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Impacts of Irrigation Development on Anadromous Fish in the Yakima River Basin, Washington

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IMPACTS OF IRRIGATION DEVELOPMENT ON ANADROMOUS FISH IN THE YAKIMA RIVER BASIN, WASHINGTON

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by

Robert L. Tuck

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Prior to Euroamerican development, the Yakima River Basin was a major producer of salmon. Total runs of approximately 800,000 have declined to 3,000-5,000, or less than 1% of original run size. Three species are extinct in the basin, including summer chinook, coho, and sockeye.

Irrigation development, including the construction of unscreened diversions, the blockage of spawning and rearing habitat by reservoir dams, and the dewatering of spawning and rearing habitat, began in the mid-1800's and today totals approximately 500,000 acres. Historical records provide a wealth of information documenting irrigation development and its consequences on anadromous fish populations.

ACKNOWLEDGEMENTS

Throughout the preparation of this thesis and pursuit of a Master's Degree at Central, I have been supported, encouraged, aided, and challenged by many people. This entire adventure began several years ago over lunch with Dr. Morris Uebelacker, who pointed out that dreams only come true when you stop talking and start working.

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DEDICATION

This thesis is dedicated to the salmon of the Yakima River Basin, and to the people who long for their return.

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PREFACE

On 16 October 1805, the "Corps of Discovery" led by Captains Meriwether Lewis and William Clark reached the confluence of the Snake and Columbia Rivers. The next day, Clark explored upstream along the Columbia River as far as the mouth of a medium-sized stream that joined the Columbia from the west side (Cutright 1969). Thus Clark became the first Euroamerican to reach the "Tapteal", what some now call the Yakima River.

This tributary of the Columbia River was only one of dozens of streams that Lewis and Clark placed on the map of North America for the first time. There is nothing to indicate that they thought there was anything unusual or remarkable about this particular stream. They did, however, take note of the large number of salmon they observed along the Columbia River near their camp.

Although they had previously observed salmon on the Lemhi, Clearwater, and Snake Rivers, it was not until they reached the Columbia River that Lewis and Clark first reported observing Pacific salmon in really large numbers, noting that the river was "crouded with them", and that they could observe salmon to a depth of 15-20 feet. Great numbers of them were dead along the shore, attracting flocks of crows and ravens to feast on their spent bodies (Cutright 1969).

The salmon that Lewis and Clark reported in the Columbia River that fall day almost two centuries ago were undoubtedly what are now termed fall chinook (Oncorhynchus tshawytscha). The fact that there were many dead carcasses along the shore indicates that this area of the Columbia River was used for spawning by this run of chinook. They also observed many scaffolds holding drying salmon, being preserved by local bands of Native Americans.

Although explorers from several nations had sailed along the coast of western North America and obtained salmon by trading with local Native Americans, Lewis and Clark were quite possibly the first Euroamericans to observe spawning salmon on a large scale in the Columbia River Basin. They also quickly came to appreciate the importance of salmon to the various tribes and bands. By the time they reached

Celilo Falls on 22 October, the catching and preserving of salmon was past its peak of activity:

> The great majority of transient tribesmen had left for their homes. Neither then nor the next spring did they witness this thriving emporium at its most animated, boisterous peak. In the many baskets filled with pounded fish on the shore, however, they saw abundant evidence of the intense, sustained industry that had been in progress since early spring when the salmon began to run (Cutright 1969).

Lewis and Clark discovered, during their trek through the Columbia River Basin in 1805-06, the two defining features of the Pacific Northwest. The first--the geographic, economic and biological artery of the Pacific Northwest--was the Columbia/Snake River system, which drains over 260,000 square miles. The Columbia River Basin collects water from the base of the Canadian Rockies; from the western side of the Continental Divide, south to the Yellowstone Country; from the northern rim of the Great Basin; from the eastern side of the high country of the Cascade Mountains; and from portions of southwestern Washington and northwestern Oregon.

The second defining feature of the Pacific Northwest recorded by Lewis and Clark was Pacific salmon. Although they did not "discover" salmon in the classic sense of the word, Lewis and Clark were apparently the first Euroamericans to record the great numbers of salmon in the Columbia River drainage, hundreds of miles inland from the Pacific Ocean. It was, in fact, a piece of salmon, provided

by friendly members of the Shoshone Tribe near the Lemhi River, that convinced Lewis that he had indeed crossed the Continental Divide and was now in the Pacific drainage (Cutright 1969).

The arrival of the expedition led by Lewis and Clark in the Pacific Northwest was "a crackling, lightning-bolt event for the Indian Society of 50,000 people that lived in the Columbia River Basin" (Wilkinson 1992). Although this society had already been modified by the presence of Europeans in North America through such impacts as disease and the introduction (or re-introduction) of the horse, the arrival of Lewis and Clark clearly signaled that the Euroamericans would soon, as a river measures time, be arriving in numbers that would grow to be a flood (Hunn 1990).

That flood, in less than two centuries, would inundate the original inhabitants of the Columbia River Basin, the abundant salmon (including steelhead) runs upon which they depended, and the Columbia River itself. The changes that have occurred in the basin since Lewis and Clark observed the fall chinook near the mouth of the Snake River would have been simply unimaginable to them. Their world was comprised of fish so plentiful that they were uncountable; rivers so wild and powerful that they were not infrequently

at risk of injury or loss of supplies as they traveled upon them.

Our world today is such a stark contrast to theirs that we can hardly imagine that earlier time. The total salmon runs are estimated to have numbered 10-16 million returning adults annually early in the 19th century (Northwest Power Planning Council 1987). Of the original 163,000 square miles of the Columbia River Basin that was open to anadromous fish in 1805, approximately 90,000 square miles are no longer accessible (Northwest Power Planning Council 1982).

Today, many runs that existed in the Columbia Basin at the time of Lewis and Clark are extinct. Several runs have been listed as threatened or endangered under the Endangered Species Act of 1973, while many other runs are extremely depleted (Nehlsen, et al. 1991). Cutright (1969) perhaps said it best:

> The explorers had reached the Columbia at a time coinciding with the final seasonal climacteric of this great anadromous fish. They had never witnessed such a piscatorial spectacle before and would never again. In fact, deplorably, no one will. Salmon runs of such magnitude no longer exist, have not for all too many years.

The Snake and Columbia Rivers, wild and powerful streams that bore the canoes of Lewis and Clark to the Pacific Ocean, are now mostly large lakes, dull and seemingly

lifeless. The rivers have been robbed of their voice, as well as their soul, by the great concrete and earthen plugs that have been placed in their paths. They no longer pulse with energy and excitement. The roar of Celilo Falls has been stilled; the great gathering place that Cutright (1969) called the "primary mart of the Columbia, the center of the salmon economy" has been buried, as in a grave, beneath the waters behind The Dalles Dam.

Salmon runs in Columbia River tributaries, such as the Yakima River, have fared no better. Many tributary runs are extinct and many others have been reduced to remnant shadows of their former abundance. Adverse habitat alterations, if sometimes more subtle than the large dams on the Columbia River, have been extensive in the tributaries and the impacts on salmon in many instances has been devastating. This thesis focuses on the fate of salmon in one tributary basin.

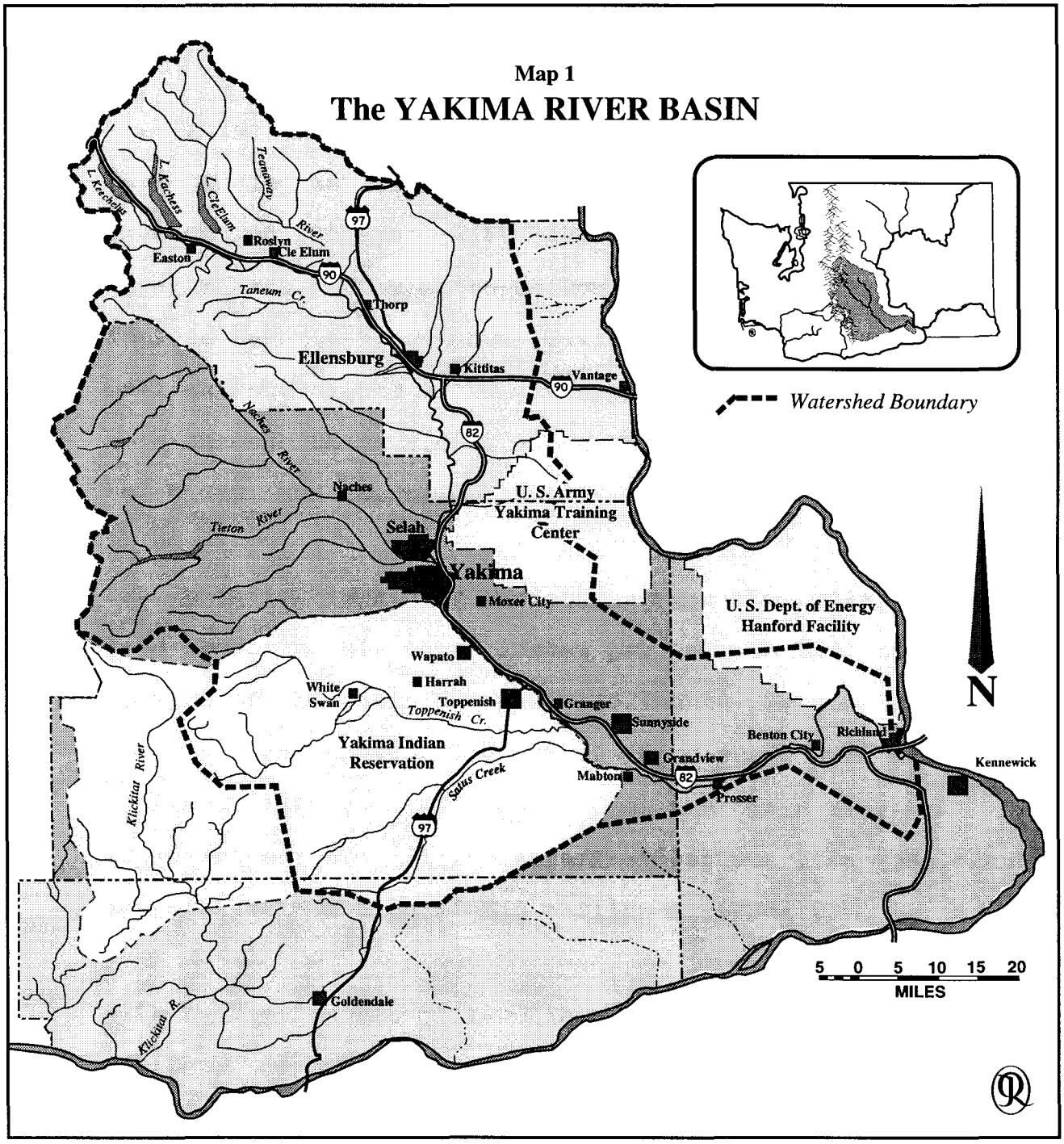
INTRODUCTION

The Yakima River Basin

The Yakima River Basin is located in south-central Washington and encompasses an area of just over 6,100 square miles (Map 1). It is bordered on the west by the crest of the Cascade Mountains, on the north by the Wenatchee Mountains, on the east by the breaks of the Columbia River, and on the south by the Simcoe Mountains and the Horse Heaven Hills.

The Yakima River originates near Snoqualmie Pass at the outlet of Keechelus Lake, 2,450 feet above mean level. It travels in a generally southeastern direction for over 200 miles before contributing its flow to the Columbia River at Richland, Washington.

A number of larger streams drain portions of the basin before joining the Yakima River, including the Naches, Cle Elum, Kachess, and Teanaway Rivers. In addition, several smaller streams are important tributaries to the Yakima


Map 1
The YAKIMA RIVER BASIN
L. Kachess
L. Cle Elum
Teanaway River
L. Keechelus
Roslyn
Cle Elum
Easton
Taneum Cr.
Thorp
Ellensburg
Kittitas
Vantage
Watershed Boundary
Yakima River
Naches
Tieton River
Selah
Yakima
Moxee City
U. S. Army
Yakima Training
Center
U. S. Dept. of Energy
Hanford Facility
N
Wapato
Harrah
White
Swan
Toppenish
Toppenish Cr.
Granger
Sunnyside
Benton City
Richland
Kennewick
Grandview
Mabton
Prosser
Yakima Indian
Reservation
Klickitat River
Satus Creek
Goldendale
Klickitat R.
5 0 5 10 15 20
MILES

River, including Taneum, Manastash, Wenas, Ahtanum, Toppenish, and Satus Creeks.

The Yakima River Basin is interrupted by a number of east-west tending anticlinal ridges, which form a series of intervening valleys: Kittitas, Wenas, upper Yakima, and lower Yakima. From north to south, the anticlinal ridges include Manastash, Umtanum, Yakima, and Ahtanum Ridges, as well as Rattlesnake Hills (Pearson 1985). The Yakima River cuts through these ridges along the Ellensburg Canyon, at Selah Gap, and at Union Gap.

Precipitation is highly variable across the basin, ranging from approximately seven inches per year in the eastern portion of the basin, to over 140 inches per year along the western border near the crest of the Cascade Mountains (Pearson 1985). Total runoff from the basin averages approximately 3.4 million acre/feet per year, ranging from a low of 1.5 to a high of 5.6 million acre/feet.

With a large amount of favorable spawning and rearing habitat, the basin was one of the primary anadromous salmonid production areas within the Columbia River Basin. The Bureau of Reclamation (1956) noted that:

> The Yakima River, as one of the good quality tributaries of the Columbia River, contributed its

share to the large runs found in the lower (Columbia) river.

Stream gradient is moderate, averaging 11 feet per mile (Robison 1957). Natural production is limited by stream gradient only in the extreme headwaters of some streams (Northwest Power Planning Council 1989).

The basin contains a variety of aquatic habitats, including the large mainstem of the Yakima River; medium-size rivers, such as the upper Yakima River, Cle Elum River, and the Naches River; and many smaller tributaries, such as Satus Creek, Ahtanum Creek, Little Naches River, Taneum Creek, and the headwaters above the original large lakes.

General Decline of Salmon

Dramatic changes have taken place on the tributaries of the Columbia River since the time of Lewis and Clark. Scores of dams have been built to divert or store water for irrigation, to divert water for cities and industry, and to utilize water for energy production. Streams have been dried up, channelized, diked, rip-rapped, and otherwise modified. Riparian areas have been stripped of vegetation. Large areas of tributary watersheds have been clear-cut, overgrazed, or converted to urban uses.

These tributaries once produced a significant portion of the total salmon that originated in the Columbia River System.

Salmon no longer have access to many of these streams, due to the construction of dams that block fish migration, the most notorious being Grand Coulee on the upper Columbia River and Hells Canyon on the Snake River. These dams totally eliminated salmon production from tributaries upstream: the Weiser, Bruneau, Payette, and Boise Rivers in Idaho; the Owyhee and Malheur Rivers in Oregon; the Spokane, Kettle, Pend Oreille, and San Poil Rivers in Washington; and the entire upper Columbia River drainage in British Columbia.

Other salmon runs have been driven to extinction from tributaries that are still accessible to the ocean: Entiat River summer chinook; Okanogan River spring chinook; Methow River coho; Walla Walla River chum; Umatilla River spring chinook; all are examples of runs that formerly existed in Columbia River tributaries that are still accessible to the ocean (Nehlsen et al. 1991).

The Yakima River is perhaps the best example of a Columbia River tributary still accessible to the ocean whose salmon runs have been devastated. Quite probably only exceeded by the Snake River Basin in terms of salmon production, the Yakima River Basin produced six runs of anadromous salmonids: spring, summer, and fall chinook; coho; sockeye; and steelhead. Today, summer chinook, coho, and sockeye are

extinct in the basin, and only remnant runs of spring and fall chinook steelhead remain (Northwest Power Planning Council 1989). The current production of salmon is less than 1% of historic production, and a petition has been filed to list Yakima River Basin steelhead as threatened or endangered under the Endangered Species Act of 1973.

The current status of salmon runs in the Yakima River Basin is not unique in the Columbia River Basin. Nor, unfortunately, is the fate of salmon runs in the Columbia River Basin atypical of what has befallen anadromous salmonids across the West Coast of North America, from northern Baja California to British Columbia. Salmon runs in the Klamath and Sacramento-San Joaquin River systems have suffered as severely as runs in the Columbia River Basin (Lufkin 1991). Euroamerican development has not been kind to, or even minimally considerate of, salmon habitat requirements. Nehlsen, et al. (1991) list over 100 extinct West Coast stocks, as well as over 200 stocks at risk of extinction.

Much has been written about the causes of the decline of salmon runs in the Columbia River Basin (Brown 1982; Cone 1995; Netboy 1958; Northwest Power Planning Council 1986, 1991; Van Dyk 1990). There are probably few, if any, more contentious natural resource issues in the United States

than the destruction of salmon in this river basin, and what should be done to correct it. In recent years, various facets of this issue have seemingly produced more litigation than fish.

The factors that have contributed to the decline of salmon runs in the Columbia River Basin include: mining; extensive logging and log drives; construction of dams for hydropower, irrigation, navigation, and industrial purposes; diversion of water from streams for irrigation and other purposes; pollution; urban development; construction of highways and railroads; overgrazing; flood control projects; and overfishing (Northwest Power Planning Council 1986; United States Army 1993). Almost every activity of Euroamericans since the early-1800's has had an adverse impact on salmon runs.

While it may be possible to list the general activities that have contributed to the decline of salmon, more specific discussions of cause and effect have tended to be extremely controversial. This has led to considerable finger-pointing across the Columbia River Basin: hydropower interests point to overfishing, logging, and irrigation; irrigation interests point to hydropower, overfishing and logging; the fishing industry points to hydropower development, logging, and irrigation.

Much of the attention in recent years has focused on the hydropower system as a cause of the decline of salmon runs, and the impact these projects continue to have on anadromous salmonids. However, this generalization tends to obscure the causes that may be responsible for the decline of salmon runs in a particular tributary. The Yakima River is one such tributary. Others include the Umatilla, Walla Walla, and Owyhee Rivers. We know that salmon runs in the Yakima River Basin declined drastically before any hydropower dams were constructed on the Columbia River. What, if not the hydropower system, was responsible for this decline?

Activities that could have an adverse impact on salmon production in the Yakima Basin during the second half of the nineteenth century include logging, mining, irrigation, and commercial fishing in the lower Columbia River. Of these four activities, only irrigation was geographically wide-spread across the entire basin. Mining was restricted to a small portion of the basin. Logging, including log drives, undoubtedly did have some adverse impact on salmon production, but was also limited in scope and time.

Commercial fishing has been cited by some as the principal cause of the decline of Yakima River Basin salmon runs. For support, they cite the catch of chinook salmon in the lower

Columbia River, which peaked in 1883 at over 42 million pounds, and then decreased (Craig and Hacker 1940).

To arrive at any conclusion with regard to possible impacts of the fishery in the lower Columbia River on salmon runs in the Yakima River Basin, we must examine the timing of the great decline in the runs in the basin and the harvest figures before and after 1900. Davidson (1953) estimates that the original salmon runs in the basin had been reduced by over 90% by 1900. By 1920, runs had been further reduced to an estimated 11,000 returning adults, or between 1-2% of the original runs (Bureau of Reclamation 1979).

However, the harvest of chinook salmon in the Columbia River during the five years, 1916-1920, averaged over 30 million pounds annually, or over 70% of the peak harvest of 1883 (Craig and Hacker 1940). Therefore, at a time when the runs of salmon in the Yakima River Basin had been reduced by over 98%, the harvest of chinook salmon in the lower Columbia River was still over 70% of the peak harvest.

The same chronological relationship holds true for the total harvest of salmon. The peak harvest of all salmon in the lower Columbia River, canned, mild-cured or frozen, was over 49 million pounds, and occurred in 1911, six years <u>after</u> the runs in the basin had been reduced by over 90% (Craig and

Hacker 1940). The total harvest in the lower Columbia River for the five years 1916-1920 averaged over 41 million pounds annually, or almost 85% of the peak harvest of 1911.

The relationship of the timing of the peak coho harvest in the lower Columbia River compared to the status of coho runs in the Yakima River also illustrates the point that factors other than harvest must have been involved in the decline of the salmon runs in the Yakima River Basin. The peak harvest did not occur until 1925, by which time only a remnant coho run existed in the basin (Craig and Hacker 1940).

It is clear from these harvest figures that fishing in the lower Columbia River had little, if any, impact on salmon production in the Yakima River Basin. Indeed, the decline in the harvest of chinook salmon after the peak year of 1883 may not reflect impacts of fishing at all, but rather the impacts of mounting habitat degradation in the chinook spawning and rearing areas in the Columbia River Basin.

That brings us to the consideration of irrigation development in the Yakima River Basin. By the time the first water was diverted in the basin to sustain vegetables in a simple garden, irrigation was an ancient method of growing crops. The origins of the practice and art of irrigation are lost in the mists of time. The Sumerians

were irrigating land at least 5,000 years ago (Matheson 1991). Irrigation was also developed in Egypt and India at approximately the same time.

In the Western Hemisphere, Native Americans developed extensive irrigation projects in Mexico and Peru several hundred years before Christ. In what is now Arizona, the Hohokam Indians developed significant irrigation along the Salt River Valley by 300 A.D. (Worster 1985). Spanish missionaries and colonists were irrigating the Rio Grande Valley and California in the 1700's.

Smythe (1969) claims that the first significant irrigation by "Anglo-Saxons" occurred in 1847, when Mormons, fleeing persecution in the East, diverted the waters of City Creek near Salt Lake. The accuracy of this statement hinges on the definition of "significant", for the origins of irrigation in what is now the state of Washington pre-dates the ditch from City Creek by at least 10 years. In 1837, near what is today the city of Walla Walla, Marcus Whitman planted an apple orchard, plus a garden, and watered them from a near-by stream (Boening 1918). However, crops may have been irrigated even earlier at Fort Walla Walla, since Narcissa Whitman noted that the first sign of civilization they observed upon their arrival in 1836 was a garden, some two miles from the fort (Locati 1979).

Irrigation in the Yakima River Basin did not lag far behind events in the Walla Walla Valley. Father Pandosy and other priests may have irrigated their garden at the Ahtanum Mission in the mid-1850's (Boening 1918). Kamiakin is generally credited with the first recorded irrigation ditch in the Yakima River Basin, sometime during the 1850's (Lyman 1919). Euroamerican settlers began irrigating crops and gardens in the 1860's, and by 1905, approximately 137,000 acres were being irrigated (Waller 1904).

Irrigation development is detrimental to nearly every aspect of salmon habitat and health. Dewatering of spawning and rearing areas, degraded water quality, elevated water temperatures, sedimentation of spawning areas, blockage of spawning and rearing areas, loss of streamside vegetation, and diversion of juvenile fish into unscreened canals or ditches are the most obvious (Stober et al. 1979; United States Army 1993: Bonneville Power Administration, Corps of Engineers, Bureau of Reclamation 1994).

Irrigation development in the basin prior to 1900 was widespread, with canals and ditches constructed along the mainstem Yakima River and many tributaries. Since 1905, irrigation development has more than tripled, and continues to adversely impact salmon production.

Perhaps no other tributary in the entire Columbia River Basin offers as good an opportunity to examine the effects of irrigation development on salmon production. The history of irrigation development and the decline of salmon runs in the Yakima River Basin is representative of a large number of watersheds in the Columbia River Basin, as well as in other regions. If we are to prepare ourselves to make wiser decisions regarding natural resources in the future, it is important to understand the context and consequences of past decisions.

The Problem

This thesis will examine the development of irrigation in the Yakima River Basin and its impacts on salmon production, from 1855 to the present. Due to on-going efforts to restore salmon runs in this basin, such a review is both an historical assessment and an identification of current conditions that must be corrected, or at least ameliorated, in order that salmon restoration may be successful.

I intend this thesis to be more comprehensive than simply a detached rendering of "facts and numbers." I believe that a genuine understanding of the processes leading to the present conditions requires more than just a knowledge of what happened, who did it, and when. To understand what the Yakima River Basin was before Euroamerican development

occurred, a person needs to not only know the facts, but to feel the facts; to understand the context in which they exist. A person needs to see the carpet of vegetation and the colors that existed before the valleys and ridges were overgrazed and denuded. One needs to hear the natural music of the streams before they were turned into ditches for irrigation; to feel and see the clear, cold waters that used to exist. One must imagine the thousands upon thousands of salmon spawning in streams throughout the basin; to hear the water splash as they constructed their redds; to see the bank covered with spawned-out salmon carcasses, mute testimony to life forces and mysteries beyond mere man's ability to comprehend. To stand along a stream and hear the silent winter, when all noise is suppressed by the snow, knowing that millions of young salmon are incubating beneath the bed of the stream, ready to renew the ageless cycle, is to witness a major miracle of nature.

Knowledge of facts and numbers without being connected to the water, the salmon, and the people, is a perversion of education. The world is full of people who know the facts and numbers, but feel nothing. I am not, and do not want to be, one of them. However, it is not my intent to paint irrigation development as a villain, and certainly not the only cause of salmon declines in the Yakima River Basin; but neither should its role be understated. The causes of the

decline of the salmon are complex and inextricably interwoven with the entire pattern of Euroamerican development, like the double helix of a DNA molecule.

Hopefully, this review can assist in the restoration of salmon runs in the Yakima River Basin, as well as helping to prevent future natural resource decisions that emphasize one resource over another, with resultant adverse impacts on the de-emphasized resource and the people who depend upon it.

ORIGINAL ABUNDANCE AND DISTRIBUTION OF ANADROMOUS SALMONIDS IN THE YAKIMA RIVER BASIN

Pre-Development Populations

The diverse aquatic habitats in the Yakima River Basin provided spawning and rearing habitat for six distinct runs of salmon: summer, and fall chinook; coho; sockeye; and steelhead (Northwest Power Planning Council 1989). Native runs of summer chinook, coho, and sockeye are now extinct in the basin (Nehlsen, et al. 1991).

Spawning gravel in the basin is abundant. Based on the data of Bryant and Parkhurst (1950), Davidson (1953) calculated that there was sufficient spawning gravel in the basin to support 500,000 spawning chinook salmon. In addition, Davidson concluded that: "In its primitive condition, the Yakima River System also supported large populations of steelhead," as well as a sockeye run "well up into the thousands."

Other investigators have also attempted to estimate historic salmon runs. The Washington Department of Fisheries (1956) estimated total salmon runs at 630,000 returning adults, comprised of 300,000 chinook; 150,000 sockeye; 80,000 coho; and 100,000 steelhead. The Northwest Power Planning Council (1989) estimated total salmon runs at 790,000 returning adults, comprised of 200,000 spring chinook; 200,000 summer/fall chinook; 80,000 summer steelhead; 110,000 coho; and 200,000 sockeye. The Bureau of Reclamation (1979) estimated that "about 600,000 salmon and steelhead migrated annually into the Yakima River system prior to 1880."

Mullan (1983) estimated adult coho returns totalled 50-114,000. The Bureau of Reclamation (1979) stated that "major runs of coho salmon occurred in the Yakima River before irrigation development."

Other authors, while not quantifying the historic salmon runs in the basin, have nevertheless recorded that large runs returned to this area. Dr. O.P. Jenkins, quoted by Marshall McDonald (1896), states:

> Those acquainted with the facts state that formerly. . . salmon of three or four kinds, including the quiunat, ran up the stream to this valley and spawned in the river in great numbers.

Bryant and Parkhurst (1950) also commented on the extent of salmon production:

> Prior to the settlement and development of the Yakima Valley this river system was unquestionably a tremendous fish producer, owing to the extensive spawning and rearing areas for chinook, silver, and blueback salmon as well as steelhead trout.

Robison (1957) states that sockeye salmon were "extremely abundant" in the basin prior to 1850. Fulton (1970) noted that the Yakima Lakes (Cle Elum, Keechelus, Kachess, Bumping) "had good sockeye salmon runs before dam construction."

Yakima River Basin salmon runs of 600,000-800,000 would not be inconsistent with the production levels estimated for the Columbia River Basin as a whole. Based on an area of approximately 6,100 square miles for the Yakima Basin, salmon production would have been 98-131 adult fish per square mile. The extent of the Columbia River Basin originally open to anadromous fish production was 163,000 square miles, which produced an estimated 10-16 million salmon and (Northwest Power Planning Council 1986). This level of salmon production would yield 61-98 adult fish per square mile, which is remarkably similar to the production level of the Yakima Basin, based on an estimated production of 600,000-800,000.

The relative magnitude, if not precise numbers, of anadromous fish production in the Yakima River Basin is also suggested by the historic harvest of salmon by Native

Americans, and the geographic extent of their fishing locations (Ray 1936). In this regard, the Yakima Basin was a part of the greater mosaic of anadromous fish utilization in the entire Columbia River Basin (Uebelacker 1986; Shalk 1986; Hunn 1990). Indeed, this annual cycle of harvest is a defining feature of the Pacific Northwest.

Beginning with the observations of Lewis and Clark in October, 1805, references to the harvest of salmon in the Columbia River Basin and the importance of this harvest to the Native Americans have appeared in countless books, reports, articles, and other publications. Craig and Hacker (1940) quantified this harvest at 18 million pounds annually, based on a basin population of 50,000 and a consumption rate of 1 pound of fish per day. More recently, Shalk (1986) calculated the historic harvest based on a revised population estimate of 61,500, and taking into consideration migration caloric loss and wastage. These calculations produced an estimated historic harvest of approximately 42 million pounds, which Shalk considered conservative, since he did not account for fish used for dog food or fuel.

Davidson (1953) estimated an historic annual harvest in the Yakima River Basin of 160,000 salmon, based on a population of 4,000 people. As he notes, a harvest of 160,000 fish out

of annual runs of 500,000 or more "would have imposed a relatively small fishery on the salmon runs in the river."

Additional evidence of the substantial production of salmon is offered by the multitude of fishing sites established and utilized for millennia by Native Americans in the Yakima Basin (Ray 1936). The fact that these fishing sites existed, indicates that the basin originally produced large runs of salmon; people do not establish fishing sites unless there is an ample return for their effort.

Salmon Life Cycles And Distribution

Based on the available records and information, we know that the Yakima River Basin produced large numbers of salmon. However, different species and different runs of the same species exhibit considerably different life histories. Following is a discussion of the original distribution and life histories of the six runs of anadromous salmonids native to the basin.

1. Spring Chinook (Oncorhynchus tshawytscha)

Chinook stocks are differentiated according to the timing of adult returns to freshwater; that is, their return to the Columbia River from the Pacific Ocean. Chinook salmon passing Bonneville Dam from 1 February through 31 May are considered spring chinook. Those passing from 1 June to 15

August are classified as summer chinook; those passing after 15 August are considered fall chinook.

Adult spring chinook salmon enter the Yakima River from early April through mid-July. Spawning begins in late July and continues through mid-October. Eggs, buried in the gravel of the stream bottom, hatch into alevins (sac fry) during December and January, which remain in the gravel for several more months, emerging during the spring.

The juvenile fish then spend several months to a full year rearing before commencing their migration to the ocean. During this migration, the juvenile fish undergo a process of adapting to salt water, known as smoltification. At this time, the juvenile fish are known as smolts. Although some juvenile spring chinook leave the basin during the winter before smoltification, most journey to the ocean during April and May of their second year. Yakima Basin spring chinook spend from one to three years in the ocean, and return as three, four, or five year-old fish.

The historic spawning distribution of spring chinook in the Yakima River Basin included the Yakima River upstream of the Ellensburg Canyon, and tributaries of the Yakima River, including the Cle Elum River and its tributaries, the Wapatus and Cooper Rivers; the Teanaway River; Taneum Creek;

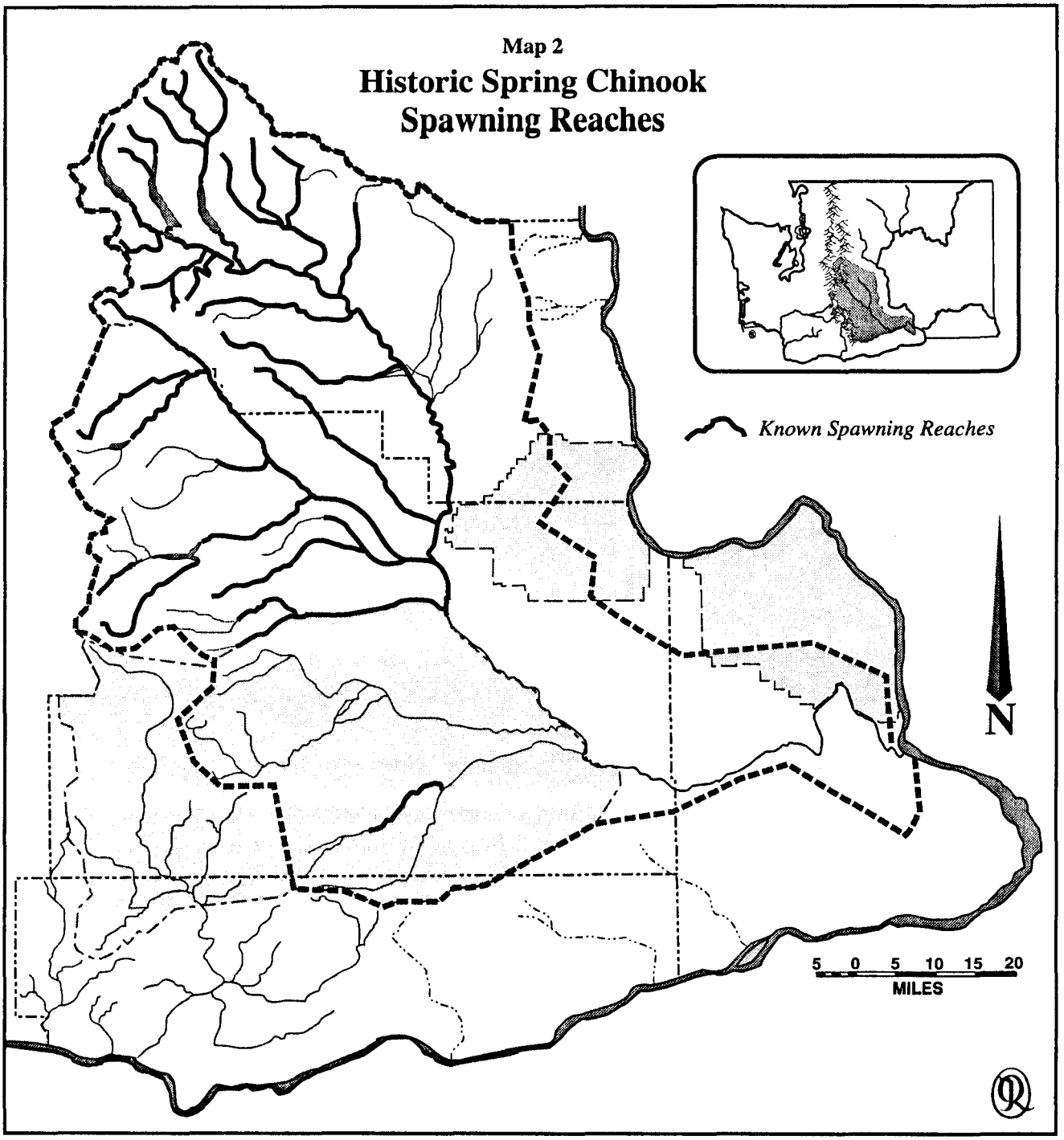
Swauk Creek; Manastash Creek; Wenas Creek; Ahtanum Creek; and Logy Creek. In addition, spring chinook spawned in the Naches River and its tributaries, including Cowiche Creek; the Tieton River; Rattlesnake Creek; Little Naches River; Bumping River; and American River (Fulton 1968; Northwest Power Planning Council 1989; Map 2).

Current spawning distribution of spring chinook in the Yakima River Basin includes the Yakima River from the vicinity of Ellensburg upstream to Kachess Dam and the Cle Elum River downstream of Cle Elum Dam. Occasionally, a very few spawn in the Teanaway River. Due to water storage and management for irrigation, spring chinook are not always allowed to spawn in the Yakima River from Easton Dam upstream to Kachess Dam.

Spring chinook spawn in the Naches River mainstem upstream of Horseshoe Bend to the confluence of the Little Naches and American Rivers; Rattlesnake Creek; Little Naches River; Bumping River; and American River (Map 3).

