The Yakima basin once supported spring, summer/fall Chinook, summer steelhead, coho (*O. kisutsh*), and sockeye salmon. Historic runs have been estimated at 790,000 adults before the 1870s (Northwest Power Planning Council 1989, table 11). By the turn of the century, more than 90 percent of the runs were believed to be depleted, with coho and sockeye runs nearly extinct (Uebelacker 1980). The primary causes were dams and irrigation canals without adequate fish ladders and screens, along with log drives that affected stream habitat, and local overfishing (Fast and others 1991). These declines were not taken seriously by management agencies until the 1950s. In addition, resident trout and bull trout were also declining.

Table 11. Historical estimates of salmon and steelhead runs in the Yakima River basin (NPPC 1989).

Species/race	Historic Run Size	Present Run Size [a]
Spring Chinook	200,000	
Fall & Summer Chinook	200,000	
Coho	110,000	
Summer Steelhead	80,000	
Sockeye	200,000	
Total	790,000	7,018

[a] - based on mean run size for all anadromous salmonids in the Yakima Basin, from 1983-87 (NPPC, 1989). Sockeye and summer chinook are extinct, with coho at severely depressed populations.

Within the basin, the major constraints currently limiting increased anadromous fish runs are believed to be inappropriate instream flows (too low or too high), upstream/downstream passage at irrigation diversions, degraded riparian and stream habitat, and excessive temperatures in the lower river (Northwest Power Planning Council 1989).

Land-use history-The early development of the Yakima River basin followed a pattern similar to that of the Grande Ronde. Cattle and sheep grazing began in the mid-1800s, with cattle use peaking in the 1880s and sheep use peaking at the turn of the century and again during World War I. By 1907, the public had already recognized that portions of the basin were overgrazed, notably along ridgetops, which served as travel corridors, and on alluvial flats where livestock were grazed. In 1909, because of overgrazing, several drainages such as the Wenas and the Manastash, had greatly deteriorated (Cooperative Western Range Study 1938, Wissmar and others 1993). By the 1930s, sheep numbers were less than 10 percent of their historical peaks.

Before 1890, livestock grazing was concentrated on the Yakima Plateau, the surrounding foothills, and lower tributary valleys. The development of irrigation, and a subsequent boom in agriculture in the main Yakima valley forced the livestock industry to expand their summer and fall range into the tributary and headwater portion of the basin. Rapid expansion of irrigated agriculture was the turning point for economic development in the Yakima basin.

In the upper Yakima, near Cle Elum and Roslyn, coal mining and development of the Snoqualmie pass route were probably as important in altering the landscape as grazing and irrigation. The earliest timber harvest occurred along the lower slopes of the Teanaway, Menastash, Taneum, and the upper Yakima basins, from 1890 to 1900 (Plummer 1902).

Until the 1950s, timber harvest was largely limited to the harvest of large trees from the valley bottoms and adjacent hillslopes (Smith 1993), with little harvest on public lands until the 1960s. Through the 1970s this was largely limited to selective harvesting. From the mid-1970s to the present, clearcutting became a common practice, with the volume of timber harvest increasing significantly. Accompanying these practices were substantial increases in road building.

Naches River basin-The Naches River drainage is the largest tributary of the Yakima River. The upper reaches of the Naches provide summer and fall rearing habitat for more than 30 percent of the juvenile anadromous salmonids in the Yakima basin (Fast and others 1991); in addition, it contains about 60 percent of the remaining harvestable timber in the Yakima basin (U.S. Department of Agriculture, Forest Service 1990).

Little Naches River-The Little Naches River is a fifth-order basin with a drainage area of 398 km^2. Most of the basin lies within the Wenatchee National Forest, with portions of the upper basin under checkerboard ownership with Plum Creek Timber Co. Before 1960, land use in the Little Naches consisted of intensive livestock grazing from 1880 to 1930, small scale selective harvest in the valley bottoms, and considerable recreational use.

Before 1900, no developed roads were built in the Little Naches basin, only a few wagon trails. Until 1962, only 30 to 40 km of roads were in the basin, but between 1962 and 1990, over 450 km were constructed. Road densities in 1990 range from 1.0 to 3.1 km/km^2 (B. Ehinger, pers. comm.). Before 1963, timber harvest was minimal. Between 1963 and 1975, 17 percent of the available harvestable acres in the basin were cut. In 1975, clearcut harvest began in the lower basin. Clearcutting on the private checkerboard lands in the head-waters started in 1985. By 1985, 26 percent of the harvestable acres in the basin had been cut, increasing to 35 percent by 1992.

American River-The American River originates in the William O. Douglas wilderness area, along the border of Mount Rainier National Park. It flows east more than 30 km, where it meets the Naches River, draining an area of 205 km^2. The river is surrounded by two wilderness areas, with State Highway 410 following it for most of its course. The major effects to the American River have been caused by road construction and maintenance along with recreational development and use.

Rattlesnake Creek-Rattlesnake Creek begins in the William O. Douglas wilderness area, flowing 30 km to the east where it joins the Naches River. The upper 16 km are in the wilderness area; the lower portions of the basin are managed by the Forest Service, with some private lands near the mouth. Historically, livestock have grazed throughout the basin, with most allotments currently vacant or minimally used (J. Smith, pers. comm.). In the lower portions of the basin, timber has been harvested on both private and public land.

Upper Yakima River basin: Taneum Creek-Taneum Creek is a fifth-order tributary to the upper Yakima River, located near Thorp, Washington. The Taneum drainage extends east-southeast about 40 km to its confluence with the Yakima River. It has a drainage area of 214 km^2 and two major tributaries, the north and south forks.

Taneum Creek was not settled until about 1868, when several homesteads were established. Taneum Ditch was completed in 1873 to provide irrigation for the croplands along Taneum Creek and the lower Yakima Valley. Since then, the pastureland has been under continuous cultivation or grazed by livestock. Sheep were grazed along the ridgetops and riparian meadows from early summer to fall from the 1870s to the 1930s. A major sheep driveway was established up and over Cle Elum ridge into Easton.

Until the turn of the century, logging had been limited to selective cutting for homes and firewood. Shortly after the railroad arrived in 1903, Cascade Lumber Company began more intensive logging operations in the surrounding area. Several sawmills and boxmills were established along the creek, and logs were skidded out for railroad ties. A spur track of the railroad was built up the Taneum in 1928, but it was only operated through the mid-1930s. Large-scale timber harvest did not begin until the mid-1950s. By 1986, about 30 percent of the basin had been harvested, with more intensive partial and clearcut harvesting in the upper watershed since then.

Changes in fish habitat in the Yakima River basin from 1935 to 1990-The results of resurveys, conducted from 1990 to 1992, indicate that pools have increased in both managed and unmanaged portions of the Yakima River basin, with the exception of the American River, where pools decreased (table 12). These surveys also indicate that substrate composition has become coarser in the Little Naches River and Taneum Creek, but remained the same in Rattlesnake Creek (table 13). In the following sections, the results of these surveys will be examined in more detail.

Table 12. Changes in the frequency of large pools for selected managed and unmanaged streams in the Yakima River basin, 1935-36 to 1990-92.

Managed Watersheds	Kilometers Surveyed	1935-1936 #/km	1990-1992 #/km	Percent Change
Taneum Creek	17.3	0.5	3.4	580%
Little Naches River	15.6	1.7	4.6	171%
Rattlesnake Creek	8.1	1.9	4.6	142%
American River	24.5	3.3	2.4	-27%
TOTAL	**65.4**	**1.8**	**3.8**	**111%**
Unmanaged Watersheds	**Kilometers Surveyed**	**1935-1945 #/km**	**1987-1992 #/km**	**Percent Change**
Rattlesnake Creek	18.8	1.6	3.9	144%

Table 13. Changes in dominant substrate in the Yakima River Basin, 1935-36 to 1990-92.

