Mohawk. By 1936, efforts were underway to drain the area and the old air photos clearly show that Wade Creek had been channelized and disconnected from this wetland (Figure 12). Today, lower Wade Creek follows a nearly linear path to the mainstem and it appears that Oregon ash trees may have invaded portions of the old “brushy swamp”.

We did not use the air photos to make a quantitative assessment of post-1930s channel changes along the lower Mohawk River, due primarily to 10-fold differences in prevailing river flows between the 1936 photo series (75 cfs) and the 1995 photos we took to represent recent conditions (720 cfs). However, two qualitative changes were evident in the photos examined. Sidechannels and unvegetated gravel bars were clearly more numerous and extensive between Marcola and the mouth in 1936 than they were in 1995. The general impression obtained from reviewing the photos was that in the mid-1930s the lower river was more dynamic and appeared to be responding to elevated rates of sediment delivery that had declined considerably by 1995.

Three stream characteristics examined at reaches we surveyed in 1999 relate to lowland channel changes and are worthy of note. First, channel down-cutting appears to have occurred along many of the lowland reaches surveyed, although the extent may not be severe. This tends to add to bank erosion problems by containing higher flows and thus causing higher stream velocities before streams top their banks. A second type of lowland channel change identified during our surveys was artificial streambank armoring with rock rip-rap. This type of modification was rare along upland reaches (<0.5% of total bank length) but more common along some lowland reaches. Levels of artificial bank protection were low along most lowland reaches of the mainstem but averaged 2.7% of total bank length due to efforts to protect streamside property in areas of concentrated rural development. Artificial bank protection was more frequent along lowland reaches of tributaries, where it averaged 4.3% of total bank length surveyed and was most common along some sections of Parsons Creek.

The third type of lowland channel change observed during the 1999 surveys relates to channel complexity and the presence of sidechannels. Stream channels tend to be more complex and have more sidechannel area in lowland areas than in uplands due to a natural pattern of lower channel gradients and reduced confinement in the lowlands. However, the pattern we found in the Mohawk watershed was just the opposite, with sidechannels accounting for an average of

6.9% of the habitat in upland reaches, 4.4% of that in lowland reaches of tributaries, and only 1.2% of that along lowland segments of the mainstem Mohawk River. This reflects a loss of habitat complexity in lowland areas that is likely related to some channelization of tributary streams and to losses of large woody debris and/or stream downcutting in both the tributaries and mainstem.

4.2.2. Responsive Stream Reaches.

Low-gradient (<2%) channels, particularly those that are unconfined by adjacent landforms, are generally regarded as having the potential to provide the most dynamic and productive habitats for a diversity of aquatic species when in good condition. A primary reason for this is their responsiveness to inputs of wood and sediment as well as the influences of adjacent riparian vegetation. The geographic distribution of these channels within the Mohawk watershed, given in Figure 13, suggests the importance of lowland areas to aquatic conservation in the Mohawk. Low-gradient channels are concentrated in lowland areas, and very few of those that are unconfined are found outside these areas. This means that habitats upon which certain aquatic species or specific lifestages of aquatic species depend will be found almost exclusively in the lowlands. Regardless of their position in the Mohawk watershed, low-gradient channels that are unconfined, or that have become incised (downcut) but can be restored to an unconfined condition, should be given special consideration in the Partnership's program because of their inherent productivity.

4.3. RIPARIAN AREAS, WETLANDS, AND FLOOD-PRONE LANDS

4.3.1. Riparian Conditions.

Properly functioning riparian areas are essential to the development and maintenance of good aquatic habitat for valued aquatic species like salmon or trout, can provide critical terrestrial habitats or migration corridors for a variety of species of wildlife, and can provide a variety of benefits to landowners. Vegetation within these areas provides shade to help keep streams cool, can contribute large woody debris and small organic matter to streams, stabilizes streambanks, and helps control sediment, nutrient, and pollutant inputs to streams. Large woody debris entering streams from riparian areas is particularly important to the proper

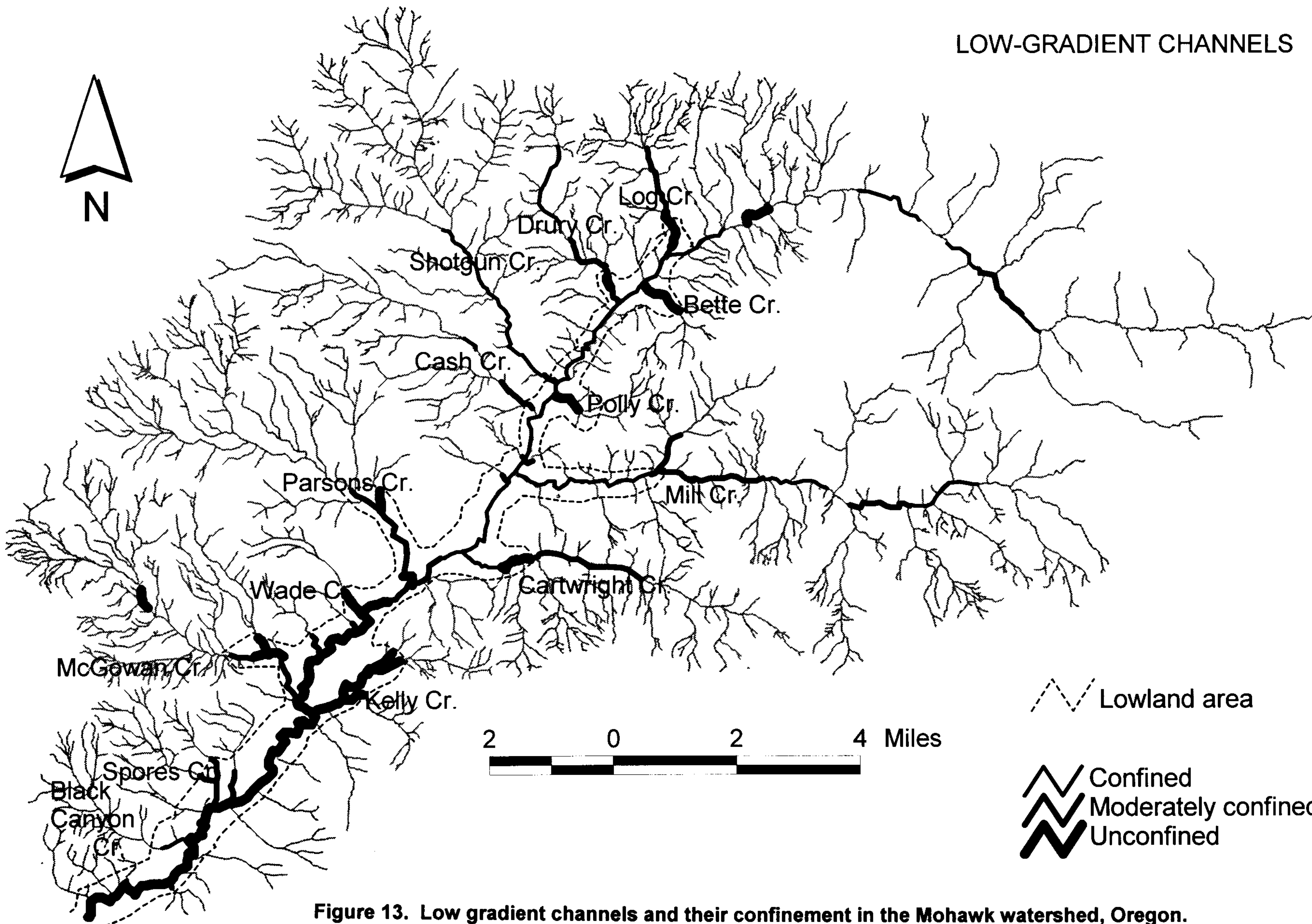


Figure 13. Low gradient channels and their confinement in the Mohawk watershed, Oregon. Sources: Weyeraeuser (1994), BLM (1995), and limited ground-truthing. Classifications of Channel confinement should be verified at the site level when designing restoration projects.

functioning of streams in watersheds like the Mohawk, and plays a central role in creating and maintaining the structurally complex habitat upon which many aquatic species depend.

As in many watersheds throughout the Northwest and elsewhere, the importance of the Mohawk's riparian areas is not always reflected by their current condition. This is partly because their role in maintaining stream health and water quality was not always understood. Many landuse activities have modified riparian areas to the point that they are no longer functioning to develop and maintain good fish or wildlife habitat, or to protect the clear, clean, and cool water associated with healthy watersheds.

The recently completed watershed analyses by Weyerhaeuser, BLM, and NRCS examined riparian conditions within nearly all areas of the Mohawk watershed using a combination of air photo interpretation and ground observance. Results of their examinations indicate that:

- Deciduous trees are more common and the mature conifers that provide the best large woody debris to streams are significantly less common in upland riparian areas than they were historically, due to past timber harvest (Weyerhaeuser 1994; BLM 1995).

- Where present, the older conifers in most upland riparian areas are usually 40-70 years old, while substantially older and larger trees were common historically (BLM 1995).

- Although past harvest practices have significantly reduced the abundance of large riparian conifers in upland areas, about 65-70% of fish-bearing streams in the uplands have moderate to high potential for some near-term recruitment of large woody debris to streams from maturing conifers (Weyerhaeuser 1994; BLM 1995).

- Well over half of the fish-bearing streams in the largely private forestlands included in the Weyerhaeuser (1994) analysis area had relatively high (70% or greater) levels of shade and shade along other fish-bearing streams in those upland areas is improving over time. Lacking better data, it seems reasonable to believe that stream shading is relatively similar along fish-bearing streams in most other upland portions of the Mohawk watershed.

- Streamside vegetation in the Mohawk lowlands is naturally more varied than that in the uplands, is rarely dominated by conifers, and is now frequently affected by agricultural practices (including livestock grazing), rural development, and invasions by non-native species like blackberry (NRCS 1999).

- In their current condition, a high percentage of lowland riparian areas appear to lack the width or vegetation necessary to provide adequate levels of streambank protection, to filter sediment or nutrients to maintain acceptable water quality, to shade streams, or to provide large woody debris for improved aquatic habitat (NRCS 1999).

4.3.1.a. <u>Changes in the spatial extent of bottomland forest</u>. The distribution of bottomland forest along the lower Mohawk River between the mouth and McGowan Creek was mapped using 1936 and 1995 air photos. This was done to identify patterns of change and because this forest provides conservation opportunities along a reach of the mainstem designated as critical habitat for spring chinook listed under the Endangered Species Act. Our interpretations and the digital mapping that resulted from this exercise, a portion of which is given in Figure 14, showed at least six patterns of interest::

- By 1936, the extensive bottomland forests along the lower Mohawk River that were documented in the 1850s by surveyors from the General Land Office (refer to Figure 3) had been substantially reduced by varied landuse practices. Removal of this forest likely reflected a considerable effort by early settlers and those who followed, because the forest is thought to have once extended laterally as much as a third of a mile across the lower valley floor in some areas.

- Isolated patches of bottomland forest still present in 1936 at dispersed locations on the lower Mohawk River floodplain often had the appearance of being associated with old oxbows or other features of abandoned channels, indicating that the river channel had changed course on multiple occasions.

- The majority of the isolated floodplain patches of bottomland forest (i.e., those not adjacent to the river) evident in the 1936 photos had been cleared by 1995.

- There was a general reduction in the overall extent and size of patches of bottomland forest along the lower Mohawk between 1936 and 1995, although the reduction appears to have

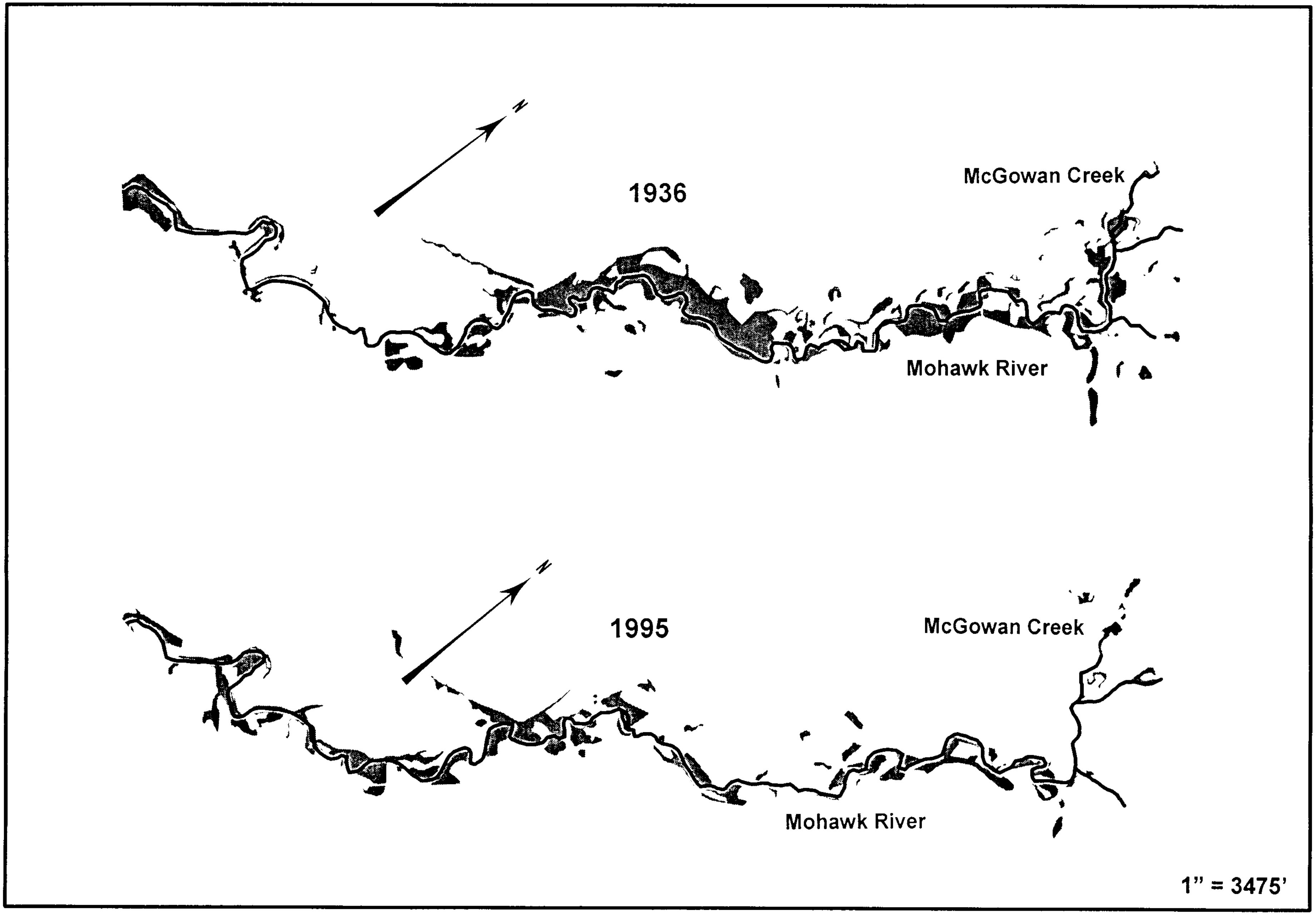


Figure 14. Distribution of bottomland forest patches of variable tree age and density along the Mohawk River below McGowan Creek, 1936 and 1995. Forest patches are shown in gray.

been small relative to the amount of forest removal that occurred between 1850 and the mid-1930s.

- Bottomland forest disappeared from multiple streamside areas but reappeared in others between 1936 and 1995, suggesting that although there was active forest removal the potential for regeneration remained good in at least some areas.

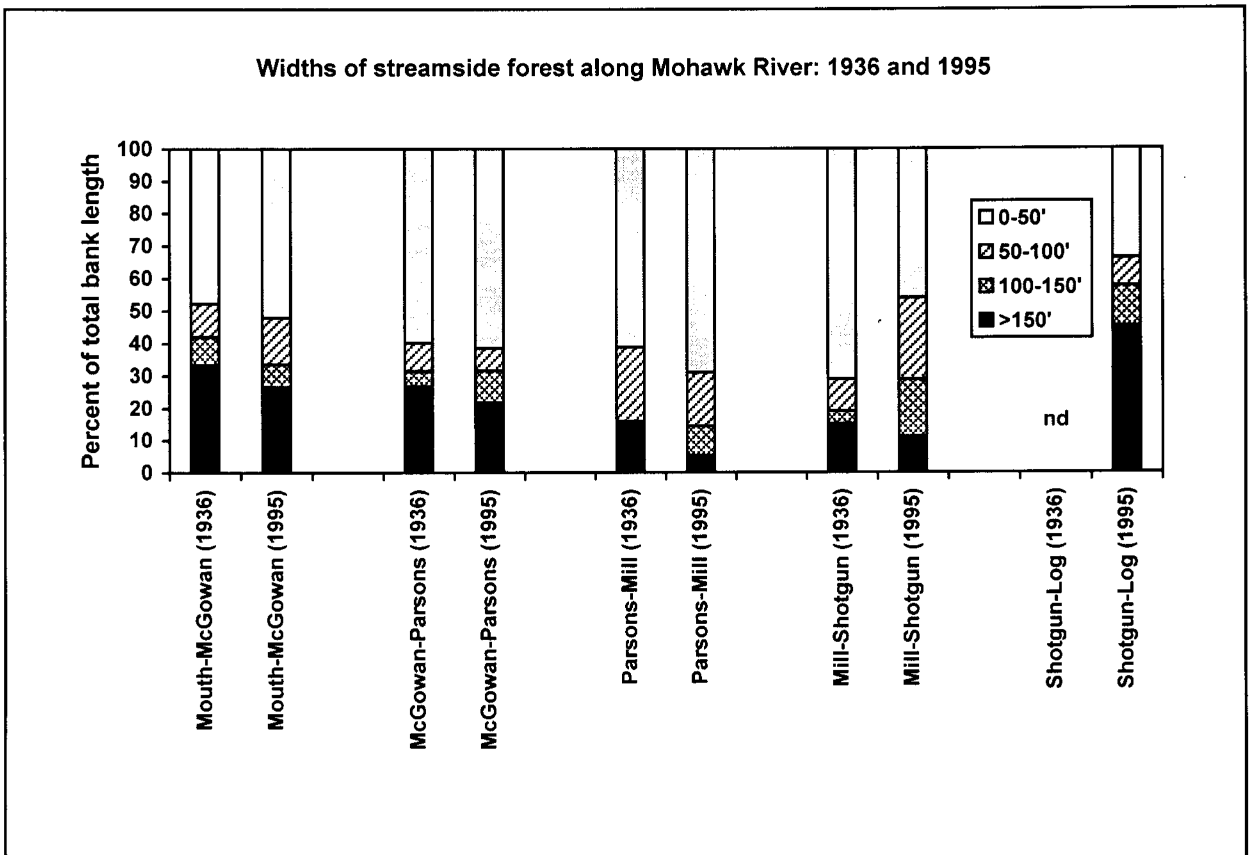
- Openings or areas of sparse tree canopy were present in areas of bottomland forest in both 1936 and 1995, with some of those present in 1936 suggesting active forest removal.

4.3.1.b. Fragments of bottomland forest that could be high priorities for protection.
We were able to identify 27 significant patches of mature, relatively dense bottomland forest along the Mohawk River between Log Creek and the mouth (Table 4). ***These patches have been delineated on air photos on file with the Partnership and should be considered as potential high-priority sites for protection against removal because they may provide important habitats for native species and represent starting points for restoring the river's bottomland forest in nearby areas.*** Patches within the Lower Mohawk subwatershed should be given particular attention, because bottomland forest there (1) has already been identified by the Oregon Biodiversity Project (1998) as an important conservation opportunity and (2) borders river areas believed to be used as wintering habitat by juvenile McKenzie River spring chinook (see section 4.9.3.b). The identified forest patches along the Mohawk vary in size from 1.6 to 24.9 acres and total 152.1 acres. They are most numerous and cover the greatest area between the mouth and McGowan Creek, with a large concentration of patches near the mouth of Black Canyon Creek.

4.3.1.c. Assessment of lowland riparian forest widths and streamside conditions.
Examination of the widths of streamside forest along the banks of the mainstem Mohawk, and changes in these widths over the last half-century, suggests that riparian conditions are not moving in the same direction along all lowland sections of the river. On balance, streamside forest appears to have exhibited a general decline in width along the mainstem between the mouth and Mill Creek between 1936 and 1995, but widened between Mill and Shotgun creeks during this period (Figure 15). Contributors to forest narrowing between the mouth and Mill Creek included agricultural encroachment and rural-residential development. The forest expansion observed between Mill and Shotgun Creek appeared to reflect recovery from old

Table 4. Number and size of dense patches of bottomland forest at least one acre in size along sections of the lower and middle Mohawk River. Information interpreted from 1995 color 1:12,000-scale air photos with limited ground-truthing in 1999.

Subwatershed	Lower Mohawk		Lower Middle Mohawk		Upper Middle Mohawk
River Section	Mouth-McGowan Cr.	McGowan-Parsons Cr.	Parsons-Mill Cr.	Mill-Shotgun Cr.	Shotgun-Log Cr.
Number of patches	19	1	3	2	2
Average size (acres)	3.9	2.2	3.0	9.2	23.9
Size range (acres)	1.6-10.3	---	2.4-3.6	4.1-14.2	22.8-24.9
total acreage	74.7	2.2	9.1	18.4	47.7



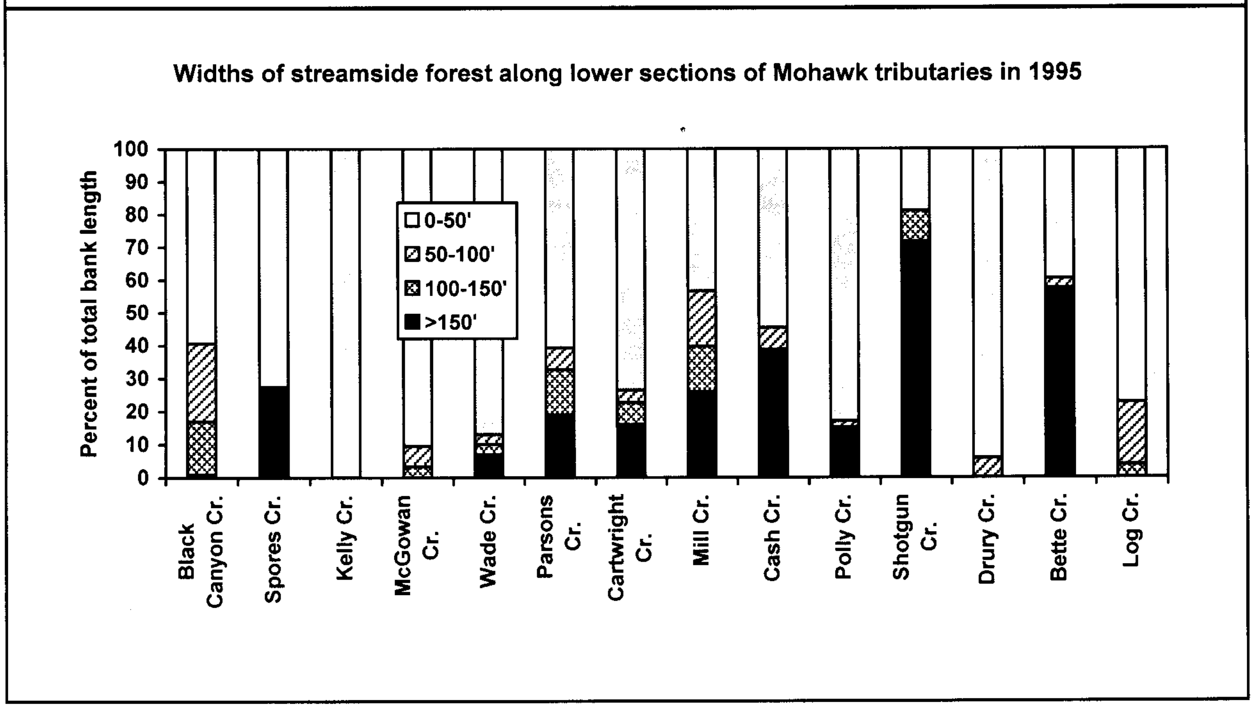


Figure 15. Widths of streamside forest along sections of the mainstem Mohawk River below Log Creek (top) and along lower sections of tributary streams (bottom). Widths are given for both 1936 and 1995 where historic air photos existed for mainstem sections. Widths given for the lower sections of tributary streams are all for 1995 and account for the lower mile of each stream except that they account for the lower two miles of Parsons and Mill creeks. All information was interpreted from 1:12,000 - 1:15,000 air photos.

logging practices. We would have liked to assess possible changes since the mid-1930s in the widths of streamside forest farther up the mainstem, but could not do so because of a lack of air photo coverage.

Although not assessed quantitatively, the air photos show that areas of streamside forest in less than mature or vigorous condition, or with sparse tree density, were significant in the Lower Mohawk subwatershed in both 1939 and 1995. This was noted earlier (see section 4.3.1.a) for the mainstem below McGowan Creek, but also applied to the McGowan to Parsons Creek section.

