Go To Next Part

Potential adverse effects on downstream migrant survival that cannot be measured due to under- or overloading turbine units during power peaking operations include unequal distribution of velocities and localized low pressure areas in the water column and over blade faces. Although unequal draft tube velocities, can be measured, there are no measurements available to describe surging velocities and pressure differences, all of which can introduce a differential smolt mortality rate in a turbine (Bell et al. 1976). Generally, the level of fish survival is directly related to the turbine efficiency curve. Therefore, it is desirable that turbines be operated at their maximum point of efficiency for a given head to maintain a low level of fish mortality (Bell et al. 1976).

5.3.4 Reducing the Adverse Effects of Hydropower Development and Operations

Programs for reducing the adverse effects of hydropower development and operations in the Columbia River Basin have involved a variety of efforts to compensate for salmon and steelhead losses. Two major areas of emphasis have focused on the upstream passage of adults and downstream passage for smolts. Safe adult passage was studied intensely during pre-Bonneville Dam times to develop effective facilities. Providing downstream passage of smolts through or over the dams proved to be a more complex problem than upstream passage.

Many of the hatcheries developed in drainage systems were eliminated from production by a given dam. Detailed information on many of these programs is presented in Chapter 6.

Many mitigation measures have been used to reduce impacts on salmonids resulting from hydropower and multi-purpose dams. A partial listing includes the following:

- o Fish ladders;
- o Fish lifts (elevators);
- o Artificial spawning channels;
- o Hatcheries and rearing facilities;
- o Fish guidance measures (attraction flow, artificial lighting, etc.);

- Screening of gatewells and turbine intakes (traveling wire mesh screens, fixed screens, etc.). Presently, two Snake River and three mainstem Columbia dams have submersible traveling screens containing bypass and collection devices. There are plans for retrofitting other dams;

- Fish bypass and collection systems (bypass smolts around dams). Two Snake River and one mainstem Columbia River dam presently have fish transportation and collection facilities: Lower Granite and Little Goose on the Snake and McNary and Priest Rapids dams on the Columbia;

- Collection, barging and trucking of smolts downstream below Bonneville Dam;

- Installation of spillway deflectors (reduce nitrogen supersaturation);

- Controlled spill for moving smolts downstream over the dams;

- Flow augmentation by the Water Budget to "flush" smolts downstream during the spring outmigration to decrease travel time and increase survival;

- Streamflow regulation studies to assess effects of power peaking and flow manipulation;

- Evaluation of predator impacts on downstream migrating smolts (with consideration of means for eradication);

- Studies to determine optimum sizes and times for release of smolts from hatcheries;

- Evaluations of disease problems and measures for immunization in hatcheries;

- Habitat improvement and enhancement work in tributaries;

- Smolt studies to evaluate sources of stress in fish handling and bypass systems.

It is important to note that not all of the measures identified above reduce impacts in all instances, and none completely alleviate all adverse impacts in any specific instance.

Another major program designed to reduce the adverse effects of hydropower on Columbia Basin salmon and steelhead is the transport of smolts to a point below Bonneville Dam. This program was initiated in 1968 at Ice Harbor Dam as a trial experiment (Phinney 1976). Experiments with the results of transported fish continued in the 1970s at Little Goose Dam, and a massive program was initiated in 1975. In 1983, more than 7.5 million juvenile salmonids were transported to a point below Bonneville Dam with collections at Lower Granite Dam of over 2.3 million fish, at Little Goose Dam of over 0.8 million fish, and at McNary Dam of over 4.3 million fish (Delarm et al. 1984). Barge transport was used for 63 percent of the fish; trucking accounted for 37 percent.

5.3.5 The Current Status of Hydropower Impacts on Fish

Delays in outmigration of junveniles and in upstream migration of adults continue to occur in the Columbia River Basin. Long reservoirs and reduced river flows increase travel time for juvenile salmon and steelhead. Poorly designed fishways and flow and spill conditions at the base of some dams (e.g., mainstem Columbia River and Snake River) result in significant prespawning mortality of adult fish (about 5 percent per mainstem dam). Extended migration times also increase exposure to disease, predation, high water temperatures, and supersaturated gases. Juvenile mortality losses are compounded by the number of dams through which they must pass.

Large mainstem dams without fishway facilities, such as Chief Joseph and Hells Canyon, continue to block access to formerly important spawning and rearing areas in the Columbia River Basin.

The last major hydroelectric project (Lower Granite Dam) was constructed on the mainstem Snake River in 1975. However, cumulative power output and storage capacity has changed with the addition of new turbine units and powerhouses at existing dams. Increased power peaking has resulted in greater reservoir fluctuations that strand juvenile salmonids. Reservoir fluctuations also influence stream flows that affect migration. More attention is being given to water releases that consider the instream flow requirements of anadromous salmonids.

5.4 LOGGING

5.4.1 Overview

The forest industry of the Columbia River Basin has accounted for a substantial portion of the basin's economy. Logging probably was the first non-Indian industry to develop in the basin, with the earliest activity begun by the Hudson Bay Company in 1827 (Thompson 1976b). By 1850, 37 sawmills were operating in the Northwest, most of which were located near the mouths of the Columbia and Willamette rivers (Geppert 1984).

During the late 1800s, logging practices ranged from selective cutting to clear-cutting, depending upon demand. Logging activities were mainly confined to lowland areas and resulted in relatively little soil disturbance. However, as logging expanded inland to steeper terrain, the resulting disturbances accelerated erosion and stream sedimentation.

Transportation of cut logs was a major problem in the early logging days (1880-1920). The most efficient means to transport the logs was to float large rafts of logs down the nearest waterways to the mills. Splash, roll, and pond dams were used extensively during this time (Geppert 1984). Generally, these dams were constructed of logs and designed to impound a sufficient supply of water to move logs downstream (Geppert 1984). Once the pond was sufficiently full of logs, the dam was breached and the surge of water helped to flush the logs downstream to the tidal waters, where they were guided to the nearby saw mills. According to Sedell (1982), approximately 56 splash dams were constructed in the western Washington portion of the Columbia River Basin from 1880 to 1910, while about 55 splash dams were built in the Willamette and Deschutes drainages of Oregon during this same period.

To accommodate the logs' downstream passage, instream modifications had to be made, such as blocking sloughs, swamps, and low banks with log cribbing to keep logs in the main channel; blasting mainstream obstructions, such as sunken logs or large boulders; and removing debris accumulations. These practices dramatically changed the substrate, banks, morphology and riparian areas of streams used for log transportation. Streams that were most severely degraded included those in the Willamette and Deschutes basins in Oregon and most streams in western Washington.

During and after World War II, logging production in the basin increased significantly. Logging operations continued to move farther inland and larger, more sophisticated equipment was used. Road construction and associated logging operations often occurred on steeper slopes, which resulted in increased erosion and stream sedimentation (Thompson 1976b).

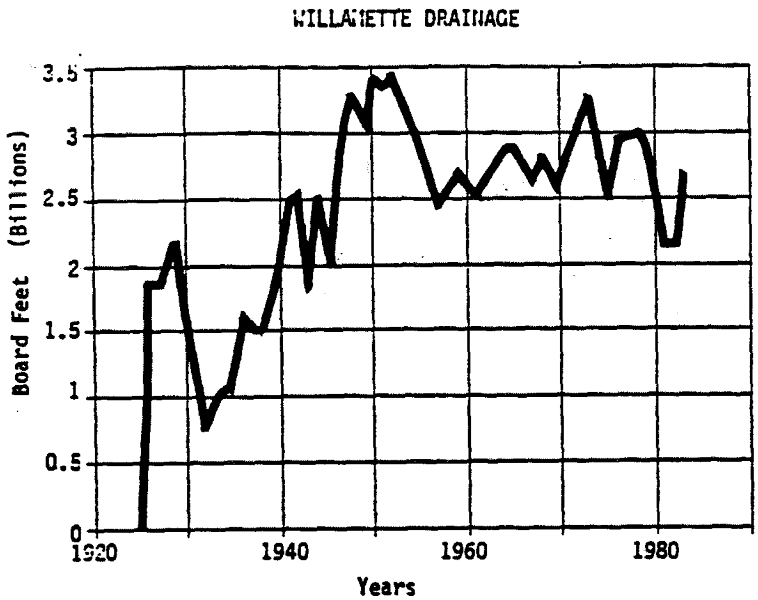
These developments in logging had several impacts on fish. The major one is the blockage of habitat caused by construction of logging roads. A second major impact is the loss of habitat complexity (reduction in types of habitat available) caused by removal of large woody debris from the stream course.

Other impacts on aquatic habitat due to forest industry activities include sedimentation (smothering of spawning gravels); degradation of water quality (increased water temperatures and decreased dissolved oxygen); and creation of barriers to anadromous fish migration (by debris dams) (Thompson 1976b). Logging practices also have reduced rearing habitat for juvenile salmonids and generally have contributed to decreased salmonid productivity in these streams (Sedell 1982). Log dams often delayed the upstream migration of adult salmonids and affected the downstream migration of smolts. Recent intensive forest management practices involving aerial applications of fertilizers, pesticide, and herbicides have increased the potential for widespread acute and chronic harm to aquatic communities.

The following sections describe logging development and related impacts to salmon and steelhead fisheries in the six Columbia River areas. The discussions of the two lower Columbia River areas and the two Snake River areas have been combined due to difficulties in separating data for these areas. Logging impacts are measured quantitatively in board-feet, because this is the only readily available statistic. However, because of differences among forests, logging production in board-feet between different geographic areas may not be totally comparable.

5.4.1.1 Lower Columbia River

Streams of the lower Columbia River area (all tributaries downstream of the Snake River confluence) probably have been affected more severely by the forest industry than other upstream areas. During the year in which the depression of 1929 started, the total board feet harvested in lower basin counties in Washington and Oregon was approximately 3.7 billion board feet, as compared to about 340 million board feet produced by counties in the middle and upper Columbia area and the Snake River area (Figures 23, 24, 25, 26). A particularly important subbasin in the lower Columbia is the Willamette, which also exhibited a higher total production than the middle Columbia, upper Columbia, and Snake River areas during this peak period of lumbering.