Managed Streams	1935-1936 Dominant Substrate	1990-1992 Dominant Substrate	Change
Taneum Creek	SR (39%)	MR (43%)	+
Little Naches River	SR (37%)	LR (47%)	+
Rattlesnake Creek	LR (33%)	LR (63%)	NC
Unmanaged Streams			
Rattlesnake Creek	LR (48%)	LR (57%)	NC

Naches River basin-Three tributaries to the Naches River drainage were resurveyed from 1990 to 1992: the Little Naches and American River, along with managed and unmanaged portions of Rattlesnake Creek. The resurveys indicated that pool habitat had increased in the Little Naches and Rattlesnake Creek, but decreased in the American River (table 12).

Little Naches River-In 1990, the University of Washington began a study to examine changes in stream and riparian habitat in the Little Naches River basin (Smith 1993). The initial hypothesis, based on current observations of stream habitat, was that pool habitat had declined since the 1935 survey, but the 1990 resurvey indicated that the frequency of pool habitat had increased and that substrate composition had changed.

Anecdotal information from the 1935 survey suggests that pool habitat had already been significantly degraded by human disturbance by 1935. Although pool habitat has increased over the past 55 years, the frequency of pools is still far below any accepted standards, such as those in the Wenatchee National Forest Plan (1990) and Pacific Northwest Region, Forest Service, Standards and Guidelines (U.S. Department of Agriculture Forest Service 1991).

Pool habitat-Smith (1993) found that the frequency of large pools had increased from 1.7 to 4.6/km for the 15.6 km of stream surveyed. The increase in large pools appears to be the result of repeated scouring of the channel around areas that have been riprapped. About 80 percent of the main channel has been constrained by roads and riprap, increasing stream energy, magnifying the effects of scour at high flows, displacing smaller particles, and shifting large particles. The 1990 survey indicated that most pools were bedform scour pools controlled by large substrate and bedrock. Smith (1993) has suggested that the frequency of extreme high-flow events (40- to 100-year floods) has increased from 0.6 events/decade before 1966, to 2 events/ decade after 1966. This change in peak flows coincided with increased harvest and road densities.

Substrate composition-For the Little Naches River, substrate composition changed significantly from 1935 to 1990 (table 14). In 1935, small rubble dominated the surface substrate (38 percent), with large rubble (30 percent) and medium rubble (29 percent) making up equal portions of the bottom. Both fine sediment (1.0 percent) and bedrock (2.0 percent) were small portions of the surface substrate. By 1990, the channel surface had coarsened and small rubble was replaced by large rubble. Large rubble dominates surface substrate (47 percent) with small rubble decreasing to 15 percent. Minor increases in fine sediment and bedrock also occurred but medium rubble stayed the same.

Table 14. Substrate composition of the Little Naches River in 1935 and 1990.

Substrate Class	1935 mean (%)	1990 mean (%)
Large Rubble (LR)	30.0	47.0
Medium Rubble (MR)	29.0	28.0
Small Rubble (SR)	38.0	15.0
Mud and Sand (MS)	1.0	6.0
Bedrock (BR)	2.0	4.0

The increase in percent fines (MS) in the Little Naches, along with the high degree of embeddedness, suggests that the input of fine sediment has increased since 1935. At the same time, large rubble has increased significantly, now comprising almost 50 percent of the surface substrate. Large rubble can be an important component of rearing habitat if it is not embedded. Juvenile fish use the interstitial spaces for thermal cover in winter and hiding cover in summer (Bjornn and Reiser 1991). Aquatic insects also use interstitial spaces, providing a food source for fish.

Large woody debris-Comparisons of the frequency of large woody debris from aerial photographs (1962 and 1990) indicate a lack of wood in the lower reaches of the Little Naches. Although large woody debris increased from 1962 to 1990, the frequency still remains far below the Forest Plan standard of 62 pieces/km (U.S. Department of Agriculture, Forest Service 1990). The upper reaches have twice the frequency of the lower reaches, but little of this wood was associated with pools; most of the wood was in a few debris jams. Even though the association of large woody debris with pool habitat was weak, the increased may contribute to pool formation and increased habitat complexity in the future.

Conclusion-The historical survey indicates that pool habitat was not abundant in the 1935 survey. Although pools had increased by 1990, the frequency of pool habitat was still below current standards. With most of the mainstem now constrained by roads and riprap, the potential of the stream to create pool habitat may be severely reduced, especially in the lower reaches. Constrained channels typically have more high-gradient habitats, such as riffles, rapids, and cascades (Grant 1986), except at meander bends where large pools may form and persist (Lisle 1986). Current standards may need to be revised for streams of this nature, and efforts at rehabilitation may need to be rethought.

For example, alternative types of rearing habitat may need to be considered for restoration efforts. Side-channel areas that were cutoff from the main channel through road construction could be reconnected to provide highly productive refuge areas. Also, instead of trying to create large pools from riffle areas, riffle areas can be made more complex. Pocket pools and step-pool cascades can be established in riffles with large and small boulders combined with large woody debris. Besides providing cover, these structures lower stream energy and reduce the scour and erosive power that removes the structural components.

Even though pools increased over time, other habitat components critical to abundant and high quality spawning and rearing habitat have been reduced over the last 55 years. Off-channel habitat, channel complexity, riparian cover, and spawning gravels all have decreased over time. In addition, substrate embeddedness, percentage of fines, and water temperatures are above currently accepted values for fish.

Rattlesnake Creek-Our resurvey results indicated that pool habitat increased in both the managed and unmanaged portions of the basin by the same magnitude (table 12). Current pool frequencies remain quite low compared to current standards. A possible explanation for the improving trend may be recovery from intensive grazing in the early part of the century, followed by wilderness protection for the headwaters, and relatively little management activities in the lower portions (J. Smith, pers. comm.). No changes were observed in dominant substrate in either the managed or unmanaged portions of the basin (table 13).

American River-Survey results indicated that pool habitat has decreased by over 25 percent (table 12), with pools becoming shallower. The river has been altered over time by the continuous maintenance and realignment of the highway, along with heavy recreational use along the limited floodplain. These activities are likely to have influenced pool habitat by increased sediment loads which could result in the filling of pools (J. Smith, pers. comm.). In addition, debris removal for road and bridge maintenance is likely to have reduced channel complexity (for example, large woody debris), further reducing pool habitat. Road construction and maintenance, along with recreational development, have probably provided chronic and persistent sediment sources.

Upper Yakima River: Taneum Creek pool habitat-The frequency of large pools increased from 0.5/km to 3.4/km from 1936 to 1990 in Taneum Creek (table 12). Although the frequency of pools increased seven-fold, current frequencies are quite low for a stream of this size, indicating a general lack of pool habitat.

Substrate composition-In 1936, substrate was dominated by small and medium rubble (40 and 39 percent overall, table 15). By 1990, medium rubble (43 percent) was the dominant substrate, with a subsequent decrease in small rubble (26 percent) and increase in fine sediments (18 percent). The current level of fine sediments is approaching Forest Plan standards (< 20 percent fines). Furthermore, the most upstream reach exceeds the forest standard by 5 percent. The increase in percentage of fines, along with the embedded condition of the bed throughout most reaches, indicates that fine sediments have increased over the past 50 years. The ability of the stream to export fines has been exceeded.

Table 15. Substrate composition of Taneum Creek in 1935 and 1990.

Substrate Class	1935 mean (%)	1990 mean (%)
Large Rubble (LR)	14.0	13.0
Medium Rubble (MR)	39.0	43.0
Small Rubble (SR)	40.0	26.0
Mud and Sand (MS)	7.0	18.0
Bedrock (BR)	0.0	0.0

Conclusion-The historical record indicates that grazing pressure had greatly diminished in Taneum Creek by the 1930s. From that period until the 1970s, land-use effects were largely limited to agriculture in the lower reaches, with some selective timber harvest along the mainstem of the creek. This period of relative inactivity may have provided a window over which stream habitat began to show some recovery from past effects. From the 1970s to the present, the basin has experienced greatly accelerated road construction and timber harvest.

