Long Range Plan For The Klamath River Basin Conservation Area Fishery Restoration Program

Prepared by the

Klamath River Basin Fisheries Task Force

with assistance from

William M. Kier Associates

January 1991

Cover:
Mouth of the Klamath River
at Requa, California

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FISHERY RESTORATION PROGRAM

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EXECUTIVE SUMMARY

THE KLAMATH ACT

Public Law 99-552, the "Klamath Act," was adopted by the Congress on October 27, 1986 for the purpose of authorizing a 20-year-long Federal-State cooperative Klamath River Basin Conservation Area Restoration Program for the rebuilding of the river's fish resources. Congress observed correctly that "floods, the construction and operation of dams, diversions and hydroelectric projects, past mining, timber harvest practices, and roadbuilding have all contributed to sedimentation, reduced flows, and degraded water quality which has significantly reduced the anadromous fish habitat in the Klamath-Trinity River system."

The Act creates a 14-member Klamath River Basin Fisheries Task Force and directs the U.S. Secretary of Interior to cooperate with the Task Force in the creation and implementation of a "Klamath River Basin Conservation Area Fishery Restoration Program."

The Task Force members are appointed by, and represent, the Governors of California and Oregon; the U.S. Secretaries of Interior, Commerce and Agriculture; the California counties of Del Norte, Humboldt, Siskiyou and Trinity; Hoopa Valley, Karuk and Yurok Indian tribal fishers; anglers and commercial fishermen.

The Act also creates an 11-member Klamath Fishery Management Council to "establish a comprehensive long-term plan and policy ... for the management of the in-river and ocean harvesting that affects or may affect Klamath and Trinity River basin anadromous fish populations." The Council is comprised of essentially the same interests as the Task Force, except for those four Basin counties which hold seats only on the Task Force.

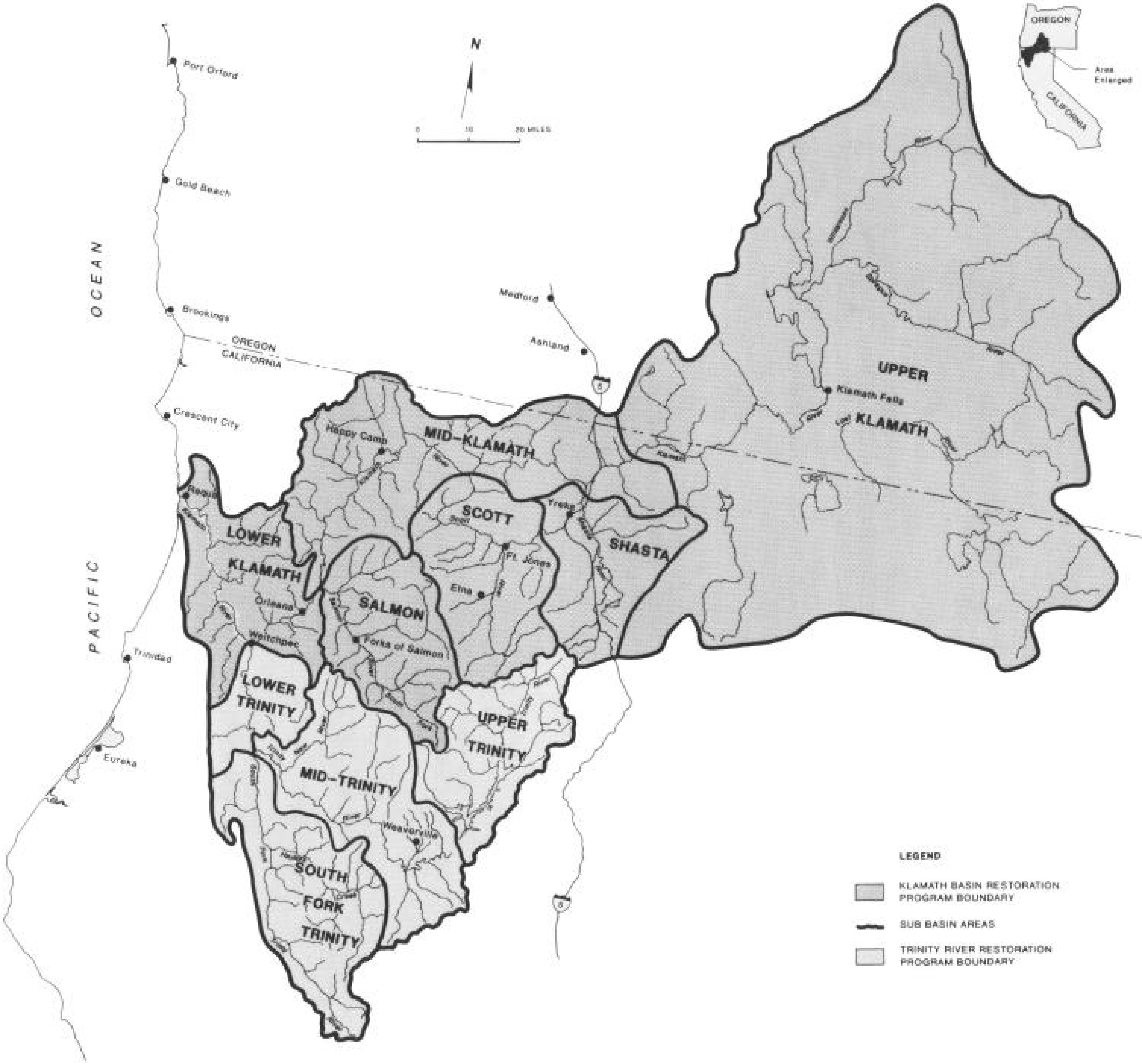
CALIFORNIA'S NEW ANADROMOUS FISHERIES PROGRAM

Like Congress, the California Legislature has recently expressed its concern over the continued decline of the state's native salmon, steelhead and other anadromous fish resources. In a 1988 urgency act, Senate Bill 2261, the Legislature directed the Department of Fish and Game to draw up basin-by-basin plans for the conservation and restoration of the state's remaining anadromous fish. The long-range plan presented here is intended to fulfill the planning requirements, for the Klamath River Basin, of the new statewide anadromous fisheries program.

ANADROMOUS FISH OF THE KLAMATH RIVER BASIN ARE VALUABLE

The Klamath Act declares that the Basin's streams "provide fishery resources necessary for Indian subsistence and ceremonial purposes, ocean commercial harvest, recreational fishing, and the economic health of many local communities." The proof of this statement is the substantial reliance on Klamath River fish and fishing by the Hoopa Valley, Karuk and Yurok Indian tribes, commercial salmon fishermen from both

Klamath River Basin
California and Oregon



California and Oregon, and the visitors and fishermen-serving businesses throughout the vast Klamath region.

A financial analysis of the prospective Restoration Program was performed as part of this long-range plan. The analysis, which appears as an appendix to the plan, was based on values recently developed by the State of California's Advisory Committee on Salmon and Steelhead. Those same values provided the economic basis of the State's new SB-2261 fisheries program.

Both the financial analysis and the earlier Advisory Committee economic study point up one characteristic of fishery restoration efforts that is especially important to rural areas of underemployment like northwestern California and southern Oregon: fishing brings new money into such areas and that money remains in the region, moving from fishermen to small businesses to their workers, longer than for most resource-based activities. Even modest improvements to fish populations during the early stages of the Klamath Restoration Program will bring significant benefits to the very communities for which Congress expressed its concern.

THIS PLAN AND THE ONE BEFORE IT

The U.S. Department of Interior completed a "Klamath River Basin Fisheries Resource Plan" in 1985. It was that plan that Congress had before it when it discussed the proposal that became the Klamath Act. The 1985 plan covered the entire California portion of the Klamath River watershed, including its main tributary, the Trinity River. Recognizing that the Trinity River Fish and Wildlife Management Program was well-launched, Congress deleted Trinity restoration from the proposed Klamath Task Force's duties.

When it was organized in July, 1987, the Klamath Task Force recognized the need to update the information presented in the 1985 plan and, considering the deletion of the Trinity, to review the earlier plan's restoration approach. This long-range plan is the result of that review.

HOW THIS PLAN WAS DEVELOPED

Public involvement was emphasized in the development of this plan. The Task Force held public "scoping" meetings in Eureka and Yreka, California, and Klamath Falls, Oregon attended by more than 200 interested citizens who came forward to share some 700 suggestions, expressions of concern, need and so forth. Copies of a draft plan were mailed in June, 1990 to 100 State, Federal, and local government agencies and public interest groups for their review and comment. Copies of the draft were placed, as well, in 30 libraries and other public places in California and Oregon, and public meetings to review the draft were held in a half-dozen communities throughout the Basin in late summer, 1990.

Other anadromous fishery restoration programs in Canada, Washington, Oregon and elsewhere in California were reviewed in a search for good models of science, management and public participation.

With the help of an inventory of fishery and stream restoration projects undertaken in the Klamath Basin in recent decades prepared by the Task Force's team of technical advisors, the planning team made field inspections of nearly 400 instream work sites involving fishways, barrier removals, bank stabilization, log and boulder weirs, spawning channels, and fish rearing facilities.

Throughout the planning process emphasis was given to writing, discussing and refining clear statements of the Task Force's goals, objectives, and policies for the Restoration Program. The goals are presented in the plan's opening chapter; the objectives, policies and, in some instances, project priorities, are presented at the end of each principal chapter discussion (for example, Chapter 3, Habitat Restoration); and, finally, all are gathered into a "step-down" structure in which they may be maintained, amended and easily updated. The step-down structure is found at the end of the concluding chapter.

THE DIRECTIONS THIS PLAN TAKES

This long-range plan for the Klamath Restoration Program not only updates the 1985 plan, it virtually replaces it by redirecting its principal thrusts. Overall, this plan:

Emphasizes the need for both fish habitat protection and fish habitat restoration from a total watershed, not simply an in stream, perspective.

Recognizes that instream structural treatments (which are a major feature of the 1985 plan) improve fish habitat in specific, necessarily limited ways, and that they are not a cure-all for the underlying causes of fish habitat degradation.

Recognizes that the success of the Restoration Program will depend largely on the ability to the Task Force to secure the support and good will of the Basin's landowners and water users.

Stresses the importance of education and public information in promoting public understanding of, and sustained support for, the Restoration Program.

Calls for ongoing assessments of stream habitat and fish populations necessary to gauge the Program's effectiveness and to make timely adjustments in its investment priorities.

Argues that each distinct population group of anadromous fish remaining in the Klamath River Basin should be protected from over-harvesting, poaching or loss of its habitat, since each serves as a building block essential to the long-range success of the Restoration Program.

Identifies those anadromous fish population groups scattered throughout the Basin that appear to be distinct from fish produced at the Iron Gate and Trinity River hatcheries and commits the Task Force to monitoring these populations closely and advising the Klamath Fisheries Management Council on ways to prevent their existence from becoming endangered.

Analyzes the public policy environment in which the Restoration Program operates at this initial stage, and makes clear that the Task Force will aggressively seek policy improvements when they are found to be needed to protect the Basin's fish resources and the Program's investment in them.

THE NEXT STEPS

This plan will strengthen the work of the Klamath River Basin Fisheries Task Force and the Restoration Program's day-to-day managers, the U.S. Fish and Wildlife Service. Following its formal adoption in early, 1991 the Task Force and the Service staff will discuss each policy in the plan to determine precisely what steps must be taken, and in which budget years, to assure that each is carried out. The Task Force refers to this process as "operational planning."

The Task Force's operational plans will provide the public an even clearer understanding of how the Program's energy and funds will be applied to its objectives and how landowners, fishing groups, cooperating agencies and potential contractors can best assist the multi-year restoration effort.

A FINAL WORD ABOUT THIS LONG-RANGE PLAN

Fishery restoration is a relatively new area of human endeavor. There are few proven fishery restoration planning models from which to draw guidance. The process by which this plan was developed takes the following traditional approach to planning:

- Identify the key issues.
- Make accurate, substantiated findings about the issues.
- Select long-term goals.
- Choose shorter-term objectives.
- Develop policies which address the key issues and which will help attain the goals and objectives.
- Identify specific actions that will implement the plan.

A plan that is useful is, by definition, one that can be implemented. The implementation of the plan starts a dynamic process called "adaptive management," also referred to as "learning by doing." The important thing is to have clearly stated goals, objectives and policies so that everything you do can be related directly to a specific part of the plan. When something works, note it and do more of it. When something fails to produce results, note that, and cease expending funds on it.

We hope that this long-range plan for the Klamath River Basin Conservation Area Restoration Program will prove an effective model from which to borrow wherever people set about to rebuild their natural stream and fishery heritages.

WHERE TO FIND SUBJECTS IN THIS PLAN

Chapters	Subjects
1. Introduction	Purpose, Act, Council, Task Force, SB-2261, Fish Users, Plan Development, 1985 and Other Plans, Goals
2. Habitat Protection	Watersheds, Timber Harvesting, Mining, and Management Agriculture, Urban Encroachment, Water Development, Stream Diversions
3. Habitat Restoration	Instream Structures, Riparian Zone, Watershed Rehabilitation, Biological assessment, Evaluation, Education, Limiting Factors by Subbasins
4. Population Protection	Fish Population Identification, Population Trends, Harvesting, Poaching, High Seas Nets, Predators
5. Population Restoration	Hatcheries, Small Facilities, Diseases, Broodstocks, Stock Transfer, Genetic Integrity, Fish Rescue, Economic Considerations
6. Education	Public Schools, Community Education, Communication Fishermen, Ranchers, Loggers
7. Program Administration	Task Force Operations, Staffing, Funding, Information Sharing, Agency Jurisdictions, Coordination, Project Selection Process
8. Conclusions	Principal Findings, Conclusions, Step-down Summary
Bibliography	References, Contacts, Photo and Illustration Credits
Appendix A	Klamath River Basin Act
Appendix B	Evaluation of Prior Klamath Basin Stream, Fishery Restoration Efforts
Appendix C	Financial Feasibility of the Klamath Restoration Program
Appendix D	Environmental Assessment

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CHAPTER 1

INTRODUCTION

FOREWARD

The success of the Klamath River Basin Fishery Restoration Program will depend in large measure on the extent to which the Klamath River Basin Fisheries Task Force can draw upon the good will and relevant authority of all interested parties. The long-range policies of the Klamath Fishery Management Council and the fish management plans of the Basin's Indian tribes will, for example, be recognized and, to the extent practical, embraced in this plan. Because the Task Force welcomes the fullest cooperative involvement of all interested parties, it wishes to make clear that nothing in this plan is intended to affect the jurisdiction or rights of any Indian tribe.

THE NEED FOR A LONG-RANGE FISHERY RESTORATION PLAN

For tens of thousands of years the fish of the Klamath River basin contributed generously to the wealth and sustenance of their human neighbors. As stated by Congress in the Klamath River Basin Act, the fish habitats of the basin have been greatly diminished in extent and value in the past century by the construction of impassable dams and by stream diversions and sand and silt from mining, logging, grazing, road development, and floods.

As the fish resources of the Klamath River Basin dwindled, concern for their welfare commanded an increasing amount of time on community, state, and federal administrative and legislative agendas. In 1984 Congress authorized a comprehensive 10-year Federal-State cooperative fish and wildlife restoration program (Public Law 98-541) for the Trinity River basin, the Klamath's largest tributary, in response to the dramatic decline in salmon and steelhead runs caused by the diversion of that river's flows to the federal Central Valley Project. The same year, the U.S. Department of Interior's Bureau of Indian Affairs (BIA) completed its "Klamath River Basin Fisheries Resources Plan" (usually referred to as the "CH2M-Hill Plan" after the consulting firm that assisted BIA's planners). And, in 1985, the commercial, recreational, and Indian fishers of the Klamath's salmon, after decades of sharp conflict, reached a harvest management agreement providing for the steady rebuilding of the basin's salmon resources.

Congress heard the public's concern for Klamath River conditions and took special note of the historic accord reached by the fishing groups for sharing the salmon harvest and rebuilding the river's salmon runs. On October 27, 1986 it adopted Public Law 99-552, an act to create a 20-year-long Federal-State cooperative "Klamath River Basin Conservation Area Restoration Program" for the rebuilding of the river's fish resources. The plan presented here is intended to give initial guidance to that long-term Restoration Program.

PUBLIC LAW 99-552, THE KLAMATH RIVER BASIN ACT

The Klamath River Basin Act creates a Klamath River Basin Fisheries Task Force and directs the U.S. Secretary of Interior to cooperate with the Task Force in the creation and implementation of "a 20-year program to restore the anadromous fish populations of the [Klamath River Basin] Area to optimum levels and to maintain such levels." (See Appendix A for the full text of the Klamath Act.) The Act also created the Klamath Fishery Management Council to assist the Secretary, and to coordinate with the Task Force in planning and carrying out the Restoration Program. (The Secretary has assigned responsibility for the Program's day-to-day administration to the U.S. Fish and Wildlife Service. The Service established a Program headquarters, the Klamath River Fisheries Resource Office, in Yreka in 1987.

KLAMATH FISHERY MANAGEMENT COUNCIL

The 11-member Klamath Fishery Management Council is to "establish a comprehensive long-term plan and policy, that must be consistent with the goals of the (Restoration) Program, for the management of the in-river and ocean harvesting that affects or may affect Klamath and Trinity River basin anadromous fish populations." The Council is directed to conduct public hearings for the purpose of developing and making recommendations concerning harvesting regulations to the California Fish and Game Commission, Oregon Department of Fish and Wildlife, Pacific Fishery Management Council, Bureau of Indian Affairs, and the Hoopa Valley Tribal Council. The Council's recommendations are to be based upon the best scientific information available, are to minimize costs, avoid unnecessary regulation, and shall be designed "to achieve an escapement that preserves and strengthens the viability of the Area's **natural** anadromous fish populations."

The members of the Council are appointed by the Governor of California (one representative each from the California's salmon fishing industry, the in-river sportfishing community, the offshore recreational fishing industry, and the California Department of Fish and Game), Hoopa Valley Tribal Council (Hoopa Valley Indian Tribe), Secretary of Interior (non-Hoopa Indians of the Area and the Department of Interior), Secretary of Commerce (National Marine Fisheries Service and Pacific Fishery Management Council), and the Governor of Oregon (Oregon's salmon fishing industry and the Oregon Department of Fish and Wildlife).

Since its organization in July 1987 the Klamath Fishery Management Council has conducted a number of public meetings to gather information upon which to base its harvest recommendations and has appointed a team of technical advisors to assist it in organizing and analyzing biological and harvest data. In November 1989 the Council began a focused effort, with planning assistance from the National Marine Fisheries Service, to create its Congressionally mandated "long-term plan and policy" to guide its harvest regulation recommendations.

KLAMATH RIVER BASIN FISHERIES TASK FORCE

The 14-member Klamath River Basin Fisheries Task Force is directed to assist the Secretary of Interior in creating and implementing the Restoration Program and to coordinate "Federal, State, and local governmental or private anadromous fish restoration projects within the Area." The Program's restoration work is, to the extent practicable, to be performed by "unemployed commercial fishermen, Indians, and other persons whose livelihood depends upon Area fishery resources."

The members of the Task Force are appointed by the Governor of California (salmon fishing industry, in-river sportfishing industry, California Department of Fish and Game), Hoopa Valley Tribal Council (Hoopa Valley Tribe representative), Secretary of Interior (U.S. Interior representative), Secretary of Commerce (National Marine Fisheries Service), Secretary of Agriculture (U.S. Agriculture representative), Governor of Oregon (Oregon Department of Fish and Wildlife), one member each representing the Boards of Supervisors of the California counties of Del Norte, Humboldt, Siskiyou, and Trinity and one member each representing the Karuk Indian Tribe and Yurok Indian Tribe (the Yurok member is to be appointed by the Secretary of Interior until the tribe is formally organized, after which time that member will be appointed by the new Yurok tribal government).

Since its organization in 1987, the Task Force has, with staff assistance from the U.S. Fish and Wildlife Service and the California Department of Fish and Game, organized a team of technical advisors (Technical Work Group), solicited restoration project proposals and committed funds from Federal and State sources for two fiscal years extending into 1990. The Technical Work Group, which includes representatives from the several State and Federal fishery, land management, and resource conservation agencies that are active in the Klamath Basin, has inventoried the nearly 700 fish restoration-related projects attempted in the Klamath Basin in the past two to three decades. Available information concerning the location, owner, nature, purpose, and cost of each such project was entered into a computerized database.

The Task Force reviewed the 1985 (CH2M-Hill) Klamath River Basin Fisheries Resource Plan and concluded that there was a need to update both the information in, and the approach taken by the earlier plan. Inasmuch as it had been undertaken **before** Congress approved the Trinity River Basin Restoration Program, the 1985 plan presented Trinity proposals and priorities together with those for the balance of the Klamath Basin, a mix no longer workable for the separate, although coordinated, programs. Additionally, the 1985 plan assumed substantial restoration efficacy would result from largely <u>structural</u> treatments of fish habitat problems. The Task Force sensed that the problems of restoring the fish resources of the Klamath Basin were more complex than suggested in the 1985 plan and concluded that a major rethinking of the best approach to the Restoration Program was in order.

Because the Fish and Wildlife Service's Klamath River Fishery Resource Office staff is small (see Chapter 7 for staffing information) the Task Force determined it would need outside help to assist in the development of a new long-range plan to guide the 20-year

TABLE 1-1 -- The Klamath Basin. Size of Subbasins (in acres).

Sub-Basin Name	Area in Oregon	Area in California	Total Area
Lower Klamath	-	320,200	320,200
Middle Klamath	23,700	1,061,600	1,085,300
Salmon River	-	475,200	475,200
Scott Valley	-	423,500	423,500
Shasta River	-	507,400	507,400
Upper Klamath	339,300	238,400	577,700
Butte Valley	16,000	387,800	403,800
Lost River	846,200	1,089,700	1,935,900
Upper Klamath Lake	458,200	-	458,200
Sprague River	980,900	-	980,900
Williamson River	-	945,200	945,200
Subtotals	**3,609,500**	**4,503,800**	**8,113,300**
Trinity River	-	1,896,500	1,896,500
TOTALS, KLAMATH RIVER BASIN	3,609,500	6,400,300	10,009,800

From: California Department of Water Resources (1960). Klamath River Basin Investigation. Bulletin No. 83, Sacramento.

TABLE 1-2 Areas of Counties Within the Klamath Basin.

State and County	Acres
Oregon	
Lake..	332,700
Klamath....................................	3,113,100
Jackson.....................................	160,100
Josephine..................................	3,600
Subtotal....................................	**3,609,500**
California	
Modoc.......................................	752,600
Siskiyou....................................	3,270,400
Trinity..	1,635,600
Humboldt..................................	600,200
Del Norte..................................	141,500
Subtotal....................................	**6,400,300**
TOTAL	**10,009,800**

Restoration Program. The firm of William M. Kier Associates, specialists in natural resources planning, management, and policy analysis, was selected in summer, 1989 and the Task Force launched its long-range plan effort immediately.

SB-2261 -- CALIFORNIA'S NEW ANADROMOUS FISHERIES PROGRAM

In 1988 the California Legislature adopted, and the Governor signed as an urgency measure, Senate Bill 2261, the "Salmon, Steelhead and Anadromous Fisheries Program Act." The Legislature found that California's anadromous fish resources have declined dramatically statewide within the past four decades, primarily as a result of stream habitat degradation. SB-2261 directs the California Department of Fish and Game to develop a statewide plan and program with the objective of doubling the State's anadromous fish production by the end of the century. (SB-2261 defines "production" as the survival of fish to adulthood as measured by the recreational, commercial, and Indian fishery harvests together with the return of fish to their freshwater spawning grounds.)

SB-2261 finds that California's increasing reliance on hatchery production of salmon and steelhead is "at or near the maximum percentage that it should occupy in the mix of natural and artificial hatchery production" and that the conservation and restoration of the State's anadromous fish resources "must be accomplished primarily through the improvement of stream habitat."

The policy directions of the 1986 Klamath River Basin Act and the 1988 California Anadromous Fisheries Program Act are highly compatible. Where the Klamath Act strives to restore the fish resources of the Basin to "optimal levels" by 2006, the State statute urges that a statewide doubling of these resources be achieved by the end of the century. Both acts recognize that the underlying reason for the decline of the anadromous fish resources has been the loss of habitat to the construction and operation of dams and stream diversions and to adverse land use practices. Both acts clearly state that their purposes are to be accomplished primarily through the restoration and protection of stream habitat and the increase of natural, instream fish production.

It is the position of the Task Force that the Restoration Program not only implements the 1986 Klamath Act but represents, as well, the Klamath River Basin component of the statewide anadromous fish conservation and restoration program contemplated in State Senate Bill 2261.

WHO USES THE ANADROMOUS FISH OF THE KLAMATH RIVER BASIN?

In approving the Klamath River Basin Act, Congress declared that the region's streams "provide fishery resources necessary for Indian subsistence and ceremonial purposes, ocean commercial harvest, recreational fishing, and the economic health of many local communities." These user groups were the driving force behind Congressional approval of the Klamath River Basin Restoration Program and today they represent active voices on both the Task Force and the Council. Since a good description of these fisheries is provided in the 1985 plan, only a brief summary is offered here. More discussion of the users is also found in Chapter 4 (Population Protection) and Chapter 6 (Education and Communication).

Tribal Fisheries

Yurok. Yurok tribal members conduct both subsistence and commercial gill net fisheries in the Klamath River between the Trinity River and the Klamath's mouth at Requa. Most of the Yurok fishing effort occurs in the estuary near Highway 101. These lower Klamath net harvests have ranged from 13,000 salmon in 1985 to 52,000 and 46,000 in 1988 and 1989. The Yuroks began a second, earlier commercial gill net fishery for spring run chinook salmon in 1989 and will pursue this fishery again in 1990.

In 1987, 1988, and 1989 the Yurok commercial fishery harvested an average of 26,000 fall run chinook salmon. These fish represent a direct value to the tribe of $3 million. The total personal income generated by support businesses of the fishery in Humboldt and Del Note counties has not been quantified.

Hoopa Valley. Since passage of the 1988 Hoopa-Yurok Settlement Act, Hoopa Valley Tribal members fish exclusively on the Trinity River which flows through their Reservation. The Hoopas' harvest of fall run chinook salmon has ranged from 2,000 to 5,000 since 1985; their take of spring chinook salmon has ranged from 1,000 in 1985 to 4,200 in 1987. Like the Yuroks, the Hoopas take coho salmon, steelhead, and green sturgeon incidentally during their spring and fall chinook salmon gill netting.

Karuk. Members of the Karuk Tribe have fishing privileges in the half-mile of Klamath River below Ishi Pishi Falls (just above the mouth of the Salmon River, near the Humboldt-Siskiyou county line). Traditional Karuk fishers use hand-held dip nets to snatch salmon from the turbulent water below the falls (Figure 1-1). Although Karuks take far fewer salmon than the downstream Indian fishers, their relationship with the river and its fish life is every bit as strong as that of the other two tribes.

Ocean Commercial Fishery

Salmon from the Klamath River Basin are taken by commercial trollers (hook-and-line fishermen) in the ocean mainly between Fort Bragg, California and Coos Bay, Oregon. Of the more than 600,000 chinook salmon taken in these waters annually since 1986, more than a third were of Klamath River origin. While these fish represent a direct value to the fishermen of nearly $6 million, their value to the supporting businesses of the fishing ports and to their employees is several times that amount.

Recreational Fishery

Recreational fishing occurs in the ocean off the Klamath River and within the Klamath River Basin. The ocean sport fishery catches Klamath River chinook and coho salmon in the same general Fort Bragg to Coos Bay area, as does the commercial troll fishery. Access is mainly by charter or party boats and skiffs.

River anglers pursue steelhead, coastal cutthroat trout, shad, and sturgeon in addition to chinook and coho salmon. Anglers harvest the fall chinook mainly along the Yurok Reservation in the lower Klamath where the fish's eating quality is still good and where

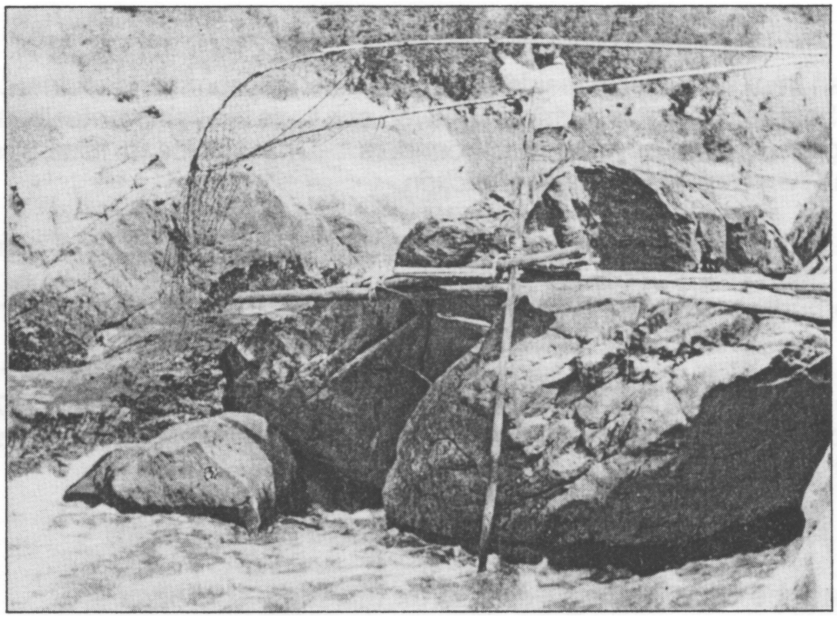


Figure 1-1 – Karuk tribal fisherman using traditional dip net to catch salmon on the Klamath River, early 1900's

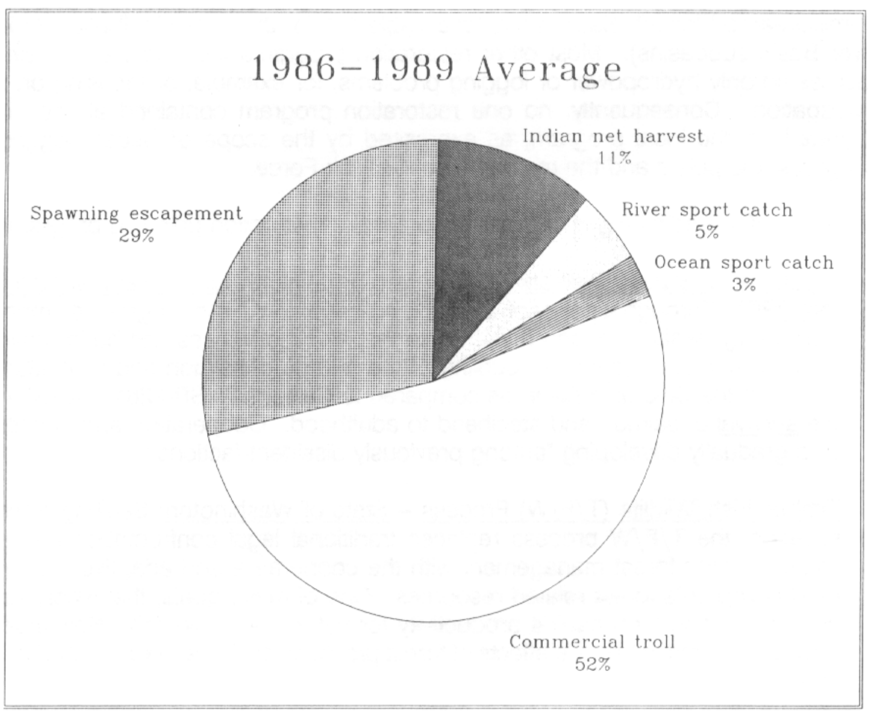


Figure 1-2 – Average annual contributions of Klamath River fall Chinook salmon to the ocean and in-river fisheries and to spawning escapement (USFWS data).

fishermen from all over join residents in an annual late summer shoulder-to-shoulder and boat-to-boat salmon fishing jubilee. Upriver, one finds the fighting steelhead most popular with anglers, particularly the "half-pounders." The steelhead fishery is probably the Klamath River region's greatest attraction.

The sport fishery's popularity is reflected in the pride of the local communities. The town of Klamath's symbol is the salmon surrounded by a heart, while upriver Happy Camp proudly proclaims "Klamath River -- Steelhead Capitol of the World."

The harvest of chinook salmon by anglers in the river system increased from an average of 4,100 fish between 1978-85, to nearly 17,000 fish for 1986-87, reflecting the threefold increase in the size of the returning spawning runs between those periods (see Figure 1-2).

PREPARING THE LONG-RANGE PLAN

Choosing the Best Fishery Restoration Planning Approach

As part of the initial preparation of this long-range plan, fishery restoration planning efforts underway elsewhere were examined to help identify useful concepts. From this analysis we gleaned those strong points of each program which could be applied to the 10-million-acre Klamath Basin effort (see Table 1-1 for the area distribution of Klamath River Basin subbasins). Most other restoration programs were limited in their scope, addressing only hydropower or logging problems, for example, or focusing on artificial propagation. Consequently, no one restoration program contained all the elements desirable in the local program, as expressed by the scope of issues suggested by Congress, the public and the members of the Task Force.

Some of the advantages of these other fishery restoration planning programs are:

<u>Columbia River Basin Fish and Wildlife Program</u> -- <u>Northwest Power Planning Council (NWPPC)</u>: Through a policy of "adaptive management," this program is emphasizing monitoring, evaluation, and research so that its effectiveness can be improved over time. The interim goal is a doubling of the returns of salmon and steelhead to the mouth of the Columbia River, as compared to California's SB-2261 goal of doubling the <u>survival</u> of salmon and steelhead to adulthood. Cooperation and consensus is also gradually developing "among previously dissident factions."

<u>Timber/Fish/Wildlife (T/F/W) Process</u> -- <u>State of Washington</u>: Seeking a "win/win" situation, the T/F/W process replaces traditional legal confrontation and political bickering over forest management with the cooperative and adaptive management of Washington's forest related resources. One of many goals, the fishery resource goal is the long-term habitat productivity for natural and wild fish. New studies will provide in formation on the effects of forest practices on fish and water quality, among other resources.

Salmonid Enhancement Program (SEP) -- Canadian Department of Fisheries and Oceans/British Columbia: The most noted successes of this program are the SEP's education package for school children, "Salmonids in the Classroom," and its extensive community volunteer effort. Similar to the Klamath Program, the SEP is jointly funded by both Federal and provincial governments, but management depends on the species of fish. Its goal is also to double the number of salmonids.

Salmon and Trout Enhancement Program (STEP) -- State of Oregon: This ten-year-old Oregon Department of Fish and Wildlife program emphasizes "hands on" public involvement. Department specialists assist more than 250 organized groups statewide to develop and carry out stream survey, habitat improvement, education, and egg incubation/broodstock development projects. STEP's grass-roots delivery system looks like one that would generally work well for the Klamath River Basin Restoration Program.

Trinity River Basin Fish and Wildlife Management Program -- Trinity River Basin Fish and Wildlife Task Force: Since the Trinity River Basin plan and the program that that plan contemplates has been in place since 1982 and has been funded by Congress and the State of California since 1986, it has several more years of experience with restoration efforts than the Klamath River Basin Fisheries Task Force. A mid-program review (year 5 of the 10-year program) is currently in progress and the results should be available to apply soon. Watershed stabilization and protection activities are ranked high in order of priority.

HOW THIS PLAN WAS DEVELOPED

The development of this long-range plan for the Klamath River Basin Restoration Program involved the following steps:

1. Identifying the issues.
2. Categorizing and consolidating the issues.
3. Identifying the findings related to the issues.
4. Developing goals and objectives.
5. Developing policies.
6. Identifying project selection criteria.
7. Designing a schedule for projects and tasks.
8. Developing an environmental assessment.

Identifying the Issues

Everyone has a different perception of "The Problem" and its solutions. If we are to comprehend the problem adequately in the long-range plan and Restoration Program, then the critical issues and concerns must be thoroughly identified at the beginning of the process.

Identification of issues and expressions of concern were solicited and gathered from:

1. The general public -- through public "scoping" meetings conducted in Eureka and Yreka during fall, 1989. These meetings attracted nearly 200 interested persons who provided a great deal of information and a lengthy list of legitimate concerns. Forty letters were received from people interested in the Restoration Program.

2. The Task Force -- each member was interviewed by the consulting team during the start-up of the planning effort. In addition, the planning team combed the Task Force's meeting minutes, from the beginning, for indications of long-range planning direction.

3. Fishery scientists and managers -- from State and Federal agencies, Indian tribes, and research institutions, actively engaged in Klamath River fisheries research and management, responded to interviews, questionnaires and requests for both published and unpublished data.

4. The Klamath Fishery Management Council -- whose meetings the planning team attended, minutes we reviewed and, in several cases, whose members the team interviewed.

5. Congress -- the Klamath Act and its accompanying House Report were studied closely to ensure that the intent of Congress is pursued carefully by the Task Force in developing directions for the Restoration Program.

6. The 1985 Plan -- was reviewed thoroughly as a point of departure for developing this Plan (see Table 1-3 for a comparison of how this Plan's structure, the structure used by the Task Force since 1987 to organize project proposals and funding decisions, and the 1985 Plan structure all compare).

Categorizing and Consolidating the Issues

In order to better manage the lengthy list of issues, those that appeared to be related were put into the natural categories that appear in the left-hand column in Table 1-3.

Reaching the Findings

Working from the list of issues (the public sessions, interviews, reviews of the minutes, the Klamath Act, the House Report, and the rest yielded **nearly 700** expressions of concern, need, etc.) the planning team asked the Task Force and the fishery specialists "What do we know about these issues? Is this a real problem or just a perceived problem? Is there information enough to compel an action, or is more information needed?" The planning team tried to keep the findings short and to the point -- and used tables and figures wherever possible, so that the findings would not become lost in a thicket of information. The major issues addressed in the Plan have been listed at the beginning of each chapter.

Developing Goals and Objectives

Recalling that the Task Force wishes to structure and maintain the Restoration Program's long-range plan in an updateable, "step-down" format (a structure that we have borrowed from the Trinity River Basin Task Force that shows the relationship of Plan objectives, policies, and priorities to each major goal) the planning team kept the concepts separated into **goals** (an enduring statement of purpose, the end toward which effort is directed) and **objectives** (the specific attainable ends toward which effort is directed) under which the selected priorities, policies and tasks could be organized.

TABLE 1-3

CATEGORY RECONCILIATION
or
How this Plan's Categories Mesh with the Old One's

This Plan	1987-89	1985 Plan
Habitat Protection and Management	Get Information	Production Constraints
Habitat Restoration	Manage Habitat	Production Constraints
Fish Population Protection	Get Information	Fisheries Management
Fish Population Restoration	Artificial Propagation	Artificial Propagation
Education and Communications	Education	--------------------
Program Administration	Administration	Action I-1; Fish Management

Developing Policies

Once the issues were evaluated, findings reached, goals and objectives framed, the planning team drafted recommended policies for the Task Force's consideration. The importance of having clearly stated, adopted policies cannot be overemphasized. The policies set out in this Plan will provide a firm foundation for its position on issues and actions.

Identifying Project Selection Criteria

The basis for developing project selection criteria is discussed in Chapter 3 (Habitat Restoration), Chapter 5 (Population Restoration), and Chapter 7 (Administration).

Designing the Schedule of Projects and Tasks

The schedule of projects and tasks will be designed and incorporated into the step-down structure when the Task Force and its technical advisors, the public, and the agencies sharing jurisdiction for Klamath River Basin fishery management have reached agreement on the priorities for Program investment.

GOALS OF THE KLAMATH RIVER BASIN RESTORATION PROGRAM

The following goals are to provide the Task Force its long-range direction in accomplishing the restoration of the Klamath River Basin anadromous fish populations.

I. Restore, by the year 2006, the biological productivity of the Klamath River Basin in order to provide for viable commercial and recreational ocean fisheries and in-river tribal (subsistence, ceremonial and commercial) and recreational fisheries.

II. Support the Klamath Fishery Management Council in development of harvest regulation recommendations that will provide for viable fisheries and escapements.

III. Recommend to the Congress, state legislatures, and local governments the actions each must take to protect the fish and fish habitats of the Klamath River Basin.

IV. Inform the public about the value of anadromous fish to the Klamath River region and gain their support for the Restoration Program.

V. Promote cooperative relationships between the lawful users of the Basin's land and water resources and those who are primarily concerned with the implementation of the Restoration Plan and Program.

These goals are repeated in Chapter 8 (Conclusions) where they are placed together with their associated objectives and policies.

CHAPTER 2

HABITAT PROTECTION AND MANAGEMENT

ISSUES

* First priority of program should be the protection of watershed and habitat quality.
* Need to prevent habitat degradation in the first place.
* Need to address the cause of habitat degradation rather than just the symptoms.
* Emphasize the necessity of avoiding harmful watershed and water use practices.
* Quality and quantity of fish reflect the watershed status.
* Agency management ineffective in protecting habitat.
* Need to identify where and in what form long-term habitat protection can be implemented.
* Need to identify practical processes for multi-agency review of projects which threaten fisheries habitat.

> Even the tremendous ability of Western streams to naturally heal themselves has yet to match the opposing artificial stress constantly placed upon them. We have yet to turn the corner .... If Stewardship had its proper place in the management of the lands and waters over the past century, we wouldn't face this large, expensive challenge.
>
> -- William S. Platts, 1984

> ... unless more effort is devoted to looking forward toward prevention rather than backward toward correction, we will continually be trying to catch up. The successful management of erosion is as much a philosophical and political problem as a technical one.
>
> -- Robert R. Ziemer, 1981

INTRODUCTION

Protection of habitat must be the first priority of a restoration effort if long-term success is to be achieved. The importance of "pristine" habitat for the health of the salmon fishery was first recognized by biologists in the late nineteenth century. In 1892, a scientist from the U.S. Fish Commission proposed setting aside an entire coastal watershed "as a great national nursery" for salmon. The most likely candidate, he thought, was the Klamath River: "the land extending some distance from the mouth of the Klamath River is, I believe, a Government reservation, requiring no special legislation to close the stream to outside commerce." (McEvoy 1986)

Such a sanctuary was never established. The Klamath watershed had already been substantially altered by 1892 from gold mining activities and the dramatic flood of 1861. Impacts yet to come were major dams, intensive water diversions, gold dredging, numerous roads, extensive logging, two more phenomenal floods, and catastrophic forest fires. Had we known then what we know now about the importance of watershed and stream habitat protection, the salmon and steelhead populations of the Klamath River Basin would very likely not need this restoration program.

HISTORICAL PERSPECTIVE

Wild salmon and steelhead stocks have evolved with stream systems that were flushed by floods, blocked by fallen trees and beaver dams, muddied by natural landslides, and dried by droughts. The stream and watershed conditions we see today are also reflections of at least 150 years of human alterations. When fur trappers removed 1800 beaver from the Scott Valley in 1836, the anadromous fish habitat was altered. Land and water uses over the years have transformed the landscape, in many places permanently.

The historical perspective on how and when the land and water has been modified is brought into each section of this chapter: timber harvest, mining, agriculture, urban and rural development, dams, and water diversions. As ecologists have told us, it is important to understand the sequence of changes that have occurred for two reasons (Sedell and Luchessa 1981):

1. To learn from past mistakes and to provide better habitat protection in the future; and
2. To provide both a rational context and an effective direction for habitat restoration efforts.

ORGANIZATION AND STRATEGY OF THIS CHAPTER

To describe the various issues and findings on the subject of habitat protection, this chapter is divided into two major sections and several subsections:

LAND MANAGEMENT	**WATER MANAGEMENT**
Timber Harvesting	Water and Power Projects
Mining	Water Diversions
Agriculture	

Within each subsection, the findings are organized as follows:

History
Management Practices
Salmon and Steelhead Impacts
Regulations
Conclusions

At the end of each subsection is a list of Policies to be used for guiding Task Force actions on that subject. Since the Task Force does not have any regulatory powers of its own to protect habitat (though individual member agencies do), it is essential that the Task Force have a strategy on how it can be most effective. The following policy strategy is proposed:

- Promote a cooperative approach with land and water users, including incentives.
- Support information collection about habitat impacts.
- Feed the collected information back into the loop through data bases and regulating agencies.
- Seek changes in regulations which are ineffective and recommend minimum standards.
- Recognize decision-making and problem-solving methods locally available, such as the Coordinated Resource Management and Planning approach.

RELATION OF NATURAL SETTING TO HABITAT PROTECTION

A description of the basin's general environment was offered in the 1985 Fisheries Resource Plan. Only a summary pertinent to the Habitat Protection chapter is offered here, along with some new information.

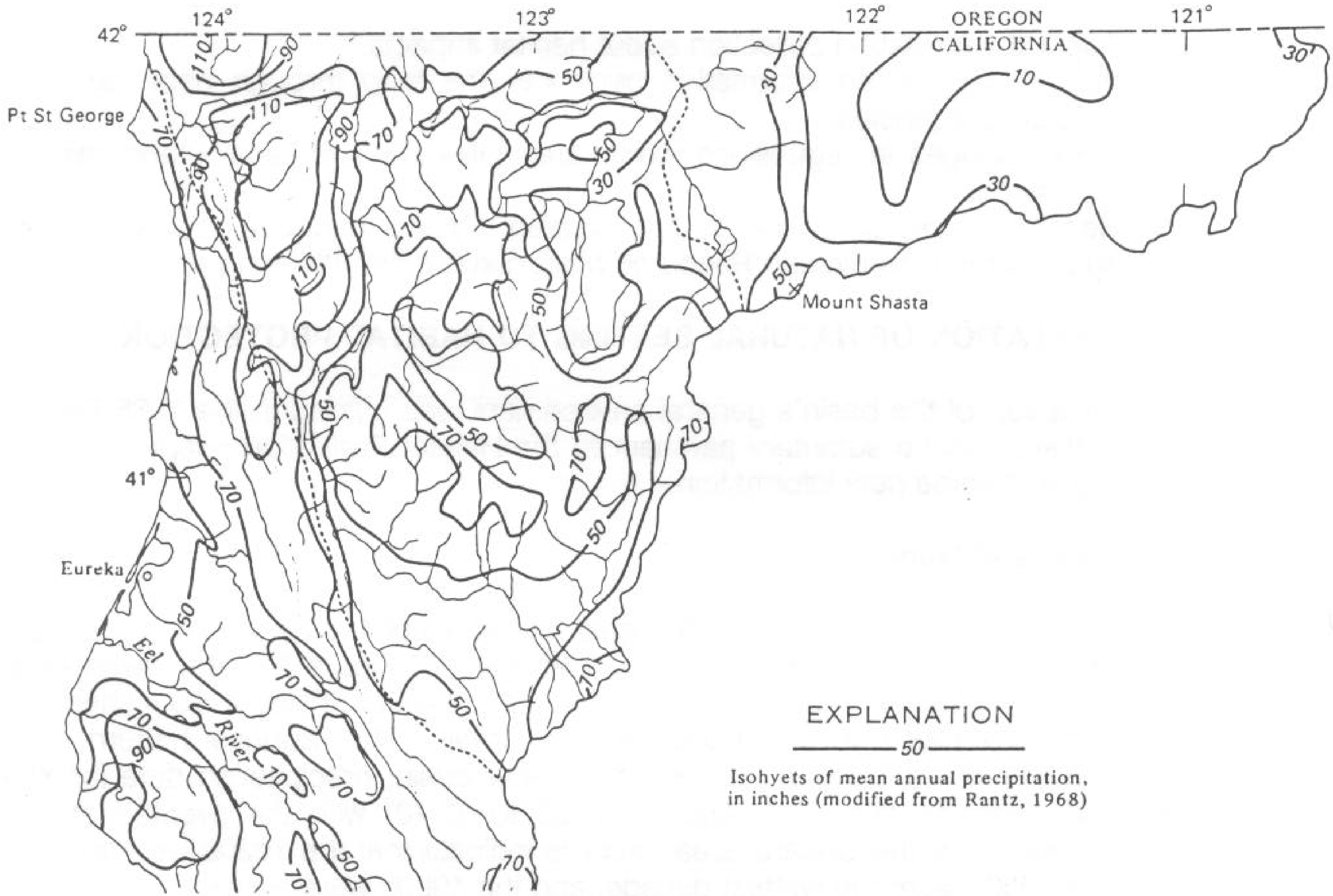
Precipitation and Runoff

A pattern of extreme floods and droughts has appeared to be the norm during the 20th Century in the Klamath Basin. As can be seen in Figure 2-1, the mean annual precipitation in the basin ranges from 10 inches near Klamath Falls, to 50 inches in the upper Scott River Basin, to 110 inches at Blue Creek. The historical pattern is best represented in Figures 2-2 and 2-3. For the upper basin, precipitation data for Yreka reveals fairly extreme annual fluctuations (7.53 to 33.10) with the average at 18.09 inches per year. For the Orleans area, records indicate that the 1920s were the driest decade, the 1950s were the wettest decade, and the 1980s were average.