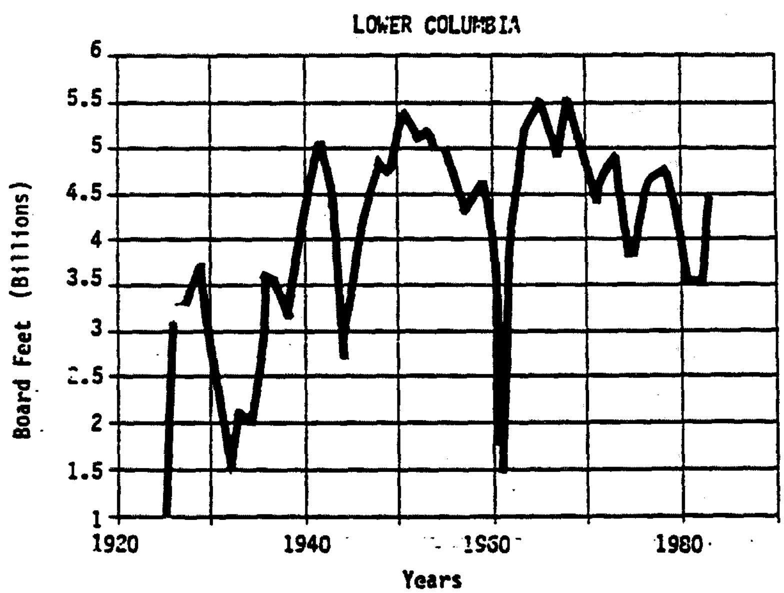


Figure 23. Logging production from 1925 to 1983 in Willamette River Drainage and lower Columbia River area (WDNR 1949-1983). (Discontinuous curve reflects data gaps.)

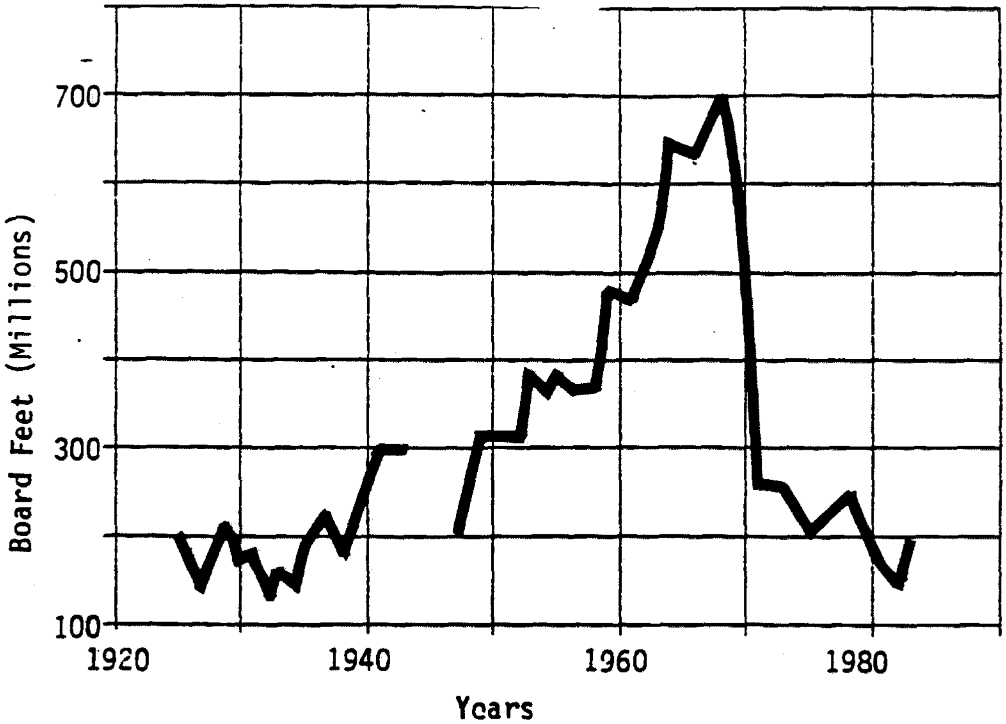


Figure 24. Logging production from 1925 to 1983 for the middle Columbia area (WDNR 1949 to 1983). (Discontinuous curves reflect data gaps.)

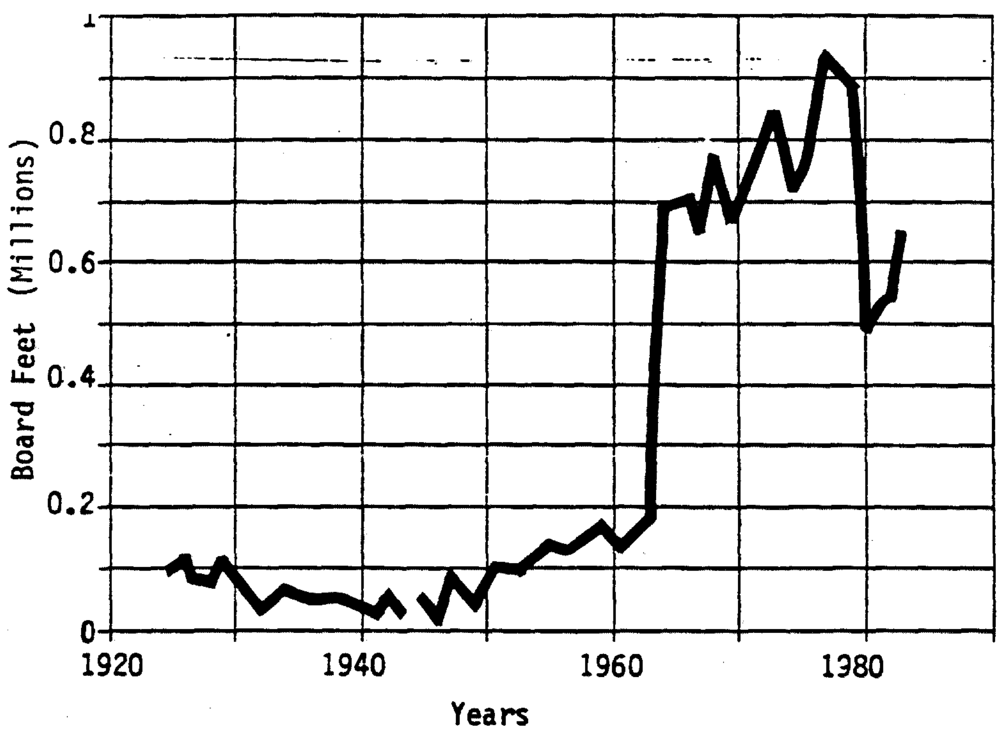


Figure 25. Logging production from 1925 to 1983 for the upper Columbia area (Pacific Northwest Forest and Range Experiment Station, 1972). (Discontinuous curve reflects data gaps.)

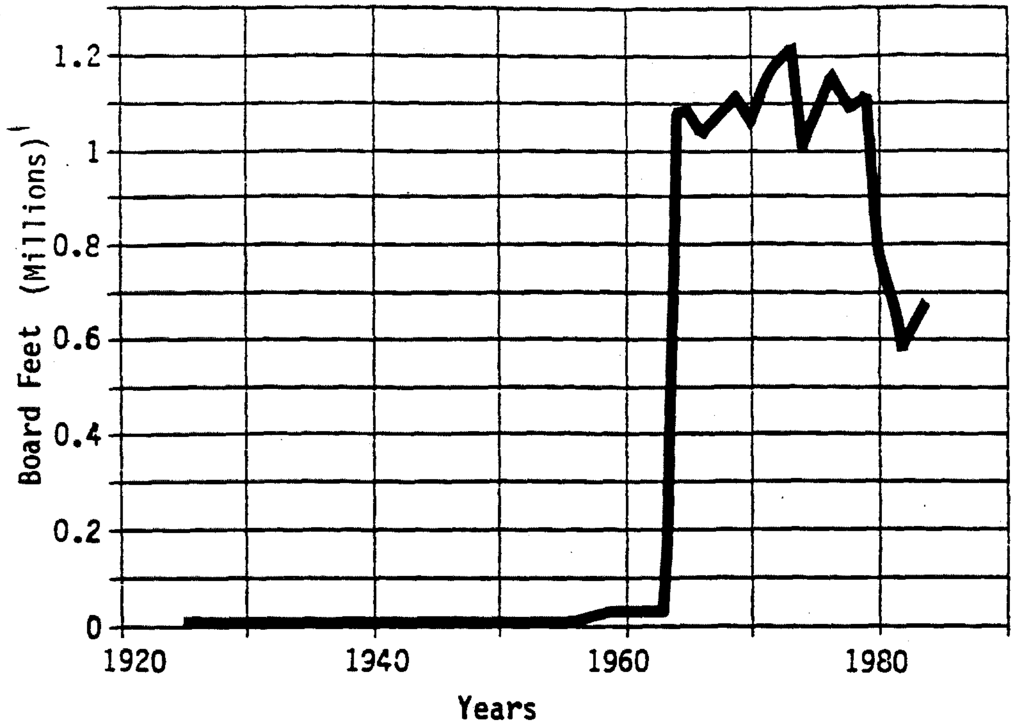


Figure 26. Logging production for the Snake River drainage 1925 to 1983 (Western Wood Products Association 1962-1983).

5.4.1.2 <u>Columbia River Between Its Confluence with the Snake River and Chief Joseph Dam</u>

Logging production of counties in this area has been significantly less than in the lower Columbia River area (e.g., 215 million board feet versus 3.7 billion board feet in 1929, and 149 million board feet versus 4.4 billion board feet in 1983). Most of this area's lumbering activity occurred in the Yakima and Okanogan drainages (Pacific Northwest Forest and Range Experiment Station 1972).