Our interpretations of 1995 air photos indicate riparian forest greater than 150 ft wide bordered 24% of the banks of the Mohawk River between the mouth and Log Creek, forest 100-150 ft wide bordered 10%, forest 50-100 ft wide bordered 13%, and forest less than 50 ft wide bordered 53%. This result is consistent with NRCS (1999) observations that a high percentage of riparian areas in the Mohawk lowlands are not supporting their full array of beneficial functions. Sections of the mainstem between the mouth and McGowan Creek and between Shotgun and Log creeks are not without riparian problem areas, but have higher percentages of locations with wide riparian forest than the sections of the mainstem between McGowan and Shotgun creeks. This appears to be related primarily to landuse patterns in or adjacent to the river corridor.

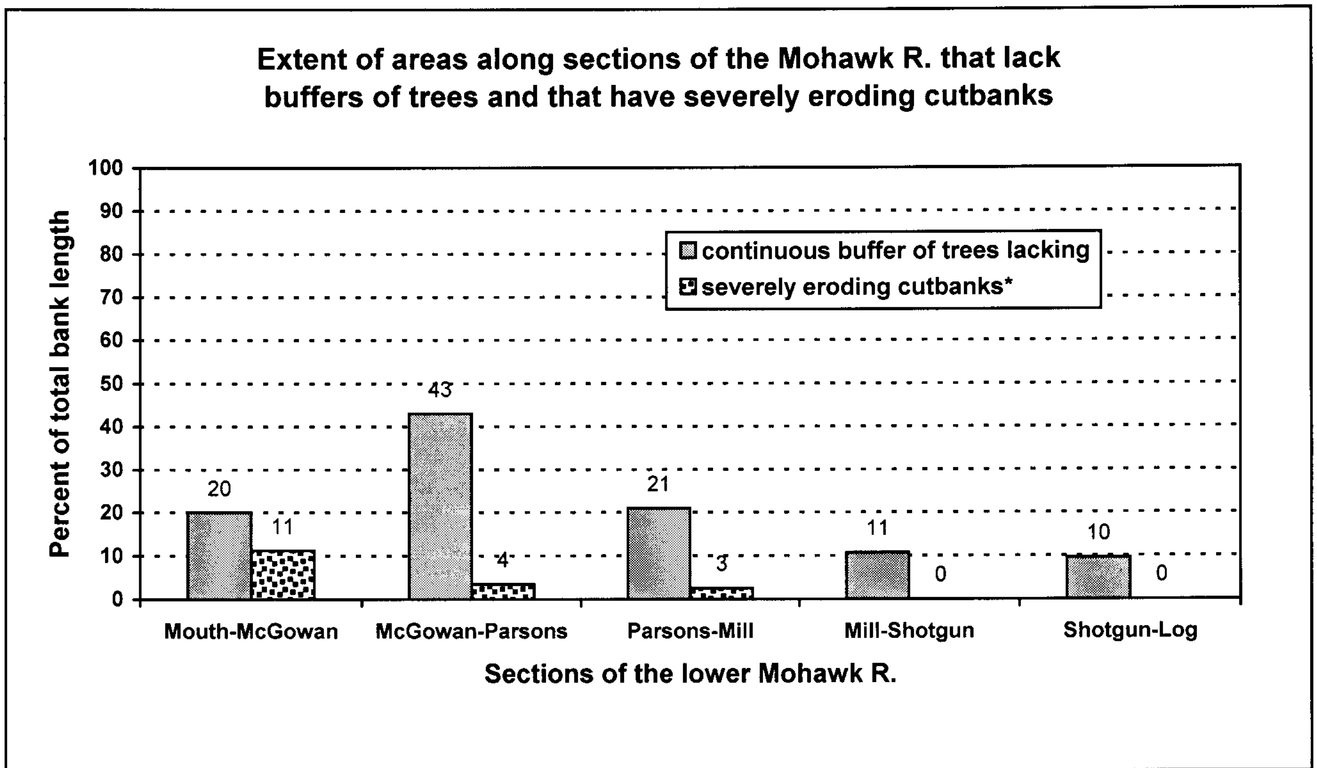
Riparian forests along the lower sections of tributaries to the lower Mohawk were quite variable but tended to be narrower in 1995 than those along the mainstem, reflecting encroachment by agriculture or residential development in some areas and variation in the potential for tree growth in others (Figure 15). We estimate that collectively, 23% of the streambanks along these sections had adjacent forest >150 ft wide, 6% were bordered by forest 100-150 ft wide, 7% were bordered by forest 50-100 ft wide, and 64 % were bordered by forest less than 50 ft wide. Tributaries to the lower Mohawk that appear to have relatively wider riparian areas along their lower sections are all upriver from Marcola and include Mill, Cash, Shotgun, and Bette creeks.

Many riparian areas along the Mohawk River are clearly good candidates for restoration work. These include segments of river that lack continuous buffers of trees, quite a few of which have severely eroding cutbanks that are likely delivering significant quantities of fine sediment to the river during high flows. Our interpretations of 1995 air photos, which do not account for possible effects of the 1996 flood, suggest that 7.9 miles (21.4%) of the riverbanks between the mouth and Log Creek lack a continuous buffer of trees and that 2.0 miles (5.5%) of the banks have severe erosion problems (Figure 16). Mainstem areas lacking a continuous buffer of streamside trees are most prevalent in the section between McGowan and Parsons creeks, while the most severely eroding and extensive cutbanks are between McGowan Creek and the mouth. The severe cutbanks are clearly related to a lack of streamside vegetation, but may also reflect past channel downcutting or other cumulative changes to the river that are operating at spatial scales larger than individual sites.

There are also abundant opportunities for riparian improvements along the lower sections of the Mohawk's lowland tributaries. In fact, 30% of the streambanks along the lower sections of all the tributaries examined lacked continuous buffers of trees, with Kelly, Polly and Drury creeks each lacking such buffers along more than half of their lower sections (Figure 16). Along these three lowland tributaries and several others, areas that lack trees may reflect natural vegetative patterns. However, our field observations suggest that segments of lowland tributaries that lack buffers of trees frequently have some of the poorest riparian conditions in the watershed and would benefit from restoration efforts that encouraged the growth of whatever native woody or other vegetation is adapted to growing along them.

4.3.1.d. <u>Landuse patterns near streams</u>. Landuses adjacent to the lower Mohawk and lower sections of its tributaries were frequently different than suggested by zoning data acquired from Lane County, and varied among sections of river and among the lower sections of tributaries. Variable patterns of landuse in these areas will be of importance to the Partnership's program because types of conservation measures and scopes for improvement will often vary with landuse type. In general, the scope of conservation opportunities is likely to be most constrained in areas where rural development occurs in close proximity to streams because its effects on natural systems tend to be permanent. Such areas tend to be most prevalent along the lower sections of Black Canyon, McGowan, Parsons, and Log creeks (Figure 17).

Landuse patterns along the lower Mohawk and the lower sections of its tributaries have changed over the last half-century, but in most cases these changes have reflected differences in cropping patterns or similarly reversible shifts in the activities of landowners. One change evident in the photos that would be difficult to reverse has been an increase in the frequency of rural residences constructed within or in close proximity to the riparian corridors along streams.



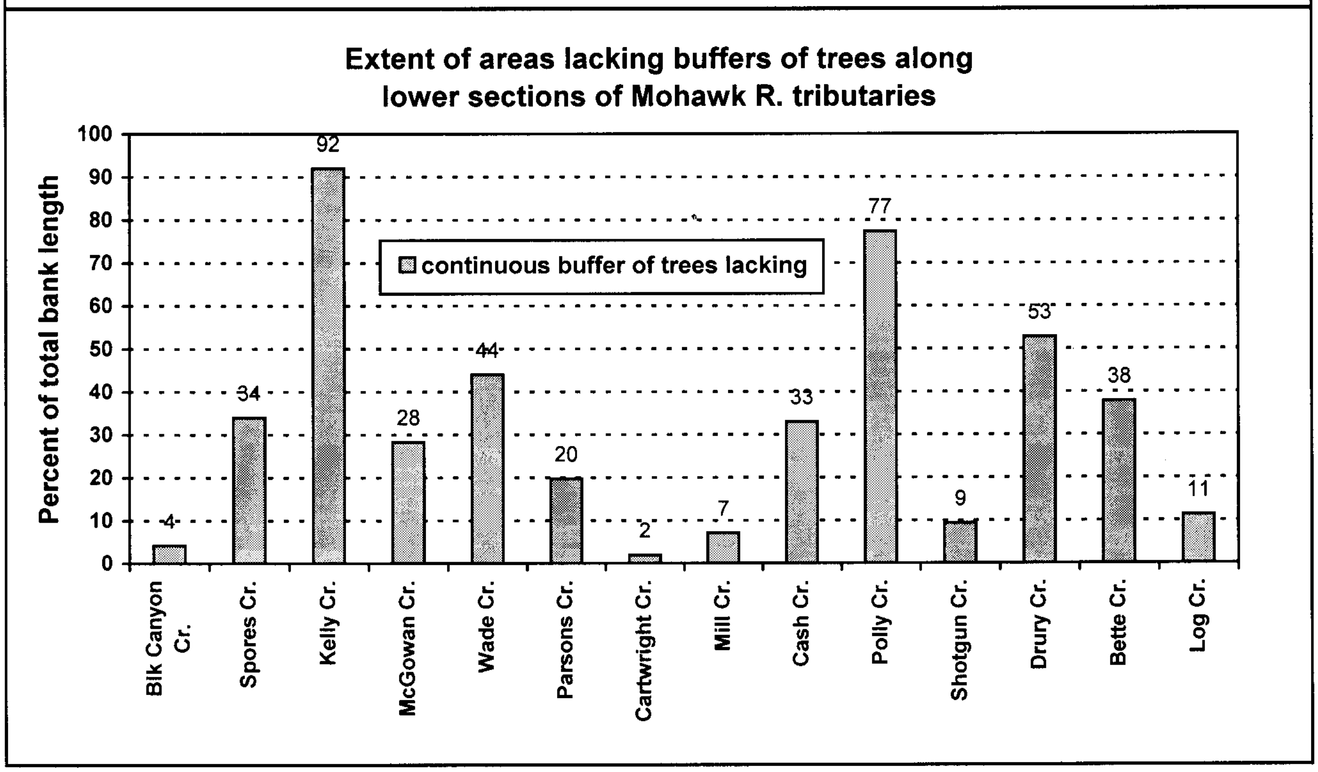
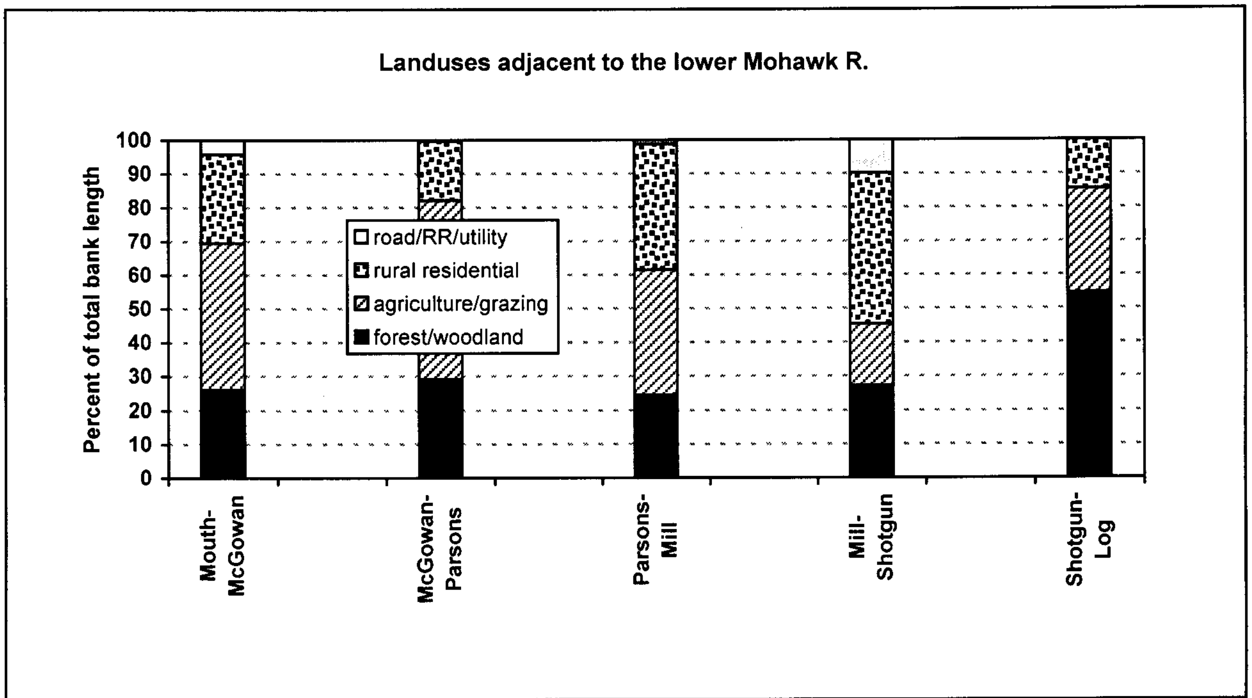


Figure 16. Extent of areas lacking buffers of riparian trees or having severely eroding cutbanks along the lower Mohawk River, and of areas lacking buffers of trees along lower sections of Mohawk R. tributaries, 1995. All information was interpreted from color 1:12,000-scale air photos. "Severely eroding cutbanks" were defined as those discernable in the photos.



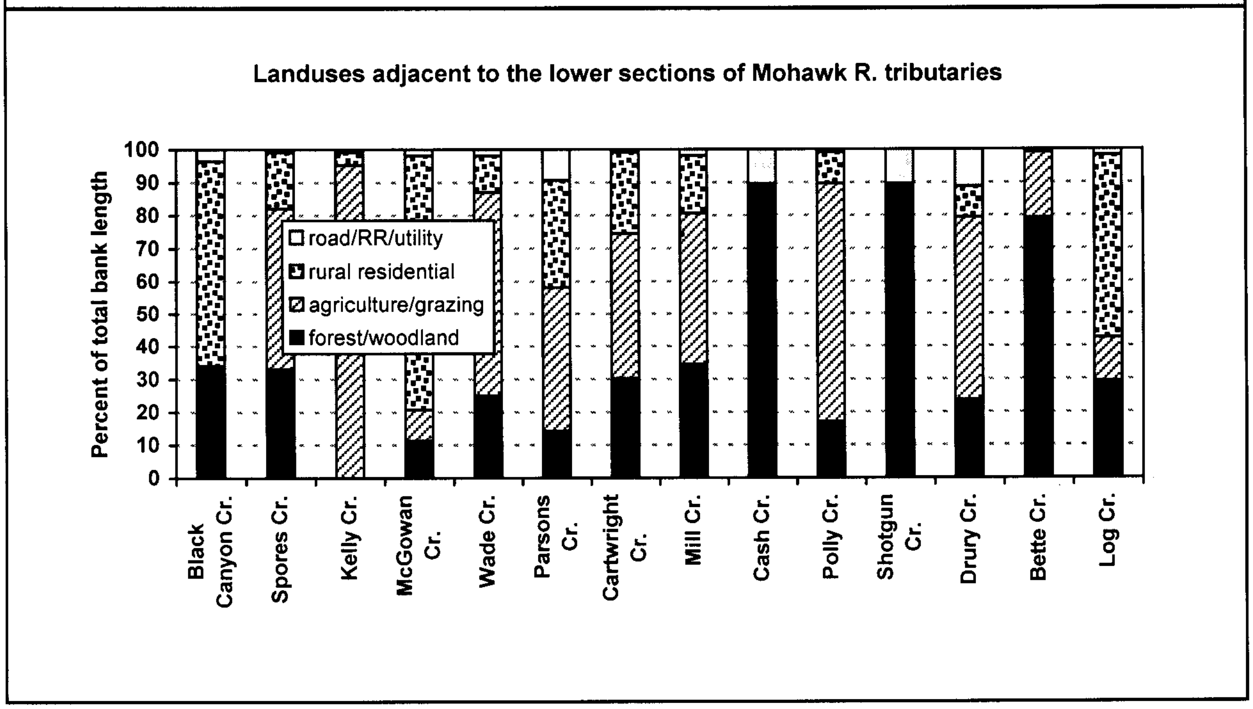


Figure 17. Percent (by length) of the lower sections of Mohawk River and its tributaries that had adjacent landuse dominated by forest/woodland, agriculture/grazing, rural residential, or road/railroad/utility, in 1995. The evaluated section of each tributary was one mile long except that two miles were considered along lower Parsons and Mill creeks. All information was interpreted from color 1:12,000-scale air photos.

This type of development appears to have been the largest cause of post-1936 declines in riparian condition along several lowland tributaries, including McGowan Creek.

4.3.2. Riparian Protection Rules.

Riparian buffers of native vegetation are a central and widely accepted component of ongoing efforts to maintain and restore aquatic habitat and water quality, although appropriate buffer widths and the level of vegetative removal or other modifications allowed within buffers continue to be subjects of considerable debate. Much of this debate relates to tradeoffs between ecological processes and functions within streamside areas, scientific uncertainty regarding exactly how much these processes can be impaired without appreciably damaging streams, and the economic value of resources that can be exploited within the buffers.

Buffer requirements in the Mohawk watershed currently provide varying levels of protection to native riparian vegetation, aquatic habitat, and water quality, with the widest buffers being on federal (BLM) forests where aquatic conservation is a primary management objective (Figure 18). Narrower buffers, with greater levels of modifying activities allowed within them, are allowed on the watershed's private forestlands and areas of rural development. Riparian areas on agricultural lands within the watershed (and elsewhere in Oregon) are at present unprotected by clear regulatory mechanisms, although significant but at times patchy native vegetation is found in many of these areas. With the exception of the buffers (riparian reserves) on federal forestlands, we are unaware of any independent scientific assessment that has suggested that the types of riparian buffers currently required in the Mohawk watershed are likely to support the levels of aquatic habitat restoration and water quality protection envisioned in the Oregon Plan for Salmon and Watersheds.

Field observations we made during multiple tours of lowland portions of the watershed suggest to us that knowledge and enforcement of existing riparian rules for rural residential areas is inadequate to ensure that existing rules are followed. We found several locations where it appeared that Lane County's riparian ordinance had been violated by the removal of substantial quantities of native shrubs or other vegetation from areas close to fish-bearing streams.

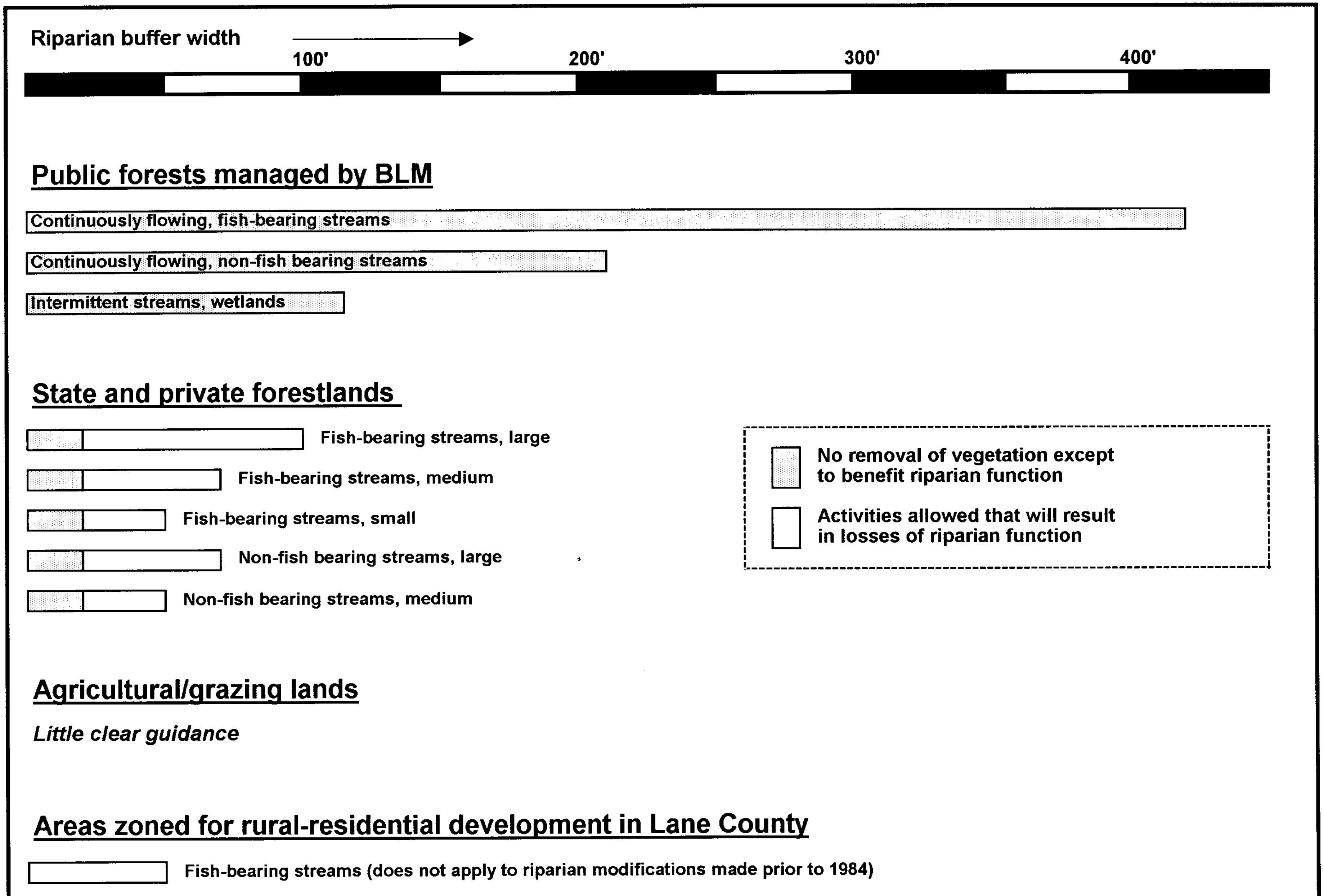


Figure 18. Relative riparian buffer widths required for differing land ownerships and uses within the Mohawk watershed, Oregon, 1999. Sources: BLM (1995), Spence et al. (1996), ODF (1998), and Lane County (1999).

4.3.3. Wetlands and Flood-Prone Areas.

Wetlands mapped by the US Fish and Wildlife Service (NWI wetlands), and hydric soils and flood-prone areas mapped by Patching (1987) combine to account for more than 3% of the watershed, including sizeable areas of the Lower Mohawk subwatershed, particularly the Mohawk Valley floor and associated valley footslopes (Figure 19). In combination, these areas approximate the potentially flooded portion of the watershed's land surface and places where further land development would have a high potential for conflicting with the Partnership's goals for maintaining or restoring water quality and habitat for native species.

The combination of mapped NWI wetlands and hydric soils shown in Figure 19 as "natural and modified wetlands" represents a best-estimate of historic wetlands within the watershed, and amounts to 1958 acres. NRCS (1999) reports that less than 200 of these acres remain as healthy, functional wetlands. This means that about 90% or more of the watershed's historic wetlands have been converted to agriculture, pastures, or other uses. The majority of wetlands remaining in the watershed are seasonally or intermittently flooded sites with emergent, forested, or scrub-shrub vegetation. Some functional wetlands remaining in the watershed are associated with beaver ponds on stream channels, although these types of areas are typically less than one acre in size and generally not shown in Figure 19.

After examining recent air photos and making direct observations within the watershed, it is our conclusion that available NWI maps of wetlands in the Mohawk Valley are deficient in identifying potentially wet areas. The map in Figure 19 should help the Partnership better identify potential wetlands and restoration sites. Several areas of modified wetlands that might be restorable are associated with lower Cartwright, Wade, Kelly, and Spores creeks, as well as several unnamed tributaries that cross the valley floor within the Lower Mohawk subwatershed. Recent changes in drainage patterns beneath an old railroad grade have created a new pond and wetland area on the western edge of the valley a short distance upriver from Black Canyon Creek. This pond and associated wetlands might provide a valuable conservation opportunity and are geographically close to several of the river's larger patches of bottomland forest.