The effects of intensive logging over the past 20 years are likely to curtail further recovery in pool habitat, as evidenced by increased fine sediments and high embeddedness, and may result in further declines in habitat conditions in the future. With accelerated harvest in the steep headwaters areas, along with chronic surface erosion from sparsely vegetated upland meadows, fine sediments are likely to persist for some time. This condition may result in decreased pool habitat through sedimentation, accompanied by a reduction in fish productivity from the direct effects of fine sediments on salmonid reproduction.

Summary-Recent research (Mullan and others 1992, Wissmar and others 1993, this volume) indicates that the land-use history in the mid-Columbia region may be quite different from patterns seen west of the Cascades and in the Snake River basin, thus influencing the effects to riverine ecosystems. Generally, streams were heavily affected by livestock grazing from about 1860 to 1920. After that point, development pressures were concentrated in the larger river valleys, while the headwater and tributary portions of the basins had a period of relative inactivity. This pattern changed in the late 1950s, as timber harvest and road construction began in the upper portions of the basins. Harvest practices changed over time from selective harvest to clearcutting. Since the 1970s, timber harvest has accelerated dramatically throughout the mid-Columbia region (Wissmar and others 1993).

The period of relative inactivity in the tributary portions of the Yakima basin, followed by much later entry for timber harvest, may explain the trend in increased pool habitat. These trends must be viewed in the perspective of current standards for pool habitat. None of the streams we have surveyed meet current Forest Service standards for pool habitat (table 4). Although the trend in improving habitat is encouraging, the stream habitats we surveyed are still in poor condition. Given the late entry for timber harvest, stream habitats may not be expressing the full cumulative effects of harvest activities. Management priorities for stream protection should emphasize continuing these improving trends.

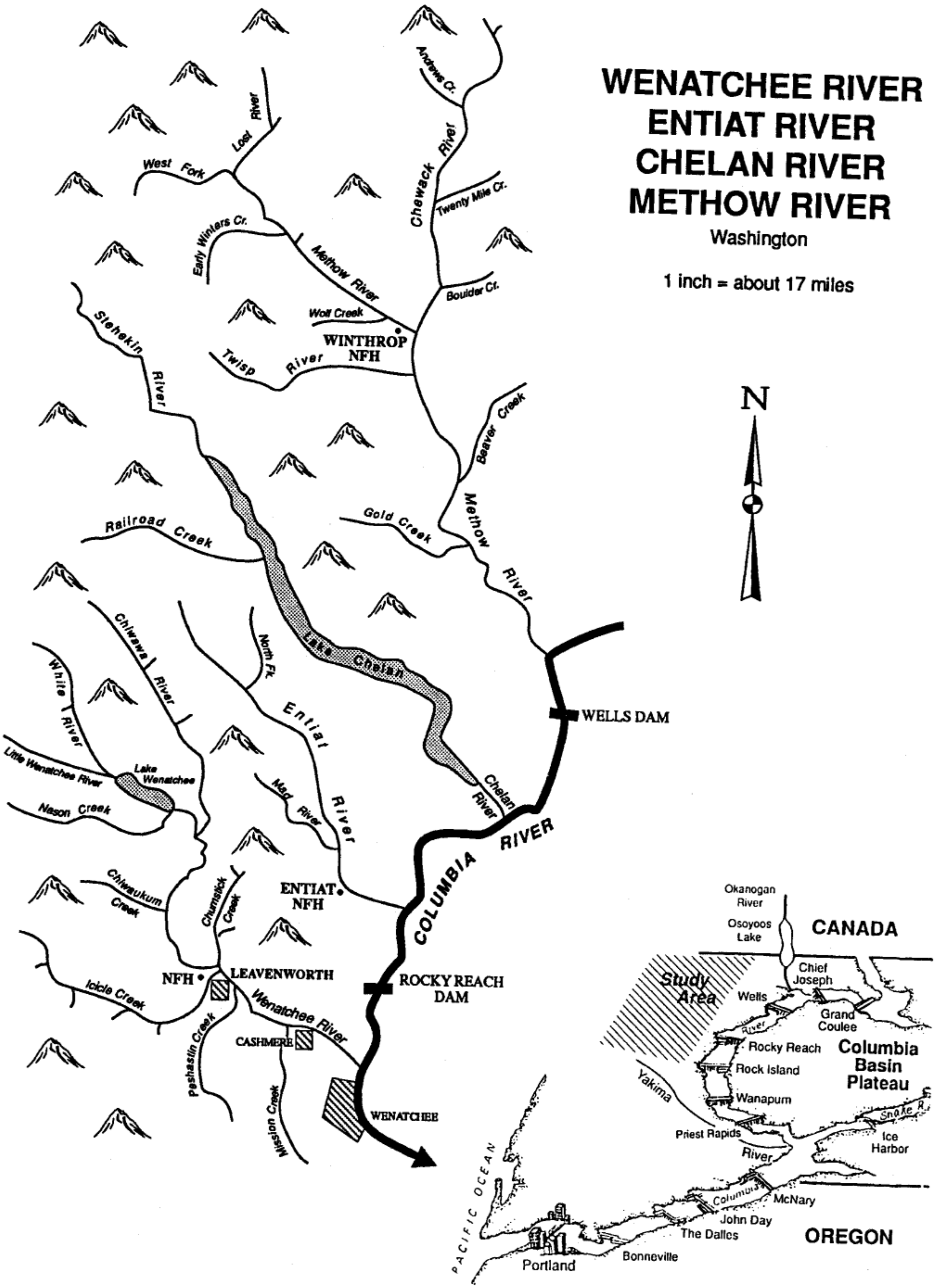


Figure 17. Wenatchee and Methow River basins, Washington

Changes in Fish Habitat -Wenatchee River Basin, Washington

Study area-The Wenatchee River basin is located in north-central Washington, draining an area of 3437 km^2 (fig. 17). It flows to the southeast from glacial outflow in the Cascade Range, through mountainous, heavily forested reaches, to a broader, more arid valley at its confluence with the Columbia. The basins climate is strongly influenced by the orographic effects of the Cascades; the region is in the coldest of 24 western climate zones (Mullan and others 1992). Precipitation is primarily winter snowpack, with little falling from April to September.

Irrigated agriculture, primarily fruit orchards along the lower river, has been the economic base of the Wenatchee basin. Livestock production and forestry are also important components of the economy. The basin is about 80 percent public land, mostly in the mountainous, forested regions.

Historically, the Wenatchee had large runs of spring/summer/fall Chinook, coho salmon, sockeye salmon, and steelhead. Coho runs were probably a minor component of the population, and these small runs became extinct sometime after the 1940s Recent research (Mullan and others 1992) suggests that current wild runs appear to be similar in size to historical runs (table 16). Although total run sizes are about the same, the species composition of the runs has shifted substantially-coho are extinct and sockeye reduced. The majority of the run is now spring Chinook. Summer steelhead were listed as a species of special concern by Nehlsen and others (1991), primarily because of the effects of hatchery introgression.

Table 16. Historical and current run sizes of naturally produced salmon and steelhead in the Wenatchee River basin (from Mullan and others 1992).

Species	1850s	1967-87
Chinook Salmon	41,300	204,800
Coho Salmon	3,900	0
Sockeye Salmon	228,100	93,700
Steelhead	7,300	8,200 [a]
TOTAL	**280,600**	**306,700**

[a] - for years 1987-1989.

Land use history-The historical pattern of land use in the Wenatchee basin follows a familiar pattern in the Pacific Northwest. Mining was probably the first activity during the settlement era, beginning in the 1870s The records indicate that mineral production was minor, with effects being mostly local and short lived (Mullan and others 1992, Wissmar and others 1993).

After the advent of mining was a period of intense livestock grazing, similar to what has been documented for other river basins. Grazing pressure was highest from the late 1800s to the 1930s, with subsequent reductions as allotment systems replaced the open range (Carter 1990). Currently, the Wenatchee National Forest lists no rangelands in unsatisfactory condition, with most considered to be improving (U.S. Department of Agriculture, Forest Service 1990).