2. Summer Chinook (Oncorhynchus tshawytscha)

Although a remnant run of summer chinook existed in the Yakima River Basin until the 1970's, little is known of


Map 2
Historic Spring Chinook
Spawning Reaches
Known Spawning Reaches
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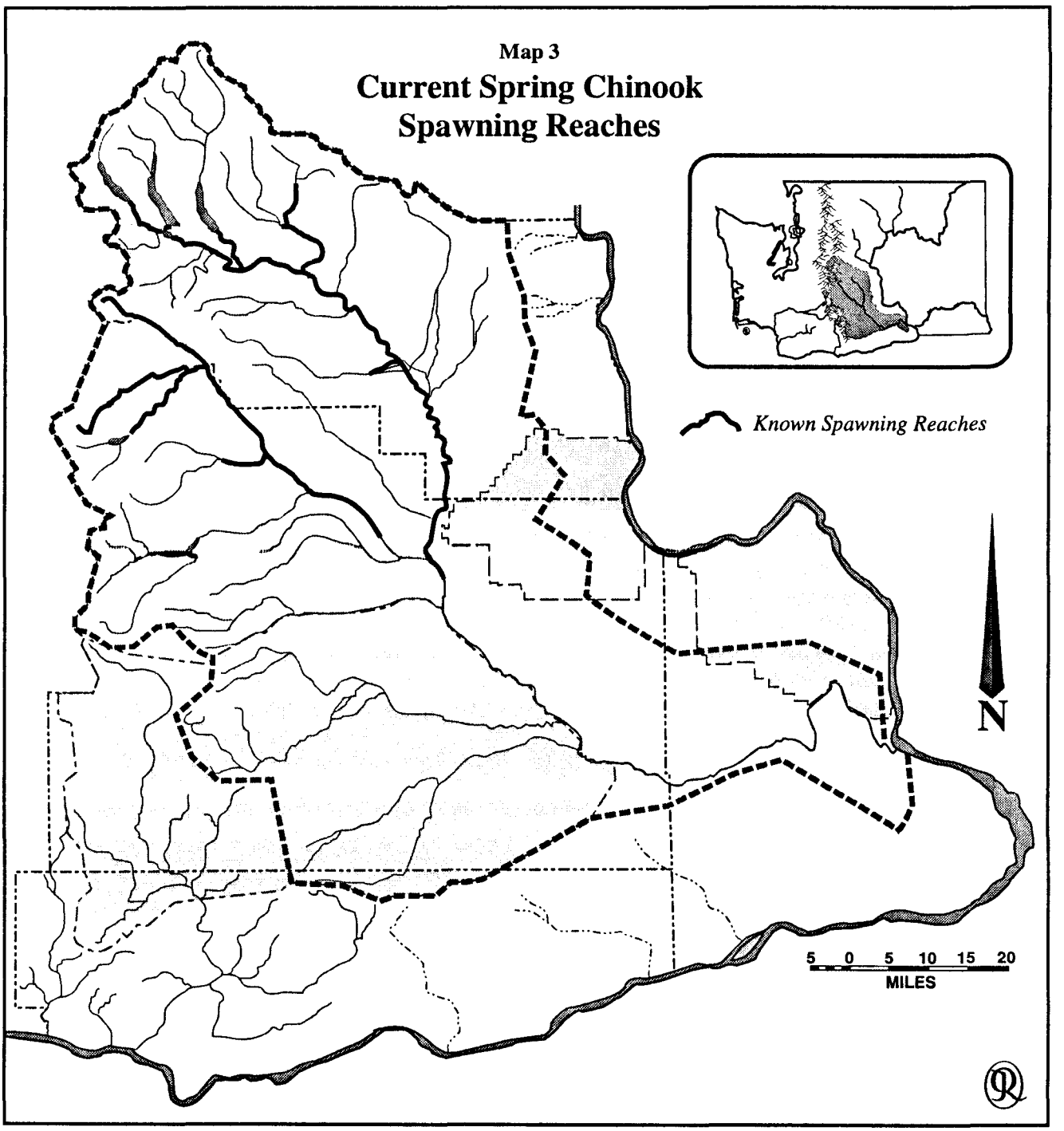
Map 3
Current Spring Chinook
Spawning Reaches
Known Spawning Reaches
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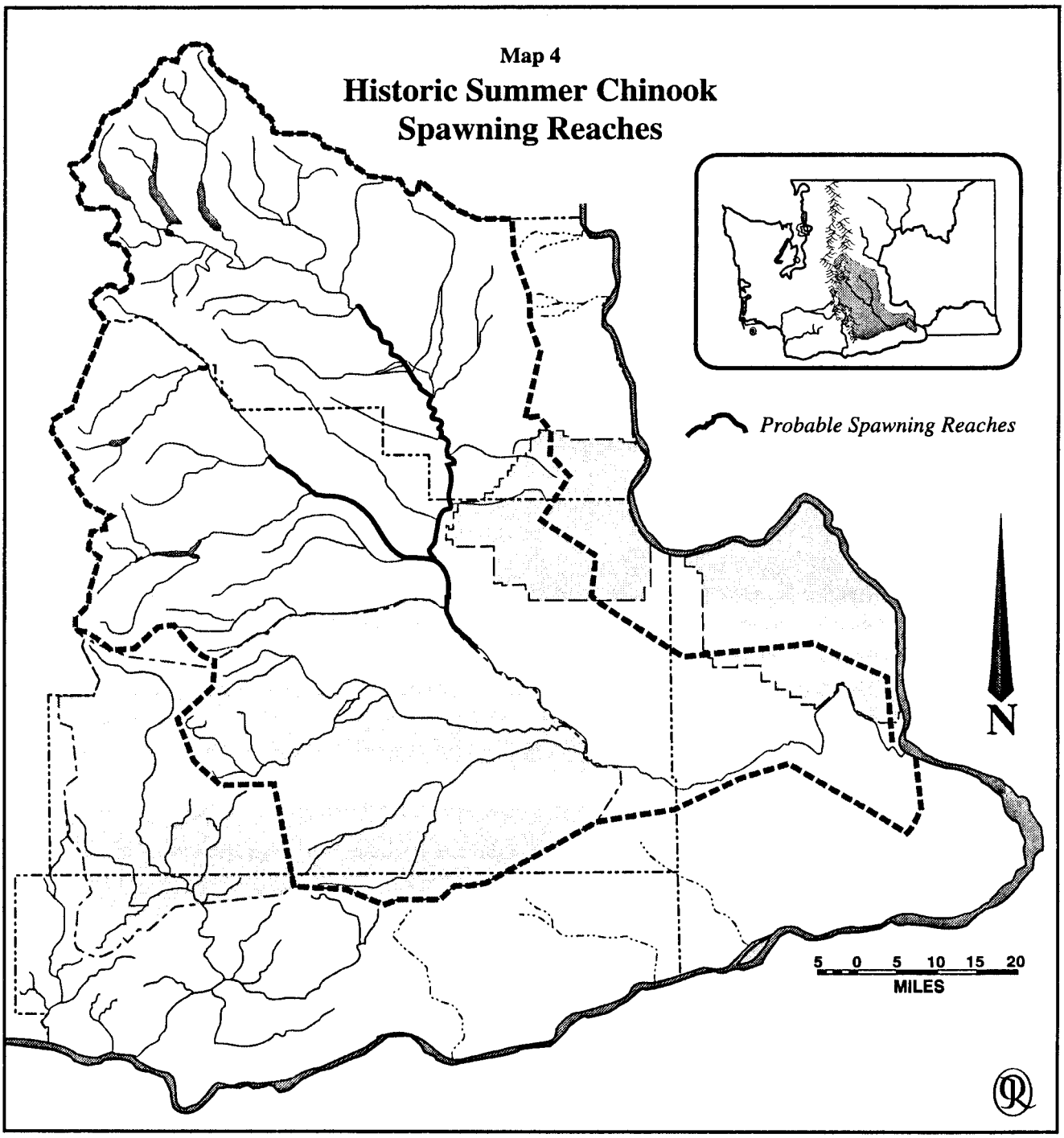
MILES

their original distribution. It is believed that they spawned in the Yakima River from below Sunnyside Dam upstream into the Ellensburg Canyon north of Yakima, and in the Naches River from its confluence with the Yakima River upstream to the vicinity of the Tieton River (Map 4).

The last confirmed spawning of summer chinook in the Yakima River Basin occurred in the Yakima River below Sunnyside Dam. The Washington Department of Fish and Wildlife conducted annual spawning surveys along this reach of river until 1970 (Northwest Power Planning Council 1989). No documented summer chinook spawning has occurred in the basin since that time.

Assuming that the Yakima River Basin summer chinook run was similar in timing and life history to the current run of summer chinook in the Wenatchee River, adult summer chinook originally returned from mid-July to mid-September. Spawning occurred from late September to mid-October. After incubation in the gravel, the fry emerged during February, March, and April. Unlike spring chinook, juvenile summer chinook in the Wenatchee River Basin migrate to the ocean during the spring and summer of their first year, from May through August. Most adult summer chinook return to the Wenatchee River Basin as 4 or 5 year-old fish (Northwest Power Planning Council 1990).


Map 4
Historic Summer Chinook
Spawning Reaches
Probable Spawning Reaches
N
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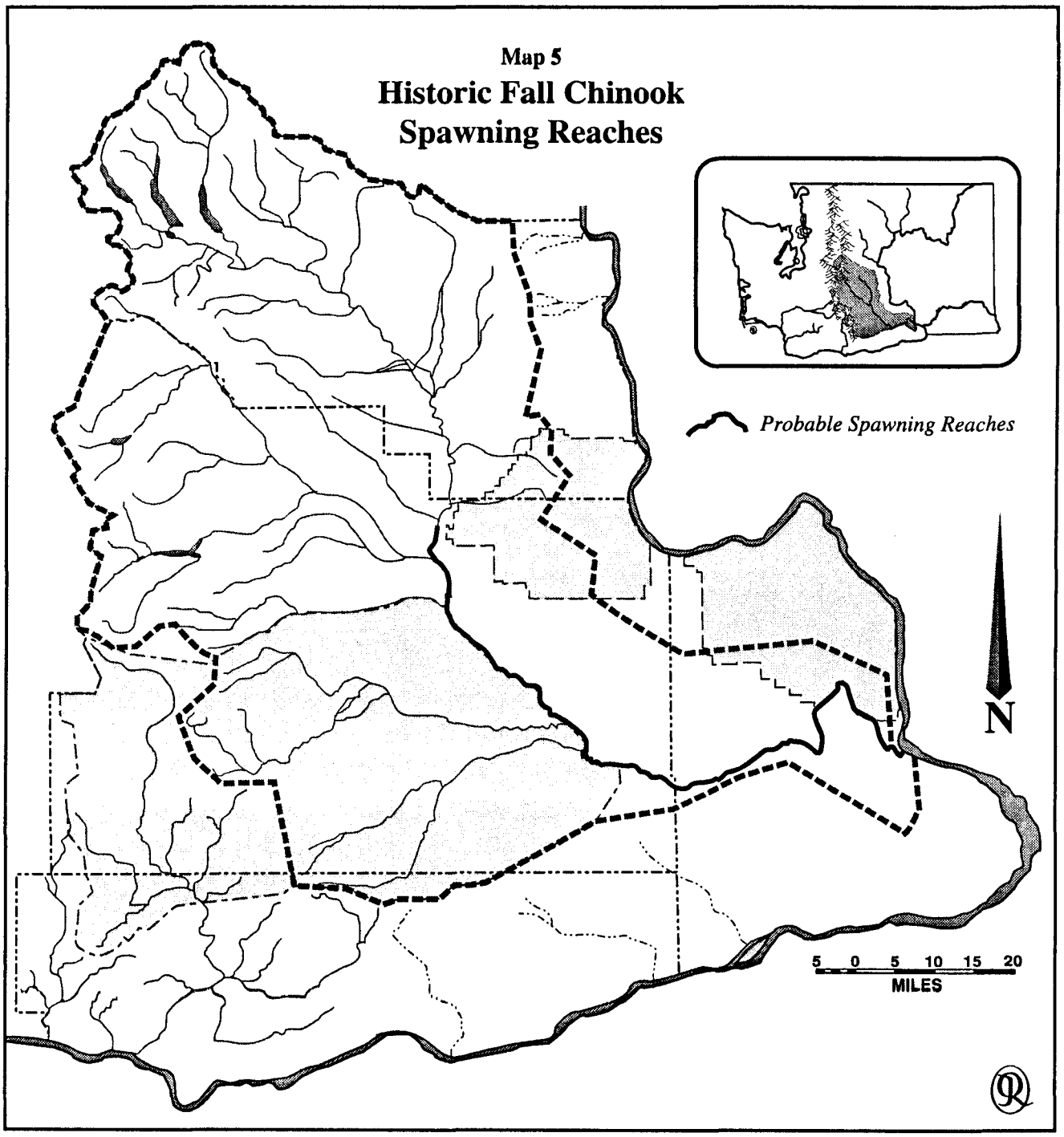
MILES

3. Fall Chinook (Oncorhynchus tshawytscha)

Although a run of fall chinook still exists in the Yakima River Basin, the original spawning distribution is not well documented. Fulton (1968) states that the extent of the historic spawning range is unknown. It is probable, however, that the historic fall chinook spawning areas in the Yakima River extended from the vicinity of Sunnyside Dam downstream to the confluence with the Columbia River, since, as he also notes, fall chinook spawned in the lower reaches of the larger Columbia River tributaries, as well as the mainstem Snake and Columbia Rivers (Map 5).

Fall chinook currently spawn in the lower Yakima River from Sunnyside Dam downstream to the head of McNary Pool. A small population also spawns in Marion Drain, an irrigation return drain that joins the Yakima River at Granger (Map 6).

Adult fall chinook return during August, September, October, and November. Spawning occurs during October and November. After incubating in the gravel, the fry emerge during February and March. After a short rearing period in fresh-water, juvenile fall chinook migrate to the ocean during the spring and summer of their first year. Adult fall chinook return to the as 2, 3, 4, and 5 year-old fish.


Map 5
Historic Fall Chinook
Spawning Reaches
Probable Spawning Reaches
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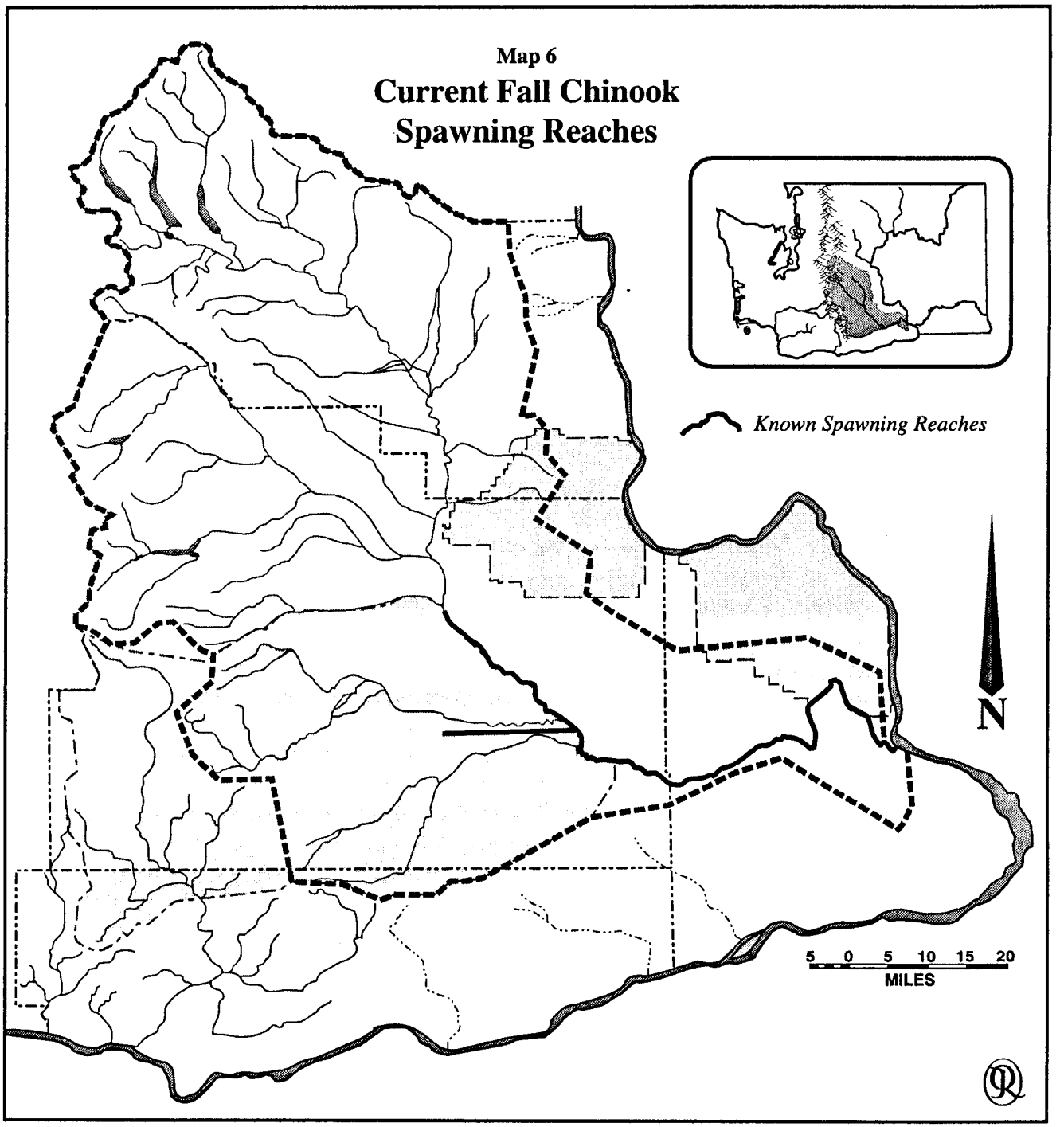
Map 6
Current Fall Chinook
Spawning Reaches
Known Spawning Reaches
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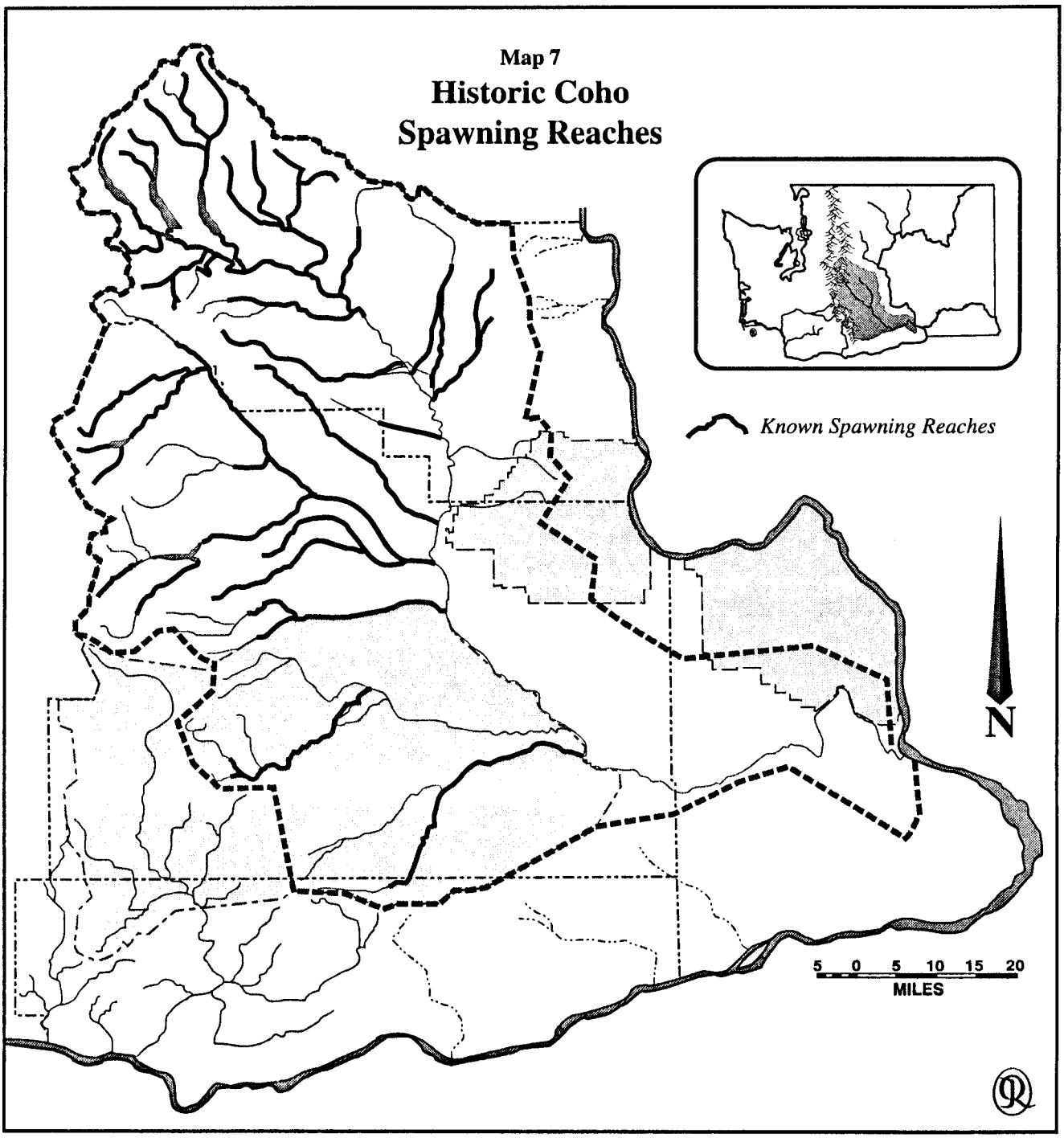
MILES

4. Coho (Oncorhynchus kisutch)

Like summer chinook, a remnant run of native coho persisted in the Yakima River Basin until the 1970's. The original distribution of coho spawning was quite widespread: the upper Yakima River above Ellensburg; the Naches River above the confluence of the Tieton River; and most tributaries of both the Yakima and Naches Rivers, including Cabin Creek, Big Creek, Cle Elum River and its tributaries, Teanaway River, Swauk Creek, Taneum Creek, Manastash Creek, Wilson Creek, Cherry Creek, Coleman Creek, Umtanum Creek, Wenas Creek, Little Naches River, American River, Bumping River, Rattlesnake Creek, Tieton River, and Toppenish Creek (Fulton 1970; Northwest Power Planning Council 1989; Map 7).

This widespread distribution would be consistent with observations of coho spawning in the Wenatchee River Basin, where coho were noted in most of the small tributaries. In the process of documenting historic salmonid distribution in the Wenatchee, Methow, and Okanogan Rivers, a number of affidavits from local residents relating details of salmon migration and spawning in the Wenatchee River were collected. The statements contained in several of these affidavits clearly indicate that coho returning to the Wenatchee River Basin spawned in small tributary streams: ". . . nearly all the smaller creeks had runs of silvers


Map 7
Historic Coho
Spawning Reaches
Known Spawning Reaches
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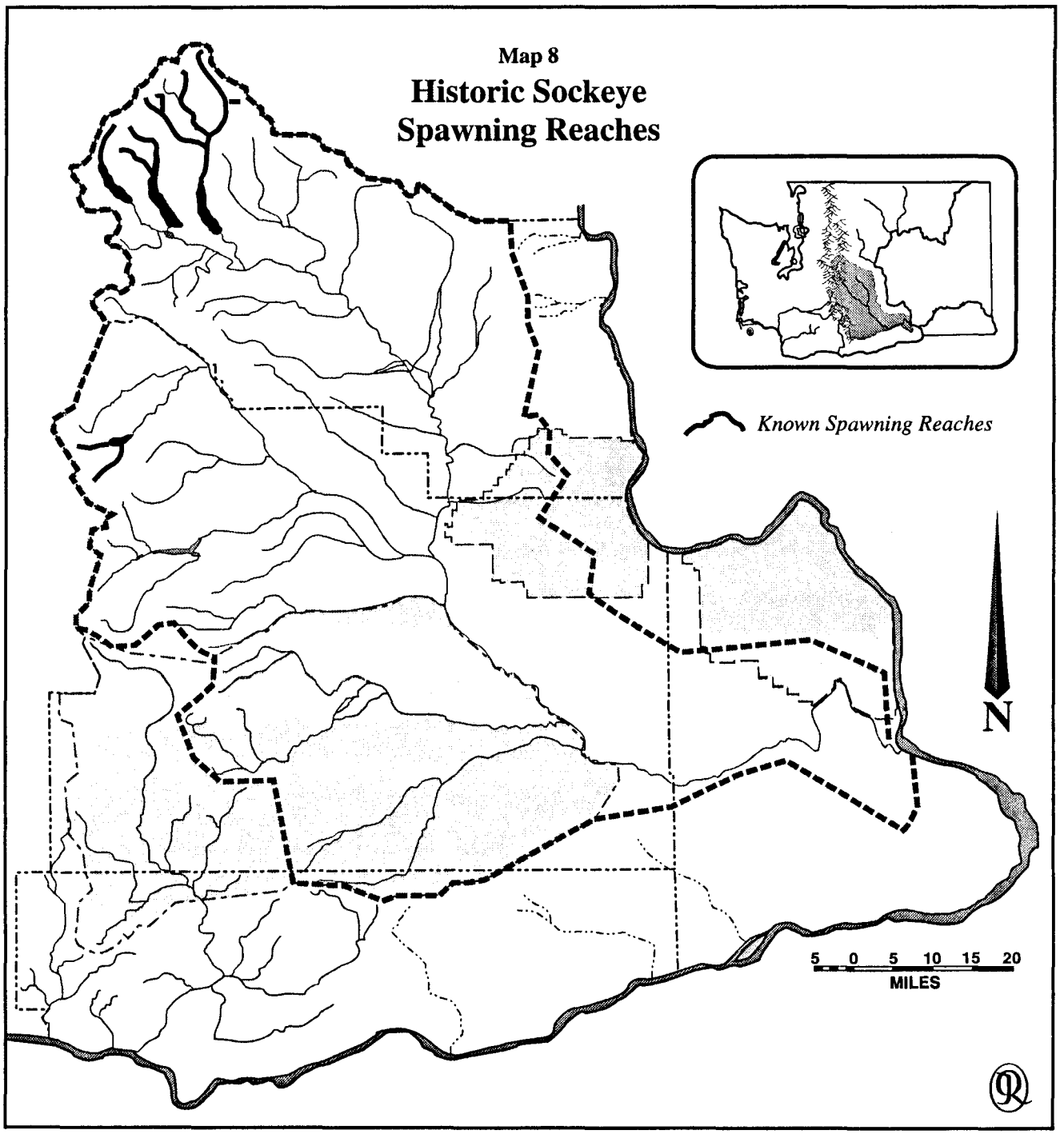
MILES

(coho) and steelhead;" "All the creeks had their runs of silvers (coho) and steelhead" (Anonymous 1942).

5. Sockeye (Oncorhynchus nerka)

The Yakima River Basin was one of eight areas in the Columbia River Basin that produced sockeye before Euroamerican development. Sockeye require lakes for juvenile rearing; therefore, they spawn in the vicinity, normally upstream, of appropriate nursery lakes, though some sockeye spawn along the shore of a lake. Sockeye historically spawned in streams above Bumping, Keechelus, Kachess and Cle Elum Lakes (Fulton 1970; Map 8).

Since sockeye have been extinct in the Yakima Basin since early in this century, we do not have any direct information on their life history. It is reasonable to assume, however, that it closely resembled that of extant Wenatchee River sockeye. Adult sockeye return to the Wenatchee River from July through September. Spawning occurs in September and October. After incubating in the gravel, juveniles emerge during April, May, and June, and then spend at least one year, sometimes two, rearing in Lake Wenatchee before migrating to the ocean. Smolt outmigration occurs during April, May, and June. They then spend two or three years in the ocean before returning as adults to spawn (Northwest Power Planning Council 1990).


Map 8
Historic Sockeye
Spawning Reaches
Known Spawning Reaches
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MILES

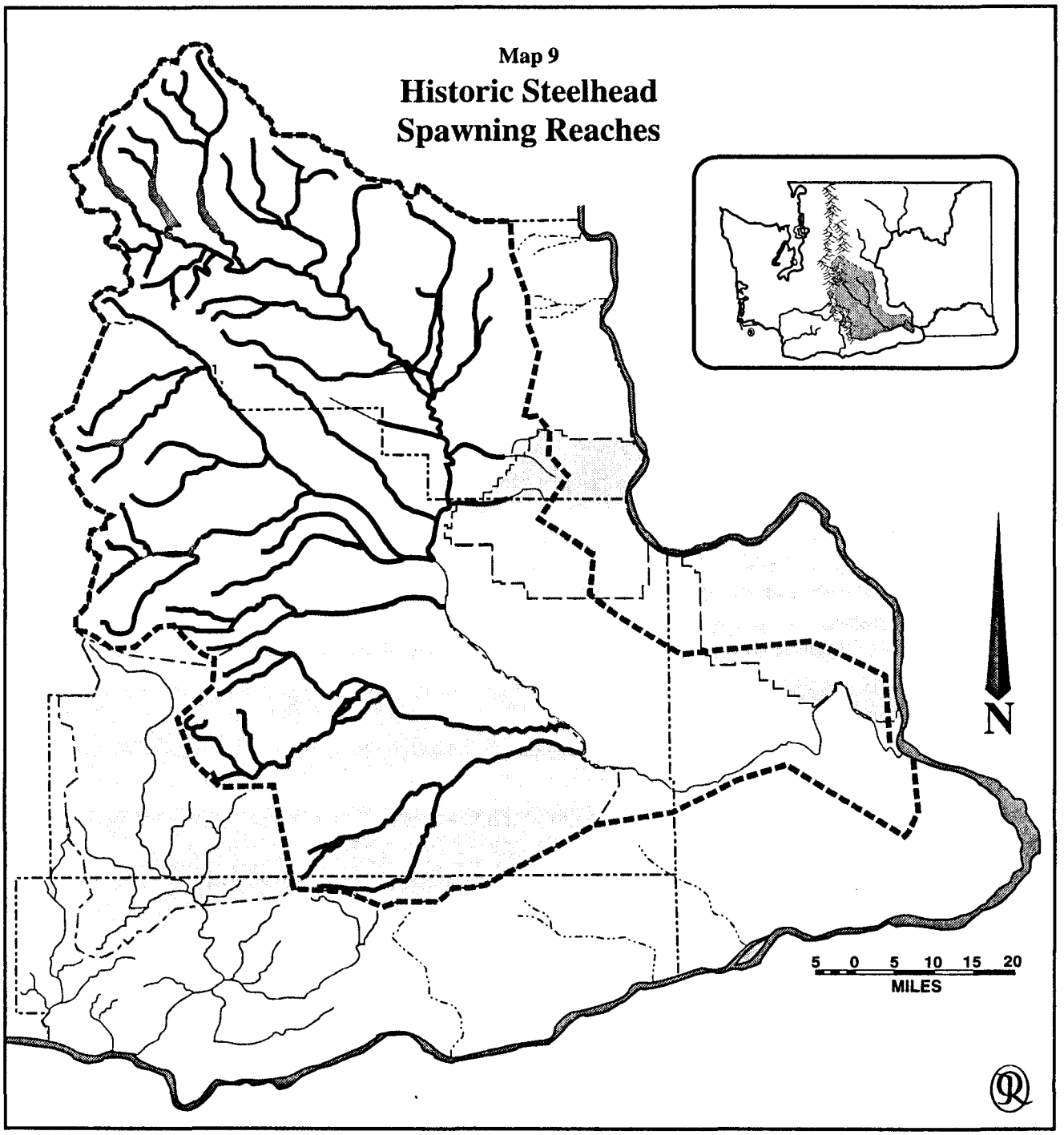
6. Steelhead (Oncorhynchus mykiss)

Steelhead are the anadromous form of the rainbow trout. Prior to Euroamerican development, they were broadly distributed throughout the Yakima River Basin, spawning in streams of every size, from the mainstem Yakima River, to small creeks. Hubble (1992) documented steelhead spawning and rearing in intermittent tributaries of Satus Creek. Historically, there were probably few, if any, streams in basin that were not utilized by steelhead for spawning and rearing, with the exception of those few headwater streams that were inaccessible due to blockages (Map 9).

Currently, steelhead spawn primarily in Satus and Toppenish Creeks, with scattered spawning in other areas (Map 10). Less than 100 adult steelhead have been counted passing Roza Dam annually in recent years.

Adult steelhead enter the Yakima River Basin from September through the following May, although movement may cease during periods of cold weather in the winter. Spawning occurs in the late winter and spring, primarily during March, April, and May. After incubating in the gravel, steelhead fry emerge from May through August.

Juvenile steelhead spend one to three years rearing in freshwater before migrating to the ocean. Most steelhead


Map 9
Historic Steelhead
Spawning Reaches
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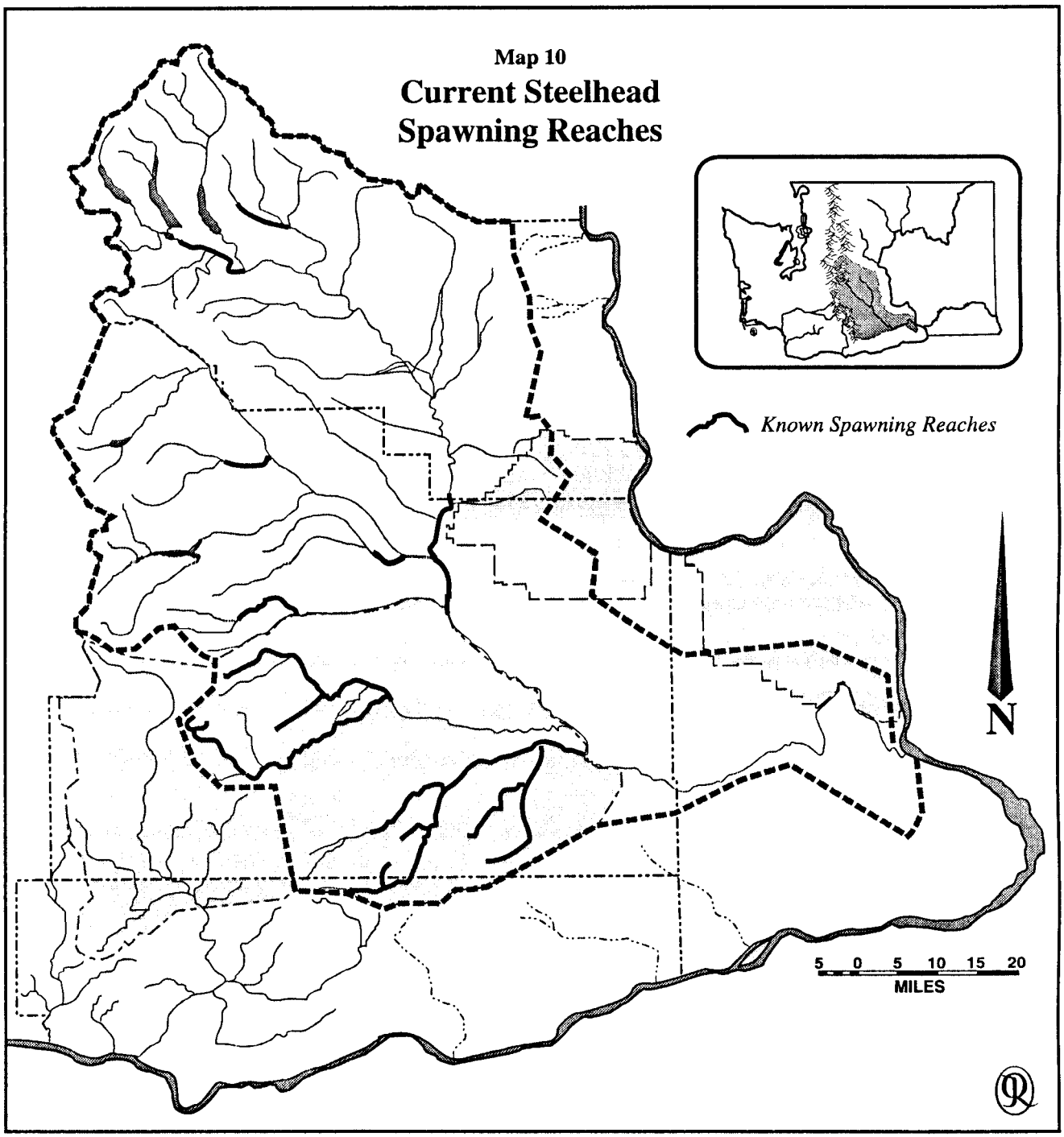
Map 10
Current Steelhead
Spawning Reaches
Known Spawning Reaches
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MILES

smolts move downstream during March, April, and May, and spend one or two years in the ocean. It should be noted that, unlike other salmon, steelhead do not necessarily die after spawning, but attempt to return to the ocean. However, it is considered highly unusual for an adult steelhead to successfully complete a second spawning journey in the upper Columbia River Basin, although it is not uncommon in coastal rivers.

Before Euroamerican development caused low flows and high water temperatures in the lower Yakima River, it is probable that adult steelhead entered the Yakima River Basin earlier in the summer. Currently, they tend to hold in the Columbia River until the first fall rains or cooler weather reduce water temperatures in the Yakima River. Robison (1957) noted that historically "Steelhead trout seemed to be in the river throughout the year."

DEVELOPMENT OF IRRIGATION IN THE YAKIMA RIVER BASIN: 1855-1905

Irrigation Development Prior To The Arrival Of The Railroad

By the early 1860's, immigration into the more attractive portions of the Pacific Northwest, such as the Willamette Valley and Puget Sound, had been underway for over 20 years. For many reasons the interior of Washington Territory had yet generated little interest with respect to permanent settlement. There was a perception that the interior was a "desert"; it had relatively poor transportation routes and there was a continuing threat of hostile action by local Indian Tribes.

By the beginning of the Civil War, development activity in the interior of Washington Territory began to increase, prompted, in part, by the cessation of hostilities with Native Americans and the establishment of the Yakama Indian Reservation. The lure of growing markets for beef, both in the Okanogan mining districts of British Columbia and across

the Cascade Mountains in Puget Sound, encouraged cattle ranching (Highsmith 1946). Supported by the abundant supply of bunch grass in many parts of the Yakima River Basin, it was the first wide-spread agricultural activity.

However, the cattle era proved to be short-lived, and by the early 1880's, the large herds that made legends of Ben Snipes and a few other ranchers were already passing from the scene. This rapid decline was the result of overstocking of the range and subsequent lowering of the carrying capacity, large losses of cattle due to severe winters, and the gradual encroachment of homesteaders on the range (Highsmith 1946).

But even as cattle production enjoyed its moment in the sun, water was undoubtedly being diverted to irrigate vegetables and produce for winter use (Figure 1). Primitive ditches, dug with shovels and hoes, guided water from small streams to waiting seeds. Cattle ranchers and their families benefited from the bountiful harvest of these gardens.

After Kamiakin, who diverted water from Ahtanum Creek to irrigate his garden in the 1850's, the next recorded irrigation diversion was by N. T. Goodwin, who in 1867 diverted water from the Naches River through a small ditch to his five acre wheat field (Lyman 1919). The yield from this

irrigated grain field was so remarkable that the following year, a group of farmers, including Goodwin Stooloop, Vaughn, Mayberry, and Simmons, began work on the first cooperative ditch in the basin--later enlarged and developed into the Union Canal (Kuhler 1940).

The record undoubtedly does not include all of the early attempts by settlers to irrigate gardens or small plots of grain or hay. Many of these small, single farm diversions were developed along tributary streams, where irrigable land was located close to the stream (Jayne 1907). Highsmith (1946) notes that early small-scale irrigation occurred along Ahtanum and Wenas Creeks.

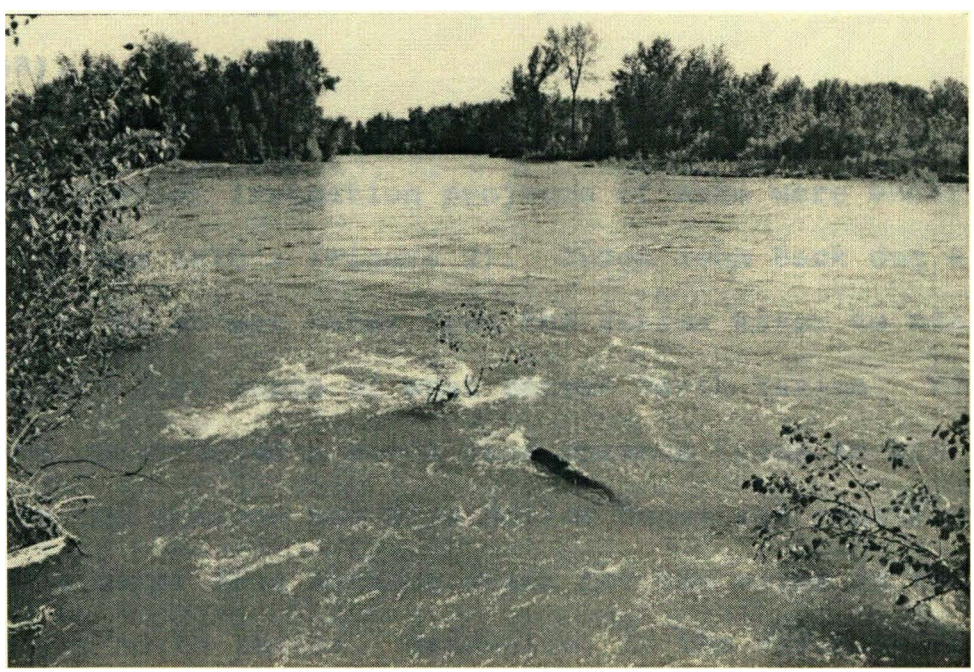


Figure 1. Yakima River--water for irrigation.

As the decade of the 1870's dawned, the basin was on the brink of significant development. Meinig (1969) states that:

> After several years of slow infiltration, settlement in the Yakima Valley had recently increased and begun to develop a focus. Ranchers were scattered through the whole axis of the main valley, but the principal concentration was along Ahtanum Creek and through the main water gap.

The first really significant irrigation diversion ditch was begun in 1871 by Charles and Joseph Schanno and Sebastian Lauber. This ditch, completed in 1875, was eighteen feet wide at the bottom, 1.5 feet deep, and diverted water from the Naches River to the vicinity of old Yakima City, now Union Gap. If there were any lingering doubts about the feasibility of large-scale irrigation in the basin, the Schanno Ditch appears to have put them to rest (Vandevere 1948).

Several other irrigation projects of note were undertaken during the 1870's (Figure 2). Judge John Beck dug a ditch in 1872 to divert water from the Yakima River to his property just north of what became North Yakima. William Lince constructed a ditch from Ahtanum Creek to his farm, while the Ahtanum and Wide Hollow Canal was constructed to divert water from Ahtanum Creek for ten miles in the direction of North Yakima. Meanwhile, in the vicinity of Prosser, J. M. Baxter constructed a small irrigation ditch on the south side of the Yakima River (Vandevere 1948).