Individual years seem to attract the most attention. During the 1976-77 drought, the seasonal precipitation amounted to only 20% of normal in the Scott River and 40% of normal in the upper Klamath River. Since that period, a majority of years has been below normal precipitation (80% in 1987, 60-80% in 1988), according to records of the California Department of Water Resources. In contrast, the calendar year 1983 recorded the highest rainfall of the century.

Flooding of extreme magnitudes occurred in December 1955, December 1964, and February 1974. The only similar flood to be documented was in 1861-62, although good prehistoric flood evidence reveals others of similar severity (Helley and LaMarche 1973). In a study of historic and prehistoric flood deposits and botanical evidence in the Klamath River Basin, major flood events similar in magnitude to the 1964 flood

Figure 2-1 – Mean Annual Precipitation Map of the Klamath Basin.



Source: Helley and LaMarche, 1973

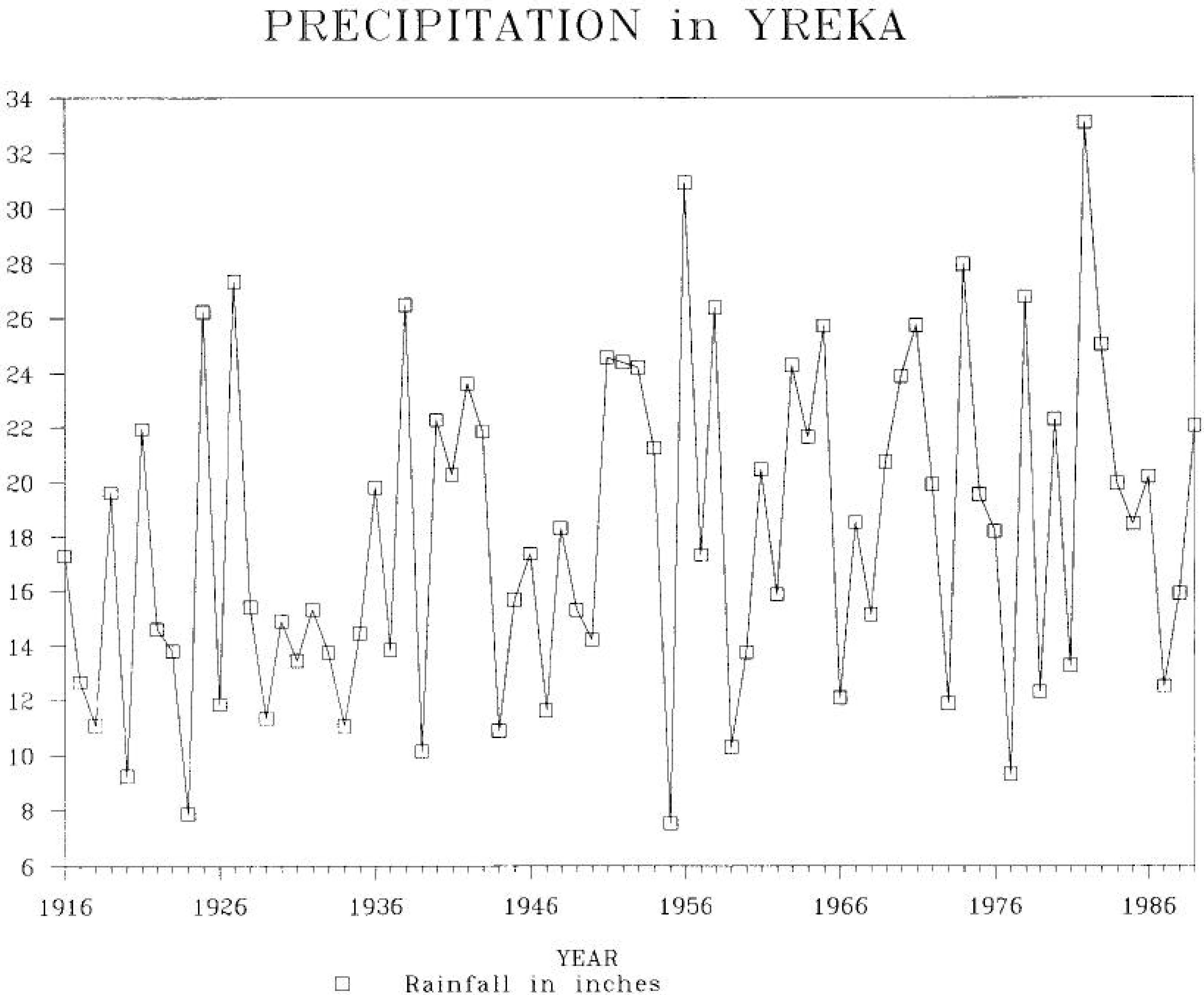
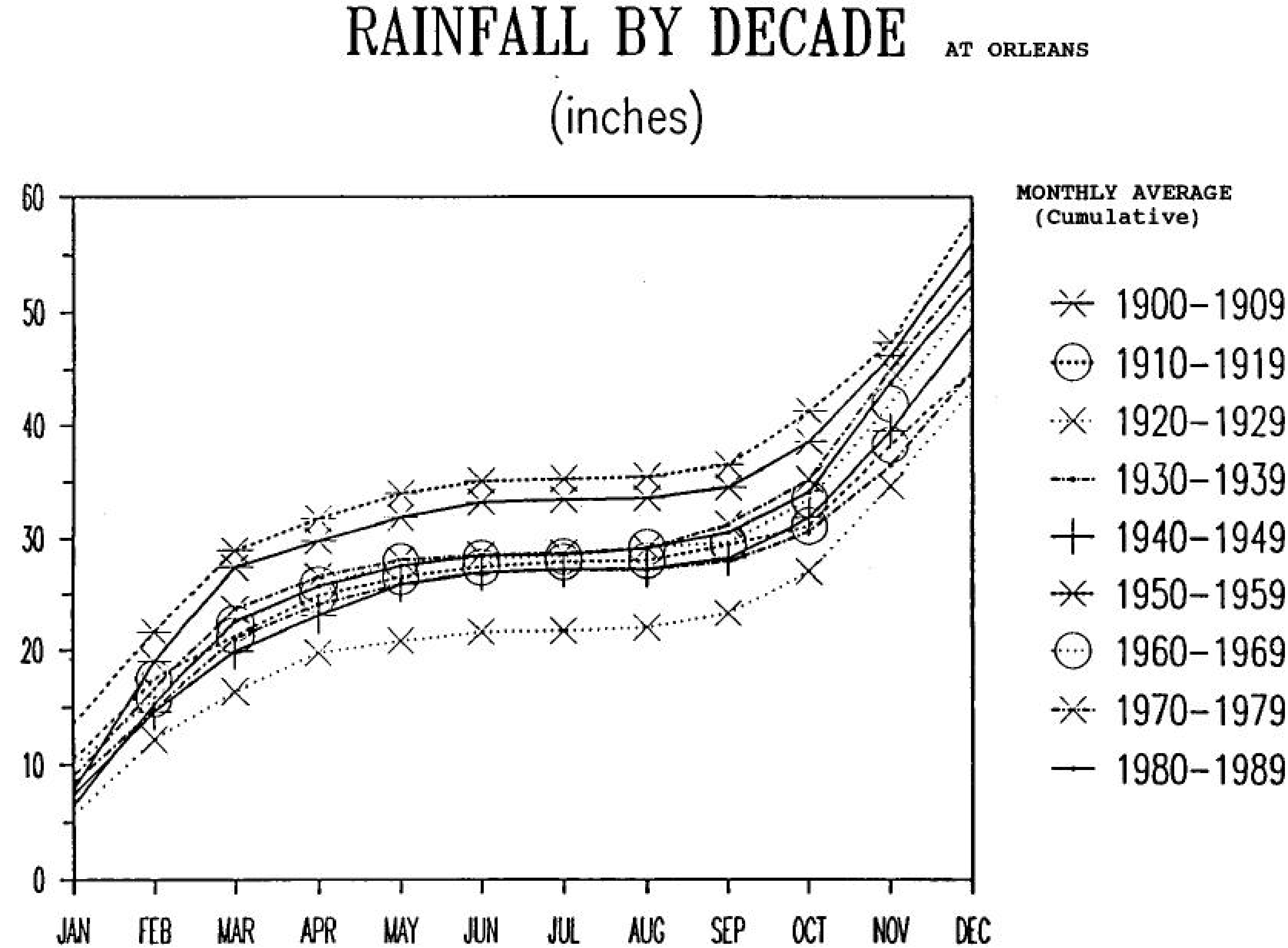


FIGURE 2-2 -- Annual Precipitation in Yreka, 1916 to 1989.



Source: Orleans Ranger District, Six Rivers National Forest

FIGURE 2.3 -- Rainfall by decade at Orleans.

occurred around 1600 and again about 1750. The 1955 flood was smaller and was probably equivalent to the one in 1861. Less intensive floods recur anywhere from two to fifty year intervals. The intensity of flooding also varies with location in the Basin.

Geology

The Klamath River Basin encompasses three major geologic provinces: the Southern Cascades to the east, the Klamath Mountains in the middle, and the North Coast Ranges to the west. Each province acts quite differently (Helley and LaMarche 1973). In the North Coast Ranges, landslides and soil slips are common due to the combination of sheared rocks, shallow soil profile development, steep slopes, and heavy seasonal precipitation. The Klamath Mountains are underlain by highly metamorphosed volcanic and sedimentary rocks that have been intruded by granitic and ultramafic rocks, which weather at different rates. Its drainages are deeply incised, exposing old land surfaces along river channels. In contrast, the headwaters of the Klamath River are found in the Cascade Range, which is volcanic in origin. Surface drainage is poorly developed, possibly because the highly permeable volcanic rocks allow ready infiltration of snowmelt and precipitation. Acreages of each geologic type in the Klamath Basin (only California figures available) and Trinity Basin can be found in Table 2-1, while a map is offered in Figure 2-4.

Recent Fires

Forest fires have always occurred in the region but the historical record was overshadowed by the most recent fire. An unusually intensive lightning storm, in late August 1987, ignited forest fires throughout the Klamath River Basin that were not extinguished until the rains of November. On the Klamath National Forest, where the most extensive fires occurred, about 217,000 acres were burned (C. Conklin, USFS, personal communication). As identified in Table 2-2, the intensity of the burn varied by area: 13% of the burned acres were of high intensity, 32% of moderate intensity, and 55% of low intensity.

The Klamath National Forest developed a Recovery Philosophy and Goal Statement to guide the Forest in responding to the fires: "to return, if possible, the burned areas to either their former or potential biological and economic productivity or to the best use based on existing land capabilities." Its short-term recovery goals are to "reforest burned areas, reduce fuels, salvage dead timber, and mitigate the impacts of the catastrophic event on wildlife, watershed, fisheries, and recreation values" (USFS 1989).

Emergency watershed measures were taken immediately after the fires. One saving factor was the lack of intensive rains on most of the burned drainages during the two years following the fires. Depending on the proportion of area burned with high to moderate intensity, each watershed is recovering at different rates. In the Elk Creek subbasin, degradation to fish habitat has been only minimal (J. West, USFS, personal communication). However, projections are that wildfire impacts causing excessive sedimentation in certain Salmon River tributaries (Crapo, Kanaka Gulch, Olsen, and Big Creeks) may reduce anadromous fish escapement by an estimated 80 percent between 1990 and 1998 (Goines 1988).

The fires have created both challenges and opportunities for the Forest Service. Seeking the appropriate balance in treating ground cover for fuel management and erosion control is one of the critical challenges related to water quality and fish habitat.

TABLE 2-1 -- Major Geologic Units in the Klamath and Trinity Basins[1].
(California Portion Only) (In Square Miles)

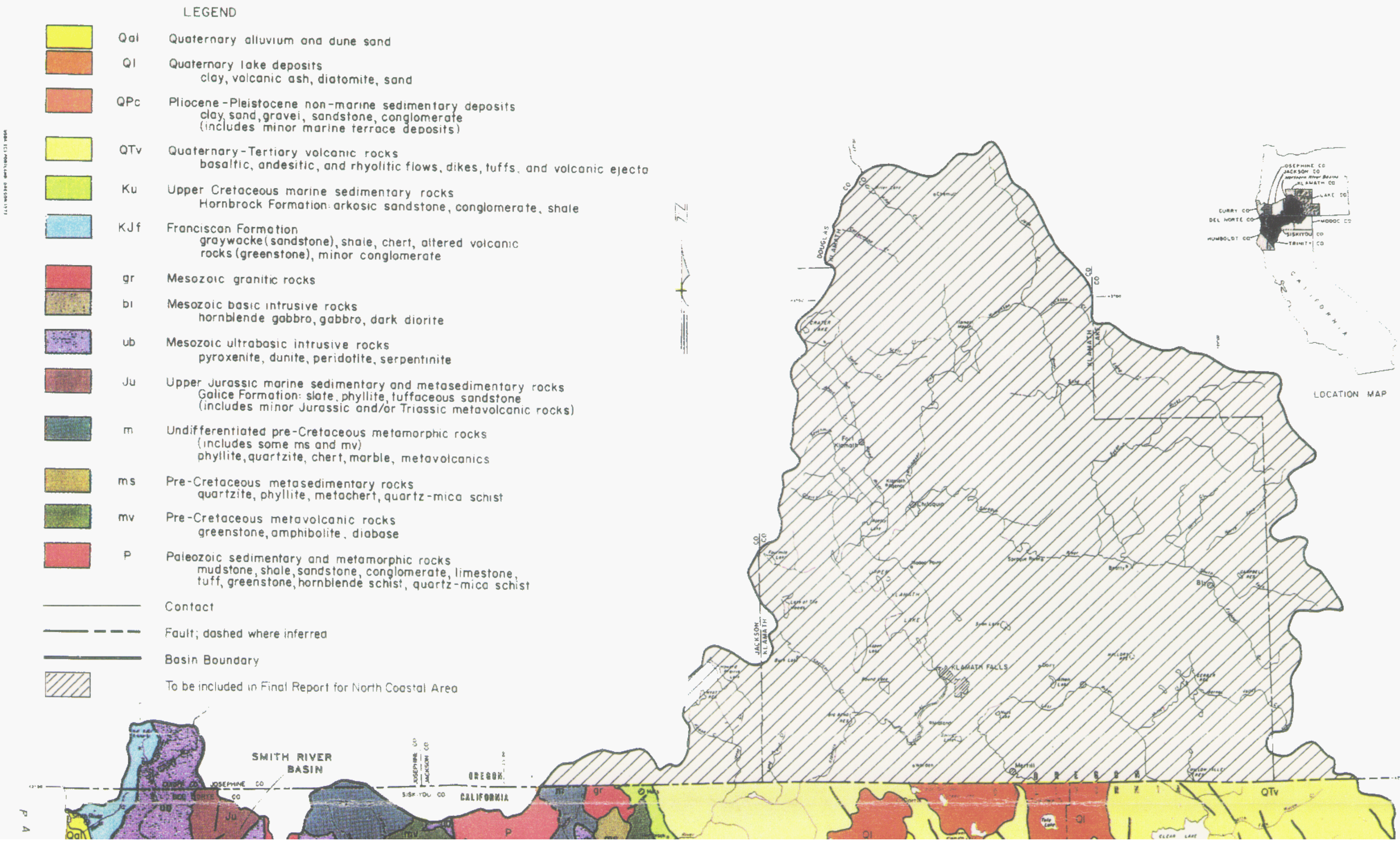
Geologic Assemblage	**Klamath**	**Trinity**	**Total**
Alluvium	166	-	166
Lake Deposits	318	-	318
Nonmarine Sediments	41	-	41
Volcanic Rocks	2,675	-	2,675
Marine Sediments	42	-	42
Franciscan Formation	246	24	270
Granitic Rocks	535	413	948
Basic Intrusives (gabbro)	24	72	96
Ultra-basic Intrusives (serpentine, pyronxenite)	460	278	638
Older Marine Sediments	394	232	626
Undifferentiated Metamorphics	982	999	1,981
Metamorphosed Sediments	250	201	451
Metamorphosed Volcanics	353	81	434
Oldest Sediments/Metamorphics	550	669	1,219
Totals	7,036	2,969	10,005

[1] From: USSCS, 1972. North Coastal River Basins, Main Report

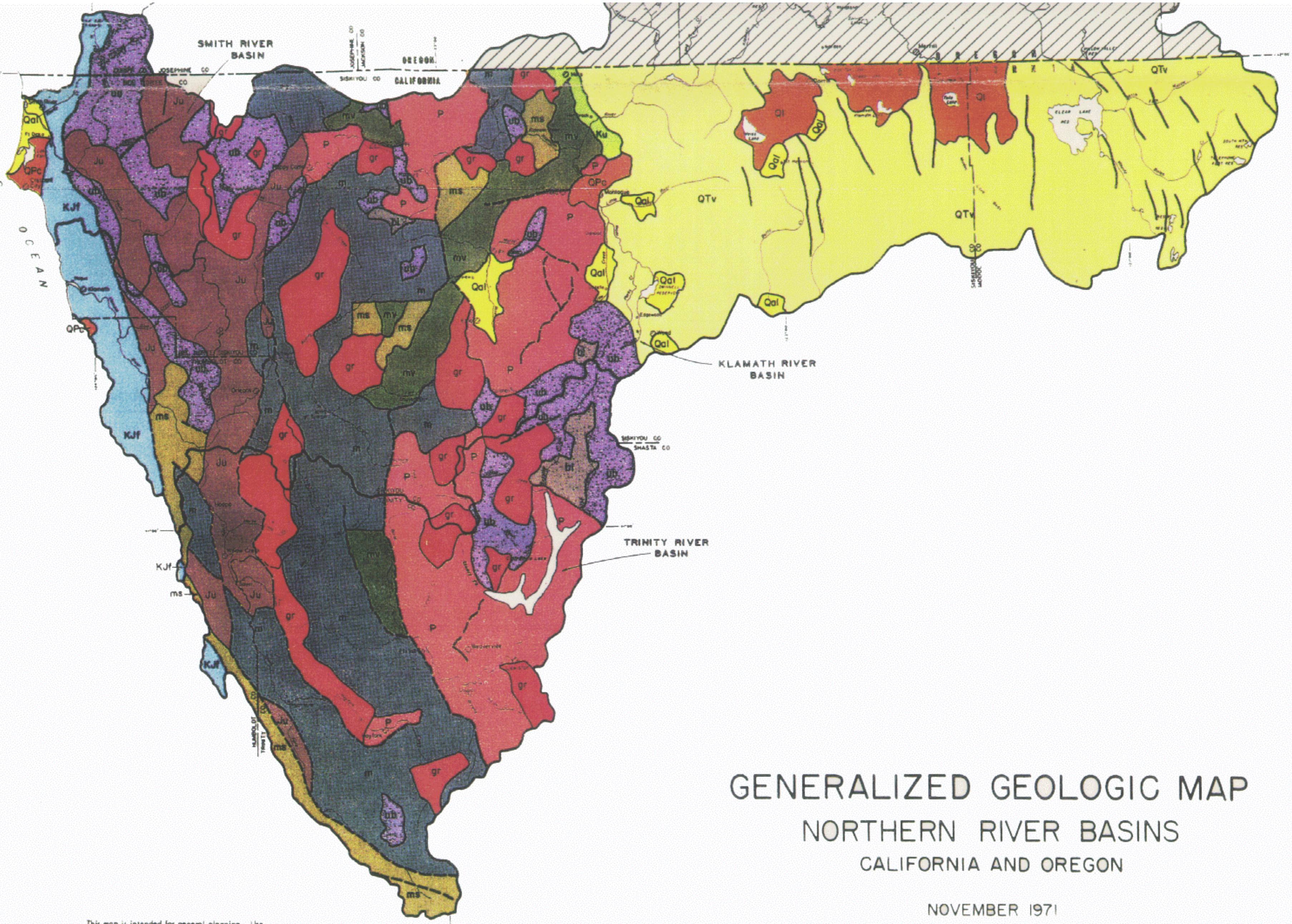
TABLE 2-2 -- Klamath National Forest Fires of 1987 Subbasin Acreage Burned by Level of Intensity[1].

		Intensity Burned in acres		
Watershed	Total Area Burned	High	Medium	Low
Elk Creek	24,329	1,956	10,979	11,394
Salmon River	78,128	13,832	17,325	46,971
Indian Creek	4,710	231	2,525	1,954
Thompson Creek	6,372	367	3,305	2,700
Clear Creek	20,341	1,662	8,433	10,246
Grider Creek	11,404	370	3,670	7,364
Scott River	8,649	684	2,488	5,477
Small tributaries	62,911	8,018	21,638	33,255
Total	216,844	27,120	70,363	119,361

[1] Compiled from compartment data provided by R. Van de Water.



LEGEND
Qal Quaternary alluvium and dune sand
Ql Quaternary lake deposits
clay, volcanic ash, diatomite, sand
QPc Pliocene-Pleistocene non-marine sedimentary deposits
clay, sand, gravel, sandstone, conglomerate
(includes minor marine terrace deposits)
QTv Quaternary-Tertiary volcanic rocks
basaltic, andesitic, and rhyolitic flows, dikes, tuffs, and volcanic ejecta
Ku Upper Cretaceous marine sedimentary rocks
Hornbrock Formation: arkosic sandstone, conglomerate, shale
KJf Franciscan Formation
graywacke (sandstone), shale, chert, altered volcanic rocks (greenstone), minor conglomerate
gr Mesozoic granitic rocks
bi Mesozoic basic intrusive rocks
hornblende gabbro, gabbro, dark diorite
ub Mesozoic ultrabasic intrusive rocks
pyroxenite, dunite, peridotite, serpentinite
Ju Upper Jurassic marine sedimentary and metasedimentary rocks
Galice Formation: slate, phyllite, tuffaceous sandstone
(includes minor Jurassic and/or Triassic metavolcanic rocks)
m Undifferentiated pre-Cretaceous metamorphic rocks
(includes some ms and mv)
phyllite, quartzite, chert, marble, metavolcanics
ms Pre-Cretaceous metasedimentary rocks
quartzite, phyllite, metachert, quartz-mica schist
mv Pre-Cretaceous metavolcanic rocks
greenstone, amphibolite, diabase
P Paleozoic sedimentary and metamorphic rocks
mudstone, shale, sandstone, conglomerate, limestone, tuff, greenstone, hornblende schist, quartz-mica schist
Contact
Fault; dashed where inferred
Basin Boundary
To be included in Final Report for North Coastal Area
SMITH RIVER BASIN
JOSEPHINE CO
JACKSON CO
SISKIYOU CO
OREGON
CALIFORNIA
DOUGLAS
KLAMATH
JACKSON
KLAMATH
KLAMATH LAKE
KLAMATH FALLS
QTv
Qal
Ju
mv
P
gr
Ql
LOCATION MAP
CURRY CO
DEL NORTE CO
HUMBOLDT CO
SISKIYOU CO
TRINITY CO
KLAMATH CO
LAKE CO
MODOC CO



GENERALIZED GEOLOGIC MAP
NORTHERN RIVER BASINS
CALIFORNIA AND OREGON

NOVEMBER 1971

5 0 5 10 15 20 MILES
SCALE 1:1,250,000

This map is intended for general planning. Use detailed maps for operational planning, and on site inspection for more detailed decisions.

M7-S-21456-N

Figure 2-4
Source: US SCS 1972

LAND MANAGEMENT

As Congress stated in the Klamath Basin Restoration Act, the region has a long history of fish habitat damage from various causes. How historic land management activities caused habitat damage and whether current activities are still contributing to the problem are discussed in this section.

TIMBER HARVESTING

Issues

* Concern about both short and long term effects of public and private forest management activities on fisheries resources.
* Habitat degradation from granitic sand accumulation as a result of logging activity on decomposed granitic soils.
* Effect of logging on riparian canopy over streams.
* Need to distinguish between impacts of past and current timber harvesting and road construction practices.
* Cumulative effects of timber harvest activities on watershed and stream habitat condition.
* Adequacy of current forestry regulations to protect fish habitat.

History

<u>Early Years: Pre-1900</u>

The commercial harvesting of timber in the lower Klamath Basin began about the same time as the commercial harvesting of fish in the river. One of the earliest ventures, in fact, was the "Klamath Commercial Company" in 1881, whose purpose was both lumbering and fishing at or near the mouth of the Klamath River. This first sawmill shipped only "hard lumber -- cedar, laurel, oak, etc." to Crescent City for reshipment to San Francisco (McBeth 1950). In 1890, another mill was built on Hunter Creek.

Upriver, the gold mining areas required "a great deal of timber," and by 1860, about 30 mills were located in Siskiyou County (Wells 1881). The arrival of the railroad in 1887 near Yreka helped develop the markets for timber in the upper Klamath area (Figure 2-5). As a result, a very large sawmill was built about 1889 on the river at Klamathon, near what is now Iron Gate Dam. The local paper reported at the time that 10 billion board feet of lumber was estimated "tributary to the Klamath River" (Jones 1953).

Figure 2-5 – Logging in Siskiyou County in the late 1890’s.

A wooden-wheeled logging cart pulled by a steam donkey.

Source: Siskiyou County Museum, Yreka

1900 - 1947

Logging began in the "Klamath Bluff" area about the close of World War I (Bearss 1981). Since no roads existed in the area, cedar logs were dropped into the Klamath River and floated to the mouth, to be made into ocean-going rafts. These large rafts were towed out to sea and down the coast from Klamath to Eureka during the 1920s and 1930s. The lumber industry "died prematurely" in 1939 in Del Norte County when a large mill shut down.

In Siskiyou County before World War I, local lumbermen had "only thinned the front ranks of the far-reaching files of forests" (French 1915). In Hilt, north of Yreka, the Fruit Growers Supply Company operated mills and a box factory in 1915 and planned that year to log and cut 30 million board feet of lumber (French 1915). Timberland sold for about $4-5 per acre in the 1920s and 1930s in the Scott Valley region, while timber sold for about $4.50 per thousand board feet in 1947 (O. Lewis personal communication). During the Depression, many new roads were built in the Klamath Basin with Civilian Conservation Corps (CCC) labor, opening up new territory for logging. By 1934, automobile roads paralleled the Klamath (except from Klamath

Glen to Pecwan Creek), Salmon, Scott, and Shasta rivers. In addition, roads had entered the smaller creek basins: Redcap, Indian, Elk, Seiad, Shackleford/Mill, French, Horse, Beaver, and Cottonwood (Taft and Shapovalov 1935).

A biological survey of the streams in the Klamath National Forest in 1934 made no mention of any aquatic problems related to logging. However, several instances of road construction cutting off spawning tributaries were noted: the road crews were "directing the streams through culverts whose lower ends terminate in vertical drops of fifteen to thirty feet, barring the way to spawning steelhead and salmon." Examples of such construction were located in Coon, Crawford, Little Grider, and Beaver Creeks (Taft and Shapovalov 1935).

Post-WWII Timber Boom to 1980

The post-war economy brought a boom to the lumber markets and local Douglas fir and redwood timber industry. Technological improvements also brought power saws, bulldozers, rafts, tugs, trucks, and trailers (Bearss 1981). From an annual level of 23.4 million board feet (MMbf) in 1947, timber production in Del Norte County rose to 305.7 MMbf in 1955 and, with annual fluctuations, peaked at 350.9 MMbf in 1964.

As a result of the rapid expansion, log rafting in the lower Klamath River came into conflict with sports fishermen, who claimed that this practice "contaminated the waterway with bark from the logs to an extent that the water was becoming untenable for fish life" (Bearss 1981). A bill was introduced in the 1955 California Legislature to prohibit all log rafting on the river between July 15 and October 15, but action was suspended while the industry tried to "do everything possible to make their operation ... compatible with the fishermen's right to use the river."

To investigate the issue further, the Assembly's Interim Committee on Fish and Game conducted local hearings and a field trip in August 1955. Where heavy logging was underway, they saw cases of "small creeks and streams tributary to the Klamath completely obliterated by earth moved into the stream bed from a 'cat' roadway and in other cases by being choked with logging debris" (California Assembly 1957). The damage from redwood slash and debris in some areas had been remaining for years. The results were presented in a 1957 Committee report, "Problems Relative to the Klamath River." While they concluded that there was insufficient bark in the river to harm fish life, the destruction of spawning grounds in the tributaries by current logging practices was a very great threat to fish life and "corrective action was urgently needed." (See "Regulations: Private Lands" for further discussion.)

Scott Valley's sawmill industry in the 1950s was a substantial source of local income, with four mills cutting 40,000 or more board feet per day, and about nine mills cutting 5,000 or more board feet per day (Mack 1958).

Not all of the region was opened up during this period. As of 1953, the state reported that in the southwest half of the Klamath River Basin, a "large portion of the timber resource is as yet untouched," with timber production about one-third of its sustained yield potential. This "untouched" condition was attributed to the rugged terrain, inaccessible timber, and lack of transportation (CSWRB 1954).

Areas of public lands in the Klamath Basin were first harvested at different times. The earliest logging was concentrated on the gentler terrain with easiest access, leaving the steeper areas for later development. In the Scott River Basin, U.S. Forest Service (USFS) records indicate that logging on public lands did not begin until about 1959. The remote Salmon River region initially opened up to road building and logging in the mid-1960s. The Hog Fire of 1977 burned 56,000 acres in that subbasin, with an estimated 450 million board feet being salvage logged over the ensuing five years (J. West, USFS, personal communication).

Land Ownership

Public Ownership

The U.S. Forest Service manages the majority of the forestlands in the basin. The Klamath National Forest was established in 1905 and covers 1.7 million acres, almost all of which is in the Klamath River Basin. The Six Rivers National Forest was created in 1947 from parts of the Klamath, Trinity, and Siskiyou national forests (USDI 1980). Public ownership of forestland in the basin was centered in the more remote areas, "especially on the upper watersheds of the many full-flowing streams." Originally, the U.S. Forest Service's activities were "largely devoted to the conservation of the water supply that means so much to the farmers in the valleys." By 1915, "large tracts" in Siskiyou County were being opened up for lumbering operations. (French 1915).

Some forest and range lands are also managed by the Bureau of Land Management (BLM), primarily in scattered blocks in the eastern portion of the basin. The agency's records show that most of its forestlands have been logged during the past few decades.

Private Ownership

Private timberlands originally developed on the more accessible tracts, which were nearest the two ends of the Klamath Basin with access to interstate highways or railroads. Timber owners would usually buy up new land from their profits to expand their holdings. Within Siskiyou County, about 600,000 acres are private timberland (Siskiyou County Assessor). The trend in the last decade has been consolidation of timberland ownerships. Presently, three large timber companies control the majority of these lands, while one company controls much of the lands tributary to the lower Klamath.

Tribal Ownership

Each of the three tribes has some forestland within its jurisdiction, ranging from 76,000 acres for the Hoopa Valley Tribe, to 3,840 acres on the Yurok Reservation, to about 100 acres for the Karuk Tribe. Most of these sites were logged in recent decades.

Forest Management Practices

Types of Silvicultural Systems

In California, forest management uses both even- and uneven- aged silvicultural systems. Even-aged management has three basic systems: clearcut, shelterwood, and seed tree. In contrast, uneven-aged management is done by selective harvest of individual trees. As shown and defined in Figure 2-6, each system has certain advantages and disadvantages (CDFFP 1988).

"Clearcutting," or "High Grading" (e.g., high quality trees removed, low value trees retained) was a common practice on private lands before about 1930, when "donkeys" and railroads were usually used in hauling the timber. Between 1930 and

Figure 2-6 – Advantages and Disadvantages Of the Silviculture Systems.

CLEARCUT SYSTEM	ADVANTAGES	DISADVANTAGES
Removal of the entire stand of trees in one cutting with reproduction by seeding or planting, or by natural reseeding from adjacent stands STRIP, PATCH, OR BLOCK cutting are modifications of the clearcut system	• The cost of logging and transportation are reduced. • Easier than other systems • New growth can lake advantage of full sunlight. • Replanting to more desirable species made easier, using improved stock. • Natural regeneration of intolerant species such as ponderosa pine • Small clearcuts provide an edge effect and improve habitat for many wildlife species • Complete conversion of brushfields, diseased, or degraded stands	• Total removal of forest cover • Risk of erosion. • No merchantable materials for many years from the area harvested • No direct seed source; planting of desired species required • Aesthetically controversial • Vegetation control of undesired species often needed
SEED TREE SYSTEM:	**ADVANTAGES**	**DISADVANTAGES**
Removal of the mature limber in one cutting, except for a small number of trees left singly or in small groups to reseed the site	• Superior trees retained as seed source • The cost of logging and transportation arc lower than shelterwood or selection. • Easier than shelterwood or selection • New growth can take advantage of full sunlight • Regeneration less costly than planting	• Risk of blowdown • Many seeds must be available to be dispersed by the wind • Scarification of topsoil needed for desired regeneration • Vegetation control of undesirable species may be needed.
SHELTERWOOD SYSTEM:	**ADVANTAGES**	**DISADVANTAGES**
A regeneration cutting in more or less mature forest designed to establish a new crop under the protection of an overstory. Enough mature trees are left uncut to shelter the site until new growth is well established	• Regeneration is more certain than seed tree • Superior trees retained as seed source • Seedlings develop in the shelter and shade of the older stand • Site is protected • Less risk of erosion than seed tree or clearcut • Slash disposal less often necessary	• Markets must be available for small and low quality trees • Greater skill in logging is necessary • Risk of damage to residual trees during logging • Risk of blowdown • Not suitable to regenerate all species, i.e.. intolerants such as ponderosa pine. • Greater inspection of logging operations needed
SELECTION SYSTEM:	**ADVANTAGES**	**DISADVANTAGES**
Removal of mature timber, and thinning of intermediate sized trees either as single, scattered individuals, or in small groups at relatively short intervals, repeated indefinitely, or by means of which the continuous establishment of reproduction is encouraged and a balanced stand is maintained	• Volume of growth is sustained or increased for the life of the stand. • Resulting stand can be left with desirable trees or species. • Reduced blowdown problem • Advantageous for wildlife adapted to later seral stages. • Aesthetically least controversial • Least risk of erosion on site	• Markets must be available for small and low quality trees. • Greater skill in logging is necessary • Risk of damage to residual trees during logging • Cost of logging tends to be higher • Reproduction of some valuable shade intolerant tree species may be difficult • Highest degree of supervision required • Requires most frequent entries, access

Source: Modified from Meeks, 1982 in: CDFFP, 1988.

1960, selective cutting was the general practice in California when tractors and trucks began to be used. Starting in about 1960, clearcutting of the entire stand, using highlead and tractor yarding, became the predominant method in the redwoods but was also applied elsewhere (ESA 1980). It had become more attractive to private landowners for primarily economic reasons (Arvola 1976).

The type of silvicultural system used today depends on the forest characteristics and landowner, as well as the economic forces. For private lands harvested in 1985, 35% of the proposed harvested acres in the Northern District (includes most of Siskiyou and Trinity Counties) were using even-aged systems (primarily seedtree and shelterwood) while 90% of the acres in the Coastal District (includes Del Norte and Humboldt Counties) were applying even-aged systems. The differences in use of the silvicultural systems are attributed to the relative success rate and cost-effectiveness of regeneration of the different species (e.g., redwood vs. Douglas fir vs. ponderosa pine) and the site quality. On the national forests, clearcutting became a larger share of the acres harvested, accounting for 46% of the total in 1986 in comparison to 28% in 1977 (CDFFP 1988).

Causes of Timber Harvesting Impacts

Although "any harvesting system will have some negative habitat impacts," the extent to which each type of harvest affects the stream habitat depends considerably on the choice of equipment, geographical layout of the harvest unit, and the mode of operation. These methods include tractor, highlead cable systems, skyline systems, and helicopters. (Hartsough 1989)

Roads associated with timber harvesting account for a sizeable portion of the erosion from logged areas (Weaver et al. 1987). Poor road design, location, construction, and maintenance can cause erosion of all types: mass soil movement (slide, slump, debris flow, earth flow), surface (sheet and rill), gullies, and streambank (Brown 1988). Harvesting has expanded from established roads into more difficult terrain, and therefore into areas of greater environmental risk.

One local study evaluated 237 miles of roads on 30,300 acres of commercial timberland in the Six Rivers National Forest (McCashion and Rice 1983). Total erosion averaged about 4.5 cubic yards per acre, while average erosion on the road rights-of-way was 47 cubic yards per acre, or 17 times the average erosion in the timber harvest areas. Overall, the road network contributed 40% (on less than 1% of the disturbed acres) and the logged area 60% of the total erosion, percentages which are similar to studies in Oregon. While roads recover more slowly than harvest sites, the harvest sites will be disturbed each time they are entered for additional cutting, the researchers noted, and will therefore add an increased proportion of erosion in subsequent years.

In a study of timber harvesting on private lands in interior northern California, soil loss measurements averaged about 80 tons/acre/year and sediment reaching the stream averaged 50 tons/acre/year, "mostly from roads" (USFS 1983). Mass wasting (landslides and debris slides) induced by roads was the major source of erosion and sedimentation, and culvert failures were the greatest single road-related problem. Unmaintained roads continue to plague many watersheds as private landowners are not required to maintain logging roads after completion of a timber harvest plan (Weaver et al. 1987).

Cumulative Impacts from Timber Harvesting

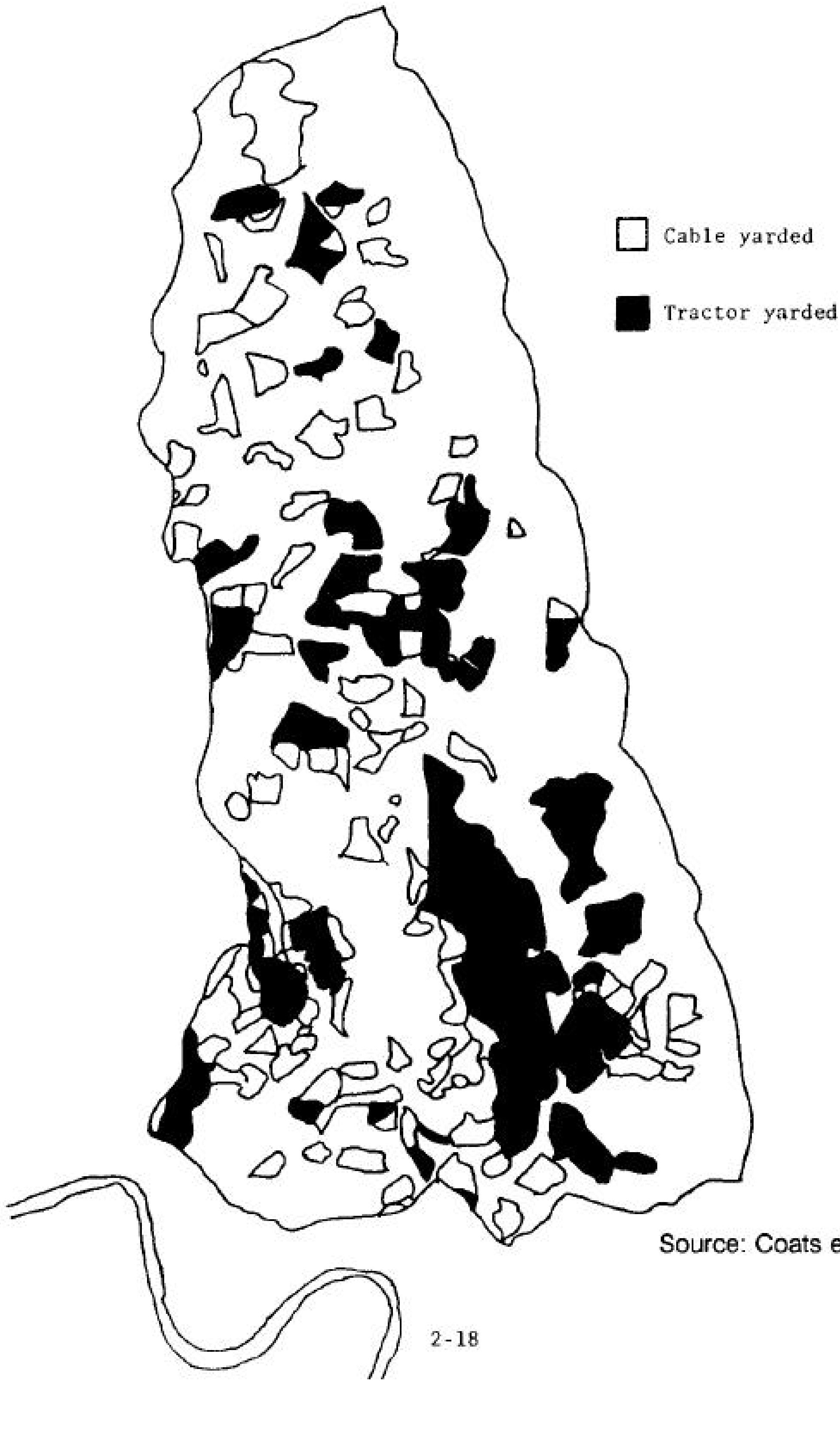
The issue of cumulative impacts first came to public attention primarily because of the requirement in the 1969 National Environmental Policy Act (NEPA) and the 1970 California Environmental Quality Act (CEQA) to address such impacts in the preparation of Environmental Impact Statements (EIS) and Reports (EIRs). Recent court decisions in California have upheld complaints that timber harvest practices on private lands were ignoring cumulative impacts (Coburn 1989). Additionally, the 1972 federal Clean Water Act's Section 208 (as amended) requires water quality plans to cover "silviculturally related nonpoint sources of pollution ... and their cumulative effects" and "to set forth procedures and methods (including land use requirements) to control to the extent feasible such sources."

During the past two decades, considerable effort has been made to better understand the subject. One such study describes how timber harvesting relates to cumulative impacts (Coats et al. 1979): "Cumulative effects are long-term effects that accumulate over space or time. In one sense, any lasting effects are cumulative over time, but because of the nature of watersheds, some effects of silvicultural activities may occur off-site, downslope or downstream from the area of the original timber harvest plan. Thus, the overall effect of an operation, and of multiple operations in the same watershed, may be quite different than the immediate on-site effects of a timber operation reviewed in isolation." The possible negative cumulative effects on the watershed from timber harvesting include streamflow changes and erosion and sedimentation effects.

In a 1972 North Coast stream study, sustained logging was found to prolong adverse conditions and delay stream recovery. The researcher recommended that logging operations "should be implemented in the shortest time possible and then the watershed left to recover." Recovery was also improved by scheduling the major logging operation after the stream had recovered from the road construction (Burns 1972).

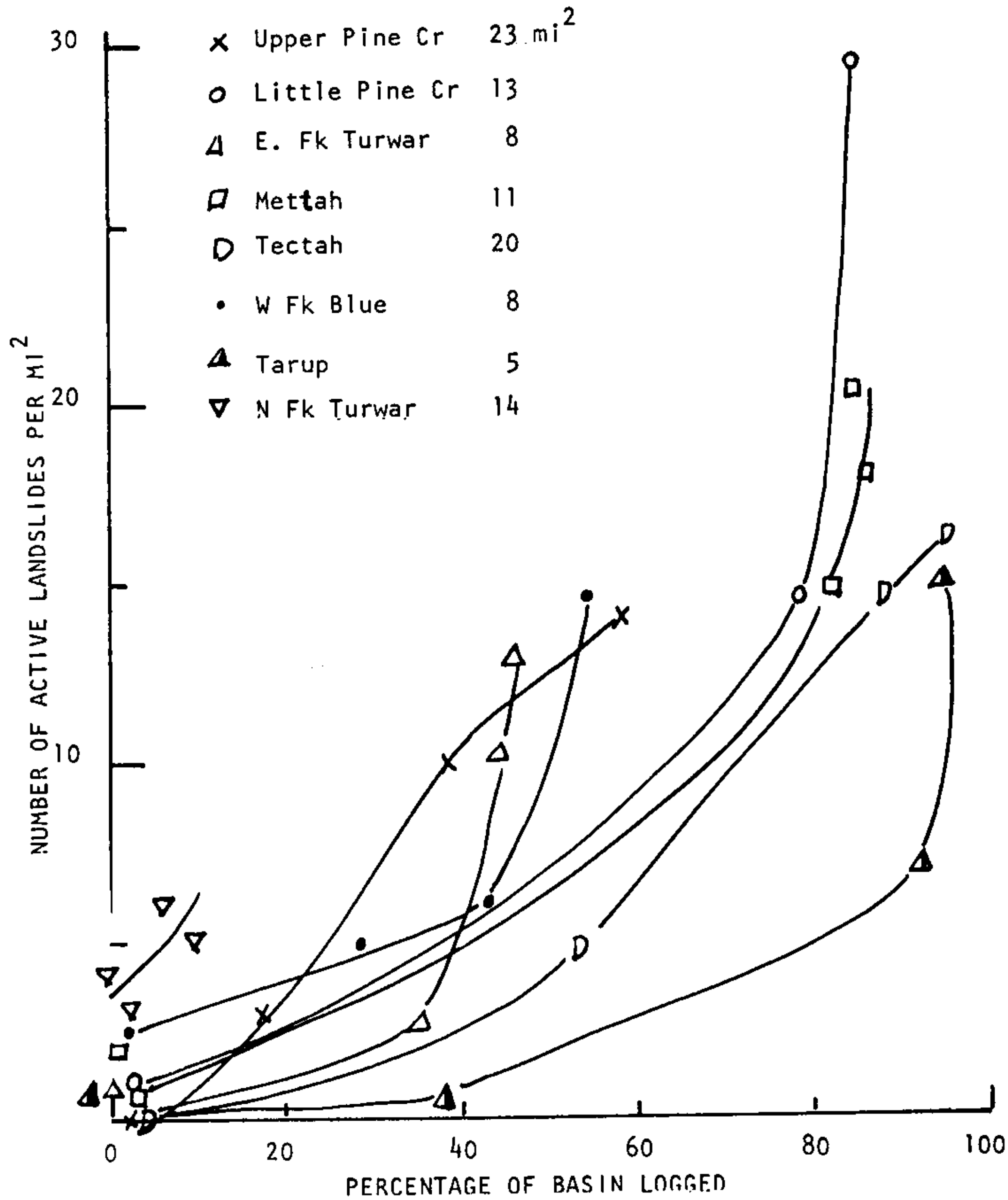
Turwar Creek, located in the steep, unstable, and wet area of the lower Klamath River Basin, was the subject of several cumulative effects evaluations (ESA 1980, Leopold 1981, Coats et al. 1979, CDWR 1982a). Logging in the lower part of the basin began before 1962 and in the upper basin in 1975. Between 1970 and 1978, 32.5 percent of the watershed was clearcut, about half cable-yarded and half tractor-yarded (see Figure 2-7). Roads, landings, skid trails, and layouts amounted to 8.7 percent of the basin. An analysis of aerial photos over time revealed a "dramatic increase in frequency and activity of mass movement associated with progressive timber harvest," but with a delayed reaction time. With such a large amount of soil disturbance, the

Figure 2-7 – Tractor and cable clear-cut units in the Turwar Watershed (1970-1979).