As with the Yakima basin, timber harvest came later to the Wenatchee. Up until 1955, selective harvest or “high grading” was the primary harvest method. Since then, partial cutting and clearcutting have been the predominant practices. The 1980s represent the period of most intense harvest (Mullan 1992, U.S. Department of Agriculture, Forest Service 1990). Even with increased harvest in the past decade, about 65 percent of the Wenatchee National Forest is currently designated as wilderness or roadless areas (U.S. Department of Agriculture, Forest Service 1990).

Although the basin has been affected by stream channelization, irrigation, and pollution, these effects are not nearly as extensive as those found in the Yakima basin. A major effect early in the century were dams and irrigation diversions with inadequate bypass or screening facilities. Overfishing by Euro-Americans was also a problem during the settlement period.

Fires have been an important part of the natural disturbance regime in the Wenatchee River basin. Variations in the pattern, magnitude, and frequency of fire are complex throughout the Wenatchee. In the presettlement era, Native Americans used fire to maintain and enhance their hunting and berry producing areas (Mullan and others 1992). With the initiation of fire suppression, fuels have accumulated and vegetative composition has changed, from open stands of fire-tolerant species to dense stands of less fire-tolerant species. These changes have increased fire frequencies, and the risk of catastrophic fires are much greater.

Changes in fish habitat in the Wenatchee River basin from 1935 to 1991: pool habitat- During 1991, the Pacific Northwest Research Station surveyed four streams in the Wenatchee River basin, covering more than 70 km of streams. Three of the streams were in unmanaged basins, and one was in a managed watershed. Pool habitat increased in both the managed and unmanaged portions of the basin (table 17), with both having similar pool frequencies in the resurveys. Compared to Nason Creek, which is the stream in the managed area, the increase was twice as great in the unmanaged portions of the basin.

Table 17. Change in the frequency of large pools for selected streams in the Wenatchee River Basin, 1935-37 to 1991.

Managed Watersheds	Kilometers Surveyed	1935-1937 #/km	1991 #/km	Percent Change
Nason Creek	33.6	4.9	7.7	57%
Unmanaged Watersheds	**Kilometers Surveyed**	**1935-1945 #/km**	**1987-1992 #/km**	**Percent Change**
Jack Creek	6.8	1.9	8.1	326%
Icicle Creek	14.1	3.8	10.3	171%
Chiwawa River	59.1	1.8	4.2	133%
TOTAL	**80.0**	**2.5**	**7.5**	**200%**

The reasons for the increases in pool habitat are largely unknown at this point, but several explanations are possible. We know that the Wenatchee has had several large flood events (return interval 40 to 100 years) since the surveys in the 1930s; the most recent was in 1990. Our 1991 surveys indicated that the 1990 flood was probably a major pool-forming event in the Wenatchee systems. In some systems, such as the Chiwawa River, evidence of debris flows, which brought large woody debris and boulders to the stream channel, was extensive. In addition, the interaction of the flood with the Chiwawa's large, intact riparian floodplain greatly increased channel complexity.

A contrast to this would be Nason Creek, which has an extensive management history. In the lower portions, Nason Creek has a fairly broad floodplain that has been significantly altered and constrained by a railroad grade and a State highway. The historical record indicates that timber resources had been significantly reduced by the turn of the century, because of the demands of the railroad (Plummer 1902). In addition, the railroad right-of-way has been burned repeatedly to maintain passage, which undoubtedly had a large effect on riparian vegetation (Mullan and others 1992). Although Nason Creek showed an increase in pool habitat from the 1930s survey, the increase was considerably less than what we found in the unmanaged systems. This finding suggests that unmanaged systems with intact, fully functional floodplains, were further enhanced by the interaction with large flood events, which are a key to shaping and maintaining high-quality fish habitat.

Substrate composition-Changes in dominant substrate varied for surveyed streams in the Wenatchee River basin (table 18). Of the unmanaged streams, two did not change, and Icicle Creek shifted to a finer dominant substrate. Nason Creek, the managed stream, also had a shift to finer substrate.

Table 18. Changes in dominant substrate in the Wenatchee River basin, 1935-36 to 1991.

Managed Streams	1935-1936 Dominant Substrate	1991 Dominant Substrate	Change
Nason Creek	LR (33%)	MR (34%)	--
Unmanaged Streams			
Jack Creek	LR (76%)	LR (45%)	NC
Icicle Creek	LR (48%)	SR (26%)	--
Chiwawa River	LR (46%)	LR (33%)	NC

MR = medium rubble, SR = small rubble, NC = no change, - = decrease

Large woody debris-As the general trends for eastside river basins have indicated, large woody debris is much more prevalent in unmanaged than in managed streams in the Wenatchee River basin (table 19). From the unmanaged (72.5 pieces/km) to the managed streams (26.7 pieces/km) there was nearly a threefold increase in large woody debris. Also, the frequency of large woody debris complexes was much higher in the unmanaged streams. As an example, the Chiwawa River has a very complex stream channel, with numerous debris jams and multiple channels throughout its course and is representative of the potential of these systems to create highly diverse stream habitat.

Table 19. Current amounts of large woody debris (LWD > 0.1 m diameter and > 2.0 m length) in selected managed and unmanaged streams in the Wenatchee River basin.

Managed Streams Name	LENGTH (KM)	LWD (#/KM)	LWD COMPLEXES (#/KM)
Nason Creek	33.6	26.7	3.5
Unmanaged Streams Name	**LENGTH (KM)**	**LWD (#/KM)**	**LWD COMPLEXES (#/KM)**
Jack Creek	6.8	73.3	10.7
Icicle Creek	14.1	81.9	11.2
Chiwawa River	59.1	62.4	13.9
TOTAL	**80.0**	**MEAN 72.5**	**11.9**

Summary-The historical resurveys, along with Mullan and others (1992), indicate that fish habitat is in good condition in the Wenatchee River basin. The primary effects to anadromous salmonids appear to be irrigation diversions and low flows in the mainstem Wenatchee River. Some tributaries, such as Mission Creek, are in poor condition, but they represent a small portion of the total habitat.

The data from this case history strongly imply that the stability of anadromous fish runs in the Wenatchee River basin are tied to the abundance of high-quality habitat. This condition is largely because most of the Wenatchee National Forest is in wilderness or roadless designation. Having a wealth of intact headwater and floodplain areas has helped shape and maintain productive fish habitat. To maintain the productivity of the Wenatchee River basin, these features of the landscape must be maintained.

Changes in Fish Habitat-Methow Diver Basin, Washington

We resurveyed 176 km of streams in the Methow River basin during the summer of 1992, including most of the mainstem Methow, along with the two major drainages, the Chewack and Twisp Rivers. The survey results indicated that the frequency of large pools had increased significantly in both managed and unmanaged systems over the past 50 years.

Summary documents from the historical survey indicate that pools were infrequent at the time of the survey, with no suggestion as to a cause. Although current pool frequencies have more than doubled, the cause is not obvious. Whether the reason is natural geomorphic constraints or is an artifact of past disturbance, natural or human, is unknown. Using the historical record, we will examine potential reasons for the improvement in pool habitat.

Study area-The Methow River basin is in north-central Washington, just south of the Canadian border (fig. 17). It drains an area of 4641 km^2 as it flows about 140 km from the crest of the Cascades to the Columbia River. About 80 percent of the basin is public land managed by the Forest Service, with the lower 100 km of the river in private ownership. Logging and livestock production are the economic base of this sparsely populated basin, with orchards also a significant part of the local economy.

The basin is characterized by a wide alluvial valley and forested uplands. Glaciers have provided extensive alluvium throughout the valley, often several hundred meters deep, which has allowed for development of significant groundwater storage in the floodplain (Wissmar and others 1993). Many reaches of streams in the upper basin naturally de-water during periods of low flow because of this. Like the Wenatchee, the Methow is located in the coldest of 24 western climate zones (Mullan and others 1992).