5.4.1.3 <u>Columbia River Above Chief Joseph Dam</u>

Logging in this area was less extensive than in the area between the Snake's confluence and Chief Joseph Dam, until the 1960s when production was about equal. Logging in the Spokane Basin did not commence until after dams were constructed on this river so that power could be provided for sawmills (Scholz et al. 1985).

5.4.1.4 Snake River Area

Timber production data indicate that logging activity in the Snake River area was initially concentrated in the Tucannon River drainage (Pacific Northwest Range and Experiment Station 1972). Production statistics exist only for Columbia and Garfield counties in Washington from 1925 to 1964. In 1964, production statistics for Ada, Adams, Gem, Lemhi, Washington, Elmore, Valley and Boise counties in Idaho became available. Until the 1960s, logging production was relatively low, ranging from one million board feet in 1932 to about 30 million board feet in 1959. Current production (1983) appears to be in the 600-700 million board feet range. Both the historical and current production statistics are considerably below the production of the lower Columbia River area (Figures 23 through 26). Current production, however, is greater than the other two Columbia River areas (Figures 24 and 25).

5.4.2 Reducing the Adverse Effects of Logging

In 1905, the U.S. Forest Service (U.S. Department of Agriculture) was established to protect and manage production in the forests on federal land. The Washington State Board of Forest Commissioners was formed in 1905. In 1908, the Washington Forest Protection Association was established to protect the forest from wild fires. In 1911, the Weeks Act authorized the federal purchase of timber lands that had been clearcut to protect soil, check fires, conserve scenery, and manage the resources with a broad social view or multiple use concept.

An attempt to improve forest practices in the Columbia River Basin occurred in Washington when the Reforestation Act (RCW 84.28) was passed in 1931. However, the program was unsuccessful because of failure to raise the taxes that were to have funded the program. The Oregon Forest Practices Act (ORS 527.610 et seq.), Washington Forest Practices Act (RCWA 26.09.010 et seq.), and the Idaho Stream Protection Act (Idaho Code 42-3801) all provide for improved forest practices, but statutory law is not effective without strict enforcement. This enforcement is expensive and passage of these statutes has rarely been accompanied by appropriations of necessary funds.

In 1946, the "sustained yield" concept was established by the U.S. Forest Service. Under this concept, forested lands are managed to produce at levels commensurate with the production capacity of the land instead of managed based on external factors such as economic factors or demand for lumber. In order to achieve goals of timber production, cut-out areas are replanted in trees and certain limitations on harvest are imposed. Intensive forest management practices increased in the 1960s, including long-reach cable systems to reduce the need for additional roads.

Logging practices have changed for the better through time. The waterways are no longer used as transport corridors to market as they were in earlier times. This has eliminated the need for splash dams. In the last several years, the extensive use of buffer strips along streams has eliminated much of the damage that was once commonly caused to the aquatic environment. But logging in fragile soil areas and roads continues to cause sedimentation and associated problems for fish.

5.4.3 The Current Status of Logging Impacts on Fish

Not all detrimental impacts to anadromous fish habitat from logging activities have been eliminated. Current technology allows the elimination of many harmful effects of logging on salmon and steelhead if the proper techniques are used and the pertinent laws enforced. However, forest practices continue to have a significant impact on salmon and steelhead.

5.5 MINING

5.5.1 Overview

In the mid-1880s mining, primarily gold and silver, was the most important non-Indian industry in the Northwest. It also spurred other industries, such as logging, because mining resulted in a large population influx. By 1880, nearly all of the major hard rock (extracting minerals from the ground) mining districts had been discovered on the Salmon River, Boise River, Orofino Creek, John Day River, and Powder River. The majority of these districts are in the lower Snake River Basin. Other large mining districts within the Columbia River Basin included the Coeur d'Alene and Clark Fork areas; however, streams in these areas were not accessible to anadromous fish.

In the early days the predominant gold mining method was placer mining, which removed nuggets and fine gold particles from the stream bed itself and from bench deposits. Placer mining generally involves the agitation of gold-bearing deposits (i.e., stream gravels) so that gold particles, which are heavier than the surrounding rock debris, settle out. Water is then used to wash away the rock debris, leaving the gold particles behind. Several methods of placer mining were employed, including using a miner's pan, large sluice boxes, rocker cradles, and hydraulicking (hosing deposits with powerful jets of water). The most effective means of placer mining was dredging with large stream dredges. These dredges could process 1,000 to 15,000 cubic yards of gravel per day (Brooks and Ramp 1968). In some areas, especially in the Powder River drainage in Oregon, miners used large-scale placer dredging operations.

The following sections describe mining development and impacts to salmon and steelhead fisheries in the six Columbia River areas. The two lower Columbia River areas and the two Snake River areas analyses have been combined due to difficulties in separating data for these areas.

5.5.1.1 Lower Columbia River Area

Historically, gold and silver mining in the lower Columbia River area occurred mainly in the Willamette River drainage. Major mining districts included North Santiam and Quartzville on the Santiam Creek drainage; Blue River on both the Santiam and McKenzie Rivers; and Fall Creek and Bohemia on the McKenzie River. No major gold and silver mining districts were located in Washington within the lower Columbia River area.

Gold and silver mining in this area was done largely by underground methods and began around 1902. One of the major producing counties was Lane, which produced 34,000 ounces of gold and nearly 72,000 ounces of silver from 1902 to 1965 (Figure 27). This is relatively low production compared to other mining districts in northeastern Oregon and southwestern Idaho in the Snake River Basin (Figures 27 and 30).

Currently, there is very little gold and silver mining in the Willamette Basin. Mining in the lower Columbia area is mostly limited to small placer operations in the upper John Day Basin in Oregon, to one active gold mine in the Wind River drainage of southwestern Washington, and until its eruption in 1980, to the vicinity of Mount St. Helens, Washington.

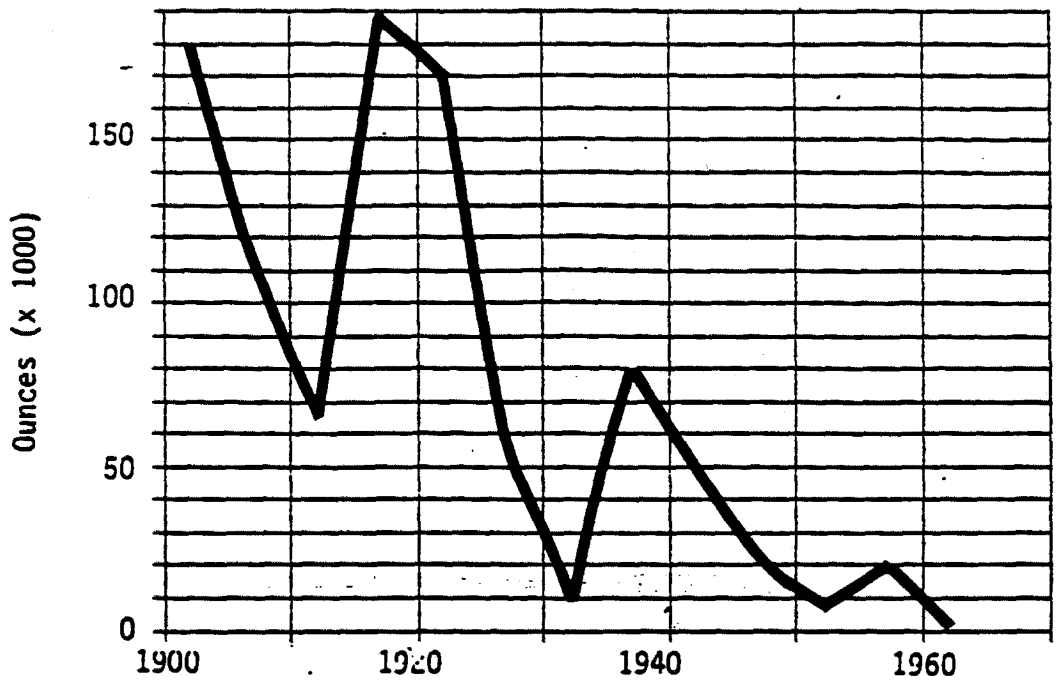


Figure 27. Gold and silver production in Oregon 1887-1962 (Brooks and Ramp, 1968).

Sand and gravel extraction from river beds is the other type of mining that occurs in this area. Presently, sand and gravel mining activities in the Willamette Basin (Figure 28) produce the greatest revenues and greatest land disturbance (Oregon State Water Resources Board 1963, 1965). The largest sand and gravel deposits occur near the mouth of the Willamette River near Portland, where approximately 40 to 70 million tons are available for mining (Oregon State Water Resources Board 1965).