Source: Coats et al. 1979

Figure 2-8 – Effects of various percentages of basin logged for timber harvest on number of landslides per square mile, Lower Klamath Basin, California.



Source: Leopold, 1981.

watershed was considered in 1980 to be at the point where increased stormflow peaks could result, "with implications for bank erosion and aggradation downstream" (Coats and Miller 1981).

Such aggradation did result and was obvious in Turwar Creek in 1989 (Caltrans 1989, S. Downie personal communication). In the lower section, streamflow now goes subsurface during late summer and fall, blocking access to fall chinook and possibly other species. Only steelhead now have access to the stream. Habitat restoration efforts upstream are of questionable effect because of the continuing aggradation and lack of a permanent solution to the present blockage.

Eight lower Klamath tributaries were also analyzed for landslide frequency. The results (Figure 2-8) indicate a geometric increase in landslide frequency for all but two of the streams (Leopold 1981). Between 1940 and 1960, 77% of Little Pine Creek was harvested. Landslides in the watershed averaged 1 per sq. mile in 1950 but jumped to 30 per sq. mile in 1965. While the 1964 flood obviously exacerbated the situation, the watersheds were more vulnerable as a result of land management activities. Leopold concluded that "the effects not only accumulate with each increment of land surface disturbance, but each increment has a larger effect than the preceding one."

Such a rapidly increasing rate of change indicates a threshold being exceeded. As a result, the naturally resilient watershed system is finally thrown out of equilibrium.

Impacts of Timber Harvesting on Salmon and Steelhead

Over the years, many studies have been made of the effects of logging practices on water quality, streamflow, and aquatic habitat. It is not the intent here to provide an exhaustive review of the literature, but to highlight some of the latest findings, particularly those from case studies in the Klamath Basin. In California, biological concern initially focused on log jams blocking access by salmon and steelhead to spawning grounds. Later, interest expanded to streambed damage and to "erosion resulting from improper road and skid trail construction on steep terrains" (Burns 1972). Local examples of habitat damage in the Klamath Basin are also described in Chapter 3 -- Habitat Restoration.

Stream habitat impacts, potentially resulting from timber harvest activities, can be grouped into the following categories:

- Riparian cover
- Water Quality
- Streamflow/runoff
- Streambed quality
- Instream cover
- Stream channel stability
- Migration barriers
- Aquatic organisms

Riparian Cover

Riparian vegetation is called the "benchmark criterion for ideal salmonid environs," providing water-cooling shade, bank-stabilizing roots, sediment-trapping vegetative litter, and insect-bearing branches and leaves (CBOF 1987). If too much streamside vegetation is removed through logging practices, then the results could include: lethal or sub-lethal water temperatures (too hot in summer and too cold in winter), eroding streambanks, excessive fine sediment, and lack of food for fish. Such impairment of spawning and rearing habitat would then lead to lower salmon and steelhead production.

The functions of the riparian zone as they relate to the stream system are described in Figure 2-9a, while vegetation changes in the riparian zone through time following clearcutting, wildfire, or other disturbances are shown in Figure 2-9b.

Water Quality

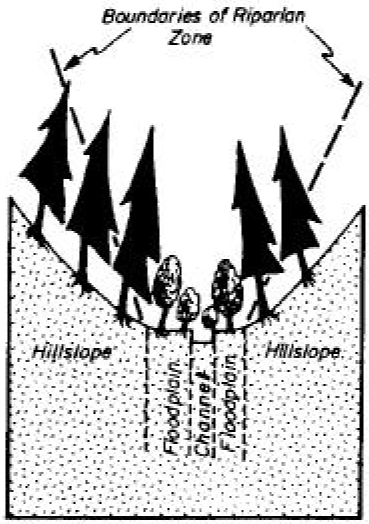
Turbid water, high temperatures, low dissolved oxygen levels, and herbicides are the main water quality problems attributed to improper timber harvest and silvicultural practices.

Soil from bare slopes, skid trails, and logging roads can erode during storms and end up in streams if adequate protections are not employed. Fine sediment (clays and silts) can stay in suspension and cause turbid water conditions. Persistently high concentrations of suspended sediment can cause silt to accumulate on the fish's gill filaments and inhibit the ability of the gills to aerate the blood, which could lead to death (Cordone and Kelley 1961). In addition, muddy water impedes sport fishing. As flows diminish, the sediment will deposit on the streambed (see Streambed Quality discussion below).

Removing a significant amount of the riparian canopy will likely lead to more extreme stream temperature fluctuations as well as increased mean and maximum temperatures. Temperature changes affect the rates of salmonid egg development, rearing success, species composition, and other factors. For example; stressful temperatures will lower fish production by increasing the metabolic rate and decreasing disease resistance, thereby decreasing the ability of the fish to compete (Beschta et al. 1987). Young coho salmon prefer cooler temperatures than chinook salmon or steelhead trout and will therefore not compete as well in streams warmed from the effects of logging (Moyle 1976).

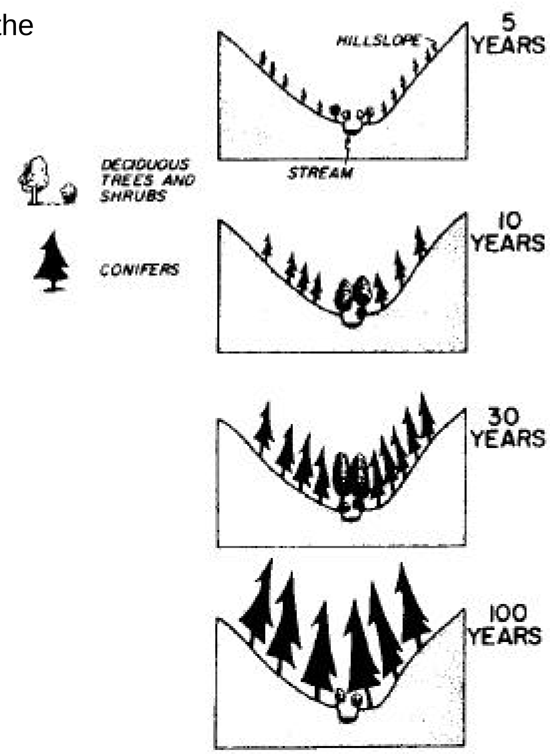
The amount of dissolved oxygen within the stream is inversely related to the temperature and the nutrient levels: the higher the temperature and nutrient concentrations, the lower the dissolved oxygen levels tend to be. Too little dissolved oxygen can be lethal to salmonids, with initial stress symptoms showing up at levels of about 6.0 mg/l (Reiser and Bjornn 1979).

Figure 2-9a – Extent of riparian zone and functions of riparian vegetation as they relate to aquatic ecosystems.



	RIPARIAN VEGETATION	
SITE	COMPONENT	FUNCTION
above ground-above channel	canopy & stems	1. Shade-controls temperature & in stream primary production 2. Source of large and fine plant detritus 3. Source of terrestrial insects
in channel	large debris derived from riparian veg.	1. Control routing of water and sediment 2. Shape habitat - pools, riffles, cover 3. Substrate for biological activity
streambanks	roots	1. Increase bank stability 2. Create overhanging banks - cover
floodplain	stems & low lying canopy	1. Retard movement of sediment, water and floated organic debris in flood flows

Figure 2-9b – Changes in the riparian zone through time.



Source: Meehan et al. 1977

Stream contamination from herbicides could prove toxic or growth inhibiting to salmonids. Studies of the effects of the herbicide 2,4-D by CDFG indicated that chinook salmon were more sensitive than steelhead-rainbow trout and that fry were more sensitive than smolts (Finlayson and Verrue 1983). Maximum safe chronic exposure concentrations of 2,4-D were determined to be 40 parts per billion (PPB).

Streamflow/Runoff

Historically, forest cover was viewed as helping to equalize the streamflow during the year by making the low stages higher and the high stages lower. As a result of this mitigating influence, forests were thought to reduce the severity and destructiveness of large floods. The national forests were originally established by Congress for the primary purpose of protecting the downstream water users from flooding and sedimentation (Hays 1974).

The relationship between forest removal and runoff patterns is considered more complicated today and studies continue on the effects. We do know that the streamflow increases in the first year following clearcutting, and that the increase is proportional to the reduction of the vegetation cover. As forest cover returns, runoff declines (Dunne and Leopold 1978). Peak discharge from storms is also increased as the result of timber harvesting and its associated soil compaction (which reduces infiltration rates), particularly for storms of moderate magnitude. Forest practices have only a small effect, however, on the discharge from heavy, prolonged storms (Leopold 1981).

Streambed Quality

Soil erosion can contribute fine sediment to the streambed, which can directly affect fish survival. By filling in the spaces between spawning gravels, the fines impede the circulation of oxygen to the embryos and fry lying in the spawning redds. Both laboratory and field studies have shown an inverse relationship between survival from egg deposition to emergence and the amount of fine sediment (Everest et al. 1987). In addition, increased sand concentrations resulted in earlier emergence, more prematurity, and smaller fry, all of which reduce survival. Food sources are also reduced, as lower densities or diversity of aquatic insects are found in heavily sedimented riffles.

By filling in pools, sediment reduces the amount of critical habitat for the rearing of juveniles or holding of adults (in both summer and winter).

Excessive sand deposits in spawning and rearing habitat of the upper Scott River, Cottonwood Creek, and Beaver Creek are attributed to upstream roads and logging on decomposed granitic soils and previous flood deposits (CH2M-Hill 1985). Sand in the Scott River continues to migrate downstream to the lower river, where it was not so extensive in the early 1980s (J. West, USFS, personal communication). The impact of the sand on spawning habitat in the Scott River is currently being evaluated in a study by the Siskiyou Resource Conservation District through Task Force funding.

Spawning salmon and steelhead can significantly reduce amounts of fines from redds. This is an adaptive trait to help survival in marginal habitats. One theory is that large annual spawning escapements are needed to maintain high quality spawning habitat. "When populations of spawning adults are reduced by habitat degradation or overfishing, the overall quality of spawning habitat may decline, because the annual cleaning effect exerted by spawners is diminished" (Everest et al. 1987).

Instream Cover

Instream cover provides places for fish to hide from predators, to find food, or to rest. Examples of cover include boulders, logs, deep water, overhanging vegetation, and tree roots. Logging practices could remove this cover by damaging the riparian vegetation or the streambank (Chamberlin 1982). Large trees that have fallen into streams ("large woody debris") can help scour out much needed pools and provide high quality habitat. In managed forests, however, the trend is toward smaller and fewer pieces of wood in the stream channels. The loss of instream cover in young-growth forests may have the most significant impact on over-wintering salmonid populations in some locations (Sedell et al. 1988).

Stream Channel Stability

Extensive channel changes resulting from past logging and road building have been well documented in certain North Coast watersheds (Kelsey 1980, Hagans et al. 1986). With the combination of steep slopes, erosive and landslide-prone soil, and intense rainfall, the coastal region is vulnerable to greatly increased rates of sediment deposition when large areas of vegetation are removed and bare soils are exposed (e.g., clearcuts, skid trails, landings, roads). The excess sediment in the channel causes the banks to erode, which undermines unstable slopes and stimulates mass movement of hillsides into the stream (Dunne and Leopold 1978). Large accumulations of logging debris in a stream (as opposed to intentional placement of large woody debris) can also deflect flows, accelerating streambank cutting, or it can temporarily trap sediment, damaging the downstream channel when it fails (Erman et al. 1977).

Migration Barriers

Historically, log jams were the most obvious migration barrier resulting from logging. The 1964 flood exacerbated the situation by bringing an excessive amount of logging debris into local stream channels and blocking access (CDFG 1965). Other potentially serious barriers to fish passage are: landslides, poorly designed culverts at road crossings, loss of resting pools due to sedimentation, and heat barriers in large open areas where riparian canopy is removed (Chamberlin 1982). Aggradation of the lower reaches of several heavily logged tributaries of the Klamath River (e.g., Blue Creek, Roach Creek) is making the water go subsurface or become shallow and braided at their deltas, which blocks access to spawners during low water (ESA 1980, Payne 1989).

Aquatic organisms

Stream invertebrates, which are the primary food source for young salmonids, are directly affected by certain stream conditions: sedimentation, water quality, and light. In a study which included 15 streams on the Klamath National Forest, the major change in the invertebrate community caused by logging in the riparian area was the decrease in community diversity (Erman et al. 1977). Less diversity, the researcher noted, usually means less ecological stability, implying that logged streams were less stable. Changes in the invertebrate community were most significant in streams without adequate stream protection measures: "those streams with narrow bufferstrips (less than 100 feet) showed effects comparable to those found in streams logged without bufferstrips" (Erman et al. 1977). Many of these documented impacts can reportedly be avoided or reduced with the "implementation of appropriate practices" (CBOF 1987).

Reducing Timber Harvesting Impacts

Some general principles for logging operations and forest roads have been recommended to limit or prevent damage to fish habitat (Hartsough 1989, Furniss and Roelofs 1989, Weaver et al. 1986):

- Prevent erosion wherever possible.
- Minimize the risks of eroded material entering streams.
- Create little or no direct physical disturbance to the streams from logs or equipment.
- Minimize reduction of shading of streams.
- Retain larger trees in the riparian zone for future recruitment of large organic debris.
- Ensure that fish migration is provided for at stream crossings.
- Reduce or avoid the alteration of hillslope drainage patterns.

How to best protect fish habitat is still being researched and debated. In western Oregon and northern California, for instance, intact buffer strips 30 meters (100 feet) or more in width along small streams apparently provide as much shade as an old-growth forest (Erman et al. 1977; Beschta et al. 1987). Others believe that only a no-cut policy in the riparian or stream protection zone can maintain the supply of large organic debris needed in the streams (B. Franklin, Hoopa Valley Tribe Fisheries Department, personal communication). Many of these principles are now incorporated into current practices or mitigation measures required by the State Board of Forestry and the U.S. Forest Service.

Remedial actions are also taking place on previously harvested sites: corrective road maintenance and improvement, drainage and erosion control on skid trails, reforestation, and revegetation. Cooperative Road Agreements help reduce adverse cumulative effects due to road construction by sharing roads between ownerships (R. Dragseth, Fruit Growers Supply Co., personal communication).

Herbicides used to control competing vegetation on timberlands are another concern. The chemicals 2,4-D and Garlon are presently the most commonly used, either through aerial spraying or hand application. They are mainly applied in the spring and fall months. With steep slopes and heavy rainfall typical in the Klamath Basin, risk is involved in the herbicides entering streams during or after use. Best Management Practices (BMPs) are currently being used to reduce the risk of water quality contamination on public and private lands, although debate continues over the effectiveness of the BMPs.

Timber Harvest Regulations for Private and Public Lands

<u>Private Lands: Board of Forestry</u>

Government regulation of private timber lands in California has a tortuous history and is still evolving. In 1885, California was the first state in the nation to have a State Board of Forestry. Initially, laws mainly addressed fire prevention and slash disposal (Arvola 1976). The first Forest Practice Act affecting forest management was passed in 1945, but its effort was "to be one of education and persuasion because of the philosophical tone behind its formulation and the lack of any misdemeanor, criminal, or civil penalties in the law."

Gradually, the Act was amended, although the intent remained to protect the productivity of timberlands and not other resources. In 1951, the Fish and Game Code was amended to prohibit the blockage of streams in the North Coast district and the California Department of Fish and Game began an education effort for timber operators about the new law. In 1953, the first erosion control rule was developed by the Redwood Committee of the Board. California Department of Fish and Game, along with various public groups, continued to advocate stream protection during the 1950s and 1960s, but these attempts were always defeated. The devastating effects of the 1964 flood, in the North Coast, definitely intensified public concerns about the relationship of forest practices to soil erosion and stream and fisheries damage (Arvola 1976).

Years of debate culminated in the passage of the Z'Berg-Nejedley Forest Practice Act of 1973, and in the adoption of the implementing Forest Practice Rules in 1974. This law provided a major change in the way forest practices were regulated in California and at last addressed some non-timber values. However, stream protection proponents and others were still not satisfied that their concerns were adequately resolved. Challenges to the rules were made the following year under the California Environmental Quality Act of 1970 (CEQA), demanding that an Environmental Impact Report (EIR) be made for each timber harvest plan. With the adoption of tighter controls, the Board of Forestry's regulatory program was exempted from the EIR requirement, following the program's certification by the Secretary for Resources. However, it remains subject to other provisions of CEQA, "such as the policy of avoiding significant adverse effects on the environment where feasible" (Section 15250 of State CEQA Guidelines). A forest policy observer concluded that "CEQA has been responsible for much of the change in forest practices that has occurred over the life of the Forest Practice Act" (Green 1982).

One of the most obvious improvements was the elimination of the common practice of dragging logs with heavy machinery down stream channels. Stream buffer zones must now be left in certain areas. Instead of focusing on penalties after the damage is done, the emphasis has shifted to prevention of damage. (Green 1982)

Other State laws have also resulted in significant improvement in timber harvest practices. These laws include: the Forest Taxation Reform Act of 1976 (the Yield Tax Law), which eliminated the tax penalty for owning standing timber and has given a tax incentive for letting timber grow to a larger size by providing for restrictive zoning and reduced property taxes of timber producing land placed by counties in a Timberland Production Zone (TPZ); the Professional Foresters Law of 1972, which sets standards for registering and licensing foresters in the state who are responsible for management of private timberlands; Sections 1600-1606 of the Fish and Game Code, which require mitigation conditions be agreed to by California Department of Fish and Game for streambed alterations.

CEQA continues to be the basis for litigation concerning the adequacy of current forest practices. Recent court cases have ruled against CDF for its timber harvest plan (THP) review and decision-making process for failing to address certain CEQA requirements (e.g., Sierra Club vs. CDF, EPIC vs. Johnson, EPIC vs. MAXXAM).

Besides CEQA, the other most influential legal force is Section 208 of the federal Clean Water Act and its amendments. This section deals with "nonpoint" sources of pollution, of which soil erosion is one of the most common. After more amendments in the rules, the State Water Resources Control Board in 1988 conditionally certified the Forest Practice Rules as being the "Best Management Practices" (BMPs) to prevent stream sedimentation. Although a four-year monitoring and assessment program was placed on the certification, the program has not been done to date. The effectiveness of the new rules and their amendments in protecting the beneficial uses of water has only been evaluated by the Board of Forestry's interdisciplinary "208 Assessment Team," with the findings released in a 1987 report. The study team made visual observations and no quantitative measurements "because of study limitations."

One overall observation of the 208 team was the general improvement:

> Severe and extensive damage to stream systems was still evident from timber operations conducted as late as the middle 1970s. With very few exceptions, the adverse effects of operations conducted under the current rules and process are minor compared to those of earlier operations. The team was impressed by the relative improvements which have been made under the current forest practice program in protecting water quality.

However, the team also concluded that **"actual forest practices as currently conducted under the rules and process do not provide the best feasible protection of the beneficial uses of water."** Some practices were quite adequate while others were definitely inadequate. Observed problems included noncompliance with the rules; roads and landings placed too close to streams, lack of standards for site preparation activities, and others. Specific recommendations were also made to address these problems; rule changes, training, consultations, and administrative actions.

As a result, some significant changes have occurred since 1987. Improvements in the Forest Practice Rules for "Erosion Control and Site Preparation," "Watercourse Protection," and "Roads and Landings" have either been adopted or are pending adoption (J. Steele, CDFG, personal communication). Since these improvements are in a state of flux, the Task Force will need to monitor the changes and update this section of the plan periodically. As of January 1, 1990, review teams composed of staff from California Department of Fish and Game (CDFG) and the North Coast Regional Water Quality Control Board (NCRWQCB) are specifically allowed to participate in inspections of timber harvest plans (THP) with CDF staff, and their agencies now have the right to appeal a THP. Timber operators must now be licensed and complete a course about current forest practice rules. Continuing education classes are being offered on harvesting issues by CDF and others.

Other improvements still needing completion are: database development, watershed planning, surveillance monitoring and special studies, and guidance documents and training programs that discuss near-stream and in-stream conditions requiring protection measures by foresters and timber operators.

To date, the U.S. Environmental Protection Agency (EPA) has not certified the State Forest Practice Rules. It is reportedly waiting for a "cumulative effects assessment" procedure as well as a BMP effects assessment program to be adopted by the Board of Forestry. As follow-up, the RWQCB staff in the North Coast is directed by its Board to "investigate and review, on a continuing basis, logging operations, road building, and related construction activities within the region to determine the effect, or potential effect, of such activities on water quality" (NCRWQCB 1989).

In sensitive areas where the current rules have not seemed adequate, the Board of Forestry and CDF staff have promoted special measures. One example is the "Recommended Mitigation Measures for Timber Operations in Decomposed Granite Soils with Particular Reference to Grass Valley Creek and Nearby Drainages," which offers alternative yarding system and road location suggestions for these fragile soils (CDF 1986). These special measures are under constant review and modification.

Herbicide use is regulated by the California Department of Food and Agriculture and the County Agricultural Commissioners. The county can issue a Cease and Desist Order and a fine of up to $1,000 for violations. It inspects some of the application sites (S. Thornhill, Siskiyou County Agricultural Department). The North Coast Regional Water Quality Control Board has set a zero discharge level for 2,4,5-T and a 10 parts per billion discharge level for all other herbicides. It has waived waste discharge permits for most herbicide spraying on private lands, assuming that the Best Management Practices are adequate to protect water quality, but permits can be issued on a case-by-case basis when needed (NCRWQCB 1989). Monitoring over the past 5 years has detected only infrequent minor violations (C. Green, NCRWQCB, personal communication).

Public Lands: U.S. Forest Service

Timber harvest activities of the U.S. Forest Service (USFS) are regulated by many federal laws. Under the Multiple Use and Sustained Yield Act of 1960, formal recognition was given to all types of resource uses in the management of the national forests. Timber production is one of the uses along with watersheds, fish, and others. In 1969, the National Environmental Protection Act (NEPA) promoted the thoughtful evaluation of potential impacts on the environment before a federal action, like a timber-harvesting program on national forests, occurs. As a result, an Environmental Impact Statement (EIS) and public involvement is required when a federal action may cause a significant impact on the environment.

Quite a few EISs have been prepared on proposed actions of the Klamath and Six Rivers National Forests over the last decade, with at least two currently pending on fire salvage sales (USFS 1989a; 1989b). Mitigation measures to prevent possible damage to fish and water quality must be included in each EIS.

As a result of public concern over logging practices on national forests, Congress passed the National Forest Management Act of 1976 (PL 94-588). One major change was the specification of a new planning process for each forest. The new land management plans must follow policies to achieve the goals of the Act. For stream habitat, the pertinent policy is: (Sec. 6 (g)(3)(E))

> ... insure that timber will be harvested from National Forest System lands only where--
>
> (i) soil, slope, or other watershed conditions will not be irreversibly damaged;
> (ii) protection is provided for streams, streambanks, shorelines, lakes, wetlands, and other bodies of water from detrimental changes in water temperatures, blockages of watercourses, and deposits of sediment, where harvests are likely to seriously and adversely affect water conditions or fish habitat.

Although a new forest-wide plan is currently being prepared for the Klamath National Forest (KNF), current timber management direction comes from its 1974 Timber Management Plan. Additionally, each Ranger District has a District Multiple Use Plan. However, Regional Standards and Guidelines adopted by the U.S. Forest Service in 1984 are more restrictive than the 1974 Plan and District Plans, and must be incorporated as minimum standards and guidelines in new Land Management Plans (LMPs) (USFS 1984). These standards and guidelines also currently guide all USFS projects. An interim timber sale program adjustment was made in June 1989 as a result of spotted owl and 1987 fire recovery concerns (L. West, KNF, 1990).

The land management planning process for the Klamath National Forest has been in development for about 10 years. One draft was released for public comment in 1982. That Draft EIS/Plan was withdrawn by the Regional Forester in mid-1983 because of the new Regional Standards and Guidelines (B. Rice, USFS, personal communication). The new draft is expected for public review in 1991. On the Six Rivers National Forest, the most recent Draft Land Management Plan was issued in 1987 and withdrawn in 1990 as the result of the spotted owl habitat conservation areas and the newly designated Smith River National Recreation Area. The new draft is expected for release in 1992.

As with the State Board of Forestry, the federal Clean Water Act's provisions for controlling nonpoint sources of pollution (Sect. 208) required the Forest Service to reevaluate its timber harvest practices and mitigation measures. "Best Management Practices" (BMPs) to protect water quality were also proposed in a 1979 document entitled "Water Quality Management for National Forest System Lands in California." After review and negotiations with the North Coast Regional Water Quality Control Board and the State Water Resources Control Board, the Forest Service's "208 Water Quality Management Plan," and its accompanying BMPs (including herbicide use) were certified by the State Water Resources Control Board and approved by EPA. A monitoring program was not required of the USFS but its method to evaluate cumulative impacts was withheld from certification pending further review (G. Lee, SWRCB, personal communication). The USFS has deferred herbicide use since 1983 in California due to a court injunction. Resumption of use will be addressed in each LMP.

Cumulative Impact Analysis Methods are Still Debated

The "threshold of concern" is a key factor in the Cumulative Watershed Effects (CWE) analysis method now used by the U.S. Forest Service in California (Coburn 1989, USFS 1989b). It focuses on quantitative measurements of watershed disturbances (roads and landings, wildfire, harvest and site prep), weighted by equalizing coefficients, to come up with values for each subbasin. If this disturbance value exceeds the watershed's determined threshold value, then the stream system is at risk of damage, if it has not already occurred. Forest managers are to then decide whether to:

A. Adopt less intensive management activities.
B. Defer activities.
C. Initiate substantial watershed rehabilitation projects.

Such a CWE analysis was done by the Six Rivers National Forest in Grouse Creek of the South Fork Trinity River. The agency has concluded that cumulative watershed impacts due to private timber harvesting requires the deferment of federal timber harvesting while an EIS is prepared to evaluate the available options (C. Knopp, Six Rivers N.F., personal communication). Deferment has also occurred on Klamath National Forest lands in the French Creek subbasin of the Scott River for similar reasons. This "mixed-ownership" problem of balancing the cumulative effects of public and private timber harvesting with the watershed's capacity for such disturbance is a problem in other basins as well.

The California Department of Forestry (CDF) is in the process of revising its method of cumulative watershed impact analysis. In 1986, the procedure was a 14 point checklist to be completed by the registered professional forester doing the timber harvest plan. The presently proposed modification is a more complex questionnaire, which includes effect on fish habitat (Coburn 1989). In contrast to the USFS procedure, the CDF analysis is qualitative rather than quantitative, is prepared primarily by a professional from one discipline rather than a multi-disciplinary team, encompasses mainly one ownership rather than all lands within the study area, does not use the "threshold" concept, and has a shorter time frame for evaluation and decision-making.

A recent evaluation of CDF's timber harvest planning process concludes that the current cumulative impact analysis methodology is inadequate since the process has very rarely identified the occurrence of cumulative impacts, despite evidence to the contrary. The proposed rule modification also does not include the substantive changes which are required for CDF to improve its performance in the courts or to regain public confidence in its ability to adequately regulate the actions of the timber industry (LSA 1990).

Wild and Scenic Rivers Designation and Timber Management

Several sections of the Klamath River system are designated under both the State and National Wild and Scenic Rivers Acts: the mainstem Klamath below Iron Gate Dam, the lower Scott River, and the Salmon River (also portions of North Fork and Wooley Creek). (Also see "Water Development" section.) What this status means in terms of habitat protection has been the subject of considerable debate. In the California Act's original language, the Secretary of the Resources Agency was to develop a management plan for each river component of the system (including its "immediate environment") "which shall be administered so as to protect and enhance the values for which it was included in the system, without unreasonably limiting lumbering, grazing, and other resource uses, where the extent and nature of such uses do not conflict with public use and enjoyment of these values."

Draft Waterway Management Plans for the Scott and Salmon Rivers were released by the CDFG in 1979 and 1980, sparking much controversy with the extent and content of their recommendations (CDFG 1980 a,b). The focus of the debate was whether the Act is a watershed management directive or merely for the prohibition of water impoundment structures (UCLA 1980). Land and water users within these watersheds loudly protested the need for management plans.

Finally, the State Act was amended in 1982 (AB 1349) to remove the requirement for management plans, define the term "immediate environment" as "the land immediately adjacent" to the designated segments of the rivers, and remove the words "in a natural condition" from the "free-flowing" definition. A 200 foot zone on either side of State-designated rivers is considered a "Special Treatment Area" in the Board of Forestry's Rules.

The National Wild and Scenic Rivers Act requires that detailed boundaries be established (of not more than 320 acres per mile on both sides of the river); appropriate sections be designated "Wild," "Scenic," or "Recreational"; and that a plan be prepared "for necessary developments in connection with its administration in accordance with such classification." The National Forests technically administer most of the Klamath River components in the National System. No management plans have been issued to date by either Forest.

Other eligible streams in the Klamath Basin are also being studied in the USFS Land Management Plan process for possible addition to the National System because of their "outstanding values," including summer steelhead and spring chinook: Salmon River tributaries, Kelsey Creek, Clear Creek, Grider Creek, Dillon Creek, and Ukonom Creek. While being considered for addition, "particular attention shall be given to scheduled timber harvesting, road construction, and similar activities which might be contrary to the purposes of the Act."

As the result of a recent lawsuit, the U.S. District Court for the Eastern District "permanently enjoined" in 1989 the U.S. Forest Service's proposal to salvage log 17,000 acres along the South Fork of the Trinity River, which is a "Wild" section of a designated Wild and Scenic River. The timber sale reportedly would violate the act because the Forest Service failed to: 1) designate the boundaries of the Wild and Scenic Corridor, 2) adopt a river corridor management plan, and 3) cooperate with federal and state water quality agencies to assure that the river's water quality and outstanding anadromous fishery resource were protected.

Conclusions

While over the years timber harvest practices on both public and private lands in the Klamath Basin have definitely improved, negative impacts to habitat continue to impair fish production. **The lack of any quantitative analysis of the effectiveness of current forest practices on watershed conditions and stream habitat in the Basin is also very apparent.** Although over 15 years have past since the new State Forest Practice Rules were adopted, the state agencies have not been able to collect the necessary baseline or post-harvest field data needed for such an evaluation. In addition, both private and public foresters are in need of accessible stream and watershed information, such as the quality and quantity of fish habitat and populations in the areas where they are planning timber harvests.

To help address these serious needs, the Task Force should promote the collection of useful habitat and population data on each tributary supporting anadromous stocks in the basin. Evaluation studies of timber harvesting impacts are also needed. To make this information available to the people making forest management decisions, a practical data base (e.g., the EPA Reach File system) should be used for data storage and retrieval of habitat and population information by Task Force funded projects.

Making the connection between studies and action on habitat protection will be critical. One notable example is the 1976 study by Six Rivers National Forest identifying the sensitivity of the inner gorge area and, subsequently, removing such fragile sites from the commercial timber base (J. Barnes, USFS, personal communication). As the distinguished hydrologist Dr. Luna Leopold cautioned in 1981:

> To put it in simple terms, **we are not learning from experience** ... the feedback loop between research, policy, and regulations seems on the whole to be not only incomplete, but sometimes quite overlooked. The nature of the research program itself is often not directed to those effects of management that might do the most to lessen adverse impacts.
>
> The second part of this problem is that even when research has shown how practices should be carried out in order to minimize impact, these results are often either neglected or disregarded.

POLICIES FOR TIMBER HARVESTING

Objective 2.A. Protect stream and riparian habitat from potential damages caused by timber harvesting and related activities.

2.A.1. Improve current timber harvest practices through the following:

a. Instigate local workshops and seminars on timber harvest methods, including erosion control and stream and riparian protection methods for timber operators and foresters by working with appropriate resource agencies and groups.
b. Develop salmonid habitat protection and management standards and guidelines (by the Technical Work Group) for agency endorsement and use.
c. Develop educational materials addressing stream protection measures for use by foresters, timber operators, and their employees.
d. Obtain existing fish habitat data and place into a data base system which can be easily accessed by agencies and field users.
e. Encourage foresters, landowners, and timber harvesters to view the existing regulations as minimum rather than maximum expectations.
f. Promote communication between timberland managers and salmon and steelhead users.
g. Foster Coordinated Resource Management and Planning in mixed ownership watersheds with important fish habitat (e.g., Blue Creek, Beaver Creek, French Creek, and others).

2.A.2. Contribute to evaluating the effectiveness of the current timber harvest practices in protecting stream habitat through:

a. Development of an index of habitat integrity to better understand the possible cumulative effects.
b. Incorporation of fish habitat and population data into clean water assessments of the State Water Resources Control Board and E.P.A.
c. Monitoring the recovery of stream habitat in logged watersheds.
d. Evaluating watershed and riparian conditions in logged areas.

2.A.3. If the results of the above and other evaluations reveal inadequacies, promote the necessary changes in:

a. The State's Forest Practice Rules and administrative actions.
b. The U.S. Forest Service's policies in its Land Management Plans, Best Management Practices, and administrative actions.

2.A.4. Anticipate potential stream protection problems by requesting:

a. Surveillance monitoring programs, which "208" certification requires, be conducted as soon as possible in Klamath Basin streams by the State Board of Forestry and the U.S. Forest Service.
b. Modification of the State Forest Practices Rules to:
    1. Protect highly erodible soils like the decomposed granitic soils.
    2. Incorporate watershed planning in THP reviews.
    3. Provide adequate protection of riparian areas.
    4. Allow for a longer review period for THPs in critical watersheds.
    5. Provide a meaningful level of cumulative impact analysis.
    6. Provide damaged fish habitat adequate time to recover before new timber harvesting or roads occur in watersheds that are over threshold.
c. Policies in the US Forest Service's Land Management Plans and changes in administrative actions to:
    1. Give first priority to protection of salmonid habitat which is presently unimpaired (e.g., Clear Creek, Dillon Creek).
    2. Protect highly erodible soils like the decomposed granitic soils.
    3. Provide damaged fish habitat adequate time to recover before new timber sales or roads occur in watersheds that are over threshold.
    4. Ensure the survival of anadromous salmonids through adequate protection of their habitat.
    5. Provide adequate protection of riparian areas.
    6. Provide a meaningful level of cumulative impact analysis.
    7. Ensure the land base allocation and protective measure for water quality and fish habitat are adequate.

MINING

Issues

* Habitat damage from past mining activities.
* Impact of current suction dredge mining on fish and other aquatic life.
* Impact on fishermen's safety of new dredging holes.
* Resource impact of gravel extraction operations and batch plants.
* Potential of increased mining impacts with sharp rise in gold price.
* Need to educate miners about potential stream habitat impacts.

History

Early Gold Mining: 1850-1900

Many of the communities in the Klamath River Basin owe their origin to the gold mining boom of the 1800s in the Klamath and Trinity Mountains (Wells 1881). The towns of Happy Camp, Orleans, Somes Bar, Sawyers Bar, Hamburg, Callahan, Yreka, and Scott Bar were all located near the largest gold mining sites of the period. Beginning in 1850 with the exploratory mining by John Scott and his party at Scott Bar, the region mushroomed by 1852 with enough gold miners and other residents for the Legislature to form Siskiyou County.

Along with the placer mining activity came the development of a great many diversion ditches from the creeks and rivers to provide the water for sluicing the claims. Water was also pumped for hydraulic mining operations, which washed the gold deposits out of the hillsides (where the placer deposits also originated) (Albers 1966).

One of the earliest observations of the water quality impact of these gold mining operations was by George Metlar in 1856, who commented:

> ... the Klamath, being the larger, is usually clear and transparent, while Scott River, is turbulent and muddy on account of its extensive mining operations -- a line of demarcation is always perceptible where they approach each other.

The salmon were still thick in the "clear" upper Scott River in 1854, however, as noted in the diary of another miner camping in the Scott Valley on October 2nd (Stuart 1925):

> During the night we heard continual splashing in the water near where we were sleeping, and couldn't imagine what kind of animal was in the stream all night .... In the morning we went to the place whence came the noise and found that all that splashing in the river was caused by salmon fish, from

three to four feet long, flopping and jumping in, forcing their way up the stream over the riffles where the water was not deep enough for them to swim.

In later years, miners would come to cite these observations of large populations of spawning salmon during the heavy hydraulic mining period as evidence that silt and mud from placer operations are not harmful to fish. Without knowledge of the size of salmon and steelhead runs before the advent of mining, it is of course difficult to measure any population decline. Researcher O.R. Smith (1939) thought that "runs may well have been reduced 30 per cent or more and still remained large enough to be noticeable to miners working in the streams." Later studies, he noted, revealed that salmon and trout will migrate upstream through muddy water but that they seek clear tributaries in which to lay their eggs.

Floods in 1852-53, 1861 (a major flood of similar magnitude to the one in 1955), 1864, 1875, and 1880 all reportedly "swept the rivers clear of all mining improvements" (Wells 1881). According to a Scott Valley historian, the flood damage of 1861 was greatly affected by the upstream mining operations which "tore up the watershed" and "left nothing but piles of rock and debris in the upper valley and along tributary streams" (Jackson 1963). He claims that "many of the mountain slopes were stripped of their protective covering of trees" and then the heavy rains of 1861 "flushed soil, logs, trash, and mine tailings out of the watershed into the upper end of the valley." Forming a debris dam, the Scott River was diverted from the west to the east side of the valley. This historical channel can still be seen in current aerial photos.

Despite the repeated floods, they still did not deter further mining. An observer at Hoopa Valley noted in 1865 that the Klamath and Trinity were very muddy from upstream mining and "almost deserted" by salmon (McEvoy 1986). Whether this small population was attributable to the sediment or the effects of the 1861 flood, or both, is debatable. In 1880, 15 active mining claims were noted on the South Fork of the Scott River alone (Wells 1881). While hydraulic mining was outlawed by the state in the late 1880s for the rivers near Sacramento, the Klamath River was not regulated. Gold production reached a peak in 1894 but by 1900 many of the mining operations (in Scott Valley at least) had closed down due to low profits (Albers 1966, Jackson 1963).

Hedgpeth (1944) believed that this period of hydraulic mining, which "damaged hundreds of miles of rivers," had a greater effect on the state's salmon fishery than the large canneries of the era. Certainly the intensity of mining activity has since not been approached.

<u>The Next Era: 1900-1970</u>

Expectations of cheap power and motor transportation to reduce the costs of mining and milling helped revitalize the local mining industry in the early 20th century (Frank 1915). Although extensive hydraulic mining was still being conducted near Happy Camp and Forks of Salmon in 1915 (see Figure 2-11a), the "new era of placer mining" was to be the massive dredges which could profitably work the gold out of the old tailing dumps and other auriferous gravels. How these dredges worked is illustrated in Figure 2-10, while a picture of a dredger at work at the mouth of Humbug Creek in the 1940s can be seen in Figure 2-11b.

With the increase in the gold price from $20.67 to $35.00 a fine ounce in 1934, plus the Depression channeling many men into prospecting, gold production in the Klamath Basin began to boom again (Albers 1966). Dredging companies were very active throughout the Salmon and Scott Rivers and their tributaries. One Yuba-type dredge near Callahan on the Scott River was able to dig to a depth of 50-60 feet below water line, process 210,000 cubic yards of soil and gravel per month (24 hours per day) and use 10,000 gallons per minute of water, which was pumped from a pond to wash the gravel through screens (Averill 1946). Its tailing piles permanently transformed about 5 miles along the upper Scott River.

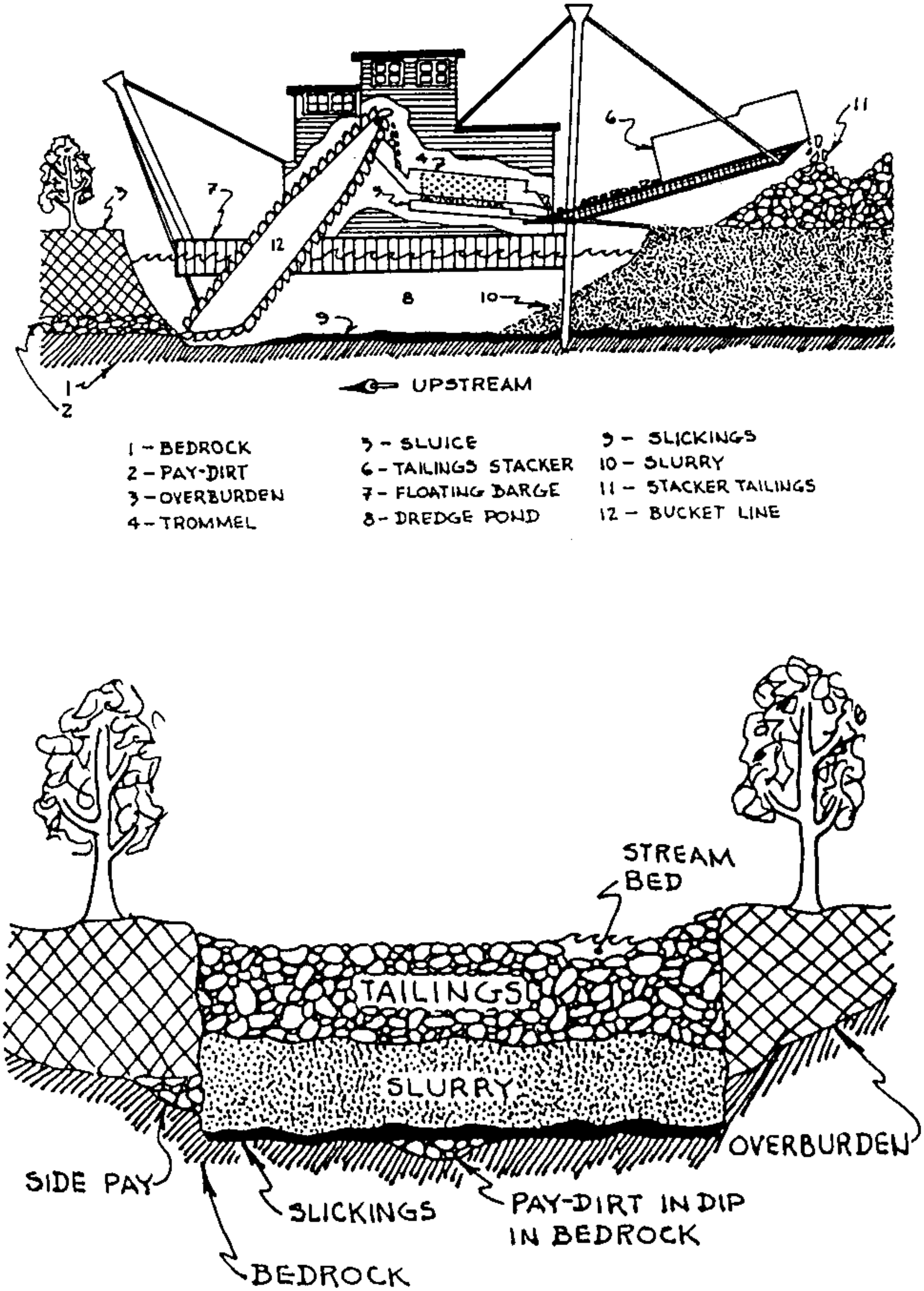
The resurgence in placer mining also brought renewed attention by fishery biologists and sportsmen over the effects of silt on fish (Smith 1939). Despite claims by miners that their silt load was similar to the natural silt load during flood stages, evidence showed that the duration of turbid conditions was quite different: placer mining creates continuously muddy water while storm turbidity usually clears up quite rapidly. **The Scott River in sections was so muddy from mining pollution in June of 1934 that California Department of Fish and Game stream surveyors could not see the streambed.** Observations of several mining streams in northern California and Oregon revealed that "streams which are always silty seldom have large populations of salmon or trout" (Smith 1939). The reasons for their absence are several.

One of the best documentations of mining impacts in the Klamath River Basin was performed in the summer of 1934 by the U.S. Bureau of Fisheries (Taft and Shapovalov 1935). An analysis of hydraulic mine operations on the East Fork Scott River involved taking samples of streambottom organisms (larvae of mayflies, trueflies, caddisflies, beetles, and stoneflies) located on riffles above and below a tributary carrying considerable mining silt. Above the silted site, the gravels contained an average of 249 organisms per square foot while below the muddy tributary the average was 36 organisms per square foot.

These stream fauna represent important food for salmon and steelhead and their loss reduces the capacity of the stream to support fish production. In a Salmon River tributary (Merrill Creek), the investigators found the bottom of the lower portion of the stream to be composed largely of coarse "mining silt," which "was productive of almost no food except snails." Their final conclusion, following many quantitative bottom samples, was that **"the average number of food organisms in the one square foot samples was <u>always</u> less in mined areas than in non-mined areas."**

In addition to the reduction in fish food, studies in the 1930s found that silt would also cover the spawning nests and suffocate the salmon and trout eggs (Smith 1939). The level of egg mortality seemed related to the amount of "silt" (not defined as to size). Filled-in pools were another symptom of streams with excessive sediment, a condition which leaves no hiding or rearing places for fish.