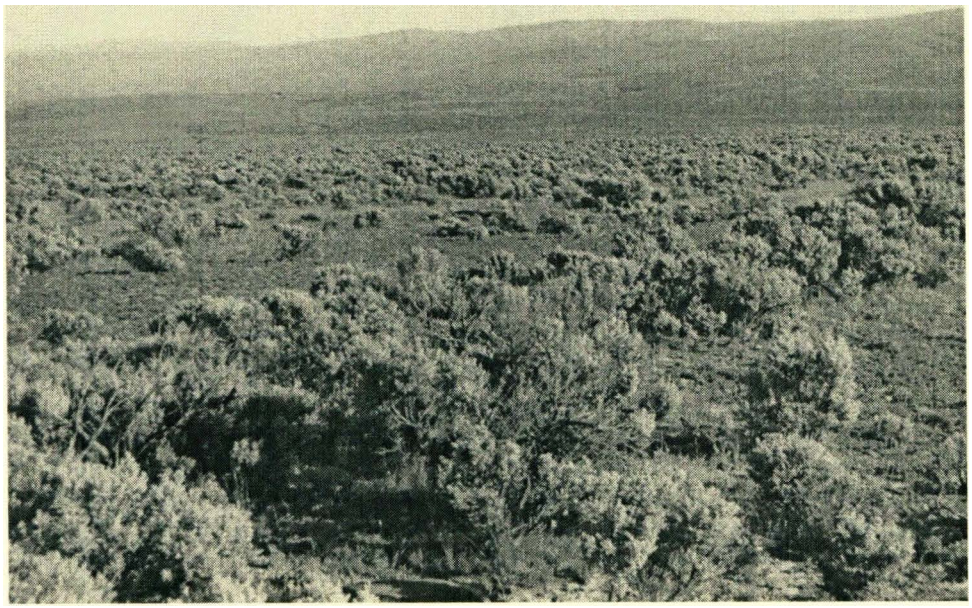


Figure 2. Land such as this began to be irrigated in the 1870's.

In the Kittitas Valley, 1872 also marked the advent of major irrigation diversions, with the start of the Manastash Canal, built by farmers to divert water from Manastash Creek. The following year, work commenced on the Taneum Ditch, which was placed in operation in 1874. This ditch diverted 90 cubic feet per second and was over 7 miles in length (Bureau of Reclamation 1925). The construction of a ditch of this magnitude with shovels and horse-drawn Fresnoes was a considerable accomplishment.

The non-Indian population in the Yakima Valley had increased from 410 in 1870 to 2,811 in 1880 (Vandevere 1948), and there were 226 farms in Yakima County. The vast majority, 201, contained between 100 and 500 acres. These 226 farms totaled over 48,000 acres, more than 25,000 of which were irrigated (Kuhler 1940).

As the 1880's began, irrigation development in the Yakima River Basin was clearly no longer an experiment, or confined to gardens and other small-scale enterprises. It appeared that one could apply water to the land in any of the valleys and almost any crop flourished. As more settlers moved into the area, additional canals were dug and more land was placed under irrigation.

In 1880, the Konnewock Ditch was begun by a group of farmers from the Parker area, just below what is now Union Gap. The Moxee Ditch Company irrigated 4,000 acres in the Moxee Valley by a ditch they constructed during 1880-1882. On the Naches River, the Naches-Cowiche Ditch, Hubbard Ditch, Wapatox Ditch, and Taylor Ditch all were constructed and placed in operation during the early 1880's. The Selah Valley Ditch was completed in 1888 to divert water from the Naches River for irrigation in the Naches and Selah Valleys (Vandevere 1948).

In the Kittitas Valley, the next large ditch was constructed in 1885. The Ellensburg Town Ditch diverted water from the north side of the Yakima River, several miles northwest of Ellensburg (Bureau of Reclamation 1925).

Although new ditches were being constructed and additional lands placed under irrigation, by the middle of the 1880's two problems were apparent to those interested in expanding irrigation in the Yakima River Basin: (1) Transportation of produce to markets outside the basin was expensive and not conducive to shipping highly perishable commodities; (2) Construction of larger canals required more capital than was locally available.

Arrival Of The Railroad And Irrigation Development

As irrigation development expanded in the 1870's it became apparent that the transportation system was grossly inadequate. Perishable crops required dependable and timely shipment to markets. This simply did not exist until the completion of the railroad line over Snoqualmie Pass in 1888. The best wagon road from the Yakima Valley went to the Dalles, but this area offered little in the way of potential markets (Babcock et al. 1986).

All across the region, settlers were facing the same dilemma: crops could be grown in abundance, but there was no way

to transport the produce quickly to Portland or Puget Sound markets (Meinig 1969). Construction of railroad lines through the Pacific Northwest had been contemplated since the mid-1850's. Isaac Stevens had been directed by Secretary of War Jefferson Davis in early 1853 to survey a railroad route through the Northern Rockies and on to the West Coast. As part of that survey, Lt. George McClellan had surveyed potential railroad routes through the Yakima River Basin during the summer and early fall of that year (Richards 1993).

But the Civil War caused a hiatus in all transcontinental railroad work, and serious efforts to construct a rail line across the northern United States did not resume until the 1870's. Unfortunately, the Northern Pacific encountered financial difficulties that caused it to suspend planning for its routes through the Pacific Northwest for several years (Meinig 1969). In 1880, the Northern Pacific commenced construction east of the Columbia River, and logs were floated down the Yakima River from Cle Elum for ties and bridge construction (Babcock et al. 1986).

The inevitable boom was eagerly awaited by merchants and farmers in the basin. Once again, their hopes and expectations were dashed: the Northern Pacific decided to concentrate construction on the route that tied in with the

Oregon Railroad and Navigation (OR&N) line at Wallula, which provided access to Portland and the Puget Sound region via the OR&N line down the Columbia River (Meinig 1969).

Ironically, it was further financial problems that prompted the construction of the Northern Pacific line through the Yakima Valley. Henry Villard lost control of the OR&N early in 1884, and was left with a trunk line that terminated at Wallula--not exactly a thriving metropolis, then or now. Villard immediately started construction on a line to the Puget Sound area that, finally, resulted in a railroad line up the Yakima Valley. The first train arrived at the city of Yakima on Christmas Eve, 1884 (Meinig 1969).

After reaching Yakima, construction of the line over the Cascade Mountains was vigorously pursued, and a temporary line was completed over Stampede Pass in 1887. The Stampede Pass Tunnel was completed in 1888 and with that farmers, in the basin finally had a dependable and timely means to transport their agricultural produce to large markets in the Puget Sound area (Meinig 1969).

The long-awaited boom finally materialized:

> Consequently, the first boom, an all-Yakima explosion, which extended form 1885-1895, took place (Vandevere 1948).

Kuhler (1940) pointed out the impact on irrigation development of the new rail line to the Puget Sound region:

> The agricultural development of the Yakima Valley increased with great rapidity from that time. . . The influx of population is noted by the fact that in 1884 North Yakima did not exist, but by 1890 it had a population of close to three thousand.

The adequacy of the water supply in the basin was becoming an issue of concern by the 1890's. As more and more water was diverted from the various streams, the total flow of some was totally depleted for part of the year, and disputes over water rights erupted, a common situation in the West. Waller (1904) states that it was so bad that, "Under present conditions no man knows what his rights are." (A century later concerns over water supply and water litigation still dominate discussions in the basin.)

Indeed, the courts began to determine rights to water on a number of tributary streams, and by 1904 decrees had been issued for several creeks, including Wenas, Naneum, Manastash, Swauk, Coleman, Wilson, and Ahtanum Creeks (Waller 1904). In addition to the question of water rights for those farmers who were already diverting water, claims had been filed by 1900 for far more water than could be supplied by the entire Yakima Basin:

> The total filings in Yakima and Kittitas Counties aggregate many times the flood capacities of the streams (Waller 1904).

This situation resulted in growing demand for the construction of storage reservoirs; these had been proposed since at least the early-1880's (Coulter 1951). Despite these problems, the decade of the 1890's had been a decade of amazing growth in irrigation development.

By 1905, 137,000 acres were being irrigated and agricultural production was beyond the wildest dreams of only 10 years before. Clearly, the ability to transport produce to large markets had stimulated substantial, one could almost say massive, expansion of irrigation in the basin.

However, irrigation development had reached the limits of what private interests could accomplish. By the summer of that year, the entire flow of the Yakima River had been diverted. The newly-formed Reclamation Service (hereafter Reclamation) was just beginning work on the federal Yakima Project; 1905 is thus a convenient and appropriate point to assess the impacts of the first wave of irrigation development in the Yakima River Basin on the salmon runs that had existed in such great numbers.

THE GREAT DECLINE--ANADROMOUS SALMONIDS IN THE YAKIMA RIVER BASIN: 1855-1905

Prelude To The Great Decline

On 9 June, 1855, Territorial Governor Issac I. Stevens, his personal secretary, James Doty, and Superintendent of Indian Affairs Joel Palmer, persuaded the leaders of the tribes and bands that now constitute the Yakama Indian Nation to sign a treaty with the United States. After thirteen days of sometimes contentious negotiating on the plains near Walla Walla, Kamiakin, Skloom, Owhi, and Tuckquille, among others, placed their mark on a document that opened a new chapter in the history of the Yakima River Basin (Richards 1993).

At the time that the Walla Walla Council occurred, during the latter part of May and the first nine days of June, the basin existed much as it had for several thousand years. The land, water, vegetation, and animals constituted a distinct, varied and productive ecosystem.

As the Tribal leaders listened to Governor Stevens and then discussed among themselves this strange concept of selling the earth, the rivers and streams in the Yakima River Basin

were just approaching their annual peak flow. Snowmelt was continuing, but soon the stream levels would begin to decline slowly until low flows were reached in September and October. Here in the rivers and streams a large portion of the bounty produced by the basin was found.

An ancient cycle ran its course in the rivers and streams, largely unseen. For thousands of years, salmon had returned to dig their redds, lay their eggs, and die. When the pyramids of Egypt were being built, this annual cycle that connected the uplands of the Yakima River Basin with the far reaches of the North Pacific Ocean was well established. Even as the Treaty Council convened and the negotiations occurred, some members of the various tribes and bands were fishing from their scaffolds on the Yakima River, as they had for thousands of years.

As Governor Stevens addressed the assembled Tribal leaders, literally millions of salmon smolts were moving down the Yakima and Columbia Rivers to the ocean. At the same time, what we know call "spring chinook" adults were making their way up the Yakima River to the spawning areas in the upper part of the basin.

As spring ended and summer progressed, more salmon would return to the Yakima River. Sockeye, headed for the streams

above Kachess, Keechelus, Cle Elum, and Bumping Lakes. Coho, returning to the upper basin and many tributaries. Steelhead, which would quietly hold over the winter and spawn in the spring of the following year. More chinook, which would spawn in the middle reaches of the basin as well as the lower Yakima River. The latest of the chinook, what we now term "fall chinook," were the same run of chinook that Captains Lewis and Clark had observed on that crisp October day almost 50 years earlier.

That was the Yakima River Basin in 1855, a productive, nearly pristine ecosystem producing hundreds of thousands of returning adult salmon annually, as it had for thousands of years. But with the signing of the Treaty at Walla Walla, all that began to change.

A few Euroamericans had, of course, entered the Yakima Valley prior to the Walla Walla Treaty Council, although they had little impact on the basin. Trappers, eager to exploit untouched populations of beaver and other fur bearers, may have entered the Yakima Basin within a few years of the Lewis and Clark Expedition. In the spring of 1814, a small party led by Alexander Ross departed Okanogan and entered "the Bearutiful Eyakema Valley" seeking to trade for horses. This was actually the Kittitas Valley, where they found a large encampment numbering at least "3,000 men,

exclusive of women and children." It appears that this was not his first visit to the Yakima Basin, since "to this place I had been once before" (Lyman 1919). Because trading posts were established at Fort Okanogan and Fort Nez Perce for the express purpose of collecting furs, it is reasonable to assume that Euroamerican trappers, singly or in small groups, operated irregularly in the Yakima Basin during the first third of the nineteenth century (Hunn 1990)

In addition to the trapping of beaver during the first half of the nineteenth century, which was the first direct exploitation of resources in the basin by Euroamericans, Native Americans and the area had been influenced by objects and forces that arrived as the bow-wave of Euroamerican colonization. The horse, introduced (or re-introduced) into North America by Euroamericans during the sixteenth century, arrived in the Northwest by the middle of the eighteenth century (Hanes 1995). Diseases previously unknown in North America, such as smallpox, severely, sometimes catastrophically, reduced Native American populations before the first Euroamerican actually set foot in the basin, and continued their ravages during the first half of the nineteenth century (Hunn 1990).

Another impact was the introduction of Euroamerican tech-

the interior of the Pacific Northwest began to receive an infusion of industrial goods, such as firearms and metal utensils, first from ships that traded for furs along the Pacific Coast, and then from trappers themselves once they arrived early in the nineteenth century (Hunn 1990).

However, none of these developments had seriously affected the Yakima River Basin ecosystem at the time the Treaty was signed in 1855. But with the conclusion of the Treaty, the formation of the Yakima Reservation, and the cessation of hostilities, the interior of Washington Territory was opened to Euroamerican settlement. In 50 years, these newcomers would virtually destroy a resource that had survived fire and ice, drought and flood, for millennia. How did it happen?

The Great Decline

Although different salmon species have a varied life history and slightly differing habitat needs, they all have certain basic habitat requirements that must be present in order for them to complete their life cycle and produce the next generation. These requirements include: (1) Adequate spawning gravel of proper size; (2) a constant supply of high quality water; (3) adequate supply of food; (4) proper habitats for juvenile rearing; and (5) free and open access to the ocean (Reiser and Bjornn 1979; Northwest Power

Planning Council 1986). As we shall see, irrigation development negatively impacts each of these habitat requirements (Stober et al. 1979; Northwest Power Planning Council 1986; United States Army 1993).

As discussed earlier, anadromous fish spawned and reared in virtually every river, stream, and lake in the Yakima River Basin prior to Euroamerican development. Total adult returns of approximately 800,000 would have required the rearing and migration of many millions of juvenile salmon. This means that juvenile salmon, of one species or another, were present in most streams, including the major rivers, essentially the year round. It is during the rearing and migration portions of their life cycles that juvenile salmon are vulnerable to becoming victims of the most essential feature of irrigation development, the diversion ditch or canal (Figure 3).

When the first ditch was dug in the early 1860's to divert water from a stream to a cattleman's garden, it carried more than water. Darting from side to side as the ditch became smaller, silver and grey fish, mottled with darker patches and spots, attempted to regain deep water in which to hide. Instead, they ended up in small rills between the potato hills and turnip rows. Perhaps the family cat took advantage of the easy meal, grabbing a sleek eight inch steelhead

smolt and retiring to the wood pile to feast at its leisure. In this or a closely similar manner the first juvenile salmon were diverted into an irrigation ditch in the basin, to perish among the growing crops. These first few fish would, over the coming decades, be joined by uncounted millions.

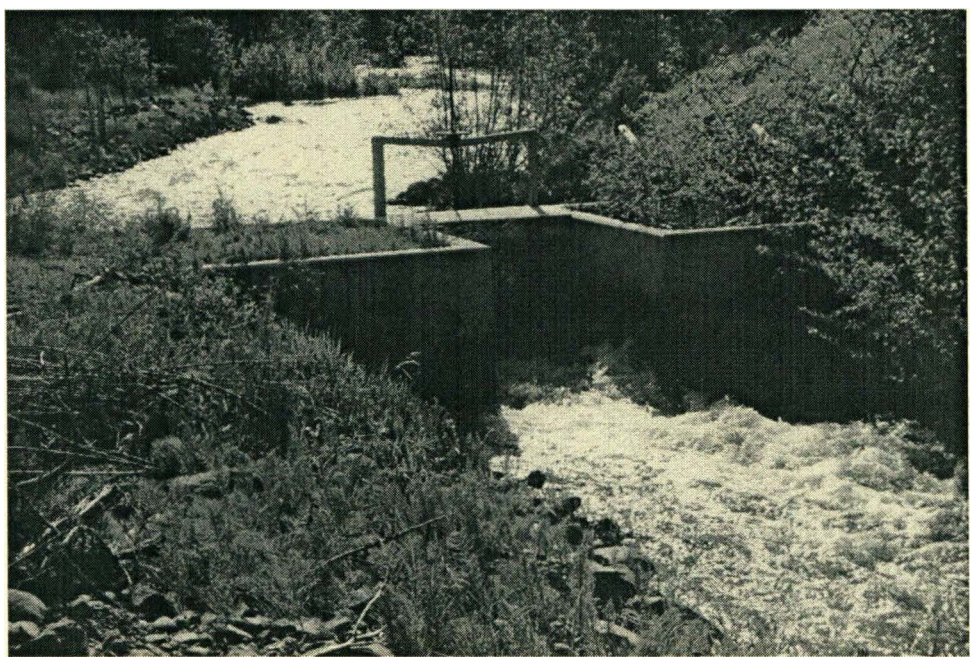


Figure 3. Unscreened diversions allowed millions of juvenile salmon to be lost.

The great destruction of juvenile salmon in irrigation ditches in the Pacific Northwest was already well documented by 1900. In Oregon, the State Board of Fish Commissioners noted in 1890 and 1892 that irrigation ditches were causing the serious loss of juvenile salmon, and proposed

legislation to curtail such impacts (Oregon State Board of Fish Commissioners 1890, 1892). In 1896, the Oregon Fish and Game Protector reported the continuing loss of juvenile salmon in irrigation ditches (Oregon Fish and Game Protector 1896). In 1898, the Oregon legislature enacted the first statute in the Pacific Northwest requiring the screening of irrigation canals to protect juvenile salmon (Crammond 1995).

In Washington, T.R. Kershaw, the State Fish Commissioner, stated in his 1904 Annual Report:

> Two years ago I made a trip through Eastern Washington for the express purpose of investigating these conditions, and in many ditches that I visited I found thousands of young salmon that had entered the irrigation ditches and died; in some instances I could have gathered up pails full within a radius of 20 feet (Washington State Department of Fisheries and Game 1904).

This report also contains a picture of a revolving drum screen, constructed to prevent juvenile salmon from entering irrigation ditches.

Over the next 20 years, annual reports of the Washington Departments of Fisheries and Game repeatedly stressed the great loss of juvenile salmon that was caused by irrigation ditches and canals. In 1909, L. Riseland, Commissioner of Fisheries, enumerated "some of the principle (sic) destructive agencies which militate largely against the maintenance and perpetuation of the industry," including

"large irrigation projects of every description" (Washington State Department of Fisheries and Game 1909).

In 1911, Riseland states:

> The irrigation ditches taken from the Wenatchee River are very destructive to the fry hatched in this river (Washington Departments of Fisheries and Game 1911).

This report also contains a picture of "a device for keeping young fish out of irrigation ditches." The "device" is a small rotating drum screen.

The 1912 annual report includes a picture of a large pile of juvenile salmon, with the caption: "Seven hundred salmon fry taken from one lateral irrigating ditch within a distance of 200 feet" (Washington Department of Fisheries and Game 1913).

By World War I, the serious loss of salmon and other fish in irrigation canals attracted the attention of the United States Bureau of Fisheries (hereafter "BOF"). In 1919, Dennis Winn, Field Superintendent, was asked to "investigate the loss of fish in irrigating ditches supplied from the Yakima River" (Winn to Commissioner of Fisheries; 8 November 1919). He did not conduct this investigation until the late fall, after the irrigation season had ended and the canals drained:

> Various points were visited along the canals of the different irrigating projects in the vicinity of Yakima and most of the ditches were found dry, with the exception of small pools directly below each drop in the ditches...At one point, on "A" canal of the Yakima reservation, sixty-five frozen fish ranging from one-half to two pounds were taken from between the rocks...among which were six steelhead trout...It was estimated that from 700 to 1,000 fish similar to the ones picked up and photographed were seen in this small space. The water being shut off from the ditches visited since October 15 and in view of the fact that the farmers in the vicinity gather the best of the fish by the washtubful for salting when the water disappears sufficiently, it was felt that the few good varieties found by us were simply overlooked by the farmers (Winn to Commissioner of Fisheries; 8 November 1919).

In addition, cold weather had already produced ice on what little water remained. This required some unusual field techniques:

> At several places where considerable water yet remained, holes were made in the ice at different points and the fish driven toward them by hammering on the ice and moving toward the hole. Large numbers of both trout and salmon from six to eight inches in length were seen but considering the methods we were compelled to adopt and fright of the fish when near the openings not one in one hundred in the pool could be observed (Winn to Commissioner of Fisheries; 8 November 1919).

Winn knew, of course, that his observations and data obtained during the late fall did not give a true sense of the magnitude of the loss of salmon in the irrigation canals:

> The fall season does not represent the most serious losses in regard to the salmon. Through July when they are migrating, it is estimated that from 90 to 97 per cent of the river passes into the irrigation ditches, through which the migrating salmon also pass, only to be washed out on some farm where they must of necessity perish (Winn to Commissioner of Fisheries; 8 November 1919).

Winn reported the results of a field survey conducted in July, 1916, that provides some insight into the enormous loss of juvenile salmon in irrigation canals during the migration season:

> In July, 1916, a systematic investigation was made by Mr. Frank Bryant at the Hubbard ditch, near the sugar-beet factory. Two hundred acres were checked over carefully and thoroughly, after a watering, and 20 fish to the acre were found, or a total of 4,000 fish, of which 90 per cent were migrating salmon. As we are advised there are about 250,000 acres under irrigation, and figuring one watering at the same time, it would prove a loss of approximately 5,000,000 fish, 4,500,000 being salmon in their fish and second years. For a season this can be multiplied many times and its seriousness appreciated (Winn to Commissioner of Fisheries; 8 November 1919).

Winn concluded that:

> The marvel is that it is possible for any salmon to return after so many years of extreme waste...The economic waste is stupendous as many tons of migrating salmon...are destroyed each year (Winn to Commissioner of Fisheries; 8 November 1919).

If this was the magnitude of the loss of juvenile salmon in the irrigation canals in the 1916-1919 timeframe, by which time the runs of salmon in the Yakima Basin had been reduced by over 90%, the number entering irrigation canals and ditches during the 1870's and 1880's must have been truly staggering.

In 1921, acknowledgement of the serious loss of fish in irrigation canals came from an unexpected source, Reclamation Record, the semi-official publication of the Bureau of

Reclamation. An article written by Glen C. Leach, a fisheries biologist for BOF, states:

> To apply large sums of money to the production of fish through State or National agencies and then allow them to go to certain destruction in the irrigation ditches is not only a criminal waste of funds, but it clearly demonstrates the inability or negligence of the constituted authorities to comprehend and safeguard the interests of the public (Leach 1921).

Although Leach was referring specifically to hatchery-reared fish, it is obvious that naturally produced fish would be subject to the same hazards from irrigation ditches.

In June, 1926, L.E. Mayhall, General Superintendent of Hatcheries, conducted a field review of migration conditions for salmon in the Yakima River Basin. He reported to Charles R. Pollock, State Supervisor of Fisheries, that:

> Ninety-eight percent of last year's hatch is being destroyed by the irrigation ditches, as they are now migrating down the river (Mayhall to Pollock; 4 June 1926).

Charles E. Pollock, State Supervisor of Fisheries, writing in the annual report for 1926, pointed out the continuing loss of fish in irrigation ditches:

> The screening of the irrigation ditches is still an unsolved problem, and the destruction of young salmon and trout is enormous, and it seems at this time proper to call attention to the reports that have been made on the subject from time to time in the past; and during the past year especially as concerns the Yakima River, a tributary of the Columbia (Washington State Department of Fisheries and Game 1928).

Pollock then proceeds to refer to the photograph in the 1912 annual report showing "seven hundred salmon fry taken from one lateral irrigation ditch," and includes information from the 1919 Winn report.

Moving on, Pollock includes portions of a resolution passed by the Yakima Valley Fish and Game Protective Association on 4 March 1922:

> Whereas: said ditches or canals, operating to capacity for seven months of each year, and during parts of said period, taking fully 90% of the water out of the Yakima River. Whereas: said ditches or canals, taking said amount of water out of the Yakima River and being protected in no way whatsoever, are taking, during this operating period, a large amount of the food fish as well as the game fish from said Yakima River. Whereas: The Yakima River, with its tributaries, is positively known to be one of the best natural salmon streams in the Pacific Northwest. Whereas: This loss of salmon each year amounts to millions of dollars of lost to the people of the states of Washington and Oregon.

Pollock goes on to cite from two additional reports that document the loss of juvenile salmon in irrigation ditches:

> Abstract from L.E. Mayhall's report dated June 8, 1922: "The destruction of spring Chinook salmon in these two irrigation systems is enormous. As a result of the large percentage of the Yakima River flow being diverted, there is very little opportunity for the small salmon migrating down stream to avoid passing into these canals." (Mayhall was referring to the Sunnyside and Wapato canals.)
>
> Abstract from report made by J.B. Phillips, dated September 11, 1926. Mr. Phillips was working under Hugh C. Mitchell, Field Representative for the Columbia River Salmon Protective Association: "The larger irrigation canals of the Yakima District tend to divert the main part of the river into the canal, they might be called down stream fish traps. The Sunnyside Canal leaves no

> alternative whatever but for the young fish to go down the canal."

Pollock then summarizes the situation in the Yakima River:

> Briefly stating the conditions on the Yakima River where the greatest loss is occurring: The Sunnyside Canal, a Reclamation project and the Wapato Canal, an Indian Service project, are diverting at times, and normally at a time when the young salmon and trout are migrating down stream, practically the entire flow of the Yakima River (Washington Department of Fisheries and Game 1928).

To cap this discussion of the great losses of juvenile salmon in the irrigation canals of the Yakima River Basin, it is illuminating to refer to the work logs of H.O. Hoggatt, Ernest M. Brannon, and William Whitfield. These three men were field workers for the Washington Department of Fisheries and were assigned the task of surveying some of the irrigation canals and ditches in the Yakima River Basin during 1928, 1929, and 1930, respectively, in order to document, at least in relative terms, the loss of juvenile salmon (Figure 4). In order to accomplish this goal, they spent several months each year during the irrigation season sampling the fish in the various canals and ditches, principally by hook and line, hand seine, or small traps. Excerpts from these work logs amply demonstrate that many juvenile salmon were still being lost in the irrigation canals, even though the salmon runs had by then been reduced to mere remnants consisting of 1-2% of historic numbers:

> August 1, 1928-Went down to the lower end of the Sunnyside ditch this a.m. . . . Caught 97 salmon from 4 to 7 inches, 7 steelhead from 7 to 9

inches...Ranchers down at the lower end of the ditch report that they see lots of fish in their fields (Hoggatt 1928).

September 6, 1929-I visited the Tieton ditch today above Tieton City. I fished with hook and line ahead of dam No. 1 just below the tunnel and I caught 68 young salmon 4 1/2 to 7 inches long, 2 steelhead 7 to 10 inches long, 1 cutthroat trout 12 1/2 inches long. I saw 10 salmon 5 to 7 inches long that I did not get and I hooked 2 steelheads about 11 and 14 inches long that I played out and then I lost them (Brannon 1929).

July 7, 1930-The water being shut off of Lateral II of the Wapato, I followed it down and caught 49 salmon about 3" long. All but one looked like silversides. There were about 250 salmon taken out of the canal, 50 of which were chinook 4" to 6" long. The others, the species uncertain (Whitfield 1930).

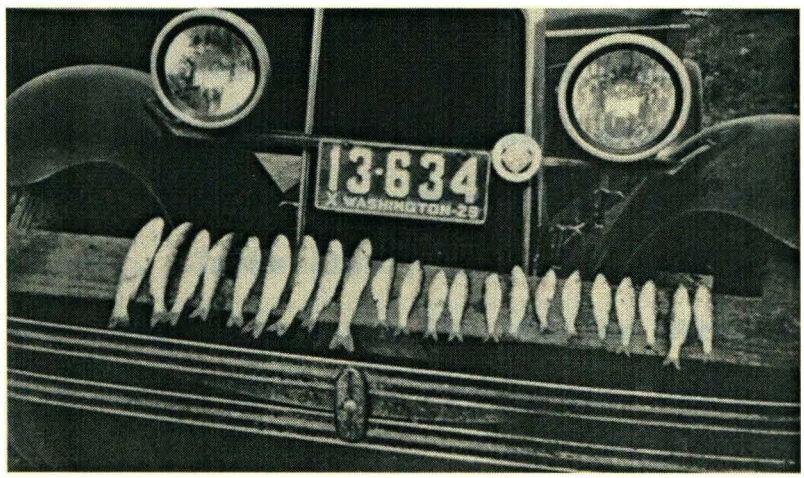


Figure 4. Nine juvenile steelhead and thirteen salmon caught in Lateral 371, Wapato Irrigation Project, by E. Brannon, on 26 May 1929. (Source--WDFW)

However, the loss of juvenile salmon in ditches was not the only impact of irrigation development on salmon. As more

and more ditches were constructed, the amount of water removed from a stream may reach a point where the stream was essentially dewatered--entire stretches of the stream may be dry. This not only resulted in most of the juvenile fish being swept into the ditches, it also destroyed rearing and spawning habitat, and blocked migration of juvenile and adult salmon. As irrigation development progressed in the Yakima River Basin, streams were dewatered, with the expected negative impacts on salmon.

Many of the early ditches diverted water from tributaries, such as Ahtanum, Wenas, and Manastash Creeks. Wenas Creek, for example, had between 40 and 50 irrigation ditches diverting water onto nearby land. As more land was placed under irrigation along these streams, more water was diverted from them, until all the water was diverted and shortages began to occur. Jayne (1907) indicates that water shortages first became a problem along the smaller streams. When shortages occurred and water rights were contested, it was common for the courts to step in and adjudicate all water claims for a particular stream. Waller (1904) lists a number of tributaries covered by court decrees or where all the water was diverted, including Ahtanum, Wenas, Naneum, Wilson, Coleman, Swauk, Taneum, Reeser, and Manastash Creeks.

Parker and Storey (1916) note that:

> Wenas Creek was one of the first tributaries to be used for irrigation and the low-water flow has been over-appropriated to such an extent that considerable litigation has resulted . . . Ahtanum Creek, like all the other small tributaries of the Yakima, has been greatly over-appropriated.

All of these tributaries were utilized as spawning and rearing areas for one or more species of salmon, including coho, spring chinook, and steelhead. The fact that an adjudication occurred on a particular stream clearly indicates that all of the available water was being diverted for irrigation. Not only does this imply that few of the juvenile salmon escaped the yawning maws of the irrigation ditches, but the entire stream was dried up. This completely eliminated spawning and rearing habitat and blocked migration of juvenile and adult salmon. In essence, salmon production was completely eliminated from these tributaries.

Further documentation of stream dewatering prior to the turn of the century is found in the 1891 report to the Commissioner of Indian Affairs by Jay Lynch, Indian Agent on the Yakama Reservation:

> Another cause of ill-feeling is that the Ahtanum Creek, designated as a reservation boundary line for a considerable distance and in times past was an excellent stream for catching fish in, is now used by the whites for irrigation purposes, so that there is not now enough left in the creek for the use of the stock . . . belonging to the Indians (U.S. House of Representatives 1892).

Irrigation diversions were constructed along every tributary stream that could be converted to irrigation. In 1913, A.C. Libby, a Surveyman for the Bureau of Reclamation, conducted a review of the existing irrigation diversions in much of the Yakima River Basin, excluding the Yakama Indian Reservation. His report contains numerous references to streams where all, or nearly all, of the water is diverted:

> Teanaway River: This stream has many more irrigation ditches then the Tieton River . . . Water is said to be short occasionally in mid-summer when all wish to irrigate at the same time.
>
> Ahtanum Creek: . . . it turns, comparatively, no water into the Yakima River during the irrigation period and its water rights have been adjudicated.
>
> Manastash Creek: . . . its water is fully appropriated and used.
>
> Naneum Creek: After reaching the Kittitas Valley it originally spread out into several branches which have been worked over into ditches so that it is difficult now for a stranger to distinguish the creek from an artificial ditch. The water of this creek is used up long before it gets through the valley . . . Water rights on Naneum Creek have been fixed by court decree.
>
> Taneum Creek: . . . it is dry in the irrigation season at its mouth. The water of this creek is being distributed by a court decree.
>
> Wilson Creek: This creek enters the city of Ellensburg in two branches, the East Branch being sometimes called Essex Creek. The West Branch is a very small affair when it reaches Ellensburg and in the irrigation season Essex Creek carries but little water also . . . In addition to the Bull Canal there are quite a number of small irrigating ditches that take water from Wilson Creek.
>
> Wenas Creek: The water rights on Wenas Creek have been adjudicated by the courts.

Libby even reports that irrigation ditches were diverting water from relatively insignificant tributaries. Oak Creek, a very small tributary of the Tieton River, "has some patches of land irrigated by ditches from the creek." In some circumstances, tributaries were being diverted even though there was no irrigable land lying along them:

> Rattlesnake Creek: There is no irrigated land on this creek but two ditches take water from it to irrigate land in the Naches Valley proper.

Further confirmation of the over-appropriation of water from streams throughout the Yakima River Basin is found in House Document No. 1299, issued in 1913:

> In the year 1903, when the first investigations were begun in the valley by the Reclamation Service, the water-right conditions had approached the chaotic, as the low-water flow of all the streams had been much over-appropriated (U.S. House of Representatives 1913; emphasis added).

It is clear that well before the turn of the century, enough irrigation ditches had been constructed along most tributary streams in the Yakima River Basin to render them useless for salmon production. Tributary streams were important spawning and rearing areas for steelhead, coho, and in some instances, spring chinook. The virtual elimination of these production areas would have caused a severe decline in the numbers of returning adults of these species.

While flows in the tributary streams were greatly reduced by the 1890's, it took another decade before the considerably

greater flows of the mainstem Yakima River were diverted into irrigation ditches. But by 1905,

> all of the low water flows in the Yakima River had been appropriated and were diverted for irrigation. During the summer irrigation season, only irrigation return flows of poor quality and high temperature provided water in the lower main stem Yakima River (Bureau of Reclamation 1979).

During an exchange of correspondence concerning the construction of a fish ladder at Prosser Dam, E.F. Benson, Chief Land Examiner for the Northern Pacific Railway Company, commented on the low flows in the Yakima River at Prosser:

> It is not my fault that the Yakima River has been practically dried up by the U.S. Reclamation Service and private irrigation companies. While in former years we had from 700 to 1000 second feet at low water we are now reduced to considerably less than 200 second feet at low water (Benson to Hay; 15 October 1909).

Thus, in a mere 50 years, a fraction of a second on the great earth clock, streams of cold, clear water that had nurtured literally millions of juvenile salmon became dry beds, or at best sickly trickles of warm, polluted water. Even the mighty Yakima River itself had been reduced to "irrigation return flows of poor quality and high temperatures" throughout its lower 100 miles; almost 50% of its total length. Most of the tributary streams were diverted to the point that salmon production was drastically reduced or even completely eliminated. Runs that are estimated to have totalled approximately 800,000 returning adults prior to development were reduced by approximately

90% by 1900 (Davidson 1953). Figure 5 depicts a hypothetical curve for the reduction of salmon runs in the basin between 1850 and 1920.

To understand the causes of mortality, we have to examine the basic life histories of the various species of salmon, and the timing of these life history phases. It is obvious that many juvenile salmon were swept into irrigation ditches and perished in the fields. Diversion of water into irrigation ditches commonly begins in March or April, depending upon specific weather conditions and location of the diversion, and continues into October.

Unfortunately for the salmon, the great out-migration of juvenile salmon (smolts) occurs concurrently with the beginning of irrigation water diversions. Data from the juvenile monitoring facility on Chandler Canal below Prosser Dam indicates that movement of wild spring chinook and steelhead smolts begins in early April, and is largely completed by late May (Major and Mighell 1969; Fast et al. 1991). Juvenile coho and sockeye smolts typically migrate downstream at approximately the same time (Bureau of Reclamation 1984; Northwest Power Planning Council 1990).

Under natural conditions, the spring out-migration is facilitated by the annual spring freshet, when flows are at their

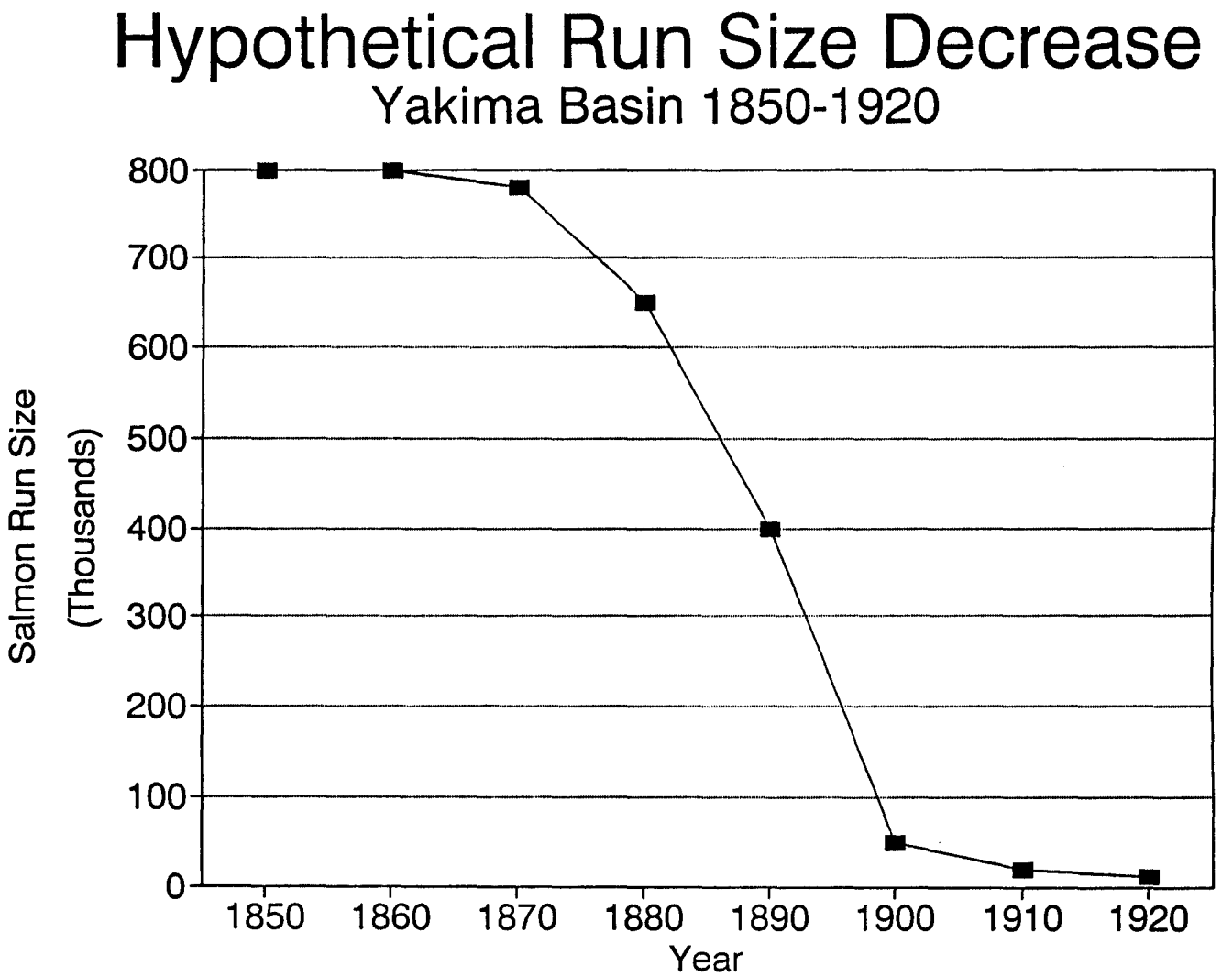

Hypothetical Run Size Decrease
Yakima Basin 1850-1920
Salmon Run Size
(Thousands)
800
700
600
500
400
300
200
100
0
1850
1860
1870
1880
1890
1900
1910
1920
Year

Figure 5

yearly peak owing to snowmelt. As a greater and greater proportion of the spring flow is diverted, the percentage of juvenile fish entering the irrigation ditches increases accordingly, until the point is reached where the vast majority of the juvenile fish are swept into the irrigation ditches. Data from the Chandler juvenile facility indicates that approximately 90% of the smolts enter the canal when diversions reach about 70% of the river flow (Fast et al. 1991).