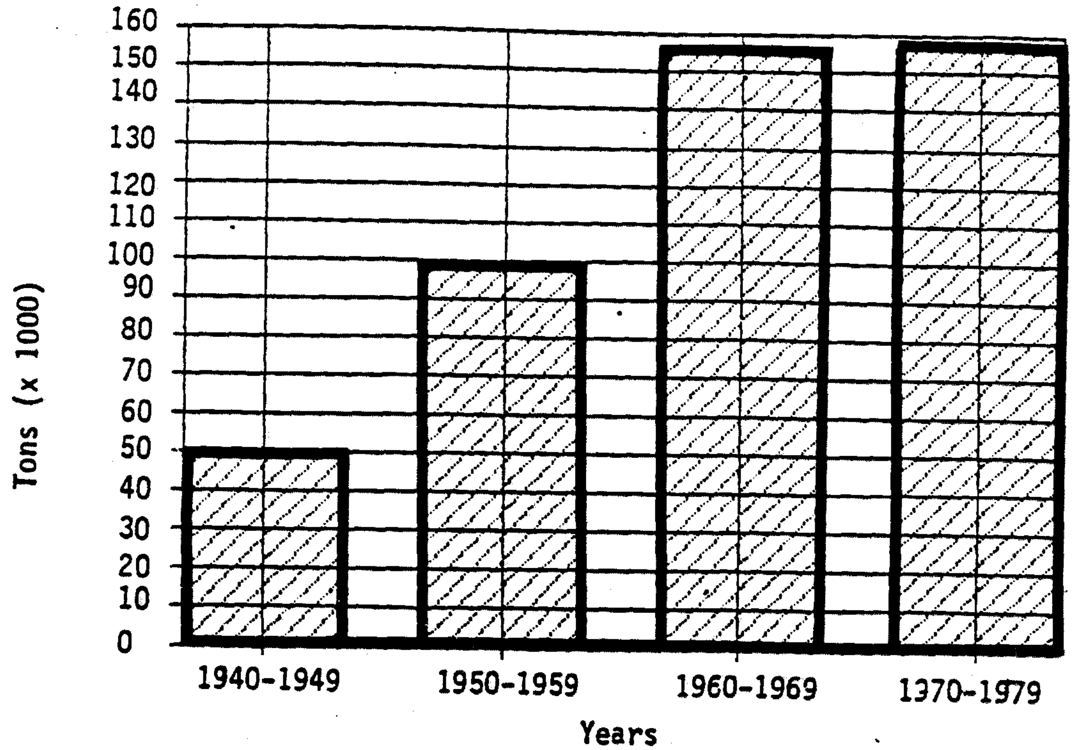


Figure 28. Sand and gravel production in Oregon 1940-1979 (Friedman et al., 1979).

Sand and gravel operations are the most prevalent mining activity in the Deschutes River drainage also. Other drainages with significant gravel mining activity include the Hood, John Day, and Umatilla in Oregon and the Cowlitz, Lewis, White Salmon, and Klickitat in Washington.

5.5.1.2 Columbia River Between Its Confluence With the Snake River and Chief Joseph Dam

This area consists of the Methow, Okanogan, Wenatchee, Chelan, Entiat, and Yakima drainages, all in Washington. Of these, mining was most prevalent in the Yakima, Okanogan, Entiat, and Chelan drainages. Most of Washington's gold and silver production occurred in counties in these drainages. Although placer mining was prevalent in the 1800s, underground mining dominated after 1900 (Koschman and Bergendahl 1968). Trends in gold and silver production in Washington from 1897 to 1982 are presented in Figure 29.

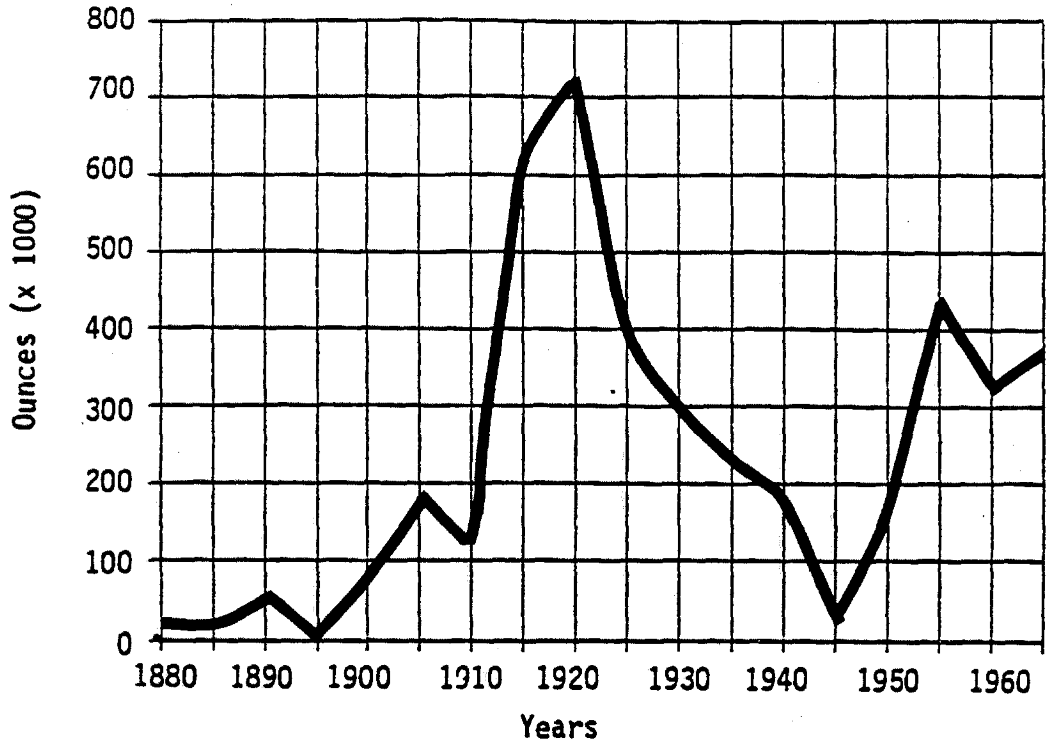


Figure 29. Gold and silver production in Washington 1887-1962 (Washington Department of Geology and Earth Resources 1985).

Gold was first discovered in Washington in the Yakima Valley; however, development was not extensive and existed primarily as placer mining up to 1900. Gold and silver mining in the Chelan, Okanogan, and Entiat drainages was mostly underground, with placer mining on tributary streams where deposits were economically recoverable. Therefore, disruption of streambeds and sedimentation due to placer mining probably was not extensive.

5.5.1.3 Columbia River Above Chief Joseph Dam

Considerable mining and degradation occurred in streams of the upper Columbia River area such as the Coeur d'Alene, Clark Fork and upper Kootenai rivers. However, few, if any, anadromous fish reached these areas because of passage barriers.

5.5.1.4 Snake River Area

The Snake River area encompasses most of Idaho, several important tributaries in northeastern Oregon, and some of southeastern Washington. The most prominent southern Idaho mining districts were located in the Salmon, Boise, and Clearwater drainages. Gold and silver mining in Idaho has been more extensive than in Washington or Oregon (Figure 30). In northeastern Oregon, the major districts were located on the Powder, Burnt, Malheur and Owyhee drainages (the Blue Mountains). No significant mining occurred in the Washington area of the Snake Basin. Gold and silver production from 1902 to 1965 for Oregon and Idaho is presented in Figures 27 and 30, respectively.

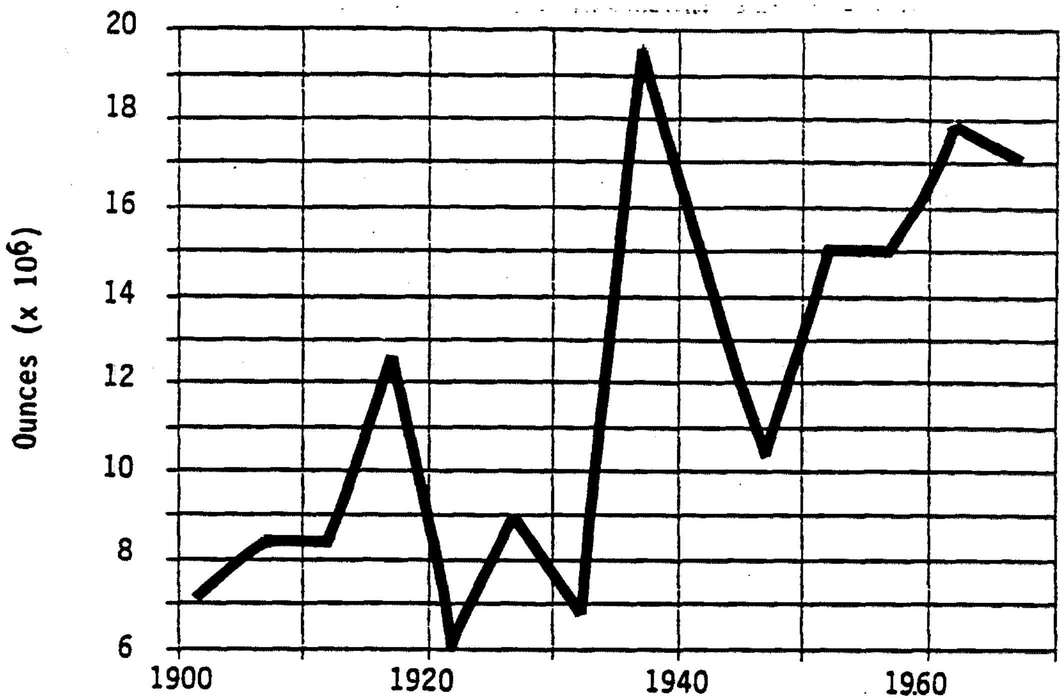


Figure 30. Silver and gold production in Idaho 1902-1967 (Idaho Mine Inspectors Annual Report, 1899-1974).

Placer mining in northeastern Oregon and southeastern Idaho began around 1860 (Brooks and Ramp 1968). Steam-powered dredges replaced placer methods in northeastern Oregon during 1910 to 1920, greatly increasing gold production and stream bed disturbances. The Sumpter dredge mined over 10 miles of stream on the Powder River below Sumpter. Other tributary streams in the Powder River drainage were also dredged (Brooks and Ramp 1968).

Dredge mining had devastating effects on salmon and steelhead habitat. The method alters the existing stream bed totally and destroys riparian vegetation, leaving the stream channel unsuitable for fish. In addition to total stream bed disruption, large amounts of sediment are released and flushed downstream. In the Powder, this sediment settled out on gravel bars that fish used for spawning and feeding.

Besides these direct instream impacts, water diversion dams without passage facilities completely blocked anadromous fish runs and precluded use of upstream spawning areas. For example, Swan Falls Dam was built on the Snake River in 1910 to supply electricity for the mining districts of the Owyhee Mountains.