Figure 2-10 – Gold dredge at work and cross-section of dredge tailings.



Source: Ahnert, 1990.

Figure 2-11a – Gold Mining on the Klamath River, Early 1900s.

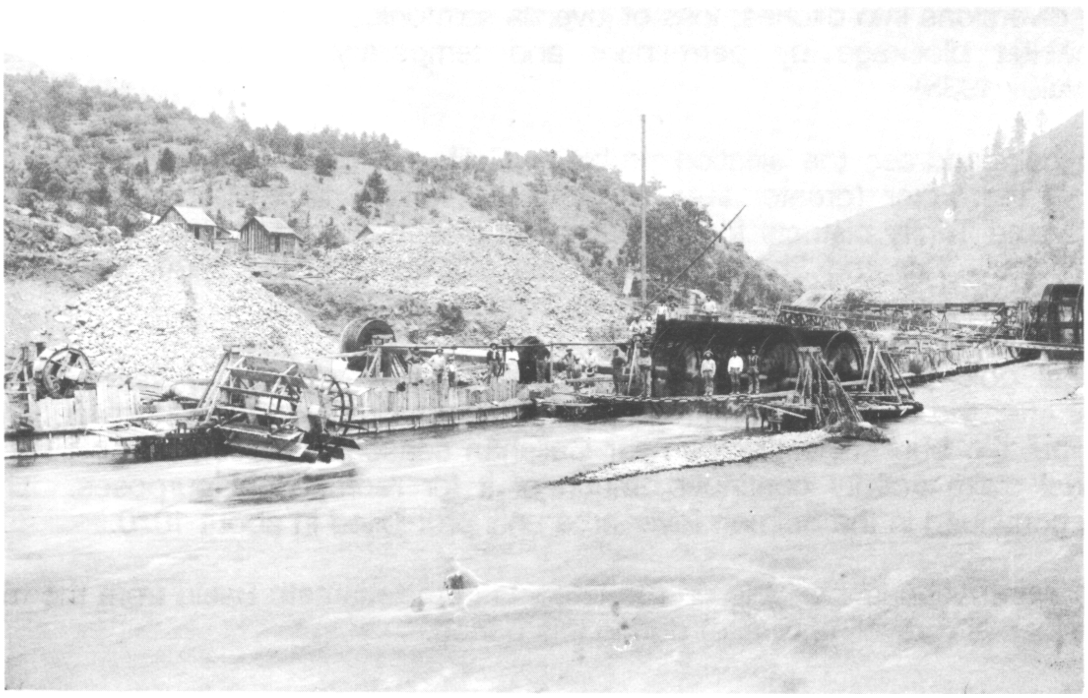


Figure 2-11b – Gold dredge at mouth of Humbug Creek, early 1940s.

Source: Siskiyou County Museum, Yreka.

Many other problems were also noted: increased poaching in the small, clear streams where spawners were forced to congregate; reduced streamflows due to mining diversions into ditches; loss of juvenile salmonids in unscreened mining ditches; and habitat blockage by permanent and temporary diversion dams (Taft and Shapovalov 1935).

To help address the siltation problem, California made it unlawful "to affect the clarity of the water (greater than 50 ppm, by weight, of suspended matter) in the Klamath and Trinity districts for a distance of one mile or more between July 15 and October 15." Taft and Shapovalov felt that this law (Section 5800, Fish and Game Code) was only affecting the "most flagrant cases" in 1935.

Local gold production declined sharply during World War II and was slow to recover after the war due to the high cost of labor. Dredging operations continued for a while but the bucketline dredge near Callahan ceased operation about 1949. Small individual claim activity continued, much of it for recreational purposes. Hydraulic mining continued in the Salmon River area until prohibited in about 1970.

No information is available on fish impacts in the Klamath Basin from the mining of other minerals (gravel, chromite) during this period.

Current Mining Practices

Commercial placer mines became scarce in California in the 1970s because of stricter environmental laws, such as stream discharge requirements. With the removal of governmental control on the price of gold, its price skyrocketed in the late 1970s and, not surprisingly, a phenomenal level of gold mining activity followed suit.

Suction Dredging

The primary extraction method in the region had now become small, portable suction dredges (though large scale "high bar" gold mining in old gravel bars occurs in some places on the Salmon River). Suction dredge permits issued by the California Department of Fish and Game quadrupled in number between 1975 and 1980 (Harvey et al. 1982). In 1982, there were 147 **special** suction dredge permits (large diameter or outside normal season) issued in western Siskiyou County by the Department, but the numbers dropped to about 35 permits on an average in the late 1980s (D. Maria, CDFG, personal communication). Although the price of gold dropped to less than half of its peak by the mid-1980s, the interest in small suction dredging as a recreational activity has not significantly waned. On one recent summer day, 22 suction dredges were counted in the Klamath River between Seiad Valley and Happy Camp (D. Maria, CDFG, personal communication).

A description of how and where a small suction dredge works is provided by Freese (1982), with an illustration provided in Figure 2-12:

> The suction dredge operates like an underwater vacuum cleaner. Water is taken up through the pump intake, fed

> through a small-diameter pressure hose and then directed up through a flexible large-diameter hose. Gravel and water is taken up through the suction hose intake and fed through a baffled sluice box; it is here that the gold settles out. Gravel and small rocks continue on through the sluice box and are redeposited, as dredge tailings, in the stream channel. (Smaller fines are carried downstream and redeposited (Thomas 1985)). Dredges are classified according to the diameter of the suction intake; they range in size from 1.5 inch "mini" or "backpack" models weighing as little as 35 pounds, up to very large units, 10 inches or more in diameter.
>
> Most bedload material is moved during large flood events. Since gold is very heavy, it tends to settle out first and is generally found in cracks in the bedrock which underlies the stream gravels. It is often necessary for dredge operators to remove voluminous quantities of overburden in order to reach bedrock. Gold is likely to be found in any area where the current suddenly slacks off, such as suction and pressure eddies, behind dikes, outcrops and boulders, wherever the channel widens or the gradient decreases, and under the gravels of point bars at the inside of bends in the river. These are the areas where dredging operations are concentrated.

Dredge capacity quadruples as intake diameter doubles (Griffith and Andrews 1981).

<u>Placer Mining</u>

In addition to suction dredges, small placer mines (panning, sluice box and/or power sluice operations) are still in operation throughout the middle Klamath Basin. McCleneghan and Johnson (1983) found that "placer mining of the streambank can damage the riparian and stream more than suction dredge mining" if adequate controls are not enforced. No direct discharge is presently allowed into the streams by placer mining (Lt. Franklin Cox, CDFG, personal communication). However, in Canyon Creek (Trinity River), placer miners were observed sluicing tailings into the stream (Hassler et al. 1986).

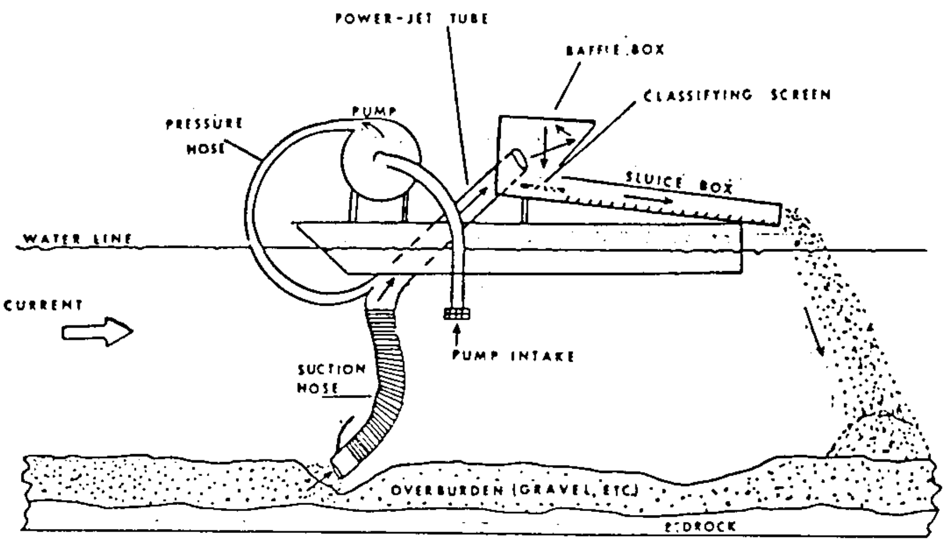
<u>Gravel Mining</u>

In-stream gravel mining activity fluctuates in the Klamath Basin. Commercial operations are primarily scattered in accessible tributaries near towns. In the 1970s, Cottonwood Creek was used as the gravel source for the construction of Interstate 5 north of Yreka and its spawning habitat has yet to recover (Lt. Franklin Cox, CDFG, personal communication). During the same period, the Army Corps of Engineers removed about 800,000 cubic yards from a large gravel bar in the lower Klamath River to build the flood levee at Klamath Glen, with reportedly "no change in the basic river geometry" as a result of that extraction (Caltrans 1989).

Concern has been expressed about the increased demand for Klamath River gravel in the lower river near Klamath to support the Redwood National Park/Highway 101 bypass project. During the 1980s, about 600,000 cubic yards of gravel were extracted from a few bars (Caltrans 1989). A recent proposal by Caltrans calls for the removal of up to 500,000 cubic yards from gravel bars on the mainstem or from Turwar Creek. These stream sections are thought to be in an aggraded condition: the Klamath River is reportedly aggrading at the rate of 100,000 to 150,000 cubic yards per year in the proposed reach while Turwar Creek has shown "substantial aggradation in the channel" over the last thirty years. The streamflow there goes subsurface during the summer and early fall, posing a barrier to upstream migrants in the fall (Caltrans 1989).

The potential for damage to spawning gravels is related to the extent and rate of removal as well as the methods used. While gravel bar skimming or deep dredging are the prevailing practices, permits may be issued which could cause, individually or

Figure 2-12 – Cross-section of a typical power-jet suction dredge, showing key components.



Power-Jet Surface Dredge

Source: Griffith and Andrews, 1981.

cumulatively, the annual extraction rate to be greater than the annual replenishment rate (Sommarstrom 1981). In aggraded streambeds, this net loss may not be a problem or could be useful. However, in degraded streambeds any further removal could be a serious concern for channel stability and gravel quality.

To avoid damages to fish habitat and channel stability from gravel removal, Dunne et al. (1981) have proposed that the following four steps be taken before a gravel permit is issued: 1) define the historical activity of the river at the proposed site, 2) estimate bedload transport rate through the reach, 3) evaluate probable impact of bar scalping on channel stability, and 4) require explicit information on proposed mining procedure.

If construction needs increase significantly during the next 20 years, stream habitat could be adversely affected by intensive instream gravel removal if proper precautions are not taken.

Lode Mining

Gold, copper, and chromite mines (representing the largest scale operations) have been in production off and on during the past century. The Salmon River and Happy Camp areas have seen the greatest gold and copper mining activity in the past due to their massive sulfide ore deposits. Little documentation is available of the impacts except for one recent operation, the Gray Eagle Mine.

Once a very large operation, the Gray Eagle mine above Indian Creek was reopened for gold extraction in the early 1980s. While previous tunnel mining had created a large acid drainage situation, the new process used a cyanide leaching method. Although the mining company was required by the Regional Water Quality Control Board to contain all waste in ponds with clay lining, cyanide seeped out of the dam in 1981 (D. Evans, NCRWQCB, personal communication). New requirements demanded a continuous treatment process below the dam, which still generates 1 ton of dry powdered sludge per day (stored on-site and then hauled off for ore value). Water produced from the process is within drinking water standards and released into Indian Creek through a leach field; no direct discharge is allowed.

Gray Eagle mine closed down in 1987, yet the treatment process for the seepage continues. Old mine tailings, which contain copper, were placed near Indian Creek and are still leaching copper (as shown by rust color) about a mile downstream. At this site, copper levels are lethal for fish, but the toxicity fades to low levels not far below. Concern is also expressed about the tailings pond location within the 100 year flood plain (D. Evans, NCRWQCB, personal communication).

With the present surge in copper prices, the mining company is expressing interest in once again opening up the Gray Eagle mine but this time for the copper. A joint EIS/EIR would likely be required, states the Siskiyou County Planning Department, due to the magnitude of the operation. Other copper and gold mines in the region may also show renewed activity with higher mineral prices.

Impacts of Mining on Salmon and Steelhead

Suction Mining

As during the previous gold mining boom, biologists and sportfishers were concerned, if not alarmed, by the possible effects of these new suction dredges on aquatic organisms. New studies were done to address the various concerns:

1. Spawning gravels.
2. Adult fish migration, feeding, and holding.
3. Early life stages of salmonids.
4. Aquatic invertebrates.
5. Water quality impacts.
6. Increases in bank erosion, changes in channel morphology, destruction of riparian vegetation.

The results of research to date, as well as the lack thereof, concerning each of these impacts is discussed below.

Spawning Gravels. Where winter flows are high enough to provide flushing action, the sand and dredge tailings are not evident the following year (Harvey et al. 1982, Stern 1985). However, "dredging-related substrate alterations could be long lasting below impoundments," cautions Harvey. Hassler et al. (1986) observed that salmon and steelhead did not spawn on dredge tailing piles in Canyon Creek (Trinity River), but there is concern about the ability of early run fish to spawn in these areas before the flushing flows of the fall occur, which may not be until November or December on the Klamath River.

Changes in the quality of spawning gravels, such as the percent of fines or degree of embeddedness, have not been measured after suction dredging. Observations seem to indicate an on-site improvement in porosity yet the fines may be transported only a short ways downstream. Fines that had filtered down through the gravels would be brought to the surface for redeposition. A lack of flushing flows could recreate the embeddedness condition and continued siltation would only refill the dredged gravels (Bjornn et al. 1977). However, some biologists believe that suction dredgers can enhance the spawning habitat, if clean gravels are a limiting factor (Stern 1985).

Another unknown is the ability of dredged gravels and tailings to provide a stable redd until emergence of the young. Elk Creek is one area of such concern (J. West, USFS, personal communication).

Impacts on Adults. Adult fish in holding areas, particularly summer steelhead, are quite vulnerable to poaching by miners. Dredging activity could force the adults to congregate in a few pools instead of being more dispersed (Freese 1982). During spawning season, dredging activity and tailing piles could impede access to upstream spawning sites by scaring the adults downstream or by physically blocking tributary access. This was not observed to be a problem in Canyon Creek, Trinity River (Hassler et al. 1986).

Pools which fill up with sediment from upstream dredging have a reduced capacity to hold adult fish (as well as young) (Harvey et al. 1982). Resident trout, however, did tend to occupy the holes created by dredging in the riffles in the Harvey study. Pool and riffle configuration can be altered, depending on the amount of dredged material (Thomas 1985).

Impacts on Eggs, Juveniles. In an Idaho study of a small (3 inch) suction dredge, un-eyed trout eggs (the youngest ones) experienced 100% mortality after entrainment through a dredge, while eyed eggs suffered 24-62% mortality (Griffith and Andrews 1981). Results could be different for eyed eggs of chinook salmon, the authors stated, as they are "generally considered more resistant to shock and might be less affected." Hatchery operators are well aware of the relative sensitivity of salmonid eggs at different stages and with various species. An increase in egg or alevin mortality could also result from a small decrease in gravel permeability in a stream where intergravel flow and dissolved oxygen is marginal to begin with (Thomas 1985).

For rainbow trout sac fry, 83% mortality resulted after passage through a dredge (compared to 9% in controls), primarily due to detachment of the yolk sac from the body of the fry (Griffith and Andrews 1981). The probability of survival would increase as the size of the yolk sac decreases and nearly complete survival of free-swimming fry would be expected. With small suction dredges (30 cm/second intake velocity or less), fingerling and larger trout could avoid being entrained but would still likely survive. In the middle Klamath River and tributaries, concern exists over the impact on the eggs and fry from late spawning steelhead as they would still be in the gravels at the June 1st start-up date for allowable dredging (Leidy and Leidy 1984).

Loss of summer rearing capacity occurs when sediment is deposited in pools, while winter capacity for juveniles is reduced when deposited within the streambed gravels (Bjornn et al. 1977). The questions to ask with dredging are, what is the net change in rearing habitat quality and quantity, and does the change have biological significance? Stern (1985) believes that suction dredgers can enhance rearing habitat, if limiting factors of a reach of stream are known (i.e., cover, woody debris, and low velocity refuges).

Impacts on Aquatic Invertebrates. Benthic invertebrates (larvae of mayflies, caddisflies, etc.) fared much better than salmonid eggs and fry, with a short-term survival rate of nearly 100% after dredge passage (Griffith and Andrews 1981). Only emerging insects appeared prone to damage. Long-term survival could be reduced, depending on the amount of physical damage, predation, and the suitability of their new habitat downstream. Other studies concluded that impacts of dredging on benthic organisms "appear to be highly localized" (Harvey et al. 1982, Thomas 1985). Part of the reason is that "different habitat requirements result in a range of effects on individual species (and life history stages)." For instance, if sand is dredged up to the surface, those insects which can use a sandy substrate may become more abundant if provided enough time to recolonize, whereas those organisms which require unembedded cobbles and boulders would decline in abundance. Smaller dredges (i.e., 2 1/2 inches) in a low sediment stream had a minimal impact on the benthic community (Thomas 1985).

Since most invertebrates are found in the top 4 inches (10cm) of the streambed, a dredge which covers a large area has a greater effect than one which excavates a deep pit to bedrock (Harvey et al. 1982). Insect density is usually greatest in riffles and shallow runs, where damage from sand would be great. On Butte Creek, riffle dredging created exposed stream bottom areas, "clearly reducing the area of productive insect habitat." Dredged sites were repopulated in Idaho streams from adjacent areas in slightly more than a month in one area, while in another area repopulation took 3 months to 1.2 years, depending on the distance upstream to a source or pool of invertebrates (Griffith and Andrews 1981). The amount of bedload movement in a stream also probably affects the benthic recovery time (Thomas 1985).

Water Quality Impacts. The degree of turbidity created during the dredging process, such as the sediment plumes observed downstream, is related to the amount and size of sediment deposited in the streambed as well as the capacity of the dredge. In streams with low levels of fines (size less than about 0.5mm) or only sand and gravel, turbidity may be nearly undetectable, while very noticeable turbidity increases occur when dredging clay deposits or silty stream banks (Griffith and Andrews 1981, Harvey et al. 1982, Stern 1985). Turbidities in the 10-50 NTU range, while noticeable, do not seem to impair feeding by trout yet levels over about 30 NTU do affect the "fishability" of the stream.

Where dredging is concentrated, turbidity plumes can become continuous from one operation to the next as the silt is constantly resuspended. This phenomenon was recently observed during the summer on the Klamath River between Seiad Valley and Happy Camp. The effect of such persistent levels of turbidity on salmonids and the benthic community is not known. Muddy water could also possibly be a contributing factor to the high water temperatures noted in the middle Klamath River (D. Maria, CDFG, personal communication).

Bank and Channel Impacts. Two surveys of suction dredgers in California found these adverse effects: bank undercutting, stream channelizing, riparian damage, removal of instream woody debris, and bank sluicing (McCleneghan and Johnson 1983, Hassler et al. 1986). These problems were considered greater and of longer-term impact than dredge holes or tailing piles (Stern 1985). While only a few of the miners caused damage, the investigators were concerned about the cumulative impact created by the great amount of dredging effort. In Canyon Creek, a tributary of the Trinity River, impacts were considered "moderate," though seasonal and site specific, at the current level of suction dredge activity (Hassler et al. 1986).

In addition, large boulders were moved from some of the dredge sites by miners using powered winches. The boulder removal could alter streambed morphology for several years (Hassler et al. 1986). Riparian damage was observed as a result of camping in the riparian zone (McCleneghan and Johnson 1983, Stern 1985).

Fishing Safety. Concern was expressed by several fishermen during the initial public comment phase of this plan that they, or a companion, had almost drowned after stepping into an unseen dredge hole. As a result of this experience, they strongly recommended that either dredgers should be required to restore dredging sites to their pre-dredged shape, or dredging should be stopped. No evaluations of this impact have been done.

Current Mining Regulations

Suction Dredging

The California Department of Fish and Game (CDFG) takes the lead in regulating suction or vacuum dredge use in any river, stream, or lake by requiring either a standard or special (when intake is larger than 8 inches or to operate in waters otherwise closed to dredging) permit before any use. Through Fish and Game Code Section 5653, the agency primarily controls the activity by determining open and closed waters, the season of use, and the maximum size of dredge. A permit must be issued "if the Department determines that such operation will not be deleterious to fish."

For the Klamath River Basin, the 1989 regulations are shown in Table 2-3. The season restrictions are primarily designed to protect spawning grounds, while the dredge size restrictions are intended to limit turbidity. Closures in Clear, Dillon, and Wooley Creeks are aimed at protecting their sensitive summer steelhead populations. In proposed regulations for 1990, Yreka Creek is recommended by CDFG staff for closure because of all of the habitat restoration and education attention it is receiving. In addition, a 6 inch diameter will be the maximum allowed on all tributaries while the 8 inch size will be the largest for the mainstem Klamath River and mainstem Trinity River (D. Maria, CDFG, personal communication).

Standard suction dredge permits are issued by any CDFG regional office for any stream open to dredging while special permits must first be reviewed with recommendations by the local fishery biologist. As a result, record keeping of the location of standard dredging activity is not available from the permits.

A "1603 Streambed Alteration Agreement" (Section 1603, F&G Code) is only being required for mining when heavy or motorized equipment is operated "which would substantially change the bed, channel or bank" of any river or stream. Several researchers have noted that this section of the code may need to be applied to suction dredging when operations become "substantial," but with clear guidelines (McCleneghan and Johnson 1983, Stern 1985).

TABLE 2-3

CALIFORNIA DEPARTMENT OF FISH AND GAME
STANDARD SUCTION DREDGING REGULATIONS - 1989[1]
KLAMATH RIVER BASIN

Location	Restrictions
Del Norte County	Open to dredging from June 1 through October 15
Humboldt County	Open to dredging from June 1 through October 15
Siskiyou County	Open to dredging from June 1 through September 15

Further restrictions or additional open waters are listed alphabetically by stream with particular applicable county shown by parentheses:

Klamath River (Del Norte, Humboldt, Siskiyou Co)	From the mouth upstream to Scott River, open to dredging throughout the year.
Klamath River (Siskiyou Co.)	From the mouth of Seiad Creek near the town of Seiad Valley upstream to the first Hwy 96 bridge is closed to all suction dredging between Jan 1 – Aug 15
Clear Creek (Siskiyou Co.)	Closed waters--no dredging permitted at any time.
Dillon Creek (Siskiyou Co.)	Dillon Creek and its tributaries, NF Dillon Creek and Copper Creek are closed waters.
Greenhorn Creek (Siskiyou Co.)	Above City of Yreka reservoir, open to dredging year round
Salmon River (Siskiyou Co.)	Salmon River and its tributaries, NF Salmon and EF Salmon; no dredge with intake larger than 6" may be used.
Scott River (Siskiyou Co.)	No dredge with intake larger than 6" may be used
Shasta River (Siskiyou Co.)	Dredging allowed by special dredge permit only
Wooley Creek (Siskiyou Co.)	Closed waters--no dredging permitted at any time

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[1] Special permits not valid in these waters unless so specified in the special permit.

On federal lands, the U.S. Forest Service requires that each suction dredger first obtain a CDFG permit. A Notice of Intent is then filed with the local ranger district. If the disturbance will be more than 25 cubic yards, or there is more portable equipment than can fit inside a pickup truck, or if a permanent campsite is involved, then the miner must also file a Plan of Operation. The agency may then place special conditions on the plan and require the posting of a reclamation bond before operations can begin (J. Power, USFS, personal communication).

The North Coast Regional Water Quality Control Board has also deferred to the CDFG for impact regulation in most suction dredge cases (B. Rodriguez, NCRWQCB, personal communication). If a very large operation is proposed (e.g., 14 inch intake diameter or more), then the Board would likely require a waste discharge permit and set operating conditions through that procedure. While the Board's water quality standards require that "turbidity shall not be increased more than 20 percent above naturally occurring background levels," suction dredging activities have not yet triggered enforcement of this requirement. No turbidity monitoring is currently being done of suction dredging areas.

Stern (1985) claims that the current state suction dredge regulations are "vague, poorly understood, and minimally enforced," based on observations in a tributary of the Trinity River. He recommends that the most serious impacts of suction dredge mining could be reduced through education of miners of the reasons behind the CDFG regulations and the habitat needs of salmonids. By restricting mining to summer months, Stern also found that current CDFG regulations "eliminate conflicts with salmonid spawning, incubation, and fry emergence" in Canyon Creek. Procedural guidelines still need to be established in the following areas:

1) Working along and under stream banks.
2) Moving large rocks, boulders and organic debris with power winches.
3) Trimming and removing riparian vegetation.

Since suction dredges are so portable, Thomas (1985) recommends that "managers should concentrate their control efforts on very sensitive areas and areas of intensive dredge activity." More field inspections of permits and improved local availability of standard permits are suggested by a CDFG evaluation (McCleneghan and Johnson 1983).

The American Fisheries Society also made recommendations for "best management practices" for suction dredging operations (AFS 1982). While several of these recommendations are addressed in current CDFG or USFS regulations, others are not (as noted with **):

- Stream closures: seasonal limits to protect fish eggs and fry.
- Categories of dredges: "under no circumstances should 6 inch or larger dredges be classed 'recreational dredges'"; larger dredges should post a reasonable bond and pay the cost of periodic inspections (**).
- Zoning to restrict dredge size: smaller dredges limited to smaller streams.

- o Frequency of dredging: to retain productivity, regulate frequency, "with a minimum of one year being allowed to elapse before redredging is considered (**).
- o Dredge operation: a) do not excavate or wash streambanks; b) fill in pits excavated at end of each day to prevent becoming traps for fish (**); (c) do not disturb large instream materials (boulders, logs, etc.) (**); (d) do not allow fuel or lubricants to enter stream.

Other Mining

California regulates mining through the Surface Mining and Reclamation Act (SMARA) of 1975, as amended. Numerous problems with the Act and its implementation were recently identified by the California Department of Conservation (CDC 1989). Environmental problems were common in unreclaimed sites. The Department suggested several remedies to the law, which are included in the recommended policies for this section. The counties only get involved with mining activities that remove more than 1,000 cubic yards of material under their Surface Mining and Reclamation (SMARA) Ordinances. For gravel mining operations, the county permit and a CDFG 1603 Streambed Alteration Agreement are the two principle controls.

Water quality protections from other mining activities are provided by the North Coast Regional Water Quality Control Board through the issuance of waste discharge permits.

Conclusions

Research on aquatic impacts of mining has tended to follow the resurgence of mining brought on by increases in prices and improvements in technology. To adequately protect the habitat, it is important to anticipate the potential impacts if conditions favorable to increased levels of mining recur during the next 20 years (e.g., price of gold shoots to $800 per ounce or more).

No recent research has focused on the effects of suction dredging in the Klamath River Basin, only in tributaries of the Trinity River which have low levels of sediment (Freese 1981, Stern 1985). Research elsewhere has also focused on smaller dredges (1.5 to 4 inches), while the larger ones (6 to 8 inch) are commonly used in the Klamath River.

Concerns have been voiced by biologists and sportsmen over the present concentration of suction dredges in the mainstem Klamath River between Seiad Valley and Happy Camp, as well as the effects on steelhead eggs and sac fry in the mainstem and tributary gravels during June following the opening date. Much of the mainstem is also open year-round, which may have broader impacts.

POLICIES FOR MINING ACTIVITIES

Objective 2.B. Ensure that mining activities do not cause habitat damage.

2.B.1. Seek to minimize impact of suction dredge mining on salmon and steelhead habitat and populations by:

a. Communicating with miners about fish habitat needs and possible impacts of dredging through personal contact as well as preparing a clear and concise illustrated handout to be distributed with suction dredge permits.
b. Evaluating the impacts of concentrated dredging activity, where cumulative effects may pose serious problems.
c. Supporting evaluation of the effects of the larger suction dredges (6 to 10 inch) on salmonid habitat.
d. Supporting CDFG in maintaining complete closure (no exceptions) of essential summer steelhead streams: Wooley Creek, Dillon Creek, and Clear Creek.
e. Requesting that the California Department of Fish and Game:
    1. Change the season's beginning date from June 1 to July 1 to protect winter-run steelhead eggs and fry, which may still be in the gravels during early summer.
    2. Require miners dredging in the river to mark the dredged site for safety reasons, and notify fishermen through the licensing process.
    3. Promote a better record-keeping system through the permit process for collecting data on the numbers, locations, and sizes of dredge activity.
f. Based on the results of research, pursuing any necessary improvements in regulations and education to adequately protect the habitat.

2.B.2. Seek effective protections of salmonid habitat from potential impacts of other mining practices (gravel, lode, placer) by:

a. Promoting education of miners.
b. Supporting needed evaluations and monitoring.
c. Working with the appropriate regulatory agencies in establishing permit conditions.
d. Ensuring minimum reclamation standards be adopted, implemented and enforced.
e. Supporting a mandatory form of financial assurance (e.g., bond) to assure reclamation of mines.
f. Promoting the abatement of any water quality and habitat problems associated with abandoned mining operations.
g. Requesting lead SMARA agencies to assess penalties and fines for non-compliance with SMARA statute provisions, and also for failure to comply with reporting requirements.

2.B.3. Promote communication between miners and salmon and steelhead users.

AGRICULTURE

See also Stream Diversions section.

Issues

* Impact of stream channelization on habitat.
* Loss of riparian vegetation as a result of livestock grazing.
* Stream pollution caused by runoff of livestock wastes, fertilizers, and pesticides.
* Impact of livestock on stream habitat.
* Need for a voluntary and cooperative approach with landowners.

History

While much of the lower Klamath Basin is timber country, the upper basin contains fertile valleys and hillside grasslands. Cultivation of crops and the raising of livestock began shortly after the mining settlements sprang up in the 1850s. (See also the discussion under "Water Diversions.") Valleys were cleared of trees and brush to provide more farmland.

After the turn of the century, Siskiyou County supported 30,000 sheep grazing on the hillsides: "The highlands of Siskiyou seem made by Nature for a paradise for sheep ... there is ample room for hundreds of thousands more without encroaching upon the agricultural and horticultural acreage of the valleys." An additional 50,000 cattle were being raised on the rangelands at the time, and often pastured in the summer on the mountain meadows of the "forest reserves" (French 1915).

According to the U.S. Soil Conservation Service, "heavy grazing pressure and the widespread droughts of the 1860s" reduced the extent of the native perennial grasses on the grazing lands of Siskiyou County (USSCS 1983). They were replaced by various species of annual grasses and forbs (juniper, brush, medusahead) of less desirable quality for grazing. Under brushfields, less duff layer exists to hold water for percolation and runoff is more rapid, causing surface erosion and greater peak flows in streams. The same problem also results from soils compacted by intensive grazing (Platts 1981).

Besides livestock, the farms and ranches produced many annual and perennial crops: grains, alfalfa hay, potatoes, and corn, among others.

To address many soil and water conservation problems, farmers and ranchers in the Scott Valley joined together in 1949 to form the Siskiyou Soil Conservation District (now called the Resource Conservation District, or RCD), while a few years later farmers in the Shasta Valley formed the Shasta Valley RCD. As a result, the U.S. Soil Conservation Service (SCS) was able to come in and provide the districts needed technical assistance, such as providing soil surveys, engineering advice, irrigation system design, and improved forage plants (SSCD 1969).

The County Farm Advisor's Office (University of California Cooperative Extension) also provided information with which local farmers and ranchers could apply the lessons of soil and crop research to their lands.

Agricultural Practices

Flood Control and Stream Channelization

As farmland became more productive and valuable, the damages caused by each flood became less tolerable. Streambanks were eroded; fields were covered with silt, gravel, and debris; and fences, buildings, equipment, and livestock were destroyed (SSCD 1969). Floods recurred quite regularly since the first major post-settlement flood of 1861: 1881, 1890-91, 1900, 1926, and 1934 (Jackson 1963).

In 1938, the U.S. Army Corps of Engineers came into Scott Valley to help prevent flood damage. It reportedly removed all of the riparian vegetation along certain portions of the Scott River (between Horn Lane and Meamber Bridge), straightened the channel, and constructed dikes. The following winter, a flood broke behind the dikes and could not get back into the channel. Rocks and other debris were again left behind in the pastures (O. Lewis personal communication).

To protect the streambanks from eroding and lessen the river's "punch while it was on the rampage," landowners would drive pilings by hand to make jetties or make revetments by piling trees and rock against the bank (Jackson 1963). Unfortunately, the straightening increased average water velocities which accelerated damage to unvegetated banks.

The flood of 1955 and the high water of 1958 widened the Scott River channel from about 120 feet to over 1000 feet across in some places (SSCD 1969). As a result, the Siskiyou Soil Conservation District (SSCD) helped landowners place very large rock riprap along the more critical reaches of the river banks. Of the 20 miles or so completed, only about 2 1/2 miles washed out in the 1964 flood. By 1969, the District had completed 158,700 feet (30 miles) of streambank protection.

After studying the problem, the Siskiyou Soil Conservation District and its SCS staff found that: 1) there was insufficient vegetation along the banks to protect them, 2) physical protection was needed on the banks until vegetation could be reestablished, 3) there was no way to contain the river within its banks, and 4) it would be "easier and less costly to stabilize this channel in a series of gentle curves than trying to keep it straight" (Jackson 1963).

Thus, the rock riprap projects of the District, which incorporated willow cuttings and required protective fencing, became the primary streambank protection effort. An evaluation of some of these projects on the Scott River showed that **when riparian vegetation is established (3 to 5 years after construction), the streambank protection projects had "produced positive or beneficial effects on both fish and wildlife"** (Patterson 1976).

Agricultural Runoff

Stream pollution from agricultural runoff is another concern. Animal wastes, fertilizers, pesticides, and herbicides can enter the stream during storm runoff or as a result of irrigation return flows. Livestock can also directly contribute to stream pollution when the stream is used for open grazing or watering, such as is often done in the Shasta and Scott Rivers.

The extent of pollution from runoff is related to soil type and depth, slope, rainfall amounts, and irrigation practices, as well as the quantities of these potential pollutants. Fertilizers are used primarily on pasture and grain in the local valleys, although saline soils and low rainfall limit their use in the Shasta Valley (B. Bartholomew, USSCS, personal communication). While pesticides and herbicides are also used locally, their use is becoming more difficult due to increasingly restrictive regulations and greater expense.

According to the North Coast Regional Water Quality Control Board, the discharge of poor quality drainage water from agricultural operations is a problem in the region. There is a particular problem with high water discharge to the Klamath River from Butte Valley (the Klamath Project) via Meiss Lake drainage facilities (Klamath Straits Drain) (NCRWQCB 1989). The agency also noted the warming of stream water by irrigation return flows, which heat up due to solar exposure in open ditches and fields.

Nutrient levels in the Klamath and Shasta Rivers are "generally higher than those found in most other Northern California waters" and are "within the range found in agricultural surface drainage" (CDWR 1986). No detectable levels of pesticides have been found in the Scott and Shasta Rivers to date (R. Klamt, NCRWQCB, personal communication).

Impacts of Agricultural Practices on Salmon and Steelhead

The impacts of riparian vegetation removal, livestock, and agricultural runoff on salmon and steelhead can be categorized into the following:

1. Spawning habitat.
2. Rearing habitat.
3. Water quality.

Spawning habitat

Livestock can trample redds during or after the spawning season, which will disrupt the nest and cause egg loss. Sedimentation, such as from bank erosion and runoff, will fill in the spaces within the spawning gravels, creating poor quality sites for spawning and lowering the survival rate for the eggs and fry. Eroded streambanks also lack shrubs and trees. Without the downed wood which naturally fell into the stream, material is not present to scour out hiding and resting places for adult spawning fish (Reiser and Bjornn 1979).

Rearing habitat

As depicted in Figures 2-13 and 2-14, the removal of riparian plants creates a dramatic change in the availability and productivity of stream habitat. Young fish need pools and shelter, as well as terrestrial insect food, which riparian plants provide. Sedimentation will also fill in the pools and smother vital aquatic insect food. Juvenile steelhead and coho salmon are particularly vulnerable to loss of summer habitat since these species must spend at least one summer in the stream before migrating to the ocean.

Water quality

Maximum summer stream temperatures in the Shasta River were recently measured to be in the range of 22-29.5^{o}C (72-85^{o}F), which are levels stressful or lethal for salmon and steelhead (CDWR 1986). The Scott River is also known to have high temperatures (J. Power, USFS, personal communication). The cause is attributed to the lack of shading from riparian vegetation in many reaches, in combination with reductions in flow from irrigation diversions (CDFG 1965). With their location higher up in the Klamath Basin, these tributaries may affect temperatures in downstream reaches of the Klamath River. Such high temperatures also contribute to lowering dissolved oxygen levels in the water, another critical factor for survival (CDWR 1986, Reiser and Bjornn 1979).

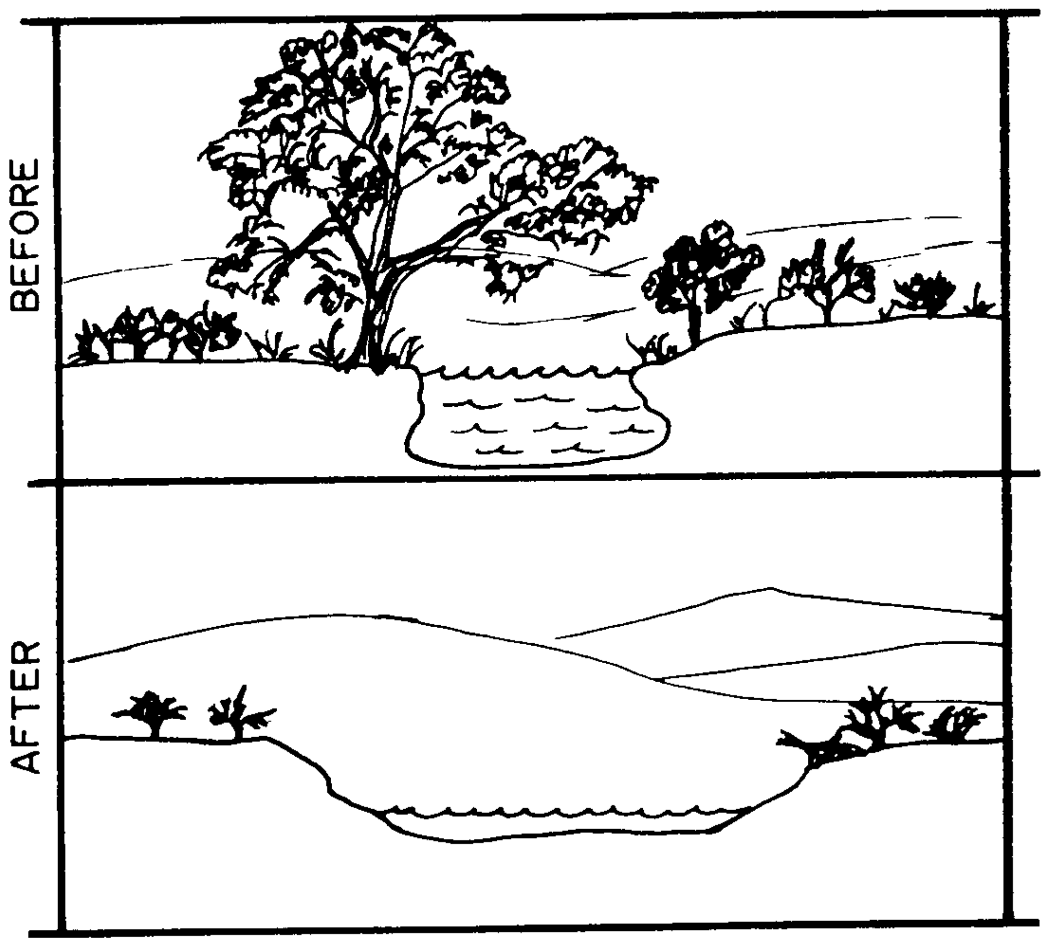
Livestock wastes and fertilizer runoff contribute excess nutrients (e.g., nitrogen, phosphorus) to the stream. As a result, aquatic plant and algae growth is stimulated. After these plants die, the decomposition process by bacteria can demand more oxygen than the living plants produce, which will lower the oxygen levels in the stream. In combination with high temperatures and low streamflow, these decreased oxygen levels can be stressful or lethal to both adult and juvenile salmon and steelhead (see Figure 2-23). Such critically low levels of dissolved oxygen have been measured in the Shasta River in recent years (D. Maria, CDFG, personal communication). While the State's water quality objective for dissolved oxygen is a minimum level of 7.0 mg/l, Shasta River has reached levels of 4.7 mg/l or less in the summer (CDWR 1986).

Riparian Benefits

Many studies have described the varied benefits of riparian vegetation, which can be summarized as follows (Bottom et al. 1985, Bjornn and Reiser 1979):

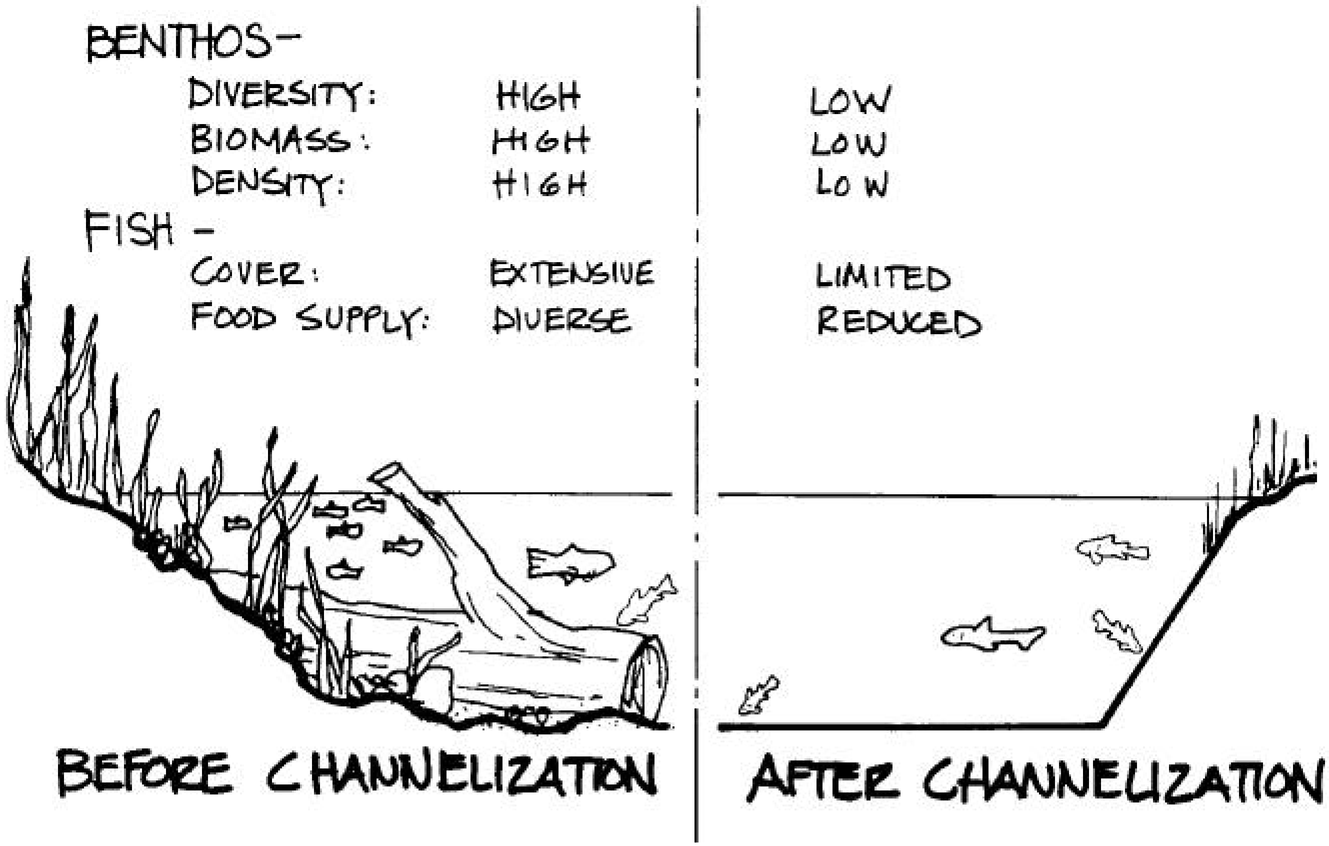
- Filters fine sediment, debris, and other pollutants in runoff from upland sources.
- Root masses stabilize streambank and prevent erosion.
- Provides shade, which help prevent water temperatures from reaching stressful or lethal levels for salmonids during summer.
- Provides insulation in the winter time, helping to prevent stream freezing and loss of overwintering fish.

Figure 2-13 – Changes in cross-sectional channel profile due to riparian degradation.



Source: Bottom et al. 1985.

Figure 2-14 -- Impact of loss of snags, instream and streamside vegetation on fish and benthos (bottom Organisms).



Source: U.S. Fish and Wildlife Service, 1982.

- Large woody debris from riparian trees offers cover for fish to escape predation and disturbance, and refuge from high velocity water in the channel.
- Shelters insects which fall into the stream and become food for fish; deposits leaves and other organic material into stream for food for aquatic insects.

Identifying Protective Alternatives

Riparian Area Practices

Protection of riparian areas on farms and ranches can physically be accomplished through many practices (AFS 1982):

- Development of offsite watering facilities or structures to prevent concentrations of livestock along streambanks.
- Keep bedding areas and corrals out of riparian areas.
- If access to stream for water is essential, limit access sites and provide bank protection structure for each site.
- Fencing riparian areas from livestock grazing temporarily or permanently.
- Instituting alternative livestock grazing systems.
- Providing an uncultivated "leave strip" next to a stream.

The U.S. Soil Conservation Service has found that, in many cases, fencing to exclude livestock will provide for the natural regeneration of riparian plants if seed is available from upstream or nearby sites. Replanting of sites with cuttings or nursery stock can speed up the process if properly done. Fencing along the Scott River to control livestock use of the streamside has contributed to some dramatic improvements in riparian growth in certain areas, as observed from comparing aerial photographs (1974 versus 1987) as well as field observation.

Riparian Protection and Economic Incentives

In addition, several economic options have been suggested: tax incentives, conservation easements, and land purchase. The State of Oregon has tried a Riparian Tax Incentive Program since 1981 to encourage private landowners to protect or restore streamside vegetation within 100 feet of the stream. Once a cooperative management agreement detailing approved protective measures is signed with the Oregon Department of Fish and Wildlife and implemented, the landowner will receive: 1) an ad valorem property tax exemption for riparian lands that are protected or enhanced, and 2) a 25% personal or corporate income tax credit for costs incurred in fish habitat improvement projects (Duhnkrack 1984).