Results of our GIS-based analysis of wet areas and land use zoning in the Mohawk watershed indicate that areas zoned for agricultural use and those zoned for rural development both overlap considerably with the potentially flooded landscape. Approximately 45% of the land

WETLANDS AND AREAS SUBJECT TO FLOODING

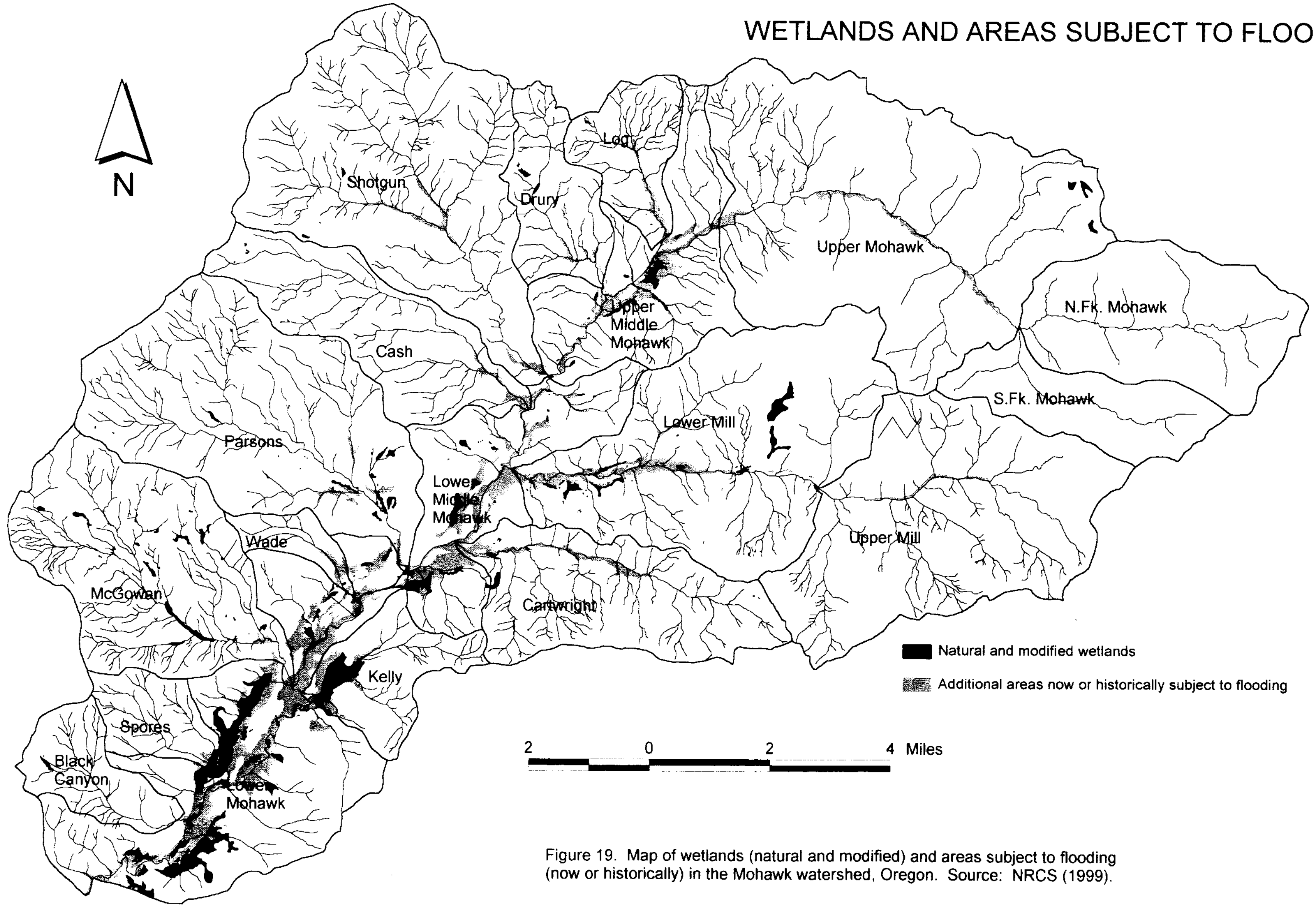


Figure 19. Map of wetlands (natural and modified) and areas subject to flooding (now or historically) in the Mohawk watershed, Oregon. Source: NRCS (1999).

zoned for agriculture is within historically flood-prone areas and more than 15% of it consists of existing or historic wetland areas. Given the potential for continued improvements in agricultural practices, this land will represent an important opportunity for maintaining or restoring aquatic conditions within the watershed unless it is converted to residential development. Land within the watershed that has already been zoned for development is more than 29% current or historic flood-prone areas, and about 7% existing or former wetland. These sizeable areas of overlap make clear that cautious development of this land will be necessary to avoid future flood damage to property, to maintain options for restoring floodplains or wetlands, and to assure that water quality is not further impaired during periods of flooding.

Several additional patterns became apparent to us as we reviewed air photos and examined flood-prone and potential wet areas on the ground within the Mohawk watershed. These included:

- Ditches or other drainage improvements have been constructed in multiple lowland wet areas since the mid-1930s, although much alteration of these areas had occurred prior to that time.

- Within the last few decades there has been a noticeable amount of rural development in areas prone to flooding, and in the vicinity of former wetland areas, particularly in the Lower Mohawk and Kelly subwatersheds.

- New rural development on the Mohawk River floodplain is at risk of property damage during floods, but also threatens other property by modifying the way floodwaters are routed across the Mohawk Valley floor. As one example, we saw where recent floodplain construction on one side of the Mohawk had apparently triggered accelerated bank erosion along agricultural land on the other side of the river when flood flows were re-routed during the 1996 flood.

- Large woody debris is very sparse or (more commonly) completely absent from most seasonally wet areas in the lowlands, possibly creating habitat problems for turtles or other semi-aquatic species that use rotting logs as winter habitat.

4.4. SUBWATERSHED SENSITIVITY AND FOREST STANDS

4.4.1. Steep Slopes and Ancient, Deep-Seated Landslides

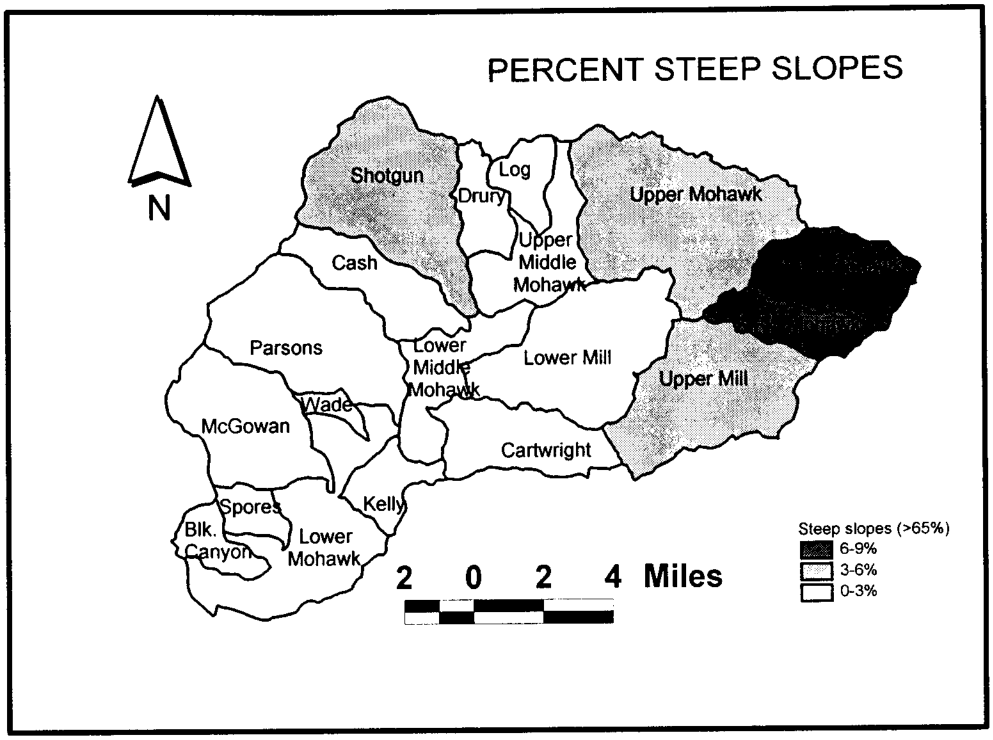
The presence of steep slopes and ancient, deep-seated landslides are two indicators of the potential of an area to exhibit increased mass wasting in response to forestry activities. Watershed analyses by Weyerhaeuser (1994) and BLM (1995) used these and other indicators to classify the mass wasting potential of differing portions of the Mohawk watershed. Combined, those two analyses classified about 80% of the watershed as having low potential, approximately 20% with moderate potential, and less than 1% as having high potential for mass erosion.

Our GIS-based analysis and mapping suggests that approximately 3% of the Mohawk watershed has slopes steeper than 65% and that old, deep-seated landslides cover about 10% of the watershed. These indicators of mass wasting potential are unevenly distributed across the watershed, and suggest that the subwatersheds with relatively higher potential for mass erosion include the North and South Forks of the Mohawk, Upper Mohawk, Upper Mill Creek, Parsons Creek, Shotgun Creek, and McGowan Creek (Figure 20).

4.4.2. Rain-on-Snow Zones

Rain-on-snow events are responsible for many of the floods in the Mohawk system. They occur when rain falls on and melts snow that has accumulated during earlier and colder storms, with the degree to which snowmelt adds to runoff influenced by a number of factors including forest conditions. In general, runoff during these events can be increased when there is a high proportion of recently harvested or hydrologically immature forest at elevations where rain is falling on snow within a watershed. On a percentage basis, such peak flow increases tend to be greater for small than for large floods, and for small tributary streams than for rivers with large drainage areas.

Our GIS analysis shows that 44% of the Mohawk watershed lies within a 1500-3500 foot potential rain-on-snow zone identified by the BLM (1995). Subwatersheds with the greatest proportions of land area within this zone include N.Fk. Mohawk, S.Fk. Mohawk, and Upper Mill



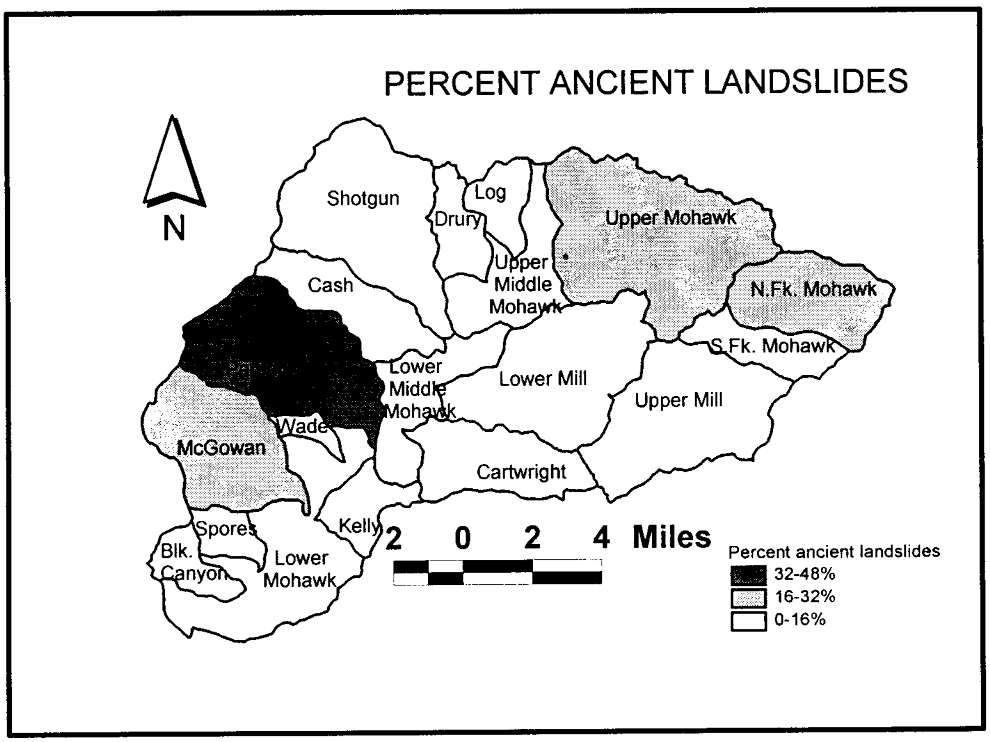


Figure 20. Percentages of subwatershed areas in steep slopes (>65%; top) and in ancient, deep-seated landslides (bottom), Mohawk watershed, Oregon. All subwatersheds in the 0-16% class for "percent ancient landslides" had these features account for less than one percent of their total area except for Log Creek (Log), where they accounted for 5% of total area. Source: GIS analysis of elevation data from a 30-meter digital elevation model (steep slopes) and of landslide mapping by Weyerhaeuser (1994) and BLM (1995).

Creek (Figure 21). Subwatersheds with the lowest proportions of rain-on-snow zone in the Mohawk watershed tend to be the same as those with relatively lower potentials for mass erosion (see Figure 20).

4.4.3. Forest Stands

The most recent watershed-wide data available to us suggest that in 1995, forest stand conditions in the Mohawk watershed varied noticeably among subwatersheds even though, as noted early in this report, the distribution of conifer trees more than 80 years old has become very limited (Figure 22). "Older" conifer dominated stands (~60 years or older) accounted for about 21% of the forest area in the watershed, varying from a high of 35% in the Cartwright subwatershed down to 11% in the Drury and Spores subwatersheds. The percentage of area covered by forest not clearcut from 1972-95 was approximately 74% for the entire watershed, ranging from above 90% in the Cash and Shotgun subwatersheds to a low of 44% in the Upper Mill subwatershed.

4.4.4. Relationship Between Forest Stands and Subwatershed Sensitivity

In 1995, variations in forest stand conditions across the Mohawk watershed reflected ownership patterns, timing of timber harvest cycles, and faster average harvest rates on private than on public land. In several cases this meant a greater abundance of older aged stands or lower abundance of areas clearcut during the preceding 23 years in subwatersheds that were relatively more sensitive to disturbance, but in some areas of the watershed it meant otherwise. Some of the relatively more sensitive subwatersheds, like N.Fk. Mohawk or Upper Mill Creek for example, had stand conditions reflecting a relatively higher level of timber harvest and associated activities than many subwatersheds thought to be less sensitive to this type of disturbance. This suggests an elevated level of risk of cumulative effects on aquatic habitat that forest managers are working to minimize by applying management prescriptions developed through watershed analyses completed in the mid-1990s.

4.5. ELEVATED SEDIMENT YIELDS

The network of forest roads on private and public lands in the Mohawk watershed is the primary source of elevated levels of upland sediment delivery to the stream system and is being

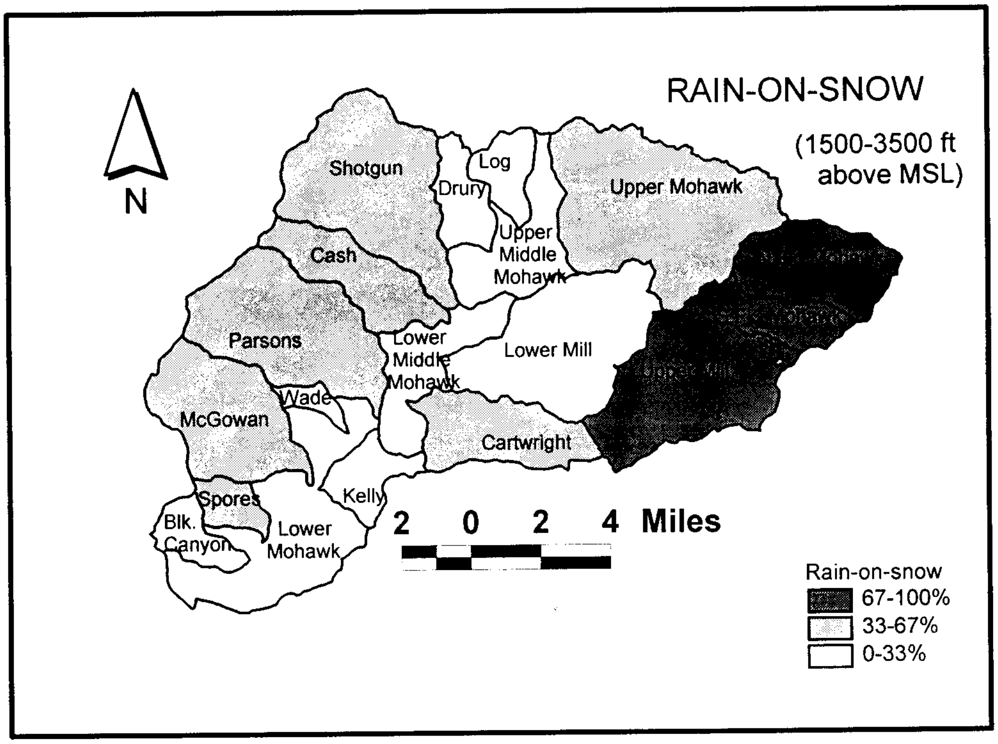
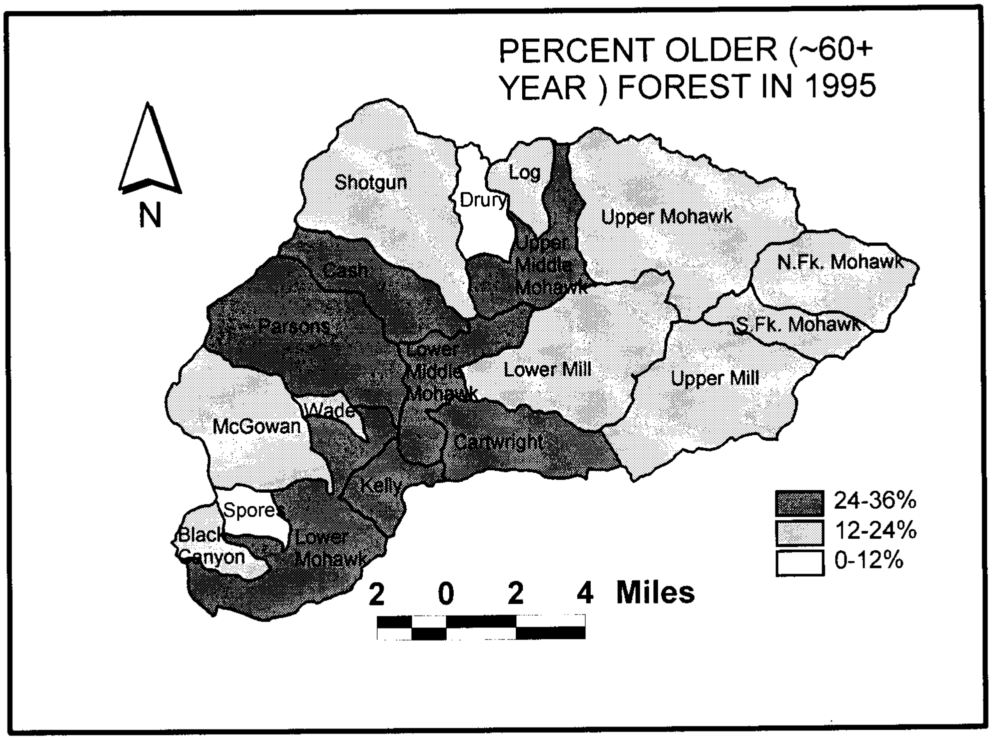


Figure 21. Percentages of subwatershed areas in an assumed rain-on-snow zone of 1500-3500 ft above mean sea level, Mohawk watershed, Oregon. Source: GIS analysis of elevation data from a 30-meter digital elevation model.



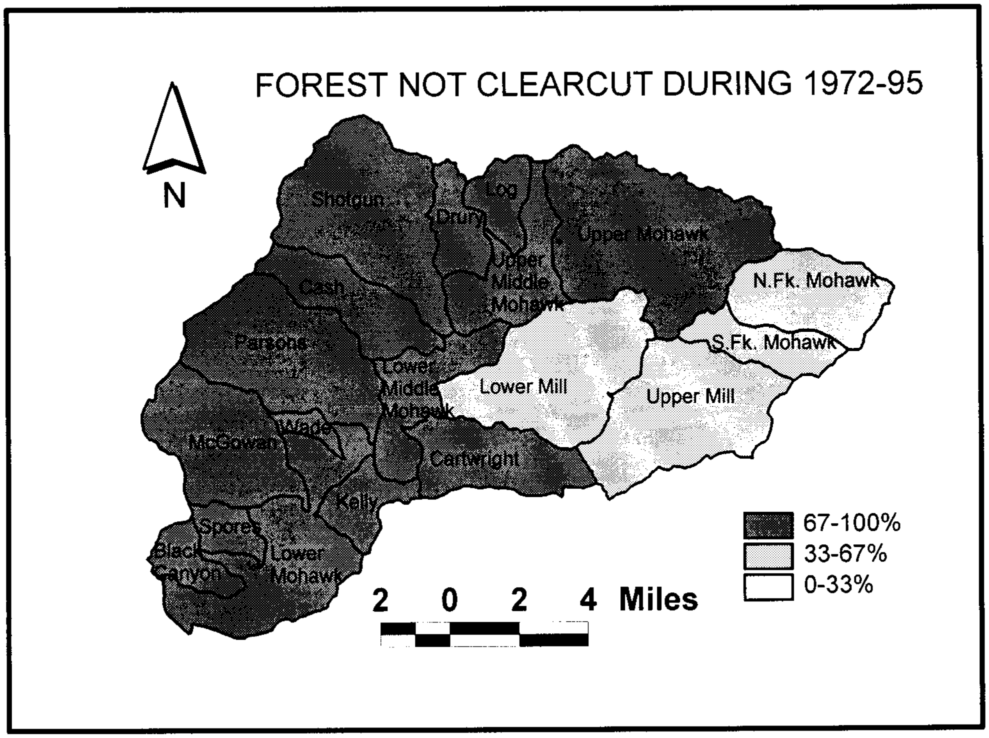


Figure 22. Percentages of forest in "older" conifer stands (~60+ yr old; top) and of forest not clearcut from 1972-95 (bottom), Mohawk watershed, Oregon. Source: GIS analysis of 1988 stand age data from the Laboratory for Applications in Remote Sensing in Ecology (Corvallis, OR) and of data on timber harvest from Cohen et al. (1998).

mitigated by a variety of practices including improved design and maintenance. We could find no comprehensive estimate of forest road abundance across the entire watershed, but information that is available suggests active road densities during the mid-1990s were in the range of about 3.5-6.5 mi/mi^2 among differing subwatersheds. Although this range is high enough that it would raise concerns about potential cumulative effects on streams among federal forest managers focused strongly on watershed restoration, it falls below the threshold of concern identified by OWEB (1999).

Analyses by Weyerhaeuser (1994) and BLM (1995) combine to suggest that annual delivery of fine sediment from forest road runoff to streams is about 0.04 tons/acre/year across the watershed, an increase of 50% or more above a background ("natural") level of delivery estimated at 0.06-0.08 tons/acre/year for all sizes of sediment combined. The roads also account for a high percentage of forestry-related landslides or debris torrents (essentially landslides down creeks) in the system, but these events have apparently declined over time as route selection, road design, construction, and maintenance techniques have improved (Weyerhaeuser 1994).

Forest roads in the Cartwright and lower half of the Parsons subwatershed, plus abandoned railroad grades throughout the Mohawk watershed, have yet to be systematically inventoried. We measured the lengths of the watershed's old railroad grades as mapped by Polley (1984) and found his maps to show more than 170 miles (>1 mi/mi^2) of grades that were distributed across all subwatersheds. ***These types of abandoned grades are widely recognized as potential trigger points for severe erosion problems, have caused such problems in the Mohawk watershed in the past, and have been identified by many authors as a key risk area that should be addressed in watershed restoration efforts.***

On a field tour of the watershed's lowlands during an intense winter storm, we found additional sediment sources that were at least locally significant. These included:

- several native or lightly gravel-surfaced roads and driveways that drained turbid stormwater into ditches or streams within agricultural or rural-residential areas

- unvegetated earthen ditches, particularly along steep driveways on valley footslopes, that themselves contributed sediment when conveying stormwater toward streams

- eroding streambanks that appeared particularly severe along a few areas of the lower mainstem Mohawk where agricultural practices had removed essentially all woody vegetation to the edge of the active channel

4.6. FISH HABITAT

Weyerhaeuser (1994) and the BLM (1995) conducted assessments of stream conditions in the Mohawk watershed prior to the 1996 flood, focusing largely on areas in the uplands. These assessments concluded that stream channels in the watershed were deficient in woody debris and associated habitat complexity, had elevated but usually not severe levels of fine sediments, and often had less than desirable but improving riparian conditions. Our survey results were consistent with their observations although we did not find as much good habitat as described by the BLM, possibly because we did not survey the same areas and found fewer beaver ponds than they described as being present in streams prior to the 1996 flood.

The 47 stream reaches we surveyed during September 1999 had a combined length of 10.41 miles and included 27 upland reaches, 13 lowland reaches of tributary streams, and 7 lowland reaches of the Mohawk River between Log Creek and the McKenzie River. Detailed summaries of the data collected within each of these reaches are given in Appendices A and B. These appendices also include:

- Summaries of survey data the EPA collected at 5 stream reaches in years since the 1996 flood.

- Summaries of survey data for 54 stream reaches surveyed by ODFW, Weyerhaeuser, or the BLM in years prior to the 1996 flood.

- Results of supplemental benchmark analyses of habitat conditions within reaches surveyed in the watershed.

The combination of all the data we collected or acquired, for periods both before and after the flood, provides good coverage of the Mohawk watershed and should provide a reasonable picture of the condition of the watershed's streams.

4.6.1. Benchmark Analysis.

Results of the 1999 stream survey are consistent with those of other recent surveys within the watershed and suggest that reaches of truly high-quality habitat are uncommon along the Mohawk River and its tributaries. Although the majority of reaches surveyed in 1999 met at least a couple of the six habitat benchmarks upon which we focused, only about a quarter of the reaches met as many as half of them (Figure 23). Most of the surveyed reaches had habitat that could be characterized as being of low to moderate quality, but several had noticeably better habitat than did others. Some of the higher quality habitat seen during the 1999 surveys was in middle Cartwright Creek, Cash Creek, upper Mill Creek, and multiple stream reaches in the Shotgun and McGowan Creek systems.