The downstream migration of salmon smolts during the spring is a well-known phase of the salmon life history. However, prior to Euroamerican development, it appears that many, if not most, of the chinook juveniles migrated downstream not as yearling fish, but during the late spring and summer of their first year.

Based on his sampling of migrating juvenile chinook in the lower Columbia River, Rich (1920) determined that "migration takes place throughout the year," but the

> chief period of migration for the fry is during the months from June to October, inclusive...the migration of yearlings is completed by June.

Indications of the summer migration of juvenile salmon can be found in the Winn report (1919), which states: "Through July when they are migrating . . . " The 1916 Bryant survey recorded by Winn was conducted during July.

Additional evidence that the bulk of the juvenile chinook downstream migration in the basin originally occurred in the summer can be found in the work log of H.O Hoggatt (1928a), in which he records several comments from local people familiar with the timing of the downstream movement:

June 14, 1928: Had a talk with Mr. Cobb today...He seems to think this is very early for the fish to be coming down stream...Mr. McNutt...also thinks it early for the fish be to going down.

July 14, 1928: This is about the time every one seems to think they start down.

July 26, 1928: Looked over the same ditch that was dry on the 23rd and showed the engineers lots of salmon. There seems to be lots more than there were on the 23rd.

Lichatowich and Mobrand (1995) examined chinook salmon life histories that existed historically in several mid-Columbia tributaries, including the Yakima River Basin.

They concluded that:

> Even when the shortcomings of the data on life history are considered, it seems clear that juvenile spring/summer chinook were migrating in the Yakima River through the summer months.

Fall chinook smolts also tend to migrate downstream during the late spring and summer, which would place them at risk from poor water conditions in the lower Yakima River. Based on data collected at the Chandler juvenile facility, their migration period currently extends into early July (Fast et al. 1988).

In addition to movements associated with smolt migration, many juvenile salmon also travel considerable distances within the basin during the rearing phase of their life. Fast et al. (1991) documented movement of fry during the summer from the spawning areas in the upper Yakima into the Ellensburg Canyon area, as well as into the lower reaches of some tributaries, including Big, Swauk, Taneum, Manastash, and Ahtanum Creeks. As water temperatures in the lower Yakima River cooled in the fall, juvenile chinook moved out of both the Yakima and Naches Rivers into the lower Yakima River. Beginning in November, considerable numbers of juveniles moved downstream past the Chandler juvenile facility. This winter movement of juveniles accounts for approximately 20% of the total (spring plus winter) spring chinook outmigration (Fast et al. 1991).

Juvenile steelhead and coho probably exhibited considerable intra-basin movement, although few data are available on the movements of rearing steelhead and coho in the Yakima Basin. Hubble (1992) noted downstream movement of steelhead fry after emergence in intermittent streams in the Satus Basin.

The exception to the downstream movement of rearing juvenile salmon is sockeye, which do indeed disperse (normally downstream) soon after emergence. However, this dispersal ends

at an appropriate nursery lake, where they then reside until they outmigrate as smolts in the spring.

From the discussion above, we can reconstruct a fairly accurate picture of the original movement pattern of juvenile salmon in the Yakima Basin:

(1) A major downstream movement of chinook, steelhead, coho, and sockeye smolts during the April-June timeframe.

(2) A continuing major downstream movement of chinook juveniles and smolts during the July-September timeframe.

(3) A downstream movement of rearing chinook fry from the upper spawning areas to mainstem and tributary rearing areas.

(4) Downstream dispersal of juvenile steelhead and coho throughout the summer.

(5) Fall and winter downstream movement of juvenile chinook, and perhaps juvenile steelhead and coho.

To properly evaluate the impact of irrigation development on anadromous fish between 1865 and 1905, we also need to keep in mind the timing of adult upstream migration. This can be summarized as follows: chinook began entering the lower Yakima River in April and continued in a steady stream into November. The peak may have been reached in July and August. Steelhead probably began entering in July and continued for several months, but most likely in uneven peaks. Coho began entering in August and continued through October. Lastly, sockeye began entering in August and

continued through September. Most of the adult salmon migrated upstream during the April-November timeframe.

Based on what we know about the habitat requirements of juvenile and adult salmon, and on the nature and extent of irrigation development in the Yakima Basin, we can identify the mechanisms by which this activity had such a deleterious impact on anadromous fish:

(1) The loss of huge numbers of juvenile fish in unscreened diversion ditches and canals, both parr and smolts. This loss commenced when the first irrigation ditch was dug, and accelerated as more and more irrigation diversions were constructed. When irrigation diversions reached the point where most, if not all, of the water was being diverted from a stream, the loss of juvenile salmon from a particular stream became nearly total. This point was reached on a number of important spawning and rearing tributary streams by the 1890's, and on the lower mainstem Yakima River itself by 1905.

(2) Irrigation diversions increased to the point where all, or most, of the water from various streams was being diverted. This blocked migration of both juvenile and adult salmon, and denied them a crucial link in their life history: free and open access to and from the ocean.

(3) The dewatering of streams eliminated or seriously reduced important spawning and rearing habitat.

(4) The reduction of flows in the lower 100 miles of the mainstem Yakima River, in addition to reducing rearing and spawning habitat, produced water quality conditions that were often untenable to both juvenile and adult salmon. These poor water quality conditions, including elevated temperatures, eliminated any possibility that species and runs that historically utilized the lower Yakima River during the late spring, summer, and early fall, could maintain themselves in any appreciable numbers. The poor water quality conditions in this reach of river was especially injurious to portions

> of the spring chinook run, summer chinook, portions of the fall chinook run, coho, and sockeye. Steelhead were probably less affected by conditions in the lower Yakima River, due to the ability of adults to delay entry until water quality conditions had improved. It is no accident that the only runs of salmon that still hang on, barely, in the Yakima River Basin are spring chinook, fall chinook, and steelhead, all of which migrate as adults either before or after the height of the irrigation season during the summer.

Two reports produced by the Corps of Engineers directly address the impacts of irrigation development on anadromous fish listed above. In 1950, the Corps of Engineers' comprehensive Columbia River Basin study was published as a House of Representatives document. This study, thousands of pages in eight volumes, was a thorough review of all water and water-related resources. In the chapter on the Yakima River Basin, the study states:

> The Yakima River system was formerly one of the major salmon-producing areas in the Columbia River system. However, most of the stream system drains a valuable agricultural area, where irrigation developments began at an early date and have increased steadily to the present day. As a result, the anadromous fishery resources were greatly depleted as <u>early as the year 1885</u> (U.S. House of Representative 1950; emphasis added).

Nearly 35 years later, in 1984, the Corps of Engineers completed a survey of fishery needs in the Columbia River Basin. One portion of this report sums up the impact, past and present, of irrigation development on anadromous fish:

> Irrigation diversion historically has been and remains a common problem facing anadromous fish. Diversions are often made by permanent or temporary dams which can block fish passage and create inhospitably low flow and warm streams. Spawning and rearing areas can be dried up and

> unscreened diversions direct smolts into fields. Any one of these impacts is enough to render a potential production area unusable. This problem is widespread within the interior Columbia River Basin. Where waters are diverted for irrigation and return flows carry them back to the stream course, oftentimes the water is enriched and warmed to the point that though sufficient flows are available, the water quality and temperature are no longer suitable for anadromous fish (U. S. Army 1984; emphasis added).

Based on the foregoing discussion, it seems clear that while several different types of activities related to Euroamerican development contributed to the drastic decline of salmon runs in the Yakima River Basin between 1865 and 1905, irrigation development played the major role. Irrigation development was geographically wide-spread; adversely impacted one or more, usually several, phases of the salmon life cycle; and drastically, often profoundly, altered salmon habitat. Adverse impacts continued year after year, essentially becoming permanent.

For thousands of years the salmon had returned to the Yakima River Basin, forming the central focus of the ecosystem, as well as providing a dependable supply of high protein food for several thousand Native Americans. These great runs had survived ice ages, volcanoes, floods, and droughts. Only fifty years after the signing of the Treaty in 1855, they were largely destroyed. Fifty years; less than one human lifespan; a mere tick on the great earth clock is all it took to undo millennia of adaptation. Many Yakama Tribal

members who could remember the Walla Walla Treaty Council now stood on the bank of the Yakima River and observed the dry riverbed below Sunnyside Dam. Where once there had been cold, rushing water, full of vibrant life in countless numbers of fish, now there were dry rocks and a trickle of warm, sickly water.

It was incomprehensible--had not the United States promised that Yakama Tribal members could fish as their ancestors had for thousands of years, at "all usual and accustomed places"? How could they fish if there were no fish in the river; indeed, how could they fish if there was no river? While they may have hoped, or dreamed, of a day when the river would again run cold and clear, when the salmon would again return in uncounted abundance, the future would in fact bring the extinction of some runs, and the reduction of the others to mere tragic remnants.

THE CONTINUING DECLINE: ANADROMOUS SALMONIDS AND IRRIGATION DEVELOPMENT--1905 TO 1933

Federal Reclamation In The Yakima River Basin

President Roosevelt's signature on the newly-passed Reclamation Act was hardly dry before the citizens of Yakima, in January, 1903, petitioned the Secretary of Interior, urging the immediate construction of storage reservoirs and distribution canals (Parker and Storey 1916). Reclamation was quick to oblige, and formal investigations were initiated on 12 April, 1904, less than two years after enactment of the Reclamation Act (United States Reclamation Service 1905).

As the field investigations gained momentum, two impediments preventing actual federal construction of irrigation facilities in the Yakima River Basin were addressed. First, since the Reclamation Act required the Secretary of the Interior to construct and operate irrigation facilities in accordance with state laws respecting water rights, Reclamation had to formally acquire legal title to the waters of the Yakima River Basin. This was solved on 4 March 1905, when the

Washington State legislature passed legislation authorizing Reclamation to withdraw all unappropriated waters in the Yakima River and its tributaries (Parker and Storey 1916).

The second problem was the chaotic condition of water rights claims in the Yakima River Basin. Settlers had filed such exaggerated claims that "no man knows what his rights are"; these claims in Yakima and Kittitas counties

> Aggregate many times the flood capacities of the streams, plus maximum storage of the lakes. If the records are to be taken as evidence, then there is no more available water, not even enough to water a thirsty dog (Waller 1904).

Reclamation was not about to spend funds on irrigation projects in the Yakima River Basin if these conflicting claims could not be capped. Otherwise, it would build storage reservoirs only to have the stored water diverted by existing claim holders. The people of Kittitas and Yakima Counties, eager to see Reclamation begin construction, realized that unless existing claims were capped, or "limited," the valley might forego its opportunity to secure federal irrigation projects. Thus, during 1905, civic leaders worked with Reclamation to arrange "limiting agreements" between all the existing major diverters and the federal government. These limiting agreements capped the diversion claims of the existing major diverters to actual average diversion during August, 1905 (United States Reclamation Service 1907; Parker and Storey 1916).

With the passage of the state legislation giving Reclamation virtually carte blanche in the Yakima River Basin, and the securing of the limiting agreements to cap current water rights claims, the federal government wasted no time in beginning design and construction of irrigation facilities. In December, 1905, the Secretary of the Interior approved development of the Yakima-Tieton and Sunnyside Divisions, and within weeks field crews were hard at work on both projects (Parker and Storey 1916).

During this transition time between private and federal irrigation development, the first effective steps were taken to augment the irrigation water supply through development of storage. In 1904, the Cascade Canal Company completed a crib dam at the outlet of Lake Kachess that stored approximately 16,000 acre/feet of water. The same company completed a similar crib dam at the outlet of Lake Keechelus, which stored about 15,000 acre/feet of water. Both of these dams were shortly acquired by Reclamation, which then built much larger storage dams at these locations (Lyman 1919). Reclamation also built a crib dam at the outlet of Cle Elum Lake (Figure 6).

Construction of federal irrigation facilities in the Yakima River Basin then moved swiftly. Sunnyside Dam and diversion canal were purchased in 1906 and the dam was rebuilt by

Reclamation in 1907. Construction of the first permanent reservoir at Bumping Lake was begun in 1908 and completed in 1910. Construction of Kachess Reservoir was begun in 1910 and completed in 1912. Keechelus Reservoir was completed in 1917, and Rimrock Reservoir (then known as "McAllister Meadows") was completed in 1925. The last reservoir, Cle Elum Dam, was completed in 1933. Significantly, from the perspective of the salmon, four of these reservoirs, Bumping, Keechelus, Kachess, and Cle Elum, were constructed on existing lakes without fish passage facilities.

Figure 6. Crib dam at the outlet of Lake Cle Elum, 1923. Box-like structure on the right side of the spillway may be a fish ladder. (Source--NADC)

After completion of the new Sunnyside Dam by Reclamation in 1907 (Figure 7), work was pushed on the Tieton Dam and distribution system, and water was first delivered in 1910. The next major diversion dam, built by the Bureau of Indian Affairs, was completed in 1917 to provide water to the Yakama Indian Reservation (Figure 8). The last major irrigation diversion facility constructed during this time frame was Easton Dam, completed in 1929 to furnish water to the Kittitas Reclamation District.

In summary, the federal irrigation facilities constructed in the basin between 1905 and 1933 were the following: Sunnyside Diversion Dam, Tieton Diversion Dam, Wapato Diversion Dam, Easton Diversion Dam, Bumping Reservoir, Kachess Reservoir, Keechelus Reservoir, Rimrock Reservoir, and Cle Elum Reservoir. By 1930 the number of acres under irrigation had increased to 345,000 acres (Bower 1990).

Impacts On Anadromous Fish

What was happening to the salmon runs during this period of expanded irrigation development? It is clear that salmon runs continued to decline, since the adverse conditions that existed prior to 1905 not only continued, but intensified. It is estimated that the salmon runs were reduced to 11,000 returning adults by 1920 (Bureau of Reclamation 1979). It

is likely that they continued to decline after that date, but apparently there have been no estimates made for run sizes during the 1920's and 1930's.

One of the major factors in the continuing decline was the annual loss of millions of juvenile in unscreened diversions. The danger to juvenile salmon posed by unscreened diversions intensified, due to the construction of large federal canals without any protective fish screens.

Sockeye salmon, already heavily impacted by unscreened diversions and adverse water conditions in the lower Yakima River, were exterminated outright by the construction of impassable dams at the outlets of their four nursery lakes, Bumping, Kachess, Keechelus, and Cle Elum. Fulton (1970) states: "All four Yakima Lakes had good sockeye salmon runs before dams construction at outlets." The same conclusion is found in Mongillo and Faulkner (1980):

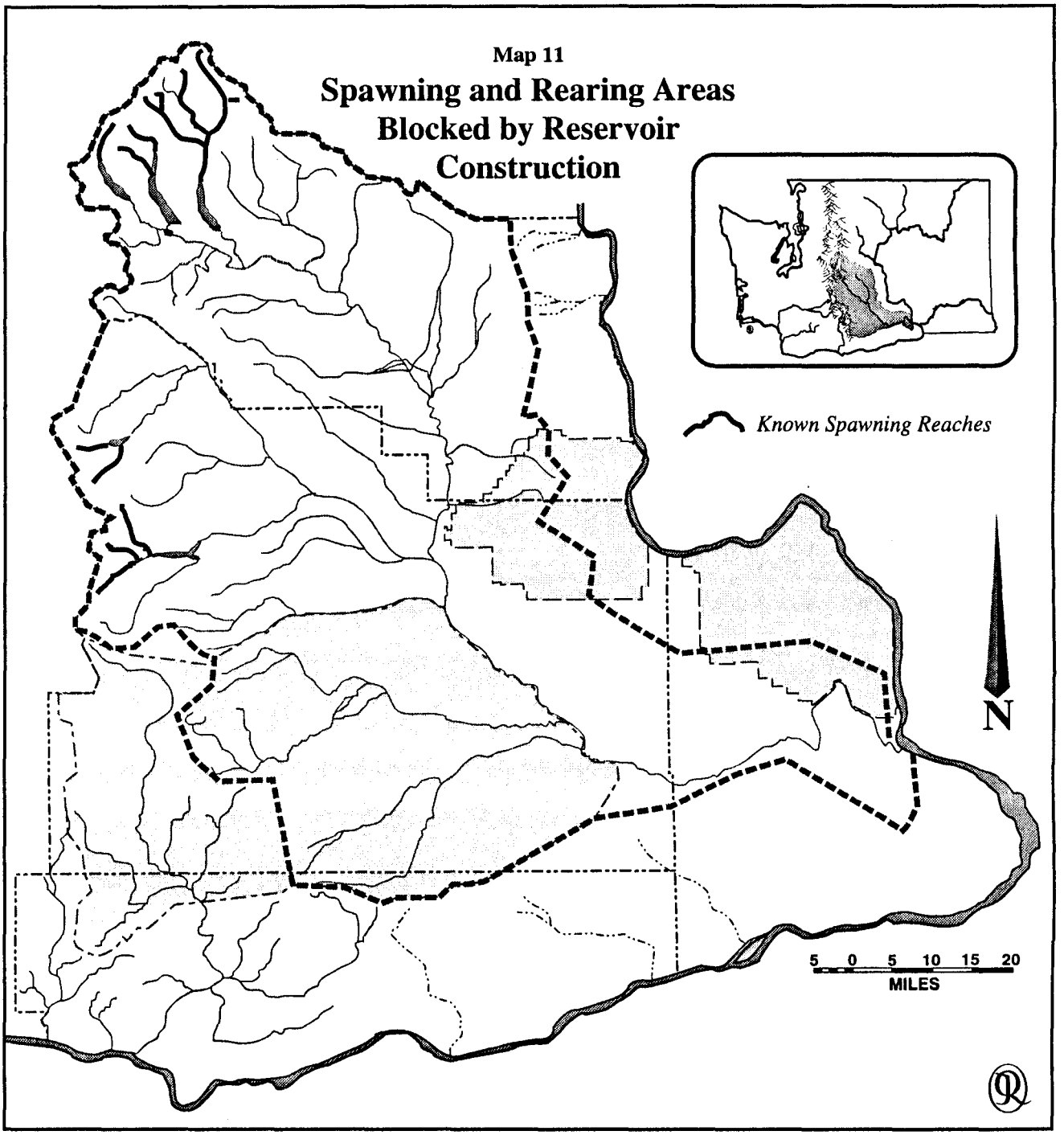
> Before construction of the dams, the natural lakes contained a variety of sport fish . . . Sockeye salmon used the lakes for rearing . . . When dams where constructed at the lower end of these natural lakes, the sockeye salmon were eliminated.

In addition to the total elimination of sockeye salmon, construction of the storage dams without fish passage also blocked access to many miles of spawning and rearing habitat for chinook, coho, and steelhead, as indicated by Map 11. Salmon production was eliminated in all of the streams above

these four dams. Mongillo and Faulkner (1980) note: "Coho, chinook, and sockeye salmon used the streams above the lakes for spawning." Bryant and Parkhurst (1950) also noted impacts of the storage dams:

> The construction of irrigation dams make large sections of spawning area inaccessible and resulted in the extermination of the blueback salmon populations.

An additional impact of the storage reservoirs was the greater control they provided over flows in the Yakima River Basin. Releases of water from the reservoirs normally ceased in the fall as soon as the irrigation season concluded. This operational control of flows essentially dewatered entire stretches of river downstream of the reservoirs during the fall and winter, at a time when flows are critical for the incubating eggs that have bad deposited by spawning salmon.


Map 11
Spawning and Rearing Areas
Blocked by Reservoir
Construction
Known Spawning Reaches
N
5 0 5 10 15 20
MILES

DEVELOPMENT OF FISH PASSAGE FACILITIES

Adult Fish Passage

The problem of fish passage at dams goes back literally centuries. We find the earliest known mention of fish passage problems in the Magna Carta, signed in 1215. Provisions of this document prohibited the construction of man-made obstructions across certain salmon-producing rivers in England (Andrew and Geen 1960). Young (1854) discusses a series of acts adopted to protect salmon rivers in Scotland, beginning with King Robert the First in 1318, that prohibited

> the erection of fixtures of any size or dimensions whereby the fish may be destroyed, or their progress up and down the river prevented.

In the United States, fishway development can be traced back to at least 1787, the year that the Constitutional Convention was held. Declines in Atlantic salmon and shad in the New England states provided the impetus for developing some means of passing adult fish over the many dams that were built to provide water power for the rising industrial age. In 1837, the Maine legislature required the

Augusta Dam on the Kennebec River be equipped with adult fish passage, but when the dam was constructed, the owners ignored this requirement. By the 1860's, the Fish Commission of Maine was engaged in a organized program of providing adult fish passage at some dams (Decker 1967).

In 1875, Virginia and Maryland conducted topographic studies of the Great Falls of the Potomac, 15 miles upstream from Washington, D.C., for the purpose of constructing a fish ladder (Anonymous n.d.). In 1882 Congress appropriated funds to the Army Corps of Engineers to complete the field studies and design the facilities (House of Representatives 1886). Due to a delay in appropriating money for construction, the fish ladder was not completed until 1889.

The Commissioner of BOF at the time the fish ladder was completed was Marshall McDonald, holder of a number of patents related to adult fish passage facilities. McDonald had considerable experience in building adult fish passages, both in the United States and Europe (Bretherton to Editor; 1891).

The legal requirements to provide fish passage facilities at dams that obstruct adult fish passage are embedded in both federal and state statute. Congress passed legislation on 21 June 1906 that required approval of the Secretary of War

and Chief of Engineers for any dam prior to construction. In addition, this legislation required that fishways be provided at the owners expense (von Bayer 1910).

Most states had legislation requiring fish passage facilities long before Congress passed the 1906 legislation. One of the first legal tests of this duty occurred in 1808, when the state of Massachusetts sued the owner of a dam to compel the construction of a fish ladder. The Massachusetts Supreme Court upheld the state requirement, even though ownership of the dam derived from a grant in 1633 from the English Crown. The Court found that there was a common law duty of the owners to protect the interests of the public. Other early court cases upholding the requirement to provide fish passage at dams include another Massachusetts Supreme Court case in 1827, a Maine Supreme Court Case in 1854, and a U.S. Supreme Court case in 1872 (Coniff to Mains, Thayer, and Leal; 23 August 1962).

In the State of Washington, Sec. 8 of the Laws of 1889-90 required the owners of obstructions placed across any stream to construct appropriate fish passage facilities. Revisions and updates of this legislation were passed in 1893, 1913, and 1915 (Coniff to Mains, Thayer, and Leal; 23 August 1962).

Therefore, the legal foundation requiring adult fish passage was well established by the time permanent dams began to be constructed in the Yakima River Basin for irrigation development. As so often happens, actual performance did not measure up to legal requirements.

It did not take long for the adverse attitude of the Reclamation Service (hereafter "Reclamation") regarding protecting fish in general, and constructing fish passage facilities specifically, to surface. On 18 March 1908, R.B. Williamson, Reclamation Examiner in North Yakima, wrote to Morris Bien, Supervising Engineer in Washington, D.C., complaining that the State Fish Commissioner was attempting to enforce the state law requiring fish passage on all dams, including those under construction or planned by Reclamation. His recommendations were either to "absolutely disregard the law and the officials in as a courteous a way as possible", or attempt "at the next session of the legislature to obtain remedial legislation" (Williamson to Bien; 18 March 1908).

In response, Bien noted that as a matter of law, federal facilities were not subject to state statutes. Therefore, if building a fish ladder was not feasible "the situation should be covered, if possible, by remedial legislation" (Bien to Williamson; 30 March, 1908). "Remedial legisla-

tion" was never obtained, and Reclamation is still in violation of state laws that require fish passage facilities at dams.

This exchange set the tone of the relationship between Reclamation and agencies attempting to protect anadromous fish in the basin for approximately eighty years. It is also interesting to note that while Reclamation claimed, and still claims, to operate in strict compliance with state water laws, it took the exact opposite position when it came to complying with state statutes designed to protect anadromous fish.

Even with this unsympathetic attitude, some adult fish passage facilities were built during this time frame. Sunnyside Dam, constructed in 1892 by private investors, most notably the Northern Pacific Railroad, was hinged at the bottom and laid flat during the non-irrigation season. No fish ladder was provided. With a height of approximately four feet, adult salmon were able to pass during periods of high flows, but probably encountered varying degrees of difficulty as flows decreased through the summer and early fall.

Reclamation built a fish ladder next to the east abutment when they purchased and rebuilt Sunnyside Dam during 1906-07. This ladder failed to function properly due to small

entrance size and poor entrance location. The cost of this ladder was $116.00 (Gilroy 1932).

The Washington Department of Fisheries built another fish ladder, this time against the west abutment, in 1922, but this ladder also failed to function properly, due to poor entrance location. In 1929, BOF built a new ladder in the center of the dam; the cost of this ladder was $4,400.00 (Gilroy 1932). This center ladder provided the only route of passage at Sunnyside Dam, other than jumping the dam, until replaced in 1985.

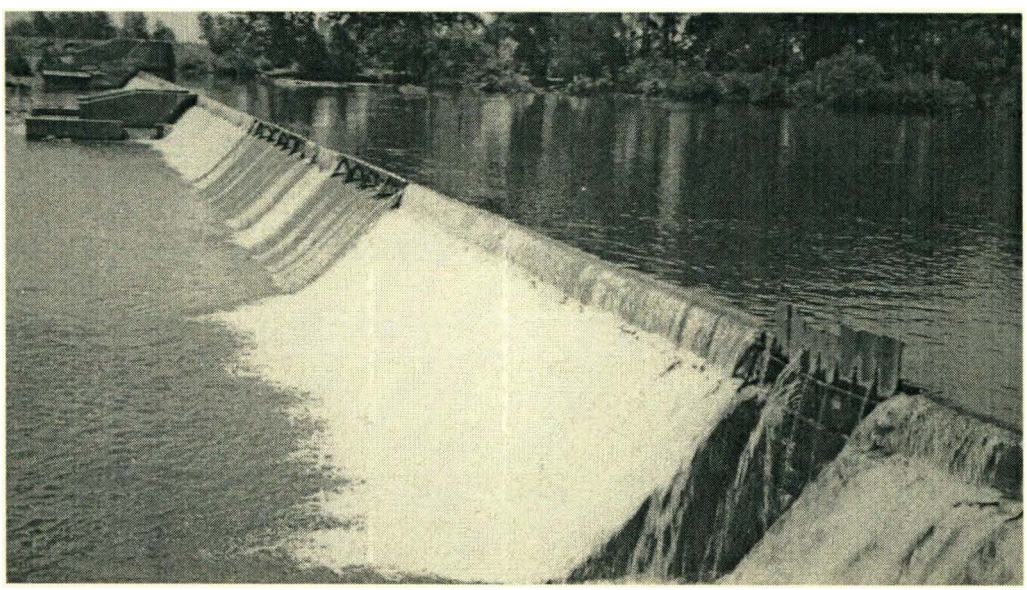


Figure 7. Sunnyside Dam, showing the 1922 fish ladder at the far end, and the 1929 ladder in the center of the dam. (Source--NADC)

The Wapato Dam, built by the Indian Irrigation Service in 1916-17, included a fish ladder on the right abutment of the dam on the east channel--the east and west channel are separated by a small island. This ladder also did not function well due to poor placement of the entrance. A new center ladder was built by BOF 1930 (Gilroy 1932). The dam on the west channel was not equipped with a fish ladder.

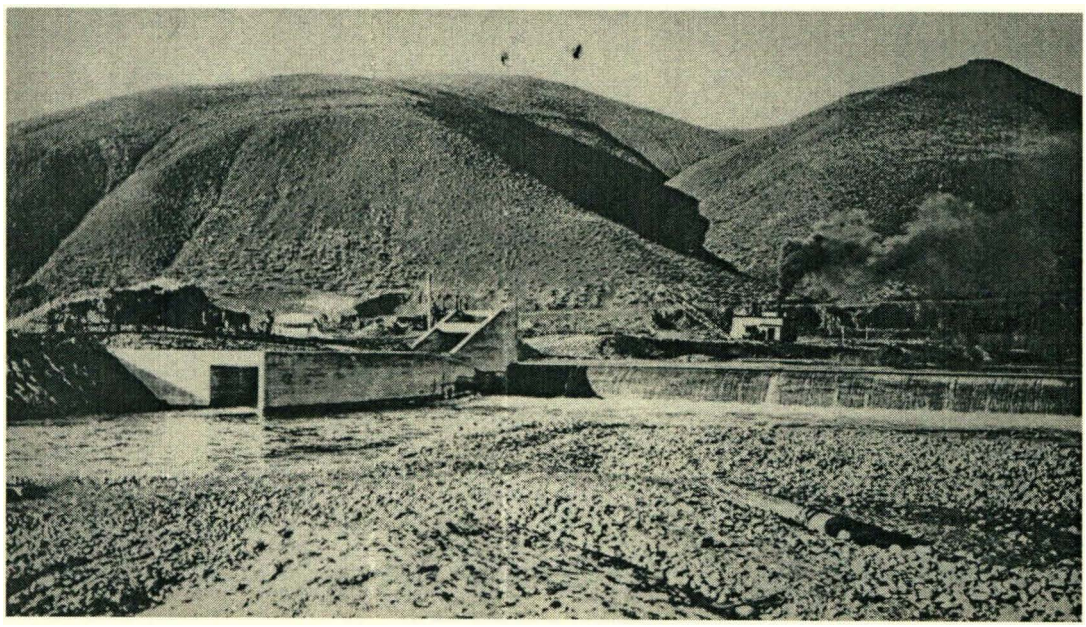


Figure 8. Wapato Dam and fish ladder nearing completion, November 1916. (Source--NADC)

The apparent lack of effectiveness of the early, pre-1929, fish ladders at Sunnyside and Wapato Dams produced this comment from Hugh C. Mitchell, Field Representative of the Salmon Protection Association:

> I don't know who planned the fishways over these dams but he would have served the State nobly if

> he had drowned himself two days before he undertook the job (Mitchell to Pollock; 25 May 1926).

Prosser Dam was built in 1904 by private interests. The owners added a fish ladder two or three years after the dam was constructed, at the request of the state, but this ladder washed away within months (Riseland to Hay; 19 November 1909). The state again intervened in 1909, and another fish ladder was constructed (Benson to Hay; 22 November 1909).

The second fish ladder also apparently vanished within a few years. In 1915, the state again insisted upon the

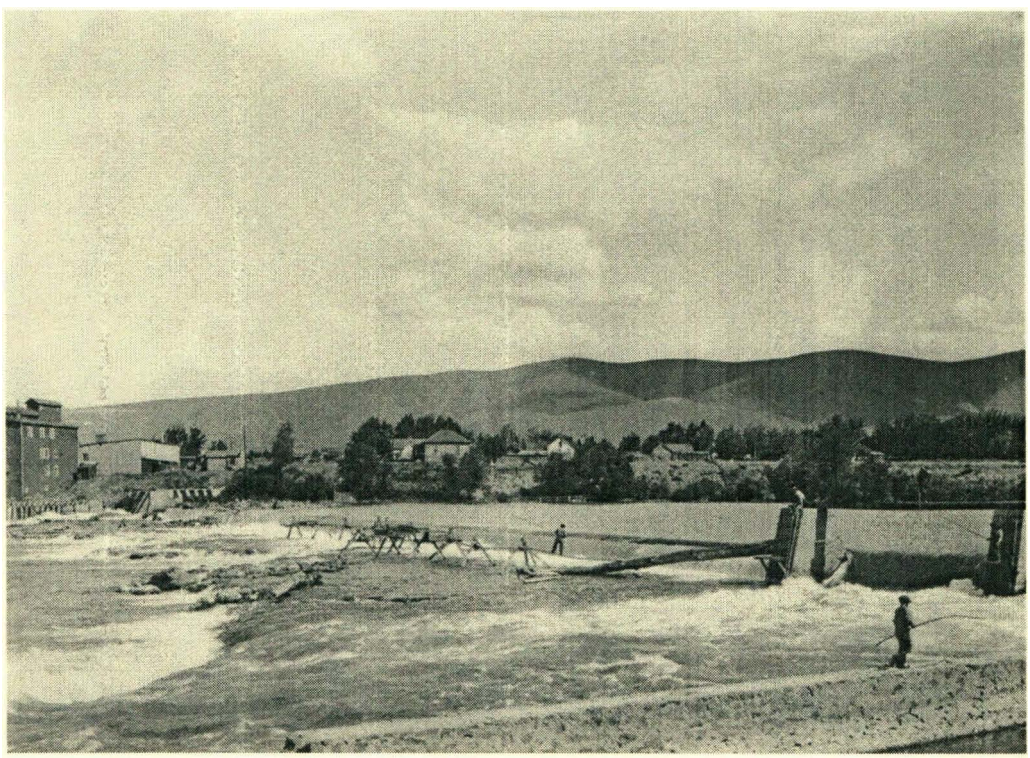


Figure 9. Prosser Dam--1923. Notice the absence of fish ladders. (Source--NADC)

construction of a fish ladder, which was built in June of that year (Darwin to Pacific Power and Light; 27 April 1915). It is unknown how long the third fish ladder remained in service (Figure 9). The effectiveness of any of these fish ladders is likewise unknown, but it is probable that they were marginal, at best.

In 1930, Prosser Dam was acquired by the federal government. A permanent fish ladder was built by the State of Washington in 1930 as ownership was transferred.

Easton Dam was built in 1929 to divert water for the Kittitas Reclamation District. A fish ladder was included at the time of construction, reportedly the first ladder designed by Milo Bell. The ladder was less than satisfactory, due to poor placement of entrance, small pool size, and excessive pitch (Figure 10).

The last dam built during this time frame was Cle Elum. The wood crib dam built in 1907 apparently had some type of fish passage facility, but the effectiveness of this installation is unknown. The large storage reservoir completed in 1933, without adult fish passage, was approximately 140 feet high. However, the state of Washington made an attempt to ensure that adult fish passage was included in this project, and a

considerable exchange of correspondence between Reclamation and the Department of Fisheries took place in 1931-32.

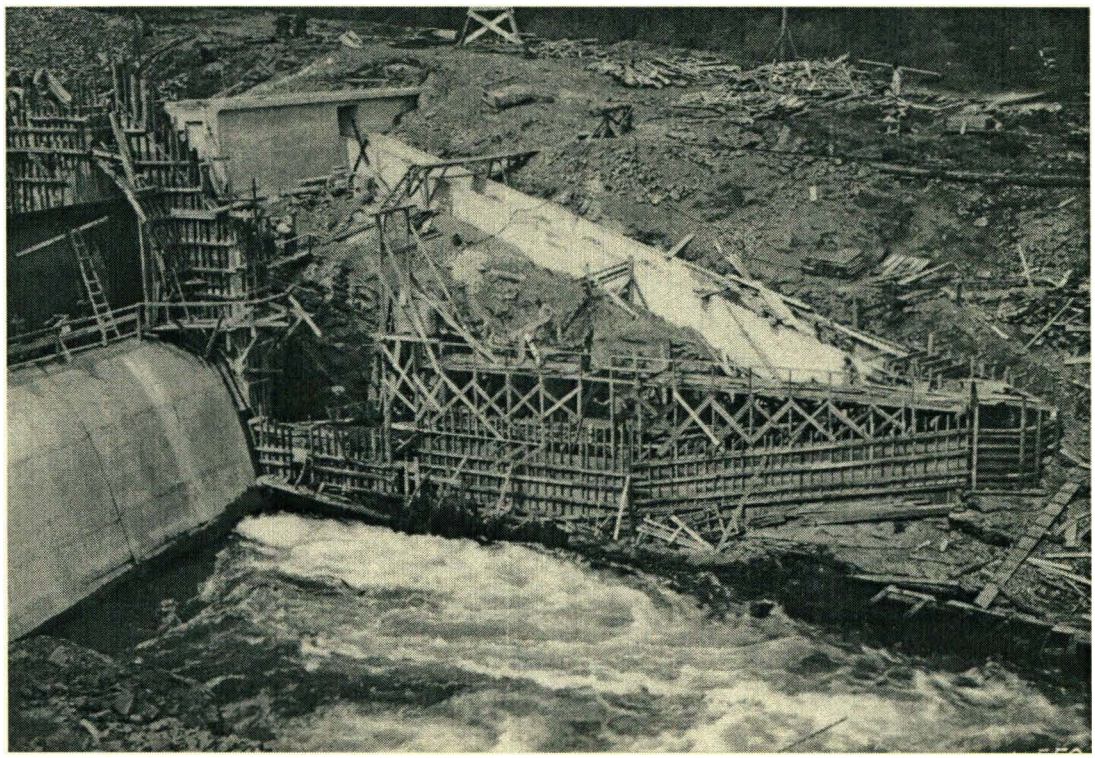


Figure 10. Fish ladder at Easton Dam under construction, 14 September 1929. (Source--NADC)

Nothing came of this effort, however, and in February, 1932, Henry O'Malley, Commissioner of Fisheries, conceded that:

> Since it now appears that fish ladders or other equipment are not likely to be installed in the Cle Elum Dam there will be no other alternative except to offset any possible damage by hatchery operations (O'Malley to Russell; 19 February 1932).

Another approach to mitigate the impacts of the lost habitat due to the construction of storage reservoirs was the

concept of providing some level of instream flows. It was apparent by this time that full construction of the federal irrigation project, including the planned Roza and Kennewick Divisions, would exacerbate the already serious instream flow problems. In view of the on-going debate over fish ladders at Cle Elum Dam, and cognizant of the need for instream flows, Charles Pollock, Supervisor of Fisheries, proposed water for instream flows:

> Like the Keechelus, Rimrock, and other reservoir dams, the Cle Elum Dam will stop fish migration but in lieu of a fishway over this dam and the other dams mentioned, the constant maintenance of a reasonable amount of water footage throughout the Yakima and its tributaries below these reservoirs would furnish ample spawning beds (Pollock to Maybury; 7 October 1931).

U.B. Gilroy, engineer for BOF, discussed acquiring storage water for instream flows during a visit with Reclamation officials in Denver in April, 1932. In a telegram to J.R. Russell, Field Superintendent for BOF, he notes:

> No physical difficulties preventing securing special storage for fish protection . . . Cle Elum will have excess storage above that now contracted for. Storage can be secured Cle Elum or other reservoirs depending on economy. Value fish thousand acre feet in perpetuity roughly seventy five thousand (Gilroy to Russell; 29 April 1932).

Gilroy's concept of obtaining storage water for fish was promptly forwarded to Henry O'Malley, Commissioner of Fisheries. The next day, J.R. Russell wrote to O'Malley, recommending that Gilroy's proposal be pursued by the Departments of Interior and Commerce, noting:

> As conditions are now during the irrigation season in the Yakima River the stream bed is practically dry at the height of the irrigation season (Russell to O'Malley; 30 April 1932).

Unfortunately, nothing developed from any of these concepts or proposals. No hatchery was developed in lieu of fish passage, even though a hatchery is required by state statute if no fish passage is provided. Indeed, no salmon hatchery facility has ever been constructed in the Yakima River Basin.

No storage water was ever acquired for instream flows at any of Reclamation reservoirs; Gilroy's proposal quickly vanished and all storage capacity was taken under contract by the irrigation districts.

Juvenile Fish Facilities

As discussed earlier, the severe damage caused by juvenile salmon being swept into irrigation canals and ditches, where they invariably perished, had been recognized since at least 1890. In 1905, the Washington Legislature enacted legislation that required any ditch or canal diverting water from a stream to be equipped with a device to prevent fish from entering the ditch or canal. This legislation was amended and updated in 1915 and 1917 (Coniff to Mains, Thayer, and Leal; 23 August 1962). Therefore, the legal

requirement to prevent fish from entering irrigation canals existed when Reclamation began operations in the basin.