Before settlement by Euro-Americans, the Methow supported significant runs of spring/summer Chinook salmon, coho salmon, and steelhead, with coho being the most abundant (Mullan and others 1992, table 20). By 1941, coho were at or near extinction because of impassable dams, unscreened irrigation diversions, overharvest, and the indiscriminate use of coho eggs for early hatchery programs. Currently, anadromous salmonid stocks are supported by Chinook salmon and steelhead in the Methow. Recent research suggests that current runs exceed the historical runs in the Methow River basin, with Chinook replacing coho (Mullan and others 1992). Wild steelhead were listed as having a high risk of extinction by Nehlsen and others (1991), primarily because of the effects of irrigation and hatchery introgression.

Table 20. Historical and current run sizes of naturally produced salmon and steelhead in the Methow River basin (from Mullan and others 1992).

Species	1850s	1967-87
Chinook Salmon	24,200	86,100
Coho Salmon	36,000	0
Steelhead	3,600	5,000 [a]
TOTAL	**63,800**	**91,100**

[a] - for years 1987-1989

Land use history-The land-use history of the Methow River basin is similar to the other river basins of central Washington. Unlike the other basins, though, the Methow remains very sparsely populated. The first settlers in the basin were miners and livestock grazers. With its extensive floodplain and gentle uplands, the Methow provided excellent summer range for livestock. The heyday of grazing was from the late 1800s, continuing until after the turn of the century, with subsequent declines. As with the other river basins in the Pacific Northwest, sheep grazing came first, followed by cattle grazing. Undoubtedly, stream and riparian habitats suffered under this intensive grazing pressure, providing a legacy that continues today in many places.

As the basin was settled, fruit orchards became prominent on terraces throughout the floodplain, although not as extensively as in the Wenatchee. To support a growing fruit business, extensive irrigation was developed throughout the lower reaches of the Methow. As noted previously, dams and irrigation diversions greatly contributed to the decline of anadromous salmonids in the Methow early in the century.

Timber harvest and road construction of any significance began in the 1970s in the Methow (J. Spotts, pers. comm.). The current Forest Plan (1989) indicates that about 75 percent of the forest is designated as wilderness or roadless areas. Before the 1970s, timber harvest was limited to the riparian zone and adjacent hillslopes. The Twisp basin has had the most management activities over the development period (J. Spotts, pers. comm.).

Changes in fish habitat in the Methow River basin from 1935 to 1992: pool habitat-During the summer of 1992, the Pacific Northwest Research Station resurveyed the three major drainages of the Methow River basin, namely the Chewack and Twisp Rivers, along with the upper 70 km of the Methow River. Our surveys indicated that pool frequencies doubled in the managed portions of the basin, and increased more than three-fold in the unmanaged portion (table 21).

Table 21. Change in the frequency of large pools for selected streams in the Methow River basin, 1935-37 to 1991.

Managed Watersheds	Kilometers Surveyed	1935-1937 #/km	1991 #/km	Percent Change
Chewack River	33.9	1.0	3.5	250%
Methow River	69.6	1.4	3.0	114%
Twisp River	42.5	2.8	3.9	37%
TOTAL	**146.0**	**1.7**	**3.4**	**100%**
Unmanaged Watersheds	**Kilometers Surveyed**	**1935-1945 #/km**	**1987-1992 #/km**	**Percent Change**
Chewack River	30.3	1.0	3.4	40%

The low pool frequencies indicated by the 1930s survey suggest that stream habitat was in poor condition at the time. The period of declining grazing coupled with late entry for timber harvest may have allowed some time for stream habitat to recover. The important point is not the size of the change, but the direction. Both the Chewack and the Methow are near current Forest Service standards for large pools, with the Twisp still below them.

Substrate composition-Comparisons of substrate composition in the Methow River basin indicated no significant trends (table 22). The exception was the Methow River, where the dominant substrate shifted from medium rubble to small rubble.

Table 22. Changes in dominant substrate in the Methow River basin, 1934-38 to 1992.

Managed Streams	1934-1938 Dominant Substrate	1992 Dominant Substrate	Change
Methow River	MR (44%)	SR (39%)	--
Twisp River	MR (35%)	MR (33%)	NC
Chewack River	MR (34%)	MR (35%)	NC
Chewack River (unmanaged)	LR (35%)	LR (49%)	NC

MR = medium rubble, SR = small rubble, NC = no change, - = decrease

Large woody debris-The frequency of large woody debris in the Methow basin was the reverse of what was detected in the other river basins (table 23). About 50 percent more large woody debris and debris complexes were found in the managed portions of the basin than in the unmanaged portion. This distribution may be an anomaly, the result of a large fire in the headwaters of the Chewack River in 1929, described below. The apparent high-intensity of this fire may have eliminated much of the large woody debris and set back future recruitment, which later became evident in the current survey.

Table 23. Current levels of large woody debris (LWD > 0.1 m diameter and > 2.0 m length) in selected managed and unmanaged streams of eastern Oregon and Washington.

Managed Streams Names	LENGTH (KM)	LWD (#/KM)	LWD COMPLEXES #/KM
CHEWACK RIVER	33.9	71.5	12.5
METHOW RIVER	69.6	50.6	7.8
TWISP RIVER	42.5	85.6	16.7
TOTAL	**146.0**	**MEAN 69.2**	**12.3**
Unmanaged Streams Name	**LENGTH (KM)**	**LWD (#/KM)**	**LWD COMPLEXES #/KM**
CHEWACK RIVER	30.3	40.2	8.1

Summary-As examples of different disturbance regimes and how these systems have changed over the past 50 years, we will examine the Twisp and Chewack Rivers. When the Chewack was surveyed in 1935, the surveyors noted that:

> *the hillsides are covered by a good growth in the lower and upper reaches with the exception of the last three miles of stream surveyed. This area was burnt over by a fire in 1929 which killed the timber and killed the under-brush. At the time of the survey, there was [sic] little or no protected stretches along the stream banks.*

Based on this description, the low frequency of pools in 1935 is likely explained by the effects of the 1929 fire. Also, this portion of the basin has not been affected by human activities and is currently a wilderness area, thus raising the likelihood of this explanation.

In contrast, the Twisp river has been a managed river basin since settlement. At the time of the 1935 survey, extensive irrigation development to support fruit orchards was noted in the lower 20 km of the river. The upper portions of the basin had been grazed, but no extensive burns were reported. In the historical survey, the Twisp River had a pool frequency three times greater than the Chewack-most likely explained by its relatively undisturbed state as compared to the Chewack, which had experienced the 1929 fire. Since 1935, the Twisp has had the most intensive timber harvest of all the drainages in the Methow River basin (J. Spotts, pers. comm.). The management history of the Twisp may explain why it shows the least improvement in pool habitat of the streams resurveyed.

IDENTIFICATION OF KEY WATERSHEDS WITH HIGH QUALITY FISH HABITAT AND THOSE WITH THE GREATEST POTENTIAL FOR RESTORATION

Fishery and aquatic specialists generally recognize that conservation and restoration efforts for aquatic resources need to be focused at the watershed scale (Johnson and others 1991, Meehan 1991, Reeves and Sedell 1992, Sheldon 1988, Williams and others 1989, Wissmar and others 1993). This section identifies key watersheds in eastern Oregon and Washington that can serve as cornerstones to regional protection and restoration efforts for aquatic systems (table 24a, b; figs. 18, 19).

The criteria for selection were based on Johnson and others (1991) and Reeves and Sedell (1992). Key watersheds were larger than 15 km^2 and contained relatively high-quality water and fish habitat, or had the potential to provide high-quality habitat with appropriate restoration efforts; and contained habitat for threatened or potentially threatened anadromous and resident fish species. These watersheds were determined by Federal, State, and Tribal fish biologists from across the region.

Table 24a. List of key watersheds for anadromous and resident fish in Washington.