The benchmark analysis showed both similarities and differences in patterns of habitat quality between the upland streams, lowland reaches of tributaries, and lowland reaches of the mainstem Mohawk we surveyed during 1999 (Figure 24). Reaches in each of these settings usually failed to meet habitat benchmarks for instream woody debris and large streamside trees capable of contributing large woody debris to the stream, although the degree to which streams were below these benchmarks tended to be substantially greater in lowland areas. At least with regard to a few lowland tributaries, this may be partly a reflection of natural patterns of vegetation, but it also reflects rural-residential and agricultural encroachment on lowland stream corridors.

Key pieces of large woody debris, those that are generally considered to be large enough to have a major influence on channel form, were very sparse throughout the areas surveyed in 1999. We found none in lowland reaches of tributaries, an average of <1% of the benchmark abundance of key pieces in lowland reaches of the mainstem, and an average of only 6% of benchmark abundance in the upland reaches surveyed.

Upland reaches were frequently well shaded and tended to meet the habitat benchmark for pool frequency, but often failed to meet the benchmark for fine sediments (sand, silt, etc.) in riffles, most frequently in smaller stream channels. In contrast, lowland reaches of tributaries and the mainstem often lacked benchmark levels of shade, but frequently met the benchmark for fine sediment in riffles (low levels are desirable) despite having the low gradients often associated

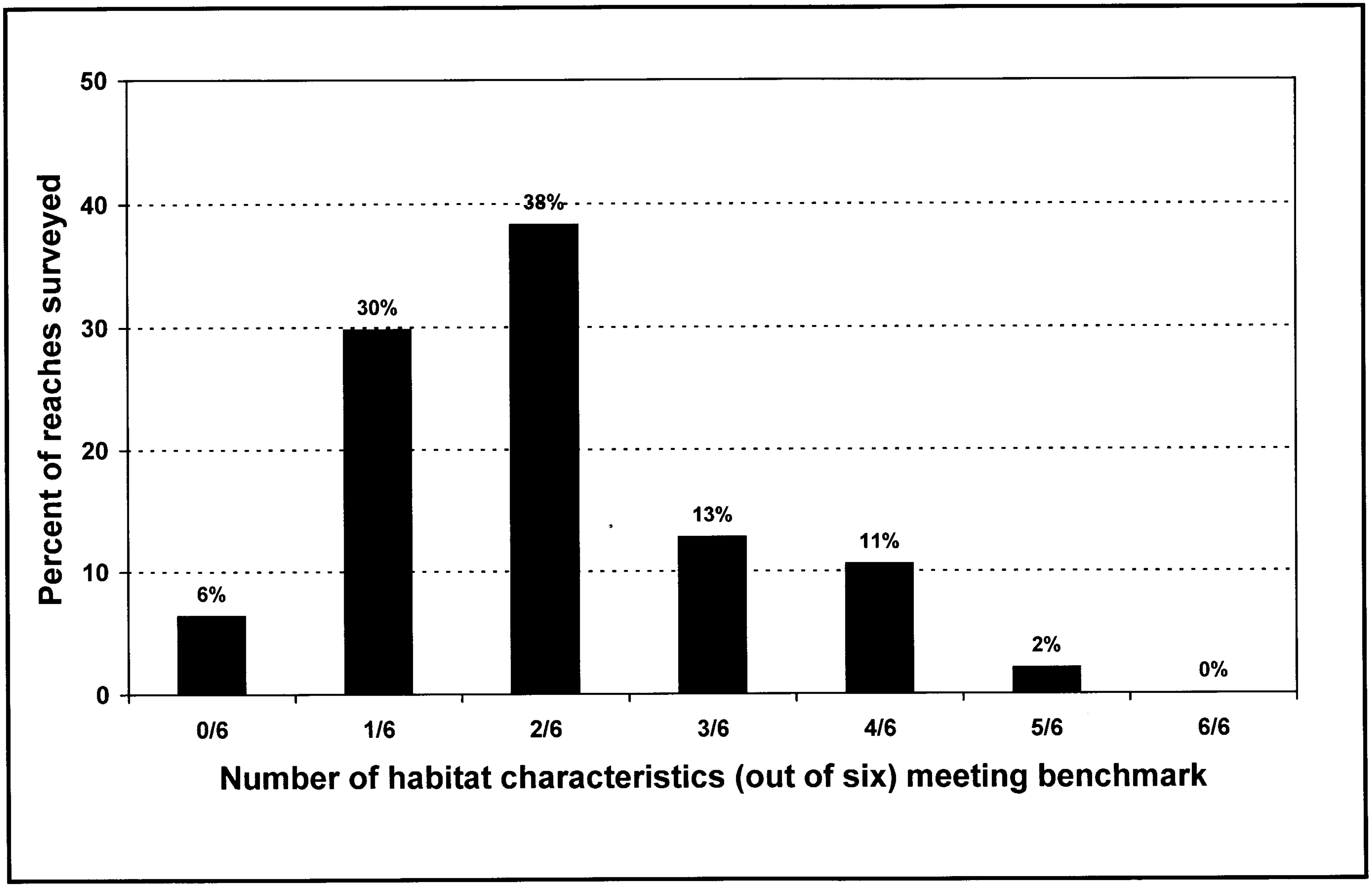


Figure 23. Percent of stream reaches surveyed in the Mohawk watershed (n=47) that met differing numbers of six habitat benchmarks, 1999.

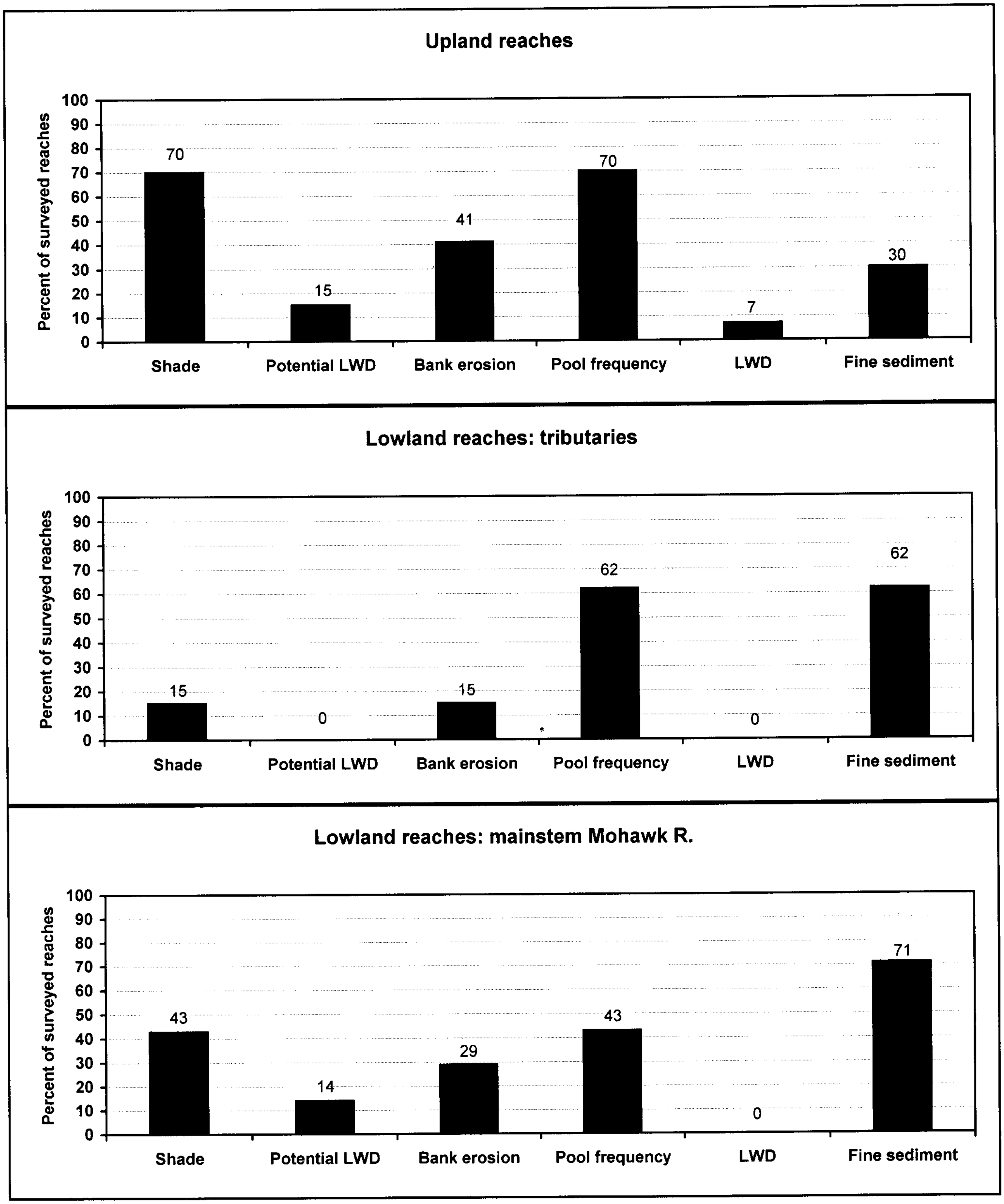


Figure 24. Percent of surveyed upland (n=27), lowland tributary (n=13), and lowland mainstem reaches (n=7) that met benchmark conditions for six specific habitat characteristics, Mohawk watershed, 1999.

with sediment deposition. The reason lowland reaches met the fine sediment benchmark for riffles more frequently than upland reaches did is not entirely clear, but may be related to greater stream size, reduced deposition due to a lack of woody debris, or increased transport capacities associated with past alterations of lowland channels. We did note, however, that the lowland reaches tended to have higher overall levels of fine sediments than upland reaches, due to deposition that was often extensive in low-velocity habitats like pools.

Bank erosion, likely elevated to some degree as a consequence of the 1996 flood, was common along many of the reaches surveyed, but was a more severe problem in lowland areas. Median levels of bank erosion were a relatively high 12% for the upland reaches surveyed, but a considerably more severe 42% for the lowland reaches of tributaries and 32% for lowland reaches of the Mohawk. Bank erosion problems along many of the lowland reaches appeared to be related to adjacent riparian conditions and past channel downcutting. Downcutting increases water velocities (and erosive forces) during floods due to reduced stream access to floodplains.

The spatial distributions of all recently surveyed stream reaches (pre- and post-1996 flood) that met or failed to meet each of the six habitat benchmarks are mapped in Figures 25 through 30. Multiple patterns evident within these maps are worthy of note:

- Stream shade met benchmark conditions along half or more of the upland reaches surveyed in each subwatershed except Parsons Creek.
- Surveyed reaches meeting the benchmark for large riparian trees (potential large woody debris) were infrequent although a few were found in the western or lower portions of the watershed.
- The upper mainstem Mohawk and Mill Creek appear to be areas where surveyed reaches were most consistent at meeting the benchmark for raw banks, possibly due to resistance to further erosion following historic alteration of these channels by splash damming or other old logging practices.
- Pool frequencies (abundance) met benchmark conditions at half or more of the reaches surveyed in each subwatershed for which we collected or acquired data, except Parsons Creek.

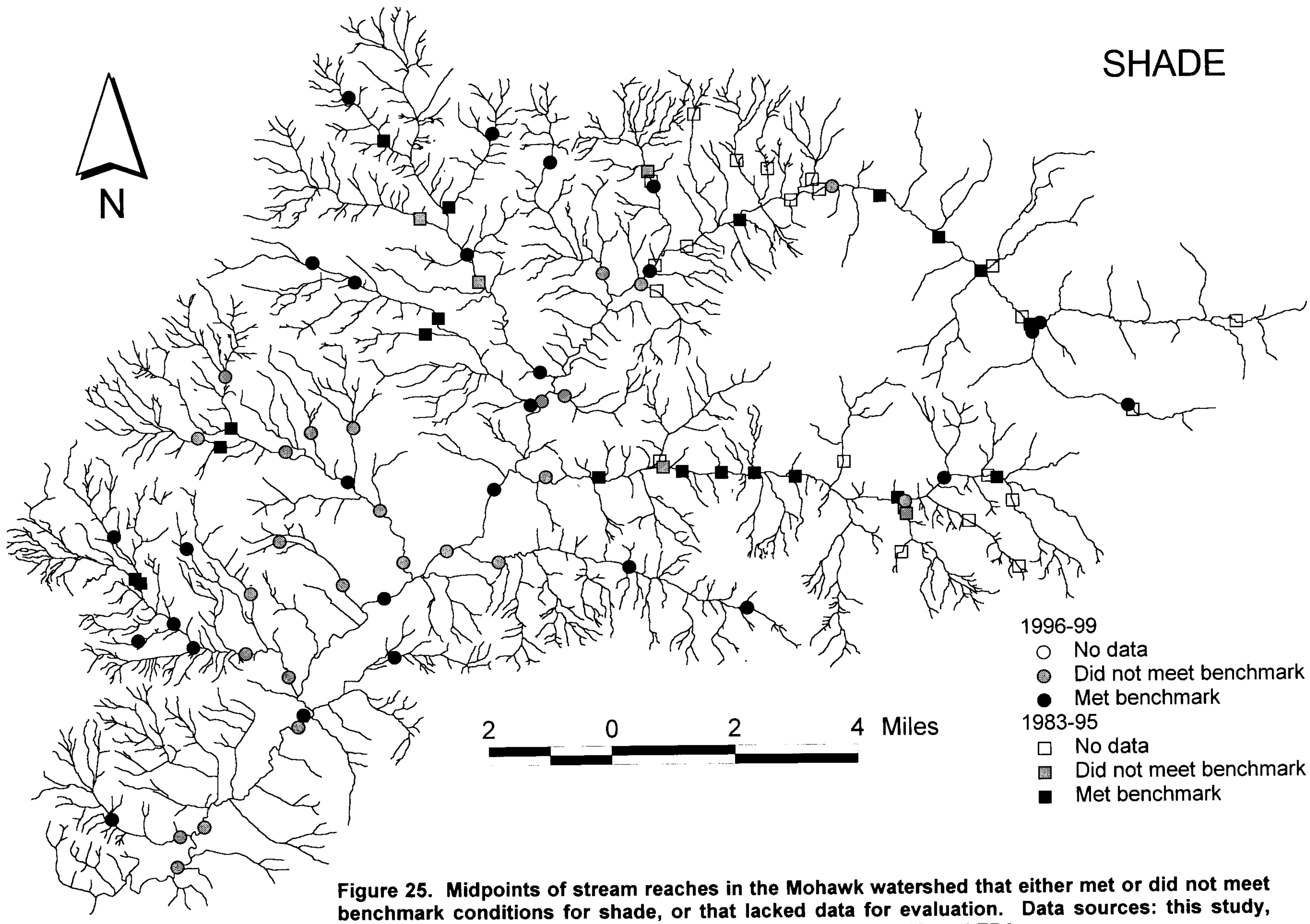


Figure 25. Midpoints of stream reaches in the Mohawk watershed that either met or did not meet benchmark conditions for shade, or that lacked data for evaluation. Data sources: this study, Weyerhaeuser (1994), and unpublished data from ODFW, BLM, and EPA.

POTENTIAL LARGE WOODY DEBRIS

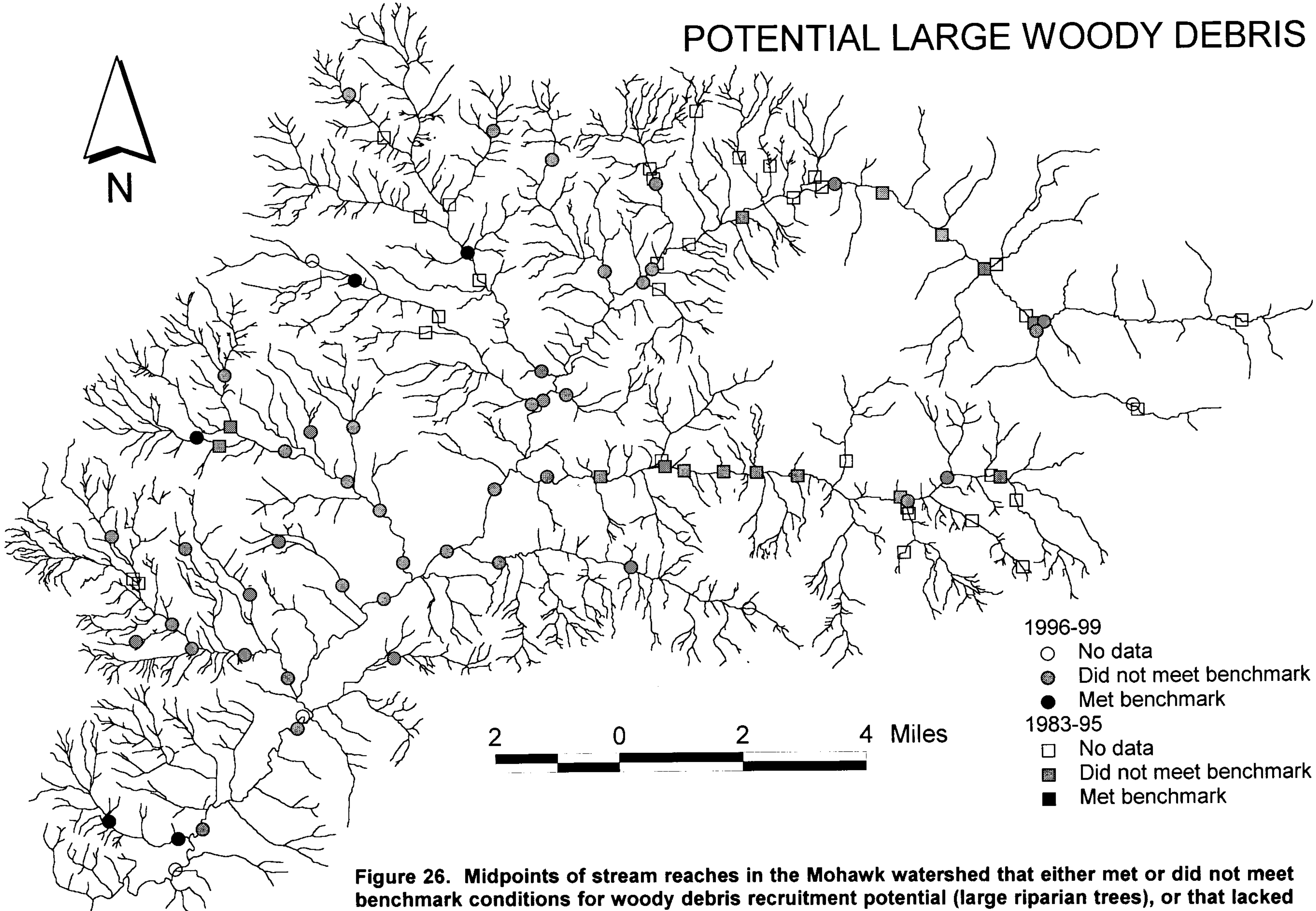


Figure 26. Midpoints of stream reaches in the Mohawk watershed that either met or did not meet benchmark conditions for woody debris recruitment potential (large riparian trees), or that lacked data for evaluation. Data sources: this study, Weyerhaeuser (1994), and unpublished data from ODFW, BLM, and EPA.

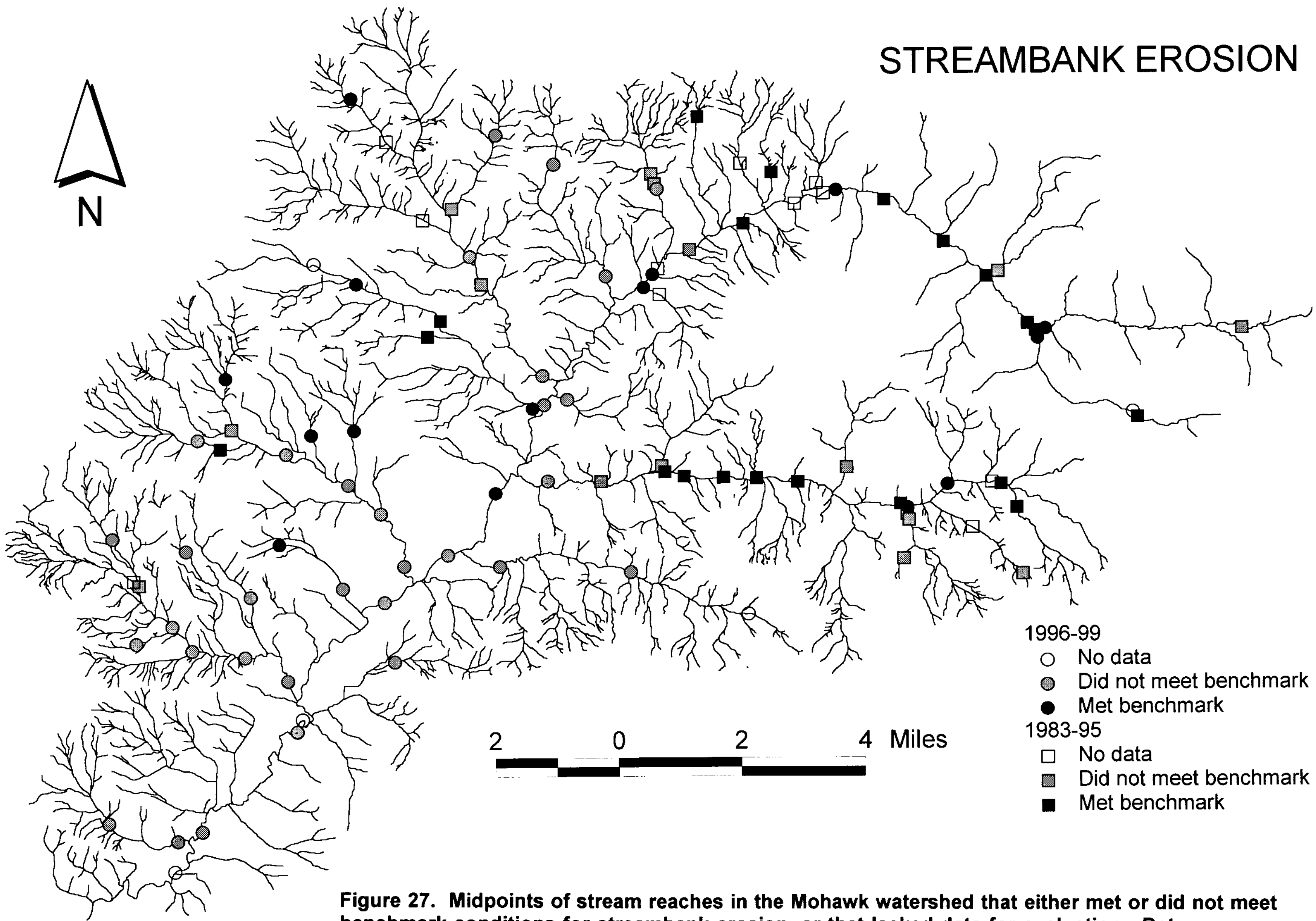


Figure 27. Midpoints of stream reaches in the Mohawk watershed that either met or did not meet benchmark conditions for streambank erosion, or that lacked data for evaluation. Data sources: this study, Weyerhaeuser (1994), and unpublished data from ODFW, BLM, and EPA.

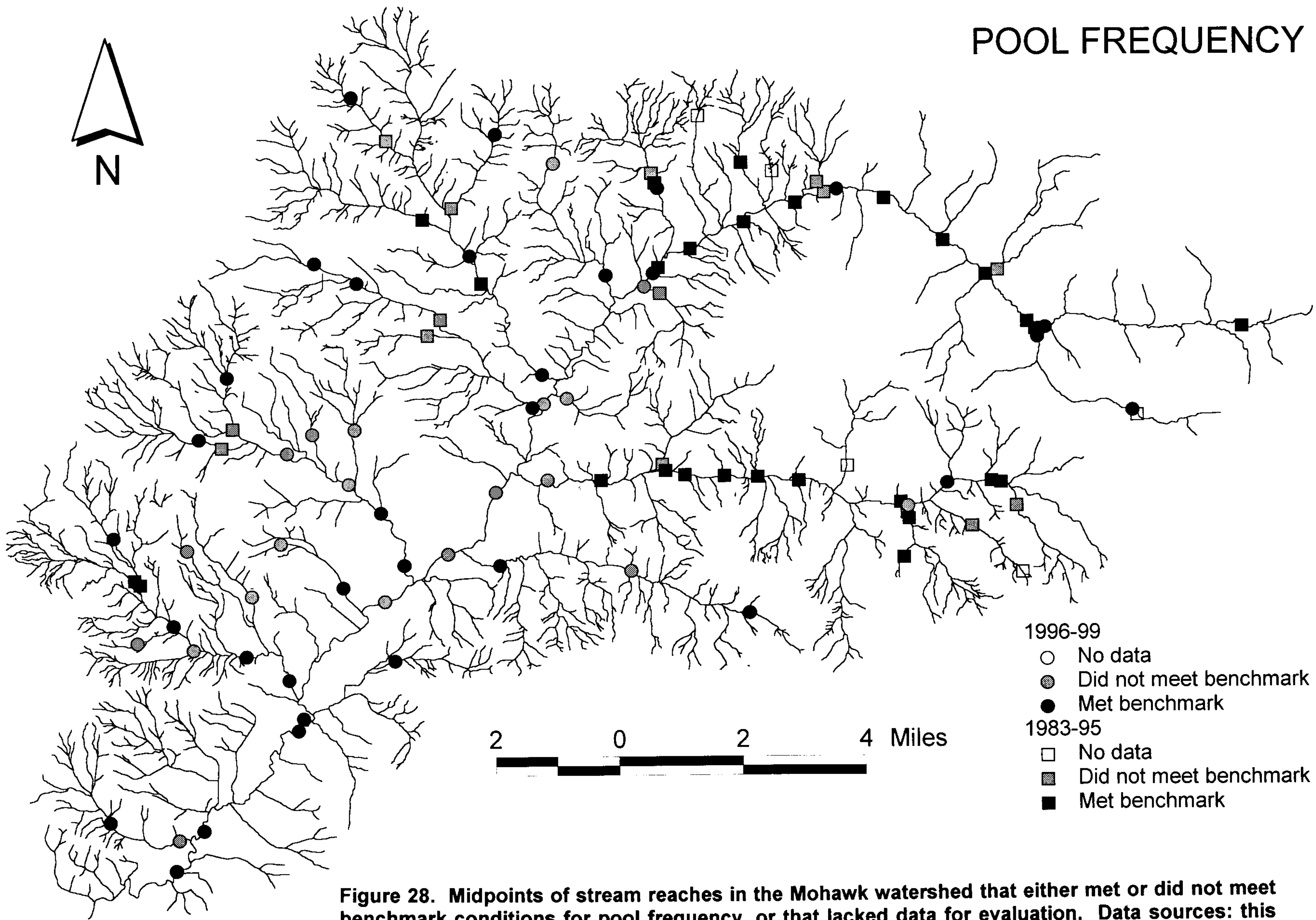


Figure 28. Midpoints of stream reaches in the Mohawk watershed that either met or did not meet benchmark conditions for pool frequency, or that lacked data for evaluation. Data sources: this study, Weyerhaeuser (1994), and unpublished data from ODFW, BLM, and EPA.