Unlike the installation of adult fish passage facilities, which had been undertaken, undoubtedly with varying degrees of success, for hundreds of years, preventing juvenile fish from entering water diversions apparently only became a serious concern in the late 19th century. In the early 1900's, it was not entirely clear what method could be used to achieve this protection. A flat screen of sufficiently small mesh size placed to prevent movement of juvenile fish into an irrigation canal soon became clogged with debris, and either washed out or prevented the free flow of water into the ditch. Either result was unsatisfactory to the irrigation interests. What was needed was a device that would not become clogged while at the same time prevent juvenile fish movement into the irrigation canal.

As salmon runs declined in the Columbia Basin and irrigation expanded, increasing attention was focused on the need to prevent the wanton waste of juvenile salmon that was occurring due to unscreened irrigation diversions. Between 1900 and 1930, much time and effort in the Pacific Northwest was dedicated to the development of methods to keep this from happening. The Yakima River Basin played a key role in this effort.

The 1904 Annual Report of the Washington Department of Fisheries and Game contains an illustration of a revolving drum, covered with fine mesh, and set in a wooden casing. The entire structure was to be constructed in an irrigation ditch for the purpose of preventing juvenile salmon from entering the ditch. The invention of this device is credited to Frank B. Morse, Game Warden of Walla Walla County. T.R. Kershaw, Commissioner of Fisheries and Game notes:

> This seems to me to be well worth looking into, as in my opinion it will prevent the destruction of millions of young salmon (Washington Department of Fisheries and Game 1904).

Six years later, the 1910 Annual Report of the Department of Fisheries and Game contains a photo of a small rotating drum screen in an irrigation ditch. This drum screen appears to have a metal frame and, unlike the 1904 model, is driven by a set of paddle wheels connected to the axle by a chain drive. The caption reads: "Devise (sic) for keeping young fish out of irrigation ditches" (Washington Department of Fisheries and Game 1911). Unfortunately, the text does not discuss this device. The basic features of the screen, a revolving drum covered by wire mesh driven by paddle wheels through a chain drive, were standard features of most fish screens installed in the Yakima River Basin until the 1980's.

Efforts were also underway in Oregon to develop methods to prevent the loss of juvenile fish in irrigation canals. J.C. Aitken of Medford patented a revolving drum screen that was adopted by the Oregon Fish and Game Commission, which began installing them in 1916. According to Carl Shoemaker, State Game Warden:

> We have installed hundreds of these in various portions of the State and they are giving absolute success . . . J.C. Aitken . . . for more than three years has been installing them for the State (Shoemaker to Meritt; 31 January 1920).

Other sources indicates that the Aitken screen may have been improved by Oregon, or Oregon may have developed an improved version on its own. In any event, this screen was adopted by that state in 1921 (International Pacific Salmon Investigation Federation 1929). This then became known as the "Oregon screen." Clay (1961) credits Oregon with developing the revolving drum screen: "The revolving drum screen was developed by the Oregon Game Commission in 1921." However, development of the revolving drum screen apparently grew from a number of different sources in Washington, Oregon, and California, as those interested in protecting juvenile salmon from this common menace and on-going loss searched for practical methods to implement.

Experiments concerning screens for irrigation canals had been on-going for some time in several Western States. A survey conducted in 1917 revealed that California was

installing revolving drum screens at that time, while a different patented screen had appeared on the market in California in 1914 (Smith to Commissioner of Indian Affairs; 12 January 1920). Smith also mentioned the Aitken screen being installed in Oregon, and the electric fish screen patented by H.T. Burkey.

By 1920, the use of revolving drum screens to prevent the loss of juvenile salmon in irrigation diversions was rather wide-spread in Oregon and California. Given the state of technology and understanding of effective fish screens at that time, it is probable that these screens were considerably less than fully effective. Nevertheless, they offered some protection. By comparison, Washington, including the Yakima River Basin, lagged considerably behind in this effort.

As the decade of the 1920's commenced, juvenile fish protection in the Yakima River Basin managed to turn down a promising avenue, only to eventually discover that this was a dead-end street. But before this approach was abandoned fourteen years later, considerable time, effort, and money had been committed to no useful end.

The concept of using electric current to guide fish away from man-made dangers dates from at least 1915 (Spencer to

Foster; 12 January 1935). An "electric fish screen" was patented by H.T. Burkey in 1917 who, for the next 30 years, manufactured and promoted electric fish screens as a means to keep fish from entering water diversions (Holmes 1948). The concept involves sending an electric current through suspended electrodes that extended into the water in front of an intake structure. As fish approach the area, they sense the electric field and swim away from the unpleasant sensation, thus avoiding the danger of the water intake.

In 1918, Burkey demonstrated his electric fish screen at the fish hatchery located at Clackamas, Oregon. Among those who witnessed this demonstration was Henry O'Malley, the future Commissioner of BOF (Holmes 1948).

In 1920, Burkey convinced the Yakima County Game Commission that his device offered a means to prevent the juvenile salmon from entering an irrigation canal. In April, 1920, they bought the rights to install up to ten of his devices in Yakima County for $1,500 (Agreement; 9 April 1920). This Agreement was superseded in August, 1920 by a second Agreement that authorized the Yakima County Game Commission to install as many devices as it desired, and adjusted the price downward to $750.00 (Agreement; 13 August 1920). At least one unit was installed for field testing during 1920 (Cobb 1922). In 1921, the Yakima County Game Commission

installed four electric fish screens in various ditches for testing (Yakima Valley Fish and Game Protection Association; 4 March 1922).

Opinions as to the effectiveness of the electric fish screens varied. California apparently never considered this device adequate to accomplish its intended purpose (Shebley to Kinney; 27 November 1923). The Washington Department of Fisheries and Game was initially favorably impressed, and proposed installing such devices on all irrigation canals in order to protect juvenile salmon (Holmes 1948). But by 1926, their attitude had changed, and they considered the electric fish screens ineffective:

> The electric fish stops as operated in the Yakima and Wenatchee irrigation districts never were efficient, and were not approved by the department (Pollock to Sturgess; 18 February 1927).

By 1930 their opinion was even more critical:

> We watched with much interest Mr. Burkey's installation in the Yakima district some ten or twelve years ago and they were inefficient. We have also worked with Mr. Baker and Mr. Gilroy since they have been using Mr. Burkey's later developments and found them far from satisfactory. In fact, most of Mr. Burkey's principles and appliances are now in the junk heap (Pollock to Carey; 23 January 1930).

By 1926, use of electric fish screens in the Northwest, including the Yakima River Basin, had virtually ceased (Holmes 1948).

However, one chapter in the story of electric fish screens in the Yakima River Basin remained to unfold. It will be remembered that when Burkey demonstrated his electric fish screen at the Clackamas, Oregon hatchery in 1920, one of the observers was Henry O'Malley, at that time on the staff of BOF. By 1928, O'Malley was Commissioner of the Bureau of Fisheries, and he and his bureau were under increasing pressure to prevent the loss of juvenile salmon in irrigation canals.

Prior to 1928, BOF had not been directly involved in any of the early fish screening programs. Staff members undoubtedly stayed abreast of developments as they unfolded in the Northwest, including state programs and development of equipment. But until 1928, Congress had not authorized a federal program of fish passage design and construction. Due to Congressional action that year (elaborated on below), O'Malley found himself with the authority to protect juvenile salmon, and under pressure to use it.

Burkey was quick to offer his equipment to BOF, and convinced them to install a demonstration project on Tieton Canal (Figure 11) (Baker and Gilroy 1928). These tests were conducted in the fall of 1928, and concluded in early November (Holmes 1948).

Evidently the tests favorably impressed Shirley Baker and U.B. Gilroy, engineers hired by BOF to assess fish passage facilities in the Northwest. Based on their recommendation, electric fish screens where installed at Sunnyside, Wapato, and Tieton Canals prior to the start of the 1929 irrigation season (International Pacific Salmon Investigation Federation 1929). In addition, electric fish screens were installed on the Old Indian Canal in 1930 (Gilroy 1932), and on the Wapatox Canal by Pacific Power and Light Company in 1931 (Baker and Gilroy 1932). Electric fish screens were also installed in the Selah-Naches Canal for at least the 1928 and 1929 irrigation seasons (Mayhall to Pollock; 21 May 1928; Drolet to Pollock; 3 September 1929).

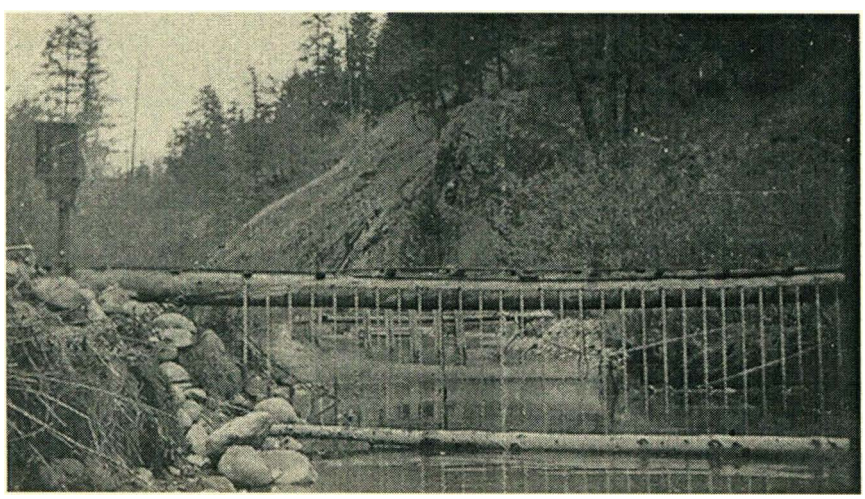


Figure 11. Burkey electric fish screen test installation, Tieton Canal, September 1928. (Source--WDFW)

These electric fish screens, with the probable exception of the installation on the Selah-Naches Canal, operated through the 1932 irrigation season. By then it was becoming apparent, even to BOF, that electric fish screens were not entirely suitable equipment to prevent juvenile salmon loss in irrigation canals. They were not as efficient as the rotary drum screens, there were unanswered patent questions, the electric field killed some fish, and the public image of these facilities was less than desirable. Even in light of these considerations, BOF felt that the electric screens in the Yakima Valley had been successful (Holmes 1948).

Like a lot of situations, the final blow was dealt by budget considerations. By the summer of 1933, the country was in the depths of the Great Depression, and funding for operation and maintenance of the electric screens was inadequate to continue operations. They therefore were removed and stored in July, 1933 (Gilroy to Higgins; 17 July 1933).

That should have been the final use of electric fish screens in the Yakima River Basin, but they lasted one more season. It had been anticipated that rotary drum screens would be installed before the 1934 irrigation season. Due to delays in design and construction, this did not occur, and the electric fish screens were installed for the 1934 irrigation season (Spencer to Foster; 12 July 1934). When they were

removed at the end of the 1934 irrigation season, the era of electric fish screens in the Yakima Valley, at last, came to an end.

The First Mechanical Fish Screens

We temporarily left the development of rotary drum screens at the beginning of the 1920's. With attention focused in the Yakima River Basin on development and field testing of the electric screens, little seems to have transpired with respect to the rotary drum screen for several years. But the removal of the electric screens in the mid-1920's left those interested in protecting juvenile salmon to seek other methods. In 1926, the Department of Fisheries and Game began more direct investigations with respect to the preventing juvenile salmon from being lost in irrigation canals. After reviewing all the devices then in use in the Pacific Northwest, the department decided that the rotary drum screen offered the best protection. Their design included revolving drum screens, seal strips along the bottom and each side, and a by-pass pipe or channel back to the river. By late 1927 the department was ready for a field test (Washington Department of Fisheries and Game 1930).

Concurrent with the efforts of the Department of Fisheries and Game to develop effective fish screens, A.C. Cobb,

Superintendent of the Yakima Valley Water Company, was apparently mulling over the same problem. Cobb is credited with independently developing a rotary drum screen similar to the "Oregon" Screen. The Cobb, or "Reliable" screen included one crucial improvement: a by-pass pipe or channel by which juvenile salmon were shunted back to the river (International Pacific Salmon Investigation Federation 1929). Obviously, Cobb and the Department of Fisheries and Game were thinking along similar lines.

In December, 1927, Charles Pollock and L.R. Mayhall visited Yakima and discussed fish screens with J.L. Lytel, Yakima Project Superintendent. Out of this meeting came a proposal to build a rotary drum fish screen in the Congdon Canal "along the lines suggested by Mr. Cobb." By the end of January, 1928, the design was completed and installation began (Pollock to Maybury; 30 January 1928).

With funding provided by the Department of Fisheries and Game (Pollock to Maybury; 30 January 1928), the Cobb screen was installed in the Congdon Canal in 1928, and was judged an immediate success: "The revolving screen in the Congdon ditch is a complete success to date" (Mayhall to Pollock; 21 May 1928).

Amazingly, considering the number of rotary fish screens installed in Oregon, it appears that this was the first rotary drum screen installed by the Department of Fisheries and Game (Washington Department of Fisheries and Game 1930). Therefore, H.O Hoggatt, who, as stated earlier, spent the 1928 irrigation season documenting the loss of juvenile salmon in irrigation ditches, was directed to conduct frequent inspections of the installation and record his observations. Throughout the irrigation season, his work log contains frequent confirmation of the "Congdon screen working fine" (Hoggatt 1928b). Debris and aquatic vegetation did not cause a problem. Most important, in terms of preventing the loss of juvenile salmon in irrigation canals, the screen worked:

> July 3, 1928. Mr. Mayhall, Mr. Gilroy and Mr. Drolet all looked down the ditch about 5 miles but saw no fish . . . Mr. Cobb reported that other years he has found fish in all the places we looked, so it seems as if the revolving screen is a success (Hoggatt 1928b).

Finally, the state of Washington and the Yakima River Basin were firmly embarked on installing rotary drum fish screens. The excursion down the ultimately dead-end road of electric fish screens had cost the Yakima River Basin almost ten years of lost time with respect to installing rotary drum fish screens.

But even as the Cobb screen was being installed in the Congdon Canal, events were unfolding that would profoundly alter the efforts to provide fish screens throughout the Pacific Northwest. And the epicenter of these events was located in the Yakima River Basin.

Federal Legislation And The Development Of Fish Screens

By the mid-1920's it was clear that the continuing loss of juvenile salmon in irrigation ditches was unacceptable, if the salmon fishing industry was to have any future at all. There was increasing pressure to address this serious issue on all involved--state and federal fisheries agencies, Reclamation, and private irrigation districts.

Discussions relating to preventing the loss of juvenile salmon in irrigation canals were taking place, and are reflected in the correspondence of that period. By early 1927, Reclamation was well aware of the problem, and increasing attention was devoted to this problem by state and federal fisheries agencies. Some within Reclamation questioned the need for fish screens, and were opposed to installing them unless funding was provided by the fishery agencies. Sentiments regarding fish screens within Reclamation were mixed, and some were flatly opposed:

> The question of providing fish screens at the intake to canals has come up on several occasions and at different places throughout the projects of this Bureau . . . On the whole this office is much

> opposed to their use, especially for a canal as large as the Kittitas main canal and they should be provided only if absolutely necessary (Acting Chief Engineer to Construction Engineer: 19 January 1927).

The pace picked up towards the end of the year. On 8 November, 1927, the Western Food and Game Fish Protective Association passed a resolution requesting that the federal agency constructing irrigation facilities cooperate with the state and federal fisheries agencies in order to protect migratory food and game fish. This resolution was then submitted to the entire Washington and Oregon Congressional delegation, including Rep. Albert Johnson and Sen. C.C. Dill, both of whom then wrote to Elwood Mead, the Commissioner of Reclamation. In his response to Rep. Johnson, Mead states that:

> This bureau is thoroughly in sympathy with the endeavor to preserve the fish life of our western streams and is anxious to take any steps <u>not in conflict with our obligations to the water users on the projects</u> (Mead to Johnson; 22 December 1927; emphasis added).

This Congressional exchange prompted Dr. Mead to request that the Superintendent at Yakima and the Construction Engineer at Ellensburg confer with state fisheries officials and report "on the existing situation and the means proposed for its alleviation" (Mead to Chief Engineer; 22 December 1927).

Earlier in December, Charles Pollock, Supervisor of Fisheries, had written a long letter to Hubert Work,

Secretary of Interior. In this letter, Pollock summarized efforts to protect juvenile fish at irrigation diversions:

> For a great many years there have been from time to time agitation and resolutions of one sort or another pertaining to the constant yearly wastage of food and game fish in irrigation ditches (Pollock to Work; 3 December 1927).

Pollock then pointed out that the situation was critical:

> The continued annual loss of fish life, if not corrected within the next year or so, will mean the loss forever of the Yakima River system as a spawning bed for salmon (Pollock to Work; 3 December 1927).

Pollock requested cooperation from Reclamation staff and in turn pledged his own full cooperation.

Following an abbreviated, noncommittal response, Pollock again wrote to Work, noting in somewhat stronger terms that:

> Every person conversant with the situation realizes that in the conception and development of the irrigation systems, the resultant loss of fish life, for some unknown reason, was entirely overlooked, and a great mistake has for years increasingly jeopardized the runs of game and food fish in the Yakima Valley area (Pollock to Work; 17 December 1927).

Pollock reiterated his pledge of cooperation, and expressed confidence that solutions could be developed through joint efforts.

With all this correspondence flying back and forth, the situation was ripe for that quintessential bureaucratic stroke--a conference. But this would not be just another

conference between state and federal staff. Instead, this conference would be

> an open meeting in Yakima for a frank discussion of the whole matter of preventing loss of fish in irrigation canals (Pollock to Lytel and Young; 17 January 1928).

This turned into THE conference on protecting juvenile salmon at irrigation diversions. Notices were sent to all irrigation entities in the Yakima River Basin:

> The method of preventing the loss of fish in irrigation canals in the State of Washington thru the installation and operation of screens at the point of diversion is at present under consideration by the State Department of Fisheries and Game . . . A general meeting will be convened at the Chamber of Commerce, Yakima, Washington, at ten a.m. Thursday, January 26, 1928. It is respectfully suggested that you have one or more representatives present (Young to Ellensburg Water Company; 16 January 1928).

It is not hard to imagine, based on recent experience, the tension that swirled through the meeting room on that cold, gray January day. Staff from state and federal fisheries agencies, County Game Commissioners, and members of conservation groups, aired their complaints, fears, and plans with Reclamation staff and over 50 irrigation district officials and farmers, who of course, harbored their own fears of reduced water supplies and higher costs. The minutes of this meeting, in keeping with the more genteel manner of the times, give little hint of any sharp exchanges, but they must have occurred, given the divisive nature of the subject at hand.

The Evolution of Fish Screens

One result of the meeting was the adoption of a resolution supporting federal legislation, introduced by Sen. Wesley Jones and Rep. Albert Johnson, as a result of the 8 November, 1927 Resolution of the Western Food and Game Fish Protective Association, to authorize the BOF to study means of protecting fish life at canals (Conference Minutes; 26 January 1928). It was this legislation that launched BOF into the fish protection issue.

The importance of this legislation can not be overstated. Although it is obvious that BOF was well aware of the loss of juvenile salmon in irrigation diversions (remember the Winn survey of 1919), prior to this legislation the federal agency had no authorization to investigate methods of preventing such loss, much less construct any facilities. The legislation is very short, and the operative portion states that:

> The Department of Commerce be, and is hereby, authorized to study, investigate and determine the best means and methods of preventing the destruction of fish occasioned by ditches, canals, and other works constructed or maintained by the United States; and for this purpose such sums of money as may be necessary, not exceeding in the aggregate $25,000, are hereby authorized (P.L. 70-338).

Passed by the Senate on 26 April 1928, exactly three months after the screen conference in Yakima, the legislation was signed by the President on 1 May and quickly implemented

(Pollock to Benson; 21 August 1928). Two engineers, Shirley Baker and U.B. Gilroy, both from San Francisco, were hired by Henry O'Malley, Commissioner of BOF, to conduct a survey of all existing fish passage devices in the Pacific Northwest, both juvenile and adult, and make recommendations concerning the most effective devices for future development and construction (Baker 1930).

Their first report was submitted to Commissioner O'Malley on 30 November, 1928. By this time, the Cobb revolving drum screen had operated for a full irrigation season in the Congdon Canal. They comment favorably on the by-pass feature, and state that: "The screen operated throughout the 1928 irrigation season and was entirely successful" (Baker and Gilroy 1928).

But after their field tests of the electric fish screen on the Tieton Canal, they appear to have been smitten by this approach to keeping juvenile salmon out of irrigation canals:

> Diversions of any size can be effectively and economically protected against the entrance of fish by means of the electric fish screen (Baker and Gilroy 1928).

As previously noted, this demonstration convinced Baker and Gilroy to arrange for the installation of electric fish screens in the Sunnyside, Wapato, and Tieton Canals prior to the 1929 irrigation season.

The investigation of fish passage facilities by Baker and Gilroy continued full speed during 1929. Much of the attention focused on the operation of the electric screens in the Yakima River Basin. Considerable problems were experienced with the Burkey equipment, ultimately leading to the abandonment of direct current in favor of alternating current. Even though the electric fish screens required constant maintenance and delicate adjustment, they considered them effective in preventing the loss of juvenile salmon in irrigation ditches. Further development was recommended:

> The experiments of the U.S. Bureau of Fisheries have resulted in an electric screen more simple in design and less costly than the type originally specified to us for the Yakima installations. Studies with a view to further simplification and economy will be continued (Baker and Gilroy 1930).

Reclamation cooperated, to a point, with Baker and Gilroy during their 1928 and 1929 investigations. The limitation of the cooperation centered on, not unexpectedly, funding. The scope of cooperation was laid out in September, 1928:

> The Bureau of Fisheries wishes to secure the cooperation of the Bureau of Reclamation insofar as this can be given <u>without expense</u>. It is not expected that any expense will be incurred by our Bureau in this connection . . . Will you kindly issue the necessary instructions to project officials in Washington and Oregon to cooperate with the Bureau of Fisheries as far as possible, always bearing mind that no expense is to be incurred in this connection (Dent to Chief Engineer; 4 September 1928; emphasis in original)

Transfer of BOF funds to cover Reclamation expenses was requested personally by Mead in June, 1929 (Mead to O'Malley; 29 May 1929).

During the next three years, Baker and Gilroy continued their investigations and field work with respect to fish passage facilities. This included continuing operation of the electric screens in the Yakima Valley. But the only additional fish passage facility actually constructed during this period was a new fish ladder at Wapato Dam in the fall of 1930. This ladder was a near-twin of the ladder built at Sunnyside Dam in the fall of 1929 (Rhodes to Administrative Assistant; 11 September 1930).

Baker and Gilroy continued their intense investigation and pursued the design and construction of fish passage facilities throughout the Pacific Northwest. Two are of particular interest. In 1931, they installed a rotary drum screen in the Jocko Canal in Montana. This canal diverted 300 c.f.s. and was the largest rotary drum screen installed to that point in time (Baker and Gilroy 1932). By way of comparison, the Congdon and Ahtanum Canals both diverted less than 100 c.f.s.

Much bigger rotary drum screens were on the horizon. During 1931, they designed a rotary drum screen installation for

the Sun River Slope Canal, also in Montana. This canal diverted 1435 c.f.s. (Baker and Gilroy 1932). Its design was a major breakthrough. During the early years of their investigations, they had reported that the rotary drum screen, such as installed on the Congdon Canal, worked well and was suitable for "the small and moderately large diversions" (Baker and Gilroy 1928). However, on very large diversions, the electric screen was preferable, due to supposedly lower cost and ease of installation. This was the basis for their installation of electric screens at Sunnyside, Wapato, and Tieton Canals, beginning in 1929.

By 1931, their views were clearly changing:

> For these reasons it is not our policy to recommend the electric fish screen for general use (Baker and Gilroy 1932).

The design of the rotary drum screens for the Sun River Slope diversion of 1435 c.f.s. clearly signals this change. Although they were not yet ready to abandon the use of electric screens in the Yakima River Basin, size of the diversion to be screened was no longer an issue. Rotary drum screens could in fact be used on a very large diversion.

While there was undoubtedly progress during the late 1920's and early 1930's due to the initiatives launched by BOF, there were still instances where no fish passage facilities

were provided for the protection of salmon. The sequence of events in the construction of the Prosser Canal without fish screens indicates that Reclamation was not totally convinced that it had any responsibilities with respect to protecting salmon resources. As previously mentioned, the state of Washington built a new fish ladder soon after Reclamation assumed ownership of the Prosser Dam in late 1930.

Reclamation then began to plan for the expansion of the Prosser Canal, in order to divert water for both irrigation and hydropower generation. The debate over fish screens in the Prosser Canal would bring into sharp focus the position Reclamation relative to protecting salmon and would bring several issues out into the open that would burden fish passage construction for many decades. It is therefore recounted in some detail.

In early 1932 the state reminded Reclamation of its interest in protecting downstream migrates, and added hopefully:

> It is also anticipated that your Bureau is considering some method of screening out these migrants from the diversion (Pollock to Moore; 27 January 1932).

In his reply, J.S. Moore disabused Pollock of this assumption:

> This is to advise further, relative to the proposed screen, that the present plans do not include any provisions for screening out the migrants from the diversion . . . From my limited experience with these devices, I am inclined to

> question the practicability of the mechanical screen which you suggest for the conditions to be met at Prosser (Moore to Pollock; 2 February 1932).

Moore went on to state that he preferred the electrical screens such as were then installed in the Sunnyside, Wapato, and Tieton Canals.

In his response, Pollock defended the mechanical screens:

> As you are aware, this department's work has been devoted entirely to developing the mechanical screening devices for diverting downstream migrants. These have proven their effectiveness and to such an extent that our office feels competent to design such equipment (Pollock to Moore; 18 February 1932).

Pollock goes on the suggest a meeting in Yakima to go over the matter in detail.

During the next six weeks, several site inspections and meetings occurred. Mayhall and Milo Bell met with Moore on 29 February to discuss the situation. As Moore reported, they urged the "immediate construction of a mechanical type of screen" (Moore to Chief Engineer; 1 April 1932).

Three weeks later, U.B. Gilroy was in Yakima to review the situation, at the express direction of Commissioner O'Malley. On 23 March, Gilroy and Moore visited the Prosser Canal to discuss fish screens. Despite his previous support for electric fish screens, Moore discovered that Gilroy was now fully in favor of mechanical rotary screens:

> Like the State officials, Mr. Gilroy, I find, favors the mechanical screen and is recommending to Mr. O'Malley that a screen of this design be required (Moore to Chief Engineer; 1 April 1932).

Gilroy's transfer of loyalty to rotary drum screens was apparently now complete. Notice also that Moore reported that Gilroy recommended "a screen of this design be required." This signaled a harder approach by BOF towards fish protection at Reclamation diversions.

The Chief Engineer responded to Moore's 1 April letter by pointing out that there were no Reclamation funds available to construct any fish screens. But of course, if BOF provided the funds,

> It would be permissible to build it. However, if built, it will be necessary to do the work prior to the date the canal would otherwise be operated for power purposes as it would thereafter be quite expensive to shut down the canal for the period necessary to install the screen (Chief Engineer to Superintendent; 16 April 1932).

Who Pays To Save The Fish?

Here we have one of the central issues of the debate; who will fund the construction of the fish screens? The debate over funding fish passage facilities in the Yakima River Basin would continue for several decades.

There is also another interesting feature to this letter. If the canal is shut down to build a fish screen after it

goes into operation, it will "be quite expensive" in terms of lost electrical generation. We will see this issue of lost generation during fish passage construction rise to major importance in the future.

The issue of fish screens at Prosser Canal is now elevated to the Commissioners' level. In early May, O'Malley lays the entire issue out for Mead. After reviewing the various meetings and discussions that have taken place over the past four months, O'Malley points out that Reclamation may indeed have funds for fish screens:

> It is further understood that a reduction in the contract price would leave a sufficient balance to permit the installation of the screen (O'Malley to Mead; 3 May 1932).

O'Malley then proceeds to cruise into uncharted waters:

> While it may be said that the appropriation for this project may not specifically authorize the installation of fish screens or similar devices, I believe that equipment of this nature may be considered an integral part of the entire works and could with propriety be constructed under the funds made available (O'Malley to Mead; 3 May 1932).

In other words, fish passage facilities should be considered an inseparable component of Reclamation projects, and funds authorized for those projects can be used to construct fish screens. This is clearly a new approach to the question of providing fish passage at Reclamation projects.

O'Malley goes on to point out that it will be much cheaper to build the fish screens while the canal is under construction, rather than build the screens at a later date. He also indicates that it is time to formulate a permanent policy on the issue of fish passage facilities at Reclamation projects.

Mead's response was very short, and it is easy to see, given the entire set of circumstances, that he did not know quite what to make of O'Malley's suggestion that authorization of the project included implied authorization to build fish screens. So he punted: "I am referring a copy of your letter to the field, with the request for an early report" (Mead to O'Malley; 6 May 1932).

In reality, however, the game was already over. Construction of the Prosser Canal was well-advanced and "the work is to be completed early in June" (Mead to O'Malley; 6 May 1932). Since the whole point had been to construct the fish screens concurrent with canal construction, that opportunity was already lost. But the debate lingered on to the end of May.

Mead soon received his field reports, one from the Superintendent in Yakima and one from the Chief Engineer in Denver. They provide an interesting insight on the views of Reclamation field staff concerning the issue of fish protection.

The Superintendent devotes the majority of his letter advocating the installation of electric screens, rather than rotary drum screens. He bases this preference on what he believes are the lower costs of the electric screens. He concedes, however, that rotary drum screens are now the unanimous choice of the fisheries agencies:

> The officials of the U.S. Bureau of Fisheries, however, are inclined to require the installation of mechanical screens on all new canals on the ground that the electric device is unsatisfactory and inefficient. The State department officials take the same view (Moore to Commissioner; 19 May 1932).

He then raises the concern of screen requirements for future Reclamation projects:

> Our negotiations on the Prosser installation should take into consideration the possible requirements which will develop in connection with the proposed Roza canal and the Moxee Valley power canal. The Bureau of Fisheries will certainly urge at the proper time that costly installations be made in connection with these two diversions (Moore to Commissioner; 19 May 1932).

Clearly, he is not convinced that salmon protection at Reclamation projects is justified, nor desirable. Further, he does not want to set a precedent at Prosser Canal, for fear that screens will be required at future projects.

But the most remarkable portion of his letter comes after he suggests that the fisheries agencies fund a "substantial" portion of screen construction costs:

> One reason for assuming this attitude with reference to the problem at Prosser is founded on the argument that there will be a relatively small

> number of fish at Prosser, if the electric devices at the Wapato and Sunnyside diversions are so inefficient. This would be particularly true following the completion of Cle Elum Dam. In this respect the choice of a mechanical screen over an electric one at Prosser falls into about the same class, in my opinion, as the proposed fish ladder at the Cle Elum dam, i.e., the results that may be expected do not appear to justify the expenditure (Moore to Commissioner; 19 May 1932).

This is, in effect, an admission that Reclamation's projects upstream are so detrimental to salmon that there is no justification for screens at Prosser Canal, because there will be "a relatively small number of fish" migrating through the lower river. Therefore, Moore questions the entire concept of providing screens for salmon protection. He is, in all likelihood, merely stating the opinion of most of the citizens in the Yakima River Basin at that time.

The letter from the Chief Engineer is shorter and more direct:

> You will perhaps recall that the matter of placing fish screens in the Prosser canal was discussed with you during your visit to this office on April 16, 1932, at which time the conclusion was reached that no funds were available for the construction of the screens (Chief Engineer to Commissioner; 24 May, 1932).

This is obviously the Chief Engineer's attempt to put an end to the debate concerning fish screens at Prosser Canal by saying, in effect: "It's settled, there are no funds available, let us waste no more time on this subject."

However, the Chief Engineer can not refrain from taking one last swipe at the fisheries agencies, and place the blame for the lack of funding on their shoulders:

> If the representatives of the Bureau of Fisheries and the State Department of Fisheries had been agreeable to the installation of an electric fish screen at the time the matter was first brought up, it is believed that funds could have been made available for this purpose (Chief Engineer to Commissioner; 24 May 1932).

What the Chief Engineer is saying, in effect, is, if only the fisheries agencies would have agreed to install what Reclamation wanted (electric screens), funding could have been provided. Since they would not agree to Reclamation's reasonable proposal, they ended up with no screens at all.

Several issues emerge from the debate between Reclamation and the fisheries agencies over the screens at Prosser Canal:

> (1) Are fish screens included in the authorization for a Reclamation project, or do they require separate, specific authorization?
>
> (2) Who pays for fish passage construction, the fisheries agencies or Reclamation?
>
> (3) Despite official commitments of cooperation with the fisheries agencies, the actual attitude of Reclamation field staff towards the fishery resources remained at best, indifferent, at worst, openly hostile.
>
> (4) Reclamation would make little or no accommodation in terms of scheduling or operations, for the fisheries resources or the fisheries agencies.

These issues would dominate the relationship between Reclamation and the fisheries agencies for the next 60

years, and have begun to undergo serious change only recently.

With respect to protection for the fish, the debate over fish screens in the Prosser Canal was a failure. In the end, Reclamation built still one more major diversion in the Yakima River Basin without any protection for juvenile salmon.

The Battle Over Instream Flows

During the headlong rush of irrigation development in the Yakima River Basin over the first 30 years of this century, no consideration was given to the need for instream flows for fish. The various planning documents from that era clearly indicate that the planners intended to utilize all of the water for irrigation. For example, the calculations in the Cle Elum planning report of 1929 are based on limiting the "waste", or flows, below Sunnyside Dam to 100-200 c.f.s. (Bureau of Reclamation 1929). This report also computes water available for irrigation and power generation at the then-proposed Prosser Diversion Dam, and concludes that supplies will be adequate--barely. Obviously, this would leave little in the river below the dam for the protection of salmon.

The occurrence of low instream flows in the water-short year of 1926, and the prospect that these conditions would be made permanent by the expansion of irrigation development, did not go unnoticed by the agencies attempting to protect salmon in the Yakima River Basin. On 12 January 1931, Milo Bell, engineer for the Washington Department of Fisheries and Game, expressed his concern with respect to instream flows in the Yakima River to Charles Pollock, Supervisor of Fisheries:

> The contemplated developments, as outlined by the above applications, spell complete depletion unless provisions are made for conservation in both old and new constructions. The new plans would create low water or dry areas at Prosser, Yakima to Indian Service Ditch, mouth of Tieton and the Cle Elum River. Further new diversions would take the great bulk of the water and naturally the fish life contained therein (Bell to Pollock; 12 January 1931).

On the same day that Bell expressed his concerns about instream flows in the Yakima River as a result of irrigation development, his department filed a protest against the issuance of 15 water permits to Reclamation by the Washington State Division of Hydraulics. In this letter, Pollock itemized the great damage that irrigation development has inflicted on the salmon:

> A check has been made of various ditches and has disclosed fish of all species common to this system in countless numbers in these ditches . . . Such losses are common knowledge to water users along these ditches. At times, portions of the main and tributary streams are completely dried up by certain diversions, and thus impede natural fish migrations . . . The projects which have been completed by the U.S. Reclamation Service have

> taken their toll of fish life, but, if the proposed developments are completed without proper consideration of the fisheries, these projects will destroy the migratory salmonids of this watershed (Maybury to Bartholet; 12 January 1931).

Maybury then directly requests that the applications be held in abeyance until such time as Reclamation implements a program to protect the salmon:

> The Department of Fisheries and Game is of the opinion that, before any of the above applications are granted, the applicant should agree to a definite program to be followed and put in operation to provide for the conservation and perpetuation of fish in the Yakima River and all tributaries affected (Maybury to Bartholet; 12 January 1931).

What would be included in this program? Maybury proceeds to list the principal elements required:

> (1) All diversion dams to be equipped with proper fishways and sufficient overflow to permit fish migration through the entire watershed.
>
> (2) All diversions, including both intakes and drains or tailraces to be screened by appliances acceptable to the State Department of Fisheries and Game.
>
> (3) Regulation of storage water to be worked out in such a manner that the least damage possible is done to fish life.
>
> (4) During the migratory seasons of fish, that sufficient water is left in any and all areas to assure proper accommodation for the spawning fish.
>
> (5) A free channel throughout the entire length of the river and/or tributaries affected to be provided with sufficient flowing water in same to take care of both up and down-stream migrants (Maybury to Bartholet; 12 January 1931).

At the end of the letter, Pollock looks to the day when water for fish would be granted legal protection:

> In line with the above protest it is assumed that in the adjudication of the waters of the Yakima River watershed proper recognition of the need of the fish life therein will be made a part of the final adjudication (Maybury to Bartholet; 12 January 1931).

This is a remarkable document. The basic elements required for salmon protection itemized by Maybury almost 65 years ago are exactly the elements presently being implemented, to one degree or another: fish ladders for adult passage; fish screens at diversions and tailraces; modification of storage releases for salmon migration and spawning; legal protection of instream flows. One can only speculate how the salmon would have fared in the Yakima River Basin if this program had been implemented in the 1930's. Unfortunately, speculation does not change history.

This protest was only the latest in a long series of protests involving diversions from streams throughout the state that would potentially be harmful to both resident and anadromous fish resources, dating back to at least early 1929 (Pollock to Maybury; 19 February 1931). However, Charles J. Bartholet was the Supervisor of the Division of Hydraulics and in no mood to consider this upstart idea of water for fish. Bartholet was born on an irrigated ranch in the Yakima Valley in 1884. He worked as an engineer on the Cascade Canal and other irrigation projects until 1917, when he began his career with the state (Washington State Historical Society 1940).

In a terse, one-page response, he almost contemptuously brushed Maybury's objection aside, and left no doubt as to what water in the Yakima River Basin should be used for:

> We believe that is mandatory for us to issue the permits requested without reservation . . . we do not feel inclined to place any limitations in its permits to appropriate water that may in any way hamper further development (Bartholet to Maybury; 16 January 1931).

Even while Bartholet was composing his response, Pollock forwarded a copy of the Department's protest to O'Malley, in order to gain the support of BOF. O'Malley promptly sent the whole issue across town to Mead's desk, stating in his cover letter:

> I feel that if all these permits are to cover damming of waters in the Yakima River watershed, which is a very fine spawning area for the chinook salmon of the Columbia River, the salmon in that section will soon become exterminated (O'Malley to Mead; 20 January 1931).

Since the protest involved legal issues surrounding water rights, Mead bundled up the whole packet and sent it winging across the country to the Reclamation's District Counsel in Portland for review. The District Counsel, B.E. Stoutemyer, wasted no time in putting down this budding revolt of the fisheries interests. In a bluntly worded letter to O'Malley, Stoutemyer noted that all of the unappropriated water in the Yakima Basin had been withdrawn in 1905 by the state of Washington expressly for the purpose of federal

irrigation development. Therefore, there was no legal basis for the protest (Stoutemyer to O'Malley; 28 January 1931).

Had Stoutemyer ended his response at that point, his letter would have been a straight forward, if somewhat sharp, retort to the protest submitted by Maybury. But apparently he, like others engaged in federal irrigation development, could not resist not only burying the idea of water for fish, but dancing on the grave as well. Stoutemyer first tries to reassure O'Malley that everything possible is being done to protect the fish:

> There is little ground for apprehension on the part of the State Supervisor of Fisheries, if my understanding is correct, that the best devices known to modern science have been installed in connection with the various government dams on the Yakima River for the purpose of protecting fish, so far as that is possible (Stoutemyer to O'Malley; 28 January 1931).