However, the program has failed to live up to expectations. The tax incentives apparently were too confusing, insufficient, or too indirect to help obtain better practices by often cash poor farmers and ranchers (J. Charles, Oregon Environmental Council, personal communication). In California, the financial incentive would likely be even less since most farms and ranches are already receiving property tax breaks under the Williamson Act's agricultural preserve program. New tax credits are politically unpopular also.

Conservation easements are either donated by the landowner, in exchange for tax benefits, or are bought. The easement restricts certain activities on the land (e.g., livestock grazing in the riparian area) but conditions are flexible enough to suit the wishes of the landowner while providing the desired conservation benefit (e.g., riparian protection). Since the easement is only a "less-than-fee interest," the land itself is not sold. Through a deed listing the restricted uses, the landowner conveys these rights to another party, such as a non-profit organization or the local government. This "grantee" then assumes responsibility for enforcement of the agreed upon restrictions (Barrett and Livermore 1983).

To make the conservation easement a workable option, some criteria are needed: 1) the pursuit and enforcement of the easement should be viewed as non-threatening to the landowner and his neighbors, and 2) the easement should be of mutual benefit to the landowner and the grantee. If the tax benefits are not enough of an incentive for donating the easement, then the purchase price or the completion of improvements to the property in lieu of cash (e.g., development of a stockwatering system) must be attractive to the landowner. In exchange, the riparian land could be permanently protected (the easement stays with the land and not just the owner).

Runoff and Water Quality Protection

Besides protecting a zone of riparian vegetation, other methods can be used to reduce runoff and pollution problems from agricultural lands (Platts 1981, AFS 1982):

- For flood irrigated lands, use tailwater recovery systems which recycle irrigation waters through sprinklers for further application and soil filtering.
- Change from flood irrigation to a more efficient watering system, which will reduce runoff to the streams.
- Apply a grazing management system which does not use the riparian area and avoids the concentration of animal wastes; the Holistic Resource Management (HRM) model is one being used more frequently in northern California (Savory 1988; D. Patterson, SCS, personal communication).
- Reduce need for pesticides by using an Integrated Pest Management (IPM) program or organic farming methods; both are becoming more popular in Siskiyou County.

As one stream researcher cautioned, "persuading land managers to recognize and implement management practices that protect streams and their riparian environments will be difficult" (Platts 1981).

Regulations for Agricultural Practices

No regulations presently exist in the Klamath Basin which require the protection of riparian vegetation on private agricultural land.

Streambed alteration is mainly controlled by the California Department of Fish me (CDFG), through its "1603 Agreement" provisions of the Fish and Game Code

(Sections 1601-1606). The agency also has some water pollution control power through Section 5650, which prohibits depositing any substance or material into the stream "deleterious to fish." Any major channel work (including streambank protection or riprap projects) might additionally require a "404 permit" from the U.S. Army Corps of Engineers, under authority of the federal Clean Water Act. The Siskiyou Resource Conservation District (RCD), for example, is seeking to renew a General Permit with the Corps for carrying out riprap projects on the Scott River and some tributaries.

Water quality regulations primarily derive from the federal Clean Water Act and its amendments. The U.S. Environmental Protection Agency (EPA) designated the State Water Resources Control Board to administer the permit system for discharges. While only very large agricultural operations are currently under permit, the State may prescribe waste discharge requirements for any "point source" discharger regardless of size (NCRWQCB 1989). If irrigation flows return to the stream from a ditch or pipe, for example, then it would be a "point source."

However, much of the agricultural runoff comes from numerous locations or extensive seepage. This "non-point source pollution" is more difficult to regulate but is still a serious concern of the agencies. The State Water Resources Control Board and the North Coast Regional Water Quality Control Board have recently directed funds to the Shasta Valley RCD to implement agricultural and grazing BMPs along the Shasta River.

The California Department of Food and Agriculture is the lead agency in regulating pesticide use in the region. As of January 1, 1990, all growers must make monthly reports of all pesticide applications to the County Agricultural Commissioner's office.

Conclusions

Watershed conditions in the Klamath Basin exhibit the legacy of over a hundred years of livestock grazing, some of which was very intensive. Riparian vegetation has been extensively reduced or removed along the Scott and Shasta Rivers, as well as other tributaries, causing increased water temperatures and lack of instream cover for salmon and steelhead. Drainage water from agricultural operations has contributed to high nutrient levels in the upper Klamath and Shasta Rivers, which can lead to critically low oxygen levels for salmon and steelhead young in the summer months.

While conditions are improving in some areas, much remains to be done to provide protection to the valuable riparian zone and to protect water quality from agricultural runoff. Various tools are available to assist farmers and ranchers in improving agricultural practices.

POLICIES FOR AGRICULTURE

Objective 2.C. Protect and improve the water quality of stream habitat from adverse agricultural practices.

2.C.1. Seek opportunities for farmers and ranchers to reduce their impact on stream water quality:

a. Instigate local workshops and seminars with local Resource Conservation Districts, County Farm Advisor, Soil Conservation Service, California Department of Fish and Game, Farm Bureau, Cattleman's Association, and others.
b. Encourage "best management practices" to reduce the amounts of animal waste and fertilizers entering watercourses, initially focusing on demonstration projects.
c. Promote the fencing of riparian areas in vulnerable sites to protect existing vegetation, to provide for natural regeneration, and to protect new plantings.
d. Explore the option of conservation easements to protect riparian zones.
e. Make funding available to help implement improvements which will provide a significant benefit to the fisheries.
f. Investigate and pursue other sources of financial assistance (e.g., ASCS, CDFG, SWRCB).
g. Promote communication between the farmers and ranchers and the salmon and steelhead users.

2.C.2. Monitor and assess stream quality to help evaluate the location, extent, and trends of water quality and riparian problems related to agricultural practices, particularly in the Shasta River, while coordinating with pertinent agencies.

See also: Policies in Stream Diversion section and Chapter 3 -- Habitat Restoration.

WATER MANAGEMENT

WATER AND POWER PROJECTS

Issues

* Habitat damage from construction and operation of dams and hydroelectric projects, causing reduced flows and degraded water quality.
* Potential for restoration of habitat above major dams.
* Need to identify instream flow needs below dams, using state-of-the-art techniques.
* Effect of Iron Gate and Copco Reservoirs on downstream water quality.
* Effect of Lake Shastina on Shasta River's poor water quality.
* Potential impacts of new hydroelectric project on upper Klamath River.
* Relicensing of existing hydroelectric dams in next 20 years.

History

Unlike its Trinity River subbasin, the main Klamath River Basin does not suffer from the effects of a major river diversion project exporting water out of the basin. It does, however, show the effects of years of habitat damage caused by dams permanently blocking anadromous fish runs and altering streamflow patterns and quantity.

History of Dams: 1850-1910

Water-impounding dams in the Klamath River Basin were first built in the 1850s for supplying water to mining and farming operations. These early dams were small, located on tributaries, and often washed out with a flood of any magnitude (Wells 1881). Temporary dams of rock, dirt, and logs would likely block downstream migrants, but were probably not a barrier to upstream fish, depending on the autumn flows. In the 1930s, more permanent mining dams were noted as blocking passage (i.e., no ladders or ineffective ladders) in quite a few tributaries of the Klamath: Hopkins, Camp, Indian, Beaver, Dutch, and Cottonwood Creeks; Salmon River tributaries; and Scott River Tributaries (Taft and Shapovalov 1935). Since some of the old mining dams lasted long after abandonment and were still blocking access to anadromous habitat, many abandoned mining dams were dismantled by California Department of Fish and Game through an aggressive removal program in the 1950s (CDFG 1965).

A wooden dam was built on the upper Klamath River at Klamathon in about 1889 for the large lumber mill there, but it was destroyed by fire in 1902. A fisherman commented on conditions in the Klamath River near Shovel Creek in 1907: "the dams that formerly obstructed it were burned and have washed away and the badly constructed fish ladders have also disappeared, so that large fish again resort to its upper reaches" (Cumming 1907).

For many reasons, large dams were not built during this early period, but circumstances changed. As engineer J.C. Boyle commented in his personal history of Klamath River development, "at the turn of the century when irrigation and power engineers visited the area, they generally agreed that if properly conserved and utilized, there was enough water to supply every need which might locate in the Klamath Basin." The term "properly conserved," in engineering jargon, likely meant "behind a dam." About 1892, the first hydroelectric power plant was built on the Shasta River, followed by one in 1895 on the Link River to serve Klamath Falls (CDWR 1964).

Through the eyes of California Oregon Power Company (Copco) engineers, the Klamath River represented numerous power sites between Keno and the Pacific Ocean. The "most attractive" sites were in the first fifty miles of river below Keno (where the fall is about 2,500 feet) but serious exploration also occurred down river (Boyle 1976).

At least 10 dam sites were identified along the lower river between Iron Gate and the mouth at various times by various engineers. In 1910, Copco's reconnaissance favored two: Big Bend, about 4 miles upstream of Happy Camp, and at Ishi Pishi Falls, just above the mouth of the Salmon River. Since the latter site would provide the cheapest power, Copco initiated water rights in 1908, obtained rights of way, and began extensive construction work. The company, however, abandoned plans when it couldn't find a market for the power. Since projects were not always feasible for power benefits alone, Copco was also trying to find a project which would have irrigation supply benefits. Other sites were evaluated by several entities on tributaries of the Scott River (including one with a tunnel to Yreka to supply the Shasta Valley) but none was ever found to be feasible. (Boyle 1976).

<u>1910-1925: Copco No. 1 and No. 2</u>

In 1910, Copco (formerly Siskiyou Electric Power and Light Company) finally focused on the Ward's Canyon area northeast of Yreka for the location of its first hydroelectric power plant. In anticipation, the U.S. Bureau of Sport Fisheries installed a salmon egg-taking station a few miles below the area at Klamathon, which was the site of an old logging dam at the turn of the century. These racks extended across the river, effectively blocking the salmon run, but were "necessary in order that the supply of salmon may be maintained in the Klamath River," later remarked California's chief fish culturist. (Boyle 1976).

Pre-dam flow records of the Klamath River were begun in May 1910 on a daily basis at Ward's bridge by Copco, with the maximum discharge at 4500 cubic feet per second (cfs) and the minimum discharge at 1,450 cfs. Over a five year period, the records indicated a "change from a uniform flowing stream to one with lower water in summer and higher water in early spring." The observed "uniform" flows, which at first would seem unnatural, may have reflected the moderating influence of the large, shallow natural lakes in the headwaters (Upper and Lower Klamath Lakes). Copco's engineer attributed the flow change to the irrigation development in the upper Klamath basin then being constructed by the Bureau of Reclamation. Although the change in river flows was not too serious at that time, "they were destined to get worse as the Reclamation Service projects progressed," according to Boyle. Water rights battles were beginning to heat up.

The power company's marketing survey showed that the project should be split into two phases. Copco No. 1 dam, completed in 1917, created a reservoir with a surface of 1,000 acres and a catchment of 77,000 acre-feet. In 1918, the first generating unit was put on-line, with a second one (Copco No. 1-A) added in 1922, following the raising of the dam to its ultimate height. Generating capacity was 20,000 KW. In 1925, Copco No. 2 plant was put into commercial operation. It consists of a powerhouse and a small reservoir (5 surface acres containing 55 acre-feet) located about 1/4 mile downstream of Copco No. 1 dam (Jones and Stokes 1976).

<u>1924 State Initiative on Klamath River Dams</u>

In the early 1920s, momentum was growing for more dams. The Electro-Metals Company planned two very high dams (in the lower river and at Ishi Pishi Falls) and another party wanted one in between (Bearss 1982). The California Fish and Game Commission staff claimed the lower site "will exterminate all the salmon in the Klamath, as there are no spawning grounds below the proposed dam sites." The agency finally decided to make a "determined fight against the construction of any more dams on the Klamath River," claimed an agency spokesman (Boyle 1976).

Arguing that the dams' benefits were far in excess of the value of the salmon fishery, the company convinced one local newspaper to editorialize in its favor: the Klamath salmon canneries were a "small enterprise of only local importance" and the Fish and Game Commission was a tool of the "idle rich" blocking the much needed industrial expansion of the state. The agency countered that "comparing the costs and benefits of destroying the largest remaining free-flowing river on the Pacific Coast were simply immaterial." (McEvoy 1986).

Although the Federal Power Commission (FPC) at first denied the permit for the dams, it later reversed itself because it did not want to get in the middle of a dispute between two state agencies. The State Division of Water Rights had approved the water appropriation of 8,000 cfs despite the Fish and Game Commission's recommendation for denial. Siskiyou County farmers also opposed the decision. To successfully fight the two other agencies and the power company, Siskiyou County and the Fish and Game Commission appealed directly to the people through an initiative measure on the state ballot (Proposition 11) in November 1924. As the result of the "assiduous campaigning of CFGC employees in all parts of the state," the measure passed by nearly a two to one margin. Commenting on the action, a fisheries historian noted "this was truly an extraordinary measure, and Fish and Game never tried it again" (McEvoy 1986).

The initiative created the Klamath River Fish and Game District, consisting of the Klamath River from its confluence with the Shasta River in Siskiyou County to its mouth in Del Norte County. Within the district, the construction or maintenance of any dam or other artificial obstruction is prohibited. The misdemeanor fine for violation is not less than $1,000 (increased from $500 in 1983), or 100 days in jail, or both (Fish and Game Code Section 11036).

1926-1960: Pre-Iron Gate Dam

While fish biologists and fishermen were not happy with the Copco dam construction, they were even less happy with the dams' operation. No minimum flow conditions were required of the operator. The power plants were operated to meet peak power demands (at capacity by day and shut down at night and on weekends) and the flow releases fluctuated with the anticipated demands. During one week, flows would vary from 3,200 cfs to 200 cfs while in a 20 minute period, the water level might drop or rise several feet (Jones and Stokes 1976, Taft and Shapovalov 1935).

Hazards were created for fish and fishermen with these extreme and unnatural short-term fluctuations. Complaints were common during the 1920s and 1930s and lawsuits against Copco were eventually filed. In several studies, adult and juvenile salmon and steelhead were observed being stranded along the shores of the river and stream invertebrates being killed by the exposure. Then the sudden rise in release would wash out and completely destroy recently made nests. (Snyder 1934, Taft and Shapovalov 1935). As a result, the U.S. Bureau of Fisheries recommended in 1935 that an "equalizing dam" be constructed below the Copco power plant to regulate the releases to a steady flow. In 1945, the State Legislature finally requested the Public Utilities Commission to study the effects of the artificial fluctuation and recommend a solution. The final report recommended in 1947 that a reregulating dam below Copco No. 2 be installed and operated by the company (Jones and Stokes 1976).

Studies at the time showed a phenomenal biological impact. California Fish and Game biologists calculated that, during the period from June 1948 through May 1949, the Klamath River below Copco experienced a loss of 1,862,132 salmonid fingerlings, yearlings, and adults (primarily steelhead) as a result of the power plants' fluctuating releases (Wales and Coots 1950). **Multiplying this annual loss times the 45 years it took until the problem was solved indicates the magnitude of the tremendous loss to the fishery.** Another impact of the dam noted by the agency at the time was the cementing of spawning gravel in the Klamath between the mouth of the Scott River and Copco dam, a factor which was (and still is) a serious impediment to successful spawning.

It was not until the 1950s, however, that Copco decided to build Iron Gate Dam. One of the big stumbling blocks to taking action was the resolution of the major water rights issues in the upper Klamath River Basin. Only after the ratification of the Klamath River Basin Compact by Oregon, California, and Congress in 1957 (see below for more discussion) was it possible for plans for Iron Gate Dam to proceed (U.S.A.C.E. 1979). A higher priority for Copco was the completion in 1958 of the Big Bend (now J.C. Boyle) dam and power plant upstream of Copco No. 1 in Oregon.

Current Large Dam Issues

Iron Gate Dam Reregulates Flows

Obtaining the state water rights and Federal Power Commission (FPC) license for Iron Gate Dam required negotiations over the needed instream flows below this desired project. CDFG protested the initial flow release recommendation, finally reaching an agreement with Copco in 1958 (Jones and Stokes 1976). The flows were based on 1950s state-of-the-art methods, with the primary intent to improve the fall chinook run (M. Coots personal communication). This final flow schedule was added as a Protest Dismissal Clause to the FPC license (#2082) as Article 52:

> The Licensee shall release to the streambed below Iron Gate Dam no less than the flows specified in the following schedule:

Periods	Flow (cfs)
September 1 - April 30	1,300
May 1 - May 31	1,000
June 1 - July 31	710
August 1 - August 31	1,000

> Provided that Licensee shall not be responsible for conditions beyond its control nor required to release more water than it has lawful right to use for hydroelectric purposes, and Provided further that Licensee shall restrict the changes of release rates to not more than 250 second-feet per hour or a 3-inch change in river stage per hour whichever produces the least change in stage as measured at a gauge located not less than 0.5 mile downstream from Iron Gate Dam.

A new fish hatchery in lieu of a fishway was also required by CDFG and FPC for mitigating the loss of anadromous fish habitat (the old hatchery at Fall Creek was abandoned in 1948). See below for further discussion.

Construction of Iron Gate Dam began in 1960 and was completed in 1962. Located about 7 miles below Copco No. 2, the dam is 173 feet high and the reservoir capacity is 58,000 acre-feet. Power plant capacity is 20 megawatts.

Trinity River Dams

In 1955, Congress authorized two dams on the upper Trinity River, and in 1964, the U.S. Bureau of Reclamation began full operation of Trinity and Lewiston Dams as a unit of the Central Valley Project. At least 80% of the historic annual flow of that part of the river was impounded for diversion out of the Trinity River Basin into the Sacramento River Basin. As a result, inadequate flows were available to flush sediments from the spawning gravels and pools, the river morphology changed, and the river's salmon and steelhead populations plummeted. While most of the impacts were localized in the Trinity Basin, the lower 40 miles of the Klamath River were impacted by the extreme decline in contributing flows from its largest tributary.

Efforts are ongoing through the Trinity River Basin Fish and Wildlife Management Program and others to help correct some of the problems.

Lake Shastina/Dwinnell Dam Impacts

In 1928, Dwinnell Dam was built on the upper Shasta River to hold irrigation water for the Montague Water Conservation District. It blocked access to the southern headwaters of the Shasta River. No fishway or hatchery was built for mitigation, and no minimum flows were required in the river. With a maximum storage of 41,300 acre-feet, the reservoir has a surface area of 2.85 square miles and a mean depth of 22 feet (Dong et al. 1974). Water use peaks during the irrigation season (May to October), when water is conveyed from the lake through the district's canal to its service area about 15 miles north.

While Dwinnell Dam continues to block upstream fish access, the water quality problems associated with the Lake Shastina reservoir may have the most stream habitat impact. As with most nutrient rich reservoirs, several problems occur: lack of dissolved oxygen near the bottom, heating up of the stored water, and high algal production (Dong et al. 1974). The reservoir releases downstream to the Shasta River "could and probably have significantly reduced the downstream DO (dissolved oxygen) levels by creating a high Biochemical Oxygen Demand (BOD) loading caused by the decomposition of the algal mass." Dissolved oxygen levels as low as 4.7 mg/L were recorded in August 1981 in the river below the reservoir, a level too low for salmonid survival in warm water (CDWR 1986). Nutrient sources into Lake Shastina primarily derive from agricultural, urban, and suburban land uses (Dong et al. 1974).

Spawning gravels in the Shasta River have also been impacted by the dam, preventing the recruitment of new gravel into the reach below (CH2M-Hill 1985).

Small Hydropower Projects

In the early 1980s, a combination of new federal policies, energy demand, and economic incentives created a boom to develop small hydro projects (30 MW or less) which resembled the early gold rush. California Department of Fish and Game noted the possible impacts to fish habitat: the partial or total dewatering of stream sections, adverse effects to aquatic and riparian resources, diversion of fish through the generation facility, and changes in stream temperature, dissolved oxygen and nitrogen levels (Smith 1982).

A total of 43 new small hydro projects, which could inundate or dewater at least 55 miles (89 km) of stream, were pending within the Klamath Basin of California as of 1982 (CDWR 1982b). The only river sections which could be automatically excluded from development, based on California's regulations, were those within the State or National Wild and Scenic Rivers Systems, within federally designated wilderness areas, or on waters designated "Wild Trout Waters" by California Department of Fish and Game (i.e., Klamath River from Copco to the Oregon border).

One small hydro project built on the Shasta River north of Yreka has a long history of compliance violations regarding fish passage, minimum instream flows, and screen operations (USFWS 1989a). With lower energy prices, many small hydro proposals were postponed in the mid-1980s but incentives could change once again.

Future Hydropower Development

As shown in Figure 2-15, the current number of hydroelectric projects on the upper Klamath river is six. On the drawing boards are plans by the Pacific Power and Light Company to develop several more sites, depicted in Figure 2-16, (U.S.A.C.E. 1979). In the immediate future is the present application to FERC by the City of Klamath Falls, Oregon, to build the Salt Caves project above Copco Lake and below the J.C. Boyle Dam.

Impact of Large Dams on Salmon and Steelhead

The salmonid impacts of the large dams on the Klamath River needing evaluation are:

1. Instream flow alteration.
2. Water quality.
3. Spawning gravel quality.
4. Fish passage.

Instream flows

Flow patterns in the middle Klamath River improved dramatically beginning with the operation of Iron Gate Dam. In Figure 2-17, the sharp average daily fluctuations of May 1 through June 30, 1948 can be contrasted with the same months in the year 1966. These months were selected because of the high mortality of steelhead fingerlings observed during this period in the 1948-49 CDFG study (Wales and Coots 1950). (The historic sharp drops in flow during each day are not shown as the data was not available).

The minimum monthly fish flow requirements have not always been met, however. Figure 2-18 shows that they were not met in certain years for the months of March, April, August, and September "by agreement between PP&L, USBR, and fish and wildlife authorities and by variance from the Federal Energy Regulatory Commission" (U.S.A.C.E. 1979). What the impact of these variances was (or is) on fish and other aquatic life is not known.

While minimum monthly flows were stipulated on the Iron Gate FPC license, the net effect of the agreement is for less annual discharge in the river. The historic annual average discharge near Iron Gate was about 1,400,000 acre-feet while the current requirement totals only 832,900 acre-feet (mainly to meet future upstream irrigation

Figure 2-15 – Present Klamath River Hydropower Development by Pacific Power and Light (PP&L).

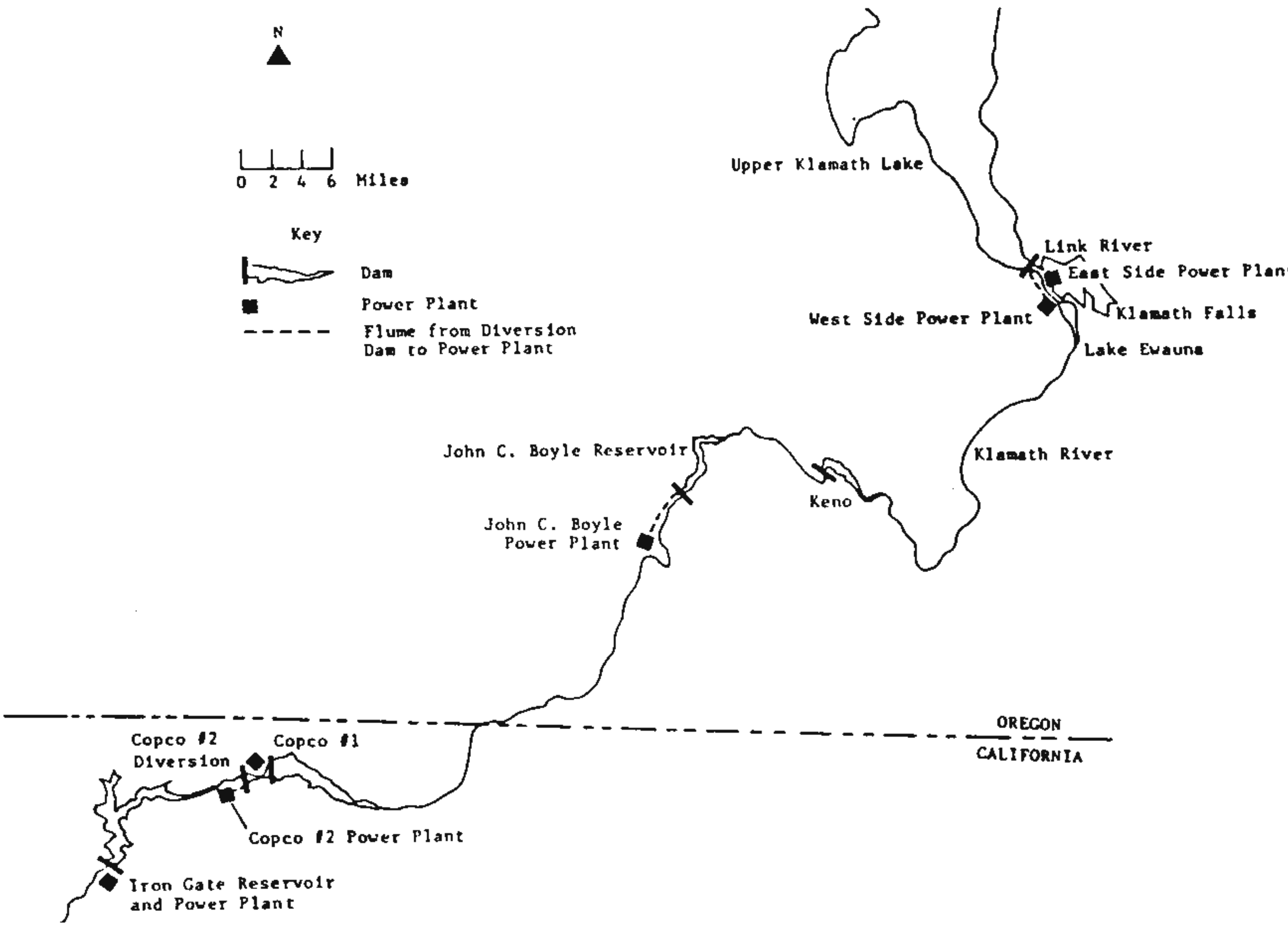
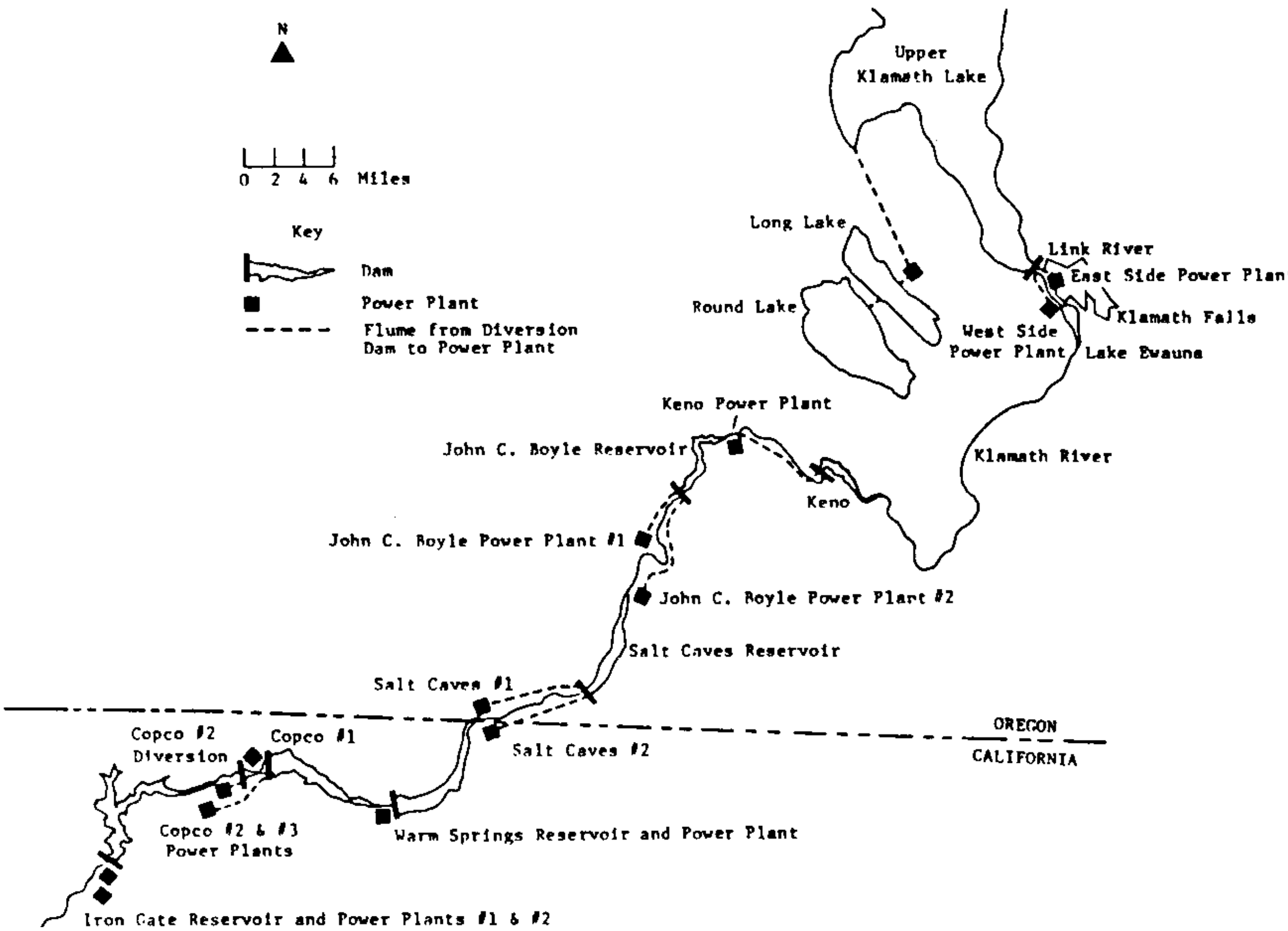


Figure 2-16 – Concept for Ultimate PP&L Hydropower Development on the Klamath River (based on 1973 Concept Plan).



Source: PP&L, 1978 in: US ACE, 1979.

demands) (U.S.A.C.E. 1979). Since 1961, however, the average has been about 1,600,000 acre-feet (CDWR 1986). What the additional 41% reduction in overall flow might do (if it ever occurred) to the salmonid population in the future is not known.

Another unknown is the effect of the release patterns on upstream and downstream migrations of each fish species. The approved schedule was primarily designed for fall chinook salmon by starting to increase flows August 1 (from 710 to 1,000 cfs), at the time the adults return to the mouth on their spawning migration (Jones and Stokes 1976). Dropping flows on May 1 (from 1,300 to 1,000 cfs) and again on June 1 (to 710 cfs), which helps to satisfy increased hydroelectric and irrigation demands, could have some effect on the spring-run and summer-run steelhead or spring chinook adult returns as well as downstream fall chinook migrants (Moyle 1976). Historically, stream gauge data shows that the month of May has sustained one of the highest flows in the undammed middle Klamath Basin tributaries due to snowmelt runoff (USGS 1989). How the current release patterns vary from the "natural" (unimpaired) flow patterns, and their relationship to fish migration needs, should be analyzed through a state-of-the-art instream flow study.

Water Quality Effects

The impoundment of water in the reservoirs contributes to algal blooms and nuisance conditions (e.g., attached algae) downstream. Nutrient levels of the reservoir inflow are also quite high, with contributions coming from natural, agricultural, and industrial sources. Outflow conditions show that between Iron Gate and Seiad Valley, 79% of the nitrogen and 68% of the phosphorus in the river originate upstream of the dam (CDWR 1986).

Temperature changes directly attributable to reservoir and powerplant operations and the downstream implications have not recently been evaluated. A high temperature problem at the Iron Gate hatchery killed chinook salmon eggs at one time. CDFG believed the increased temperatures from Iron Gate releases were the result of an overall increase in water temperatures of the Upper Klamath River. Although fishermen and others have requested a cold water release from the dam, this option may not be possible "due to the type of reservoir ('run of the river') and the high exchange rate of water in the reservoir." (Jones and Stokes 1976).

Spawning Gravel Impacts

Even before Iron Gate Dam, the spawning gravels below Copco Dam were observed by CDFG to be "cemented" with silt as far as the mouth of the Scott River, and too compacted for the smaller salmon of the Klamath River to make redds in (Wales 1950). The same problem was observed after Iron Gate in the 1970s and 1980s. In addition, rooted aquatic vegetation was able to take hold, creating slower pockets of water where silt could deposit. The poor gravel quality was attributed to the upstream dams blocking gravel replenishment and reducing scouring flows needed to clean existing spawning gravel. (Jones and Stokes 1976, CDWR 1981)

In 1981, the California Department of Water Resources concluded that with the present stream bed gravel composition, no bedload transport is likely to take place in the area below Iron Gate: "The bed is now armored with cobbles, requiring flows in excess of the December 1964 flood to move."

Fish Passage Effects

Salmon and steelhead continue to be blocked from reaching historic spawning grounds in the Upper Klamath Basin (75 miles of mainstem river, plus tributaries as far as above Upper Klamath Lake). Habitat for about 9,000 chinook and 7,500 steelhead spawners is potentially available in this area (Fortune et al. 1966).

A study was made in the mid-1960s by Oregon biologists and Pacific Power and Light Company (PP&L) to determine the feasibility of developing fish passage facilities over the power dams, which would provide for the reintroduction of salmon and steelhead to the upper Klamath (Fortune et al. 1966). Two plans were developed: Plan A, installing fish ladders on all dams and screening all diversions, would cost $3.9 million to build and $263,180 per year for O&M; Plan B, trapping and transporting fish around Iron Gate and Copco reservoirs, and laddering and screening diversions above, would cost $2.7 million initially and $207,180 per year O&M.

Arguments continue to be made in favor of renewing access, though the problems are formidable: lack of native spring chinook stock and downstream passage complications for fry and juvenile fish at impoundments seem to be the most serious (Fortune et al. 1966).

Water, Power, and Fishing Rights

Battles over water rights in the basin began with the early miners' contentions for ditch water (Wells 1881). Later the conflicts changed to those between irrigators as well as between irrigators and hydropower developers. In 1905, the U.S. Bureau of Reclamation filed for water rights under Oregon state law claiming its intent "to completely utilize all the waters of the Klamath River Basin in Oregon" for the Klamath Irrigation Project.

To ensure adequate water for both, the California-Oregon Power Company and the U.S. Bureau of Reclamation entered into a 50 year contract in 1917. Its provisions included: 1) using the Link River Dam to create water storage in upper Klamath Lake; 2) construction and operation of this dam by Copco to provide water for its downstream powerplants; 3) giving the Bureau first priority on all water to operate the Klamath Project, returning the water to the river above Keno; and 4) having Copco provide electricity to Klamath Project participants at greatly reduced rates. (Kuonen 1988).

Outside interests also sought rights. Filings during the 1920s on the Klamath River were proposing to divert and export water for irrigation and power in the Sacramento Valley (i.e., 4000 second feet), or to take it all the way to Southern California (Boyle 1976). Over the next few decades, many more proposals were made for water

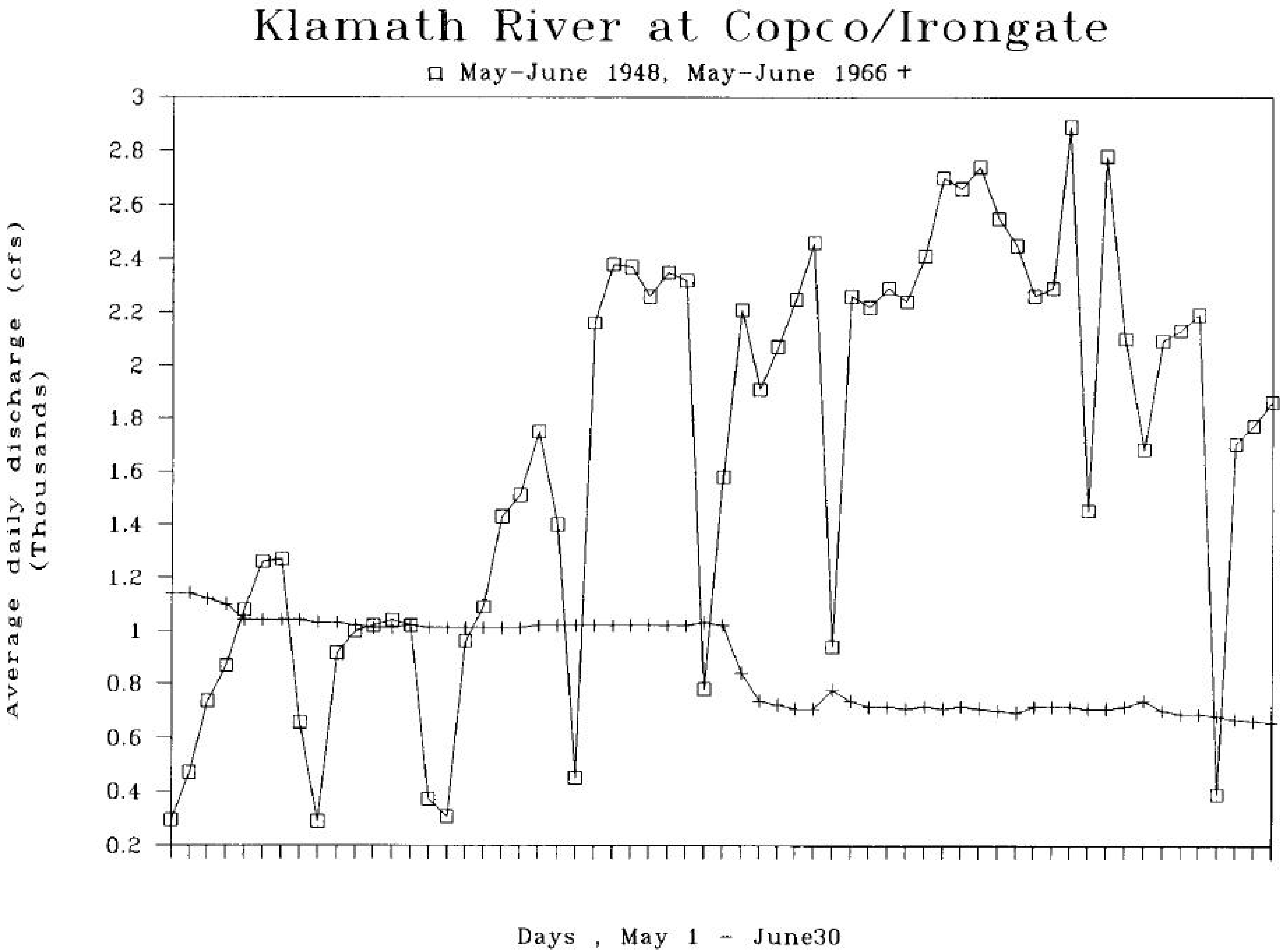
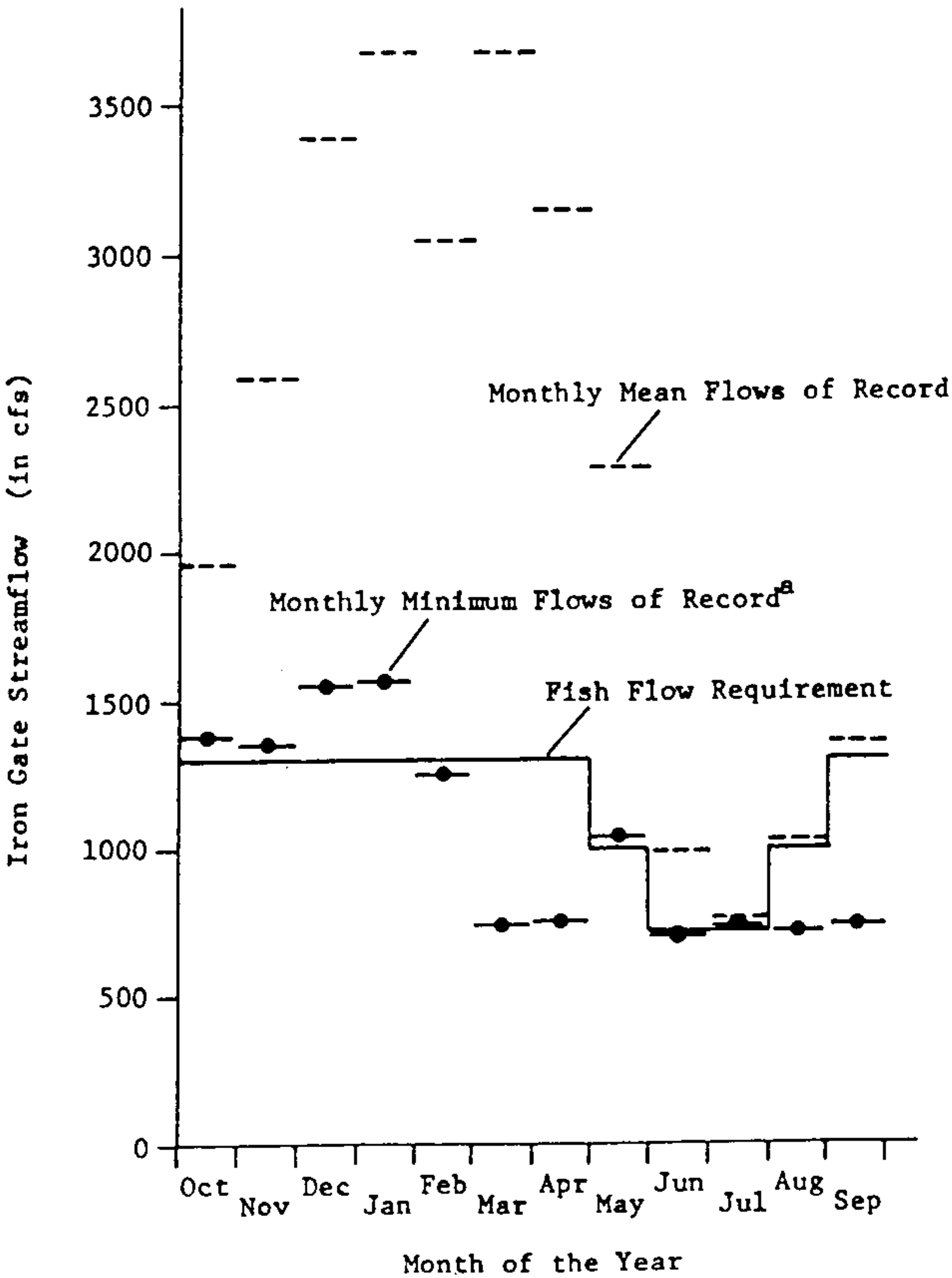


FIGURE 2-17 -- Comparison of Daily Discharge, Pre- and Post- Iron Gate Dam.

Figure 2-18 – Iron Gate Fish Flow Requirement Compared to Streamflow Data for 1961 through 1976.



Source: USBR, 1978 in Army Corps of Engineers, 1979.

development projects on the Klamath River and its tributaries (CDWR 1960, 1965). In addition, federal water power withdrawals on federal land, under the authority of the Federal Power Act, were made above Copco Lake (USBLM 1989).

Klamath River Basin Compact

Irrigation interests in the upper basin were still very concerned about the allocation of water and protested plans by Copco for further dams. Only after the FPC conditioned its approval of Copco's Big Bend project with the requirement to extend the company's contract with the Bureau of Reclamation did negotiations become eventful. Based on this contract and following many drafts, the Klamath River Basin Compact to allocate upstream water rights was finally approved by the two states and ratified by Congress in 1957 (Kuonen 1988).

Critical to fisheries interests is the Compact's preferential rights "for the anticipated ultimate requirements for domestic and irrigation purposes in the Upper Klamath River Basin in Oregon and California." Water for fish use ("recreational use") is third in priority. A superior right is also provided for adequate water to irrigate an additional 300,000 acres of land beyond that already irrigated in 1957.

Federal Power License

These stated rights were incorporated into the FPC's licenses for Copco's Big Bend and Iron Gate (FPC License # 2082) projects. In addition, the Iron Gate water rights permit from California stated, "water uses at Iron Gate and the river below are subject to irrigation needs of Shasta Valley, namely, until March 1, 2006 -- 120,000 acre feet annually and ultimately 220,000 acre feet annually" (Boyle 1976).

The federal power license for Iron Gate Dam, now controlled by the Federal Energy Regulatory Commission (FERC), will be up for renewal in the year 2006 (Boyle 1976). At this time the original fish protection conditions of the license can be reevaluated for their adequacy and changes can be proposed, if the data reveals that they are needed. Any water quantity changes in the FERC license (e.g., increased flow releases) would also require alteration of the Compact, which means reapproval by the two states and Congress.

Oregon Adjudication of the Klamath River

Since numerous water rights conflicts still exist, the Oregon Water Resources Department is in the process of adjudicating all water claims in the Oregon portion of the Klamath River Basin (USBLM 1989).

Upstream Tribal Rights

The Klamath Tribe of Oregon holds hunting, fishing, and gathering rights on its former Reservation in the Upper Klamath Basin. Federal recognition of the Tribe was terminated in 1954 and most of the tribal lands were converted to private or federal ownership. These rights survived termination and were confirmed to the Tribe in a series of court decisions in the 1970s.

A 1981 Consent Decree stemming from litigation also confirmed the Tribe's rights and responsibilities to co-manage, with federal and state agencies, resources on the former Reservation. Termination was superseded and federal recognition of the Tribe was restored in 1986 by the Klamath Tribe Restoration Act, which also recognized and protected its hunting, fishing, and gathering rights.

The Klamath Tribe actively promotes study of the anadromous fishery restoration potential of the Upper Klamath Basin above Iron Gate Dam, emphasizing the strength of pre-dam runs and explaining that the tribe "for centuries -- indeed, for thousands of years -- depended on upper basin anadromous fish runs as a mainstay of tribal existence" (Miller 1989).

Downstream Tribal Rights

Fishing and water rights are also important to the three downstream tribes: the Karuk, Hoopa Valley, and Yurok. Since fishing is at the very heart of their religion, culture, economy, and subsistence, they feel strongly about protecting their fish and water. Under the federal law concept of reserved tribal water rights, or "Winters Doctrine," the Hoopa Tribe has defended its right to instream flows in the Trinity River, with a priority date of not later than 1864 (when the Reservation was established). In addition, the Tribes claim riparian rights under California law for the Hoopa and Yurok Reservations along the Klamath River (S. Suagee, Hoopa Valley Tribal Council, personal communication).