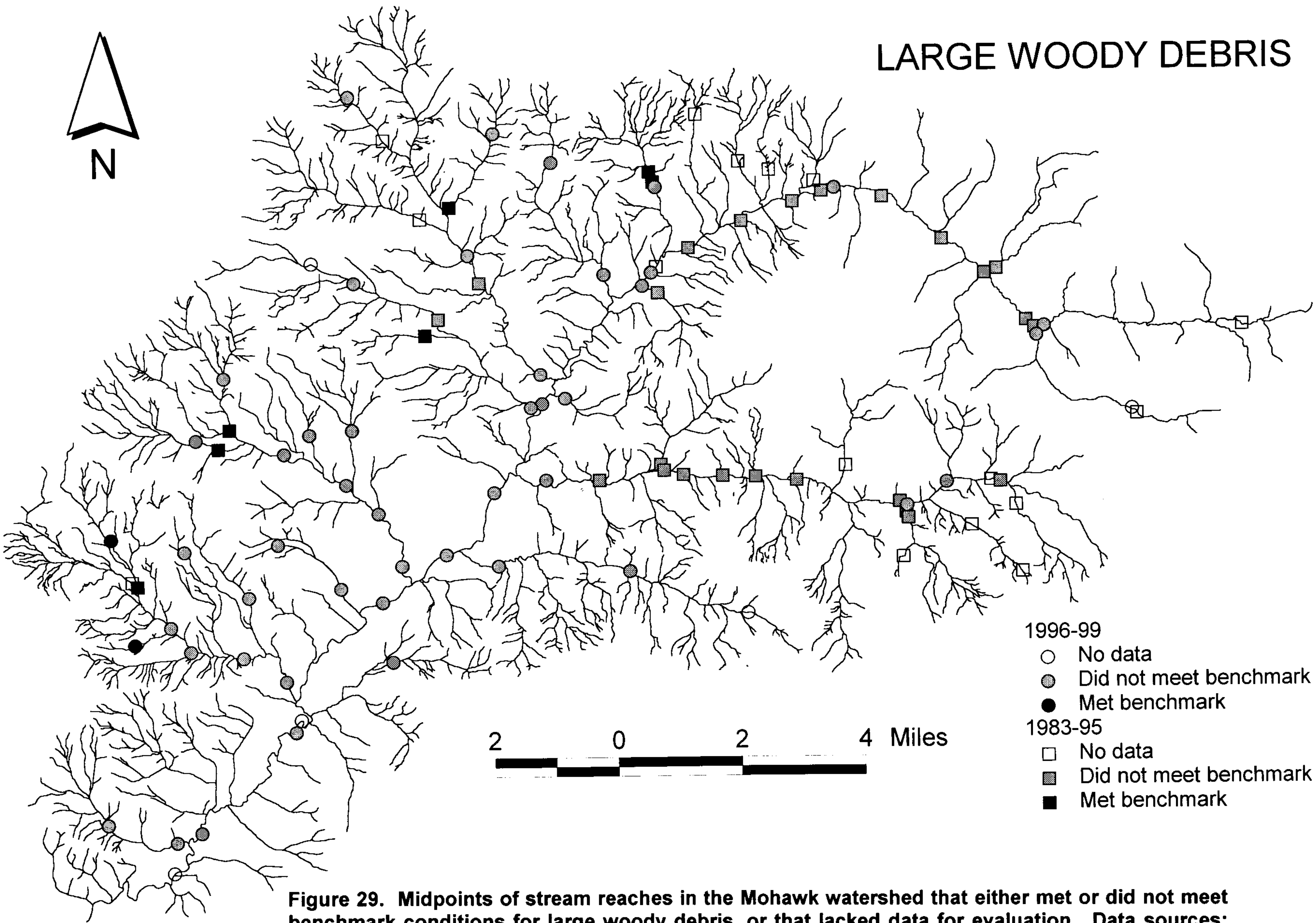


Figure 29. Midpoints of stream reaches in the Mohawk watershed that either met or did not meet benchmark conditions for large woody debris, or that lacked data for evaluation. Data sources: this study, Weyerhaeuser (1994), and unpublished data from ODFW, BLM, and EPA.

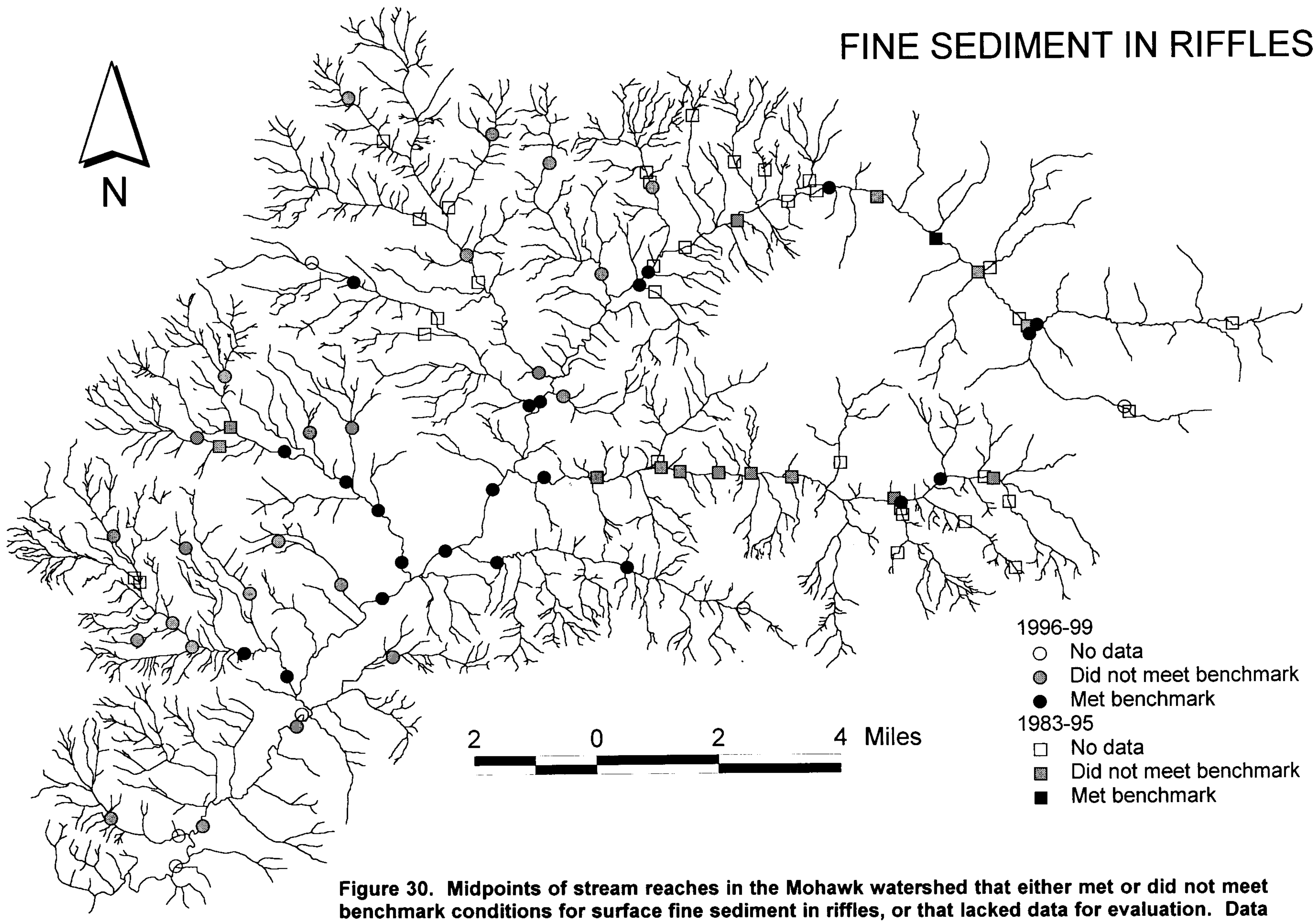


Figure 30. Midpoints of stream reaches in the Mohawk watershed that either met or did not meet benchmark conditions for surface fine sediment in riffles, or that lacked data for evaluation. Data sources: this study, Weyerhaeuser (1994), and unpublished data from ODFW, BLM, and EPA.

- Reaches meeting the habitat benchmark for instream woody debris were uncommon and were all found in smaller, middle to upper reaches of forested tributaries in the western portion of the watershed. There may be similar reaches in the eastern portion of the watershed, but available data were limited.

- Nearly all reaches that met the habitat benchmark for fine sediment in riffles were surveyed after the 1996 flood and were found along the mainstem Mohawk River upstream of McGowan Creek, along Cash Creek, or within the middle to lower sections Cartwright, Parsons, or McGowan creeks. Few small streams in the middle to upper portions of drainage networks met the benchmark, although the degree to which many of these streams exceeded the specified level of fine sediments in riffles was not severe.

4.6.2. Comparison to 1938 River Survey.

Comparisons of recent survey data for the Mohawk River to the results of 1938 mainstem surveys conducted by the Bureau of Commercial Fisheries suggest both similarities and changes over the past 60 years. Fine sediments were extensive in the Mohawk between the mouth and Marcola (Wendling Bridge) in 1938, accounting for about half of the riverbed. We found similar conditions during 1999 surveys. The 1938 surveys also found a high abundance of deep pools in the lower 5 miles of the Mohawk River (below Stafford Bridge) and a trend toward generally decreasing abundance of these pools proceeding upriver (Table 5, Figure 31). Survey data collected along the Mohawk during the 1990s suggest losses of deep pools over the past 60 years in the 14.3 miles of mainstem between the mouth and Earnest Bridge (0.9 mi above Mill Creek), but little change in the abundance of deep pools father upriver. Losses of deep pools in the mainstem between the mouth and Wendling Bridge (Marcola) appear to have been variable, and our estimates of these losses should be considered imprecise due to incomplete sampling of the river. Recent data clearly show that there are now only about half as many deep pools in the mainstem between Wendling Bridge and Earnest Bridge as there were in 1938.

The apparent loss of pools in the lower river is of significance because they are important habitat for migratory fish like salmon and fluvial cutthroat trout, and reductions in their abundance in Northwest rivers has often been taken to reflect watershed-scale habitat

Table 5. Estimated changes in the abundance of large/deep pools (>25 sq yd and >3 ft deep) in the Mohawk River, Oregon, 1938-1999.

Section	Length (mi)	1938 survey			1993-94 surveys			1997-99 surveys		
		pools	mi	#/mi	pools	mi	#/mi	pools	mi	#/mi
Mouth - Stafford Bridge	5.0	95	5.0	19.0	---	---	---	21	1.73	**12.1**
Stafford Bridge - Wendling Bridge	6.8	73	6.8	10.7	---	---	---	16	1.80	**8.9**
Wendling Bridge - Earnest Bridge	2.5	32	2.5	12.8	16	2.5	6.4	4	0.62	**6.5**
Earnest Bridge - Section 27 Bridge	3.5	34	3.5	9.7	15	1.6	**9.4**	4	0.41	**9.8**
Section 27 Bridge - Falls at RM 23.5	5.7	43	5.7	7.5	39	5.3	**7.4**	---	---	---

Note: values in **bold** indicate estimates based on subsampling.

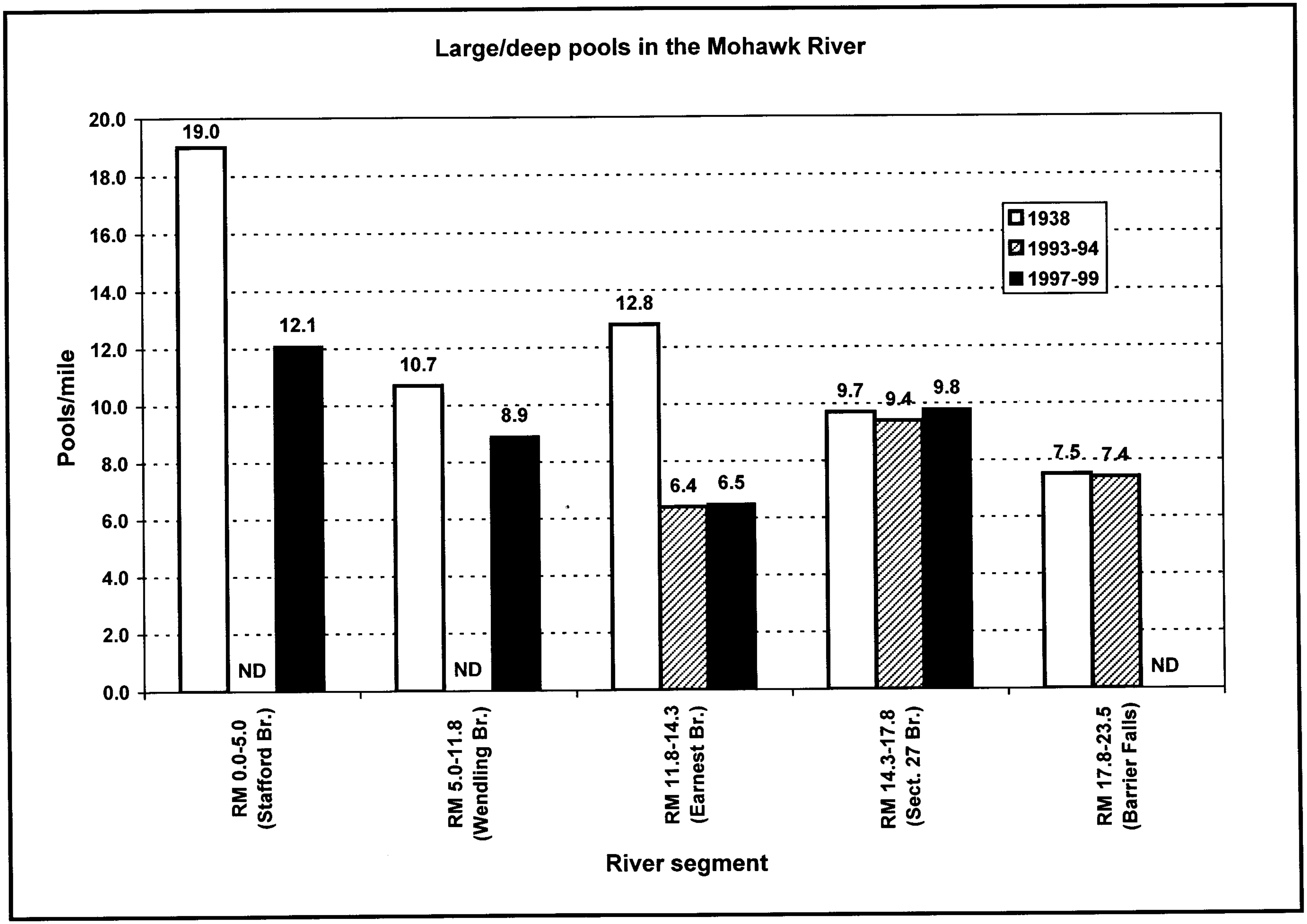


Figure 31. Estimated changes in the abundance of large/deep pools (>25 sq yd and >3 ft deep) in the Mohawk River, Oregon, 1938-1999. Note: most estimates for 1993-94 and 1997-99 are based on subsampling.

degradation. Given that our estimates of pool loss in the river below Wendling Bridge are based on sub-sampling, it would seem wise to conduct a full survey of the deep pools in this area at some time in the future.

4.7. UNNATURAL BARRIERS TO FISH MIGRATION

Unobstructed fish passage to naturally accessible areas allows salmonids to migrate upstream to spawning areas, to other seasonally important habitats like cool water refugia, and to re-colonize areas following severe habitat disturbance. However, man-made barriers often impede or prevent these types of fish movements in portions of developed watersheds such as the Mohawk.

The most common man-made fish migration barrier in the Mohawk system is the poorly functioning road culvert and multiple inventories of these structures have been or are being conducted. The inventories have tended to focus on differing geographic areas, but there has been overlap. In the largest inventory, BLM (1995) investigated 529 stream crossings within the western half of the watershed, found potential fish passage problems at 58 of those crossings, and has since been fixing the problems identified. The industrial forest companies in the watershed have examined many of the road crossings on fish-bearing streams within their lands, upgraded some that were creating problems, and continue to examine additional sites. Weyerhaeuser, for example, is now completing a comprehensive survey of road crossings of fish streams on its lands and will continue fixing them, with highest priority given to crossings that affect access to the most habitat or that need repair for other important reasons (C. Volz, Weyerhaeuser, pers comm.). Another culvert inventory was conducted in the late 1990s by a group of Salmon Trout Enhancement Program (STEP) volunteers working with ODFW. This group examined 62 road crossings of streams and completed standardized forms to define passage conditions at each culvert (M. Wade, ODFW, pers comm.). ODFW is in the process of reviewing the completed forms to identify those locations that constitute high priorities for fish passage improvements (D. Irish, ODFW, pers comm.).

The Partnership is now working with the individuals responsible for the culvert surveys that have been (or will soon be) completed to identify whether there are any watershed areas that remain to be examined. It seems likely to us that there will be areas that have been overlooked in the lowlands, where the Partnership may be able to encourage landowner cooperation. If there are such areas, the group should ensure that culverts within them are examined and that any passage problems are identified and fixed. If not replaced, such culverts could greatly diminish the benefits derived from habitat improvements, including additional repairs made to road crossings, farther up in the same stream networks.

During our stream surveys and other visits to the watershed we came across several road culverts that were at least partial fish barriers on private, agricultural sections of named fish-bearing streams. It is thus clear that fixing this type of problem on non-forested lands will be important to the Partnership's restoration efforts. We also saw migration barriers at a few small seasonal dams that had been built across stream channels for a variety of purposes, including one across a major Mohawk tributary that appeared to have created a swimming pool for adjacent rural-residential landowners. We did not survey the entire lengths of lowland streams, but given intense water use it would not be surprising if the lower-most segments of one or more small tributaries in the system were impassable to fish during parts of the summer or early fall due to channel de-watering.

4.8. WATER QUALITY

Concerns have been raised about water quality in the Mohawk River since at least the mid-1970s. In a review of data available at the time, the Lane Council of Governments (LCOG 1974) noted that during summer the lower Mohawk had elevated water temperatures, algal growths associated with nutrient enrichment, and bacterial contamination that caused the lower river to range from marginal to unsuitable for contact. At times the river also had undesirable turbidities. These conditions stood in contrast to very high water quality found throughout areas of the McKenzie subbasin higher in the Cascades. Contributors to lower water quality in the Mohawk were considered to include agricultural and livestock operations, logging-related activities, and septic tank failures. Septic tank seepage was a particular concern in the vicinity of Marcola, where more than half the systems within 100 feet of the river were performing unsatisfactorily (LCOG 1974).

More recently, an ODEQ analysis of water quality data for seven ambient monitoring sites in the McKenzie subbasin (Cude 1999) showed six sites to have excellent water quality. The seventh site, Mohawk River at Hill Road (River Mile 1.6), was rated as having lower but good water quality that was seasonally affected by elevated levels of fecal coliform bacteria, nutrients (total phosphorous, ammonia and nitrate nitrogen), biochemical oxygen demand, and total solids. These water quality conditions indicate that runoff in the Mohawk watershed is contributing soil, organic materials, untreated human or animal waste, and other pollutants to the river (Cude 1999).

Two streams within the Mohawk watershed, the mainstem Mohawk below river mile 23.5 and all of Mill Creek, are currently on Oregon's 303(d) list for having summer water temperatures that exceed state standards. Multiple additional streams within the watershed are thought by ODEQ to be impaired by high levels of sedimentation or by habitat modification, but they have not been added to the state's official 303(d) list due to a lack of sufficient quantitative data.

Recent water temperature data collected by the USGS, ODEQ, BLM, Weyerhaeuser, ODFW, and the MWC show that multiple sites on the mainstem Mohawk River and its tributaries exceed the state standard for summer rearing of salmonid fishes (7-day max <64^{o}F; Figure 32). Stream temperatures in the watershed are thought to be naturally warmer than streams higher in the Cascades but are elevated in many areas as a consequence of past landuse and channel alterations, current riparian conditions, water withdrawals, and losses of wetlands that may have otherwise contributed cool groundwater to streams during periods of low flow. With the exception of Mill Creek, tributaries monitored during summer have been cooler at their mouths than the mainstem Mohawk River and may thus provide important thermal refuge for fish even though they do tend to be warmer than current state standards.

Although the Mohawk River has very high summer temperatures near its mouth, a plot of maximum stream temperatures versus distance from headwater areas suggests that the main river's upper reaches are currently a very important source of relatively cooler water. For a given distance from its headwaters, the mainstem has significantly lower maximum temperatures during summer than any of the tributary streams that have been monitored (Figure 33; top). The difference between the mainstem and its tributaries is partly a reflection of the basic topography of the watershed and a natural tendency toward lower stream temperatures at the higher elevations within which the mainstem originates. However, even taking elevation into account, the mainstem appears to have lower maximum summer temperatures than many of its tributaries (Figure 33; bottom). This suggests that other factors, like greater streamflows (which do exist), strong influence of cold groundwater, or better shading of stream channels (of which we are uncertain) may be involved.

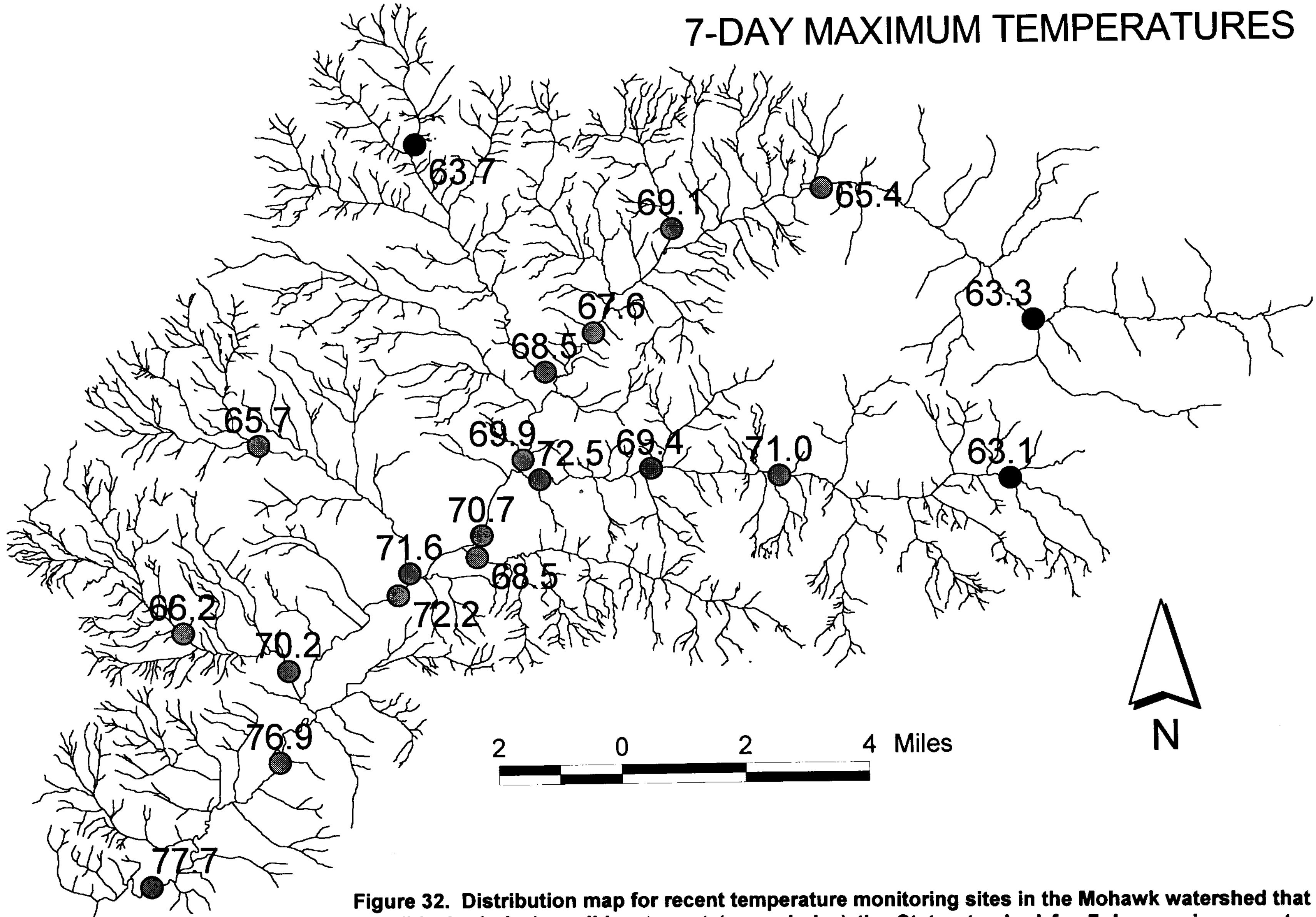


Figure 32. Distribution map for recent temperature monitoring sites in the Mohawk watershed that met (black circles) or did not meet (gray circles) the State standard for 7-day maximum water temperatures (≤64°F).