With respect to the problem of low flows, Stoutemyer points out that the river was over-appropriated before the federal irrigation project was initiated:

> The low water flow of the Yakima was over-appropriated long before the Government began its work in the Yakima Valley and serious water shortages had occurred prior to that time, so it is certain that the river would have been practically dry at the low water stage even if the government project had not been built (Stoutemyer to O'Malley; 28 January 1931).

Finally, Stoutemyer tries to show that the fisheries interest are cruel and heartless, as they want to dry up farms:

> Apparently it is the contention of the Supervisors of the Division of Fisheries and the Division of Game and Game Fish that the water should be taken away from the farmers and orchardists and the farms and orchards allowed to dry up in order to maintain a runway for the fish . . . As there are about 100,000 people living in the Yakima Valley, all dependent upon irrigation, I do not believe any serious argument could be made that the water should be taken from the farms and orchards to improve fishing conditions (Stoutemyer to O'Malley; 28 January 1931).

In summary, Stoutemyer's three points were: (1) Everything practical is being done to protect the fish. (2) The low flows existed before the federal irrigation project began. (3) It is unreasonable for the fisheries agencies to propose taking water away from the farmers. Stoutemyer was essentially wrong on all three points.

As we have already seen, everything was <u>not</u> being done to protect the fish. As Stoutemyer prepared his response, the federal government had installed exactly <u>one</u> rotary drum screen in the Yakima River Basin (on Ahtanum Canal). In addition, they were even then designing the Prosser Canal without fish screens, and one year later would delay and obstruct the attempt by the fish agencies to secure the installation of screens as the canal was under construction.

Improved fish ladders had been built only when BOF had stepped in and constructed new ladders on Sunnyside and Wapato Dams, in 1929 and 1930, respectively, both funded by BOF. The new ladder at Prosser Dam had been built and

funded by the State of Washington. No ladders had been provided on any of the storage reservoirs.

Stoutemyer is correct when he states that Yakima River low flows had been over-appropriated before federal irrigation development began in 1905. However, he either did not know or ignored the fact that construction of storage reservoirs and additional diversion dams seriously exacerbated the problem, causing greater periods of low flows in the spring, summer and early fall. He also ignores other impacts of reservoir construction, including total blockage of substantial spawning and rearing areas, dewatering of spawning and rearing areas below the reservoirs, and the complete elimination of the sockeye run.

Stoutemyer's allegation that the fisheries agencies wanted to take water away from the farmers and orchardists is not only untrue, but apparently an attempt to incite and inflame the irrigation interests. At that time, neither the Roza nor Kennewick projects were developed. Water was available from storage for instream flows, providing that a commitment were made prior to dedicating every drop for irrigation. This was particularly true after the completion of Cle Elum Reservoir.

Faced with this solid wall of resistance at both the state and federal level, the protest involving water rights for federal irrigation development in the Yakima River Basin promptly collapsed. Even the modest proposal of acquiring 5,000 acre feet for instream flows never materialized. It would be almost another 50 years before there was any effective legal protection for instream flows for salmon in the Yakima River Basin.

Status Of Salmon Runs In 1933

The year of 1933 is a convenient breakpoint in the chronology of irrigation and salmon in the Yakima River Basin. With the completion of Cle Elum Reservoir in that year, the reservoir system as it currently exists was completed. The legal, institutional, administrative, and physical systems as they now exist were largely in place. Most, if not all, of the problems that plague salmon in the Yakima River Basin to this day had been identified during the first third of the century. Attempts, however minimal and ineffective, had been made to address these problems, and had at least laid the groundwork for future efforts.

Fish passage facilities, particularly fish screens, had developed to the point that a large program was about to be launched to install such devices on many of the diversions

in the Yakima River Basin. This program will be recounted in the next chapter.

We apparently have no estimates of the salmon runs in the early 1930's. However, we can reasonably estimate that they were in substantially poorer condition than they had been in 1920, when they were estimated at 11,000 returning adults (Davidson 1953). No effective actions were taken during the next decade to stem the decline in the salmon runs. The experiments involving electric fish screens provided little protection. We know from the surveys of the ditches in the late 1920's that a considerable number of juvenile salmon were still being lost in the irrigation systems.

The completion of Rimrock and Cle Elum Reservoirs totally blocked a considerable area of spawning and rearing habitat. Operation of the reservoirs also heavily impacted spawning and rearing habitat below them. Below-average water supplies in some years during this period would have tended to exacerbate the adverse impacts on salmon.

In summary, the total number of adult salmon returning to the Yakima River Basin in the late 1920's and early 1930's was probably significantly less than 10,000 returning adults. Thus, the net result of irrigation development between 1865 and 1905 was the great decline of anadromous

salmonids in the Yakima River Basin, the net result of federal irrigation development from 1905 to 1933 was to establish and institutionalize the complete, total, and absolute dominance of irrigation in terms of water resource use and management. This dominance extended to the legal, administrative, physical, and operational use of water for irrigation. As we shall see, it is this total dominance of irrigation development that has prevented any meaningful recovery of salmon runs.

The approximately 120 years that have elapsed since irrigation development began is almost exactly divided into two eras; the first era encompasses the great decline of anadromous fish in the Yakima River Basin and the establishment of irrigation as the dominant use of water resources. The second era has witnessed the continuing dominance of irrigation and the resultant inability to pursue any meaningful salmon recovery.

COMPLETION OF THE YAKIMA PROJECT AND TOTAL DOMINANCE OF IRRIGATION: 1933 TO 1960

Fish Passage Construction: 1933-1940

All the plans, experiments, and discussions concerning fish screens during the previous several years finally bore fruit in the great burst of fish screen construction between 1934-1940. Unfortunately, but not surprising, however, it was economic depression, not concern for the salmon, that ultimately brought the screen construction program into being.

In 1933 the country was in the depths of the Great Depression. Agencies like BOF, facing declining budgets, were forced to curtail activities. One casualty of this funding crunch was the operation and maintenance of the electric fish screens in the Yakima Basin, which they were forced to mothball in July, 1933. In this type of a budget climate, how could funding for fish screens be obtained?

During 1933 BOF continued to search for a source of funding for screen construction. Additional appropriations to the

agency were simply out of the question. In due time, the BOF received funding from the same source that would fund the construction of Grand Coulee Dam--the Public Works Administration (PWA) (Pitzer 1994).

In the fall of 1933, the BOF received $75,000 from the PWA to build fish screens in the Northwest (Nelson to Holmes; 24 November 1933). They wasted little time in putting a construction program together. In January, 1934, John Spencer was hired to head up the construction effort (Commissioner to Spencer; 23 January 1934). Spencer was an engineer and long-time Director of the Bureau of Hydraulics of the California Fish and Game Commission (Spencer to Higgins; 2 January 1934). At long last, a fish screen construction program was underway in the Yakima River Basin.

It was hoped that construction of some screen installations could be completed before the 1934 irrigation season, but water was turned into the canals unusually early and this postponed construction until after the conclusion of the irrigation season in the fall (Bell to Ovenden; 14 March 1934). One result of this delay was the re-activation of the electric fish screens, which had been placed in storage in July, 1933 (Spencer to Foster; 12 July 1934). In reality, any expectation of organizing actual construction, including preparing designs, preparing and accepting bids,

and all the other activities that a construction project entails, between late January and mid-April, was probably highly unrealistic to begin with.

With construction postponed until the fall, Spencer set about arranging a well-organized program. By 1934, both the state and federal fisheries agencies were well-acquainted with the various irrigation canals and ditches in the Yakima River Basin. Between 1928 and 1933, Baker and Gilroy, the engineers retained pursuant to the 1928 legislation, had produced five reports dealing with fish passage facilities. Gilroy had produced an additional report in 1932 that summarized the need for fish screens at various federal water projects throughout the Northwest.

The state had also laid the groundwork in anticipation of a screen construction program. Two years after the installation of the Congdon Canal screen in 1928, the state had conducted an extensive survey of the smaller, private canals and ditches in the Yakima River Basin, during which basic physical and engineering data was gathered (Bell to Pollock; 29 December 1930).

Besides the information and data contained in the Baker-Gilroy Reports, Spencer also had the actual screen plans prepared for the Prosser Canal in 1932, as well as the plans

prepared the same year for the Sun River River Canal in Montana. These plans provided valuable guidance for screens in the Sunnyside, Wapato, and Easton Canals, since the canals were of similar size. Likewise, the screens installed in the Ahtanum Canal and the Jocko Canal in Montana provided both plans and actual construction and operation experience. The Jocko Canal was very similar in size to the Tieton Canal (Figure 12).

After it became clear that no construction was possible prior to the 1934 irrigation season, Spencer submitted the results of his own field survey (Spencer to Foster; 7 March 1934). Following his initial field review, he then spent the spring and summer engaged in all the preparations necessary to prepare screen designs, from flow measurements and canal dimensions to the cost of materials. For example, sand was $2.25 per cubic yard delivered to the Sunnyside Canal, while gravel was $2.10 per cubic yard (Moore to Spencer: 5 March 1934). As one would expect, these preparations required frequent meetings with Reclamation staff in Yakima and Denver as the detailed designs for the various screens were developed.

By late summer, the designs were completed and specifications for bids were ready for distribution. However, ap-

proval of local Reclamation officials was not forthcoming and Spencer wired Bell in frustration:

> Maintenance responsibility discussed with Moore and understood approval Tieton-Prosser as maintenance cost low. No approval Sunnyside. Now objects. Claims approved design only my opinion. Washington order required. Shall Brennan, James, conservation league be advised Reclamation attitude? Bids go out unless countermanded (Spencer to Bell; 21 September 1934).

Bell wired back immediately, probably concerned that the situation not deteriorate into open warfare with Reclamation: "You may issue bids. Unnecessary advise Brennan and others of Reclamation attitude" (Bell to Spencer; 21 September 1934). With that affirmation, Spencer continued the contracting process.

On 5 October, 1934, the big day arrived; bids were opened on all screens except those for Prosser Canal, which for some unexplained reason were opened separately three days later. The screen program promptly faced that bane of many construction projects; the bids significantly exceeded the estimated costs. Listed below are the costs as estimated by Gilroy and the actual low bids (Spencer to Higgins; 6 October 1934):

CANAL	BID	ESTIMATED
Sun River	$4,499.52	$18,000.00
Old Reservation	$3,650.00	$1,000.00
Tieton	$9,800.00	$2,500.00
Sunnyside	$19,674.75	$14,000.00

Wapato	$37,726.00	$18,000.00
Prosser	$29,998.00	$15,000.00
TOTAL	$105,348.27	$68,500.00

With the exception of the Sun River screens, all screen bids exceeded the estimated cost by considerable margins. The reason that the bid for the Sun River screens came in so much lower than the estimate is that Spencer had decided to replace the rotary drum screens with the much less expensive stationary bar screen (Spencer to Higgins; 6 October 1934).

While BOF officials took stock of the amount of the bids compared to the available funding of $75,000, Spencer struggled to get the first project, Sunnyside screens, under construction. Yakima Project Superintendent Moore, apparently denied permission for Spencer to begin construction, prompting another wire from the frustrated Spencer:

> Cannot proceed with construction Yakima screens. Reclamation Superintendent states no clearance from his superiors if in agreement at Washington. No excuse for delay as Reclamation should know by this time necessity of immediate start of work. Urge that wires giving clearance be dispatched immediately from Mead to Yakima Superintendent (Spencer to Bell; 25 October 1934).

One can visualize the hurried staff meetings and the anxious phone calls that this telegram precipitated. Bell probably placed a direct call to Mead to iron out the situation. The next day, Bell wired that clearance for construction was on the way: "Commissioner Mead wiring Reclamation field offi-

cers clearance for screen construction" (Bell to Spencer; 26 October 1934). With this clearance, construction of fish screens to protect juvenile salmon from being diverted into major federal irrigation canals in the Yakima River Basin commenced, 28 years after the Sunnyside Canal had been acquired by the federal government.

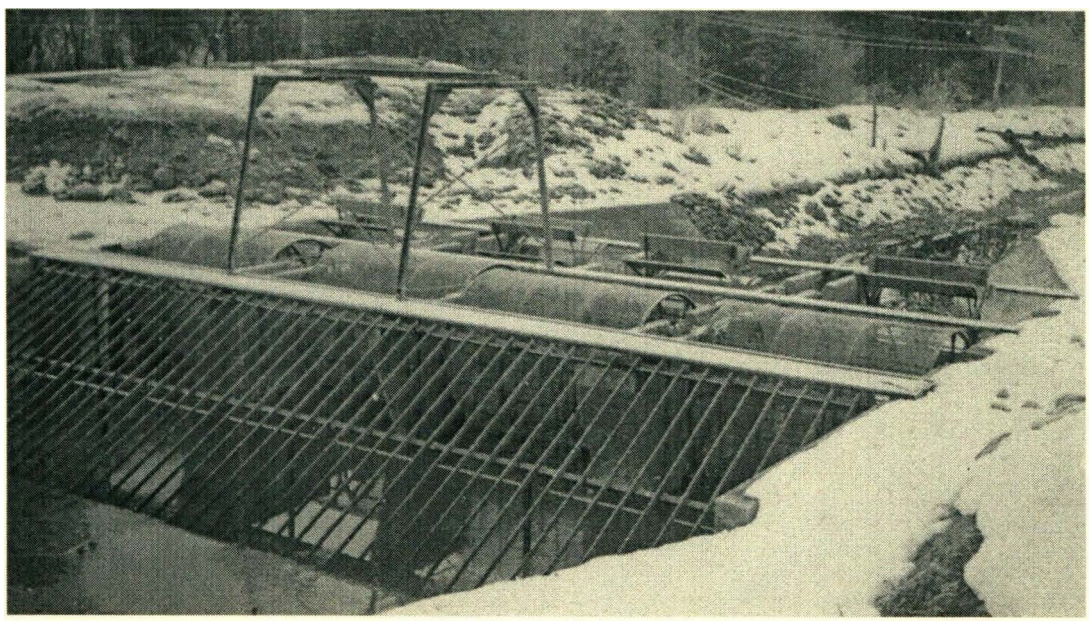


Figure 12. Tieton Canal fish screens, early 1935. (Source--NADC)

Meanwhile, BOF officials debated, by wire, what to do with respect to the bids exceeding the available funding. Additional funding, in those depressed times, was simply not available. It was obvious that some of the projects would have to be delayed, but which ones?

On 9 October, Bell wired Brennan and requested that department's recommendation concerning priority of construction for the Yakima Basin screen projects (Bell to Brennan; 9 October 1934). Brennan wired back later that same day:

> Consider Sunnyside first in importance, Wapato second, Prosser third, Tieton fourth, Indian ditch fifth (Brennan to Bell; 9 October 1934).

Some local interests, realizing that these construction projects would provide a needed boost to the area's economy, advocated construction of all of the projects. This sentiment was expressed by the Yakima Chamber of Commerce in a wire to Bell:

> We urge construction of all proposed fish screen projects this valley, especially of Wapato Canal account of large loss of game fish due to size of canal. Because this project close to Yakima would greatly relieve unemployment here. Urge allocation of additional funds if necessary to complete all units (Hagie to Bell; 9 October 1934).

But additional funds could not be provided. Two days later, Foster, BOF Regional Supervisor in Salt Lake City, submitted his recommendation to Bell:

> Recommend eliminating Wapato Canal project because excessive cost. Also Prosser as possibility migrants may pass through power wheel uninjured (Foster to Bell; 11 October 1934).

Based on this recommendation, screen projects at Wapato and Prosser Canals were deleted from the 1934-35 construction program. In the case of Prosser Canal, this would be the second time that it was denied screens.

Deletion of Wapato and Prosser screens, the two most expensive projects, meant that some funds were available for another project. Given the number of federal canals in the Pacific Northwest, there was no shortage of possibilities.

Since the inception of the screening program, the Cascade Field and Stream Club of upper Kittitas County had been advocating screen construction in the Kittitas Reclamation District (KRD) canal, which diverts water at Easton Dam. In early 1934, with news that a screen construction program was definitely funded, they attempted to have the KRD screen included in the project list (Kezak to Bell; 13 March 1934). Despite these appeals, the KRD screens did not appear on the initial list of screen projects (Figure 13).

During the late summer, with bid opening approaching, the club enlisted the support of Rep. Knute Hill, Congressman from Central Washington. A flurry of correspondence ensued between Hill and Bell, with the Congressman requesting the construction of screens in the Easton canal. Bell, ever-courteous, pointed out the lack of sufficient funding:

> I regret to advise you that the bureau's allotments from the Public Works Administration for screen installation will not permit any additional projects beyond those already approved. Indeed, the original allotment falls considerably short of being sufficient for the installation of screens already designed and for the construction of which bids have been received (Bell to Hill; 10 October 1934).

Ironically, it was the excessive bids that resulted in the addition of the Easton screen to the 1934-35 construction list. With the postponement of screens for Wapato and Prosser canals, funds were available for at least one other project. By December, it had been decided to add construction of the Easton screen to the project list, at a cost of approximately $14,000 (Foster to Higgins; 21 December 1934). However, this was a parallel bar screen, similar to the bar screen being installed at the Sun River Canal in Montana and Old Reservation Canal near Union Gap. The KRD canal would wait another 54 years for the construction of rotary drum screens.

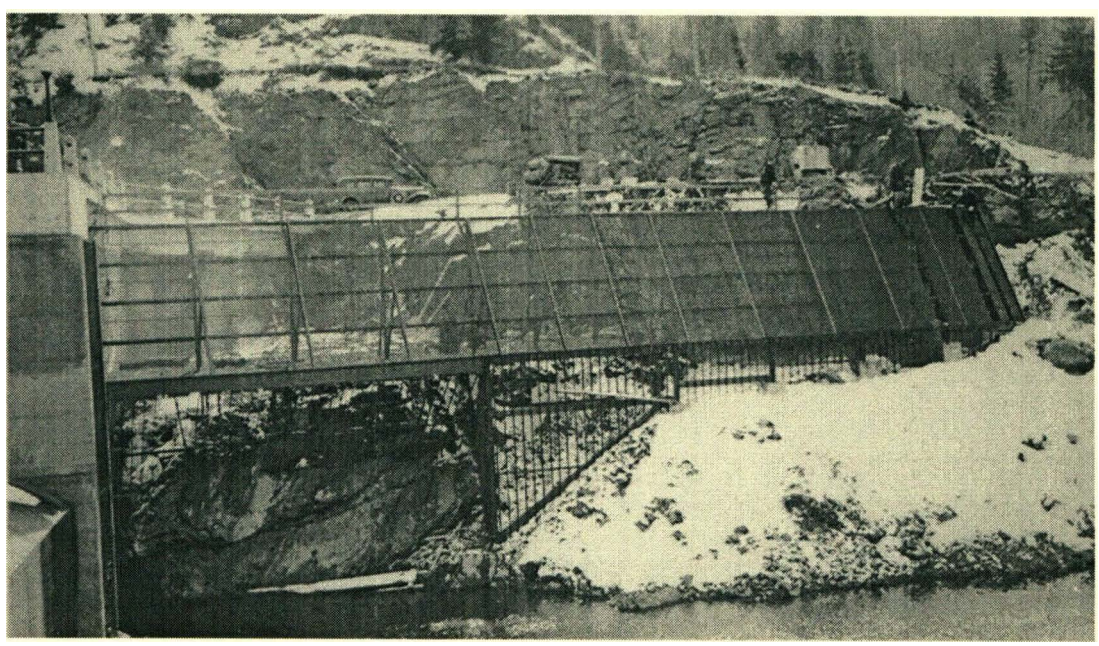


Figure 13. Bar screen on Kittitas Reclamation District canal, early 1935. (Source--NADC)

Through the winter and early spring, construction of the various screen projects progressed. Irrigation season came and water was turned into the canals. At most canals, nothing had changed since the end of the 1934 irrigation season. But in Sunnyside and Tieton Canals, big rotary drums covered with fine wire mesh turned slowly in the current, individual planks of the paddle wheels making a soft swish as they provided the power to turn the screens.

The new screens were not perfect. Deficiencies in design were recognized even before construction started the previous fall, but as is so often the case with emergency or special funding, construction had to proceed or the funding would be lost. Bell had explained this in some detail to Brennan after the bids were opened the previous October:

> Mr. Spencer . . . has completed plans for several of the screens, which, although open to many objections from a technical standpoint . . . nevertheless promise to offer a considerable amount of protection to down stream migrants . . . practically we are faced with the necessity of building some sort of screen at once or building none at all . . . we propose to continue a careful study of some of the debatable questions of screen design through the coming year, conducting specific experiments regarding water velocities, screen mesh, by-pass facilities, etc . . . It seems wise therefore to seize the present opportunity for screen construction . . . rather than attempt a complete revision of the design incorporating the results of necessary experiments (Bell to Brennan; 11 October 1934).

Milo Bell indicated that he, and others, regarded the Sunnyside screens as experimental, and not fully developed (Personal communication; 25 January 1994). Perfect or not, the basic characteristics built into the Sunnyside screens would not change in the Yakima River Basin for 50 years. And imperfect though they may have been, the Sunnyside canal screens were an impressive sight, gleaming in the bright spring sunlight, their paddles dipping rhythmically in the water; they were prominently visible from the main highway that lies immediately adjacent to Sunnyside Dam. A suitable ceremony was obviously in order.

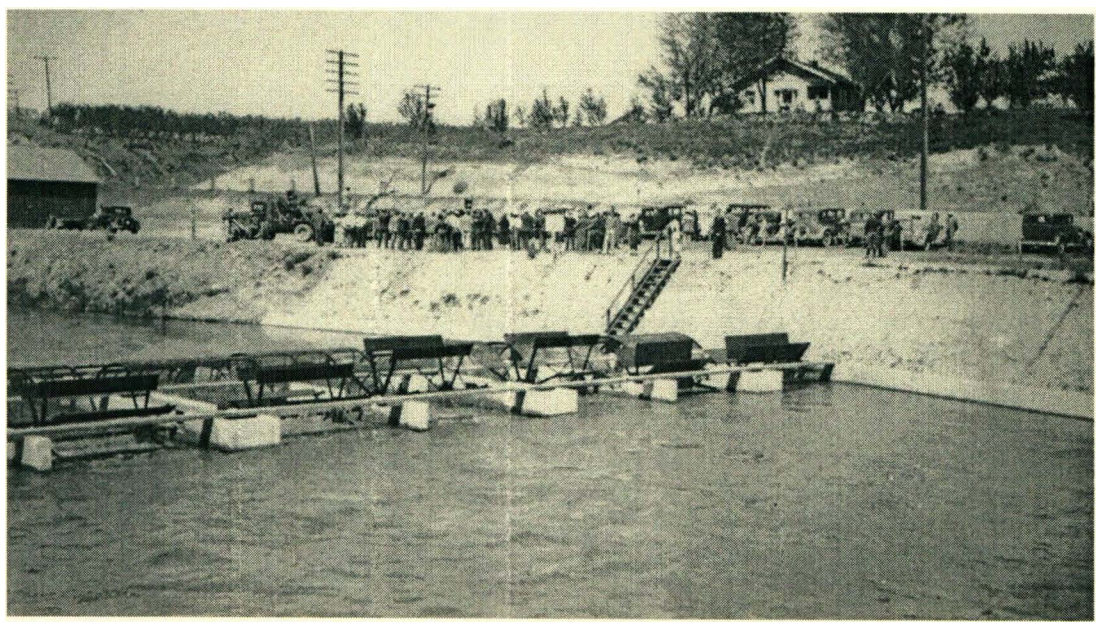


Figure 14. Dedication of the Sunnyside Canal fish screens, 26 April 1935. (Source--NADC)

Through the efforts of the Yakima Valley Conservation League, a dedication ceremony for the Sunnyside screens was held on 28 April 1935. Various dignitaries were invited to come and say a few appropriate words (Lynch to Brennan; 11 April 1935). On the appointed morning, scores of visitors inspected the new screen installation and then repaired to Yakima for lunch (Figure 14).

With the formalities of the new screens completed, efforts continued to provide screens at the many private ditches and canals not owned by the federal government (Figure 15). The state, as mentioned, had been conducting preliminary surveys of private irrigation diversions in the Yakima River Basin since 1930, but faced the same problem with respect to funding that had stymied BOF. In the end, the state turned to the same solution.

In the summer of 1935, with the new screens in operation at Sunnyside and Tieton Canals, Brennan applied to the PWA for funding to install screens in approximately 100 private ditches and canals in the Yakima River Basin. The cost would be split, with PWA and the ditch owner each providing 45%, and the state the remaining 10% (Spencer to Commissioner; 22 July 1935).

The state application was approved, and by the winter of 1936, over 150 screen installation were under construction in various regions of the state (Brennan to Shoemaker; 24 January 1936); over 50 were in the Yakima River Basin (Lynch to Hill; 3 March, 1936). By the spring of 1937, the state had installed rotary drum screens in nearly 100 private ditches and canals in the basin (Bell to Irsfeld; 16 February 1937). Statewide, the total cost of this screening program was approximately $170,000 (Brennan to Bell; 13 July 1937).

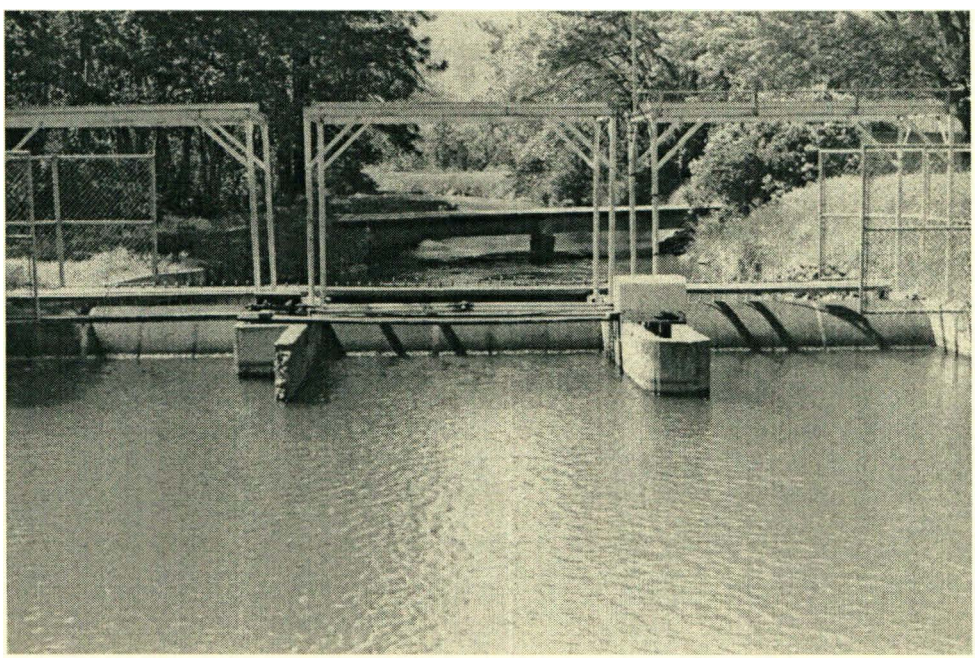


Figure 15. Naches-Selah Canal fish screens, constructed as part of the state program in mid-1930's. Still in operation in 1995, almost 60 years later.

In the three and a half years between the fall of 1933 and the spring of 1937, rotary drum fish screens had been installed in two of the major federal canals and most of the private ditches and canals in the Yakima River Basin. Judged against the backdrop of the devastating losses of juvenile salmon over the previous 60 years, and the agonizingly slow pace of progress in arresting this loss over the previous 30 years, it was a stunning achievement, made even more so by the general state of economic conditions, then at their lowest ebb.

However, two large federal canals still remained unscreened; Wapato and Prosser, deleted from the construction program in the fall of 1934 due to insufficient funding. The absence of screens in these canals was not forgotten; the persistent John Lynch and his Yakima Valley Conservation League made sure of that:

> Our committee on fish and game has requested me to forward to you the enclosed copy of the resolution pertaining to the screening of the large Wapato Canal on the Yakima Indian Reservation (Lynch to Bone; 27 April 1938).

Efforts to obtain funding for these projects were unsuccessful until the summer of 1938, when a combination of PWA and Works Progress Administration (WPA) funds were pooled to provide for the construction of screens in the Wapato and Prosser Canals (Bell to Page; 5 October 1938). The BOF quickly updated the plans for the Wapato Canal screens

prepared in 1934 and approval for construction was granted by the Bureau of Indian Affairs in early November (Irsfeld to Craig; 1 November 1938). These screens were completed and operational in time for the 1939 irrigation season (Lindgren to Commissioner; 19 April 1939).

Concurrent with the preparations for construction of the Wapato Canal screens, BOF revised the 1934 plans for the screens in Prosser Canal and sought approval from Reclamation for installation. What followed was 18 months of delay and frustration as Reclamation placed one obstruction after another in the way of BOF's attempt to build the Prosser screens. The first delay pushed construction back from the fall of 1938 to the spring of 1939 in order to:

> allow more time for working out the details of the designs, program of construction, basis of understanding regarding terms and conditions of payment for loss of power revenues, etc (Moore to Chief Engineer; 7 November 1938).

The real rub appears to have been the payment for lost power revenues. Unlike other Reclamation canals which carried water strictly for irrigation, Prosser Canal diverted water primarily for hydroelectric power production. A portion of this generation was utilized to power irrigation pumps, while the remainder of the generation was sold to Pacific Power and Light Company (Moore to Chief Engineer; 6 October 1938). Reimbursement for any lost power generation due to screen construction had been contemplated when the screens

had been part of the 1934-35 construction program. It is clear that Reclamation's position had not changed in the intervening three years.

A Cooperative Memorandum was signed by the Secretaries of Commerce and Interior in early November, 1938, that covered construction and maintenance of the Prosser Canal screens (Cooperative Memorandum; 8 November 1938). However, this document did not include any provisions for any payment by BOF for lost power revenues incurred during screen construction. Whether this was due to an oversight at the Washington, D.C., level or lack of communication between the local staff and Washington, D.C., is unclear. What is clear is that both Reclamation and BOF staff in the region had been discussing the issue for several years. When construction was postponed from the fall of 1938 to the spring of 1939, it provided an excellent opportunity for Reclamation to propose the preparation of a "supplementary agreement for review by the Bureau of Reclamation" (Page to Chief Engineer; 29 November 1938).

Discussions concerning a revised agreement dragged on through the winter of 1939. Spring came and went without a new agreement, and without construction of Prosser Canal fish screens. It was not until late-summer that the Acting Commissioner directed the Yakima Project Superintendent and

the District Counsel to draft a revised agreement (Acting Commissioner to Superintendent; 22 August 1939).

A draft revised agreement was finally circulated for review in early October (Page to Superintendent; 7 October 1939). The revised agreement required the BOF to reimburse Reclamation for lost power generation during screen construction as follows: a "free" period of seven days during which BOF would not be required to reimburse Reclamation for lost generation. For the next three weeks, BOF would have to reimburse Reclamation $50 per day. For each additional day of construction Reclamation would receive $100 per day. Under no circumstances was the power plant to be out of operation over 60 days (Draft Cooperative Memorandum; 6 October 1939).

Six weeks later, the final Cooperative Memorandum for construction and operation of the Prosser Canal fish screens was signed. The only major revisions were that the "free" period was now defined as the time that Reclamation determined it needed for normal maintenance on the canal or power plant, and the 60 day construction period had been stretched to a maximum of 75 days, ending not later than 16 February, 1940 (Cooperative Memorandum; 27 November 1939). On the same day that the agreement was signed, Reclamation notified BOF to proceed with construction (Page to Moore; 27 November

1939). After two earlier denials, Prosser Canal would finally have fish screens.

Construction started on 4 December 1939 and was completed on 3 February 1940 (Acting Superintendent to Chief Engineer; 16 February 1940). Reclamation billed BOF $5,311.00 for lost power generation (Moore to Bureau Of Fisheries; 17 May 1940). However, trouble continued to plague this project. It seems that even though construction was completed in early February, the drum screens were not placed in operation, due to the need to perform additional work, including

> the removal of silt from the bottom of the canal and other miscellaneous work necessary to be done before the screens can be placed in operation (Lindgren to Moore; 22 April 1940).

Reclamation, as expected, required that any additional work be done without shutting the canal down (Moore to Lindgren; 24 April 1940). The work was completed and the screens in operation by early May, only to have a serious leak develop on 12 May. Moore attributed this leak to debris build-up on the fish screens and resultant obstruction of flow (Moore to Lindgren; 14 May 1940). Leaks remained a problem and attempts to deal with them continued into the summer (Moore to Power House Foreman; 17 June 1940).

With the completion of the Prosser Canal fish screens, all of the pre-1939 federal canals were equipped with fish screens, including, in addition to Prosser: Kittitas,

Tieton, Wapato, Ahtanum, Old Reservation, and Sunnyside Canals. Kittitas and Old Reservation were fitted with parallel bar screens that provided questionable protection for juvenile fish.

While the screen construction program was implemented through the mid and late-1930's, Reclamation was preparing for the next large irrigation development. The 70,000-acre Roza Division occupies higher elevations in a narrow band from Pomona to Benton City. Plans for irrigating this land had been under discussion for several decades, but development had been postponed until the reservoir system was in place. The Roza, like the Kittitas, is entirely dependent upon stored water for its irrigation supply.

Construction of the Roza Division was approved by the President in November, 1935 (Bureau Of Reclamation 1980). Facilities would include a diversion dam over 30 feet high on the Yakima River 10 miles north of Yakima. The canal would divert a maximum of 2,200 c.f.s. of water for both irrigation and power production.

The development of fish passage at Roza Dam would follow a distinctly different pathway than the existing federal canals. Congress had passed legislation in 1934 requiring

BOF review of proposed federal projects to determine the need for fish passage:

> Whenever any dam is authorized to be constructed . . . the Bureau of Fisheries shall be consulted, and before such construction is begun or permit granted, when deemed necessary, due and adequate provision, if economically practicable, shall be made for the migration of fish (P.L. 73-121).

Although not quite absolutely required, in most instances fish passage now became an integral part of a proposed project rather than an add-on at some future point. This legislation was an important step forward. For the most part it laid to rest any doubt on the part of Reclamation that its projects had to include fish passage and that funding for fish passage had to be included in calculating project funding. Fish would be protected from the time a project was completed, and costs would be reduced by constructing fish passage facilities concurrent with the project rather than adding them on at some later date.

Reclamation, no doubt after giving due consideration to both the 1934 legislation and to Rep. Hill's interest, announced in early 1936 that screens and fish ladders would be included in the Roza facilities. BOF quickly responded by offering its services, pursuant to P.L. 73-121, stating:

> The Bureau will be pleased to assist the Reclamation Service during the preliminary stages of design in this field (Bell to Acting Commissioner; 23 March 1936).

Fish passage would, for the first time, be an integral part of the facilities at a federal irrigation project in the Yakima River Basin.

Design of the fish passage facilities proceeded apace, and in early 1938 draft plans were reviewed by both state and federal fisheries staff. Unfortunately, the design of the fish ladder included an upstream entrance that rendered the ladder inoperable when the pool was drawn down, such as occurred during maintenance or icing conditions. During such periods, there would be no adult fish passage at Roza Dam. Neither the state nor federal fisheries staffs apparently challenged this design feature.

The proposed facilities included a power house for hydropower generation. The design review included a recommendation that a barrier be constructed to prevent adult salmon from entering the wasteway, or return discharge canal, and being injured or killed (Brennan to Walter; 1 February 1938). This feature was not constructed, and permitted an unknown number of adult fish to be lost each year after the power house became operational in 1958, until an adult barrier was finally constructed in 1987.

Another example of the fact that these fish facilities offered only partial protection to the fish must be noted.

Neither the Roza nor Prosser screens were designed to operate in the winter. Although it was believed that little movement of juveniles occurred during the fall and winter, we now know that significant downstream movement of juveniles does indeed take place during these months.

Fish screens and ladders were duly included in the final designs, and were constructed concurrent with the construction of the dam and canal. Construction of the Roza Dam and canal was completed in 1939 (BOR 1939).

By this time, Europe was aflame in World War II and the United States was rapidly turning its attention to more pressing matters. Construction of the delivery system for the Roza Division continued, but other construction work was put on hold.

Fish Passage Construction: 1941-1960

After the war, Reclamation returned to completing the Yakima Project. On the Roza Division, this included some of the delivery system and the Roza power house. As mentioned, when the power house was completed in 1958, the wasteway was not equipped with an adult fish barrier.

Only one other division remained to be completed after the war. The Kennewick was authorized by Congress in June,

1948, with passage of P.L. 80-629 (Bureau Of Reclamation 1980). This division irrigates almost 20,000 acres in the vicinity of Benton City and Kennewick. Its development included the rebuilding of Prosser Dam, the enlargement of Chandler Canal, and the construction of the Chandler Power House.

When Prosser Dam was rebuilt in 1955-56, two new vertical-slot fish ladders were constructed to replace the single ladder built in 1931. Chandler Canal was enlarged during the same time period and two additional drum screens were added to the screen installation to accommodate the increased flow in the canal (United States Fish and Wildlife Service 1956).

Although few new fish passage facilities were constructed after 1940, the BOF and the Department of Fisheries did have their hands full with maintenance of the fish passage facilities. Maintenance of the fish screens proved particularly troublesome and labor-intensive. Both agencies established screen maintenance shops in Yakima to attend to fish passage facilities under their respective jurisdictions.

Reports prepared by R. J. Holcomb in 1948 and 1949 detail the scope of maintenance problems associated with the fish screens. Holcomb had worked on fish screens in the Yakima

River Basin for over ten years and knew their idiosyncrasies better than anyone else. Primary maintenance problems included debris accumulation; replacement of drive chains, sprockets, and bearings; silt accumulation; replacement of rubber seals; repair and replacement of paddle wheels (Holcomb to Branch of Gamefish and Hatcheries; 12 December 1948; 5 January 1949).

In at least one instance, a major renovation had been necessary within a few years of construction. The screens in the Sunnyside Canal had been rebuilt in 1939 and two new drum screens added. By 1949, these screens were "in poor shape mechanically" (Holcomb to Branch of Gamefish and Hatcheries; 12 December, 1948). The Holcomb reports indicate that by 1949, the fish screens on the federal canals were nearing, if not past, the end of their effective lifespans. Yet, it would be approximately 40 years before any of these screen facilities were replaced with new facilities.

Indeed, one screen installation was abandoned. This was the Ahtanum Canal screen, the first rotary drum screen in the Yakima River Basin constructed by the BOF. It was removed in 1954 and not replaced due to the "unfavorable location and the general disintegration of the screen itself" (United States Fish and Wildlife Service 1960). The removal of this

screen is an indication of the deteriorating condition of all the screens.

Another example of the deteriorating condition of the fish passage facilities is the fact that both the left and right bank fish ladders at Sunnyside Dam were inoperable by 1948 (Bureau Of Reclamation 1984). Other sources state the right bank ladder was inoperable as early as 1930 (Gray to Regional Director; 18 December 1973). The left bank ladder was removed in the 1950's during the construction of a sluiceway and not replaced.

Therefore, while the need for fish passage was actually increasing due to greater irrigation development during this period, there was a reduction of major fish passage facilities of at least one fish screen installation and two fish ladders.

The same general conditions prevailed at the smaller screen facilities maintained by the state Department of Fisheries. By 1956, the number of such screens had decreased from approximately 100 to 76, probably due to abandonment or consolidation of diversions (Heg to Perry; 26 July 1956). Despite the need for replacement, some of these screens are still in service.

Status Of Salmon Runs In 1960

It is estimated that the total number of adult salmon returning to the Yakima River Basin reached its highest level since the early 1900's, approximately 19,000, by the late 1950's (Bureau of Reclamation 1979). A significant run of coho still existed in the Yakima River Basin, and a remnant run of summer chinook persisted. Portions of the Yakima River were open for spring chinook sport fishing, as well as a significant steelhead sport fishery.