5.5.2 Reducing the Adverse Effects of Mining

Since passage of the federal Clean Water Act, both state and federal agencies have enforcement power to control mine discharges, gravel operations, and other water quality degradation. Each state in the Columbia River Basin has passed laws that are designed to improve and protect water quality and fish resources. For example, Idaho passed a Stream Protection Act (Idaho Code 42-3801) in 1971. Similarly, Oregon has passed the Waterways Act (ORS 390.805, et seq.), and Washington has passed the Fisheries Hydraulics and Environmental Protection acts (RCWA 43.21C, et seq.). All these laws represent important legislation regulating stream corridor use. However, lack of uniform enforcement, particularly in regulating sand and gravel operations (Thompson 1976b) has resulted in continuing degradation of fish habitat.

5.5.3 The Current Status of Mining Impacts on Fish

Present day mining activities on or near streams have relatively minor detrimental impacts on salmon and steelhead fish in the Columbia River Basin. Most historical detrimental effects (heavy metals, acid discharges, dredging, sedimentation) have been brought under control. However, some areas, such as Panther Creek, the upper South Fork Clearwater, and Bear Valley Creek in Idaho, still exhibit degraded habitat caused by earlier mining.

5.6 GRAZING

5.6.1 Overview

Over 50 percent of the Columbia River Basin is considered suitable for livestock grazing (mainly cattle and sheep) and more than half of this amount is currently in public lands managed by the Bureau of Land Management (BLM) and U.S. Forest Service (USFS) (Thompson 1976b). The use of large parcels of land for livestock grazing did not occur until after white settlers arrived in the mid-1800s, but from the start livestock owners tended to overstock the available ranges with their herds. Rangeland deteriorated as overgrazing caused "shallow-rooted" less nutritious plant species to replace high quality, deep-rooted species. Soil compaction and riparian damage also occurred as a consequence of overgrazing. These practices and resultant damage have occurred throughout most of the available rangelands.

Because of the various effects of uncontrolled grazing noted above, the land has become highly vulnerable to accelerated soil erosion which affects water quality and quantity in streams. According to Platts (1981), watersheds subject to intensive grazing experience increases in peak runoff and sedimentation as well as decreases in groundwater infiltration and minimum flows. Overgrazing on rangelands in the Columbia River Basin has had a detrimental effect on the Columbia River salmon and steelhead trout, primarily through sedimentation of spawning beds (Platts 1981). Studies that compared grazed and ungrazed watersheds have demonstrated considerable differences in fish productivity. For example, fish production in ungrazed streams ranged from 2.4 to 5 times greater than grazed streams (Platts 1981).

An indication of the amount of grazing that is occurring is the animal unit month (AUM). AUM is defined as the amount of forage necessary to completely sustain one animal unit (for example, one cow and her calf) for one month; or, as a unit of measurement of grazing privilege within grazing districts for one month. Figures 31 and 32 shows trends in animal unit months (AUMs) for Idaho and Oregon/Washington for 1945 to 1983. The AUM data indicate that grazing for the three-state area peaked during the mid-1950s and then decreased. In Oregon, grazing significantly increased during the early 1980s.

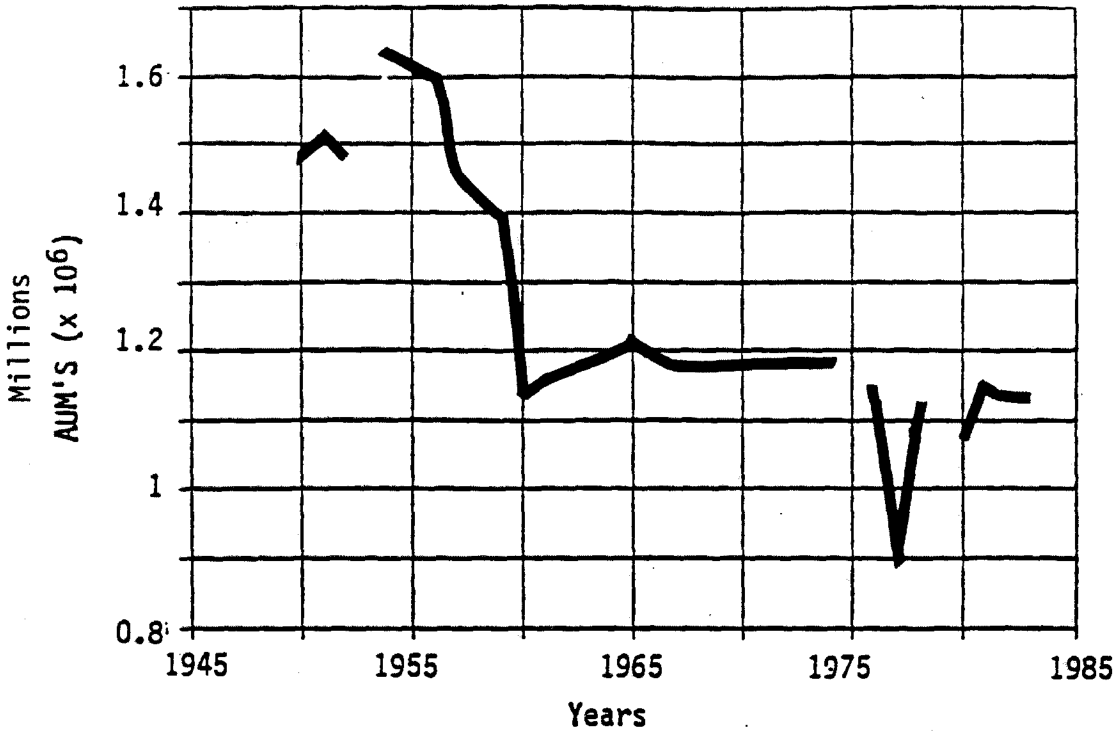


Figure 31. Grazing intensity in Idaho in AUM's from 1945-1983 (BLM, Public Land Statistics 1945-1983). (Discontinuous curves reflect data gaps.)

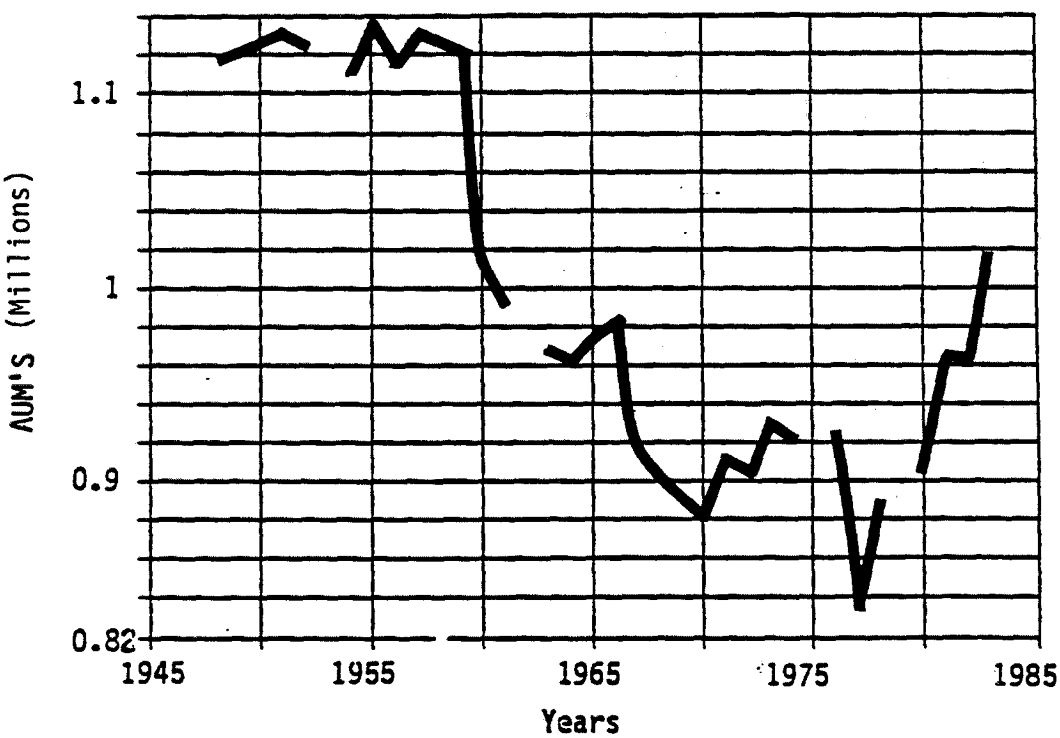


Figure 32. Grazing intensity in Oregon and eastern Washington from 1945-1983 (BLM, Public Land Statistics 1945-1983). (Discontinuous curves reflect data gaps.)

5.6.2 Reducing the Adverse Effects of Grazing

The first federal attempt to regulate grazing practices occurred in 1934 when the Taylor Grazing Act (43 U.S.C. 315, et seq.) was passed by Congress. The purpose of the act was to protect and to develop an orderly use of these lands. The Act had little immediate positive benefit because past practices were not easily changed. It was not until the mid-1960s that provisions of the Act for management by allotment was practiced extensively. Allotment management limits grazing to a specific number of AUMs per area of land as opposed to open range available to anybody's livestock.

Most of the mitigative actions affecting grazing are a result of range management practices by the USFS and BLM. In comparison to other developments, however, considerably less mitigation has been implemented to minimize impacts of grazing. Some measures used to achieve range rehabilitation and soil stabilization include increased control of livestock grazing through scientific range management practices, fencing, revegetation, and expanded fire protection (Pacific Northwest River Basins Commission 1971).

5.6.3 The Current Status of Grazing Impacts on Fish

The need for protecting streamside (riparian) habitat from livestock grazing continues to be a fisheries habitat management issue (Thompson 1976b). The most detrimental effects of grazing occur in late summer and early fall when low flows cause livestock to congregate near streams. These congregations cause stream bank deterioration, water pollution, and riparian habitat damage. It should be noted that through the use of current grazing technology and knowledge, and enforcement of pertinent laws, these problems could be solved.

5.7 AGRICULTURE/IRRIGATION

5.7.1 Overview

There are over 25 million acres of farmland in the Columbia River Basin -- 12 percent of all land in the basin. Major crop-producing areas are located in central Washington and southern Idaho (Thompson 1976b).