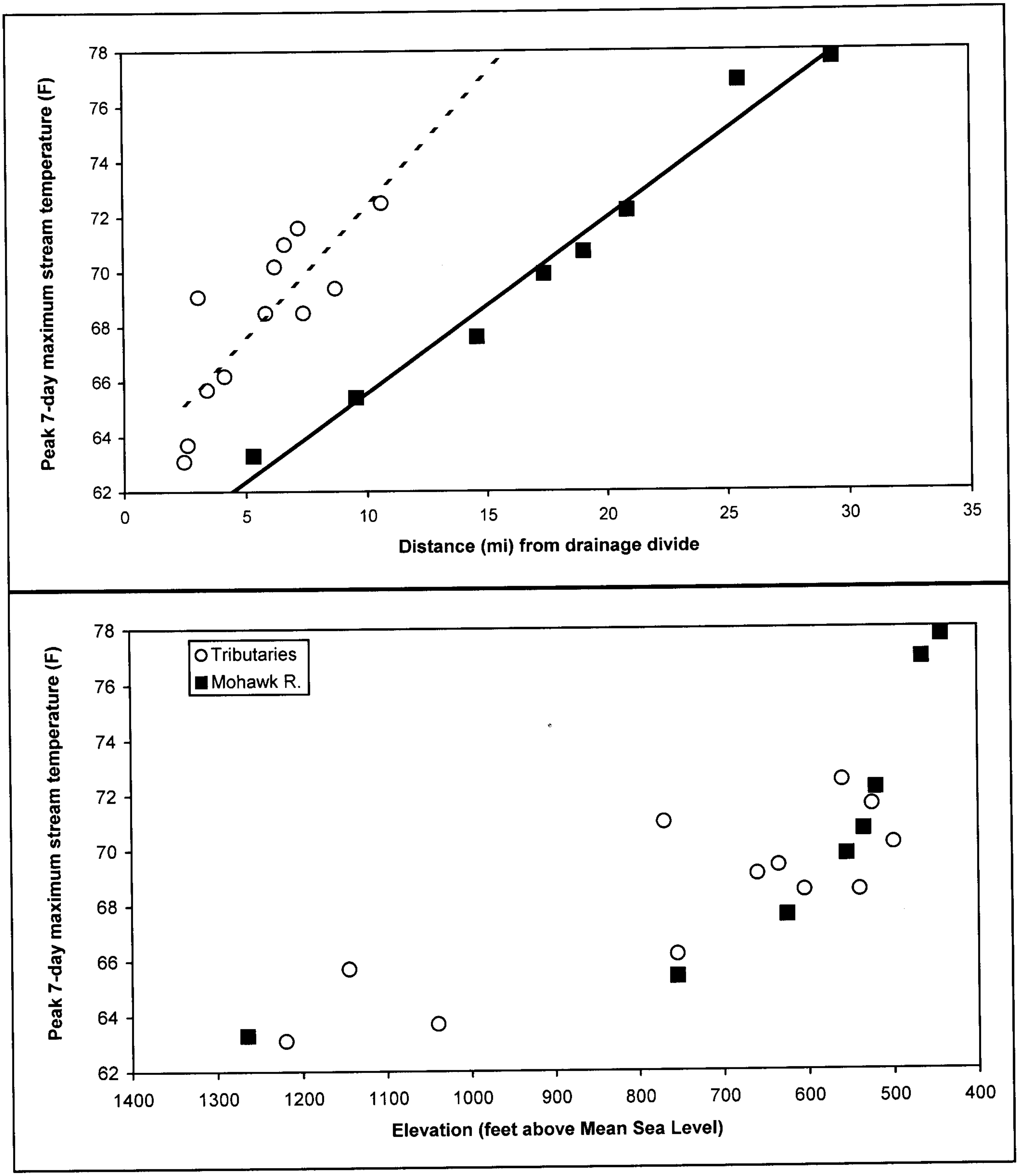


Figure 33. Relationships between maximum water temperature and distance from drainage divide (top) and elevation (bottom) for the mainstem Mohawk River and its tributaries.

Analytical methods outlined in the Oregon watershed assessment manual (OWEB 1999) were applied to data on water quality other than temperature that have been collected on the Mohawk River at Hill Road since the mid-1990s. These data included ambient monitoring information collected by ODEQ and storm event data gathered by the McKenzie Watershed Council. Overall, data collected in recent years at the Hill Road site have intermittently exceeded "red flag" levels for bacteria, nutrients (nitrates and phosphorous), and turbidity (Table 6).

Table 6. Summary analysis of recent (1996-99) water quality data for the Mohawk River at Hill Road.

Parameter	Criteria	Total number of measure-ments	Minimum	Maximum	Median	Measure-ments not meeting criteria	Percent exceedance
D.O.	>8 mg/l	39	8.2	12.0	10.4	0	0
pH	6.5-8.5 mg/l	38	6.9	7.6	7.2	0	0
Bacteria	<406 E. coli/100 ml	38	2	1140	43	2	5
Nitrates	<0.30 mg/l	40	0.02	0.46	0.10	3	8
Phosphorous	<0.05 mg/l	39	0.01	0.15	0.03	5	13
Turbidity	<50 NTU	14	3	58.5	8.2	1	7

During the winter of 1998-99, the McKenzie Watershed Council sampled turbidity levels at multiple locations on the mainstem Mohawk River and in the lowest reaches of a number of the river's tributaries during storm events. The intent was to see which streams had high turbidity levels during periods when their watersheds were being subjected to heavy rainfall and substantial runoff. Stream turbidities documented during this effort ranged from 14.6 to 129 Nephelometric Turbidity Units (NTU). Turbidities exceeded 50 NTU (a potential "red flag" because it affects the sight-feeding abilities of salmonids) during one of two sampling visits to four sites on the mainstem and to single sites on lower Log, Shotgun, Mill, Cartwright, Parsons, and McGowan creeks. Turbidity did not exceed 50 NTU in lower Cash Creek during either of two visits, but that stream is reported to experience very high turbidities on some weekends (P. Thompson, MWP, pers comm.), possibly as a consequence of localized but heavy off-road vehicle activity within its watershed. Turbidity levels at all of the sites sampled were likely elevated by runoff from roads and disturbed soil.

4.9. FISH

4.9.1 Native Species.

There have been no comprehensive surveys of fish populations in the Mohawk watershed, but information available from multiple sources provides a good indication of the species inhabiting the area. Catch data from sampling efforts by ODFW, BLM, and EPA over the last decade suggest that at least 18 species of native fish are found in the watershed (Table 7). These fish include multiple species of salmonids (salmon and trout) and sculpins that are considered relatively intolerant of water quality degradation, as well as lampreys, a variety of minnows, stickleback, suckers, and trout-perch. The distribution of these species within the watershed reflects their specific habitat requirements, seasonal variations in habitat needs during their life cycles, and the spatial distribution of suitable habitats. In general, a greater diversity of species is found in larger and lower elevation stream channels in the Mohawk Valley, while fish assemblages tend to include fewer species and a greater proportion of trout with increasing proximity to headwater areas. This pattern is strongest during summer, when very low flows and high water temperatures in the lowest reaches of the Mohawk River and some of its tributaries are stressful to salmonids (Figure 34).

Historic changes in habitat conditions and temperature regimes are thought to have contributed to a reduced presence of native salmonids in the watershed's lowland channels, particularly during summer. However, data on the historic abundance of salmon and trout in the lower portion of the watershed, during summer or at other times of year, are unavailable. Recent trapping by ODFW (1995) has shown that migratory lifestages of salmonids are relatively abundant in the lowest reaches of the Mohawk River during winter and spring (Figure 35). The contrast between limited use of the lower river by salmonids during summer (see Figure 34) and relatively higher use during winter or spring is an example of how important events in fish life cycles are often timed to allow seasonal use of areas that may not provide suitable habitat conditions throughout the entire year.

4.9.2 Non-native Species.

Several species of non-native fishes have been found in the Mohawk watershed, including salmonids introduced by past hatchery programs and at least two warmwater species that may

Table 7. Native fishes of the Mohawk watershed, Oregon[1].

Common Name	Scientific Name	Tolerance of water quality degradation[2]
Salmonids (salmon and trout)	Family Salmonidae	
Spring chinook salmon	*Oncorhynchus tshawytscha*	intolerant
Coastal cutthroat trout	*Oncorhynchus clarki clarki*	intolerant
Rainbow-steelhead trout[3]	*Oncorhynchus mykiss*	intolerant
Lampreys	Family Petromyzontidae	
Western brook lamprey	*Lampetra richardsoni*	intermediate
Pacific lamprey	*Lampetra tridentata*	intermediate
Minnows	Family Cyprinidae	
Chiselmouth	*Acrochelius alutaceus*	intermediate
Peamouth	*Mylocheilus caurinus*	intermediate
Northern pike-minnow	*Ptychoceilus oregonensis*	tolerant
Longnose dace	*Rhinichthys cataractae*	intermediate
Speckled dace	*Rhinichthys asculus*	intermediate
Redside Shiner	*Richardsonius balteatus*	intermediate
Oregon chub[4]	*Oregonichthys crameri*	intermediate
Sculpins	Family Cottidae	
Riffle sculpin	*Cottus gulosus*	intolerant
Torrent sculpin	*Cottus rhotheus*	intolerant
Paiute sculpin	*Cottus beldingi*	intolerant
Reticulate sculpin	*Cottus perplexus*	tolerant
Stickleback	Family Gasterosteidae	
Threespine stickleback	*Gasterosteus aculeatus*	intermediate
Suckers	Family Catostomidae	
Largescale sucker	*Catostomus macrocheilus*	tolerant
Troutperch	Family Percopsidae	
Sandroller	*Percopsis transmontana*	intermediate

[1] Source: Weyerhaeuser (1994) and field sampling data from ODFW, BLM, and EPA.

[2] Pollution tolerance as identified by Altman et al. (1997)

[3] Resident rainbow trout are considered native to the watershed but steelhead were apparently introduced in the mid-1950s.

[4] Not known to be present in watershed but historic conditions were likely suitable for the species.

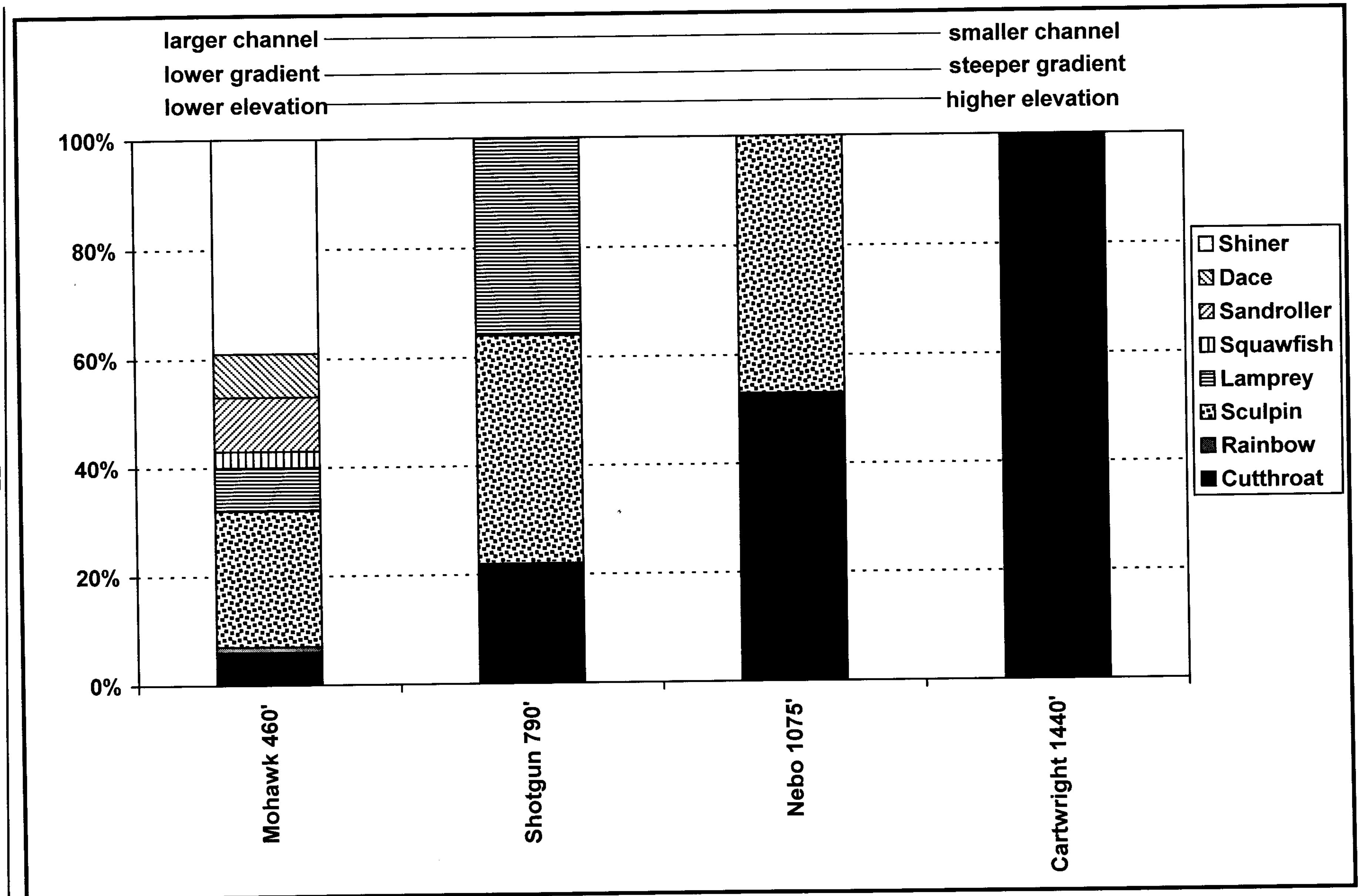


Figure 34. Fish assemblages (percent by number) for sites sampled in the 1990s on the mainstem Mohawk R. at about 460' above sea level, on Shotgun Cr. at 790', on Nebo Cr. at 1075', and on Cartwright Cr. at 1440'. Sources: BLM and EPA.

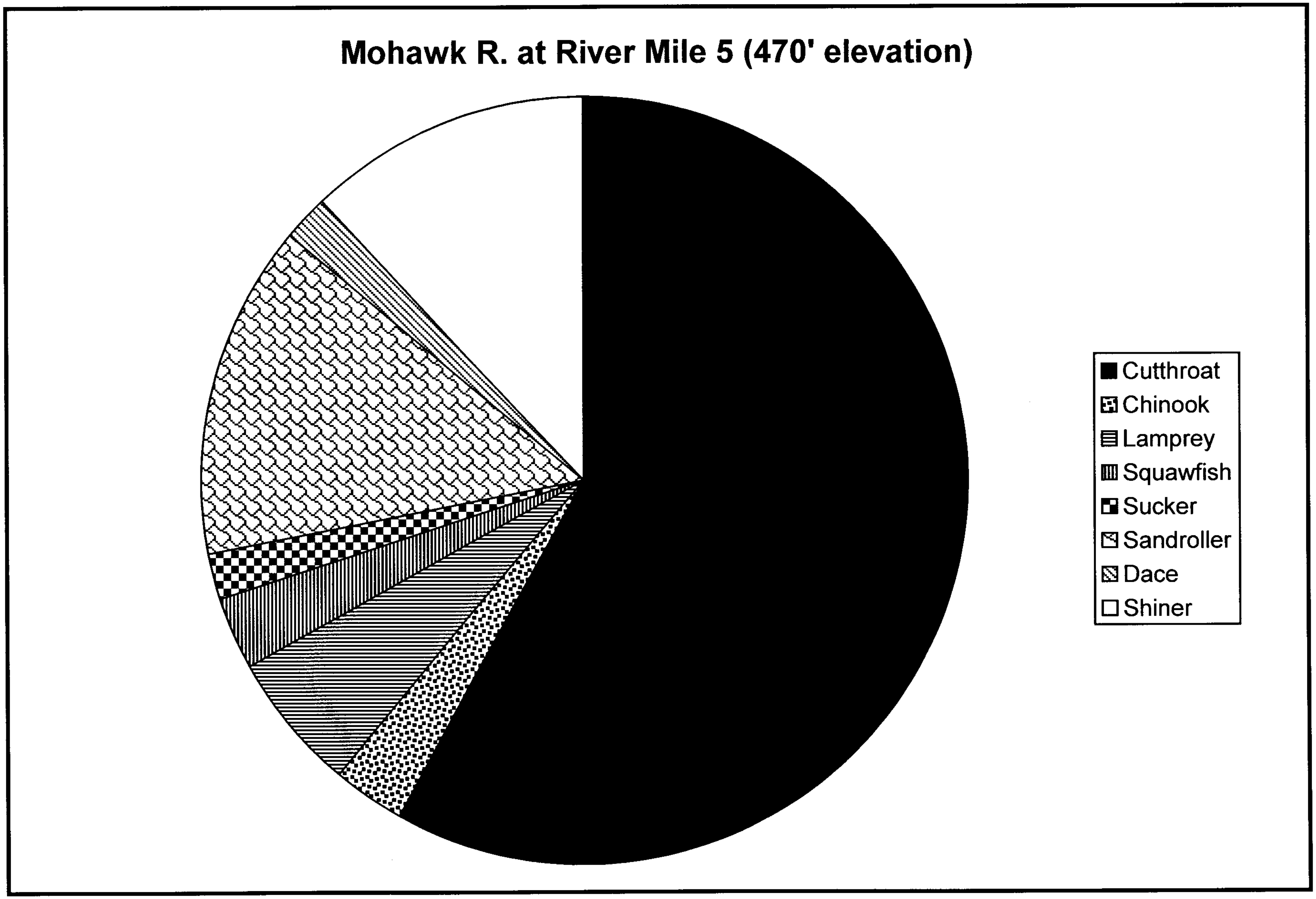


Figure 35. Composition of catch (percent by number) for fish captured by ODFW in a screw trap operated during winter and spring on the mainstem Mohawk River, 1992-94. Source: ODFW (1995).

have originated from farm pond releases: brown bullhead (Ictalurus nebulosus) and bluegill sunfish (Lepomis macrochirus). Non-native salmon and trout introduced by hatchery programs have included fall chinook salmon (Oncorhynchus tschawytscha), coho (O. kisutch), winter and summer steelhead (O. mykiss), and resident rainbow trout. The salmon introductions were of fish from lower Columbia River hatcheries. Juvenile fall chinook were released into the Mohawk system in 1967 and 1968. Hatchery coho, a species historically absent above Willamette Falls, were planted in the Mohawk and its tributaries from the early 1960s until the mid-1970s, both as juvenile fish and adults.

Steelhead were reported as historically absent from the Mohawk watershed (Dimick and Merryfield 1945; Parkhurst et al. 1950) but a small winter run apparently became established following releases of hatchery fish that began in about 1956 (Fulton 1970). Biologists with the Oregon State Game Commission counted 81 winter steelhead redds (spawning nests) in approximately 8 miles of the upper and North Fork Mohawk River in 1966 (Hutchison et al. 1966). During the late-1980s, the BLM found a few steelhead redds in Shotgun Creek (Neil Armantrout, pers comm.) that reflected stream use by either winter or summer run fish at that time. Hatchery summer steelhead of strains from the Oregon Coast (Siletz; 1968, 1969) and Washington state (Skamania River; 1972-present) have been released as smolts into the McKenzie River and stray adults from those releases have occasionally been found in the Mohawk watershed (Jeff Ziller, ODFW, pers comm.). Non-native hatchery rainbow trout were stocked into streams in the Mohawk watershed to support a small recreational fishery until the program was discontinued in 1988 (Mark Wade, ODFW, pers comm.).

The limited data available suggest that none of the non-native species of salmon or trout introduced to the Mohawk watershed founded a self-sustaining population that has persisted in significant numbers to the present day.

4.9.3 Focal Species.

The Partnership is interested in improving habitat conditions for salmonids native to the Mohawk watershed. The group intends to focus in the near-term on projects beneficial to native cutthroat trout, with a long-term goal of perhaps re-establishing a run of spring chinook salmon in the Mohawk River. Both of these species are adapted to cool, clean water and complex habitats that are spatially connected. The following subsections of this report address the life histories and habitat needs of these two species as well as the conditions limiting their distribution or abundance within the Mohawk watershed. A third salmonid reported to be native to the watershed, resident rainbow trout, is far less common in the Mohawk system than cutthroat trout and should benefit from actions taken to improve habitats for the two focal species.

4.9.3.a. Coastal Cutthroat Trout. The coastal cutthroat trout (O. clarki clarki) is the most widely distributed species of fish in the Mohawk watershed and is presumed to be present in all of the area's fish-bearing streams. Available information indicates that these fish probably inhabit 200 or more miles of streams in the watershed (Figure 36). Recent but limited fish presence-absence surveys conducted by ODFW have found cutthroat trout in several of the watershed's small headwater streams that were not previously known to support fish. In several instances, these headwater cutthroat were in streams too small to show up on available topographic maps (ODFW, unpublished data). The upstream extent of these headwater populations tends to be defined by natural falls, channel gradients exceeding about 20%, or impassable road culverts. In some instances, the fish may be found farther upstream during winter than during summer (BLM 1995), apparently due to habitat restrictions placed on them during the low flow period.

In the Willamette Basin, coastal cutthroat trout exhibit three basic life-history types (Hooton 1997): resident (fish exhibiting limited migrations within streams), fluvial (migratory fish that move between smaller natal streams and larger rivers), and adfluvial (migratory fish that move between natal streams and lakes). Cutthroat trout in the Mohawk watershed include both the resident and fluvial forms. Resident cutthroat are found in headwater areas, occasionally above migration barriers that serve to isolate populations (Nicholas 1978). However, the transition zone between resident and fluvial cutthroat in areas below barriers is not well understood (Hooton 1997).