Continuing Problems With Instream Flows

While some progress was being made with respect to fish passage construction, instream flows deteriorated. The collapse of the protests related to BOR water permits in 1931, and the failure to reserve any storage capacity for instream flows before all of this capacity was committed to irrigation, virtually guaranteed that low instream flows would seriously affect salmon in the Yakima River Basin for the indefinite future.

The impact of the flow regime resulting from manipulation of water resources for irrigation did not go unnoticed. The Cascade Field and Stream Club submitted a strong protest to Senator Bone regarding the destruction of fish caused by reservoir operations. This protest identified a serious

adverse impact on fish that would continue unresolved for over 40 years:

> We wish to file a protest with you against the destruction of fish, and other forms of wildlife, due to the complete shutting off of the flow of water in the Yakima and Cle Elum rivers by the Reclamation Bureau . . . We enclose a picture of fish that were killed by the shutting of the gates on the Cle Elum dam during the month of November of 1935. The picture was taken a short distance below the Cle Elum dam. From the dam to the mouth of the Cle Elum River, where it empties into the Yakima, a distance of about four miles, lay tons of dead and decaying fish. We noted all varieties; trout, whitefish, and salmon. The visible fish were only a part of the destruction caused by this unwarranted and unnecessary closing . . . Salmon fry and spawn were also destroyed (Sandona to Bone; 7 January 1936).

Sandona laid the blame squarely on Reclamation, and noted their lack of consideration for fish and wildlife:

> The sportsmen of this area have tried to cooperate with the Reclamation Bureau in an effort to conserve fish and other forms of wildlife . . . Neither the State Game Department nor the State Fisheries Department can get any cooperation or satisfaction from the Reclamation Bureau . . . The Bureau takes the position that the storage and supplying of water to the farmers transcends all other interests . . . This whole destructive business reeks with official arrogance and bureaucratic inefficiency and it is utterly devoid of common sense . . . We quote from one of their letters to us: 'The net result of an overflow during certain seasons of the year is nothing more or (sic) less than a waste of water'(Sandona to Bone; 7 January 1936).

This letter is very significant. It clearly identifies the loss of fish, salmon fry and eggs, due to reservoir operations, and indicates the attitude of Reclamation regarding instream flows as "a waste of water." This institutional attitude made addressing the issue of instream

flows for fish all the more difficult. Neither this protest nor later protests produced any modification of reservoir operations to protect fish.

Periodically, individuals and agencies attempted to gain some provision for instream flows. In addition to the loss of fish below the reservoirs, low flows below Sunnyside and Prosser Dams continued to adversely affect juvenile and adult salmon, particularly in years of below-average precipitation.

The year of 1941 proved to be a very low-water year. In late April, Brennan wrote to Page of his concern for the salmon run:

> An emergency has arisen which can destroy the fisheries of the Yakima River . . . at Prosser the river dropped to a point where the federal power development was taking the entire flow of the river . . . while these extreme conditions may not exist again until Roza is completely developed and may correct itself partially this year, it is certainly indicative of the future needs for the flow in the Yakima River (Brennan to Page; 29 April 1941).

Flow conditions continued poor through the month of May, and a meeting was held in late May to discuss the situation. By now, these meetings between irrigation and fisheries interests had taken on a somewhat standard format: The fisheries interests would review the history of salmon in the Yakima River Basin and causes for the decline. A review of the needs of salmon, including safe passage and instream

flows, would follow. The irrigation interests listened, and then stated the usual facts about the economic benefits of irrigation, and the need, in a water-short year, to provide all the water possible for irrigation. But they certainly would cooperate in any way that did not interfere with the delivery of irrigation water (Meeting Minutes; 29 May 1941). In other words, nothing would be done for the salmon if such action encroached, even marginally, upon irrigation.

Three years later, adult salmon were again having trouble migrating up the Yakima River, owing to low-water and irrigation diversions. More correspondence flowed between Yakima, Seattle, Denver, and Washington, D.C. The Washington Department of Fisheries reiterated its request for flows below Sunnyside and Prosser Dams. Internally, Reclamation staff re-stated its position that water for fish was "waste":

> Situation prompting request by State of Washington Director of Fisheries for bypassing additional water through Sunnyside and Prosser Dams apparently similar to that existing during 1941 . . . maintenance 150 second-feet requested Foster's wire to you would constitute waste of water for irrigation (Stuver to Commissioner; 25 April 1944).

The Commissioner pondered this situation for several days before responding, perhaps hoping that flow conditions would improve. According to his wire, flows had indeed improved:

> Have contacted project officials who advise that flow conditions Yakima River at Sunnyside and Prosser dams are improving and believed sufficient

> water will be available to enable salmon to negotiate fish ladders . . . Superintendent Ball Reclamation project will cooperate with local Fisheries officials and so far as consistent with irrigation requirements and other obligations will provide sufficient water for the salmon run (Bashore to Banks; 5 May 1944; emphasis added).

There, very clearly and explicitly laid out, was Reclamation policy with respect to water for instream flows. Water would be provided for salmon only when it was "consistent with irrigation requirements and other obligations." In other words, salmon in the Yakima River Basin were at the end of the line when it came to water. This policy would stay essentially unchanged for another 35 years. It literally would take a federal court case to effect a change.

Loss of fish below the reservoirs from shutting off flows at the end of the irrigation season continued. In 1957, over 20 years after the Cascade Field and Stream Club had complained about the destruction of fish below Cle Elum and Kachess Dams, another serious loss of salmon was documented. This time during an aerial spawning survey by Washington Department of Fisheries staff, who reported:

> Observations of the Cle Elum, Naches and Yakima Rivers revealed some very critical situations that merit prompt and drastic action. The Yakima River was heavily spawned by spring chinooks this year between Easton Dam and the mouth of the Cle Elum River. The eggs of this spawning are now incubating in the gravel. At the time of spawning the river flow was about 300 cfs. From aerial observations on Nov. 5 it appeared that the flow had been drastically reduced and that many redds

> had undergone desiccation . . . Limited spawning was observed in the Cle Elum River this year. On the flight of Nov. 5 this stream was all but dry (Anonymous; 8 November 1957).

Milo Moore, Director of Fisheries, wrote to O.W. Lindgren, Project Superintendent, detailing the substantial loss of salmon caused by reservoir operations. After making the obligatory bow to the need for irrigation water, he requested, somewhat plaintively:

> Please advise as to any action possible under your direction to cooperate in reducing the expected fishery loss (Moore to Lindgren; 2 December 1957).

Lindgren responded with the now familiar refrain:

> We stand ready to cooperate in any way possible toward regulating stream flows so as to maintain fish life but as an operating policy it must be remembered that the Yakima Project storage reservoirs were built and paid for by the farmers of the Yakima Valley so the Bureau of Reclamation, as the operating agency, <u>is obligated to conserve the water supply for irrigation use</u> (Lindgren to Moore; 4 December 1957; emphasis added)

Fish were once again last in line behind "irrigation and other obligations." Loss of spring chinook salmon redds below Reclamation reservoirs would continue for almost another quarter century.

The need for instream flows did prompt the beginning of a long planning process for additional storage for such use. After the meeting in May, 1941, Reclamation officials began to discuss the long term solution for meeting instream flow requirements. Within a few days of the meeting, Ball wrote to Moore:

> During the session on the afternoon of the 29th . . . that the only permanent solution would be provision for 'fish water' to meet river flow requirements at the Sunnyside Dam and other points, either by providing auxiliary storage or securing a water right in existing reservoirs for that purpose (Ball to Moore; 3 June 1941).

The concept seems to have gone dormant for a few years, but the low flows in 1944 produced another round of discussions concerning additional storage for instream flows. With the renewed request for flows below Sunnyside and Prosser Dams, Ball repeated his proposal of additional storage for fish:

> As a long range proposition it is suggested that fish interests take steps to secure a storage contract for a certain amount of water which might be used during period of low flow to maintain certain amounts of water at critical points (Superintendent to Regional Director; 26 April 1944).

Additional storage for instream flows had apparently become a regular item of discussion. In March, 1945, Ball made the same proposal:

> With respect to the long range problem, I feel that fish interests should make arrangements to secure a water supply from any future storage development. Such water could be used or held for the purpose of fish protection as they might direct (Ball to Banks; 20 March 1945).

By the end of the 1940's, Reclamation was actively reviewing the Yakima Basin for any conceivable storage site. Over the years, many storage sites had been proposed. Now, a serious assessment of the potential storage at each site was undertaken. In 1951, Reclamation released a preliminary report that evaluated 21 storage sites (USBOR 1951). Based on this

report, Reclamation initiated a detailed study of the enlargement of Bumping Lake. Included in this planning process was specific provisions for instream flows. For the first time in the Yakima River Basin, instream flows would be part of the basic planning process for a storage reservoir.

In 1956, Reclamation released the first Bumping Lake Enlargement report. Most of the new storage would be dedicated to providing instream flows. New fish passage facilities at various locations were also included in the proposal, based on recommendations from the Fish and Wildlife Service and Washington Departments of Fisheries and Game (Bureau Of Reclamation 1956). These recommendations reflect the fact that the then-existing fish passage facilities were not only outdated, but ineffective. But despite all the planning and recognized need for instream flows, and the realization that additional storage was the least painful way of providing for such flows, nothing came of this planning effort as the 1950's came to a close. The level of instream flows in the Yakima River Basin remained basically at the whim of Reclamation.

Status Of Irrigation Development In 1960

By the end of the 1950's, irrigation development in the Yakima River Basin approached its current level. Both the

Roza and Kennewick Divisions were nearly complete, and all major facilities that now constitute the federal Yakima Project were operational. Total irrigated acreage in the Yakima River Basin in 1955 was approximately 425,000 acres (Bower 1990).

Project operations and water management had changed little since the completion of the last storage reservoir in 1933. The reservoirs were operated to store water during the non-irrigation season and during high run-off periods in the spring. Water was released only for irrigation deliveries or, on relatively rare occasions, flood control. Both federal hydropower facilities, Roza and Chandler, were on-line and diverted available water for power production.

By the late 1950's, the Yakima Project had reached a stable annual cycle of operation for the storage and delivery of water for irrigation in the Yakima River Basin. Salmon were not considered a part of this operating regime.

CONTINUING DOMINANCE OF IRRIGATION AND SLIDE TO OBLIVION: 1960-1980

During the two decades of the 1960's and 1970's, the Yakima Project fairly hummed along, secure in the belief that irrigation was incontestably the dominant use of water in the Yakima River Basin. No major irrigation nor fish passage facilities were constructed during this period, which was characterized by: (1) routine operation of the storage and delivery systems for irrigation, (2) continuation of the planning process related to the proposed Bumping Lake enlargement, (3) continuing deterioration of the existing fish passage facilities, and (4) decline of the salmon runs and the extinction of the summer chinook and coho runs.

By the mid-1960's, Reclamation was busily up-dating the 1956 Bumping Lake Enlargement report, and issued the revised version as a joint report with the Fish and Wildlife Service in 1966. Additional fish production could be achieved if more water were available for flows:

> Fish production in the Yakima River system could be considerably increased by providing adequate

> transportation and rearing flows, improvement of construction of fish facilities, and proper development and management of the system. Under established irrigation and power rights, it is impossible to maintain the required flows . . . Hence, the only practical method of meeting fish requirements would be development of additional storage to maintain the required flows (Bureau of Reclamation, United States Fish and Wildlife Service 1966).

After further work and discussion, including a public hearing in Yakima in 1968, Bumping Lake Enlargement returned to hibernation in Reclamation files. For the second time, the concept of building additional storage for instream flows had been examined, determined feasible, and then faded into the mystical future. There was a way to provide water for instream flows, if only...

Several years later, Bumping Lake Enlargement was back on the planning table. In 1976, Reclamation and USFWS produced the third Bumping Lake Enlargement study, this time as a Joint Feasibility Report. This document took official notice that salmon runs were again declining in the Yakima River Basin:

> Salmonid populations are declining and probably will continue to decline because of chronic low water conditions coupled with near-lethal water temperatures in the Yakima River (Bureau of Reclamation, United States Fish and Wildlife Service 1976).

By then, the poor condition of many fish passage facilities could no longer be ignored:

> Some diversion dams in the Yakima River have fish facilities, but in several instances existing

> facilities do not operate properly (Bureau Of Reclamation, United States Fish and Wildlife Service 1976).

All of the large federal fish screens were approaching, or exceeded, 40 years of age.

The deteriorated condition of fish passage facilities in the Yakima River Basin was the subject of continuing correspondence over the years, as indicted by this inquiry from the Regional Director of Reclamation:

> As stated in your subject memorandum concerning the problem of debris at the Prosser Dam fish ladder, this fish passage facility, as well as those on other dams on the Yakima River, has been the subject of considerable correspondence for some time now. In order to get a better grasp of the problem, specifically on the four Bureau of Reclamation dams on the Yakima River, we are asking you to do the following:
>
> 1. Make an assessment of what is needed to make all passage facilities fully operable, and an estimate of the cost of doing this work.
>
> 2. Determine the cost to annually operate and maintain each of these fish passage facilities (Vissia to Project Superintendent; 16 December 1977).

Obviously, Reclamation was aware that the fish passage facilities were not being properly maintained and had deteriorated to the point that some were inoperable, and the remainder were ineffective in protecting juvenile and adult salmon. There is a wealth of correspondence in the record from the fisheries agencies pointing out these deficiencies. Despite these constant attempts by the fisheries agencies to generate some action to update the fish passage facilities,

it appears that Reclamation's only response was to include new fish passage facilities in each of the Bumping Lake Enlargement reports. No apparent separate efforts, such as requesting funding for this purpose as part of their annual budget cycle, were undertaken.

A complicating factor was that the U.S. Fish and Wildlife Service was still officially responsible for the maintenance of fish passage facilities at Reclamation dams, pursuant to the agreements of 15 February, 1935 and 6 January, 1958 (Meeting and Field Trip Summary; 30 November 1977). This led to confusion not only as to whose responsibility it was to perform specific maintenance on fish passage facilities, but which agency should request maintenance and construction funding (Project Superintendent to Regional Director; 30 November 1977). As in so many other situations, confusion was a perfect excuse for lack of action.

It is interesting to note that this very subject of funding for new fish passage was discussed during the field trip on 28 November 1977:

> Of probably greater concern to all present than the foregoing was a desire to rehabilitate the fish passage facilities for the entire river system of the Yakima Valley. Until now everyone was looking towards authorization of Bumping Lake Enlargement (Meeting and Field Trip Summary; 30 November 1977).

Three years later, in August, 1979, Reclamation released a Final Environmental Statement. Earlier that year, in April, Rep. Mike McCormick had introduced legislation, H.R. 3489, authorizing construction of an enlarged Bumping Lake. Although this bill was reported favorably to the full House in September, 1980, Congress adjourned before taking action. That was the end of the only legislation authorizing major additional storage in the Yakima River Basin for instream flows ever to progress to the floor of the House of Representatives.

With the end of the Bumping Lake legislation, the two decades ended with no authorization for storage for instream flows, and with no new fish passage facilities. The existing facilities had reached such a state of deterioration that they were little more than derelicts.

Status Of Salmon Runs In 1980

The salmon runs in the Yakima River Basin had entered the 1960-1980 decades at an estimated level of 19,000 returning adults (Bureau of Reclamation 1979). From this very modest peak, a little over 2% of their original abundance, the runs began a slide that carried through the entire two-decade period. This slide ended in oblivion for two Yakima River Basin salmon runs. Sometime during the 1970's, both summer

chinook and coho became extinct in the basin, joining sockeye in the dust-bin of history.

A remnant summer chinook run apparently existed into the early 1970's. The Washington Department of Fisheries conducted aerial spawning surveys between Union Gap and Granger from 1962 to 1970, after which the flights were discontinued. The average redd count was 12. No summer chinook redds have been observed since 1970, and summer chinook are now extinct in the Yakima River Basin (Northwest Power Planning Council 1989; 1991).

A remnant run of coho still existed into the mid-1970's. The National Marine Fisheries Service conducted coho spawning surveys on the upper Yakima River between Easton and Cle Elum until the mid-1970's, after which these surveys were discontinued (Doug Dompier; Personal Communication 1993). At some point in time over the next several years, coho slipped over the edge into oblivion. Native coho too, are now extinct in the Yakima River Basin (Bonneville Power Administration 1992).

By 1980, the total adult salmon returns to the Yakima River Basin were at or approaching an estimated 2,000 fish (Bureau of Reclamation 1987). This represents a reduction of over 80% from the peak reached in the late 1950's. Two runs,

summer chinook and coho had been irretrievably lost. After hanging on, waiting all those years for some relief from low flows and poor passage facilities, while humans debated whether it was cost-effective to add storage for instream flows, they simply slipped off the face of the earth. It is doubtful that anyone noticed their passing at the time . . . but the river noticed, and so did Speelyi.

The Final Blow

One of the major contributing factors to the decline of the runs in general during the 1970's, and the demise of summer chinook and coho, was the extremely poor flow conditions in the lower Yakima River due to irrigation diversions and below average precipitation in 1973, 1977, and 1979. These were the most critical years of low water since the early 1940's.

Flow conditions were so poor in 1977, with extended periods having essentially no flow below Sunnyside Dam, that adult spring chinook were trapped at Horn Rapids Dam and transported by truck and released in the river at Yakima. A total of 202 adults were thus transported (Meekin to Radach; n. d.).

Concern for the survival of the downstream migrants resulted in trapping of the juvenile smolts at the outfall of the

fish screen by-pass pipe at below Sunnyside Dam. Over 40,000 spring chinook and over 13,000 steelhead smolts were captured and transported by truck to below Horn Rapids Dam (Meekin to Radach; 21 June 1977).

By the end of the decade, the remaining salmon runs in the Yakima River Basin were hanging by the barest of threads. The author clearly remembers conducting a spawning survey for spring chinook redds in the Yakima River below Easton in the fall of 1979. A total of 49 redds were counted. If salmon were to have any future in the Yakima River Basin, corrective action was needed immediately.

FROM THE BANKS OF THE YAKIMA RIVER, TO FEDERAL COURT, TO THE HALLS OF CONGRESS: 1980-1995

By 1980, events unfolding along several lines would have significant impact on both irrigation development and salmon resources in the Yakima River Basin. These include, in chronological order, (1) the initiation of water rights adjudication in the Yakima River Basin in 1977; (2) Congressional authorization of the Yakima River Basin Water Enhancement Project study (P.L. 96-162) in 1979; (3) the decision of Judge Justin Quackenbush in Federal District Court in Spokane in November, 1980; and (4) Congressional passage of the Pacific Northwest Electric Power Planning and Conservation Act (P.L. 96-501) in December of 1980 (Northwest Power Act).

I will review these activities in the approximate order in which they affected irrigation and salmon resources in the Yakima River Basin.

The Quackenbush Decision

The decision by Judge Quackenbush had the most immediate impact on irrigation water management and salmon protection. The loss of incubating salmon eggs and fry caused by closure of the reservoir gates at the end of the irrigation season had never been resolved, even though this issue had been raised on several occasions over the previous five decades. Management of the reservoir releases in 1980 remained basically the same as it had since the completion of Cle Elum Dam in 1933. The release of irrigation water during September caused unnaturally high flows in the Cle Elum and upper Yakima Rivers, which drew the spring chinook to shallow spawning areas along the edge of the stream. When the irrigation season was over in October, the gates were closed, drastically reducing the flows in the spawning areas. As a result, many redds were dewatered and the eggs and fry lost.

On October 12, 1980, I participated in a spring chinook spawning survey on the Yakima River below Cle Elum. At the time the survey was being conducted, Reclamation was in the process of closing the gates at the reservoirs and the river flow had decreased from over 2,000 c.f.s. to approximately 600 c.f.c. At that flow, redds were beginning to become dewatered, and further flow reductions would jeopardize some

60 redds that were recorded in this section of river. Reclamation was contacted from the field and requested to maintain the flow at that level in order to protect the redds while more detailed discussions were held to resolve the matter.

In the days following, there ensued several highly charged and emotional meetings between the fisheries agencies, including the Yakama Indian Nation, Reclamation, and irrigation district officials. The fisheries officials requested incubation flows sufficient to protect the eggs and fry in the redds. Reclamation and the irrigation districts, with the water-short years of 1973, 1977, and 1979 fresh in their minds, refused the request.

The impasse led to a request by the Project Superintendent, who had also been appointed Federal Watermaster by the Federal District Court during the 1977 drought, for instructions under its continuing jurisdiction in Kittitas Reclamation District vs. Sunnyside Valley Irrigation District. It was this case that had produced the "1945 Consent Decree" which determined the manner Reclamation delivered water to the various irrigation districts.

Hearings were held in October and November at which the United States, the irrigation districts, and the Yakama

Indian Nation laid out the basic facts and positions. At the end of the second hearing, the Court held that the Treaty rights of the Yakama Indian Nation required the protection of the redds, and that Reclamation must maintain sufficient flow to protect the redds during the present incubation season. In addition, Reclamation must operate the irrigation project in the future in such a manner that spring chinook redds are protected.

After decades of simply closing the reservoir gates at the end of each irrigation season, without regard for the salmon, Reclamation was finally constrained from this wanton destruction. Salmon, finally, did have at least minimal rights to protection in the Yakima River Basin from the impacts of irrigation development. This was the first recognition that the river existed for reasons other than to fill irrigation ditches.

From this beginning, Reclamation, the irrigation districts, and the fisheries agencies have perfected the "flip-flop" operation, which allows the delivery of irrigation water while at the same time protecting the spring chinook redds in the upper Yakima River and Cle Elum Rivers. Looking back on this situation, there was nothing preventing the development of this operational modification when the problem was first identified in the 1930's, other than the insistence by

Reclamation that every drop of water was irreversibly committed to irrigation. One can only speculate on the amount of damage to the salmon runs that could have been avoided with only the slightest willingness to cooperate.

Northwest Power Act

In 1980, Congress passed the Northwest Electric Power and Conservation Planning Act (Northwest Power Act), P.L. 96-501, which initiated the formation of the Northwest Electric Power and Conservation Planning Council (Northwest Power Planning Council; NPPC). Under the Northwest Power Act, the NPPC was required to develop and implement a plan to "protect, mitigate, and enhance" the fish and wildlife of the Columbia River Basin that had been affected by the development of hydroelectric dams (Section 4(h), P.L. 96-501). Provisions of the Act allowed "off-site mitigation" in areas not directly affected by hydroelectric development (Figures 16, 17, 18).

During 1981 and 1982, the NPPC developed the Columbia River Basin Fish and Wildlife Program, which was adopted on 15 November 1982. Section 900 of this program addressed the need for new fish passage facilities:

> The Council adopts recommendations from the fish and wildlife agencies and tribes to correct structural problems at irrigation diversion dams, canals, and ditches that interfere with the passage of anadromous fish (Northwest Power Planning Council 1982).

The long-standing coupling of Bumping Lake Enlargement and new fish passage facilities in the Yakima River Basin was finally broken.

The fisheries agencies, Yakama Indian Nation, Bonneville Power Administration (BPA), and Reclamation moved quickly to implement this element of the NPPC's Fish and Wildlife Program. By mid-1983, a Yakima Basin Fish Passage Technical Advisory Group was formed and began the design and construction process.

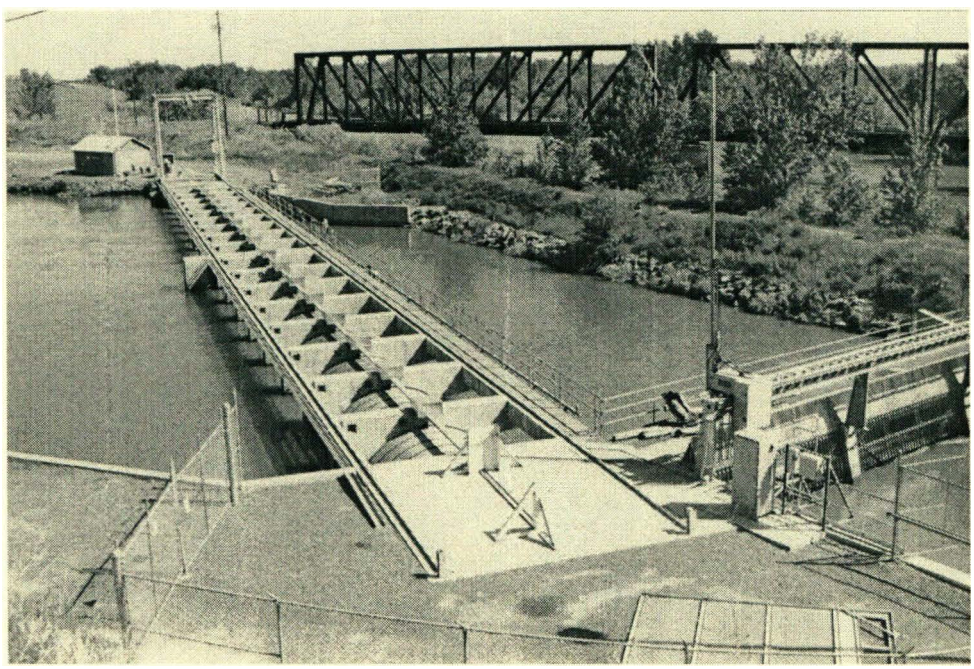


Figure 16. New Sunnyside Canal fish screens, placed in operation in 1985, 50 years after the original fish screens.

To get the construction program off the ground, BPA committed to funding new fish screens in the Sunnyside Canal. In October, 1984, a few months short of 50 years after the dedication ceremony at the original fish screens at Sunnyside Canal, a ground-breaking ceremony was held on the banks of the Yakima River next to Sunnyside Dam to properly mark the beginning of construction of the new fish passage facilities. They had been a long time coming.

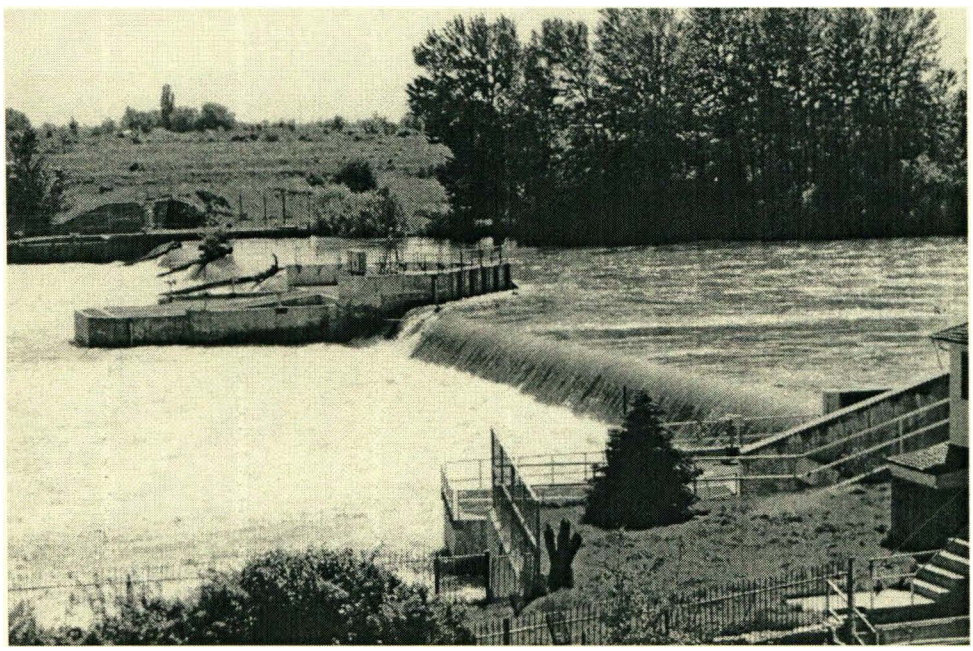


Figure 17. New fish ladders at Sunnyside Dam, left bank (nearest the camera), center, and right bank

By 1990, all of the major diversion dams and canals in the Yakima River Basin were equipped with new fish passage facilities, at a cost of approximately $60 million. The

construction program then moved on to the "Phase II" list, which had been included by the NPPC in the revised 1987 Columbia River Fish and Wildlife Program. The Phase II list includes the replacement of over 60 screen facilities, mostly on private canals and ditches that had been built and maintained by the Department of Fisheries (Bureau of Reclamation 1990).

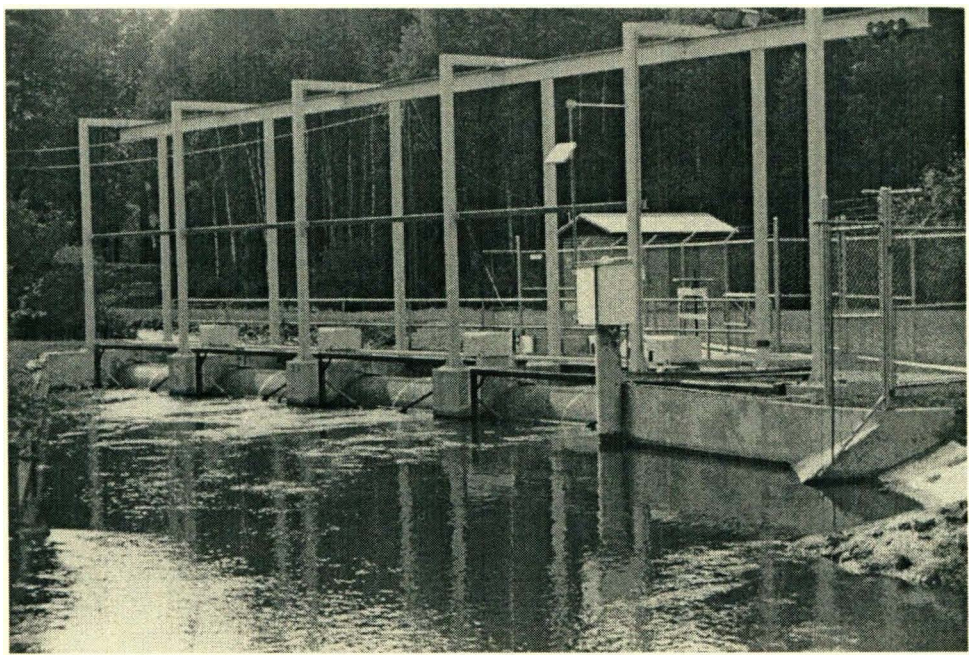


Figure 18. Taneum Ditch fish screens. This diversion operated approximately 120 years without fish screens.

Construction of the Phase II list is still in progress and will continue through the year 2000. To date, approximately 15 of the Phase II screen facilities have been completed.

Yakima Basin Water Adjudication

In November, 1977, prompted by the serious water shortage during the summer, the Washington State Department of Ecology filed a general stream adjudication in Yakima County Superior Court, State of Washington, Department of Ecology vs. James J. Acquavella et al. The purpose of this filing was to adjudicate all of the surface water rights in the Yakima River Basin, including the Treaty reserved rights of the Yakama Indian Nation for instream flows, based on its reserved right to fish at all "usual and accustomed places" as intended by Kamiakin, Skloom, Owhi, Tuckquille, and the other Yakama signers of the Treaty.

Although the case is continuing, and every indication is that it will continue for many more years, a decision handed down by the Court in 1990 bears directly on the future of salmon in the Yakima River Basin. That decision found that the Treaty-reserved right for instream flows had been "substantially diminished" and that:

> The maximum scope of the diminished treaty water right for fish remaining is the specific 'minimum instream flow' necessary to maintain anadromous fish life in the river, according to the annual prevailing conditions as they occur (Amended Partial Summary Judgement; 29 November 1990).

Although this obviously leaves a lot of unanswered questions, such as the level of anadromous fish runs to be protected, it nevertheless established a senior water right

for some level of instream flows to protect salmon at all life stages in those streams controlled by federal irrigation project facilities. This includes sufficient water for the migration of juvenile salmon through the lower Yakima River, the focus of a recent ruling by the Court that upheld the use of water for "flushing flows" during the spring of 1994 to assist juvenile migration.

Much remains unresolved in the Acquavella proceedings with respect to the extent of the Treaty-reserved right for instream flows. However, aggressive implementation of this ruling does offer the prospect of providing some level of instream flows for the protection of salmon in the majority of the Yakima River Basin. If it survives attempts by the irrigation districts to weaken its application and implementation, it is a significant step forward in the protection of salmon in the Yakima River Basin.

Yakima River Basin Water Enhancement Project

Passage of P.L. 96-162 in 1979 set in motion a long review and study of water resources in the Yakima River Basin by Reclamation, with cooperation and assistance from the State of Washington and the Yakama Indian Nation. The focus of this study was the reliability of water supplies for currently irrigated areas, and providing water for instream flows. During the 1980's, a number of attempts were made to

transform recommendations based on this study into legislation that would authorize new storage and water conservation programs. None of these attempts were successful.

After the failed attempt in 1988 that included major storage projects and other significant elements, efforts shifted to a more modest proposal that concentrated on water conservation and improvements to existing irrigation systems. Introduced as separate legislation by Rep. Jay Inslee in 1993, it was passed as Title XII of P. L. 104-434 in October, 1994.

Title XII includes a number of significant elements affecting both irrigation and instream flows. It is also notable for what it does not include. Many people in the irrigation community were disappointed by the fact that Title XII did not contain authorization for any major new storage construction. Title XII does, however, provide the means for upgrading irrigation systems in the Yakima River Basin, many of which are now outdated and inefficient.

Title XII also includes several elements that will benefit salmon as implementation progresses. These elements include:

(1) Specific instream flow levels below Sunnyside and Prosser Dam.

(2) Sixty-five percent of the irrigation water saved through implementation of water conservation measures will be returned to instream flows.

(3) An increase of approximately 15,000 acre/feet in the storage capacity of Cle Elum Dam to be dedicated to instream flows.

(4) Authorization for fish passage at Cle Elum Dam.

(5) Electrification of the hydropumps at Chandler Powerhouse.

(6) Authorization for a program to acquire water for instream flows on tributary streams.

After decades of seeking Congressional passage of legislation that would provide instream flows and new fish passage facilities in the Yakima River Basin in a single package, the last fifteen years produced means of achieving these goals through several different mechanisms. Taken together, these should provide much of what was contemplated in the packages that focused on Bumping Lake Enlargement. New fish passage has been constructed under the auspices of the Columbia River Basin Fish and Wildlife Program, adopted by the Northwest Power Planning Council pursuant to the Northwest Power Act. Instream flows for salmon have become part of the operation of the federal irrigation project due to: (1) the decision of Judge Quackenbush in Federal District Court; (2) the 1990 Amended Partial Summary Judgement issued by Judge Walter Stauffacher in the on-going Acquavella water adjudication proceedings; and (3) implementation of Title XII of P.L. 104-434, passed by Congress in October, 1994.

The future does look brighter for salmon in the Yakima River Basin, but only by comparison to a time when it could scarcely be more dim. Court decisions and legislation offer hope, but success, in terms of salmon restoration, is far from certain. Specific actions taken pursuant to Judge Stauffacher's decisions may be challenged. Irrigation interests still have no sympathy for the necessary instream flows, which was again demonstrated in the spring of 1994 when they attempted to halt further releases of water for migration flows in the lower Yakima River. Implementation of Title XII will take time, energy, and determination, and is dependent on far from certain future annual Congressional appropriations. Despite these uncertainties and caveats, we have come a long way in addressing the Yakima River Basin's water and fisheries problems over the last fifteen years.

Status Of Salmon Runs In 1995

With so much activity and energy devoted to the recovery of salmon runs in the basin over the last fifteen years, the appropriate ending would be to report that salmon were making a strong comeback. Alas, such is not the case.

Both spring chinook and steelhead runs did markedly increase through the early and mid-1980's. Spring chinook returns peaked at approximately 9,300 fish in 1986, and then held fairly steady at 3,000-5,000 for several years. Unfortu-

nately, returns have plummeted over the last two years, and less than 700 fish are expected in 1995. As of 24 May only 464 have been counted at Prosser Dam.

Steelhead runs peaked at approximately 2,800 fish in 1988, but then entered an almost un-interrupted decline, reaching a low point of only 555 fish in 1994. An increase to slightly over 900 fish in 1995 would seem, at first glance, to be a hopeful indication of recovery. However, even this increase is deceptive, as the recent run was less than 50% of the numbers of adults that produced the 1995 returns. In addition, the numbers of steelhead smolts leaving the basin have been very low, 40,000 or less, for several years.

Waiting in the wings is a decision by the National Marine Fisheries Service whether or not to list steelhead as threatened or endangered under the Endangered Species Act of 1973, as a result of a petition that was filed in February, 1994. The future of steelhead in the basin appears uncertain, at best.

A number of low-water years over the past decade, culminating in record drought conditions in 1994, have caused poor migration conditions in the lower Yakima River during the spring outmigration period. These conditions have undoubtedly contributed to the declines in spring chinook and

steelhead returns. Regardless of the exact causes, the status of spring chinook and steelhead runs in 1995 is little, if any, improved over their status in 1979.

CONCLUSION

After reviewing the history of irrigation development in the basin and the deleterious impacts that this development had on the salmon resources, what conclusions can we draw? What lessons have we learned? How can we use these lessons to improve our resource management and allocation decisions in the future?

It would be easy, after reviewing the record, to simply conclude that the irrigation interests were primarily responsible for the destruction of the salmon runs in the basin. The demise of this valuable resource was a natural result of their single-minded pursuit of turning semi-arid portions of the basin into irrigated farmland, which they carried out with no regard for other resources, or other people.

Based on the record, I believe that the irrigation interests, including Reclamation, do indeed bear much of the responsibility for the destruction of the salmon runs in the basin. They <u>did</u> pursue irrigation without regard for other

resources, and other people. But as with most resource issues, the full truth is much more complex.

The development of irrigation in the basin was no different from the general pattern of Euroamerican development across much of the West. A number of resources were being exploited on a large scale without regard for conservation or proper management, including water, land, forage, timber, minerals, and wildlife. To put Yakima Basin irrigation development in proper perspective, it was not inconsistent with resource development and exploitation throughout the West.

Irrigation development in the basin is an example of "geographic preemption," as water, originally under the control of the Tribes and Bands that now constitute the Yakama Indian Nation, was, over time, transferred to Federal and state control for the purpose of agriculture (Bower 1990). Such transfers of resources from Native Americans to Euroamericans has also been common in much of the West.

I believe the real failure, in terms of protecting the salmon runs, lies with the very agencies charged with this responsibility--the state and federal fisheries agencies. Going one step further, the ultimate failure lies with the

public and their elected officials, who did not take effective steps to arrest the destruction of this resource.

An early example of the failure of public officials to vigorously protect the salmon is a 1910 opinion by Washington State Attorney General W. P. Bell. This opinion directly addressed the question of providing fish passage at federal irrigation facilities in the Yakima Basin:

> Under the law the government of the United States is not exempted from the construction of such fish ladders by the mere fact that the legislature of the state authorized the government to appropriate certain waters and the shores and beds of certain streams to create reservoirs for use in reclamation projects. But the legislature can expressly or by clear implication make exceptions to the general rule, and in my judgement it can be clearly implied that the legislature did not intend that the United States government should be in any manner embarrassed in the carrying out of its large reclamation projects, as there seems to be no condition as to the fish or intimation that the fish are in any manner to be protected in the construction of these works. The law is certainly broad enough to permit the government to store and use all of the water in any stream . . . (Washington State 1911; emphasis added).

Is it any wonder that Reclamation and the irrigation interests believed that they had a completely free hand with respect to using the water of the basin for agriculture, and need give no consideration to protecting the salmon?

Davidson (1953) also noted the broad failure of the Federal and state governments to protect salmon resources, citing as one reason for the decline:

> The general disregard by the State of Washington and the Federal Government to the wholesale destruction of the fish populations in the river system.