Forest/Watershed	Steelhead/		Coho	Chinook				Sea run cutthroat trout	Bull trout	West slope cutthroat trout	Other
	Sum	Win		Spr	Sum	Fall	Win				
OKANOGAN NF											
COLUMBIA R.											
METHOW R.											
20 Twisp R.	X			P	X						C2
21 Early Winters Cr.	X			P					X		C2
21 Upper Methow R.	X			P					X		C2
22 Chewack R. [1]	X			P							
WENATCHEE NF											
COLUMBIA R.											
YAKIMA R.											
11 Teiton R.									X		
12 Rattlesnake Cr.	P			P					X		
13 Bumping-American R.				P					X		
14 Cle Elum R.									X		P(9)
WENATCHEE NF											
15 Ingalls Cr.	X								X		C2
16 Mission Cr.	X										C2
17 Icicle Cr.									X		C1,C2
18 Upper Wenatchee R. [2]	X			P					X		P(9)
19 Entiat. R.	X			P					X		

Table 24b. List of key watersheds for anadromous and resident fish in eastern Oregon.											
Forest/Watershed	Steelhead/ Trout		Coho	Chinook				Sea run cutthroat trout	Bull trout	West slope cutthroat trout	Other
	Sum	Win		Spr	Sum	Fall	Win				
WINEMA NF											
KLAMATH R.											
19 Clover Cr.											C2
20 Rainbow Cr.											C2
21 Pelican Butte											C1,C2
22 Cherry Cr.									X		
23 Seven Mile Cr.									X		
24 Evening Cr.									X		
DESCHUTES NF											
COLUMBIA R.											
DESCHUTES R.											
52 Big Marsh Cr.									X		
53 Odell Cr.									X		C2
54 Deschutes R. Corridor, Lava Lake to Crane Prairie [1]									X		C2
55 Cultus Cr.											C2
56 Duschutes R. Corridor, Dilman Meadows to La Pine Rec. Area [1]											C2
57 Deschutes R. Corridor, Benhan Falls Camp to Dillon Falls [1]											C2
58 Tumalo Cr.											C2
59 Squaw Cr.											C2
61 Metolius R.									X		C2
60 Three Creeks Meadows & Creek [1]											C2
MT. HOOD NF											
COLUMBIA R.											
DESCHUTES R.											
69 White R. [3]	P										X(5),C2
70 Fifteen Mile Cr./Ramsey Cr.	X	X									
72 W. Fork Hood R.	X	X	X	X				X			
67 Eagle Cr.		P	P	P							C2
71 Mill Cr./Five Mile Cr./Eight Mile Cr.		X									C2

Table 24b. List of key watersheds for anadromous and resident fish in eastern Oregon (continued).											
Forest/Watershed	Steelhead/ Trout		Coho	Chinook				Sea run cutthroat trout	Bull trout	West slope cutthroat trout	Other
	Sum	Win		Spr	Sum	Fall	Win				
<u>OCHOCO NF</u>											
COLUMBIA R.											
JOHN DAY R.											
73 Rock Cr.	P										X(5)
74 Black Canyon Cr.	P										X(5)
75 Cottonwood Cr.	P										X(5)
DESCHUTES R.											
76 Trout Cr.	P										X(5)
<u>MALHEUR NF</u>											
COLUMBIA R.											
JOHN DAY R.											
77 Fields Cr.	P									P	
CANYON CR.											
78 E. Fork Canyon Cr.	P									P	
79 M. Fork Canyon Cr./Canyon Cr.	P									P	
80 Reynolds Cr./Deardorf Cr.	P			X					X	P	
John Day R. Headwaters											
MIDDLE FORK JOHN DAY R.											
81 M. Fork John Day R. Corridor, Galena to Phipps Meadow [1]	P			X							
83 Camp Cr.	P			X					X		
84 Big Boulder Cr.	P			X					X		
84 Granite Boulder Cr.	P			X					X		
84 Beaver Cr./Little Boulder Cr./Caribou Cr./Vincent Cr./Vinegar Cr.	P										
85 Davis Cr.	P								X		
86 Clear Cr.	P			X					X		
82 Big Cr.	P			X					X	P	
SOUTH FORK JOHN DAY R.											
87 Murderers Cr.	P										

Table 24b. List of key watersheds for anadromous and resident fish in eastern Oregon (continued).											
Forest/Watershed	Steelhead/ Trout		Coho	Chinook				Sea run cutthroat trout	Bull trout	West slope cutthroat trout	Other
	Sum	Win		Spr	Sum	Fall	Win				
WALLOWA-WHITMAN NF											
COLUMBIA R.											
JOHN DAY R.											
N. FORK JOHN DAY R.											
88A Upper N. Fork John Day R.	P			X					X		
89A Granite Cr./Bull Run Cr./Beaver Cr.	P			X					X		
SNAKE R.											
GRANDE RONDE R.											
90 Meadow Cr.	P										
91 Beaver Cr.	P										
92 Upper Grand Ronde R.	P			X					X		
93 Upper Catherine Cr.	P			X							
94 Minam R.	P			X					X		
95 Wallowa R./Lostine R.	P			X							
96 Joseph Cr.	P										X(5)
96 Cottonwood Cr.											X(5)
97 Imnaha R.	X			X		X			X		
98 Cherry Cr.											X(5)
UMATILLA NF											
COLUMBIA R.											
JOHN DAY R.											
88B Upper N. Fork John Day R.	P			X					X		C2
89B Granite Cr.	P			X							C2
89B Clear Cr.	P			X							
99 Desolation Cr.	P			X					X		C2
100 Camas Cr.	P										
101 Fivemile Cr.	P										
102 Potamus Cr.	P										C2
103 Wall Cr.	P										

Table 24b. List of key watersheds for anadromous and resident fish in eastern Oregon (continued).											
Forest/Watershed	Steelhead/ Trout		Coho	Chinook				Sea run cutthroat trout	Bull trout	West slope cutthroat trout	Other
	Sum	Win		Spr	Sum	Fall	Win				
SNAKE R.											
GRAND RONDE R.											
104 Looking Glass Cr.	P			X					X		C2
105 Wenaha R. [4]	P			X					X		C2
106 Wenatchee Cr. [4]	X			X					X		C2
107 Asotin Cr. [4]	X			X					X		
108 Tucannon R. [4]	X			X					X		
WALLA WALLA R.											
109 N. Fork Walla Walla R.	X								X		C2
110 S. Fork Walla Walla R.	X								X		C2
111 Touchet R. [4]	X								X		
112 Umatilla R.	P								X		C2

P	Present in streams of watershed
X	Identified as at risk or declining by the Endangered Fish Committee of the American Fisheries Society
C1	High-Quality water source
C2	Unique or high-value resident trout populations