Cutthroat in the Willamette Basin spawn between January and July, with trout at lower elevations tending to spawn earlier in this period (Nicholas 1978). Recent studies by ODFW (1995) suggest that the Mohawk's fluvial cutthroat return from the McKenzie (or Willamette) River during the winter, spawn primarily in February and March, and return to the larger river soon thereafter. Based on studies elsewhere in the basin, many cutthroat spawn in small tributaries, some with flows less than 0.5-1.0 cubic foot per second (Wyatt 1959). However, this does not mean that the fish do not spawn in larger streams (Moring and Youker 1979), and it

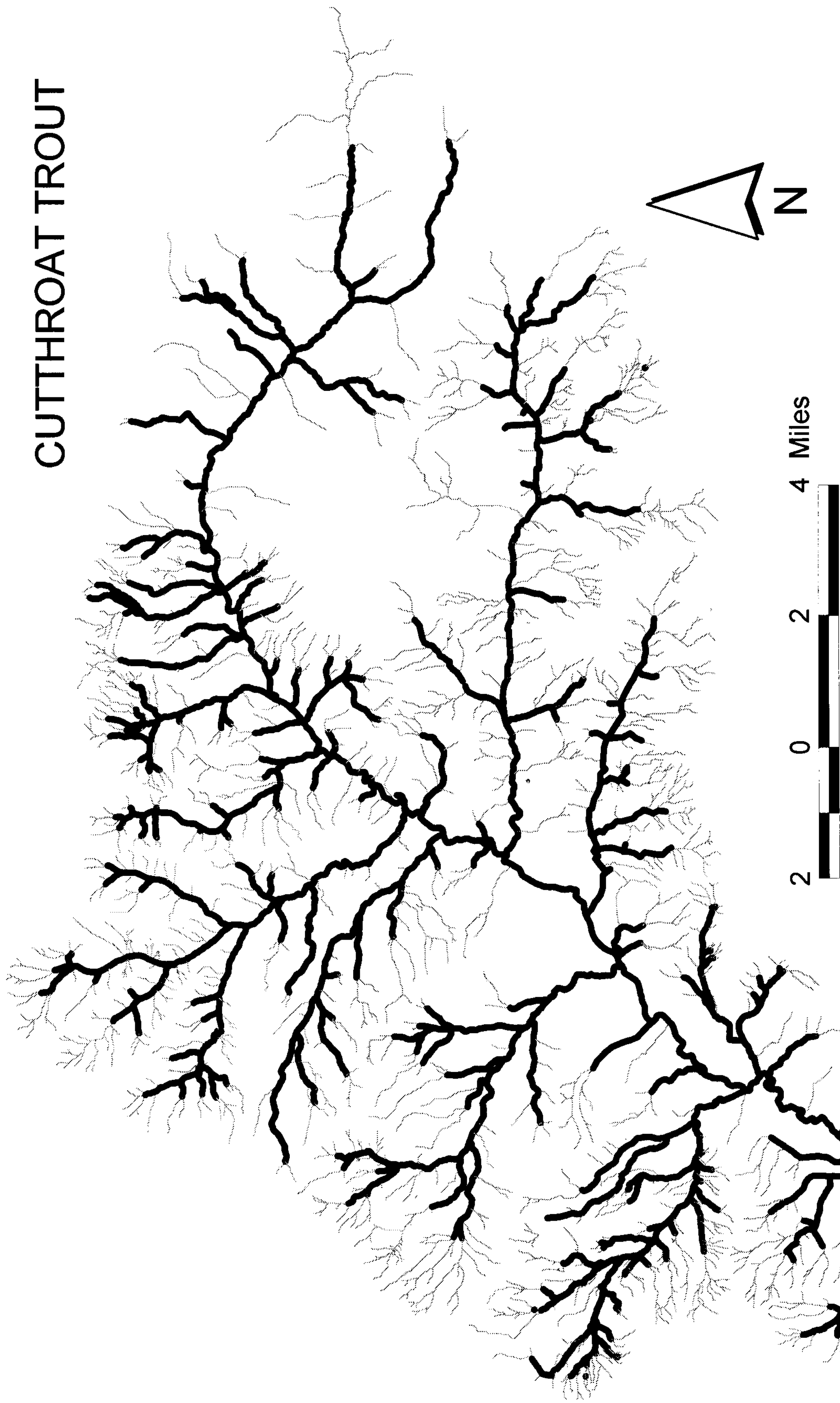


Figure 36. Reported distribution of cutthroat trout in the Mohawk watershed, Oregon. Sources: Weyerhaeuser (1994), BLM (1995), and ODF (1999).

may be that they will spawn wherever suitable spawning gravel is available to them in the Mohawk watershed (BLM 1995).

Cutthroat fry emerge from the gravel during late spring or summer, depending on the time of spawning and stream temperatures. After emergence, they disperse downstream and laterally into low-velocity channel margins, backwaters, and sidechannel areas (Moore and Gregory 1988). As juvenile cutthroat get older (and larger), they move to deeper habitats and show a strong preference for areas with good hiding cover. For example, Bisson et al. (1988) found coastal cutthroat to strongly prefer low-velocity habitats with abundant cover during winter. Similarly, Nickelson et al. (1979) found the species' biomass in Oregon streams during summer to be strongly related to the amount of cover. Cutthroat in cool headwater areas are generally smaller than those found in lower elevation tributaries and mainstem reaches, in part because the fish in larger and warmer channels grow faster (Nicholas 1978). The potential for fish to grow more rapidly in large mainstem channels is thought to be a primary reason for the existence of the fluvial life history.

Fish samples collected in the past along the middle to lower reaches of selected Mohawk River tributaries by Moring and Youker (1979), and by ODFW (1995), were dominated by juvenile cutthroat and included relatively few adults. This pattern strongly suggests that these areas provide important rearing habitats for young fluvial-type fish that move downstream to reach adulthood in larger river habitats. It also indicates that habitat in the middle to lower reaches of many Mohawk tributaries may not be of sufficient quality to support many large trout. Anecdotal accounts from older fishermen suggest that large cutthroat were caught in some of these areas and portions of the mainstem Mohawk many years ago (Jeff Ziller, ODFW, pers comm.), raising the possibility that fluvial or large resident cutthroat may once have made more extensive use of the watershed than they do at present.

Recent trapping on the lower Mohawk River shows that there is a large winter-spring out-migration of juvenile cutthroat toward the lower McKenzie River (ODFW 1995), where older and larger cutthroat are more common that they are in the Mohawk watershed (Figure 37). Hooton (1997) suggests that the magnitude of the juvenile out-migration means the Mohawk watershed may be the primary production area for fluvial cutthroats in the lower McKenzie and possibly the mainstem Willamette River downstream to Harrisburg. If correct, this would mean that streams in the Mohawk watershed are central to the maintenance of what Kostow et al. (1995) identify

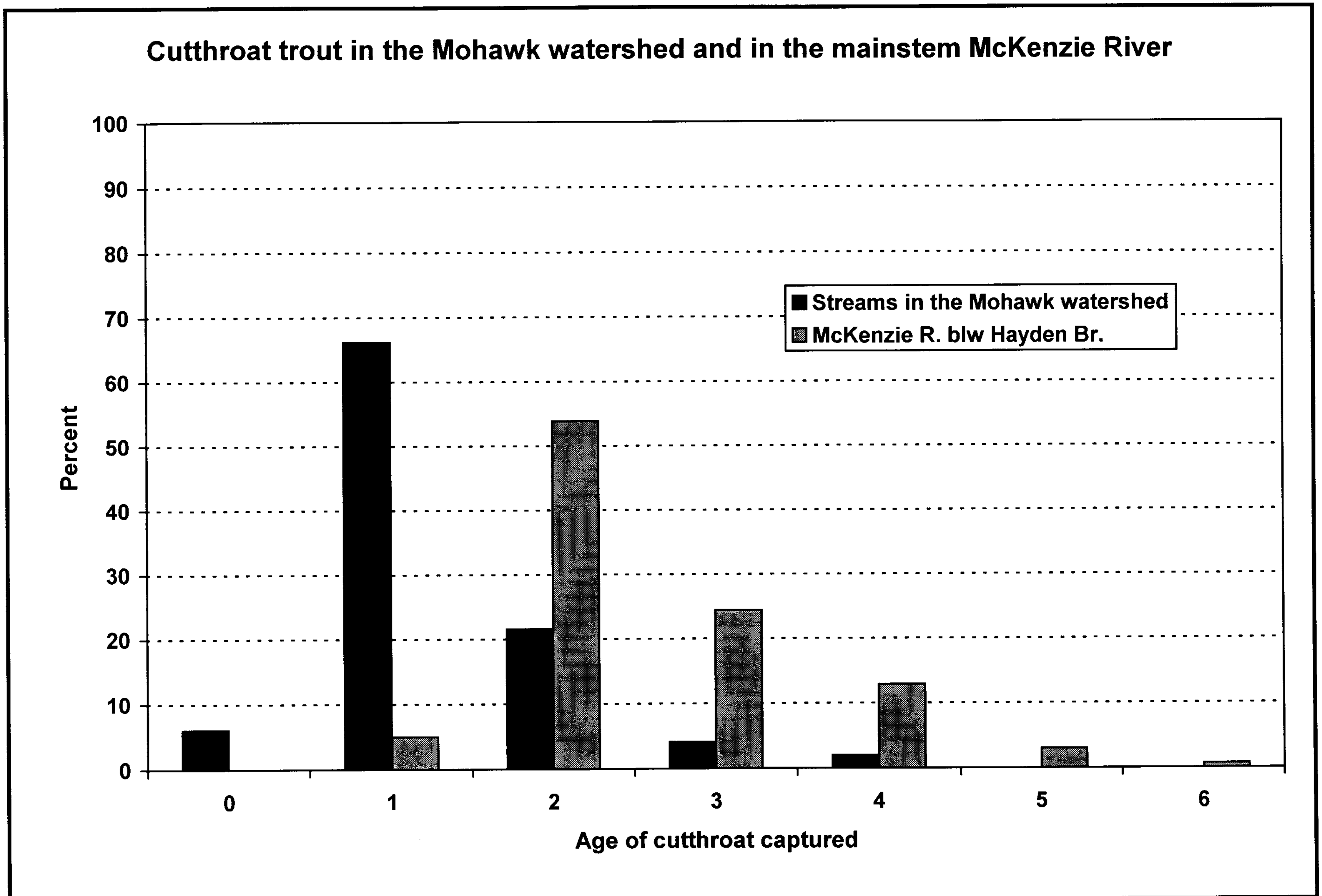


Figure 37. Age distributions for native cutthroat trout captured by electrofishing on streams in the Mohawk watershed and in the mainstem McKenzie River, Oregon. Source: Moring and Youker (1979).

as perhaps the only population group of fluvial cutthroats in the entire Willamette Basin that is not currently in decline. Fluvial cutthroat in the McKenzie River seem to be doing relatively well because of that river's high-quality habitat and restrictive fishery regulations, but it appears that their life-histories make many of them dependent on spawning and early rearing areas in the Mohawk system.

4.9.3.b. Spring Chinook Salmon. Spring chinook spawn in rivers and large streams, rear in freshwater as juveniles for up to a year or more, migrate to the ocean where they grow to adulthood, then return to their natal rivers and streams to complete their lifecycle. Within the Willamette Basin, most wild runs of these fish have become extinct as a consequence of historic habitat degradation, dams that have blocked access to important spawning areas, high harvest rates, and past hatchery practices. The Mohawk River had a native run of spring chinook reported to have become extinct by about 1910 (Parkhurst et al. 1950; Willis et al. 1960). Splash dams that damaged habitat in the mainstem Mohawk and blocked migratory fish access to much of the watershed at the turn of the century (Figure 38) likely played a major role in this extinction.

We could find no definitive records of exactly where the historic spring chinook run spawned within the Mohawk watershed. However, these fish inhabited one of the lowest elevation Willamette Basin watersheds known to have supported a spawning population of the species. After examining information on spring chinook spawning areas that were still in use during the late 1930s in other low-elevation watersheds within the Willamette basin (see Appendix D, Table D1 and Figure D1), we suspect that adult chinook were restricted to the mainstem Mohawk and possibly Mill Creek (Figure 39). Spring chinook likely spawned along about a dozen miles of the Mohawk River above Marcola, and might have used areas farther down on the mainstem or in Mill Creek as well.

The McKenzie River stands out as relatively unique within the Willamette Basin in that it continues to support a wild run of spring chinook. The current status of this run is not secure and it is listed as a Threatened species under the federal Endangered Species Act (ESA). In recent years adult spring chinook have occasionally strayed into the Mohawk from the McKenzie River (Howell et al. 1988), and it appears that some juvenile fish from the McKenzie's population rear during winter in at least the lower 5 miles of the Mohawk system (ODFW 1995).

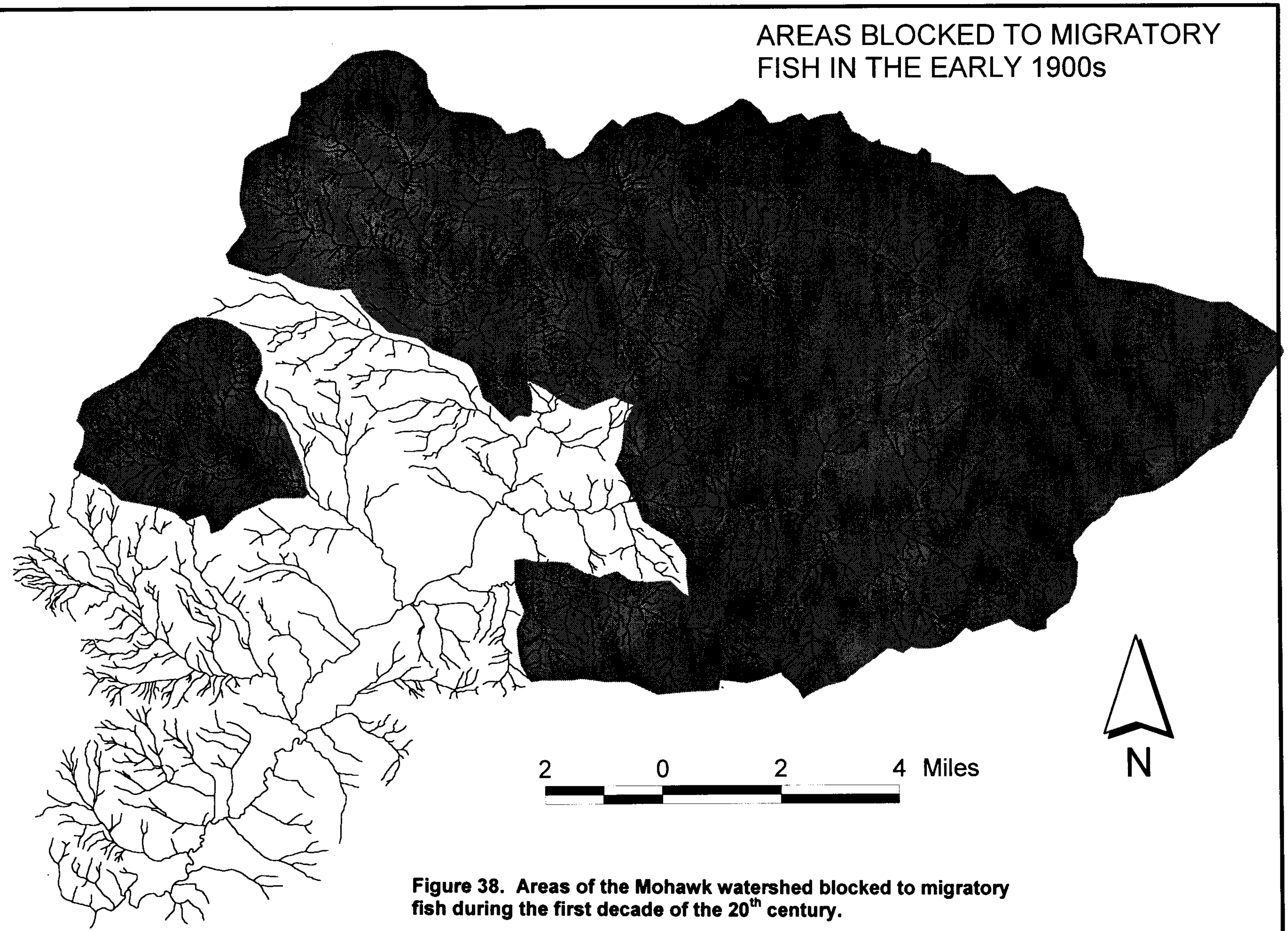


Figure 38. Areas of the Mohawk watershed blocked to migratory fish during the first decade of the 20th century.

HISTORIC SPRING CHINOOK

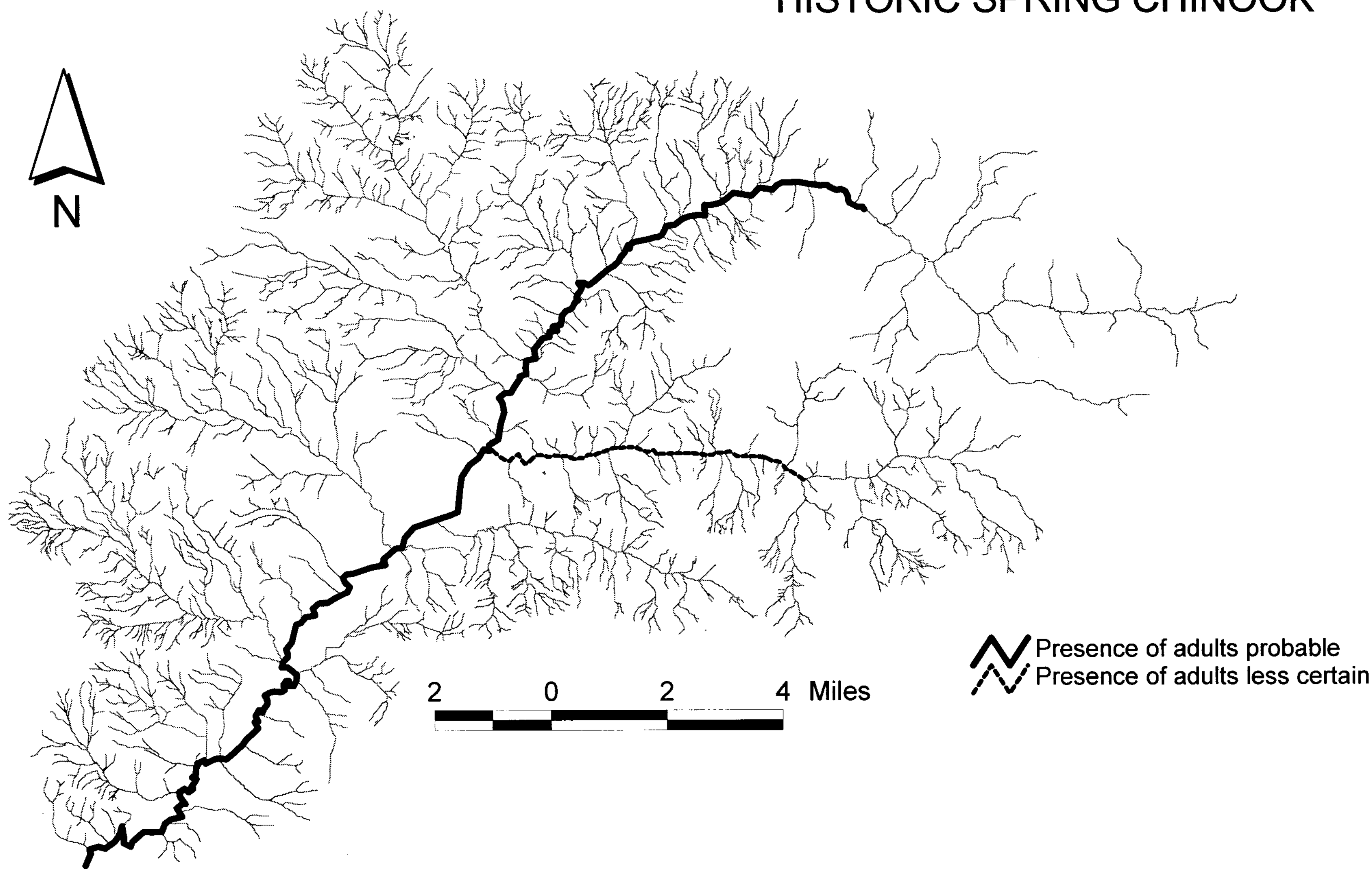


Figure 39. Estimated historic distribution of spring Chinook salmon in the Mohawk watershed, Oregon.

The National Marine Fisheries Service has designated areas within the Mohawk that are used by these fish to be critical habitat under the ESA.

Because of their close geographic proximity, chinook in the McKenzie River are thought to be closely related to the extinct Mohawk run and both juvenile and adult hatchery fish from the McKenzie have been released into the Mohawk above Marcola during the last three years as the first steps in a reintroduction effort. These releases, combined with the probable presence of juvenile chinook from the McKenzie in the lower Mohawk during winter and spring, make a discussion of the McKenzie's spring chinook run relevant to discussions of the Mohawk.

Adult spring chinook returning from the ocean migrate up the McKenzie River primarily from May to October, with a peak in June (Howell et al. 1988). The adults usually hold in deep, cool pools prior to spawning in September, although some fish spawn as late as early October (Howell et al. 1988). Many fish spawn in gravel-cobble riffles close to the pools in which they hold during summer while others move substantial distances upstream during September, just before spawning. The time required for hatching of spring chinook eggs varies from three to four months under natural conditions, depending on the prevailing water temperature (Dimick and Merryfield 1944). However, incubation times for the eggs deposited in many spawning areas within the upper McKenzie subbasin are now accelerated by increased winter water temperatures below water storage reservoirs (Homolka and Downey 1995).

Rearing patterns of juvenile spring chinook in the McKenzie system are variable but appear dominated by two distinct peaks in the downstream movement of fish following emergence from spawning areas. Many fry (fish <2 inches) disperse downstream into productive rearing habitats in the lower McKenzie and Willamette rivers soon after emergence from the gravel in winter or spring (Howell et al. 1988). Young chinook that do not disperse quickly downstream into these lower river habitats rear for variable periods of time in areas higher up in the river system, closer to where their parents spawned. Peak migration into the lower McKenzie by this second group of juvenile chinook occurs from October through December, when the fish are larger (>2.5 inches) and nearly a year old (Willis et al. 1995). All juvenile spring chinook naturally produced in the McKenzie system have moved down the mainstem Willamette River to the ocean by the spring of their second year.

After emergence, chinook fry prefer to rear in shallow habitats with low water velocities near stream margins, including backwater eddies and areas with bank cover (Lister and Genoe 1970; Everest and Chapman 1972). As they grow in size, juvenile chinook often move toward summer rearing habitats that are deeper, further from the banks, and that have higher water velocities than those preferred by fry (Everest and Chapman 1972; Hillman et al. 1987). However, this does not mean that juvenile spring chinook prefer to rear in high water velocities. Recent habitat preference studies in the mainstem McKenzie found that juvenile spring chinook in the river during summer show a strong preference for habitats with velocities that are lower than those in most of the river (Hardin-Davis, et al. 1990). The fish in the McKenzie strongly preferred lower velocity areas within pool, sidechannel, and run habitats over riffles for summer rearing (Hardin-Davis, et al. 1990).

Winter rearing habitats used by juvenile spring chinook in the Willamette Basin are known to include low-gradient tributaries to larger rivers (S. Mamoyac, ODFW, pers comm., J. Ziller, ODFW, pers comm.). These tributaries apparently provide the fish desirable feeding areas and refuge from high winter flows. Research in other areas of the Northwest have shown habitats preferred at this time of year to also include pools with abundant large woody debris, loosely packed cobble-boulder substrates (i.e., areas with abundant interstitial spaces), and protected areas along river margins (Swales et al. 1986; Healey 1991; Levings and Lauzier 1991). Hillman et al. (1987) found juvenile spring chinook to use areas associated with undercut banks in snowmelt streams that were strongly affected by fine sediment deposition.

4.9.3.c. Limiting Factors for Cutthroat Trout. Previous watershed assessments (Weyerhaeuser 1994; BLM 1995; NRCS 1999) and data collected or compiled during this study are consistent in suggesting that there are multiple instream factors likely to limit cutthroat trout within the Mohawk watershed. These include:

- low streamflows during summer
- warm summer water temperatures, particularly in large and low elevation channels
- simplified channels that have limited woody debris and few pools with complex cover
- locally high levels of fine sediments that may affect spawning success
- migration barriers at road crossings

Most of these habitat limitations are at least partly related to past practices, current riparian conditions, existing landuse activities, roads, and/or water diversions. The limitations tend to be most severe in large and low elevation stream channels.

4.9.3.d. Limiting Factors for Spring Chinook Salmon. Each of the limiting factors identified for cutthroat trout affects habitat suitability for spring chinook salmon as well. However, the natural distribution of this species within the watershed is restricted to a subset of channels that appear at present to impose the greatest limitations on salmonids. This helps to explain why the Mohawk watershed continues to sustain cutthroat trout populations but does not presently support a self-sustaining run of spring chinook. The large, low-gradient channels that provide their preferred habitat when in good condition tend to be among those most affected by a lack of channel complexity, high water temperatures, or both. Combined with severely low late season flows, existing habitat conditions give us the sense that significant recovery of spring chinook in the Mohawk system will require persistent, long-term restoration efforts and all of the resilience these salmon have to offer.

During the past three years (1997-99) ODFW has released juvenile and adult spring chinook from the McKenzie Hatchery into the upper mainstem Mohawk River (M. Wade, ODFW, pers comm.). If these chinook releases produce adult fish returning to the Mohawk from the ocean, something that might begin to occur in 2000, habitat conditions in the watershed will be given a true test of suitability for the species. At present, we believe these habitat conditions are likely to be most constraining for adult chinook because they are more temperature sensitive than juveniles of the species and may be particularly vulnerable to the very low flows found in the river during summer and early fall.

Difficulties or limitations that habitat in the Mohawk poses for specific spring chinook lifestages are given below:

- *Adult upstream migration, holding, and spawning*. Upstream migration and summer holding conditions within much of the Mohawk River are marginal to poor for adult spring chinook. An examination of available temperature and flow data suggests that adults could migrate up the river to spawning areas between Cartwright Creek (i.e., Marcola) and River Mile 23.5 in June, hold in nearby pools through summer, then spawn in late September or early October. Temperatures in the lowest reaches of the river during June would often be higher than recommended for adult migration (60^{o}C; Reiser and Bjornn 1979) but lower than those reported to block migrations (70^{o}C; Major and Mighell 1967). Adult chinook holding near the spawning areas through summer might be vulnerable to predation or harassment, because adjacent pools are not always large and deep enough to provide adequate hiding cover and large woody debris that would provide such cover is usually lacking. Adults holding in much of the river above Marcola, particularly near what currently appear to be the prime spawning areas between Marcola and Shotgun Creek, would also be exposed to very stressful water temperatures and risks of disease unless they could find pockets of cooler water.