Figures 33 through 37 show the number of acres in farms from 1900 to 1982 in four areas of the Columbia River Basin. The two lower Columbia River areas and the two Snake River areas analyses have been combined due to difficulties in separating data for these areas.

In general, land used for farming in the Columbia River Basin increased steadily until about 1960 and leveled off. There are two exceptions to this trend. In the Columbia River above Chief Joseph Dam, farming increased between 1925 and 1932, followed by a substantial decrease in farms in 1935. In the Willamette River drainage, land in farms decreased dramatically after 1950.

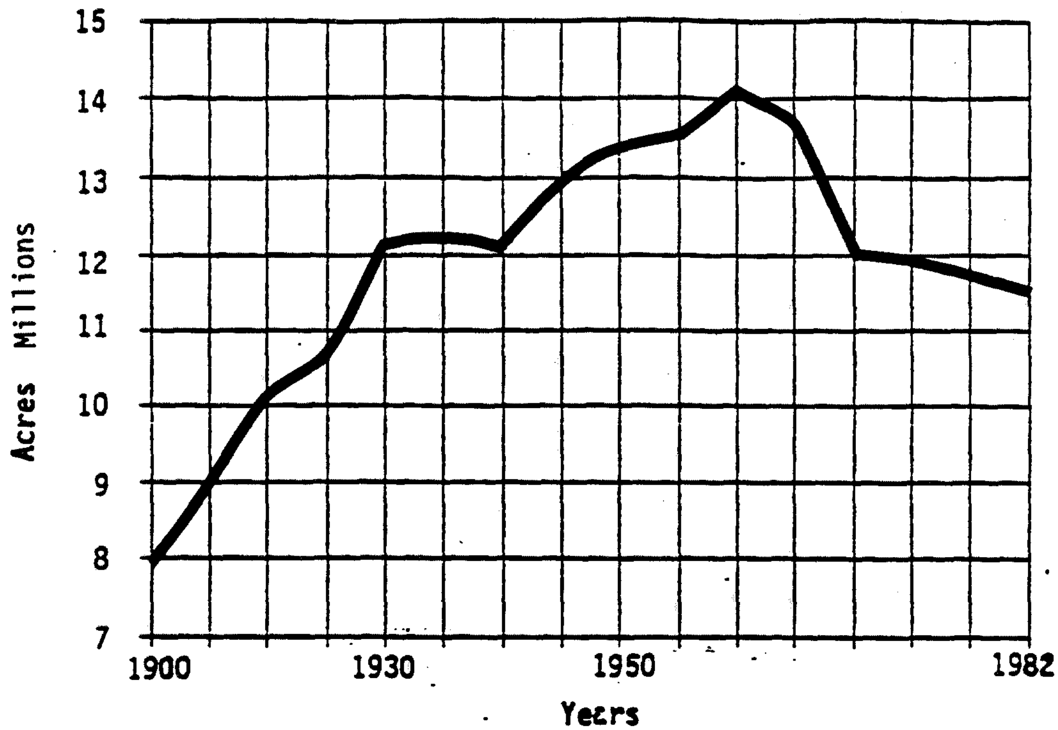


Figure 33. Acres in farm land for the lower Columbia area (U.S. Department of Commerce, 1900-1982a).

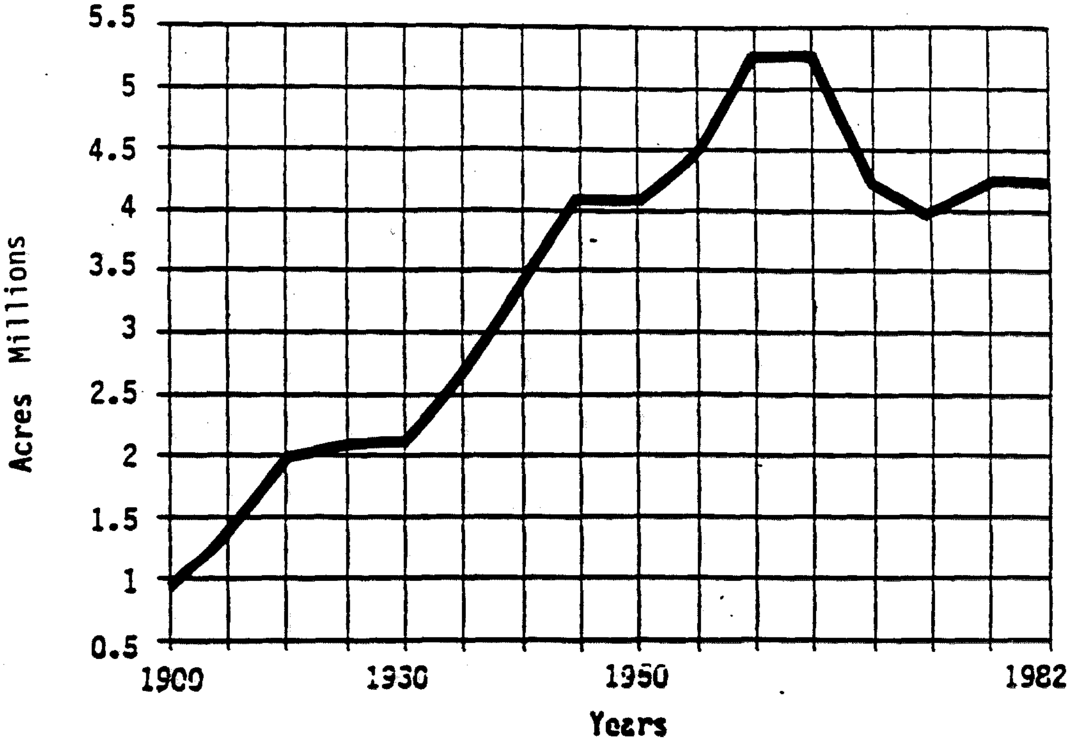


Figure 34. Acres in farm land for the middle Columbia River area (U.S. Department of Commerce 1900-1982a).

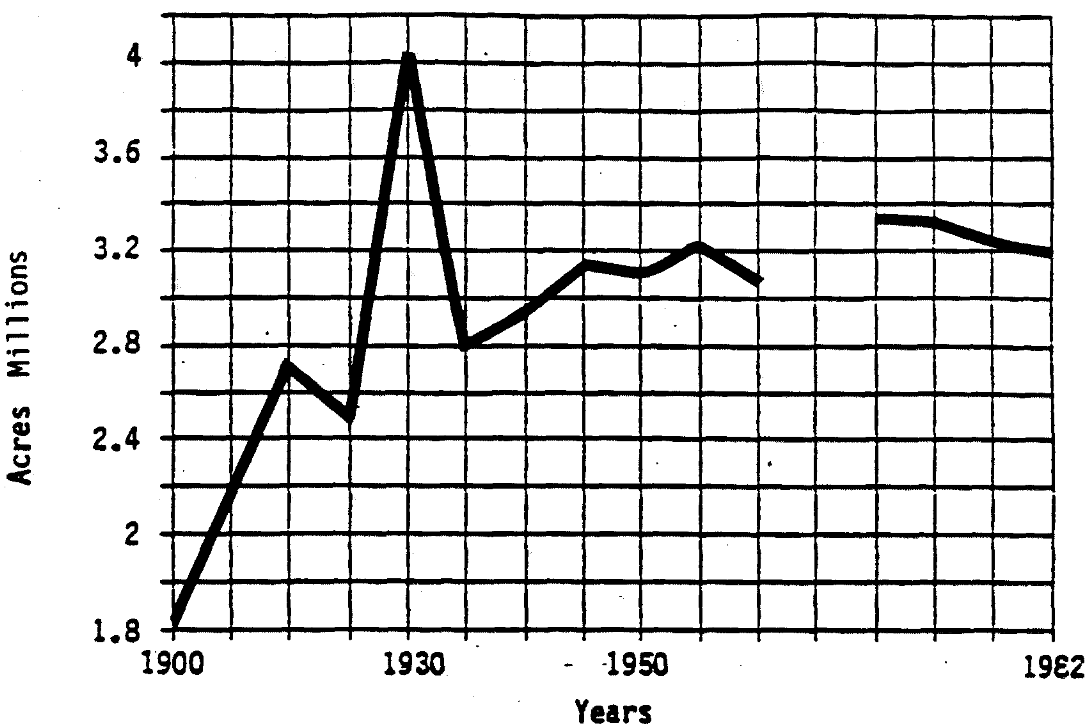


Figure 35. Acres in farm land for the upper Columbia River area (U.S. Department of Commerce 1900-1982a).

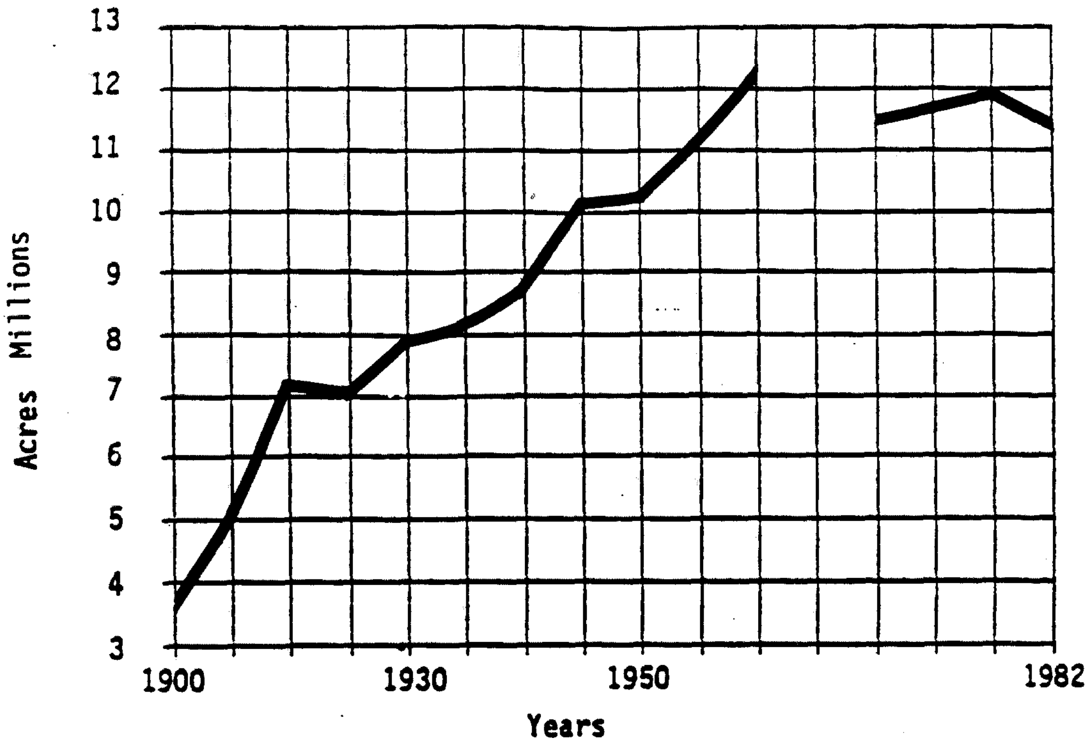


Figure 36. Acres in farm land for Snake River area (U.S. Department of Commerce 1900-1982a). (Discontinuous curve reflects data gaps.)