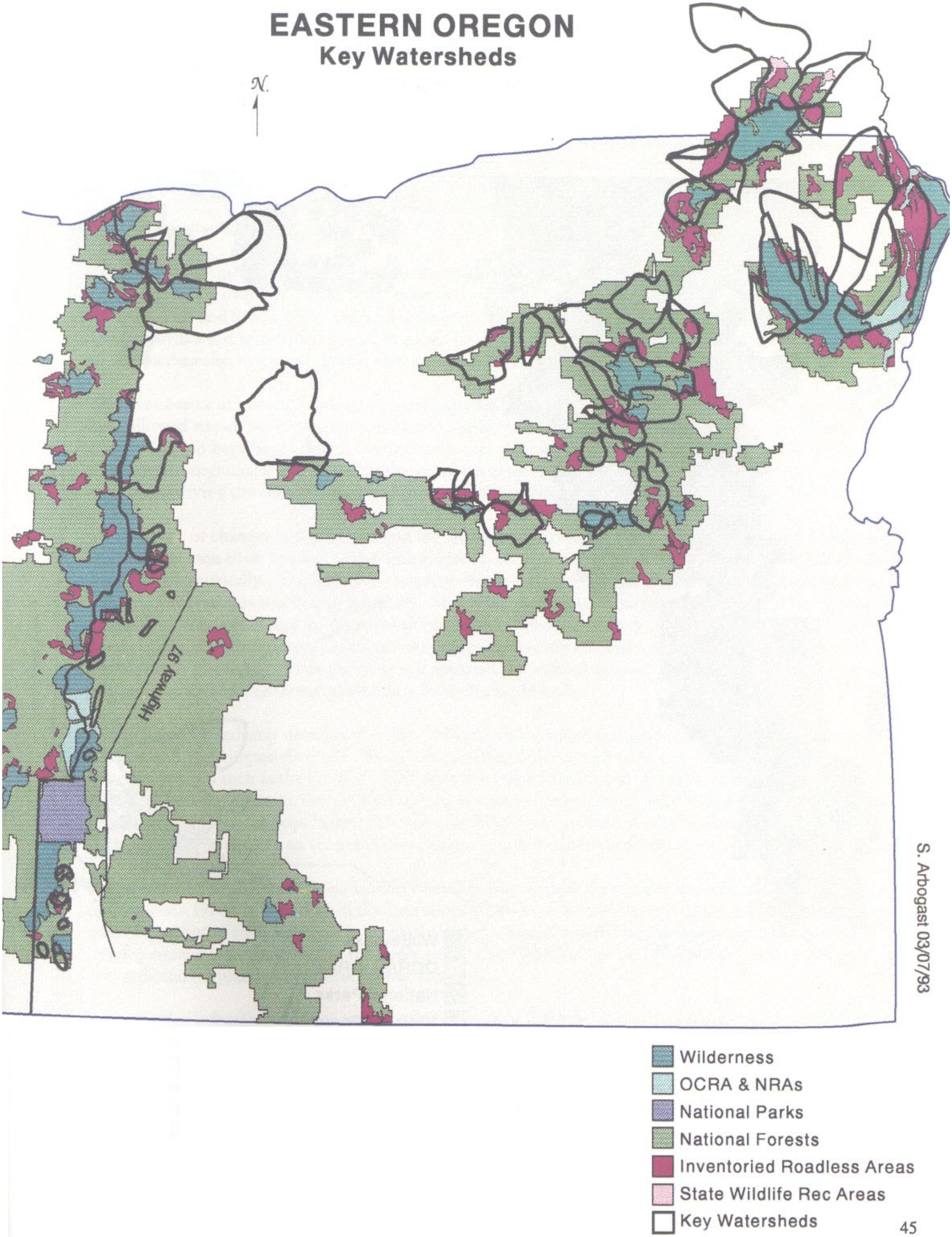
5	Red-band trout	Spr	Spring race
6	Chum salmon	Sum	Summer race
7	Oregon chub	Fal	Fall race
8	Pink salmon	Win	Winter race
9	Sockeye salmon		
10	Olympic mudminnow		

Common name	Scientific name
Chinook salmon	*Oncorhynchus tshawytscha*
Coho salmon	*O. kisutch*
Steelhead trout	*O. mykiss*
Sea-run cutthroat trout	*O. clarki clarki*
West-slope cutthroat trout	*O. clarki lewisi*
Sockeye salmon	*O. nerka*
Chum salmon	*O. keta*
Pink salmon	*O. gorbuscha*
Red-band trout	*O. mykiss gibbsi*
Bull trout	*Salvelinus confluentus*
Oregon chub	*Oregonichthys crmeri*
Olympic mudminnow	*Novumbra hubbsi*

[1] 1/4 mile no-harvest area on each side of stream.
[2] Includes Wenatchee R., White R., Nepeequa R., and Chiwawa R.
[3] Includes Rock Cr., badger Cr., Tygh Cr., and Jordan Cr.
[4] Administered by Umatilla NF (Oregon), but located in Washington.

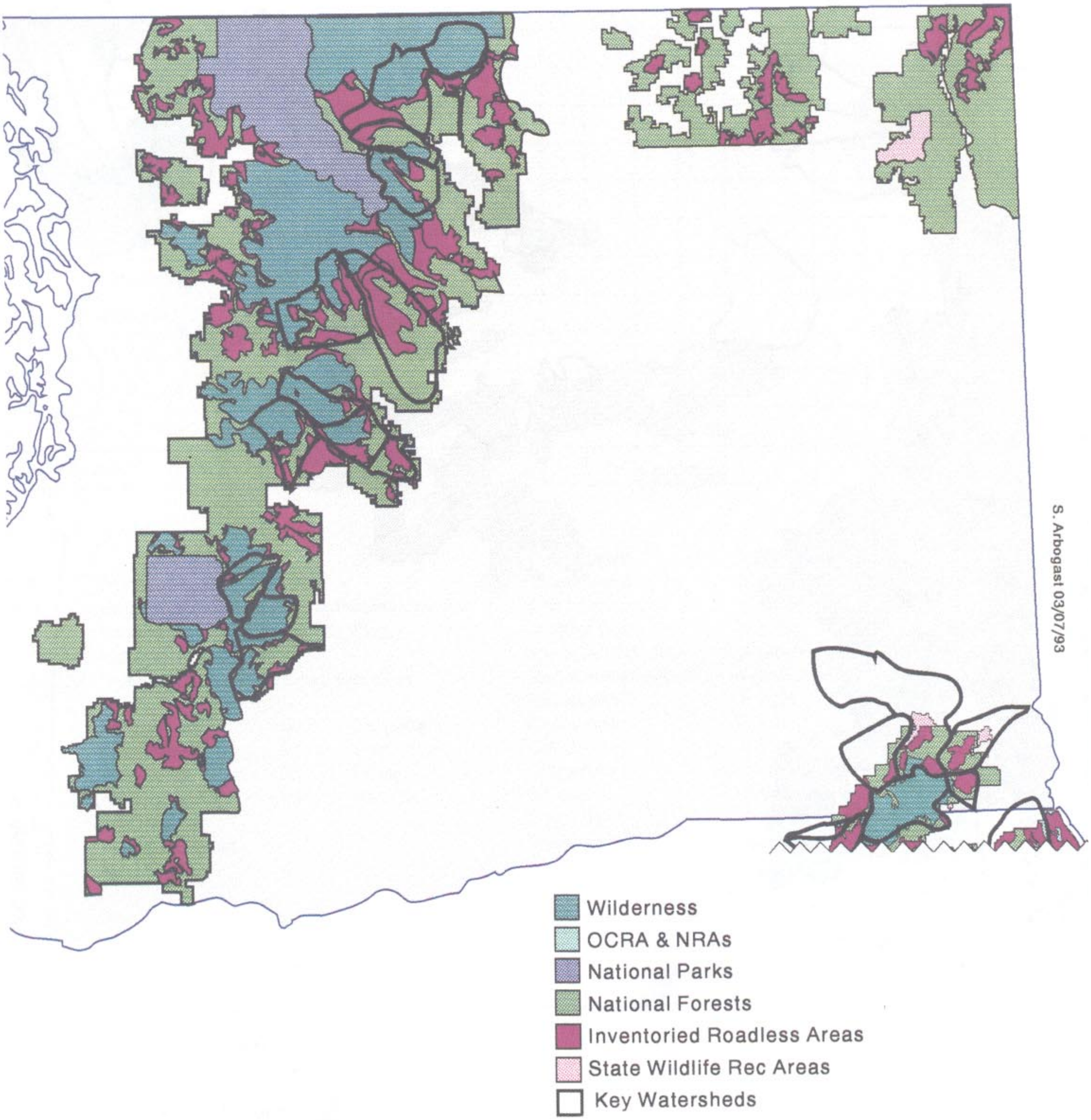
Figure 18 (next page). Key watersheds for eastern Oregon.

Figure 19 (following page). Key watersheds for eastern Washington.