Regulations for Large Dams

The California Fish and Game Commission "devoted much energy" in the early part of the twentieth century to fighting new dams and rectifying the old ones. Too much salmon and steelhead habitat in the state had already been lost behind dams, and adequate flows were not being provided for maintenance of the remaining fish runs. With the help of certain state statutes, the commission was given the authority to inspect irrigation and power dams and to order their operators to build fishways or hatcheries (at state expense) if their obstructions completely blocked fish passage (McEvoy 1986). During the 1950s, CDFG also pursued an aggressive abandoned dam removal program, which opened up passage on tributaries of the Salmon and Scott Rivers (CDFG 1965).

A Fish Ladder for Copco Dam?

With the construction of the first Copco dam on the upper Klamath, the California Fish and Game Commission had the option to require either a fishway or a hatchery. Copco took the position that it was willing to construct a fish ladder over Copco No. 1 dam, if the state provided the proper plans and specifications, but "was not willing to construct more than one fishway." After much discussion, the state finally decided upon a hatchery on Fall Creek, just below the dam site. (Boyle 1976).

According to W.H. Shebley, the Commission's Director of Fish Culture at the time,

> ... The matter of a fishway over Copco dam was gone into thoroughly by our experts and engineers before we decided to compel the California Oregon Power Company to build a hatchery, in lieu of a fishway, as provided by our fishway law. The problem involved was whether an efficient fishway could be constructed over a dam that is 100 feet in height, and with plans for construction that would raise the dam ten or fifteen feet higher, and what would be the benefit of such undertaking.

The main problem, they concluded, was "that if the Klamathon racks were removed and the salmon allowed to ascend the river, and if it were possible to build a fishway over the dam, the resultant fry would have to return to the ocean, and on their journey oceanward would be destroyed in the power wheel of the hydroelectric plant. Therefore it would be a waste of time and money to build a fishway over Copco dam .... The California Fish and Game Commission at considerable expense is maintaining this hatchery, and the people of Oregon are getting as much if not more benefit from our efforts than the people of California." (Shelby 1921, in Boyle 1976).

Not everyone upstream, where the runs of spring and fall chinook and steelhead were once quite plentiful, agreed with this decision. The Klamath Indian Reservation and the Klamath Sportsmen's Association were very dissatisfied with the hatchery solution and doggedly pursued the fish passage alternative, finally referring it to the District Counsel of the U.S. Department of Interior's Office of Indian Affairs in 1940 (Boyle 1976). With the dismantling of the Klamath Indian Tribe's status by the U.S. Government during the following years, this legal effort by the Indians faded for a period of time.

<u>Fish Flow Protections</u>

Regulations to provide adequate fish flows were not clearly in place in the first half of the century. In 1915, a new law required that adequate fish flows be guaranteed by dam operators. In 1919, a state law was passed requiring approval by the Fish and Game Commission of all water projects before construction could begin, but it was repealed in 1925 (McEvoy 1986). Why these new regulations were not used by the state for fish flow protections out of Copco No. 1 and No. 2 is not known.

<u>Hatchery Mitigation</u>

In 1948, the Copco mitigation hatchery at Fall Creek was permanently closed because of its dilapidated condition and the state's apparent lack of interest at the time in artificial salmon propagation. Although the egg collecting station was maintained, no propagation facilities operated on the Klamath until 1966.

The California Department of Fish and Game's mitigation emphasis for Iron Gate was twofold: 1) a minimum flow schedule to protect the salmonids (see above) and

2) the construction and operation of a new hatchery to produce fall chinook, coho, and steelhead. The FPC license stipulated the production capacity by species: 200,000 yearling steelhead trout; 73,000 yearling silver salmon; and 6,000,000 fingerling chinook salmon and release of an additional 5,500,000 swim-up fry. The licensee Pacific Power and Light Company (formerly Copco) pays 80% of the annual maintenance costs while CDFG covers 20%.

Wild and Scenic River Acts Prohibit New Dams

To prevent the further construction of dams on the state's few remaining free-flowing rivers, the California Wild and Scenic Rivers Act (SB 107) was passed by the State Legislature in 1972 after considerable debate. Those sections of river which were declared "to be preserved in their free-flowing state" in the Klamath River Basin of California include:

- Klamath River, main stem from 100 yards below Iron Gate Dam to the Pacific Ocean.
- Scott River, from the mouth of Shackleford Creek west of Fort Jones to the river mouth near Hamburg.
- Salmon River, from Cecilville bridge to the river mouth near Somes Bar.
- Salmon River-North Fork, from the intersection of the river with the south boundary of the Marble Mountain Wilderness Area to the river mouth.
- Salmon River-Wooley Creek, from the western boundary of the Marble Mountain Wilderness Area to its confluence with the Salmon River.
- Trinity River, below Lewiston Dam to mouth; and portions of North Fork, New River, and South Fork.

In 1981, these same sections of river were also incorporated into the Federal Wild and Scenic Rivers System. Inclusion in both the state and federal systems provides a double protection from water development. Only an act of the State Legislature (by two-thirds vote) or a majority approval by the state's voters (through the initiative process) can remove the rivers from the state system and only an act of Congress can remove them from the federal system. In addition is the 1924 Klamath River Initiative language in the California Constitution and State Fish and Game Code prohibiting dams on the mainstem Klamath.

In 1988, Oregon citizens voted to amend the Oregon State Scenic Waterways Act to add the Klamath River from the J.C. Boyle Dam downstream to the Oregon-California border as the Klamath Scenic Waterway (USBLM 1989). Competing with the Salt Caves Dam proposal is the current recommendation by the U.S. Bureau of Land Management (BLM) to include the same stretch of river in the National Wild and Scenic Rivers System. Its report finds that the trout fishing in the segment is significant, providing "an excellent trout fishery" and "reputed to be among the better fly fishing rivers in Oregon." The river is also said to be "inhabited by highly productive, genetically unique wild rainbow trout population" (USBLM 1989). The California portion of the river above Copco Lake is designated "Wild Trout Waters" by the California Department of Fish and Game.

Conclusions

Stream habitat protections from the effects of large dams in the Klamath Basin have not been adequate. For at least 80 years, salmon and steelhead have been blocked from their important historical spawning grounds in the river's headwaters above Copco. For 45 years, fluctuating flow releases from Copco Dam were allowed to kill millions of steelhead and salmon in the main stem Klamath River.

Habitat damage may still be occurring from downstream effects of the large dam operations in the basin. Studies of possible effects need to be made before the FERC relicensing of the Iron Gate hydroelectric project in 2006. The existing flow schedule was based on a single stock, the fall run chinook, and did not address the other runs in the river. On the Shasta River, Dwinnell Dam/Lake Shastina is contributing to the river's water quality problems and needs to be assessed.

New dams are now prohibited on certain sections of the Klamath River and its tributaries. Other portions are still vulnerable to new water storage or hydroelectric projects, such as the Salt Caves Project in Oregon.

POLICIES FOR WATER AND POWER PROJECTS

Objective 2.E. Protect salmon and steelhead habitat from harmful effects of water and power projects in the Klamath Basin.

2.E.1. Support the evaluation of existing large water storage projects in the basin to determine their effect on limiting factors for anadromous fish production, including the following:

a. Reevaluate (from the 1966 study) the currently available spawning and rearing habitat located above Iron Gate Dam, where needed.
b. Monitor water quality, including water temperatures, above, within, and below the Copco and Iron Gate reservoirs, for a five year period to determine the effects of water storage and powerplant operations on downstream habitat conditions.
c. Evaluate the instream flow needs, using state-of-the-art methods, of each salmon and steelhead run and life stage affected by flows released from Iron Gate Dam.
d. Examine the impact of Lake Shastina on Shasta River's water quality problems.

2.E.2. Identify and implement methods to rectify habitat problems identified in #1 above, including the following:

a. Access above Iron Gate and Copco Dams to the Upper Klamath Basin.
b. Water quality above and below Iron Gate Dam.
c. Instream flow and habitat below Iron Gate Dam.
d. Water quality and flow from Lake Shastina.

2.E.3. Promote adequate fish protection requirements in the relicensing conditions for the Iron Gate Hydroelectric Project and other power projects by the Federal Energy Regulatory Commission.

2.E.4. Advocate inclusion and enforcement of effective conditions for salmonid habitat protection on small and large hydroelectric projects and other water storage projects.

2.E.5. Oppose further large water storage projects until habitat problems caused by existing projects are rectified, and proof is available that any proposed project will not contribute to habitat problems.

2.E.6. Oppose the additional exportation (through water marketing or other means) of water from the Klamath River or Trinity River Basins, which is necessary to restore and protect anadromous fish populations.

2.E.7. Require water flows adequate to achieve optimal productivity of the basin.

2.E.8. Seek the establishment of law that mandates minimum streamflow standards.

2.E.9. Advocate improved streamflow releases from the Trinity River Project which will better mimic the natural or pre-dam streamflow patterns.

STREAM DIVERSIONS

Issues

* Habitat damage from stream diversions for irrigation and mining.
* Dewatering of some streams in sections during summer and fall.
* Potential for more water efficient irrigation practices and delivery systems.
* Diversion of juvenile and adult fish into unscreened ditches.
* Effect of stream diversions on water quality of Shasta River.
* Status of water rights.
* Use of the Public Trust Doctrine to reallocate water rights.
* Need to work with owners of water rights in Scott and Shasta Valleys.

The most obvious stream diversions are the ones which siphon water from the stream surface through a pipe or ditch at the edge of a stream. Another form of diversion pumps water beneath the surface from the underflow contributing to the stream. These wells are today considered to be using surface water ("interconnected ground water") rather than ground water (CSWRCB 1980).

History

<u>Mining Diversions</u>

Direct diversion of water from streams into ditches by placer miners began in the 1850s (Wells 1881). Mining diversions, current and abandoned, were noted as a fish problem due to lack of screens in stream surveys in the 1930s of the Scott and Salmon Rivers. Water use was not considered by the biologists to be much of a problem as the larger mining diversions operated during the winter and most of the flow was returned directly to the river (Taft and Shapovalov 1935). In the 1950s, abandoned diversion dams were removed by the California Department of Fish and Game (CDFG) throughout the streams of the basin, but many of the ditches remain in place (CDFG 1965). Some of the old mining ditches later became used for irrigation. (See "Mining" section for more discussion.)

<u>Irrigation Diversions</u>

Farmers in the Scott and Shasta Valleys found an immediate market for hay and grain to the burgeoning mining camps in the region. After the first gold mining boom "followed a fallow era when livestock grazed over these old-time grain fields," but by 1915 "billowing fields of wheat, oats and barley wave(d) their promises of wealth each summer" (French 1915). Originally, much of the land was dry farmed, but irrigation was much more desirable since it increased both yields and profits. Following the turn of the century, Shasta Valley was noted for having completed most of the work of diverting streams for irrigation purposes while in Scott Valley several ditches were "supplementing the generous rainfall of that region" (French 1915).

Another opportunity for improved irrigation came when affordable power (through local hydroelectric projects by the California-Oregon Power Company) became available during this period, allowing for the pumping of water directly from the rivers or from the ground water instead of by developing gravity-fed long ditches.

The amount of lands under irrigation mushroomed from 57,000 acres in Siskiyou County in 1912 to nearly 100,000 acres in 1914 (French 1915). Dry farming continued to be practiced by farmers for certain crops in both valleys.

Upper Klamath Basin: Klamath Irrigation Project

In 1905, the U.S. Bureau of Reclamation began its Klamath Irrigation project near Klamath Falls, Oregon. Marshes were drained ("reclaimed") and dikes and levees were constructed. What resulted was a major transformation of the hydrology of the upper Klamath basin. As shown in Figure 2-19, Lower Klamath Lake shrank to a fraction of its former size. The level of Upper Klamath Lake was also raised in order to provide better flow regulation; its average depth is now about 12 feet (U.S. Army Corps of Engineers, 1979).

Irrigation water in the upper basin is primarily provided by diversion from Upper Klamath Lake (through a canal above the Link River Dam) and the Lost River system, which connects the Klamath River and Lost River through a channel about 3 miles south of Klamath Falls. Depending on demand and irrigation requirements, the water in this channel can flow in either direction (USSCS 1985).

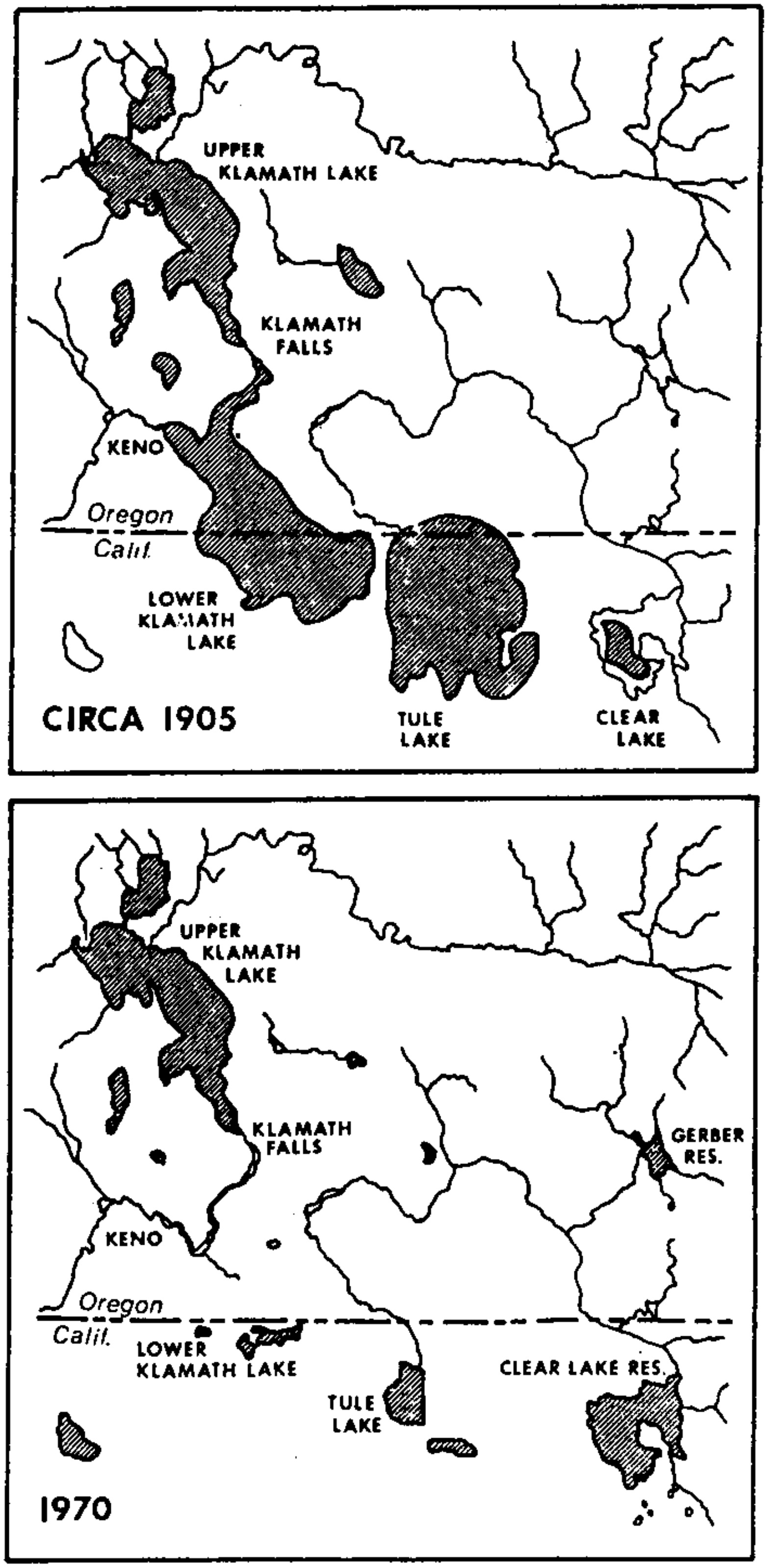
Shasta Valley

As noted above, water in the Shasta River was developed for irrigation over 80 years ago. Between Montague and Grenada in the Shasta Valley, the Montague Land and Irrigation Company pumped water into its ditches through two centrifugal pumps lifting 16,840 gallons per minute to ditch heads 86 and 107 feet above, to be released onto 5,000 acres of adjacent lands in 1915. Water from a dozen wells near Big Springs irrigated another 10,000 acres (French 1915). By 1931, a biologist was already commenting on the decline of the Shasta River's contribution to the Klamath River's salmon population, attributing its condition to "local causes such as diversion of water for agriculture, mining, and power purposes, spearing fish on the spawning beds, and what not" (Snyder 1931).

In the 1960s, CDFG commented that "fall-run kings (chinook) will encounter complete and partial blocks to upstream migration in the (Shasta) river unless the present program of policing and providing passage over diversion dams is continued." While the Shasta River was considered a very productive stream for fish at the time, the agency found the limiting factors to be temperature and heavy use of water for irrigation: "The timing of migration and spawning is based on availability of water along with suitable water temperatures" (CDFG 1965).

At present, irrigation of permanent pasture and alfalfa fields below the ditches or near the river is primarily done by "wild flooding," with much of the return water

Figure 2-19 – Water surface areas before and after man's influence.



Source: OSWRB, 1971 in: US ACE, 1979

recaptured and used on lower pasture lands (CDWR 1989). The Montague Water Conservation District provides water to about 11,000 acres of the 48,000 acres of irrigated farmland in the valley from Lake Shastina (50,000 acre-feet storage), located on the upper Shasta River (NCRWQCB 1989). The topography of the Shasta Valley is quite uneven with many small hills and shallow, volcanic soils, creating challenges in farmland irrigation practices.

Annual water demand (applied water) by agriculture in the Shasta Valley has been estimated by the California Department of Water Resources (C. Ferchaud personal communication):

YEAR	APPLIED WATER	IRRIGATED ACRES
1970	130,300 (acre-ft)	48,000
1980	146,100 (acre-ft)	45,800
1985	144,000 (acre-ft)	46,500
1988	150,500 (acre-ft)	50,000

Water quality problems associated with low flows (e.g., high temperature and low dissolved oxygen levels) and nutrient-laden agricultural runoff are presently the most common complaint about fish habitat in the Shasta River basin (CH2M-Hill 1985).

Scott Valley

The Scott Valley has a long history of stream diversions. In a June 1934 stream survey of the Scott River, biologists from CDFG noticed that the ditch beginning at the concrete diversion dam near Etna (now known as Young's Dam) was diverting about 30 cubic feet per second (CFS) while only 2 to 5 cfs was passing through the planks in the upper half of the dam into the main river. Salmonid fry were also observed beyond the fish screen at the time (CDFG 1934). On June 9th, 1934, no surface water from Shackleford Creek was reaching the Scott River, "all of it being taken into irrigation ditches" (Taft and Shapovalov 1935).

In 1958, water use in the Scott Valley was estimated at 118,200 acre-feet which was applied to 31,300 acres through 240 miles of ditch and pipeline by about 200 diversions (CDWR 1963). Although the 1958 water year was the wettest season on record at the time, water in the Scott River was still insufficient to meet all of the late season irrigation demand (McCreary Koretsky 1967). Considerable acreage was also sub-irrigated or dry farmed.

California Department of Fish and Game concluded in 1974 that, "many of the methods and extent of diversion and irrigation currently in practice in the Scott River Basin have created a large degree of incompatibility between agriculture and fisheries. The flows required to maintain fishery values and support heavy agricultural diversions clearly are not in the system during the latter part of July, August, and often in September. Many of the streams would have critical level flows (less than minimum) during this time period even if no water is diverted."

Problem sections of the stream system noted for going dry or intermittent during the summer months were (CDFG 1974):

- Scott River at river mile 50 for 1-3 miles, below diversion ditch.
- East Fork Scott River below diversion dams.
- Etna, Kidder, and Patterson Creeks over several miles of lower reaches.
- Sniktaw and Shackleford Creeks near mouths.
- Patterson Creek (near Meamber Bridge) and Indian Creek.
- Moffett Creek.

Estimates of agricultural water demand (applied water) in the Scott Valley in recent decades are as follows (C. Ferchaud, CDWR, personal communication):

Year	Applied Water	Irrigated Acres
1970	92,400 (acre-feet)	31,500
1980	98,700 (acre-feet)	33,500
1985	97,600 (acre-feet)	33,600
1988	96,400 (acre-feet)	34,100

Water use averages about 3.0 acre-feet per acre year.

Other Agricultural Areas

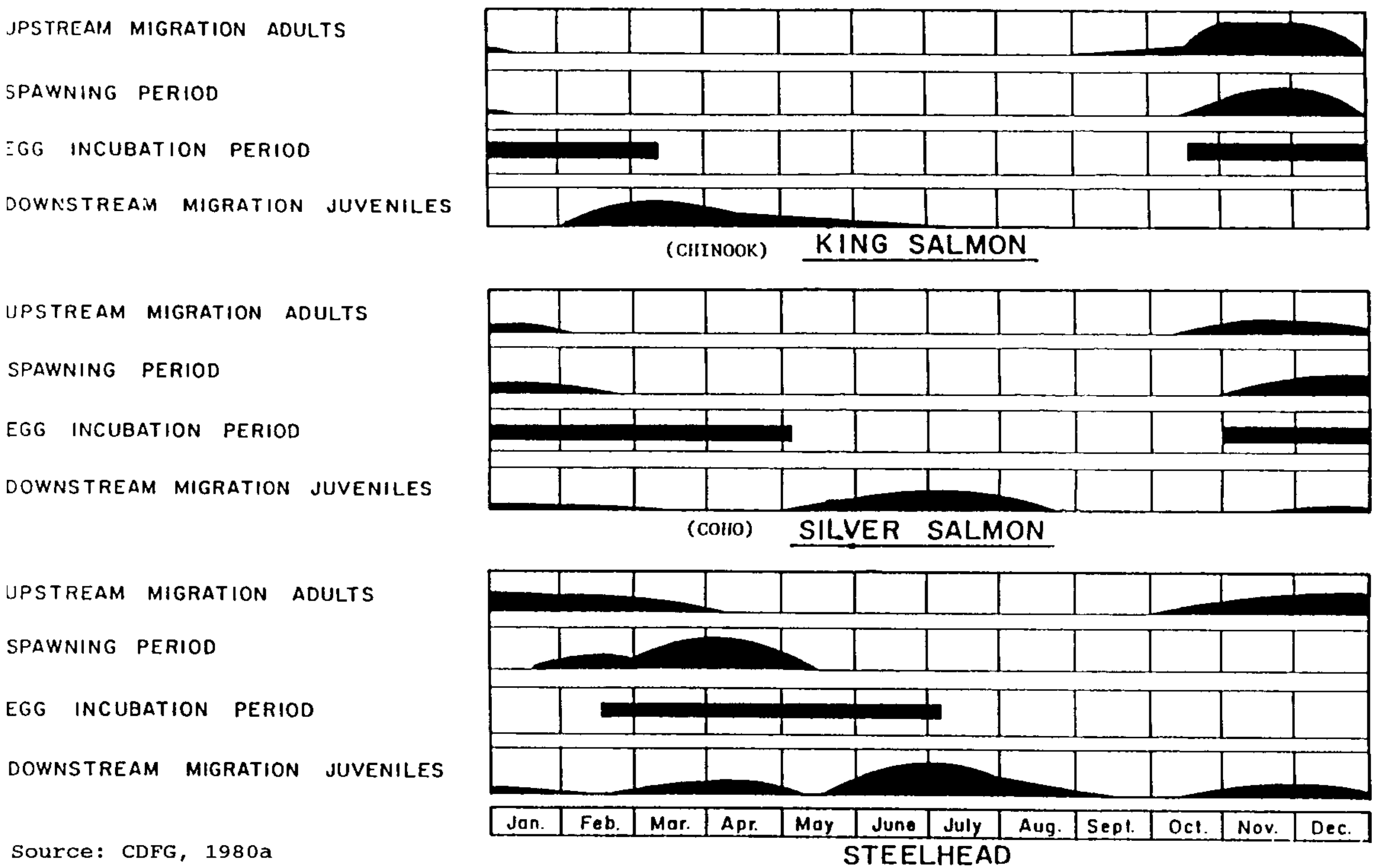
Besides the above two major valleys, smaller water diversions for agriculture occur in several other direct tributaries to the middle Klamath River: Grider Creek, Cottonwood Creek, Horse Creek, Bogus Creek, Little Bogus Creek, and Willow Creek.

Impacts of Water Diversions on Salmon and Steelhead

Water for instream fish needs was not considered of much importance when irrigation was being developed in the basin. "A large volume of water runs to waste in the Shasta River and its tributaries but this excess is now about to be put to good use," commented a spokesman for Siskiyou County before World War I (French 1915). While the development of irrigated agriculture was certainly an asset to the economy of the area, the water removal damaged another of its valuable assets, the salmon and steelhead fishery.

Removal of water from the stream has a critical relationship to the timing of different life stage needs of anadromous fish. Figure 2-20 indicates the spawning, egg incubation, and migration periods for the three salmonid species found in the Scott River (CDFG 1980a). The time periods would probably be very similar for the Shasta River (Leidy and Leidy 1984). While naturally low water conditions can also prove unfavorable to salmonid fish, the problems are greatly accentuated by the numerous

FIGURE 2-20 -- Spawning, egg incubation, and migration periods of anadromous fish for the Scott River.



Source: CDFG, 1980a

diversions. The fish impacts related to stream diversions can best be discussed within these categories:

1. Adult holding areas.
2. Upstream migration of spawning adults.
3. Downstream migration of juveniles.
4. Incubation and rearing habitat for juveniles.
5. Water quality impact.

Adult Holding Areas

Historically, the Scott and Shasta Rivers supported good populations of spring-run chinook and spring-run steelhead, which need adequate flows and temperatures to summer-over in the pools of the lower canyon sections of the rivers until they could spawn the following fall or winter. Now these two runs are considered extinct or relict in the Scott and Shasta Rivers because of poor summer flow conditions (West 1983). Holdover conditions for adult fall chinook and coho salmon prior to spawning are considered poor to fair (CDFG 1974).

Upstream migration

Stream flow in certain reaches of the Scott and Shasta tributaries in the early fall months is a limiting factor in the spawning migration of the adults of each species. While flow in the main Klamath River is sustained each year by Iron Gate releases at a minimum of 1,300 cfs after September 1st, flow in these tributaries is still being strongly affected by irrigation diversions. Irrigation demand drops off towards the end of September after the final cutting of alfalfa, but some diversions continue to be made during the fall, primarily for stockwatering. In the Little Shasta River, diversions of almost the entire stream are legally made from October to mid-April to fill several small storage reservoirs (R. Dotson, CDFG, personal communication).

Lack of water creates low velocities and depths in the stream which can hinder or completely block movement by the large spawning adults, particularly the fall-run chinook salmon. This problem has been noted for some time in the Scott and Shasta Rivers (CDFG 1965). As a result, the timing of the historically early runs has been delayed until irrigation diversions stop and the river level rises to an adequate level (West 1983). During dry years, the diversion of even 10-15 cfs for stockwatering can be critical to migration access when the Scott River is only running at 35 cfs in mid-October, as it was in 1988 (USGS 1989). In the Shasta River, fall chinook only have access to the lower 10-15 miles in dry years but to over 38 miles in wet years (CH2M Hill 1985). Much of the Little Shasta River is essentially considered a "write-off" for anadromous stock due to excessive winter diversions to off-stream storage reservoirs there (R. Dotson, CDFG, personal communication).

Another impact on adult migration is the physical barrier of temporary diversion dams. Over the years, these dams were the subject of complaints by CDFG biologists and wardens (CDFG 1965, CDFG 1980a). Recently, many of the dams have been replaced by wells adjacent to the stream in the mainstem Scott River. Other streams still have a problems. On Horse Creek, a 12 foot high diversion dam continues to block all spawners to 14 miles of upstream habitat (S. Fox, USFS, personal communication).

California Department of Fish and Game has recommended a flow of 150 to 200 cfs for adult chinook salmon to "navigate the Scott River safely and reach the best spawning grounds," an amount which has rarely been met in October (see discussion below) (CDFG 1980, USGS 1989).

Downstream migration

Steelhead young and surviving adults as well as coho salmon young are very vulnerable in the spring and summer months to stream diversions (Figure 2-20). (If irrigation begins in March in dry years, then fall chinook juveniles may also be affected.) Smolts are trying to migrate downstream to the ocean during the same period as the irrigation season, from April to August. Both adequate flows and clear passage are needed but are not always found.

Unscreened or ineffectively screened diversions have caused serious losses. In one historic study on a tributary of the Scott, an unscreened ditch was drained in June and the stranded fish were counted: 1,488 young steelhead and 105 young coho salmon (Taft and Shapovalov 1935). As recently as March 1988, a major irrigation ditch was opened in the Scott Valley without the fish screen installed and an unknown amount of young fish were lost (R. Dotson, CDFG, personal communication). The fish diverted into ditches are either spread with the water onto the fields or left to die in the ditch when the water is shut off in the fall.

Downstream migrants also become trapped in pools or side channels when the streamflow drops sharply during early summer and soon die from high temperatures, lack of food, or predation. Some portions of streams often become entirely dewatered due to diversion: lower Shackleford Creek, lower French Creek, lower Etna Creek, Kidder Creek, McAdams Creek, Moffett Creek, and Scott River below Farmers' Ditch (CDFG 1965, Puckett 1982). In 1989, a near normal water year, fish rescue efforts by CDFG captured 341,428 juvenile steelhead below diversions in these dewatered streams of the Scott River system during the months of May through July (R. Dotson, CDFG, personal communication).

Incubation and rearing

Steelhead eggs are still incubating in the gravels during May, June, and early July, depending on the timing of spawning and the water temperatures. Since developing eggs are very dependent on an adequate exchange of fresh water to provide oxygen and to remove metabolic wastes, inadequate flows can reduce egg survival (CDFG 1980). Fall chinook eggs and young are probably the least vulnerable to diversions, while steelhead and coho salmon juveniles are quite susceptible as they need to spend at least one full summer in the stream.

Rearing habitat requires sufficient shelter, food, and water temperature. Reduced flows shrink the amount of shelter in pools (see Figure 2-21) as well as the quantity of streambed invertebrates available for food from the riffle areas. Lack of shelter also exposes the fish more to potential predators, such as heron and otter. All of these factors lower the number of fish the river can support (CDFG 1980).

The large numbers of young steelhead and coho rescued by CDFG from drying tributaries and the main rivers (over 300,000 per year from the Scott Basin alone) indicates the significant loss of population occurring from this deprivation of habitat (Puckett 1982).

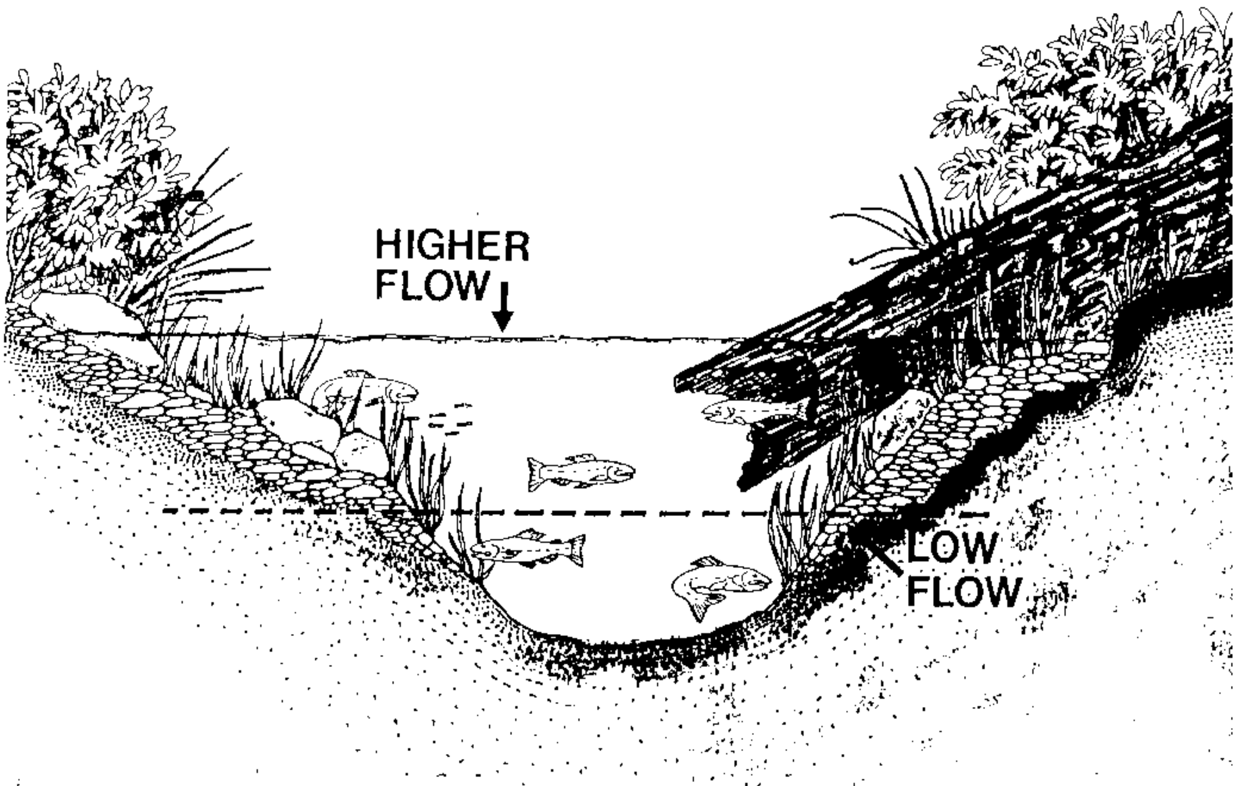


Figure 2-21 – Effect of lower streamflow on amount of fish habitat.

Source: Bottom, et al. 1985.

<u>Water quality</u>

Stream temperatures above tolerable levels for salmonids have been attributed for over 20 years to low flow conditions and the return of warmed irrigation waste water to the Scott and Shasta Rivers (CDFG 1965, CSWRCB 1974, CDFG 1980a, CH2M-Hill 1985). Cooler water (about 56° F) is needed for chinook salmon spawning in the fall. As shown in Figure 2-22, temperatures below 59° F are considered optimum for rearing anadromous salmonids while lethal temperatures occur at about 78-80°F, depending on the adaptability of the local stock. Cooler water pockets can be found

Figure 2-22 – Temperature preferences and danger zones for rearing and incubating anadromous salmonids (adapted from (Brett 1952 and Everest et al. 1982).

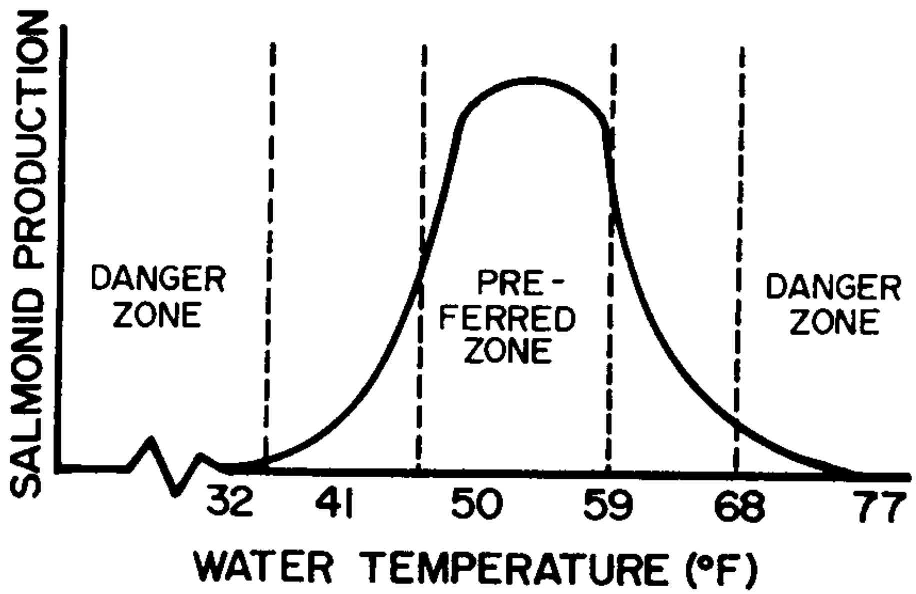
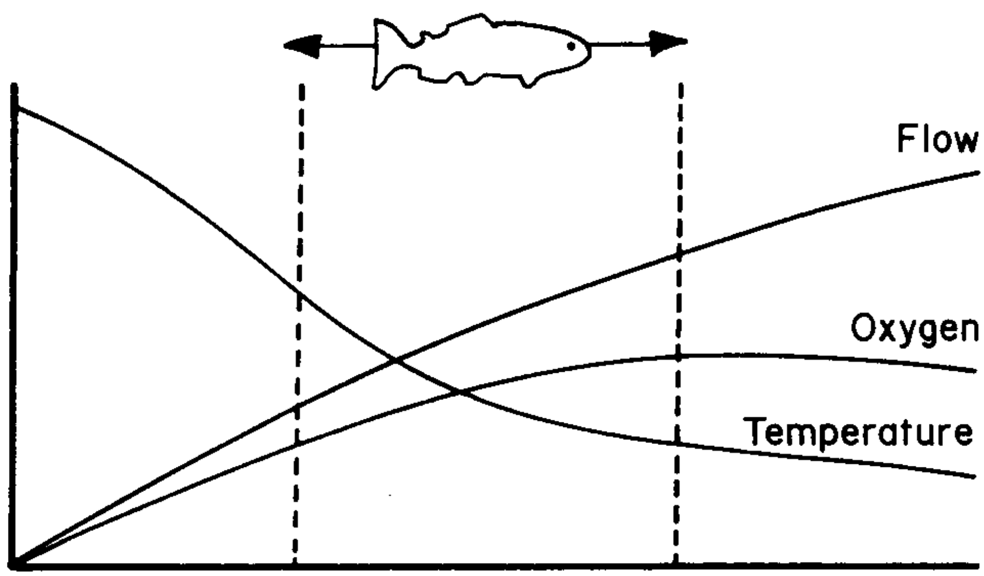


Figure 2-23 – Relationship of Flow to summer water temperature and dissolved oxygen. (The range for optimum salmonid production is indicated by dashed lines).



Source: Bottom, et al. 1985.

in the bottom of deep pools, but sedimentation will fill in pools. In the Shasta River, monitoring efforts recorded a high of 85^{o}F in July 1982 near its mouth and 78^{o}F at the mouth of the Scott River (CDWR 1986). Such high temperatures continue to be an annual problem (D. Maria, CDFG, personal communication).

In Figure 2-23, the relationship of water flow to stream temperature and dissolved oxygen (D.O.) levels is indicated. Oxygen levels in portions of the Shasta River have reached critically low levels for salmonids in recent years (e.g. 4.7 ppm in 8/81) (CDWR 1986). A minimum level of 7.0 mg/l (ppm) is the specific water quality objective for the Shasta and Scott Rivers of the North Coast Regional Water Quality Control Plan, which was designed to protect the anadromous fish populations (NCRWQCB 1989). Overall, the impacts of low flows and high temperatures have created poor to fair conditions for salmon and steelhead, as summarized below in Table 2-4 (CDFG 1974).

TABLE 2-4

Adequacy of Current Stream Flow and Temperature Conditions
for
Anadromous Salmonid Populations in the Scott River
(CDFG 1974)

Species and run	Holdover of adults prior to spawning	Spawning	Juvenile rearing
Steelhead (winter run)	Good	Good	Poor
Chinook Salmon			
Spring-run	Poor	Poor	Fair
Fall-run	Poor to Fair	Poor to Fair	Fair
Coho Salmon	Fair	Fair	Poor

Water Practices

Changes in agricultural water practices have generally been for the better regarding fish needs. In the past, irrigation was commonly done by the flood irrigation method in the Scott and Shasta Valleys. This practice uses excessive amounts of water in comparison to the moisture needs of the plant and low irrigation efficiencies result. The California Department of Water Resources (DWR) studied agricultural water use in the two valleys in 1958 and found that an average of 6.3 acre-feet was being applied per acre yet the consumptive water use was only 2.28 acre-feet per acre, creating an overall irrigation efficiency of just 36%. Some landowners would also apply water before it was needed just to exercise their water right (CDWR 1963, McCreary Koretsky 1967).

Sprinkler irrigation was just starting in the late 1950s in the Scott Valley, a technique which has a higher irrigation efficiency (McCreary Koretsky 1967). Wheel-lines there are now common. The numerous temporary gravel diversion dams found in the mainstem Scott River during the 1950s-1970s have almost disappeared in the 1980s, largely due to the results of the 1980 Scott River Adjudication (see below). Pumping water from wells near the river, which is still legally considered surface water, is the more common practice along the river at present (though diversion dams are still frequent on the tributaries). Since such pumps do not require fish screens or diversion dams, they are less harmful to fish. The effect on surface water levels from pumping by the newer deep wells on the edges of the Scott Valley is not known.

Water loss in canals and ditches is also a serious waste. Data collected by the U.S. Soil Conservation Service (SCS) for a major ditch in the Scott Valley showed that water delivery was reduced 21 to 39% as a result of seepage (USSCS 1976). One of the recently funded Task Force projects is for the Department of Water Resources to study the potential for lining (or piping) the irrigation ditches in Scott Valley to reduce the demand for diversions.

Water use also varies by crop. In Siskiyou County, grains use less water than alfalfa, for instance: 1.9 acre-feet per year (afa) applied average compared to 3.2 afa (CDWR 1986b). Actual water use for a particular site and year varies by rainfall, soil type, and other factors. Irrigated pasture today tends to be uneconomic if money has to be spent for pumping; gravity-fed water systems are the only affordable method (K. Whipple personal communication).

In addition, DWR's current study of the Scott River will determine the potential for implementing agricultural water conservation measures for adjudicated surface water to make more water available for instream uses. In general, a statewide DWR drought report (1988) recommends that irrigators can stretch their water supply if they try to follow some or all of the following practices:

1. Improve land grading, particularly using laser leveling.
2. Install irrigation return flow systems.
3. Use sprinklers or drip irrigation systems on appropriate crops.
4. Control weeds and other phreatophytes.
5. Use gated pipe, lined ditches, or pipelines instead of earth-lined ditches.
6. Monitor soil moisture to be more precise in preirrigations and to properly schedule timing and amount of irrigation water application.
7. Use information on the water use of various crops and determine whether deficit irrigation would be feasible.

While the first three practices may have limited application to the Scott Valley, they are applicable to the Shasta Valley. Demonstrations of water conservation and management measures as well as public information displays on water conservation and management at various community activities and fairs are also encouraged.

Another opportunity to save water could be through intensive grazing practices, which helps to reduce the acreage needed for irrigated pasture (Water Heritage Trust 1988).

Water Storage Alternative

The Shasta River has Dwinnell Reservoir/Lake Shastina as the source for the Montague Water Conservation District's irrigation customers. No storage projects exist on the Scott River, though many sites have been studied for additional irrigation water and flood control (McCreary Koretsky 1967). To date, none of these potential projects (i.e., East Fork Scott River, French Creek, Kidder Creek, and Moffett Creek) have been found to be affordable.

A new storage project calls into question concerns regarding potential net benefits to the anadromous fishery of the Scott or Shasta Rivers. As demonstrated by the water quality problems of Lake Shastina, small to medium reservoirs are quite notorious for heating up the stored water, lowering dissolved oxygen levels, and facilitating algal production (CDWR 1986, Jones and Stokes 1976). Even if cold water releases could be obtained when needed, it is very difficult to mimic the instream temperature needs of the stream ecosystem. The loss of spawning and rearing habitat above an on-stream dam site would also be irrecoverable. As part of its current Scott River Flow Augmentation Study, DWR will also be examining the feasibility of a reservoir to augment instream fishery flows.

Water Rights

Conflicts between irrigators (and others) over water rights to the local streams have led to the defining of their rights under adjudication procedures. An adjudication "results in a (court) decree specifying the amounts and priorities of diversion on a watercourse" (Goldfarb 1984). It does not necessarily mean that the stream is fully appropriated (i.e.,, no new water appropriation permits can be issued). Adjudications are complete for the following Klamath Basin streams (CSWRCB 1980, CDWR 1989):

Stream	Year Decreed	Number of decreed users	Total decreed Water Right (cfs)
Scott River	1980*	648	874.29
French Creek	1958	n/a	n/a
Oro Fino Creek	1980	10	21.74
Shackleford Creek	1950	n/a	n/a
Sniktaw Creek	1980	15	10.68
Wildcat Creek	1980	7	7.49
Shasta River	1932	212	618.82
Willow Creek	1972	(see above)	(see above)
Cold Creek	1978	-	-
Seiad Creek	1950*	n/a	n/a

(* = No Watermaster Service being provided)

(The Upper Klamath Basin's water rights for irrigation were partly resolved in the 1957 Klamath River Basin Compact, which is discussed in the previous section on "Large Water Storage Projects." The Oregon Water Resources Department is presently in the process of adjudicating all water claims in the Oregon portion of the Klamath River Basin.)

The degree to which these adjudications address the critical issues depends on how long ago they were completed. According to the Watermaster for the Shasta River, "a peculiarity of the Shasta River decree (1932) is that it defines only appropriative rights and excludes a number of riparian users on the Lower Shasta River. Owners of these riparian rights are not subject to watermaster supervision, causing considerable distribution problems during the season of short water supply" (CDWR 1989).

In the Scott River Adjudication (1980), irrigation diversions must end October 15 to protect the fall chinook salmon run, but water is entitled for stockwatering and domestic uses during the entire year for an amount "reasonably necessary."

For most of these adjudicated streams, the State Water Resources Control Board (SWRCB) has just recently declared them "fully appropriated" during the period 4/1 to 11/30 (SWRCB Order #89-25). This decision means that no new applications for appropriation of water during these months will be accepted. It should also be noted that the right to use a certain amount of water does not mean that that amount is always naturally available.

<u>Water Rights and Fish</u>

Unfortunately for fish, California water law:

1) Does not allow for appropriative rights to be secured for instream uses (i.e., fish).
2) Does not consider instream uses in an adjudication; and
3) Encourages water waste through a "use it or lose it" approach.

The only way to legally appropriate water is to physically control and divert the water from the stream, an action which is not desirable for protecting fish life. Several recent attempts to improve state water law through the legislature and the courts have been unsuccessful, for various reasons (Turner 1981).

In the 1980 Scott River Adjudication, California Department of Fish and Game was greatly disappointed that the State Board had "no intention to consider the instream water needs for fish upstream from the lower end of the Scott River Valley," despite CDFG's study which showed such a need (CDFG 1974, CDFG 1976). In response, CDFG strongly advocated watermaster service with the emphasis on:

- Enforcement of schedules and priorities designated by decree.
- Adherence to the allotted amounts and designated periods of use of water.

- o Significant reductions of ditch losses.
- o Recommendation and implementation of more efficient use of water, particularly in the tributaries which have the highest priority of use.

At present, Watermaster Service is being provided by DWR for these Scott River tributaries: Shackleford, Sniktaw, Oro Fino, French, and Wildcat Creeks.)