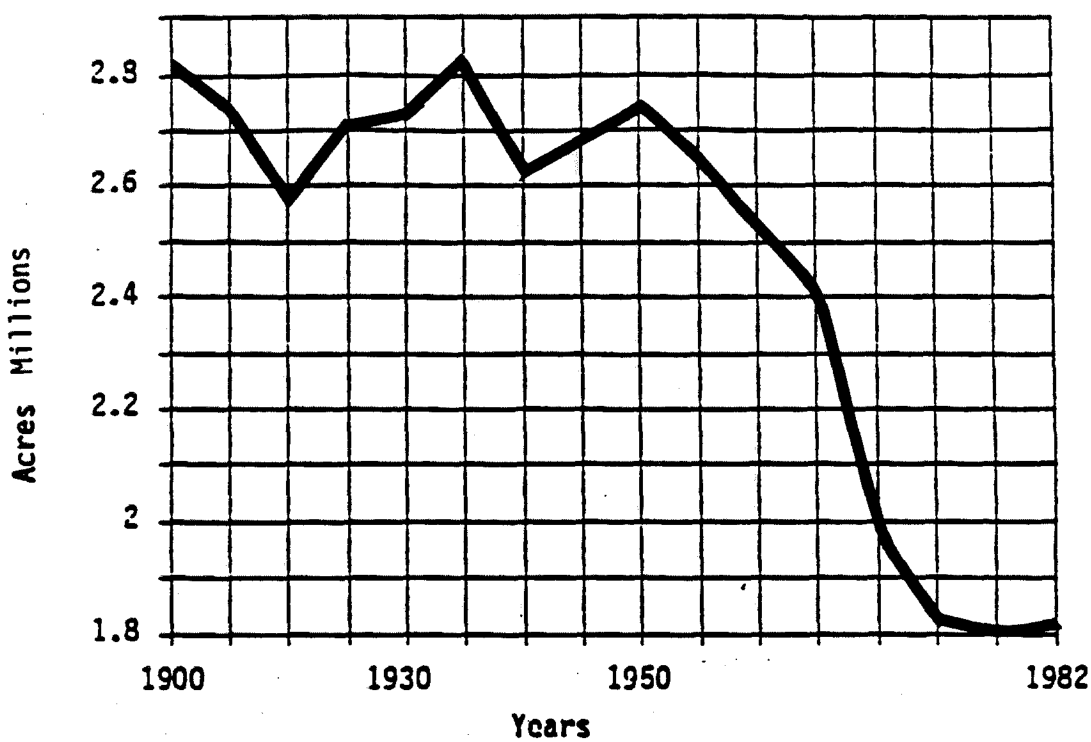


Figure 37. Acres in farm land for the Willamette River drainage (U.S. Department of Commerce 1900-1982a).

A history of farming in the basin can be seen through the development of irrigation. Irrigation in the Columbia River Basin developed slowly after settlers arrived in the 1800s. The first known irrigation in the basin was recorded prior to 1840 at missions near Walla Walla, Washington, and Lewiston, Idaho (Columbia River Water Management Group 1983). The first irrigation project in the Columbia River Basin was started in the Walla Walla River Valley in 1859 (Craig and Hacker 1940). Subsequently, water projects were developed in the John Day, Umatilla, and Hood River valleys in the 1860s. By 1889 there were 400,000 acres under irrigation in the Columbia River Basin (Pacific Northwest River Basins Commission 1971).

Several factors contributed to the increased interest in irrigation in the 1890s and early 1900s. An expanding market for foodstuffs and the completion of railroads attracted commercial-scale farmers to the basin during the late 1800s. Two Congressional acts, the Oregon Donation Land Law (Act of Sept. 27, 1850, 9 Stat. 496) and the Homestead Act of 1862 (Act of May 20, 1862, 12 Stat. 392), also created a demand for land. Legislation promoting irrigation development by private enterprise also passed during this period. The 1877 Desert Land Act (43 U.S.C. § § 321-329) allowed the sale of lands in 640-acre parcels, provided the land was irrigated for three years. Although less successful, the Carey Act of 1894 (43 U.S.C. § § 641-648) encouraged irrigation development by granting individuals 160 acres. In 1902, the Reclamation Act (32 Stat. 388) authorized the federal government to assist in irrigation development and enabled settlers to own 160 acres for the purpose of irrigating crops.

The effect of this legislation was to increase irrigated lands in the basin -- from 0.5 million acres in 1900 to 2.3 million acres in 1910. Total irrigated acres increased to 2.9 million in 1925, 6.6 million in 1966, and 7.6 million in 1980 (Columbia River Water Management Group 1983). Today irrigated lands are increasing at about 53,000 acres per year with a projected area of about 10.5 million acres by 2030 (Dillard 1985).

The funding for the various irrigation projects in the Columbia River Basin has varied considerably, depending upon the area. Overall, more than 70 percent of the irrigation development in the basin was initiated by individuals, cooperatives, and agencies other than the federal government.

However, most of the projects have received some federal support for obtaining supplemental water for developing dry lands (Pacific Northwest River Basins Commission 1971).

Irrigation methods have evolved from the initial concept of simple stream diversions to complex systems that use a variety of pumping and application mechanisms such as sprinklers, storage reservoirs, groundwater pumps and pressure distribution devices (Pacific Northwest River Basins Commission 1971). The early irrigation systems, which consisted mainly of gravity systems, were privately designed, financed, and built (Markham 1975). Many of the early irrigation projects also used a pump with a single intake line to feed the gravity system. The pumping/intake systems developed during the early and mid-1900s included vault-like structures with rectangular screened openings, pier-like structures supporting turbine pumps, and combination pier/vault structures (Swan et al 1980). Beginning in the 1920s, ditches or canals were often constructed to route water to pump stations (Easterbrook 1985).

The rapid increase in irrigation during the early 1900s was due to a decline in private development and an increase in federal multipurpose projects, primarily through the Bureau of Reclamation (Markham 1975). Beginning with the initiation of the Bonneville Dam in 1933, the Corps of Engineers also became involved with dam projects. Most of the major federal storage projects are multipurpose, which includes authorization for irrigation.

The number of individual intake systems for irrigation in the Columbia River Basin was extremely large by the mid-1900s. Mallett (1970) identified over 700 intake structures in Oregon and Idaho. The estimated number of intake structures during peak operation in Washington was at least 200 (Easterbrook 1985).

Although acres of land irrigated is the most common unit used to describe irrigation development, its use in characterizing historical trends should be clarified. The acreage irrigated does not reflect changes in irrigation practices that resulted in more efficient use of water. In other words, sprinkler systems need less water to irrigate the same area of land than is required for gravity feed systems. The dominance of sprinkler irrigation generally began in the mid-1960s.

To account for changes in irrigation practices, it is also useful to examine the amount of water diverted for irrigation (acre-feet). Federal records for 1947 to 1983 show the volume of water diverted to farms increased from about 2.6 million acre-feet in 1947 to 12.2 million acre-feet in 1969 (Table 27). Since 1969, the amount of water diverted by federal projects for irrigation has ranged between about 9.5 and 12 million acre-feet. This leveling off of federal irrigation water use is due to the efficiency of sprinkler systems and the involvement of non-federal projects. The amount of additional water diverted by non-federal projects is not readily available in the literature.

All portions of the Columbia River Basin have some irrigated land, but significant concentrations occur near large irrigation projects (Columbia River Water Management Group 1983). These areas include the Snake River plain from the Wyoming-Idaho state line to the Idaho-Oregon state line; the Yakima Valley and east of the Columbia River from Moses Lake on the north to the mouth of the Snake River on the south in Washington; and the Deschutes, Willamette, and Crooked river basins in Oregon. Below, a more detailed discussion of the location of irrigated land is provided for the four major areas of the basin.

The following sections describe irrigation development and related impacts to salmon and steelhead resources in the six areas of the Columbia River Basin. The two lower Columbia River areas and the two Snake River areas analyses have been combined due to difficulties in separating data for these areas.

5.7.1.1 <u>Lower Columbia River Area</u>

Non-Indian irrigation in the lower Columbia River area began in 1845 around Walla Walla, Washington (Pacific Northwest River Basins Commission 1971). Development proceeded gradually, reaching nearly 300,000 acres of irrigated land in the 1920s. As shown in Figure 38, development leveled off from 1925 to about 1950. During this period, four areas (Umatilla

Table 27 - Acre-feet (x 1,000) of surface water delivered to farms in the Columbia River Basin by the Bureau of Reclamation.