EASTERN OREGON
Key Watersheds
N.
Highway 97
S. Arbogast 03/07/93
Wilderness
OCRA & NRAs
National Parks
National Forests
Inventoried Roadless Areas
State Wildlife Rec Areas
Key Watersheds

45

EASTERN WASHINGTON
Key Watersheds



DISCUSSION

In this paper, we have examined how fish habitat has changed in select river basins of eastern Oregon and Washington over the past 50 years. These snapshots over time show considerable variability in how fish habitats have been affected by natural and human-induced disturbance. Although quantifiable relations between land-use practices and long-term trends in fish abundance have been difficult to obtain (Bisson and others 1992), the body of literature concludes that land-use practices have simplified fish habitat (Bisson and others 1992, Hicks and others 1991, Meehan 1991).

"Simplification" means a loss in the frequency and diversity of habitat types-pools, riffles, side-channels-decreased large woody debris and other structural elements, and declining water quality (higher temperatures) (Reeves and Sedell 1993). Although the general trend throughout the Columbia River basin has been towards a loss in pool habitat on managed lands and stable or improving conditions on unmanaged lands, the data also suggest a regional pattern to this change.

The river basins of eastern Washington apparently had a period of recovery after World War I, which may have allowed stream habitat to show moderate improvement since then. In contrast, the river basins of eastern Oregon have been affected continuously over the entire settlement period (1850-1930), explaining their current degraded state. The cumulative effects of these impacts have operated collectively, exacerbating or magnifying the effect of any one factor operating in isolation.

Our analysis of changes in fish habitat and the chronology of settlement and land use suggests a different response for each basin because of the timing and duration of human disturbance events, acting individually and synergistically. The historical records indicate that during the settlement era, the major influence on stream ecosystems was livestock grazing. Sheep and cattle grazed the high meadows and floodplains year-round in numbers that far exceeded the capacity of the range (Platts 1991, U.S. EPA 1990). Anecdotal reports and photographs depict summer ranges so heavily stocked with sheep, they appear to be snow drifts. The legacy of this period is still apparent throughout the eastside as evidenced by the terraced hillslopes caused by near constant trodding by millions of hoofs.

As the livestock industry declined after World War I, this similarity in land-use histories for eastern Oregon and Washington diverged. While eastern Oregon developed more rapidly, being along the main migration routes such as the Oregon Trail, most of eastern Washington was relatively isolated. As the livestock industry declined, the timber industry in eastern Oregon expanded to supply the railroads and support the burgeoning population. After World War II, the timber industry boomed, and it has been increasing since then. As an economic base, timber has dominated the forested regions of eastern Oregon.

In eastern Washington, the timber industry developed at a much more moderate pace, not really booming until the late 1970s, as is evident in the land allocations of the Wenatchee and Okanogan National Forests: over 65 percent of their land base is currently under wilderness or roadless designation. Most human development was concentrated in the larger river valleys (the Yakima and Wenatchee), where irrigated orchards and croplands were the economic base.

Based on this information, along with data on changes in fish habitat and the relative health of fish runs in these two regions, fish habitat appears to be in far better condition in eastern Washington than in eastern Oregon. This argument is further strengthened by the stable condition of anadromous runs in eastern Washington, with the exception of the Yakima system; anadromous species in eastern Oregon are listed as threatened species or of special concern (see Nehlsen and others 1991). Anadromous runs to these regions are affected both by fishing and by 8 to 10 mainstem Columbia River dams.

These generalizations must be viewed with caution. A broad regional overview of this nature will fail to identify particular known areas of concern. Clearly, fish stocks in the Yakima basin are imperiled, but primarily because of mainstem flow issues and irrigation diversions (Fast and others 1991). On the other hand, anadromous runs to the Wenatchee and Methow River basins appear to be stable, with the exception of summer steelhead. In eastern Oregon, we know of no anadromous runs that are stable. All are declining.

Strategies to protect and restore anadromous and resident fish populations and their habitat must be based on a watershed approach that protects remaining habitat and restores historical habitats (Johnson and others 1991, Reeves and Sedell 1992). Currently, the Forest Service is developing a strategy (PACFISH) to be applied across the range of anadromous salmonids throughout the west (U.S. Department of Agriculture, Forest Service 1992). Restoration activities that deal with issues of forest health must incorporate a watershed strategy that recognizes the critical linkages between the uplands, riparian zones, and fish habitat. Active restoration and protection of eastern Oregon and Washington watersheds is critical if high-quality fish habitat is to be restored and maintained.

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GLOSSARY[1]

Animal Unit Month (AUM)-Amount of feed or forage required by one animal-unit grazing on a pasture for 1 month; an "animal-unit" is one mature (454-kg) cow or the equivalent of other animals, based on an average daily forage consumption of 12 kg dry matter; an AUM is also defined as 1-month tenure of one animal-unit.

Channelization-Human-caused alterations to the stream channel that cause the channel to be fixed in place, such as levees, dikes, trenching, and rip-rap.

Cover-Any feature that provides protective concealment for fish and wildlife; cover may consist of live or dead vegetation, or geomorphic features such as boulders and undercut banks; cover may be used for escape from predators, feeding, or resting.

Geomorphology-The geological study of land-form evolution and configuration.

Headwater (headwall)-Steep slope at the head of a valley.

Large woody debris (LWD)-Any piece of woody material that intrudes into a stream channel, the smallest diameter of which is greater than 10 cm, and has a length greater than 1 m.

Orographic-Pertaining to mountains, especially as the affect precipitation that results when moisture-laden air encounters mountains and is forced to rise over them.

Reach-Section of stream between two specified points.

Refugia-Areas where animals or plants can survive catastrophic disturbance events.

Resting Habitat-Areas used by adult fish during their migration to spawning habitat.

Roughness-Features found in stream channels that interact with streamflow to reduce flow, cause channel scour, or both. Examples include boulders, large woody debris, vegetation, and meander bends.

Salmonids-Fish of the family Salmonidae, including salmon, trout, chars, whitefish, ciscoes, and grayling; in general usage, the term often refers to salmon, trout, and chars.

Salvage-The cutting of trees that are dead, dying, or deteriorating (because they are "overmature," or materially damaged by fire, wind, insects, fungi, or other injurious agencies) before they lose their commercial timber value.

Scour-Local removal of material from streambeds by flowing water.

Smolt-Juvenile salmonid 1 or more years old that has undergone physiological changes to cope with marine environment; the seaward migrant stage of an anadromous salmonid.

Spawning Habitat-Areas used for spawning by adult fish.

Streamflow (discharge; instream flow)-A measure of the volume of water flowing past a reference point per unit time (such as cubic meters^3 per second).

Watershed (also catchment area, basin, drainage area)-Total land area draining to any point in a stream, as measured on a map, aerial photo, or other horizontal, two-dimensional projection.

[1] After Meehan (1991) and Gregory and Ashkenas (1990).

McIntosh, Bruce A.; Sedell James R.; Smith, Jeanette E.; Wissmar, Robert C.; Clarke, Sharon E.; Reeves, Gordon H.; Brown, Lisa A. 1994. Management history of eastside ecosystems; changes in fish habitat over 50 years, 1935 to 1992. Gen. Tech. Rep. PNW-GTR-321. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 55 p. (Everett, Richard L., assessment team leader; Eastside forest ecosystem health assessment; Hessburg, Paul F., science team leader and tech. ed., Volume II I: assessment.)

From 1934 to 1942, the Bureau of Fisheries surveyed over 8000 km of streams in the Columbia River basin to determine the condition of fish habitat. To evaluate changes in stream habitat over time, a portion of the historically surveyed streams in the Grande Ronde, Methow, Wenatchee, and Yakima River basins were resurveyed from 1990 to 1992. It is clear from the data gathered that land-use practices have degraded fish habitat throughout eastern Washington and Oregon. Strategies to protect, restore, and maintain anadromous and resident fish populations and their habitat, must be based on a watershed approach that protects the remaining habitat and restores historical habitats.

Keywords: Anadromous fish, fish habitat, historical changes, land-use practices, pools, restoration, stream-flow.

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