The closest approximation to minimum fish flows in the Scott River decree can be found in the instream water rights allotted to the U.S. Forest Service as a riparian owner for its lands downstream of the valley (CSWRCB 1980):

Period	Allotment, in cfs (at USGS Gauge Station)
November - March	200
April - June 15	150
June 16 - June 30	100
July 1 - July 15	60
July 16 - July 31	40
August - September	30
October	40

"These amounts are necessary to provide minimum subsistence-level fishery conditions including spawning, egg incubation, rearing, downstream migration, and summer survival of anadromous fish, and can be experienced only in critically dry years **without resulting in depletion of the fishery resource**." (emphasis added)

A comparison of these required flows and the actual minimum flows shows they are not always being met. Between 1980 and 1984, the base streamflow allocation cited above was not met about 40% of the time (Kesner 1984). For the period from October 1985 through September 1989, a graphical comparison is offered in Figure 2-24. **It can be seen that the minimum flow requirements have most often not been met in the fall months, when fall chinook, coho, and perhaps steelhead would be coming up the Scott River to spawn in the upper reaches.** The summer flow minimums were close to being met in 1986 (29 cfs vs. 30) but were not met in 1987, 1988, or 1989. The lowest flow during this period was 6.2 cfs on September 1, 1988. (The lowest flow on record was 5.0 cfs during August 18-24, 1981.)

Although the years 1987 and 1988 were quite dry, the year 1986 was a normal to wet water year and the year 1989 a near normal one, based on total discharge at the Scott River gauge (USGS 1989). According to the statement made in the water rights finding for the Klamath National Forest, the below minimum flow conditions being experienced in recent years can be said to be resulting in the "depletion of the fishery resource."

In response, the U.S. Forest Service (USFS) has been protesting any new application for the appropriation of water in the Scott River system if it might reduce instream flows awarded to the Service. For awhile, these protests were ignored by the State Board's Division of Water Rights but then started being upheld (Kesner 1984). Temperatures on the Scott River are also being monitored closely by the USFS to document the impact of low flows on salmonid habitat quality (J. Power, USFS, personal communication).

Besides the above minimum flows, the Adjudication reserved high flows in the winter and spring months for the functions of "flushing sediments from and renewing spawning gravels and food- producing riffles, and providing transportation flows for seaward migrant salmon and steelhead." These flushing flows in the range of 10,000 to 15,000 cfs are obtainable, on the average, after allowance for the current rights in the decree and after storage of an additional 25,000 acre-feet per year in upstream small reservoirs. Above these uses, the State Board shall include "conditions it deems necessary to protect said reserved flows" on new applications to appropriate water. CDFG commented that these peak flows have not been adequate to flush the sediment from the river, attributing a possible factor to "the diversion of large quantities of water even before the growing season and during the snowmelt runoff period which reduces the energy needed to move these sediments" (CDFG 1980).

Another argument in favor of improved agricultural water practices is the legal use of the term "reasonable." As the Scott River Adjudication noted,

> Nothing herein contained shall be construed to allot to any claimant a right to waste water, or to divert from the Scott River stream system at any time a quantity of water in excess of an amount reasonably necessary for his beneficial use under a reasonable method of use and a reasonable method of diversion, nor to permit him to exercise his right in such a manner as to unreasonably impair the quality of the natural flow.
>
> (CSWRCB, 1980)

<u>Alternatives for Increasing Streamflow</u>

What water waste is now occurring, such as excessive seepage from ditches and certain forms of flood irrigation, should be evaluated (as DWR is doing in the Scott Valley in 1989-90) and corrective measures should be applied.

The purchase of water rights to improve instream flow is an alternative advocated by DWR and others (Puckett 1982). This option would allow for the state (e.g., DWR, CDFG) to purchase a portion of a water right owner's allotment in exchange for the state improving the efficiency of the owner's diversion system (e.g., lining the ditch or piping the water). In concept, everyone would benefit: the state would get more water to stay in the stream and the owner would get a more reliable water delivery system.

However, several problems exist with this approach: 1) if water can be saved through such improvements, the State Board could argue that the water was previously being wasted through an unreasonable method of diversion, and that it should be forfeited (the "forfeiture doctrine") since now it is no longer being put to

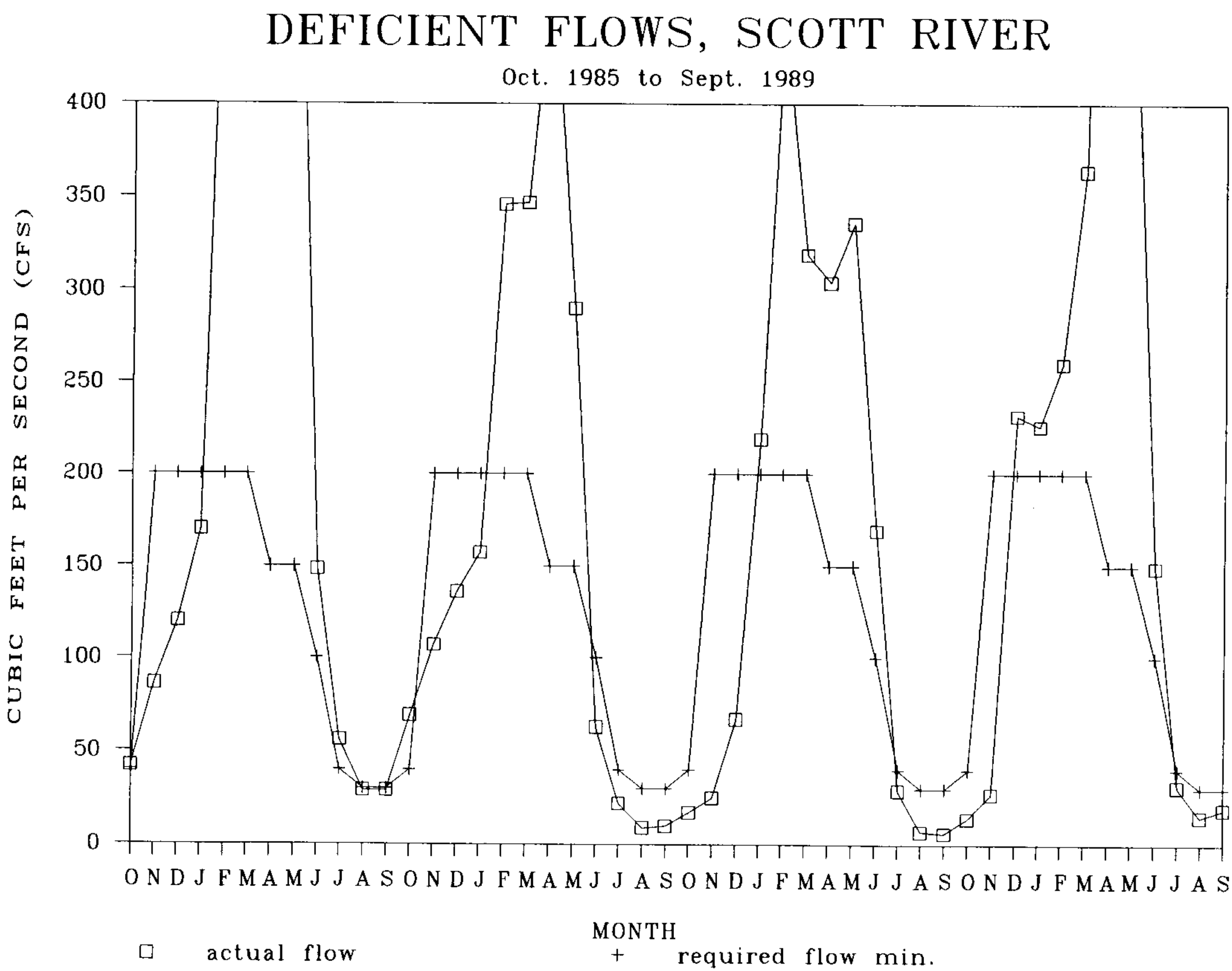


FIGURE 2-24 -- Comparison of actual minimum flows in the Scott River to required minimum flows for U.S. Forest Service, Scott River Adjudication.

beneficial use ("use it or lose it"); therefore, the right for this "excess" may not be the owner's to sell; 2) the purchased water would remain in the stream system only until a downstream user diverted the additional flow (through a new appropriation or illegal excess diversion); 3) adequate water would need to be purchased to provide a positive impact on the fish flow needs; and 4) its cost-effectiveness needs evaluation. The Department of Water Resources is currently investigating this option for purchasing private water rights from willing sellers to augment flows in the Scott River.

Because of the problem identified in #1 above, water users do not now have an incentive to improve the physical efficiency of their water delivery system or their irrigation practices. California water law is full of obstacles to water conservation and actually encourages water rights users to use the full amount of the right even when they do not need it. Changes are needed to instead provide incentives for water conservation (Governor's Commission 1978, Goldfarb 1984). During the 1980 decade, at least a half dozen laws were enacted to encourage voluntary transfers, permit water agencies to transfer their surplus water, and other changes (CDWR 1987). However, more improvements are needed and instream flows for fish life are still not allowed.

The State of Oregon can offer California at least two examples of such adopted improvements in state water law: SB 24 (1987), which allows irrigators who improve their systems and reduce historic consumptive use to market or use most of the saved water; and SB 140 (1987), which gives an in-stream water right the same legal status as any other water right, and also allows the purchase, lease or donation of private water rights for conversion to in-stream rights.

One last tool is the Public Trust Doctrine. In recent court rulings, this legal doctrine has been expanded to protect the public's rights and interests in fish habitat, among other intangible concerns. The "Mono Lake Decision" by the California Supreme Court in 1983 combined public trust issues with state water rights laws. This landmark decision concluded that: 1) state licenses to divert streams are subject to the public trust doctrine; 2) when issuing water rights permits and licenses, the state must consider public trust values; and 3) to protect public trust values, the state must continue to review and reconsider existing water rights (CACSST 1988). As a result, the state can decide to reallocate water to improve the balance between irrigation diversion and fisheries protections.

In summary, several legal alternatives may be available to the Task Force to improve the current situation if voluntary efforts do not succeed:

a. Seek enforcement of the conditions of the Scott River Adjudication through operation of Watermaster Service, including compliance with the October 15 diversion deadline for stream appropriations.
b. Encourage legal action by the US Forest Service to enable it to achieve the minimum fish flows required in the Scott River Adjudication.
c. Ask the State Water Resources Control Board to enforce the water rights condition pertaining to "unreasonable" waste of water in agricultural irrigation practices in the Klamath River Basin.
d. Request that all of the local adjudications be reconsidered for possible reallocation under the public trust doctrine for protection of fish habitat.

Stream Diversion Regulations

Regulations to control stream diversion impacts are primarily administered by California Department of Fish and Game and the State Water Resources Control Board.

Direct stream diversions often require the construction of a temporary diversion dam. Current CDFG rules require a "1603 Agreement" if equipment is used to alter the streambed for the dams, with removal before spawning season, usually by October 15. The State Board requires that users must breach gravel diversion dams at the end of the irrigation season each year to allow adult fish to swim upstream to their native spawning areas. Diversion structures shall also be "constructed and operated so as to pass stream flow in excess of the diversion allotment directly to the stream channel to allow passage by fish during the irrigation season prior to about June 1" (CSWRCB 1980). Who is responsible for enforcing these conditions when no watermaster service is in effect is unclear (CDFG 1980).

Screening of diversions is required by the Fish and Game Code (Sections 5980-6100) and diversion owners must keep the screens in good working order. Older diversions are screened and operated at the expense of the Department of Fish and Game while new diversion screens (since 1972) shall be constructed, operated, and maintained by the owner. Enforcement is difficult (CACSST 1988).

Enforcement of water rights adjudications can be handled by the Watermaster Service of DWR when enough water right owners request the service ("at least 15% of the owners of the conduits lawfully entitled to directly divert water from the streams ...") (Section 4050, State Water Code). Water right owners within most of the Scott River Adjudication area have declined the service due to the additional cost burden (proportional to the amount of consumptive flow allotment in cfs), but the other adjudicated areas of the Shasta and Scott Valleys have opted for the watermaster service.

Conclusions

Stream diversions have reduced the salmon and steelhead populations of the Scott and Shasta Rivers to a subsistence level, and may have been the primary cause of the loss of the summer steelhead and spring chinook runs in these two tributaries. Present agricultural water practices need improvement to increase their water efficiency. Through the cooperation of the farmers and ranchers in the two valleys, alternative practices could be implemented which would provide a benefit to both the water user and the fishery. **The Task Force is committed to creative solutions which will not substantially decrease agricultural productivity nor pose undue hardship on ranchers and farmers.**

California water law also needs to be changed to provide incentives for water conservation and to provide for instream water rights for fish, perhaps along the lines of Oregon's water law. If the voluntary effort does not succeed, legal alternatives are available. What we do not know, however, is a reasonable estimate of the amount of flows actually needed for sustainable salmon and steelhead production in each stream system.

In summary, instream flow problems for salmon and steelhead occur during the following seasons due to these reasons:

Season	Primary Affected Fish Run	Reason
Fall: Sept-Nov	Fall Chinook	End of irrigation; ditch diversion for stockwatering
Winter: Dec-Mar	Steelhead	Diversion for storage; water rights: "use it or lose it"
Spring: Mar-May	Steelhead, Coho	Irrigation begins; water rights: "use it or lose it"
Summer: June-Aug	Steelhead, Coho	Peak irrigation use; excess diversion to compensate for seepage losses in ditches

POLICIES FOR STREAM DIVERSIONS

Objective 2.F. Protect the instream flow needs of salmon and steelhead in streams affected by water diversions.

2.F.1. As a first priority, seek opportunities for stream diverters to reduce their impact on salmon and steelhead habitat:

a. Involve landowners in the Scott and Shasta Valleys in developing solutions to the instream flow and water quality problems of the Scott and Shasta Rivers and their tributaries.
b. Develop an inventory of water conservation practices for agricultural users in the basin, and seek their implementation by working with the local Resource Conservation Districts, County Farm Advisor, Soil Conservation Service, Farm Bureau, Cattleman's Association, and other interested groups (e.g., through workshops, seminars, County Fair displays).
c. Promote more efficient water delivery practices in order to avoid serious waste of water in unlined ditches.
d. Support effective screening of all diversions.
e. Actively support needed changes in state water rights law so:
    1. Water right holders will not be penalized for conserving water.
    2. Instream uses like fish can have water rights.
    3. Water right transfers can be made to instream uses.
f. If the above changes in water rights law occur, then support the purchase of water rights from willing sellers for the purpose of instream flow improvements.

g. Contribute financial support to water conservation measures which will provide significant benefit to the fisheries.
h. Investigate other sources of financial assistance which can help implement improved practices or purchase water rights (e.g., ASCS, DWR, Water Heritage Trust).
i. Promote communication between water users and salmon and steelhead users.
j. Evaluate the instream flow needs of the Scott and Shasta Rivers and their tributaries.

2.F.2. If fish population trends in a tributary system are found to be at critically low levels by the Task Force, the following policies will be instituted, along with necessary harvest restrictions:

a. Pursue appropriate agency solutions.
b. Exercise water allotment rights to provide emergency instream flows.

2.F.3. In the year 1995, if adequate progress towards improving instream flow conditions for salmonids has not been made as a result of Policy 2.F.1, then seriously pursue the available alternatives:

a. Seek enforcement of the conditions of the Scott River Adjudication through operation of Watermaster Service, including compliance with the October 15 diversion deadline for stream appropriations.
b. Encourage legal action by the US Forest Service to enable it to achieve the minimum fish flows required in the Scott River Adjudication.
c. Ask the State Water Resources Control Board to enforce the water rights condition pertaining to "unreasonable " use of water in agricultural irrigation practices in the Klamath River Basin.

2.F.4. In the year 2000, if adequate progress towards improving instream flow conditions for salmonids has not been made as a result of Policies 2.F.1. and 2.F.3., then investigate the option of reallocation of water rights under the public trust doctrine for protection of fish habitat.

CHAPTER 3

HABITAT RESTORATION

ISSUES

* The ability of instream work to correct fish habitat degradation is limited, unless the underlying watershed problems that cause degradation are also addressed.
* Must detailed habitat analysis necessarily precede investments in habitat restoration?
* Who should pay for the watershed restoration, streamflow augmentation and erosion control efforts necessary to protect and restore fish habitat?
* The need to work with ranchers to restore riparian zones to prevent erosion from destroying pasture land <u>and</u> to improve fish habitat.
* The need to improve streamflows, particularly in the Shasta and Scott river valleys, in ways that do not disrupt ranching.
* The need to gain a better understanding of the Klamath Basin through the use of aerial photography, Landsat imagery and other available technical resources.

INTRODUCTION

This chapter describes the methods that have been used in attempts to restore the fisheries habitat of the Klamath River Basin and the degree of success such attempts have enjoyed. Suggestions regarding appropriate means to approach habitat restoration during the balance of the Klamath River Basin Fisheries Restoration Program are made.

> We must quit looking at just a pool, a riffle, or even a reach, but address the problem as it fits into a complete watershed. How often have we visited a good looking K-dam, stream deflector, or rock crib to enhance a small reach, only to look around the watershed and see it crumbling down upon us.
>
> W.S. Platts

Bill Platts made these remarks at a 1984 habitat management workshop (Hassler 1984) that would prove to be a turning point in the use of instream structures for improving degraded fish habitat. Instream structures enjoyed a surge in popularity in the 1930's, largely for erosion control in the Midwest (Silcox 1936, Tarzwell 1938). As early as 1934, the California Department of Fish and Game (Burghduff 1934) acknowledged that stream improvement involving "retardation of stream flow by the construction of weirs and erosion dams ... do not fit existing conditions in most of our western streams, which are precipitous, rock-bound, and fall thousands of feet in a score of miles."

Despite the recognition that these instream structures did not work for most of California's streams, the Civilian Conservation Corps built them throughout the Great Depression. After evaluating these efforts, Calhoun (1966) concluded that attempts to treat California streams with instream structures had "no instances of reasonable success."

Taft and Shapovalov (1935) surveyed many of the streams of the Klamath Basin and found that, for the most part, they provided "fine pools for shelter, trees and brush for shade and to furnish terrestrial food, and many riffles to provide abundant food and spawning areas. Thus they do not seem to call for 'stream improvement' in the accepted meaning of the term." Noted exceptions were several diversion dams without ladders and "hanging" road culverts which blocked fish migration. While the stream habitat conditions found by Taft and Shapovalov may have been much different than those of today, theirs is still a valid prescription for improvement: "From the viewpoint of fish life, the most important improvement that could be effected in streams would be the general restoration to natural conditions."

Many of the stream channels of the Klamath River Basin are so disturbed today their complete restoration could well take longer than the life of the Restoration Program. Every increment of well planned habitat improvement will help, therefore, in the rebuilding of the region's fish populations. Moreover, while early restoration efforts suffered from a poor understanding of the factors that limit salmonid fish production, including inadequate knowledge of stream dynamics (Everest and Sedell 1984), renewed public interest in stream restoration has fostered a substantial increase in our abilities.

Bisson et al. (1981) and, more recently, McCain et al. (in press) have developed systems for classifying the types of fish habitat in streams. As habitat use by salmonids is noted, fisheries biologists have been able to focus more closely on the factors which limit the production of salmon and steelhead. Although habitat typing by itself does not provide a complete understanding of limiting factors, further work by Reeves et al. (1989) has provided a key which can be used to identify stream production bottlenecks for juvenile coho salmon. Hankin and Reeves (1988) have developed methods for estimating basin-wide salmonid populations in tributaries, based on the number of fish which use different habitats and the number of habitat units found in the stream.

While fisheries science has been exploring the habitat elements that limit salmon and steelhead production, the use of instream structures to mimic these elements has been widely tested throughout the Pacific Northwest (Anderson 1988). The compatibility of different treatments is now checked against stream gradient, streambed stability, height of flood flows and other critical data to assure that the structure will remain in place, at least during moderate storm events, and will function as intended. Studies of undisturbed stream systems have improved the design criteria for habitat restoration projects significantly (Sedell and Luchessa 1981).

Some of the best habitat restoration information has come from the study of geomorphology and hydrology. While fisheries managers have long been able to recognize degraded fish habitat, geologic information now provides insight into the root causes of that degradation (Hagans et al. 1986). In addition, knowledge of geology can help to determine the stage of recovery of a stream (Lisle 1981), whether an oversupply of sediment is likely to continue, and whether attempts to structurally manipulate a stream are prudent (Lisle and Overton 1988). Prioritizing erosion prevention in this way can help reduce the amount of sediment likely to reach the stream (Weaver and Hagans 1990). As watersheds are stabilized, the recovery of stream channels will be accelerated.

It has been a challenging task to evaluate instream structures to determine their cost-effectiveness (Everest and Sedell 1984). While the costs of projects are easy to determine, the number of fish which they produce can be difficult to establish (Fontaine 1988). Arriving at a value for the fish produced by a project can also be a complex process (Meyer 1980).

Methods of improving or restoring fish habitat, in addition to those involving channel and bank stabilization, include the removal of barriers to migration, screening stream diversions to reduce the loss of both juvenile and adult fish, increasing stream flows, replacing gravel, creating spawning or rearing channels below dams, and restoring riparian vegetation.

Public interest and support for salmon, steelhead, and trout restoration have grown rapidly in the past decade. Community groups in California have become an integral part of restoration, both for fund-raising and for carrying out projects. While volunteer effort lends the obvious advantage of enabling projects at low cost, it serves even more importantly to create a grass-roots, or community-level, commitment to fish conservation. Many of the state's restoration groups are associated with the California Salmon, Steelhead and Trout Restoration Federation, which holds annual meetings to share technical information and the restoration spirit. The Oregon Salmon and Trout Enhancement Program (STEP) has also been highly successful as a catalyst for involving the public in fish restoration. STEP projects have included instream structures, hatch boxes, rearing ponds, and education programs.

Although the art of fisheries restoration has advanced considerably in recent years, some still question whether structural manipulation of anadromous fish habitat is an effective strategy for increasing production of these fish (Nawa 1987). It is generally understood that instream structures are no substitute for good watershed stewardship, including the protection of productive fish habitat (Anderson 1988, Everest and Sedell 1984, Reeves and Roelofs 1982). Improving fish habitat through watershed restoration takes years, while instream structures can offer habitat improvement much quicker. In an ideal situation, structures would be used to accelerate habitat recovery after watershed stabilization is well underway. The Task Force may be required, however, to use instream structures for immediate habitat improvements to benefit those fish stocks identified in Chapter 4 as priorities for recovery.

HABITAT RESTORATION METHODS

Fisheries habitat improvements can involve four general areas: instream work, riparian area restoration, streamflow improvement and watershed stabilization.

Improving Access to Spawning Areas

Barriers to fish migration have long been identified as impediments to anadromous fish production and fishways have been constructed for 200 years or more. The sophistication of fish passage facilities benefited from research associated with construction of dams on the Columbia and Snake rivers (Savage 1986). Fish ladders that bypass dams can be a series of simple jump pools or elaborate systems involving elevators (Bell 1973). Passage over natural barriers or short, steep impediments like culverts, use vertical slots with baffles to slow the flow and allow upstream migration (Clay 1961). The most common vertical slot type fishways are the Alaska steep pass and the Denil ladder (Ziemer 1962). A common objective of all fishway designs is a good attraction flow and an easy entrance for the fish.

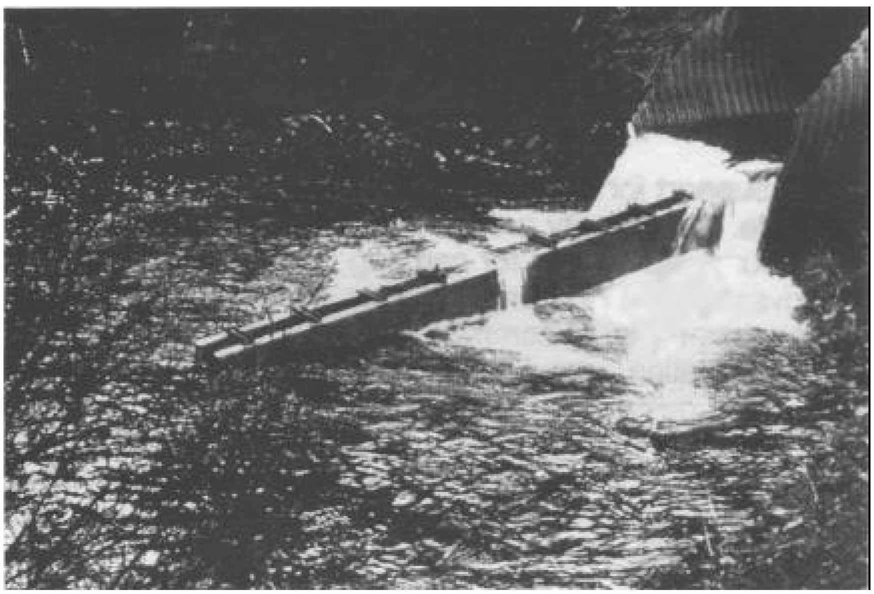


Figure 3-1 – Before installation of am Alaskan steep pass, this culvert was a barrier, at low flows, to salmon and steelhead trying to reach their spawning grounds.

Heavy equipment has been used on mid-Klamath tributaries to modify sediment plugs near stream mouths that create fish migration barriers (J. West personal communication). Other barrier modifications have included log jam removal and blasting of rock barriers. Recent work by Sedell et al. (1988) indicates that, in our haste to provide fish passage, we may have removed large woody material that provided essential habitat elements.

Fish Screens Reduce the Loss of Juveniles

Fish screens are used to prevent juvenile salmonids from being drawn into agricultural diversions. These devices range from huge drum screens that block passage into major California irrigation canals to simpler devices to keep downstream migrants out of small ditches leading to pastures. Recent designs provide for the screens to be self-cleaning to prevent them from becoming clogged with algae or floating debris.

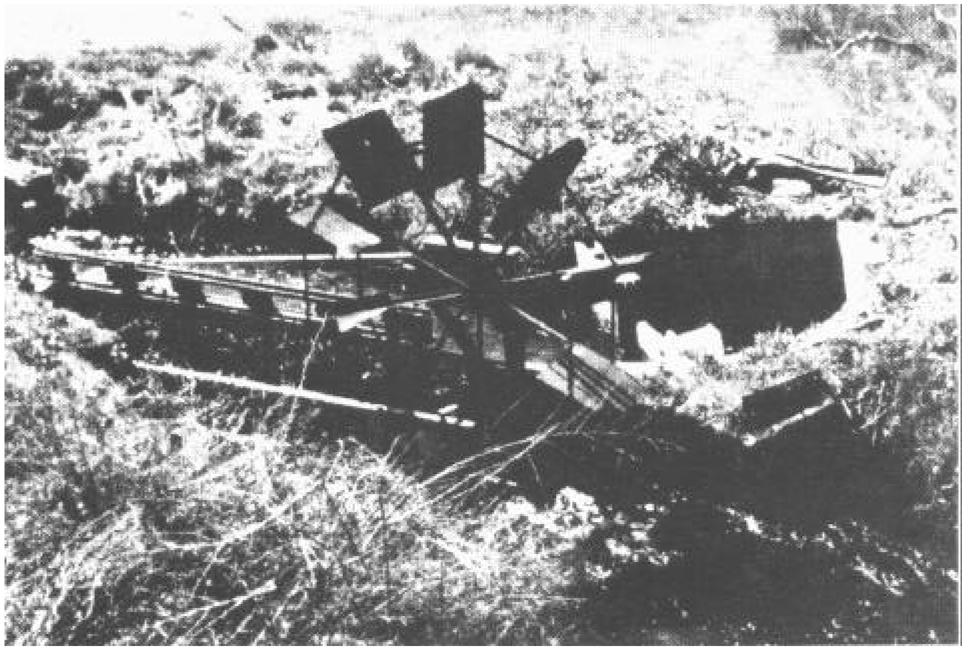


Figure 3-2 – Fish screens, such as this one along Shackleford Creek, a Scott River tributary, save thousands of young salmonids from being diverted into the fields.

Improving Fish Habitat With Instream Structures

Improvement of spawning conditions has been a major focus of instream habitat efforts. Gabions, log weirs, boulder weirs and other structures have been used successfully to trap spawning gravels (House 1984). Rearing habitat can be created for juvenile salmonids by providing cover and causing pools to form by the use of drop structures or by placing boulders, logs, or large root wads to cause scouring (Anderson 1988). Pools can also be created by blasting. These techniques are typically used in streams that have suffered degradation and that lack habitat complexity.

Streamflow Improvements Add Spawning and Rearing Habitat

Both spawning and rearing habitat can be increased by increasing flows below dams or diversions. Iron Gate Dam was constructed to reduce fluctuations in flows caused by upstream hydroelectric operations. The fluctuations caused stranding of adult salmon and steelhead and heavy mortality of juveniles. Claire Engle and Lewiston Dams on the Trinity River were completed in 1964 and divert over 80% of the river's flow into the Central Valley for agricultural use. Flows in the Trinity River have been improved over pre-1980 levels in order to study their benefit to fisheries resources (Hampton 1988). The U.S. Forest Service has worked to retain instream flows in order to maintain river channels through National Forest Lands in Colorado (Randolph 1990). Channel maintenance flows have emerged as an issue on the Trinity River (Bob Franklin personal communication). The periodic relicensing of major dams by the Federal Energy Regulatory Commission provides the opportunity to negotiate improvements in flows for fish (Echiverra 1989). Opportunities for increasing streamflows for fish through water conservation measures are being explored in Oregon, California, and Montana (see Chapter 2).

Special Restoration Techniques Appropriate Below Dams

To the extent that dams stabilize flows in the stream reaches below them, they make structural treatments in those reaches more practical. Smaller gravels and cobbles suitable for spawning are washed downstream below dams, however, and the recruitment of replacement gravel is prevented by the dams. Severe loss of the quality and quantity of pre-dam spawning habitat frequently occurs. To counteract such loss, new spawning gravels have been trucked to stream reaches below dams. The absence of flushing flows cause gravels to become so impacted with silt that they become unsuitable for spawning. Heavy equipment has been used extensively to loosen silted spawning gravels in Washington state (Savage 1986). Pools have been dredged below Grass Valley Creek on the Trinity River to provide holding areas for adult spring chinook (USFWS in press).

Side channels can be added below dams for spawning and rearing as the dams make high flows less likely. The concentrations of fish returning to hatcheries built below dams uses the stream habitat improvements made at these sites.

Restoring Riparian Areas Can Yield Big Dividends

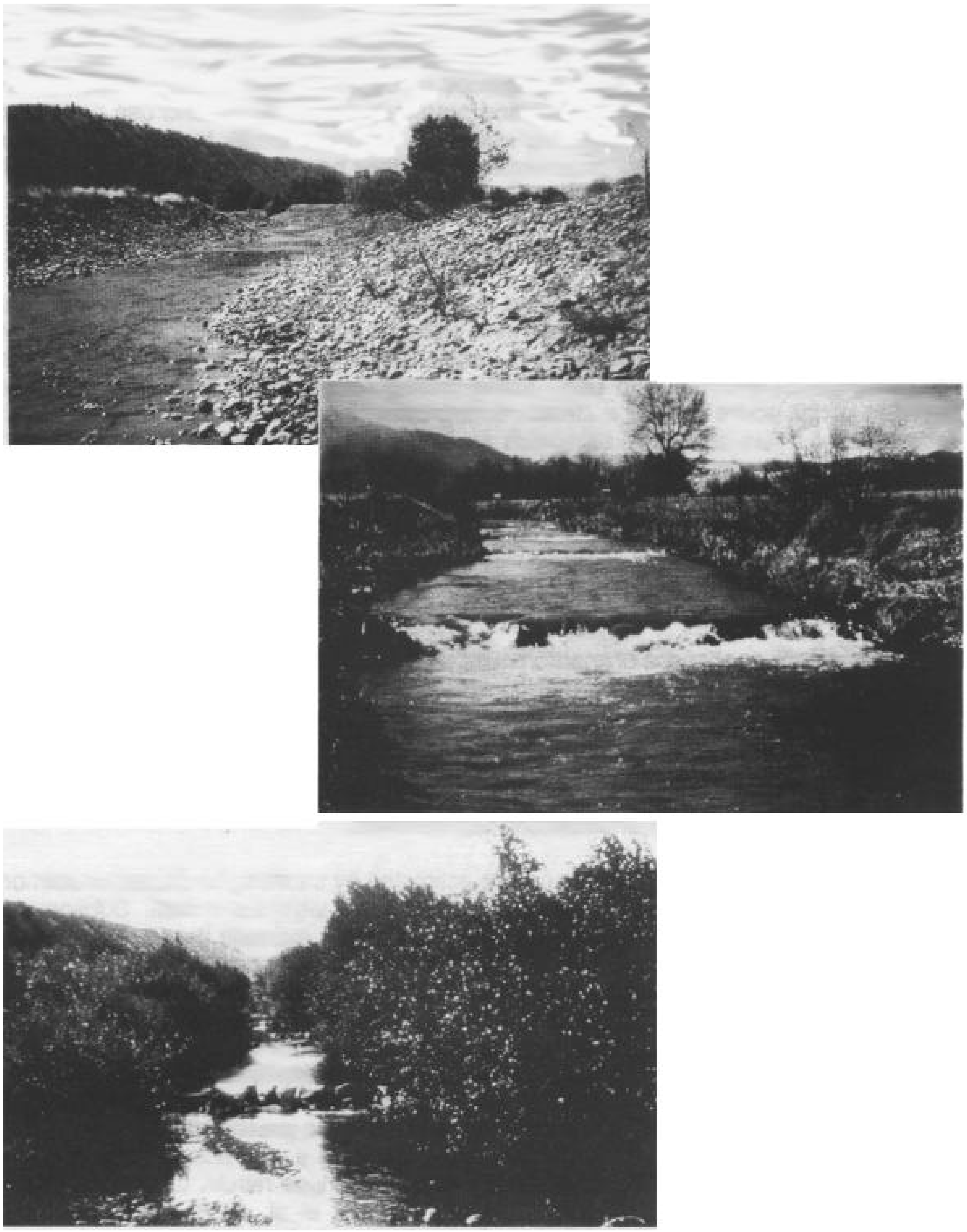
The vegetated areas next to streams provide bank stability, cover for fish, habitat for birds and animals, shade to keep water temperatures cool, terrestrial insects for fish to eat, leaf litter which fuels the aquatic food chain, and recruitment of logs which provide instream structure. Riparian vegetation also traps fine sediment and organic matter during high flows, thereby helping to build banks (Platts 1984a). Elmore (1988) has found that a healthy riparian zone acts as a conduit for recharging ground water.

Where livestock grazing has decreased riparian vegetation, streamside areas can be fenced and grasses, shrubs and trees replanted. The stabilization of streambanks with riprap, gabions, or log revetments can prevent bank erosion but may not provide optimal fish habitat unless done in conjunction with riparian planting. Riparian zones in forested streams can also be replanted but if sediment supply remains high, channel instability can make it difficult for trees and shrubs to become reestablished. Natural regrowth of conifers can take over one hundred years after severe flooding or logging in stream side areas (Lisle 1981).

Watershed Rehabilitation: Helping Nature Restore Fish Habitat

Watershed restoration to benefit fish resources would begin with an inventory and evaluation of sediment sources, the changes in sediment supply likely to result from storms or changes in land use, and the relative magnitude of the different sediment sources (Weaver and Hagans 1990). From this basic information a sediment budget can be formulated and priorities for treatment established. Treatments may include attempts to stabilize a slide by revegetating it, armoring the toe of a streamside landslide, putting roads "to bed," removing or enlarging culverts, outsloping roads or installing waterbars, dewatering slides, mulching and planting bare slopes, and a host of similar measures (Mattole Restoration Council 1989).

Figure 3-3 – Riparian restoration improves fish habitat dramatically.



Top: Stream before treatment.
Middle: After installation of boulder weirs, at higher flow.
Bottom: Streamside replanting beginning to mature.

While erosion prevention work may seem costly, it is much less expensive than the removal of sediment from stream channels after it has left the hillsides. The investment in instream structures and riparian restoration efforts may be ineffective if a high rate of sediment continues due to erosion in upslope areas. Natural processes created fish habitat, and if watersheds are restored and protected by improved land use practices, good fish habitat will return. Watershed measures may take longer to dramatically alter specific sites within streams, but once implemented their benefits are long-lasting and will enable the stream to restore itself over its entire length, not just in treated reaches.

CHOOSING APPROPRIATE FISHERIES RESTORATION STRATEGIES

Before effective action can be taken to restore fish populations, project planners should have enough information to determine which factors are limiting the production of the species to be restored (Everest and Sedell 1984). Only then can they determine accurately which treatments to use. Some limiting factors may be obvious, such as diversion of the entire flow of a stream during spawning or outmigration seasons. If substantial numbers of juvenile salmonids are being lost to irrigation, then installing fish screens is clearly logical, but when considering the use of instream structures to increase specific habitat elements, a much closer look at limiting factors is needed. Habitat needs should be determined on a basin-wide, or subbasin wide, scope and should include both biological and physical habitat assessments (Reeves 1988).

Using Fish Abundance To Determine Restoration Needs

The presence or absence of anadromous fish above a perceived barrier obviously can indicate whether barrier modification or construction of a fish pass is needed. Using fish populations to assess the need for habitat restoration measures can as easily be misleading, however. Low fish numbers can result from harvest or poor access, in low water years, of spawning migrations. For this reason, it is desirable to have estimates of fish numbers for several years. Spawner counts, electrofishing, and direct observation are three established means of estimating fish numbers.

The number of salmon spawners can be estimated by counting carcasses or salmon redds. As carcasses are counted they are marked with a tag or cut in half. Subsequent counts use the ratio of marked to unmarked carcasses to estimate the total number of spawners. Steelhead are much more wary than salmon while spawning, do not always die after reproduction and cannot, therefore, be counted in this way.

Electrofishing is also used to estimate fish numbers. The stream reach is blocked with nets and the fish in the area are stunned with electricity and counted. Several passes may be made to collect as many of the fish within the section as possible, and statistical methods are used then to determine the total number of fish present (Platts et al. 1983). In a small or medium sized stream, electrofishing can give a very accurate assessment of fish populations in the area sampled. Extrapolating these results to estimate basin population totals can lead to significant errors (Everest et al. 1986). Hankin (1986) asserted that errors in population estimates for basins resulted more from expanding data from small stream segments than from the accuracy of the counts within the segments themselves. He suggested conducting population estimates by habitat units, and not on arbitrary lengths of stream, can help reduce this error.

When water clarity is good and stream depth is sufficient, direct observation by divers is the best method for determining populations of salmonids over a basin-wide area (Hankin and Reeves 1988). The numbers of fish are related to the habitat types in which they are counted. Expansions are based on the total number and area of habitat types in the basin. Visual estimation is much quicker than electroshocking, so more stream area can be counted by direct observation and the errors associated with extrapolation can be reduced. To check the validity of these counts or to estimate the degree of bias, a subsample of habitat units where fish were counted by direct observation can be electroshocked and the numbers compared.

Figure 3-4 –Divers with masks and snorkels estimate fish populations by direct observation.

Physical Factors Determine Restoration Techniques

If a stream appears in need of rehabilitation, the first level of assessment should include an historical search to determine when changes may have occurred, what caused the changes (e.g., logging followed by a large flood event), and whether the watershed in question still contains major sources of sediment. The use of aerial photos is a quick and cost-efficient way to study changes over time (Grant 1988) and to assess current watershed conditions (Weaver and Hagans 1990). If significant sediment sources still exist in a basin, then instream structures are not a prudent investment because it is likely they will soon be buried or rendered dysfunctional (Lisle and Overton 1988). Erosion prevention measures and, where necessary, changes in land use practices should be pursued first.

If the watershed under study no longer has significant erosion problems, the next step would be an attempt to determine the current stage of stream channel recovery

(Lisle 1981). If the streambed has become aggraded it may be unstable and untreatable until it approaches its former elevation (Lisle and Overton 1988).

Rosgen's channel typing (1985) system can be used in this stage of analysis to help determine whether particular reaches are compatible with particular treatments. Lisle and Overton (1988) suggest that structures to retain spawning gravel should not be placed in stream reaches having a gradient of less than 0.25 percent nor greater than 1 percent. Any stream having a gradient greater than 2 percent (Lisle and Overton 1988) or 2.5 percent (Anderson 1988) is generally unsuitable for instream structures due to the force of water during high flows. All instream work should take into account the hydraulic forces which occur at flood stages and the expected interval at which potentially destructive flows might occur.

After the larger questions of whether the watershed and stream bed are suited to structural treatment, an in-depth fish habitat survey can be conducted (Bisson et al. 1981 and McCain et al in press). Hampton (1989) suggests that, as a first step, the freshwater life stages of each target species, and their respective habitat requirements, should be understood. In this way, the relative abundance of habitats may indicate what is limiting the production of the species of interest (Hampton 1988). Knowledge of the adjacent streams would be helpful since preferred habitats may be lacking altogether. Habitat typing is generally conducted at low summer flows, leading to the frequent conclusion that rearing habitat at these flows is the limiting factor. Increasing the amount of such habitat might not increase smolts production, however, if a more important problem is winter survival (Mason 1976, Hampton 1988). Thus, even where restoration projects are undertaken after habitat typing and limiting factor analysis, such projects should be evaluated to see if they were, in fact, the solution to low fish abundance.

Other important questions regarding habitat that should be addressed before structural treatments are pursued are those of water quality and quantity. It makes little sense to structurally treat a stream where water quality will not support fish life. Water can be tested for temperature, dissolved oxygen, or pollutants (American Public Health Assoc. 1987).

THE EFFECTIVENESS OF PREVIOUS HABITAT RESTORATION EFFORTS

A Task Force compilation of projects undertaken to improve fish conditions in the Klamath River Basin, including the Trinity River, (USFWS 1988b) indicates that $7.8 million has been spent on such efforts since 1958. Funds for these projects have come from the U.S. Soil Conservation Service, California Department of Fish and Game, U.S. Forest Service, U.S. Bureau of Indian Affairs, Hoopa Valley Tribal Council, California Conservation Corps, Pacific Power and Light Co. and the U.S. Bureau of Reclamation.

Since 1984 there has been a significant increase in fisheries restoration activity in the Klamath Basin. Substantial amounts of funds for fish restoration have been provided directly by legislation, as well as by voter initiatives. The 1984 Trinity River Restoration Program (P.L. 98-541) and the 1986 Klamath River Basin Fisheries Restoration Act (P.L. 99-552) have specifically committed the U.S. Department of Interior to fisheries restoration efforts in the Klamath-Trinity basins. Congress has expanded the U.S. Forest Service's role in fisheries conservation in recent years (P.L. 93-452, P.L. 94-588), as well.

The Task Force's planning consultants, William M. Kier Associates, inspected nearly two-thirds of the projects listed in the 1988 compilation during the summer and fall of 1989. Their observations, which are summarized in Appendix C, concerned only the physical integrity of structures and their apparent success in creating their intended stream conditions. There was not sufficient opportunity to determine the success of the structures in producing fish, or their cost-effectiveness. The following discussion draws heavily on the 1989 field review, although some examples from other areas are discussed as well.

Success In Improving Access For Migrating Fish

The Klamath Basin projects to provide fish access past migration barriers have, for the most part, been successful. Many projects conducted by the California Conservation Corps (CCC) in the lower basin have involved modifying log jams to allow migration. Unlike earlier efforts that totally removed jammed logs, the CCC now leaves much of the material in the channel to act as cover or to form natural structures. Hewitt ramps were installed on Ah Pah Creek, and appear successful in passing fish. A baffle installed by the Redwood Community Action Agency on a Richardson Creek culvert eliminated what was a velocity barrier to coho and chinook salmon.

On Tarup Creek, the CCC improved fish passage by blasting a bedrock waterfall believed to block chinook salmon migration. Similar methods were used to open up five miles of Dillon Creek to both salmon and steelhead. Low cost projects that open areas in a highly productive streams like Dillon Creek are excellent investments in restoration. Opening Bluff Creek to salmon and steelhead, after access was blocked by the 1964 flood, represents a major success in fisheries restoration. Blasting opened three miles of habitat on Clear Creek and log jam removal on its South Fork opened an additional one and a half miles of habitat to summer steelhead, as well as other runs of salmon and steelhead (D. Maria personal communication).

Several successful barrier modifications in the Salmon River Basin have been carried out, including projects on Black Bear Creek, St. Claire Creek, and Knownothing Creek. A rock fall which blocked chinook salmon migration in the main stem of the Salmon River was altered. Chinook and coho salmon numbers doubled in Knownothing Creek after treatment. A step and pool ladder was constructed on Nordheimer Creek, a tributary to the Salmon River. The ladder, located one and a half miles above the mouth of the creek, helps fish travel over a 14-foot-high bedrock falls and opened up three miles of additional habitat to anadromous fish. A large number of adult steelhead climbed the ladder in 1988, the first year it was available (D. Maria, personal communication). Barrier modification on Kelly Gulch in the Salmon River failed to assist chinook salmon passage, but improved access for migrating steelhead.

Additional habitat in Indian Creek has been made available by the removal of several obstructions to migration. Four ladders have been constructed on the Shasta River and they function. Access to Independence Creek was blocked until the mouth of the stream was altered. Steelhead are now seen entering this system in the fall before major winter flows (J. West personal communication). A fish pass on Coon Creek works at some flows, but requires ongoing maintenance.

Fish Screens, Rescue Efforts Save Juvenile Salmon and Steelhead

The California Department of Fish and Game's Yreka fisheries staff devotes a considerable amount of effort to keeping juvenile salmonids out of irrigation diversions. The Scott and Shasta rivers and their tributaries require much of this work, but several small mainstem Klamath tributaries, including Bogus Creek, Cottonwood Creek, Little Bogus Creek, Cold Creek, and Dry Creek are also important fish screen and rescue work areas.

Screens are installed at ditch intakes to prevent the juvenile fish migrating downstream from being drawn into the fields. Downstream migrant traps are placed above dewatered stream segments. Fish rescue operations at screens and traps save about 450,000 juvenile salmonids a year. Huntington (1988) found that fish screening and rescue efforts were very cost effective. He estimated a cost-benefit ratio of 3.1/1 for screening operations. Problems at screens can arise from lack of maintenance, and screens are sometimes removed or not installed when needed (D. Sumner personal communication). An additional worker has been added to Fish and Game's Yreka office to help keep up with the increasing screen operation and maintenance needs (R. Dotson personal communication).

New screens are planned for Bogus and Cold creeks which will complete the screening of stream diversions in the entire Bogus Creek watershed. Four additional screens are needed in the Kidder Creek drainage and will be installed over the next two years. Another priority is a main diversion ditch in the West Fork of the Scott River. Screen priorities are based on the potential loss of fish at each diversion site. There are currently 56 screens in the area served by the Fish and Game's Yreka staff (R. Dotson personal communication).