As an alternative, adult fish might hold during summer in the lower McKenzie River until Mohawk water temperatures dropped substantially in late September, then work their way upstream under very low flow conditions to spawn above Marcola. Adult chinook moving upstream toward Marcola or above in late September or early October might find it difficult to navigate shallower segments of the river and would probably be quite vulnerable to predation or harassment. Regardless of how they got to spawning areas in the Mohawk River, adult spring chinook would likely find a considerable portion of the suitable gravel unavailable to them due to very low streamflows.

- *Egg Incubation.* Weyerhaeuser (1994) identified a concern about the potential for increased risk of scour for spring chinook eggs that would have to incubate in potentially unstable gravels during winter high flows in mainstem channels above Marcola that have been affected by historic splash damming. This would include a high proportion of the potential spawning areas in the Mohawk River. The increased risk is associated with channel alteration and a lack of large woody debris to help create stable gravel deposits where stream channels are naturally confined.

  Riffles in the lower Mohawk River below Marcola tend to have high levels of fine sediments that would clearly reduce egg survival. This condition has been present in the lower river since at least the mid-1930s.

  An additional concern in the lower and middle portions of the mainstem is that water temperatures early in the incubation period may be high enough to elevate egg mortality rates. Few temperature data are available for evaluating this issue.

- *Fry Habitat*. Along many sections of the Mohawk River above Marcola the low-velocity, protected areas along channel margins that are a preferred habitat of spring chinook fry may be uncommon in the late winter or spring due to historic channel simplification and low abundance of large woody debris or other flow obstructions.

- *Summer Rearing*. Low streamflows, warm summer temperatures, and reduced habitat diversity limit the quality of summer rearing habitat for juvenile spring chinook in much of the mainstem Mohawk River. Available monitoring data suggest that maximum water temperatures during summer would stress these fish in many mainstem areas and would likely be high enough (~7-day maximum >71^{o}F) to restrict juvenile fish to mainstem areas above Marcola or Mill Creek during portions of the summer unless fish farther downriver could find localized thermal refuge. Warm temperatures in the lower river might cause juvenile chinook to seek refuge in relatively cooler tributary streams, making maintenance of good fish passage within those tributaries an important issue.

- *Winter Rearing.* Good winter rearing habitat for juvenile salmonids is relatively limited in the mainstem Mohawk River above approximately Parsons Creek because off-channel areas, accumulations of large woody debris in pools or along channel margins, and other habitats that might provide refuge from high flows or predators are relatively infrequent. These types of habitats are somewhat more common along the river below Marcola, but less common there than they would have been when the lower segments of lowland tributaries were less incised or more closely associated with functional wetlands. Throughout the length of the mainstem Mohawk, juvenile chinook would likely find low-gradient tributaries to be an attractive refuge from high flows. Maintaining good fish passage to these Mohawk tributaries would thus be important to their use during winter as well as in summer.

5. FRAMEWORK FOR WATERSHED IMPROVEMENT

Although it is clearly not the Partnership's intent (nor would it be possible) to return to pre-developed conditions in the Mohawk watershed, there are many opportunities to improve stream, riparian, and upslope areas for the benefit of the watershed's native fish, wildlife, and human residents. Achieving and sustaining these improvements will require efforts to address the causes as well as the accumulated consequences of long-term alteration of the watershed. Some practices on forestlands, agricultural/grazing lands, and in rural-residential areas will need to improve, and projects that address specific problems created by past practices will need to be implemented.

Early Partnership efforts to improve watershed and stream conditions will need to focus most strongly on citizen education, encouraging changes in landuse and other practices, carefully targeted projects, and maintenance of restoration options for the future.

5.1. ECOLOGICAL OBJECTIVES

Efforts to achieve sustainable habitat improvements for the Mohawk's cutthroat trout, spring chinook, and other native aquatic species should be guided by a set of ecological objectives that are consistent with scientific principles. The following objectives, modified from FEMAT (1993) and NMFS (1996), place an emphasis on reducing human impacts on natural processes that are important in creating and maintaining healthy aquatic systems:

- Improve watershed conditions to assure that the aquatic system will provide the habitat needed to support well-distributed populations of native species over the long-term.

- Maintain or reestablish unobstructed routes to critical areas for fulfilling the life history requirements of aquatic (and other riparian-dependent) species.

- Protect and restore native plant communities in riparian areas and wetlands where feasible to provide adequate summer and winter temperature regulation, nutrient filtering, appropriate rates of erosion and channel migration, and to supply amounts and distributions of large woody debris (LWD) sufficient to sustain habitat complexity and stability.

- Where feasible, move toward the natural timing, volume, and distribution of LWD recruitment by trees in riparian areas. Direct additions of LWD to streams are helpful but inappropriate unless the causes of LWD deficiencies are addressed.

- Maintain or move toward the water quality associated with healthy riparian, aquatic, and wetland systems. Water quality, including stream temperatures, should be in the range beneficial to the survival, growth, reproduction, and migration of native species.

- Move toward the sediment regime under which the aquatic system (and thus the native species) evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.

- Assure streamflows that will create and sustain riparian, aquatic, and wetland habitats, retain patterns of sediment, nutrient, and wood transport, and provide essential aquatic habitat features for native species.

- Maintain and, where possible, restore the physical integrity of the aquatic system, including streambanks and bottom configurations.

- Where feasible, improve stream channel connectivity to floodplains and raise water table elevations.

5.2. ACTIONS CONSISTENT WITH ECOLOGICAL OBJECTIVES

Actions that will be important to maintaining or improving water quality and habitat in the Mohawk system for cutthroat trout, chinook, and other aquatic species have been identified by recent watershed assessments, an ongoing state-sponsored independent scientific review of landuse practices in western Oregon, regional planning exercises, and this study. These actions are summarized below in sections on Forest Lands, Agricultural/Grazing Areas, and Rural-Residential Areas. Properly taken, all of these actions will be consistent with the ecological objectives previously outlined, but some may be beyond the Partnership's capabilities or sphere of influence within the watershed. Projects that protect or restore riparian areas or address problems created by roads (including fish migration barriers) are likely to be among the most helpful in the near-term. Riparian restoration projects will be central to addressing water temperature, other water quality, and aquatic habitat issues in lowland and many upland areas in the watershed.

5.2.1. Forest Lands

Private forest landowners have been regulated by the state's Forest Practices Act (FPA) water protection rules for nearly 30 years. These rules apply to nearly all aspects of forestry operations and have been periodically updated. In a recent review of the current FPA rules, the state's Independent Multidisciplinary Science Team (IMST) for the Oregon Plan for Salmon and Watersheds concluded that the rules are insufficient to meet objectives for salmonid recovery and water quality set forth in the Plan (IMST 1999). They recommended that the rules be revised to include multiple actions already being taken by many private landowners on a voluntary basis, plus stronger riparian protections along streams, improved standards and guidelines for forest roads, storm-proofing requirements for old or abandoned roads not constructed to current FPA standards, and other improvements. The IMST also recommended coordinated planning among landowners within watersheds but acknowledged that this might be quite difficult to implement in a regulatory context. With help from an advisory committee, the Oregon Board of Forestry will soon decide the degree to which the IMST's recommendations will be incorporated into revised FPA rules. As the rules are revised, Federal agencies with statutory responsibility will likely evaluate them for consistency with the federal Endangered Species Act and Clean Water Act.

Exactly what revisions will ultimately be made to the Oregon FPA remains to be determined. However, the Weyerhaeuser (1994) and BLM (1995) watershed analyses that have helped guide most private industrial and federal forest management in the Mohawk area for the last half-decade combine to identify multiple actions that are probably not being taken by all forest landowners in the watershed. Where possible, the Partnership should encourage these actions by small, non-industrial landowners:

- **Go beyond the current minimum regulatory requirements to protect and restore native riparian vegetation that will shade and deliver wood to streams.** Activities in this regard include leaving additional mature conifers in riparian buffers, underplanting shade tolerant conifers, and experimental manipulation of hardwood stands to encourage development of coniferous stands. These experiments should be small in scale and carefully monitored.

- **Reduce the potential for sediment delivery and runoff from active forest roads, abandoned roads or railroad grades, and ORV trails.** This action has several potential elements, including the decommissioning or seasonal closure, stabilization, drainage modification, surfacing, or other upgrading of roads and trails where delivery of water or sediment to stream channels is high or where there is a risk of catastrophic failure. Other important elements include developing (and implementing) coordinated road management plans and limiting the total abundance of forest roads and trails.

- **Reconstruct stream road crossings that block fish or are otherwise substandard (e.g., culvert replacements).** Written guidance for this activity is available in ODFW (1996).

- **Cautiously manage or avoid areas at high risk of landsliding.**

- **Place large woody debris in streams to increase habitat complexity, create high quality pools, and provide cover at strategically selected locations.** This type of activity should be done in the context of watershed-level approaches to restoration and only in combination with any needed riparian improvements in the areas treated. Recommendations for appropriate locations could be obtained from local ODFW biologists. Written guidance for proper placements is available in ODF and ODFW (1995).

- **Work with ODFW in beaver management to raise water tables, improve water storage, enhance riparian vegetation, and create desirable habitats where this can be accomplished without landowner conflicts**. Written guidance for this activity is available in ODFW (1999).

5.2.2. Agricultural/Grazing Areas

The Independent Multidisciplinary Science Team is reviewing the aquatic impacts of general farm and livestock practices in western Oregon and will issue a report on improvements needed to meet the state's salmonid recovery and water quality objectives. The Partnership should examine the results of this review when it is completed and, where possible, encourage the recommended changes in practices.

Cost-share programs, including the Environmental Quality Improvement Program (EQIP) and the Oregon Conservation Reserve Enhancement Program (CREP) are readily available in the watershed and some landowners have already made notable voluntary improvements to their management practices. However, significant problems or important conservation opportunities still exist in or near many of the watershed's agricultural fields and pastures. The Natural Resource Conservation Service's Mohawk River Watershed Assessment (NRCS 1999), the Willamette Restoration Initiative (Institute for the Northwest 1999), and our own field observations combine to suggest that the following landowner actions would help the Partnership meet its objectives:

- **Protect and expand areas of native riparian vegetation, including the bottomland forest along the mainstem Mohawk River.** This activity may include development of conservation easements, changes in landuse practices, and planting of native riparian vegetation (primarily trees and shrubs). Candidate sites along the mainstem and lower sections of tributaries have been delineated on 1:12,000-scale air photos on file with the Partnership. The Natural Resources Conservation Service has produced additional vegetation mapping of these areas.

- **Control livestock access to streams, riparian areas, and wetlands.** Options include constructing riparian fences and developing off-site watering, and modifying management practices. Air photo analysis and field inspection suggests to us that livestock access to streams and their riparian areas tends to be a greater problem along several Mohawk tributaries than it is along most lowland sections of the mainstem.

- **Control exotic species that have invaded riparian areas and that impede the growth of native vegetation.** Exotic species in the Mohawk watershed include blackberry, which is widely distributed, scotchbroom, and reed canarygrass, which is found in some riparian areas in the Lower Mohawk subwatershed. Removals should be coupled with planting of native riparian vegetation and, where the blackberries previously blocked livestock access to streams, riparian fencing.

- **Use native vegetation and organic materials where possible to treat erosion problems along streambanks.** Potential sites along the mainstem Mohawk River have been delineated on 1:12,000-scale air photos on file with the Partnership.

- **Improve livestock wintering strategies to avoid problems from manure build-up.**

- **Adopt practices that further reduce soil erosion and runoff.**

- **Adopt practices that ensure the proper management and use of pesticide and fertilizer.**

- **Conserve water where possible so that more remains in streams.**

- **Fix fish passage barriers at stream crossings and avoid creating new barriers.**

- **Restore wetlands and other off-channel habitats for native species (fish, frogs, turtles, etc.).** The greatest emphasis or priority should be placed on least modified, most easily restored, and near-stream habitats. Beaver present at scattered locations within the watershed could be employed to assist in restoring wetlands on the valley floor.

- **Ensure that water diversions are screened to protect fish.**

5.2.3. Rural-Residential Areas

Overall, the greatest long-term threat to water quality, salmonids and other native aquatic species in the Mohawk watershed is the potential for continual rural-residential development (urbanization). This is because it is irreversible, tends to have high environmental impact per unit area affected, and reflects growing numbers of people in the watershed, each of whom have small but cumulative daily impacts. Continued residential development in lowland areas, particularly in historic or current flood plains and wetlands, has the potential to further constrain options for restoring processes important to the health of the river. The IMST is reviewing the effects that urban development and associated activities in western Oregon have on the state's ability to meet its salmonid recovery and water quality objectives. The Partnership should examine the results of this review when it is completed and, where possible, encourage the recommended changes in practices.

The Natural Resource Conservation Service's Mohawk River Watershed Assessment (NRCS 1999), the Willamette Restoration Initiative (Institute for the Northwest 1999), and our own field observations combine to suggest that the following actions related to areas zoned for rural-residential development would help the Partnership meet its objectives:

- **Help Lane County ensure that there will not be further encroachment on floodplain, restorable wetland, riparian, or other sensitive areas in the Mohawk watershed.** Advisors to Lane County have been developing recommendations for updating the county's riparian protection ordinance that applies to rural development. It is anticipated that the current rules will be substantially strengthened and that some form of incentive program will be developed to encourage landowners to go beyond minimum requirements.

- **Encourage Lane County to limit the total amount of development and increases of impervious surfaces in order to avoid undesirable effects of increased peak flows, reduced base flows, and lowered water quality.**

- **Protect, and where possible expand, areas of native riparian vegetation.** This activity may include development of conservation easements, changes in landuse practices, and planting of native riparian vegetation (primarily trees and shrubs). Candidate sites along the mainstem Mohawk and lower sections of tributaries have been delineated on 1:12,000-scale air photos on file with the Partnership. The Natural Resources Conservation Service has produced additional vegetation mapping of these areas.

- **Use native vegetation and organic materials where possible to treat critical erosion problems.** Potential sites along the mainstem Mohawk River have been delineated on 1:12,000-scale air photos on file with the Partnership.

- **Improve septic system maintenance and replace failing systems.**

- **Reduce and promote the cautious use of home and yard chemicals (including fertilizer).**

- **Increase streamflows by withdrawing less water from streams.** Potential conservation measures include landscaping with native plants that have low requirements for watering. Of the respondents to a survey of landowners in the Mohawk watershed, one-third of those who withdrew water from streams used at least some of it to water their lawns (Mooney 1998).

- **Reduce sediment delivery and runoff from small rural roads and driveways.** During a winter field tour of the watershed we noticed several small, unpaved roads and driveways that were not well designed or constructed. Many more surely exist and the severity of problems they might pose could be evaluated by touring the watershed during a heavy winter storm. Written guidance for identifying and fixing such problems could be found in Weaver and Hagans (1994).

- **Fix fish passage barriers at stream road crossings or other structures, and avoid creating new barriers.**

- **Control livestock and off-road vehicle access to streams, riparian areas, and wetlands.** This action would be very helpful at a number of small hobby farms on Mohawk tributaries. During our stream surveys we encountered such farms that had livestock grazing in riparian areas that were in very poor condition and one small-acreage farm that had an active ORV trail crossing through a named fish-bearing stream and riparian zone.

- **Ensure that water diversions are screened to protect fish.**

- **Consider placing wood at strategic locations within streams, where this can be done without threatening property.**

5.3. WHERE TO FOCUS EARLY EFFORTS BY THE PARTNERSHIP

We suggest that early aquatic conservation efforts by the Partnership focus on the kinds of activities identified in Section 5.2, with priority given to strategically selected subwatersheds or geographic areas of emphasis within the Mohawk watershed. The purpose of concentrating the Partnership's efforts in specific areas would not be to reject important opportunities that might develop elsewhere, but rather to focus on protecting or restoring key resources in a way more likely to have a cumulative, positive, observable, and persistent effect on the aquatic system. The basic idea would be to work toward creating strongholds in which native aquatic species would be more resilient to disturbance or change.

After carefully reviewing ownership patterns, information contained in this report, and suggestions made by BLM (1995), we identified eight subwatersheds of the Mohawk that, along with the main river corridor (including the floodplain), could provide a good watershed context and focus to the Partnership's program (Figure 40). Five of these potential emphasis subwatersheds were first identified through a ranking procedure emphasizing high public ownership, watershed sensitivity, and forest condition (Appendix E), but their relative merits might also be expressed in the following terms. The **Shotgun** and **Cash** subwatersheds have the highest levels of public ownership in the Mohawk watershed (69 and 64% respectively) and

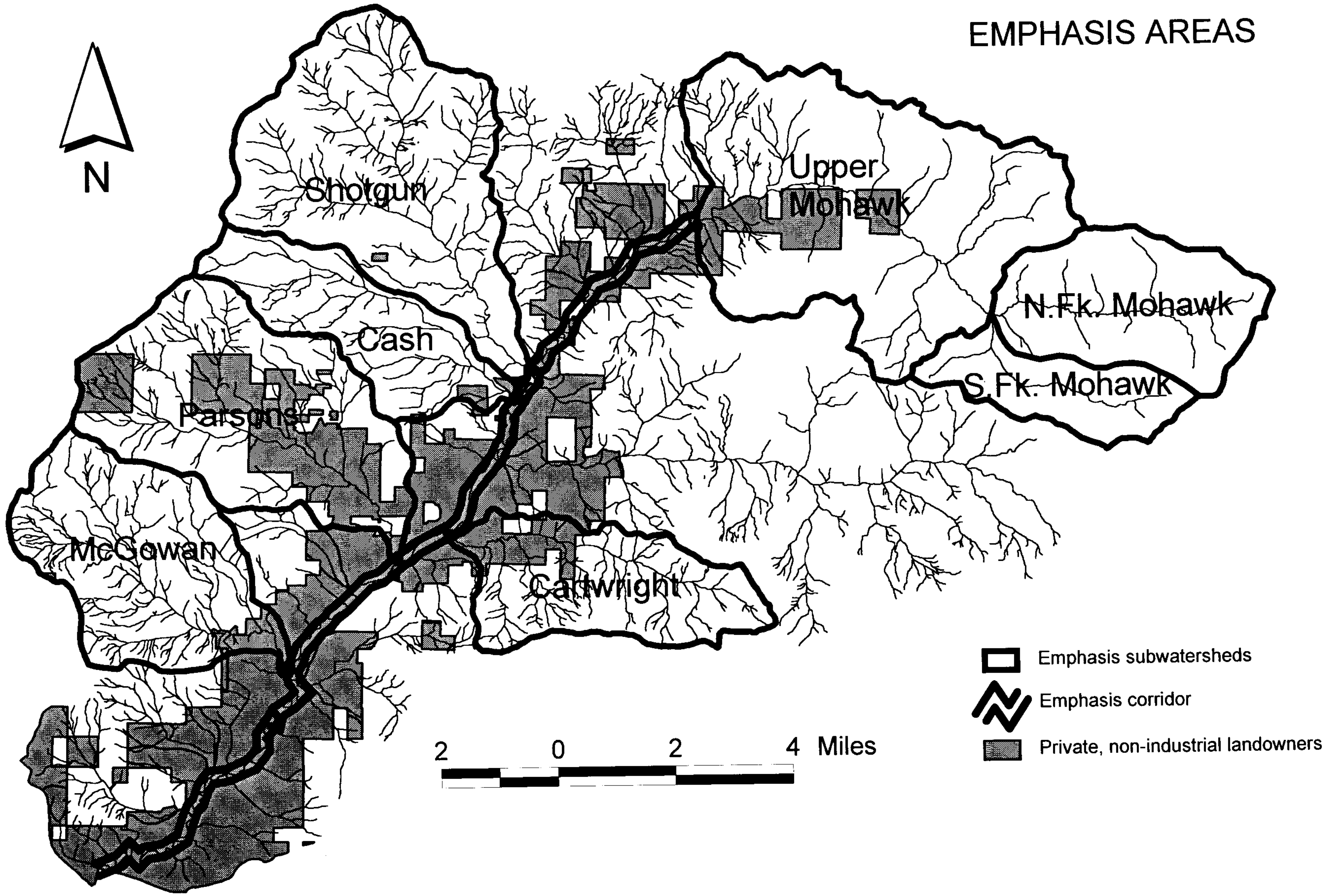


Figure 40. Subwatersheds and river corridors of potential conservation emphasis within the Mohawk watershed, Oregon.

offer the opportunity to leverage private conservation efforts against those already underway by BLM, although they contain little non-industrial private land. The **McGowan** (46% public) and **Parsons** (24% public) subwatersheds were both suggested as good candidates for restoration programs by the BLM (1995). McGowan contains much of the watershed's little remaining old-growth forest and Parsons has a high proportion of private, non-industrial land. **Cartwright** subwatershed (33% public) had one of the highest proportions of older forest in the Mohawk watershed (32% of its forestland) and unique educational opportunities because it contains the only high school in the watershed. These five subwatersheds are thought to support the highest abundances of cutthroat trout in the Mohawk watershed (Jeff Ziller, ODFW, pers comm.).

The final three subwatersheds mapped as potential emphasis areas were identified on the basis of their importance to water quality and salmon restoration in the Mohawk. The North, South, and Upper Mohawk subwatersheds combine to provide a critical source area for relatively cooler water in the system and their condition will likely have a strong influence on the success of future efforts to restore spring chinook. Each of these subwatersheds is more than 95% privately owned, with the North and South Forks having no non-industrial private landowners.

Public and private industrial landowners within the eight subwatersheds and river corridor suggested as potential "Emphasis Areas" have ongoing watershed programs. We suggested that the Partnership use these areas or a reasonable subset of them to provide a watershed context to its program. The areas could then be used as a basis for coordinating activities with all types of landowners within the Mohawk watershed and for helping to prioritize actions that non-industrial private landowners offer to take to improve natural habitats and water quality for the benefit of all watershed residents.

Following a Partnership decision to incorporate all of the candidate Emphasis Areas into its conservation program, we combined these areas, information given in Section 5.2 of this report, and input from the group's local technical advisors to develop a spatially explicit framework of conservation priorities. This framework, which places greatest emphasis on important near-term actions, is summarized in Table 8. It identifies general levels of priority for actions that can be taken or supported by the Partnership, as well as where within the Mohawk watershed many of the most important near-term opportunities for each type of action might be found, particularly among non-industrial private landowners.

Table 8. Near-term priorities for actions by the Mohawk Watershed Partnership.

Action	Priority	Primary Emphasis Areas	Other opportunity areas
Work with landowners, as well as local and other agencies, to encourage improvements in land or water use practices within forest-lands, agricultural/grazing areas, and rural-residential areas. This action could include work toward: slowing or discouraging urbanization of the watershed; increasing streamflows through improved water management; ensuring that water diversions are screened to protect fish; controlling livestock access to streams, riparian areas, and wetlands; improving septic system maintenance and replacing failed systems; reducing sediment delivery and runoff from small rural roads, drive-ways, and other surfaces; adopting practices that assure cautious and proper use of yard or farm chemicals, including fertilizer; and continued improvements in forest practices.	very high to high	Mohawk River Corridor, and the Upper Mohawk, Cash, Cartwright, Parsons, and McGowan subwatersheds	Watershed-wide
Protect and restore bottomland forest, particularly along the mainstem Mohawk between Parsons Creek and the mouth.	high	Mohawk River Corridor	Lower Mill subwatershed
Improve riparian conditions in the watershed as a whole, emphasizing areas managed by the private, non-industrial landowners who are a primary focus of the Partnership's programs.	high	Upper Mohawk, Cartwright, Parsons, and McGowan subwatersheds	Watershed-wide
Compile the results of previous and ongoing inventories, then prioritize and fix unnatural barriers to fish migration.	high	Upper Mohawk, Cartwright, Parsons, and McGowan subwatersheds, plus the seasonal reservoir within the Shotgun Creek Recreation Site	Watershed-wide
Inventory, prioritize and fix erosion hazards associated with active and abandoned roads, and railroad grades, where this work has not already been completed.	high	Upper Mohawk, Cartwright, Parsons, and McGowan subwatersheds	Watershed-wide
Monitor stream temperatures in a systematic manner so that both cool water refuge and problem areas can be identified and incorporated into the Partnership's program	high	Mohawk River Corridor, and the Upper Mohawk, Cartwright, Parsons, and McGowan subwatersheds	Watershed-wide, including Mill Creek which is already on the Oregon 303(d) list for having water quality impaired by temperatures exceeding state standards
Increase aquatic habitat and channel complexity by placing large woody debris in streams, with an emphasis on responsive channel segments, areas of relatively cooler water, or (possibly) summer holding areas for adult spring chinook.	moderate to high	Mohawk River Corridor above Parsons Creek, and the Upper Mohawk, Cartwright, Parsons, and McGowan subwatersheds	Watershed-wide
Restore wetlands and other off-channel habitats, particularly along the mainstem Mohawk and lowland reaches of its tributaries.	moderate to high	Mohawk River Corridor, and the Cartwright, Parsons, and McGowan subwatersheds	Watershed-wide, including a recently formed pond on the western edge of the valley floor north of Black Canyon Creek

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