Bollman (1971) examined the decline of salmon in the Columbia Basin in detail. He noted several reasons for the decline in tributaries such as the Yakima, all of which basically point to the failure of the public and fishery agencies to protect the salmon:

> In the mid-1930's, the depleted state of the anadromous fishery resources in the tributary areas of the Columbia are attributed to:
>
> (1) The single-purpose commitment of interests concerned only with industrial development.
>
> (2) The over-appropriation of stream flows.
>
> (3) Improperly constructed fish passage facilities.
>
> (4) Lack of support by the public in enforcing fish protection laws.
>
> (5) The granting of permits for uses of water which destroyed large segments of the fishery.
>
> The public indifference, if not acquiescence, to the destruction of habitat and small fish was as much to blame as for the depletion of the fishery resources as the oft-cited "over-exploitation" by the fishing industry.

When assessing responsibility for the decline of the salmon in the Yakima Basin, it is clear that "public indifference" played a large role. Who is responsible? There are exceptions, to be sure, but generally the answer is--everyone: sport and commercial fishermen, the fishing industry,

state legislators, Congressmen, state and Federal fishery agencies, and the general public.

And we should not forget the Bureau of Indian Affairs, whose fiduciary responsibility is to protect the Treaty Rights of the Yakama Indian Nation. Where were they when the salmon runs were being destroyed? For a quarter century, they operated one of the primary killers of salmon in the Yakima Basin. In many instances, they aided and abetted those who were destroying the (supposedly) Treaty-protected salmon resource. The abject failure of the Bureau of Indian Affairs to protect the salmon runs would be a fertile subject for further investigation.

In the final analysis, the failure to protect the salmon runs in the Yakima Basin was a failure of society to properly protect a major non-human population and a valuable resource, as well as a failure to properly protect the interests of all those who depended upon the salmon. We all bear the responsibility to make every effort to ensure that such a failure does not happen again.

For a final observation, I defer to Kai Lee, former member of the Northwest Power Planning Council, whose comment concerning salmon in the Columbia River is equally valid for the salmon in the Yakima River Basin:

> The Columbia is no longer a natural river. The well-being of the ecosystem and its component species depends upon human understanding and action. Yet human management is hampered by the multiplicity of the Columbia's riches. Each of the major uses of the basin's resources is managed by a different constellation of human institutions . . . Multiple management of multiple uses produces a tragedy of the commons. The salmon dwindle or perish.
>
> The Columbia basin has been trapped rather than domesticated; it responds to human dictate, but it does not flourish. Its salmon are bred, transported, and caught under the supervision of human managers. The control exerted by those managers is limited; they cannot determine weather or ocean conditions, nor can they extirpate the diseases and animal predators that compete for the salmon. But we no longer have a choice whether to manage the salmon or not; we have only the choice whether to manage well--and, if we choose, to learn how to do better over time (Lee 1993).

May we manage wisely and with reverence.

LITERATURE CITED

Abbreviations used:

NADC: National Archives, Washington, D. C.

UWL-MUAD: University of Washington Libraries-Manuscripts and University Archives Division. Seattle, Washington.

WSTAR-Washington State Archives, Olympia, Washington.

Reports, Books, and Journals

Andrew, F. J., and G. H. Geen. 1960. Sockeye And Pink Salmon Production In Relation To Proposed Dams In The Fraser River System. Bulletin XI. International Pacific Salmon Fisheries Commission. New Westminister, B.C. 259 pp.

Anonymous. Mid-Columbia Affidavits. 1942. Unpublished Manuscript.

Anonymous. "Report In Regard To The Location Of the Great Falls Fishway". no date. Unpublished Report. NADC.

RG-22. E-41. Box 1. Records Concerning Fishways At The Great Falls Of The Potomac River: 1894-1895. 3 of 3.

Babcock, W. A., T. E. Echert, and G. D. Williams. 1986. Yakima River Basin Historical Resource Survey: Overview and Management Recommendations. Heritage Research Center. Missoula, Montana. 351 pp.

Baker, S. and U. B. Gilroy. 1928. Preliminary Report to Honorable Henry O'Malley, Commissioner of Fisheries, Washington, D.C. On Investigation of Methods and Means of Conserving Fish Life by Means of Proper Fish Screens and Fish Ladders. San Francisco, California. 23 pp. NADC. RG-22. E-269. Box 708.

Baker, S. and U. B. Gilroy. 1930. Progress Report To The Honorable Henry O'Malley, Commissioner of Fisheries, Washington, D.C. On The Investigation of Methods and Means of Conserving Fish Life by Means of Proper Fish Screens and Fish Ladders For the Period December 1, 1929 to December 31, 1929. San Francisco, California. 47 pp. WSTAR. RG-64. Department of Fisheries. 73-7-675. Box 1010-30. Fish Facilities: Fish Screens 1930-39.

Baker, S. and U. B. Gilroy. 1932. Progress Report for 1931 To The Honorable Henry O'Malley, Commissioner of Fisheries,

Washington, D.C. On The Investigation of Methods and Means of Conserving Fish Life by Use of Proper Fish Screens and Fish Ladders. San Francisco, California. 23 pp.

Bell, M. C. 1995. Personal Communication. Interview, 25 January, 1994. Seattle, Washington.

Boening, R. 1918; 1919. "History of Irrigation in the State of Washington." Washington Historical Quarterly. IX:259-276; X:21-45.

Bollman, F. G. 1971. River Basin Development and the Management of Anadromous Fisheries: An Economic Analysis of the Columbia River Experience. Ph. D. Dissertation. University of California-Berkeley. 793 pp.

Bonneville Power Administration. 1992. Yakima River Basin Fisheries Project--Draft Environmental Impact Statement. Portland, Oregon.

Bonneville Power Administration, Corps of Engineers, Bureau of Reclamation. 1994. Columbia River System Operation Review: Draft Environmental Impact Statement-Appendix C-1: Anadromous Fish. Portland, Oregon. 276 pp.

Bower, J. A. 1990. The Hydrogeography of Yakima Indian Nation Resource Use. Ph. D. Dissertation. University of Washington. 551 pp.

Brannon, E. M. 1929. Work Logs-Yakima River Basin Irrigation Evaluations. Washington Department of Fisheries. Unpublished Report. Olympia, Washington.

Brown, B. 1982. Mountain in the Clouds: A Search for the Wild Salmon. Simon and Schuster. New York. 239 pp.

Bryant, F. G., and Z. E. Parkhurst. 1950. Survey of the Columbia River and its Tributaries-Part IV. United States Fish and Wildlife Service. Special Scientific Report: Fisheries Number 37. Washington, D.C.

Bureau of Reclamation. 1925. Reports on the Engineering, Agricultural, and Economic Feasibility of the Kittitas Division, Yakima Project, Washington, et al. Washington, D. C.

Bureau of Reclamation. 1929. Yakima Project--Storage At Cle Elum Site. Unpublished Report. BOR Files-Denver.

Bureau of Reclamation. 1951. Interim Report on Supplemental Storage, Yakima Project, Washington. Boise, Idaho.

Bureau of Reclamation. 1956. Yakima Project, Washington: Supplemental Storage. Boise, Idaho. 146 pp.

Bureau of Reclamation. 1979. Final Environmental Statement: Proposed Bumping Lake Enlargement. Boise, Idaho. 178 pp.

Bureau of Reclamation. 1980. Yakima Project, Washington: Benton, Yakima, and Kittitas Counties. Washington, D.C. 20 pp.

Bureau of Reclamation. 1984. Fish Passage and Protective Facilities Yakima River Basin, Washington: Interim Predesign Report to Bonneville Power Administration. Boise, Idaho. 30 pp.

Bureau of Reclamation. 1990. Fish Passage and Protective Facilities, Phase II, Yakima River Basin, Washington. Boise, Idaho.

Clay, C. H. 1961. Design of Fishways and Other Fish Facilities. Department of Fisheries of Canada. Ottawa. 201 pp.

Cobb, J. N. 1922. "Protecting Migratory Pacific Salmon". Transactions of the American Fisheries Society. 52:146-153.

Cone, J. 1995. A Common Fate: Endangered Salmon and the People of the Pacific Northwest. Henry Holt and Company. New York, New York. 340.

Coulter, C. B. 1951. "The Victory of National Irrigation In The Yakima Valley, 1902-1906." The Pacific Northwest Quarterly. 4(2):99-122.

Craig, J. A., and R. L. Hacker. 1940. The History and Development of the Fisheries of the Columbia River. U.S. Bureau of Fisheries, Bulletin No. 32. Washington, D.C. 216 pp.

Crammond, D. 1995. Screening Water Diversions: A Survey of Policy, Practices, and Compliance in the Pacific Northwest. Study Paper # 6. Northwestern School of Law of Lewis and Clark College. Portland, Oregon. 35 pp.

Cutright, P. R. 1969. Lewis and Clark: Pioneering Naturalists. University of Nebraska Press. Lincoln, Nebraska. 506 pp.

Davidson, F. A. 1953. The Development of the Yakima River Basin for Irrigation and its Effect on the Migratory Fish Populations in the River. Unpublished Manuscript. 17 pp.

Decker, L. F. 1967. Fishways In Maine. Maine Department of Inland Fisheries and Game. Augusta, Maine. 47 pp.

Dompier, D. 1993. Personal Communication. 4 August 1993.

Fast, D., J. Hubble, D. Watson. 1988. Yakima River Spring Chinook Enhancement Study-Annual Report FY 1987. Bonneville Power Administration. Project Number 82-16. Portland, Oregon. 101 pp.

Fast, D., J. Hubble, M. Kohn, and B. Watson. 1991. Yakima River Spring Chinook Salmon Enhancement Study-Final Report. Bonneville Power Administration. Project Number 82-16. Portland, Oregon. 345 pp.

Fulton, L. A. 1968. Spawning Areas and Abundance of Chinook Salmon (Oncorhynchus tshawytscha) in the Columbia River Basin-Past and Present. Untied States Fish and Wildlife Service. Special Scientific Report-Fisheries Number 571. Washington, D.C. 26 pp.

Fulton, L. A. 1970. Spawning Areas and Abundance of Steelhead Trout and Coho, Sockeye, and Chum Salmon in the Columbia River Basin-Past and Present. United States Fish

and Wildlife Service. Special Scientific Report-Fisheries Number 618. Washington, D.C. 37 pp.

Gilroy, U. B. 1932. A Report On Status Of Fish Protection Works On Certain Federal Irrigation Projects In The Northwest. Unpublished Report. 14 pp. NADC. RG-22. E-269. Box 707. Yakima Watershed and Cle Elum Dam.

Hanes, R. C. 1995. Draft American Indian Interests in the Northern Intermontane of Western North America: Social Assessment Report for the Interior Columbia Basin Ecosystem Management Project. Interior Columbia Basin Ecosystem Management Project Office. Walla Walla, Washington. 136 pp.

Highsmith, Jr. R. M. 1946. Irrigation Agriculture in the Yakima Valley. M.A. Thesis. University of Washington. 75 pp.

Hoggatt, H. O. 1928a. Work Logs-Yakima River Basin Irrigation Evaluations. WSTAR. Fisheries. 68-A-92. Stream Improvement. Box 747. Yakima River-1920-34.

Hoggatt, H. O. 1928b. Congdon Ditch Revolving Screen Report. Unpublished Report. WSTAR. Fisheries. 68-A-92.Stream Improvement. Box 747. Yakima River-Congdon Ditch-1928.

Holmes, H. B. 1948. History, Development, and Problems of Electric Fish Screen. United States Fish and Wildlife Service. Special Scientific Report No. 53. Washington, D.C. 62 pp.

Hubble, J. D. 1992. A Study of the Summer Steelhead, Oncorhynchus mykiss, in Several Intermittent Tributaries of the Satus Creek Basin, Washington. M. S. Thesis. Central Washington University. 78 pp.

Hunn, E. S. 1990. Nch'i-Wana "The Big River" Mid-Columbia Indians and Their Land. University of Washington Press. Seattle, Washington. 378 pp.

International Pacific Salmon Investigation Federation. 1929. Transcript of Meeting. NADC. RG-22. E-42. Box 4. Records Concerning Societies, Groups, and Councils: 1904-1937. 2 of 4.

Jayne, S. O. 1907. Irrigation in the Yakima Valley, Washington. United State Department of Agriculture. Bulletin Number 188. Washington, D. C. 85 pp.

Kuhler, J. B. 1940. A History of Agriculture in the Yakima Valley, Washington from 1880 to 1900. M. A. Thesis. University of Washington. 135 pp.

Leach, G. C. 1921. "Fish Culture in Connection with the Irrigation Projects. Reclamation Record. 11(8):376-379.

Lee, K. N. 1993. Compass And Gyroscope: Integrating Science And Politics For The Environment. Island Press. Washington, D.C. 243 pp.

Libby, A. C. 1913. Report on Hydrographic Survey of Yakima River Watershed. Bureau of Reclamation. Unpublished Report. North Yakima, Washington. 63 pp.

Lichatowich, J. A., and L. E. Mobrand. 1995. Analysis of Chinook Salmon in the Columbia River From an Ecosystem Perspective. Prepared for: Bonneville Power Administration. Contract No. DE-AM79-92BP25105. Portland, Oregon. 102 pp.

Locati, J. T. 1979. "Walla Walla County: A Cradle of Horticulture." Pacific Northwest Forum. 4(2):2-15.

Lufkin, A. (Ed.) 1991. California's Salmon and Steelhead: The Struggle to Restore an Imperiled Resource. University of California Press. Berkely, California. 305 pp.

Lyman, W. D. 1919. History of the Yakima Valley, Washington. Vol. 1. S. J. Clarke Publishing Company. 954 pp.

Major, R. L. and J. L. Mighell. 1969. "Egg-to-Smolt Survival of Spring Chinook Salmon (Oncorhynchus tshawytscha) in the Yakima River, Washington". Fishery Bulletin. 67(2):347-359.

Matheson, S. M. 1991. "Future Water Issues: Confrontation or Compromise." Journal of Soil and Water Conservation. March-April, 1991.

McDonald, M. 1895. The Salmon Fisheries of the Columbia River Basin. United States Fish Commission. Bulletin XIV:153-168.

Meinig, D. W. 1968. The Great Columbia Plain. University of Washington Press. Seattle, Washington. 576 pp.

Mongillo, P., and L. Faulconer. 1980. Yakima Fisheries Enhancement Study Final Report. Washington State Department of Game. Contract No. 7-07-10-S0038.

Mullan, J. W. 1983. Overview of Artificial and Natural Propagation of Coho Salmon (Oncorhynchus kisutch) on the

mid-Columbia River. United States Fish and Wildlife Service. Report Number FRI/FAO-84-4. Leavenworth, Washington. 37 pp.

Nehlsen, W., J. E. Williams, and J. A. Lichatowich. 1991 "Pacific Salmon at the Crossroads: Stocks at Risk from California, Oregon, Idaho, and Washington." Fisheries. 16(2):4-21.

Netboy, A. 1958. Salmon of the Pacific Northwest: Fish vs. Dams. Binfords and Mort. Portland, Oregon. 122 pp.

Northwest Power Planning Council. 1982. Columbia River Basin Fish and Wildlife Program. Portland, Oregon. 104 pp.

Northwest Power Planning Council. 1986. Compilation of Information on Salmon and Steelhead Losses in the Columbia River Basin. Appendix D of the 1987 Columbia River Basin Fish and Wildlife Program. Portland, Oregon. 252 pp.

Northwest Power Planning Council. 1987. Columbia River Basin Fish and Wildlife Program. Portland, Oregon. 246 pp.

Northwest Power Planning Council. 1989. Draft Yakima River Subbasin Salmon and Steelhead Plan. Portland, Oregon. 228 pp.

Northwest Power Planning Council. 1990. Wenatchee River Subbasin: Salmon and Steelhead Production Plan. Portland, Oregon. 122 pp.

Northwest Power Planning Council. 1991. Integrated System Plan for Salmon and Steelhead Production in the Columbia River Basin. Portland, Oregon. 526 pp.

Oregon State Board of Fish Commissioners. 1890. Fourth Annual Report. Salem, Oregon.

Oregon State Board of Fish Commissioners. 1892. Six Annual Report. Salem, Oregon.

Oregon State Fish and Game Protector. 1896. Third and Fourth Annual Reports of the State Fish and Game Protector. Salem, Oregon.

Parker, G. L. and F. B. Storey. 1916. Water Powers of the Cascade Range: Part III. The Yakima River Basin. United States Geological Survey. Water Supply Paper 169. Washington, D. C. 169 pp.

Pearson, H. E. 1985. Hydrology of the Upper Yakima River Basin, Washington. Washington Department of Ecology. Water Supply Bulletin 32. 219 pp.

Ray, V. 1936. "Native Villages and Groupings of the Columbia Basin." Pacific Northwest Quarterly. 27:99-152.

Reclamation Service. 1905. Annual Report. U.S. Department of Interior.

Reclamation Service. 1907. Annual Report. U.S. Department of Interior.

Reiser, D. W. and T. C. Bjornn. 1979. Habitat Requirements of Anadromous Salmonids. United States Forest Service. General Technical Report PNW-96. Portland, Oregon. 54 pp.

Rich, W. H. 1920. "Early History and Seaward Migration of Chinook Salmon in the Columbia and Sacramento Rivers." Bulletin of the Bureau of Fisheries. XXXVII:3.75.

Richards, K. D. 1993. Issac I. Stevens: Young Man in a Hurry. Washington State University Press. Pullman, Washington. 484 pp.

Robison, R. S. 1957. The Yakima River: Historical and Present Fishery. Washington Department of Fisheries. Unpublished Manuscript. 17 pp.

Schalk, R. F. 1986. "Estimating Salmon and Steelhead Usage in the Columbia Basin Before 1850: The Anthropological Perspective". The Northwest Environmental Journal. 2(2):1-25.

Smythe, W. E. 1969. The Conquest of Arid America. University of Washington Press. Seattle, Washington. 360 pp.

Stober, Q. J., M. R. Griben, R. V. Walker, A. L. Setter, I. Nelson, J. C. Gislason, R. W. Tyler, and E. O. Salo. 1979. Columbia River Irrigation Withdrawal Environmental Review: Columbia River Fishery Study. Prepared for: Department of the Army, Portland District, Corps of Engineers. Contract Number DACW57-79-C-0090. Portland, Oregon. 244 pp.

Uebelaker, M. L. 1986. Geographic Explorations in the Southern Cascades of Eastern Washington: Changing Land, People, and Resources. Ph. D. Dissertation. University of Oregon. Eugene, Oregon. 216 pp.

United States Army. 1984. Columbia River and Tributaries Study: Anadromous Fish Needs Assessment. CRT-58. Corps of Engineers. Portland, Oregon. 57 pp.

United States Army. 1993. Interim Columbia and Snake River Flow Improvement Measures for Salmon-Final Supplemental Environmental Impact Statement. Corps of Engineers. Walla, Washington. 556 pp.

United States Fish and Wildlife Service. 1956. Annual Report-Calendar Year 1956. Yakima Project Office Files.

United States Fish and Wildlife Service. 1960. Annual Report-Calendar Year 1960. Yakima Project Office Files.

United States House of Representatives. 1886. Fishways, Great Falls. Executive Document Number 272. NADC. RG-22. E-41. Box 1. Records Concerning Fishways At The Great Falls Of The Potomac River: 1884-1895. 3 of 3.

United States House of Representatives. 1892. The Executive Documents of the House of Representatives for the First Session of the Fifty-Second Congress. Report of the Secretary of the Interior. Washington, D. C.

United States House of Representatives. 1913. Report on the Condition of The Yakima Indian Reservation, Washington. Document Number 1299. 62n Congress-3d Session. Washington, D. C. 66 pp.

United States House of Representatives. 1950. Columbia River and Tributaries, Northwestern United States. House Document Number 531. Appendix P. 81st Congress, 2d Session.

Van Dyk, J. 1990. "Long Journey of the Pacific Salmon." National Geographic. 178(1):3-37.

Vandevere, E. K. 1948. History of Irrigation in Washington. Ph.D. Thesis. University of Washington. 263 pp.

von Bayer, H. 1910. Fishways. Bureau of Fisheries. Document No. 707. Washington, D.C. 14 pp.

Waller, O. L. 1904. A Report on Irrigation Conditions in the Yakima Valley, Washington. Washington State Agriculture College. Bulletin Number 61. Pullman, Washington. 29 pp.

Washington State Department of Fisheries and Game. 1904. Fourteenth and Fifthteenth Annual Report of the State Fish Commissioner. Seattle, Washington.

Washington State Department of Fisheries and Game. 1909. Eighteenth and Nineteenth Annual Reports of the State Fish Commissioner. Olympia, Washington.

Washington State Department of Fisheries and Game. 1911. Twentieth and Twenty-First Annual Reports of the State Fish Commissioner. Olympia, Washington.

Washington State Department of Fisheries and Game. 1913. Twenty-Second and Twenty-Third Annual Reports of the State Fish Commissioner. Olympia, Washington.

Washington State Department of Fisheries and Game. 1928. Thirty-Sixth and Thirty-Seventh Annual Reports of State Department of Fisheries and Game-Division of Fisheries. Olympia, Washington.

Washington Department of Fisheries. 1956. Yakima Rehabilitation Program: Evaluation of the Potential Salmon and Steelhead Production of the Yakima River to the Commercial and Recreational Fisheries and Report of Fish Facilities Required to Aid in the Development of the Potential Fishery Resources of the Yakima River Basin. Unpublished Rep. 146 pp.

Washington State Historical Society. 1940. Building A State: Washington 1889-1939. Vol. III.

Washington State. 1911. Report of the Attorney General-For the Period of Two Years Ending December 31, 1910. Olympia, Washington.

Whitfield, W. 1930. Work Logs-Yakima River Basin Irrigation Evaluations. Washington Department of Fisheries. Unpublished Report. Olympia, Washington.

Wilkinson, C. F. 1992. Crossing the Next Meridian: Land, Water, and the Future of the West. Island Press. Washington, D.C. 376 pp.

Worster, D. 1985. River of Empire: Water, Aridity, and the Growth of the American West. Oxford University Press. New York, New York. 402 pp.

Young, A. 1854. The Natural History And Habits Of The Salmon, With Reasons For The Decline Of The Fisheries. Longman, Brown, Green, and Longmans. London. 108 pp.

Correspondence

Letters, Memos, Telegrams

Acting Chief Engineer to Construction Engineer. 19 January 1927. BOR Files-Denver.

Acting Commissioner to Superintendent. 22 August 1939. BOR Files-Denver.

Acting Superintendent to Chief Engineer. 16 February 1940. NADC. RG-115. Project Files: 1930-45. Construction of Fish Ladders.

Agreement Between Burkey and Yakima County Game Commission. 9 April 1920. WSTAR. RG-64. Department of Fisheries. 73-7-675. 1915-1970. Box 1010-30. Fish Facilities-Electric.

Agreement Between Burkey and Yakima County Game Commission. 13 August 1920. WSTAR. RG-64. Department of Fisheries. 73-7-675. 1915-1970. Box 1010-30. Fish Facilities-Electric.

Anonymous. 8 November 1957. National Marine Fisheries Service Files-Portland.

Baker, S. to P. J. Preston. 11 September 1930. BOR Files-Denver.

Ball, D. E. to F. A. Banks. 20 March 1945. BOR Files-Denver.

Ball, D. E. to J. S. Moore. 3 June 1941. BOR Files-Denver.

Bartholet, C. J. to C. R. Maybury. 16 February 1931. WSTAR. RG-64. Department of Fisheries. 73-7-675. Box 1010-44. 1915-70. Yakima River: Cle Elum River 1930-65.

Bashore, H. W. to Banks. 5 May 1944. BOR Files-Denver.

Bell, F. T. to Acting Commissioner. 23 March 1936. NADC. RG-115. Project Files 1930-45. Construction of Fish Ladders.

Bell, F. T. to B. M. Brennan. 9 October 1934. NADC. RG-22. E-269. Box 707. Fish Screens-General Correspondence (Spencer).

Bell, F. T. to B. M. Brennan. 11 October 1934. WSTAR. RG-64. Department of Fisheries. 73-7-675. 1915-1970. Box 1010-30. Fish Facilities. Fish Screens: 1930-1939.

Bell, F. T. to K. Hill. 10 October 1934. NADC. RG-22. E-269. Box 707. Fish Screens-General Correspondence (Foster).

Bell, F. T. to N. W. Irsfeld. 16 February 1937. WSTAR. RG-22. Fisheries. 68-A-92. Box 747. Stream Improvement. Yakima River: 1935-52.

Bell, F. T. to L. Ovenden. 14 March 1934. NADC. RG-22. E-269. Box 708. Fish Screens-In Cooperation With States.

Bell, F. T. to J. C. Page. 5 October 1938. BOR Files-Denver.

Bell, F. T. to J. Spencer. 21 September 1934. NADC. RG-22. E-269. Box 707. Fish Screens-General Correspondence (Spencer).

Bell, F. T. to J. Spencer. 26 October 1934. NADC. RG-22. E-269. Box 707. Fish Screens-General Correspondence (Spencer).

Bell, M. C. to C. R. Pollock. 29 December 1930. WSTAR. RG-64. Department of Fisheries. 73-7-675. Box 1010-30. Fish Facilities: Fish Screen 1930-39.

Bell, M. C. to C. R. Pollock. 12 January 1931. WSTAR. RG-64. Department of Fisheries. 73-7-675. Box 1010-44. 1915-70. Yakima River: Cle Elum River 1930-65.

Benson, E. F. to M. E. Hay. 15 October 1909. WSTAR. Gov. Martin Hay Papers. Box 26-2-14. File: Commission-1909(1).

Benson, E. F. to M. E. Hay. 22 November 1909. WSTAR. Gov. Martin Hay Papers. Box 26-2-14. File: Commission--1909(1).

Bien, M. to R. B. Williamson. 30 March 1908. NADC. RG-115. General File 1902-1919. Box 92. File 110-E16. Legislation; Irrigation Laws; Water Codes; etc.

Brennan, B. M. to F. T. Bell. 9 October 1934. NADC. RG-22. E-269. Box 707. Fish Screens-General Correspondence (Spencer).

Brennan, B. M. to F. T. Bell. 13 July 1937. NADC. RG-22. E-269. Box 708. Fish Screens-In Cooperation With States.

Brennan, B. M. to J. C. Page. 29 April 1941. BOR Files-Denver.

Brennan, B. M. to D. A. Shoemaker. 24 January 1936. WSTAR. RG-64. Department of Fisheries. 73-7-675. 1915-1970. Box 1010-30. Fish Facilities. Fish Screens: 1930-1939.

Brennan, B. M. to R. F. Walter. 1 February 1938. National Marine Fisheries Service Files-Portland.

Bretherton, W. W. to Editor. 1891. NADC. RG-22. E-41. Box 1. Records Concerning Fishways At The Great Falls Of The Potomac River: 1884-1895. 2 of 3.

Chief Engineer to Commissioner. 24 May 1932. BOR Files-Denver.

Chief Engineer to Superintendent. 16 April 1932. NADC. RG-115. Project Files 1930-45. Construction of Fish Ladders.

Commissioner to J. Spencer. 23 January 1934. NADC. RG-22. E-269. Box 707. Fish Screens-General Correspondence (Spencer).

Conference Minutes. 26 January 1928. BOR Files-Denver.

Coniff, L. to E. Mains, M. Thayer, and T. Leal. 23 August 1962. WSTAR. RG-64. Department of Fisheries. 73-7-675. 1915-1970. Box 1010-30. Fish Facilities: 1962-1968.

Cooperative Memorandum. 27 November 1939. NADC. RG-115. Project Files 1930-45. Construction of Fish Ladders.

Cooperative Memorandum. 8 November 1938. BOR Files-Denver.

Darwin, L. H. to Pacific Power and Light Company. 27 April 1915. WSTAR. Department of Fisheries. 72-6-566. Box 0061-22.

Dent, P. W. to Chief Engineer. 4 September 1928. BOR Files-Denver.

Draft Cooperative Memorandum. 6 October 1939. BOR Files-Denver.

Drolet, J. to C. R. Pollock. 3 September 1929. WSTAR. RG-64. Department of Fisheries. 73-7-675. 1915-1970. Box 1010-30. Fish Facilities-Electric.

Foster, F. J. to F. T. Bell. 11 October 1934. NADC. RG-22. E-269. Box 707. Fish Screens-General Correspondence (Spencer).

Foster, F. J. to E. Higgins. 21 December 1934. NADC. RG-22. E-269. Box 707. Fish Screens-General Correspondence (Foster).

Gilroy, U. B. to E. Higgins. 17 July 1933. NADC. RG-22. E-269. Box 708. Fish Screens-Special Projects-Washington-Yakima Valley.

Gilroy, U. B. to J. R. Russell. 29 April 1932. NADC. RG-22. E-269. Box 707. Yakima Watershed and Cle Elum Dam.

Gray, W. G. to Regional Director. 18 December 1973. Yakima Project Office files. Fish and Wildlife: 1964-1974.

Hagie, F. O. to F. T. Bell. 9 October 1934. NADC. RG-22. E-269. Box 707. Fish Screens-General Correspondence (Spencer).

Heg, H. T. to L. E. Perry. 26 July 1956. WSTAR. RG-64. Department of Fisheries. 68-A-92. Box 747. Yakima Basin: Proposed Improvements-1956.

Hill, K. to E. Mead. 17 October 1935. NADC. RG-115. Project Files 1930-45. Construction of Fish Ladders.

Holcomb, R. J. to Branch of Game Fish and Hatcheries. 12 December 1948. Yakima Project Office Files.

Holcomb, R. J. to Branch of Game Fish and Hatcheries. 5 January 1949. Yakima Project Office Files.

Irsfeld N. W. to J. A. Craig. 1 November 1938. Wapato Irrigation Project Files. Wapato, Washington.

Kezak, J. to F. T. Bell. 13 March 1934. NADC. RG-22. E-269. Box 707. Fish Screens-General Correspondence (Foster).

Lindgren, O. W. to J. S. Moore. 22 April 1940. BOR Files-Denver.

Lindgren, O. W. to M. E. Moore. 4 December 1957. National Marine Fisheries Service Files-Portland.

Lynch, J. H. to H. T. Bone. 27 April 1938. Wapato Irrigation Project Files. Wapato, Washington.

Lynch, J. H. to B. M. Brennan. 11 April 1935. WSTAR. RG-64. Fisheries. 68-A-92. Box 747. Stream Improvement. Yakima River: 1935-52.

Lynch, J. H. to K. Hill. 3 March 1936. NADC. RG-22. E-269. Box 708. Fish Screens-Miscellaneous Correspondence

Maybury, C. R. to C. J. Bartholet. 12 January 1931. WSTAR. RG-64. Department of Fisheries. 73-7-675. Box 1010-44. 1915-70. Yakima River: Cle Elum River 1030-65.

Mayhall, L. S. to C. R. Pollock. 4 June 1926. WSTAR. RG-64. 74-12-1115. Box 3. Letter Books.

Mayhall, L. S. to C. R. Pollock. 21 May 1928. WSTAR. Fisheries. RG-64. 68-A-92. Box 747. Stream Management. Yakima River-Congdon Ditch-1928.

Mead, E. to Chief Engineer. 22 December 1927. BOR Files-Denver.

Mead, E. to H. O'Malley. 29 May 1929. BOR Files-Denver.

Mead, E. to H. O'Malley. 6 May 1932. BOR Files-Denver.

Meekin, T. to M. Radach. n. d.

Meekin, T. to M. Radach. 21 June 1977.

Meeting Minutes. 29 May 1941. BOR Files-Denver.

Meeting and Field Trip Summary. 30 November 1977. Yakima Project Office files. Fish and Wildlife: 1975-1977.

Mitchell, H. C. to C. R. Pollock. 25 May 1926. BOR Files-Denver.

Moore, J. S. to Bureau of Fisheries. 27 May 1940. BOR Files-Denver.

Moore, J. S. to Chief Engineer. 1 April 1932. BOR Files-Denver.

Moore, J. S. to Chief Engineer. 6 October 1938. BOR Files-Denver.

Moore, J. S. to Chief Engineer. 7 November 1938. BOR Files-Denver.

Moore, J. S. to Commissioner. 19 May 1932. BOR Files-Denver.

Moore, J. S. to O. W. Lindgren. 24 April 1940. BOR Files-Denver.

Moore, J. S. to O. W. Lindgren. 14 May 1940. BOR Files-Denver.

Moore, M. E. to O. W. Lindgren. 2 December 1957. National Marine Fisheries Service Files-Portland.

Moore, J. S. to C. R. Pollock. 2 February 1932. BOR Files-Denver.

Moore, J. S. to Power House Foreman. 17 June 1940. BOR Files-Denver.

Moore, J. S. to J. Spencer. 5 March 1934. BOR Files-Denver.

Nelson, W. H. to B. H. Holmes. 24 November 1933. NADC. RG-22. E-269. Box 708. Fish Screens-Miscellaneous Correspondence.

O'Malley, H. to E. Mead. 20 January 1932. WSTAR. RG-64. Department of Fisheries. 73-7-675. Box 1010-44. 1915-70. Yakima River: Cle Elum River 1930-65.

O'Malley, H. to E. Mead. 3 May 1932. NADC. RG-22. E-269. Box 707. Yakima Watershed and Cle Elum Dam.

O'Malley, H. to J. R. Russell. 19 February 1932. NADC. RG-22. E-269. Box 707. Yakima Watershed and Cle Elum Dam.

Page, J. C. to Chief Engineer. 28 November 1938. NADC. RG-115. Project Files 1930-45. Construction of Fish Ladders.

Page, J. C. to J. S. Moore. 27 November 1939. NADC. RG-115. Project Files 1930-45. Construction of Fish Ladders.

Page, J. C. to Superintendent. 7 October 1939. NADC. RG-115. Project Files 1930-45. Construction of Fish Ladders.

Pollock, C. R. to E. F. Benson. 21 August 1928. WSTAR. Department of Fisheries. 1915-1970. RG-64. 73-7-675. Box 1010-30. Fish Facilities., Fish Screens-1914-1929.

Pollock, C. R. to Bush and Carey. 23 January 1930. WSTAR. Department of Fisheries. 1915-1970. RG-64. 73-7-675. Box 1010-30. Fish Facilities-Electric.

Pollock, C. R. to J. L. Lytel and W. R. Young. 17 January 1928. BOR Files-Denver.

Pollock, C. R. to C. R. Maybury. 30 January 1928. WSTAR. Fisheries. RG-64. 68-A-92. Box 747. Stream Management. Yakima River-Congdon Ditch-1928.

Pollock, C. R. to C. R. Maybury. 19 February 1931. WSTAR. Fisheries. RG-64. 74-12-1115. Box 3. Letter Books.

Pollock, C. R. to C. R. Maybury. 7 October 1931. WSTAR. Department of Fisheries. RG-64. 73-7-675. 1915-1970. Box 1010-44. Yakima River: Cle Elum River 1930-1965.

Pollock, C. R. to J. S. Moore. 27 January 1932. BOR Files-Denver.

Pollock, C. R. to J. S. Moore. 18 February 1932. BOR Files-Denver.

Pollock, C. R. to J. Sturgess. 18 February 1927. WSTAR. RG-64. Department of Fisheries. 73-7-675. 1915-1970. Box 1010-30. Fish Facilities-Electric.

Pollock, C. R. to H. Work. 3 December 1927. BOR Files-Denver.

Pollock, C. R. to H. Work. 17 December 1927. BOR Files-Denver.

Project Superintendent to Regional Director. 30 November 1977. Yakima Project Office files. Fish and Wildlife: 1975-1977.

Rhodes, E. S. to Administrative Assistant. 11 September 1930. BOR Files-Denver.

Riseland, J. L. to M. E. Hay. 19 November 1909. WSTAR. Gov. Martin Hay Papers. Box 26-2-14. File: Commissions--1909(1).

Russell, J. R. to H. O'Malley. 30 April 1932. NADC. RG-22. E-269. Box 707. Yakima Watershed and Cle Elum Dam.

Sandona, T. to H. T. Bone. 7 January 1936. WSTAR. RG-22. Fisheries. 68-A-92. Box 747. Stream Improvement. Yakima River: 1935-52.

Shebley, W. H. to J. W. Kinney. 27 November 1923. UWL-MUAD. John Cobb. 1785-71-25. Box 1. Fishways Correspondence.

Shoemaker, C. D. to E. B. Meritt. 31 January 1920. NADC. RG-75. 110573-19-341. CCF 1907-1939. Fish Screens-Wapato Dam.

Smith, H. M. to Commissioner of Indian Affairs. 12 January 1920. NADC. RG-75. 110573-19-341. CCF 1907-1939. Fish Screens-Wapato Dam.

Spencer, J. to F. T. Bell. 21 September 1934. NADC. RG-22. E-269. Box 707. Fish Screens--General Correspondence (Spencer).

Spencer, J. to F. T. Bell. 25 October 1934. NADC. RG-22. E-269. Box 707. Fish Screens--General Correspondence (Spencer).

Spencer, J. to Commissioner. 22 July 1935. NADC. RG-22. E-269. Box 707. Fish Screens--General Correspondence (Spencer).

Spencer, J. To F. J. Foster. 7 March 1934. NADC. RG-22. E-269. Box 707. Fish Screens--General Correspondence (Foster).

Spencer, J. to F. J. Foster. 12 July 1934. NADC. RG-22. E-269. Box 707. Fish Screens--General Correspondence (Foster).

Spencer, J. to F. J. Foster. 12 January 1935. NADC. RG-22. E-269. Box 707. Fish Screens--General Correspondence (Foster).

Spencer, J. to E. Higgins. 2 January 1934. NADC. RG-22. E-269. Box 707. Fish Screens--General Correspondence (Spencer).

Spencer, J. to E. Higgins. 6 October 1934. NADC. RG-22. E-269. Box 707. Fish Screens--General Correspondence (Spencer).

Stoutemyer, B. E. to H. O'Malley. 28 January 1931. NADC. RG-22. E-269. Box 707. Yakima River Watershed and Cle Elum Dam.

Stuver to Commissioner. 25 April 1944. BOR Files-Denver.

Superintendent to Regional Director. 26 April 1944. BOR Files-Denver.

Vissia, R. to Project Superintendent. 16 December 1977. Yakima Project Office files. Fish and Wildlife: 1975-1977.

Washington Department of Fisheries and Game. 1930. Letter to Public. WSTAR. RG-64. Department of Fisheries. 73-7-675. Box 1010-30. Fish Facilities: Fish Screens 1930-39.

Williamson, R. B. to M. Bien. 18 March 1908. NADC. RG-115. General File 1902-1919. Box 92. File 110-E16. Legislation; Irrigation Laws; Water Codes; etc.

Winn, Dennis to Commissioner of Fisheries. 8 December, 1919. NADC. RG 75. CCF. 1907-39. 110573-19-341. Fish Screens-Wapato Dam.

Yakima Valley Fish and Game Protective Association. Resolution. 4 March 1922. WSTAR. Governor Hart Papers. 25-1-19. Fish Commission: 1922.

Young, W. R. to Ellensburg Water Company. 16 January 1928. BOR Files-Denver.

Legislation--Judicial Proceedings

Kittitas Reclamation District v. Sunnyside Valley Irrigation District. Civil No. 21. Eastern District of Washington. Supplemental Instructions to the Watermaster. 28 November 1980.

Amended Partial Summary Judgement. 29 November 1990. The State of Washington, Department of Ecology, vs. James J. Acquavella, et al. No. 77-2-01484-5. Yakima County Superior Court.

P. L. 70-338. An Act to Provide for the Conservation of Fish, and for Other Purposes.

P. L. 73-121. An Act to promote the conservation of wild life, fish and game, and for other purposes.

P. L. 96-162. Yakima River Basin Water Enhancement Project Study.

P. L. 96-501. Pacific Northwest Electric Power Planning and Conservation Act of 1980.

P. L. 103-434. Title XII. Yakima River Basin Water Enhancement Project.