Year	Upper[1] Columbia	Middle[2] Columbia	Lower[3] Columbia	Snake	Total
1947	0	782.2	397.9	1,459.0	2,639.1
1951	32.8	845.8	446.7	1,632.7	2,958.0
1953	20.4	860.3	340.0	2,128.4	3,349.1
1955	6.2	885.5	509.5	1,719.0	3,120.2
1957	<10.0	1,668.9	444.2	2,150.6	4,273.7
1959	12.3	1,977.8	336.7	2,450.9	4,777.7
1961	13.2	2,294.2	351.2	2,107.4	4,766.0
1963[4]	---	---	---	---	---
1965	45.2	2,764.2	432.6	2,370.3	5,612.3
1967	79.3	---	706.3	7,599.9	8,385.5
1969	177.6	3,468.8	699.3	7,893.4	12,239.1
1971	235.7	3,392.0	627.1	6,440.0	10,694.8
1973	266.3	3,672.0	712.0	6,287.0	10,937.3
1975	266.0	3,513.4	741.5	6,078.3	10,599.2
1977	258.3	3,006.6	658.8	5,963.3	9,887.0
1979	214.9	4,847.6	664.5	5,926.0	11,653.0
1981	216.8	3,737.0	718.4	6,051.0	10,723.2
1983	135.6	3,829.0	608.4	5,151.8	9,724.8

Source: Bureau of Reclamation (1947 through 1983).

-- = Data not available (assumed to be approximately 3,000 acre-feet).

[1]Columbia Basin above Chief Joseph Dam.

[2]Columbia Basin between the confluence with the Snake River and Chief Joseph Dam.

[3]Columbia Basin below the confluence with the Snake River.

[4]Data not available for 1963.

River/Willow Creek, John Day River Basin, Kennewick Return Flow, and Deschutes Project) contained most of the irrigated land (Table 28). Beginning in the 1950s, irrigation expanded substantially to about 850,000 acres of land in 1980. Two areas showing the largest growth during this period were the Willamette Basin and the Deschutes Project. Although the Willamette Basin is presently the dominant irrigation area, its development was slow until the 1930s.

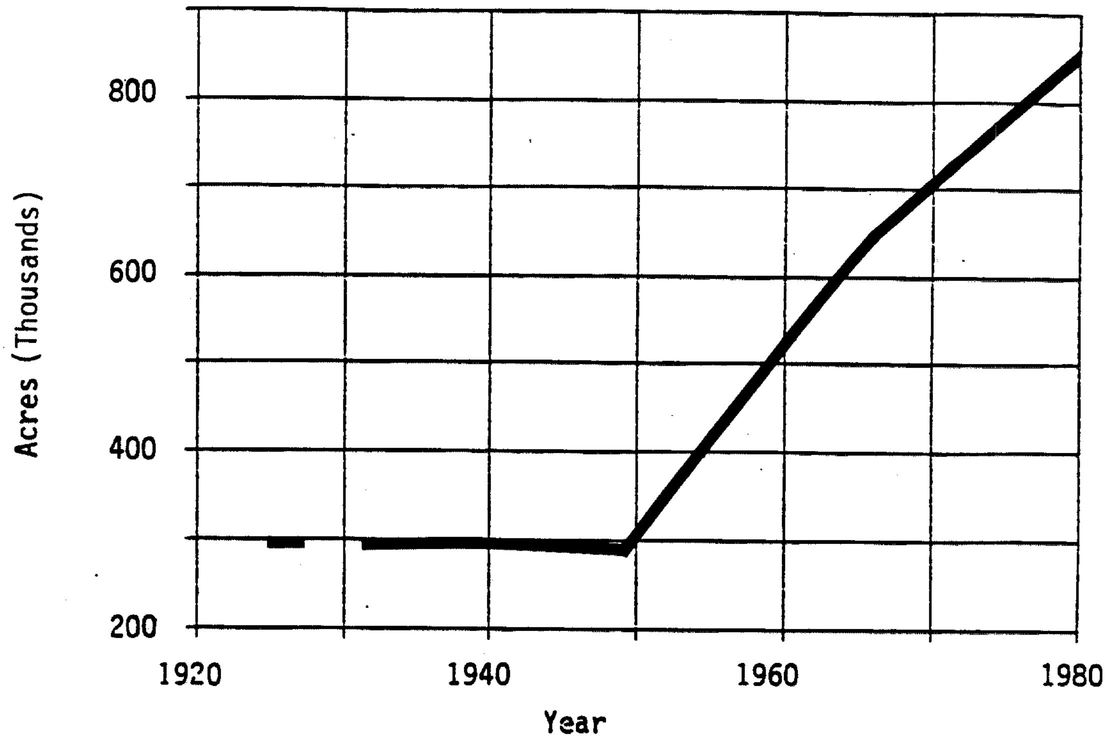


Figure 38. Total acres irrigated in the lower Columbia River area (Columbia River Water Management Group 1983).

The total estimated storage capacity for irrigation dams in the lower Columbia River area is 315,240 acre feet. Drainages that store the most water include the Deschutes, Tualatin, and Willamette. A review of the individual storage capacities of irrigation dams, found in Appendix C, Table C-1, indicates that volumes are relatively small (less than 300 acre feet) except in the Deschutes, Tualatin, and Willamette drainages.

Irrigation development in the lower Columbia River is characterized by sizable concentrations of irrigated land resulting from large project development. Some projects were funded by the federal government. Bureau of Reclamation records (1947-1983), show the volume of water diverted from federal projects has ranged from approximately 450,000 acre-feet in 1947 to

Table 28 - Acres of land irrigated (x 1,000) in the Columbia River Basin.[1,7]

	1925	1928	1948/50	1966	1980
Lower Columbia[2]					
Walla Walla River	26.2	25.8	35.6	48.2	75.4
Umatilla River/Willow Creek	50.2	50.6	52.6	46.0	37.9
John Day River Basin	45.3	47.1	50.3	56.4	57.8
Kennewick Return Flow	50.2	50.6	52.6	46.0	37.9
Pumping from McNary to North Side	3.2	3.2	3.2	4.1	34.1
Pumping from McNary to Umatilla Area	0	0	--	8.1	37.8
Willamette Basin	3.9	4.0	54.6	14.25	219.5
Fern Ridge	0	0	1.0	1.4	1.5
Deschutes Project	75.5	75.0	0	235.1	190.5
Pumping from John Day Pool to Morrow and Gilliam Counties, Oregon	0	0	0	0	74.0
Deschutes River Basin, White River-Wapenita Project	5.5	5.5	--	13.9	17.0
Klickitat Basin	7.2	7.2	7.8	7.7	9.2
White Salmon River Basin	4.8	4.8	4.8	5.1	5.3
Hood River Basin	25.2	25.2	30.0	36.9	35.0
Klickitat-White Salmon	0	0	0	0	3.3
Total Lower Columbia[3]	297.2	299.0	292.5	523.15	836.2

-- = Information not available.

[1]Source: Columbia River Water Management Group (1983).

[2]Columbia River Basin below the confluence with the Snake River.

[3]Acreages not available for the Lewis and Cowlitz Rivers.

[7]Increase or decrease in numbers of acres irrigated does not necessarily reflect amount of water used.

Table 28 (cont)

Middle Columbia[4]	1925	1928	1948/50	1966	1980
Kettle	4.5	4.6	5.8	10.7	21.1
Okanogan	84.0	80.4	93.6	117.1	133.7
Ferry-Stevens	5.7	5.7	10.0	21.0	21.7
Methow-Okanogan	32.0	31.3	35.0	34.5	39.4
Chelan-Entiat	6.1	7.2	7.2	6.5	6.5
West of Banks Lake	5.8	5.4	15.8	23.4	30.0
Wenatchee	24.6	24.6	25.0	26.0	26.0
Yakima	335.0	333.1	--	505.0	580.5
Columbia Basin Project	0	0	5.8	493.3	534.0
Big Bend	5.8	5.9	70.0	118.3	276.4
Total Middle Columbia[5]	503.5	498.2	268.2[3]	1,355.8	1,669.3
Upper Columbia[6]					
Upper Columbia above Mica	4.6	4.7	6.4	8.6	11.8
Mica to Keenleyside	0.7	0.7	1.0	1.3	2.1
East Kootenay	1.8	1.8	4.0	6.3	11.9
West Kootenay	1.8	1.8	4.0	6.3	11.9
Slacan Basin	0.5	0.5	0.9	1.2	3.8
Kneeleyside to Pend Oreille	0.3	0.3	0.5	0.8	0.9

[4]Columbia Basin between the confluence with the Snake River and Chief Joseph Dam.

[5]Total does not include Yakima Basin (not reported in 1948).

[6]Columbia Basin above Chief Joseph Dam.

Table 28 (cont)

	1925	1928	1948/50	1966	1980
Upper Clark Fork	125.8	125.0	128.0	131.0	131.0
Bitterroot	111.0	108.0	108.0	106.0	118.6
Upper Flathead	6.2	6.0	8.5	26.1	30.4
Pend Oreille	3.7	3.8	5.9	7.6	9.3
Flathead Irrigation District	31.8	33.8	93.8	116.9	126.2
Lower Clark Fork	15.3	15.5	20.0	27.0	20.9
Spokane	25.3	24.6	25.0	42.0	55.4
Total Upper Columbia	319.1	316.7	389.2	456.6	491.8
Snake River					
Lower Snake					
Upper Salmon	83.5	84.3	107.4	122.4	121.0
Lower Salmon	15.8	16.8	16.6	16.6	17.6
Grande Ronde	90.7	92.1	96.5	97.0	87.7
Clearwater	3.6	3.4	3.5	3.0	2.4
Palouse-Lower Snake	27.6	26.6	26.6	26.0	56.2
Middle and Upper Snake	1,528.4	--	--	3,818.4	4,296.9
Total Snake River Basin	1,749.6	--	--	4,083.4	4,581.8
TOTAL COLUMBIA RIVER BASIN	2,881.9	--	--	6,578.1	7,601.2

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