Mixed Results From Instream Habitat Structures

Instream structures to increase spawning and rearing habitat for juvenile salmonids generally use materials available at the site, typically logs and boulders. While the majority of the structures surveyed in 1989 appeared to be functioning as intended, many were partially or totally disabled.

Boulder clusters on the South Fork of the Salmon have attracted spawning chinook salmon and steelhead and also provided rearing habitat (West 1984). Approximately 20 percent of the boulder clusters examined had caused bank erosion. Log weirs in St. Claire Creek were functioning well, while others in steeper tributaries of the Salmon River had been washed out by high flows.

Boulder clusters in Knownothing Creek had been lost to high flows. Log weirs failed in Nordheimer Creek and 25 percent of the boulder groups on Blind Horse Creek, intended to trap spawning gravel, trapped silt instead.

Figure 3-5 -- These boulder weirs on the South Fork of the Salmon River have attracted spawning chinook salmon and steelhead, and also provide rearing habitat.

Boulder weirs and clusters constructed on Red Cap Creek were in place and had created the desired improvements in habitat. They were reported to be providing juvenile habitat and attracting spawners (J. Boberg personal communication). Camp Creek boulder weirs failed as a result of the February 1986 storm. They have been replaced with new boulder clusters which appear to be functioning well. The Bluff Creek boulder clusters were working well, although a major slide, reactivated in February 1986, had filled the spaces around some of them.

Intense rainfall during a thunderstorm in August 1989 unleashed a debris flow that buried recently installed boulder groups on Beaver Creek. Other boulder clusters in the same drainage required cleaning with a suction dredge because of sedimentation (S. Fox personal communication). Boulders used for structures on Irving Creek were too small, and the intended benefit was not derived. Irving Creek also has an aggraded delta that appears to be a migration barrier during low flows. High flows have broken apart boulder clusters in Humbug Creek. Access problems for spawners also exist in this tributary.

Attempts to increase spawning habitat in Cottonwood Creek with blast pools did not work. High flows pushed gravels through some of the pockets and decomposed granite sands settled in others. The pools did, however, provide some rearing habitat. The gravel supply in Cottonwood Creek has been diminished by gravel extraction for road construction (D. Sumner personal communication). Boulder weirs in the Shasta River had been damaged by high flows and were only partially fulfilling their intended function of trapping spawning gravel.

Projects on Hunter Creek and Tarup Creek were well constructed. The planning for these CDFG/CCC projects used a method of triangulation known as the "two pin method." The work crews found instructions to be very clear and they were successful in carrying out the plans as designed. Although the quality of work was high, large sediment deposits near the stream mouths still limit access to spawners and the downstream migration of juveniles in both creeks. Hunter Creek flows underground for over three miles in its lower reaches during summer as a result of an oversupply of sediment.

In disturbed watersheds in southern Oregon, with slopes and geology similar to the lower Klamath tributaries, 95 percent of the instream structures installed prior to the February 1986 storm were no longer functioning as designed when examined (Frissel and Nawa 1988). Structural treatments in the highly aggraded systems in the lower Klamath have not yet been tested by a major storm.

A spawning channel constructed in Bluff Creek has been used by chinook salmon and steelhead (J. Boberg personal communication). Both coho salmon and steelhead were observed using the spawning channel in Indian Creek (D. Maria personal communication). Spawning channels on the main stem of the Klamath River at Tree of Heaven and Badger Flat are not functioning as intended. Inadequate water depth in the Tree of Heaven prevented its use by salmon and steelhead spawners. Heavy flows at the Badger Flat riffle blew out rock weirs and spawning gravels. The Pacific Power and Light Co. added spawning gravels to the river below Iron Gate Dam in 1964 but they were washed down river by a flood later that year (M. Coots personal communication.)

Increasing Streamflows To Benefit Fish

In 1981, U.S. Secretary of the Interior, then Cecil Andrus, ordered that flow releases to the Trinity River from the U.S. Bureau of Reclamation's Trinity River Project be tripled to improve fishery conditions in the river and that a twelve-year study be conducted by the U.S. Fish and Wildlife Service to determine precisely how much water should be committed permanently to the conservation of the river's fish resources (Hampton 1988).

While the Trinity fisheries streamflow study is still underway, the improved flows appear to be responsible for the increased returns of adult salmon and steelhead to the upper Trinity River (USFWS in press). The improved flows have decreased summer stream temperatures below the dam to desired levels. The USFWS team has documented increases in the amount of chinook salmon rearing habitat, considered to be the limiting factor for natural chinook salmon production in the area. Even higher flows than those ordered by Secretary Andrus appear needed if the river's salmon rearing habitat potential is to be fully realized (Bob Franklin personal communication). Higher flows may also be required in the future for channel maintenance, to flush silt and sand, unless Congress wishes to supply an annual budget for maintaining channel conditions artificially by dredging and gravel ripping. Increased flows may be an important key to the successful downstream migration of fish released from the Trinity River Hatchery, that is, to improve their survival and decrease their impact upon native juvenile salmonids (USFWS in press).

Habitat Improvements Below Trinity Dam Largely Successful

Eight side channels were built along the main stem of the Trinity River below Trinity Dam, primarily to increase juvenile salmonid rearing habitat. Five of the eight channels have been evaluated and all are being used by large numbers of juveniles (USFWS in press). These side channels have withstood flows of 2,000 cubic feet per second without major damage. Gravel has been removed from the mouth of Rush Creek and deposited in riffle areas upstream to increase spawning areas. Large numbers of adult salmon and steelhead have used these riffles in the two years since the gravel was placed there (USFWS in press). Most of the gravels remained in place during the 2,000 cfs flows in 1989.

Bucktail and Cemetery pools were dredged in the Trinity in 1989 to provide additional holding habitat for adult chinook salmon. While an evaluation of this pool increase has not been made yet, the high mortality of spring chinook in 1988 was thought to be related to the overcrowding of fish in the holding areas available that summer (USFWS in press).

Mechanical ripping to remove fine sediments from spawning gravels has not been a success on the Trinity. Ripping has, in fact, caused the fine sediments to become more firmly settled in the substrate and has churned up substrate unsuitable for spawning (USFWS in press).

The Fishery Benefits of Riparian Enhancement Projects

Many bank stabilization and erosion control projects involving large boulders have been carried out along the riparian zone of the Scott River. Patterson (1976) found that scouring next to these structures had increased the depth of the adjacent pools and created more habitat for salmonids. While salmonids were, indeed, more plentiful, they were far outnumbered by suckers and dace. Many of these stabilized areas were left unfenced, riparian vegetation was not replanted, and grazing continues along the streambanks. If vegetation were allowed to grow back it would create cover, provide shade, and improve salmonid habitat.

Banks have been stabilized with boulders on Red Cap Creek and riparian vegetation reestablished with natural seedings. Ah Pah Creek fisheries habitat improvement work by the CCC included use of gabion baskets to armor the toe of streamside landslides. When the CCC blew up a rock falls that was a migration barrier on Tarup Creek, rock fragments were used to armor a nearby landslide.

Eastern Oregon streams, in areas similar to the upper Klamath Basin, recovered very well when riparian areas were planted and cattle kept out of most of the streamside zone (Elmore 1988). Even streams that had been so severely overgrazed that they flowed underground have had both their surface flows and fish life restored. Similar treatments in Wyoming resulted in tremendous increases in native trout populations (Binns 1986). Platts (1982) notes other studies where restricted grazing in riparian areas has allowed the recovery of streams in Idaho and Great Basin areas.

Watershed Stabilization: Some Successes, Lots of Potential

The U.S. Forest Service has an ongoing program of erosion control involving such practices as reforestation and road maintenance. Following the 1987 fires large scale erosion control efforts included mulching disturbed areas, such as fire lines, seeding vast areas with grasses, and constructing numerous check dams to control erosion in the draws above streams. Two basins were constructed on Hotelling Gulch and Olsen Creek to catch sediment before it enters the Salmon River. The trapped sediments will be removed after storms. These traps have been filled to capacity even by storms of moderate intensity. An experimental sediment trap was installed by the Forest Service on French Creek, a tributary to the Scott River. The lack of an on-site sediment storage area made the continued removal of sediment at this site too expensive, so the structure is no longer in use. Increased sedimentation in French Creek did not result from fire-related watershed damage, but from road cuts and disturbances related to timber harvest (Sommarstrom 1990).

Figure 3-6 -- Putting roads "to bed" in Hoopa Reservation watersheds has reduced erosion and helped streams to recover.

The USFS has begun erosion control efforts in Grouse Creek, a tributary to the South Fork of the Trinity River. Because high sediment loads stemming from timber harvest and related roads in this mixed ownership watershed have led to fish habitat degradation, the Six Rivers National Forest has ceased timber harvest on USFS lands in the basin. Studies have been conducted to determine the most effective means to revegetate and stabilize the hillslopes (Matthews et al. 1990) and a sediment budget has been formulated (Kelsey et al. 1989). An Environmental Impact Statement is being prepared to determine how much erosion control work will have to be done before timber harvest on USFS lands may resume.

The USFWS Trinity River Program Office has been moving toward a watershed approach to fisheries restoration for the Trinity River Fish and Wildlife Management Program (USFWS in press). Efforts initially focused on the Grass Valley Creek watershed, where the Trinity River Program has built a large sediment-trapping dam. Work has now expanded to include the entire Trinity watershed, including its South Fork, where monumental erosion problems exist (CDWR 1982). The potential of each stream to produce fish, together with its relative contribution of sediment to the main Trinity River, has become the basis for determining Trinity Program project priorities. Those projects that will be accompanied by changes in land use to lessen future erosion problems will be given top priority.

The CCC has accomplished several erosion control projects in the lower Klamath River tributaries. Their work on Salt and Tarup Creeks included the installation of waterbars on abandoned roads near streams. Three failed road crossings on Salt Creek were also treated. A streamside landslide on Ah Pah Creek was stabilized by replanting vegetation.

Some of the most extensive watershed restoration work in the Klamath Basin has been undertaken by the Hoopa Valley Tribal Council's Fisheries Department. When instream structures failed due to sediment problems, watershed stabilization programs were begun. Undersized culverts on logging roads have been replaced, trash racks installed on culverts, and a maintenance program to keep these racks free of debris has been initiated. Where feasible, abandoned logging roads and landings have been graded back to the slope of the hill, mulched and seeded. Streams have been deflected away from the toes of landslides and gabion baskets and riprap used to help stabilize these features. The Hoopa Valley Tribe has also begun a study on Pine Creek to identify the sources of sediment and to prioritize the measures needed to decrease sediment production.

An ambitious and comprehensive watershed approach to fisheries restoration is underway in the watershed of the Mattole River, a coastal stream downcoast of Humboldt Bay, through the efforts of the Mattole Restoration Council. A recent study, Elements of Recovery (MRC 1989), identifies the major sources of sediment throughout the Mattole watershed. The calculation of a sediment budget was beyond the scope of the project, but treatments were prioritized and rehabilitation prescriptions made in the study.

Another successful watershed program is that on the South Fork of the Salmon River in Idaho. Large amounts of decomposed granite sand had entered the river due to extensive logging, which was followed by floods. Improved land use, the replanting of hillslopes and putting roads to bed significantly reduced the amount of fine sediments in the river's spawning gravels (Platts and Megahan 1975).

MORE INFORMATION NEEDED ON BIOLOGICAL AND COST EFFECTIVENESS

While a great deal of stream restoration and enhancement work has been accomplished in the Klamath River Basin, no studies have been conducted that conclusively prove that the restoration work has increased salmon or steelhead production in any tributary. Fisheries habitat improvement structures in tributaries to the Trinity River have lacked "baseline information and post project evaluation ... thus little adaptive management information has been gained from these efforts." (USFWS in press). The evaluation of fisheries restoration and enhancement projects is complex and expensive and the problem of insufficient evaluation is not unique to the Klamath Basin (Everest and Sedell 1984). Recent studies have provided relative cost efficiencies of kinds of instream structures used on Klamath tributaries (Olson and West 1990).

> Evaluation ... of any habitat manipulation program ... is needed to determine whether enhancement projects achieve their intended objective and whether or not projects are working. Unfortunately, project expenditures are far ahead of our knowledge of the effectiveness of these 'improvements'. Without evaluation, we cannot recognize our mistakes, innovate appropriate new techniques, or determine if funds have been wisely spent.
>
> B. Fontaine (1988)

Several researchers have suggested that because salmonid populations fluctuate so much naturally, several years of study of fish populations is needed, both before and after changing habitat (Fontaine 1988, Hall and Knight 1981, Platts and Nelson 1988). Without such studies, it is difficult to determine whether changes in fish populations have occurred in response to treatments or are simply the result of natural variations. Everest and Sedell (1984) point out that evaluating stream reaches, as opposed to taking a basin wide approach, can be misleading. Increased use of habitat structures by juveniles at a certain time of year, or increased spawning activity in a reach after treatment, may actually reflect a shift from adjacent areas.

The accepted standard of judging restoration success is smolt output, determined by the use of downstream migrant traps (Everest and Sedell 1984). Except in smaller streams, however, sampling smolt output may not be possible due to trapping limitations. The use of paired samples of streams, one treated and one unaltered, can help determine whether structures are being used, but cannot provide the actual numbers of fish produced (Johnson et al. 1986).

Studies conducted on the effectiveness of habitat manipulation produce results that vary considerably (Fontaine 1988). Everest studied Fish Creek in Oregon from 1984 to 1987. When five percent of the total stream habitat had been altered, no increase in steelhead or coho salmon juveniles was observed. When more intensive structural treatment was implemented, using rootwads to create backwater pools, coho salmon numbers increased, while juvenile steelhead numbers remained unchanged.

Fontaine (1987) found that instream structures on Steamboat Creek, a tributary to the Umpqua River in Oregon, were used by juvenile steelhead but that no net increase in their population occurred. She postulated that competition with redside shiners was limiting the number of steelhead juveniles and that structures could not, therefore, increase their production.

Binns (1986) described changes in native trout population in three reaches of Huff Creek in Wyoming, one where grazing had been reduced, a second without grazing, and a third not only free of grazing, but having instream structures as well. He found that trout had increased in all three areas, but that the most dramatic increase was in the no-grazing section with the structures. Before the improvements, trout numbered fewer than 36 per mile, while afterward there were over 600 per mile. The dramatic change in fish numbers clearly demonstrated the benefit of the structures (Fontaine 1988).

West (1984) noted that spawning and rearing chinook salmon used areas treated with boulder clusters and weirs more than adjacent, untreated reaches on the South Fork of the Salmon River in the Klamath Basin. The Salmon River is so large it precludes accurate enumeration of smolt output, so the best test for increased production was not possible. On Red Cap Creek in the middle Klamath region, Brock (1987) compared reaches that were treated with boulders to untreated reaches and found greater densities of juvenile steelhead associated with the structures. However, a determination of whether smolt output was increased by the stream treatments was beyond the scope of his study.

Olson and West (1990) have recently completed an evaluation of fish habitat improvement structures on several Klamath tributaries. The study compares the use of areas altered by structures with control areas similar to the habitat before alteration. Structure life was gauged by the amount of deterioration since construction. Estimated structure life ranged from 18 to 57 years. The researchers found low cost structural treatments, such as digger logs and boulder deflectors, to be the most cost-effective. Those with the poorest cost-benefit performance were the cabled cover logs and boulder root wad deflectors, the result of the cables wearing out, and small boulder weirs on Beaver Creek that had been filled with imported gravel.

Given that the structures studied were all 3 to 5 years old and that no major floods have occurred in the Klamath Basin during the last five years, a reassessment of these results may be needed if flood events show the longevity of structures to be different than projected. While Olson and West (1990) provided some interesting and useful information regarding the use by fish of the habitat created by instream structures, it was, again, beyond the scope of their work to assess whether there was a net increase in salmon and steelhead production in any of the streams studied.

The net increase in smolt production is necessary information for calculating precise cost-benefit ratios for projects. Economic benefits can be estimated using values that include commercial fishing and processing, tourism revenues, sporting goods sales, guiding fees, license sales, access fees, and other factors (Meyer 1980). At this point, however, Klamath Basin projects lack smolt production figures to determine cost-to-benefit ratios.

THE FACTORS WHICH LIMIT FISH PRODUCTION IN THE KLAMATH RIVER BASIN

Habitat degradation is strongly indicated as the cause for the low number of anadromous fish currently returning to the Klamath River compared to historical levels. Many Klamath Basin tributaries have problems so serious that treatment with instream structures may be inappropriate at this time. Problems in the tributaries contribute to large scale ecological problems in the main river and the estuary. Mass wasting, triggered by flood events, but associated with timber clear-cutting and road failure, have caused substantial increases in sediment to stream systems (MacCleery 1974, Coats and Miller 1981). Decreased streamflow and poor water quality are major factors that depress fish populations in some upper basin streams. The effects of logging on fish habitat and problems related to water quality and diversion are discussed fully in Chapter 2. These problems are briefly reviewed here so that the main limiting factors in each subbasin can be more readily recognized and effectively addressed.

Lower Klamath Tributaries

The watersheds of many of the tributary streams of the lower Klamath basin have been extensively logged since 1950. Coats and Miller (1981) found that erosion hazards and the potential for unacceptable cumulative effects were greatly increased if logged areas exceeded 38 percent in these steep, unstable watersheds. Since that time, some watersheds on private land have been logged at rates approaching 80 percent, including the removal of old growth trees from the riparian zones. The loss of large conifers in the riparian zone can greatly increase streamside slope failure rates (Kelsey 1980, Ziemer 1981a). Streamside slides are particularly bad since the sediment from such failures is introduced directly into the stream (Frissell and Liss 1987).

Although sediment enters the tributaries during discrete storm events, the negative impacts from these events persist over time (Lisle 1982, Hagans et al. 1986, Kelsey 1980). The effects of the 1964 flood are still impacting fish populations in the lower Klamath tributaries, especially those crossing the Yurok Reservation below Weitchpec. Channel aggradation in these disturbed watersheds has caused the streams to flow underground in late summer. This prevents the outmigration of juvenile chinook, coho, steelhead and cutthroat trout and even adult spawning migrations in some years.

Figure 3-7 -- Turwar Creek runs underground at its confluence with the Klamath River because of its tremendous sediment load. The Klamath has also been filled in by sediment transported from throughout the watershed.

Payne and Associates (1989) found that stream-mouth deltas, almost nonexistent prior to 1955, have grown to 500 and 700 feet in width since 1964. Delta widths changed dramatically after the 1964 flood, but increased even more after the high water of 1972. The initial incursion of sediment came with the 1964 flood but is still being delivered to the lower reaches of the streams. Streambed conditions near the mouths were found by Payne and Associates (1989) to be so unstable that no fishways could be installed and the study concluded that no lasting solution, other than natural recovery, was possible. Logging in many of these drainages continues today. This delays their recovery and, according to Coats and Miller (1981), could lead to substantial new sediment loads in the event of a major flood.

The Payne and Associates findings concerning bedload mobility also suggests that the spawning gravels found in these highly aggraded reaches would be highly unstable. Frissell and Liss (1987) found that similar conditions in southern Oregon streams caused extremely low survival of eggs due to scour and fill in the stream. Chinook populations spawning in the main stem of Euchre Creek dropped from 2,000 adults to between 20 and 200 as a result of high bedload mobility. Chinook and coho salmon can only reach the flat, lower reaches of these lower Klamath tributaries, the reaches where these massive sediment build-ups have occurred.

Lisle (1982) noted that persistent high bedload movement can hinder the regeneration of riparian vegetation. Riparian areas have not recovered well in the tributaries below Weitchpec and elevated water temperatures result from the lack of shade. Downstream migrant traps demonstrate that suckers and dace far outnumber salmonids in most of these lower Klamath streams (USFWS 1990). Reeves (1984) found that elevated temperatures conferred a competitive advantage on redside shiners over steelhead. Habitat changes in the lower Klamath tributaries seem to be strongly favoring warm water tolerant species, such as suckers and dace.

The low number of anadromous salmonids in the lower Klamath tributaries is directly related to sediment problems. Because every watershed below Weitchpec has been degraded, major floods have the potential to devastate this region's entire stock group of chinook and coho salmon. The effects on steelhead and cutthroat trout may be serious but these fish have the ability to migrate farther upstream into high gradient areas of streams that recover more quickly after floods. The use of instream structures as a primary tool for improving fish habitat and anadromous fish populations in this area is inappropriate due to the high sediment loads that might bury structures during a flood. Investments in instream structures in most lower Klamath tributaries should be considered high risk. **Only changes in land use management and large scale watershed stabilization efforts can effectively address these problems and begin the process of recovery of the lower Klamath tributaries**.

Middle Klamath Tributaries

Large areas of the middle Klamath watershed were burned by wildfires in 1987, including portions of the Elk, Clear, Indian, Grider, King Titus, and Seiad creek drainages. Salvage logging has followed in several of the drainages. Other middle Klamath tributaries, such as Beaver Creek, have been widely disturbed by logging and associated road construction. Efforts to increase fish production using structural treatments have been largely ineffective in Beaver Creek as a result of ongoing sediment inputs. Similar problems with decomposed granite sands are found in Cottonwood Creek. Despite post-fire erosion control efforts by the USFS, erosion hazards in these drainages remains very high. A major flood could trigger massive contributions of sediment to the area's streams. The risk of major loss of salmon and steelhead resources in this area can be reduced through widespread implementation of erosion control measures and changes in land use practices.

Large areas of the Clear Creek watershed are scheduled to be salvage logged. Restricting such activity in Clear Creek would be advisable since it sustains stock groups of concern, particularly summer steelhead and spring chinook. Roelofs (1982) indicated that summer steelhead were extremely sensitive to watershed disturbances. If major losses in other tributaries occur due to floods and mass wasting before their watersheds can be stabilized, the Clear Creek populations would provide a source for the rebuilding of locally adapted stocks.

Very large plugs of sediment were deposited at the mouth of the smaller middle Klamath tributaries by the 1964 flood. Old mine tailings from just upstream in the Klamath caused this problem to be particularly severe at the mouth of Humbug Creek. These creeks have not had the ability to move this material since the earlier flooding and fish passage is limited except during very high flows. The USFS has used heavy equipment to improve fish passage into Independence Creek, which was partially blocked by a sediment plug. The feasibility of improving access for upstream migrants in other streams in the middle Klamath region needs to be explored. Fish passage problems on Horse Creek and Seiad Creek related to water diversion structures must also be addressed.

Salmon River

The potential for erosion in the Salmon River drainage was greatly increased by the 1987 fires. The fires caused large-scale denuding of several Salmon River subbasins, some of which had also been burned in the Hog Fire of 1977. The fires in some Salmon River tributaries caused the total loss of ground cover and the prospects for natural regeneration are poor. The soils are primarily granitic in these burned subbasins. The watersheds that suffered the greatest damage were Crapo Creek, Olsen Creek, Big Creek, Kanaka Creek, and the North Fork of the Salmon River.

The USFS has done some erosion control work in the Salmon drainage since the 1987 fires. The erosion hazard remains so extensive, however, a major flood event could still mobilize large quantities of sediment. Most sediment coming off the slopes will go directly into the streams because of the steep, inner gorge configuration of most of these Salmon River tributaries. Decomposed granite sands are found throughout the basin and they can have serious negative impacts on salmon and steelhead spawning and rearing success (Platts and Megahan 1975). The Salmon River spring chinook have reached very low levels and these sediment problems could lessen their chances for recovery. **An intensive program of erosion control is needed in the Salmon River**. Through the use of a sediment budget approach (Kelsey et al. 1990) or an erosion prevention assessment (Hagans and Weaver 1990), priorities for effective treatment can be established. To protect fisheries resources, timber harvest in the Salmon watershed should be conducted with special care to avoid adding to the area's erosion hazards.

Scott River

Fish habitat in the Scott River drainage suffers from both current and long-standing effects from sediment and floods. Habitat has also been diminished by livestock grazing and irrigation diversions.

The Kidder Creek drainage was extensively logged and also suffered a major fire prior to the 1955 flood. Sediment and debris, washed from the watershed by the flood, formed a major delta where Kidder Creek canyon emptied into the Scott River Valley. The creek still flows underground for much of the year as a result of massive aggradation. Stream diversions further reduce Kidder Creek's surface flow.

Figure 3-8 -- Kidder Creek's delta resulted from severe erosion triggered by the 1955 flood. The stream flows underground here throughout the summer.

Timber harvest and road building on the 55,000 acres of decomposed granite soils in the basin appear to be causing heavy contributions of granite sands to the Scott River tributaries. Big French, Sugar, Shackleford, Etna and Kidder Creeks all contribute substantial amounts of decomposed granite to the Scott. The poor quality of spawning gravel in the Scott River was found by CH2M Hill (1985) to significantly reduce the survival of chinook and coho salmon eggs. A comprehensive erosion control program, based on a sediment budget approach, is the only long-term solution to the sediment related problems in the main channel of the Scott River.

Livestock grazing is causing bank erosion and the loss of riparian vegetation along the Scott River and some of its tributaries. The loss of vegetative cover, the increased sedimentation caused by bank erosion, and the increased summer water temperatures are all serious habitat problems. Limiting livestock access to streamside areas and restoring riparian vegetation would greatly improve the Scott River's fish habitat.

Flow reductions make temperature problems worse, they limit spawning areas and make access to spawning tributaries difficult. **The Task Force should give high priority to finding ways to work cooperatively with the area's irrigators to increase streamflows for fish in the Scott River basin**.

Shasta River

The factors found by CH2M Hill (1985) to limit salmon and steelhead production in the Shasta River continue to this day to frustrate restoration efforts. Low flows limit access to the river for returning salmon and they decrease rearing habitat for juvenile coho and steelhead. Summer water temperatures reach 85 degrees F. and dissolved oxygen levels as low as 2.8 parts per million have been measured in the Shasta River (Dennis Maria personal communication). Such low dissolved oxygen and high temperatures are lethal for salmon and steelhead. The same problems caused by livestock along the Scott River are found on the Shasta, as well, in addition to which livestock along the Shasta may also be adding nutrients to the stream, which reduces oxygen levels. Again, low streamflows increase the water quality problems, decrease spawning and rearing habitat, and hinder migration.

Salmon populations in this basin have not rebounded since 1985, despite restricted ocean harvest aimed at increasing escapement. **There is a very great potential for restoring native salmon and steelhead returns to the Shasta River if only the livestock impacts on riparian vegetation, water quality, and streamflow could be reduced**.

The Main River and Its Estuary

Indian fishermen and resort owners have noted that the pools in the lower Klamath River and its estuary have filled in considerably since the early 1970's. Similar trends have been noted on other northern California coastal streams and are attributed largely to sediment contributed by the 1964 flood (Hagans et al. 1986).

Late summer water temperatures in the lower Klamath have approached 80 degrees F. in recent years. The temperature increases appear to have been caused, in large part, by the loss of vegetation along the tributary streams. Warm water released from Iron Gate Dam also contributes to these high water temperatures. The decreased depth of the lower Klamath River reduces the cold water layer along the river bottom, where migrating salmonids might otherwise find refuge when river temperatures rise.

The decreased depth of the estuary may also effect the fresh and salt water mixing patterns. The salt water "wedge" along the bottom of estuaries can host entire communities of marine organisms (Simenstad 1983) which may be critical food resources for anadromous salmonid juveniles.

The entire Klamath River, and particularly the lowest reach, is suffering from cumulative effects which may be leading to reduced survival of juvenile salmonids (see discussion on density dependent rearing mortality in Chapter 5). The substantial reduction in eulachon (candlefish), described by Indian fishermen, may be related to bedload movement or substrate conditions in the lower river. There are no technological solutions, such as dredging or construction of deflectors, to sediment problems in the estuary and lower river. Only by reducing the sediment supply of the entire Klamath River Basin, and allowing time for natural recovery, can the current problems be fully resolved. Increased releases from the Trinity River Project can increase flushing and could help speed the recovery process.

Temperature conditions need to be evaluated systemwide.

MONITORING AND ASSESSING PROJECT RESULTS

Some of the issues surrounding the analysis of the biological and economic results of habitat restoration projects have been discussed above. The ultimate indicators of the Restoration Program's effectiveness will, of course, be increases in Klamath River salmon and steelhead populations and the harvests that can be made of these fish. In the meantime, the Task Force should support measures to monitor and assess habitat restoration projects, including improvements in water quality and the other factors which appear to be limiting fish production.

Using Fish Abundance to Measure Project Effectiveness

The best way of determining the success of the Restoration Program, theoretically, would be by measuring the increase in the numbers of young salmon and steelhead produced throughout the Basin. Because of the sampling problems discussed earlier, it is very difficult to estimate the number of young fish in large streams with accuracy. Smolt monitoring in key subbasins, like that currently conducted by the California Department of Fish and Game's natural stocks assessment program in Bogus Creek and by the U.S. Fish and Wildlife Service in the lower Klamath River tributaries, should be expanded to include index streams for the populations of special concern identified in Chapter 4.

Spawner escapement, estimated by weirs and carcass counts, provides the Task Force a partial indicator of success or failure of the Restoration Program. Habitat recovery might be occurring in-river, but ocean conditions such as El Nino might decrease adult survival. Evaluation programs based solely on fish numbers might be misleading as data on smolts or spawners is often incomplete. More complete suggestions as to needs for monitoring of salmon and steelhead populations and additional studies are offered elsewhere in this plan (see Chapter 4).

Cross-sections and Longitudinal Profiles Reveal Sediment Loads

Changes in sediment supply and storage can be monitored inexpensively using stream cross-sections and longitudinal profiles of study streams. Periodic checks of relative bed elevation at various sites will indicate whether the amount of sediment stored in the channel is changing and allow the tracking of sediment pulses as they move downstream. Longitudinal profiles in these same areas will reveal increases or decreases in pool depth and volume. As watershed rehabilitation efforts are undertaken in a subbasin, measuring the changes in sediment transport will help gauge their effectiveness. (Vicki Ozaki and Maryann Madej personal communications.)

Changes in Channel Width Highlight Erosion Problems

The Riparian Aerial Photographic Inventory of Disturbance, or RAPID, is a new, low-cost tool for analyzing the downstream effects of logging, road construction and other soil-disturbing watershed activities. With the help of aerial photographs with a scale of 1:12,000, the RAPID process assesses sediment-related changes in stream channel width over time (Grant 1987). This ability to track the cumulative impacts of logging and other watershed activities will not only improve the scheduling of Task Force habitat improvement investments, but guide improvements in watershed "best management practices" as well.

Sampling Sediments in Gravel Spawning Beds

Fine sediments can reduce the survival of salmon and steelhead eggs and the emergence of fry from the spawning gravels dramatically (McNeil and Ahnell 1964). Gravel quality can be determined by measuring the percentage of fines and the average particle size through bulk gravel sampling (Everest et al. 1982). Chinook salmon appear to be the most seriously effected by increasing amounts of fine particles, followed by coho and steelhead, in that order. There does not appear to be any information at this time, however, on the precise quantitative relationships between percentages of fine material in spawning gravels and the percentage of egg survival or successful emergence that might be expected. Nor would the problems discussed earlier concerning the loss of eggs and emerging fry to shifting bedloads be identified through bulk gravel sampling.

In areas where fine sediments are suspected of decreasing egg-to-fry survival, such as the Scott River, bulk gravel sampling information should be collected so that it may be compared to the conditions which follow watershed stabilization efforts. Watershed stabilization and land management improvements in the South Fork drainage of the Salmon River in Idaho were followed by a dramatic drop in fine sediment in salmon and steelhead spawning areas (Platts and Megahan 1975). Prior to treatment, fine sediment averaged between 45 and 80 percent in South Fork spawning beds, but dropped to 12 to 26 percent afterward. With the land use improvements, gravel size distribution became nearly optimum for spawning chinook salmon.

Measuring Improvements in Water Quality

As discussed earlier, both poor water quality and reduced streamflow limit salmon and steelhead production in many stream reaches of the Klamath Basin. The Task Force should encourage efforts to gather temperature and water quality information. Where livestock are suspected of contributing to water quality degradation, oxygen measurements should be made both when livestock are, and are not, in the stream corridors. Temperature data should be gathered before and following the restoration of riparian vegetation.

Aquatic insects and other aquatic invertebrates, generically termed macro-invertebrates or "macros," are powerful indicators of water quality and general stream health (Winget and Mangum 1979). Intermittent point source discharges, brief periods of anoxic conditions, or other transient but potentially damaging water quality problems, may be difficult to detect with periodic sampling. Short-term conditions can destroy aquatic organisms that require high levels of dissolved oxygen or that are sensitive to other forms of pollution. Sampling aquatic macros above and below a suspected point source can help to detect these impacts. If samples are taken on a regular basis, changes in species diversity and the presence or absence of key species or groups can indicate water quality conditions, including nonpoint source pollution from sediments.

Because macros provide most of the diet for young salmon and steelhead, an understanding of their abundance and diversity is useful for understanding the growth and survival of these fish. While the U.S. Environmental Protection Agency has provided substantial support for the identification of macro indicator species in the eastern part of the country, little of such work has been completed in the West. A considerable amount of baseline information has been collected on the insect fauna of the Trinity River tributaries (Lee 1989). The Task Force should encourage EPA, the State Water Resources Control Board and other water quality interested agencies to assist in funding an extension of this Trinity work into the balance of the Klamath Basin.

Instream flow studies can be used to predict the changes in fish habitat and fish production that can be expected with changes in streamflow conditions (Bovee 1982). Such studies are costly, however, and may not be necessary in most cases. If a stream dries up in summer, fish production would clearly benefit from improvement in summertime flows. Formal studies using the instream flow incremental methodology (IFIM) should be performed to determine the streamflow needs of the main Klamath River prior to the relicensing of Iron Gate Dam by the federal Energy Regulatory Commission.

It will be necessary to install and maintain additional stream discharge gauges for the Restoration Program. Measurements of peak flows, in particular, are needed in order to model sediment routing and determine the fate of sediments in the fish habitats of the Klamath River system (Tom Lisle personal communication).

Using Landsat Imagery to Monitor Conditions in the Klamath Basin

The Task Force launched a study in late 1990 to determine the practicality of developing a computer-based geographic information system, or "GIS," for the Klamath Basin, or selected portions of it, using Landsat imagery. The Landsat satellite's orbit high above Earth brings it over the Klamath Basin on a regular basis and transmits multispectral information useful for monitoring physical conditions on a basinwide scope. For example, the California Department of Fish and Game is using infrared Landsat images to follow the post-fire succession of vegetation in the Scott and Salmon River watersheds. Both the U.S. Forest Service and the California Department of Forestry and Fire Protection are using Landsat imagery of the Klamath Basin for selected purposes.

While Landsat imagery cannot replace the on-the-ground monitoring needs discussed above concerning sediment conditions, water quality or the rest, it can enable broad-scale comparisons over time of Basin conditions of interest to the Restoration Program. It is clearly advisable for the Task Force to follow the use of Landsat imagery and GIS development in the Basin by the other agencies and to remain alert to the contribution this technology can make to the evaluation of the Basin's watershed and stream conditions.

THE RESTORATION PROGRAM'S NATURAL ALLIES

The California State Water Resources Control Board (SWRCB) is responsible for implementing the federal Clean Water Act under a delegation of authority from the U.S. Environmental Protection Agency (EPA). The SWRCB, acting through its nine regional water quality control boards (Regional Boards), has prepared plans for the protection of water quality, and the "beneficial uses" made of the waters, of every river basin in the state. The plan for the Klamath River specifically designates the production of coldwater fish resources as a beneficial use of the water of the Basin.

The SWRCB, with the assistance of its North Coast Regional Board, and pursuant to its responsibilities under the federal Clean Water Act, completed the first statewide Water Quality Assessment in April 1990. The Assessment was reviewed and approved, with modifications, by EPA in July 1990. In its Assessment, the SWRCB found that the coldwater fish beneficial use of the Klamath River and its Shasta, Scott and Salmon tributaries, is not being adequately protected. The SWRCB based its findings on "fact sheets" prepared by the Regional Board which describe the nature of the widespread, or "nonpoint," pollution responsible for the decline in the Basin's coldwater fish habitats.

The EPA took the SWRCB findings a step further. The EPA found that because the decline in the Basin's coldwater fish resources is attributable to the deterioration of their habitat, the streams in question are "impaired," as that term is used in Section 304 of the Clean Water Act. The designation of these streams as impaired makes them particular targets for state and federal pollution abatement efforts -- and makes the SWRCB, Regional Board and EPA natural allies in the restoration of the Basin's watersheds, streams and fish resources.

A logical first step for this natural alliance is a merger of information useful to both fish restoration and water quality management interests. The Northwest Power Planning Council uses the Reach File, EPA's national data base of surface water features, as the computerized geographic base for its integrated system plan for salmon and steelhead production in the Columbia River Basin. The Reach File can be easily modified to provide for the management of information for specific stream segments, or "reaches." Each Reach File stream segment has its own catalog number and information can be entered and retrieved through the use of this map-based system with a high degree of geographic specificity.

The hydrologic unit data base that the SWRCB uses now does not have the Reach File's computerized flexibility. The Reach File is used by California's neighboring states and EPA is interested in extending its use into California. The Klamath Basin, representing more than five percent of the state's area, would provide an excellent demonstration of the Reach File's use in water quality management. Such a demonstration could also enable the organization of information essential to the Restoration Program.

The Task Force should seek assistance from the SWRCB and EPA to carry out, in close cooperation with those agencies, the North Coast Regional Board and the Trinity River Task Force, a Reach File demonstration mutually beneficial to all parties.

Community Support and Involvement: The Key To Program Success

While agencies can provide essential technical support to the Restoration Program and bring substantial funds with which to address problems and monitor progress, gaining the support and participation of the citizens of the Klamath basin is absolutely critical to the success of the Program. There are numerous successful models from California's north coast where citizens have directly undertaken fish rearing and stream and watershed restoration projects. These projects tend to hold the volunteers' interest and substantially lower project costs. Direct participation in the Restoration Program tends to keep project funds in the local communities which, in turn, builds good will. Public involvement also encourages landowners to participate in restoration activities on their lands or, where necessary, to modify land use practices that might hinder fisheries restoration. Finally, volunteer participation in fish restoration will likely lessen localized fish poaching problems.

There are already restoration projects in the Klamath Basin that are enjoying substantial volunteer effort, the Orleans Rod and Gun Club's Pearch Creek steelhead rearing ponds, for example, but such efforts need to be expanded. The Mattole Restoration Council has recently completed a study that identifies erosion problems (MRC 1990) throughout the entire Mattole River watershed and the volunteer Council is addressing these problems subbasin by subbasin.

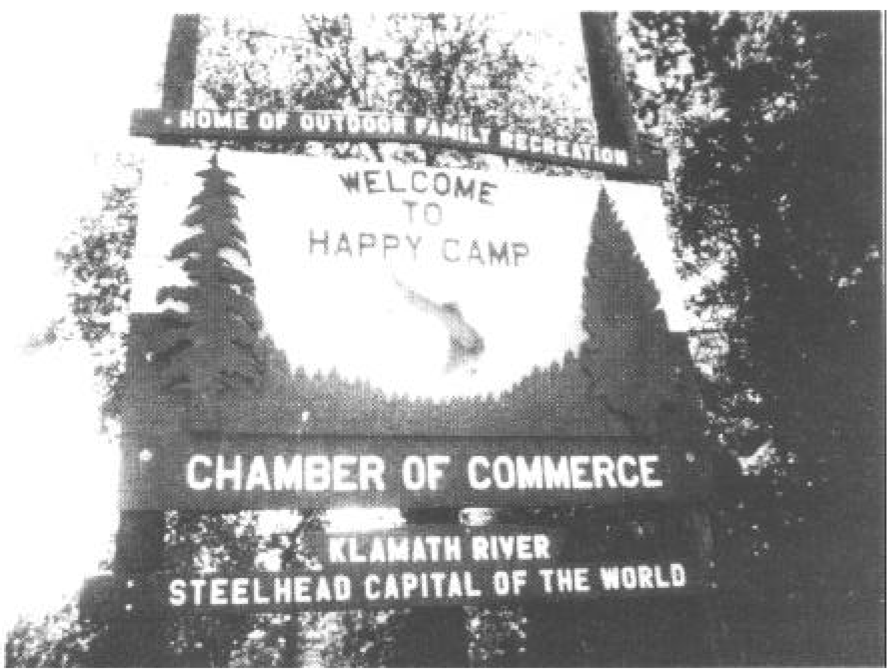


Figure 3-9 -- Sportfishing is important to the economy of the Klamath Basin and the Basin's communities are natural allies for the Restoration Program.

The challenge to the Task Force is to empower local groups by increasing their understanding of the problems that have caused the decline of anadromous fish populations and the techniques can be employed to remedy these problems.

Workshops sponsored by the Humboldt Chapter of the American Fisheries Society (AFS) in 1986-88 provided training to people interested in fisheries and restoration. Topics included spawning counts, stream measurement techniques, basic aquatic invertebrate monitoring, stream processes, barrier analysis, and other subjects that helped develop the understanding and skills needed in restoration. Similar training should be arranged for those interested in restoration in the Klamath basin. To maximize local involvement in the Restoration Program a special session on understanding the contract process is needed.

The Humboldt AFS also hosted a 1988 conference on "Harvesting Trees While Retaining Our Fish: A Challenge We Can Meet" to share information between fisheries scientists and foresters. Both the California Department of Forestry and Fire Protection and private timber operators have expressed a willingness to participate in and to sponsor workshops on timber harvest and its relationship to fisheries restoration (CDF 1990, FGS 1990). AFS has also held conferences in other western states on protecting and restoring riparian areas. A seminar or workshop in Yreka on this topic would help inform the agricultural community about techniques of restoration and the potential benefits for them and the Restoration Program. Resource Conservation Districts would be natural cosponsors of such educational programs.

CONCLUSION

> There are tremendous and persistent forces in the flow of water down steep channel gradients that move large and abundant material. Forces that can annually transport many tons of cobbles and boulders can make short work of poorly designed and placed structures .... Because fish density in nutrient poor streams is low even under the best habitat conditions, it takes a large number of enduring structures to make a significant difference challenges, some workers contend that habitat enhancement by artificial structures is rarely cost-effective, and people should emphasize protecting stream habitats through better management of hillslopes and riparian areas.
>
> T. Lisle (1988)

Prior restoration efforts in the Klamath River Basin have had mixed results. The removal or modification of migration barriers and the construction of fish passes have had almost universal success. The screening of diversions is saving hundreds of thousands of juvenile salmon and steelhead from certain death in the fields. Habitat improvement structures in the South Fork of the Salmon River are holding up well and seem to be attracting salmon and steelhead spawners and providing rearing habitat. Structural habitat modifications in watersheds with sediment problems have a very high rate of failure and need for continuous maintenance. Some of these structures may have failed because they were installed in steep, confined channels with tremendous hydraulic force. Many of the structures recently installed have yet to be challenged, however, by major flood flows.

The problems which have led to the deterioration of the Klamath Basin's fish habitat must be dealt with honestly and openly. It is the problems, not the symptoms, which need to be addressed. Sediment must be abated through programs of erosion control and prevention (see Chapter 2). Problems of water quality and streamflow deficiencies caused by agricultural need to be dealt with if the Restoration Program is to succeed.

Stabilizing all the watersheds in the Klamath Basin, funding all the needed riparian restoration or water conservation programs is clearly beyond the capability of the Restoration Program. Help is available from the entities that have interests or responsibilities that overlap with fisheries restoration, particularly those involved with the federal Clean Water Act -- which includes every forest landowner and agricultural operator, in addition to virtually every state, federal and local agency, in the Basin.

Where stream systems are recovering, the factors limiting fish populations may be less obvious than in recently-damaged streams. Habitat typing will help us understand better the relationship between the Klamath Basin's fish species, their age groups and their habitats. By comparing streams in recovery with undisturbed watersheds we can see which habitat elements are limiting fish production and which techniques will contribute most effectively to restoration.

No rigorous scientific studies have been conducted anywhere in the Klamath Basin concerning increases in salmon and steelhead smolt production associated with the use of instream structures. Recent studies give the Task Force a measure of the relative cost effectiveness of instream structures in the Klamath Basin, based largely on their cost and projected life. The life of instream structures can be relatively brief in the high energy of the Klamath tributaries. It would be clearly unwise to become overreliant on instream structures as the primary tool of the Restoration Program. Where channels are recovering, the prudent use of instream structures can speed the recovery process. Finally, the Task Force may invest in risky instream structures where the recovery of priority stocks must be addressed on an emergency basis (see Chapter 4).

As indicated above, the process of monitoring the effectiveness of the Restoration Program should attract a number of cooperating agencies, particularly those interested in the implementation of state and federal clean water laws.

The support and confidence of the local communities is essential to the success of the Restoration Program. Educating residents along the river and its tributaries about fisheries restoration, how it will be achieved and how it will benefit the region, will ensure their participation in the rebuilding process.

POLICIES FOR HABITAT RESTORATION

Objective 3: Restore the habitat of anadromous fish of the Klamath River Basin by using appropriate methods that address the factors that limit the production of these species.

3.1 The Klamath River Basin Fisheries Restoration Task Force should solicit the support and cooperation of all the citizens of the Klamath River Basin in its mission to restore anadromous fisheries resources. The communities can be involved by:

a. Holding training sessions on restoration techniques and opportunities.
b. Holding training sessions to increase understanding of the contract and bid process to encourage local firms and groups to get involved.
c. Giving preference to projects that have strong local participation.
b. Encouraging the formation of local restoration groups to "adopt" subbasins and become advocates for fisheries resources and the Restoration Program.

3.2 Because large scale contributions of sediment continue to have substantial negative impacts on the ecosystem of the Klamath River, the Task Force will focus on evaluating areas where erosion continues to be a problem, and will work to solve the problem by:

a. Entering into formal long-term cooperative agreements with the U.S. Forest Service, Resource Conservation Districts, Indian Tribes other agencies.
b. Entering into Cooperative Resource Management Plans (CRMPs), with public and private landowners, with the objective of reducing erosion from their land.
c. Working with resource agencies such as the State Water Resources Control Board, the California Department of Forestry and the Environmental Protection Agency to identify problems, monitor progress on the abatement of sediment problems, and, where necessary, step up enforcement of clean water laws.
d. Exploring the feasibility of using a GIS system and the EPA Reach File to track the fate of sediment basinwide.

3.3 Technically sound habitat restoration measures which benefit depressed stock groups of concern (see Table 4.4) will receive priority consideration for funding.

3.4 The Klamath River Task Force will support the Trinity River Task Force in its efforts to restore adequate streamflow for fisheries resources in the Trinity subbasin.

3.5 The Task Force will work to gain the release of flows of adequate quality and quantity for fishery resources from Iron Gate Dam.

3.6 The Shasta River should be given high priority in the Restoration Program because of its significant potential to produce fall chinook salmon and steelhead. Adequate streamflow for fish are needed here, together with the restoration of riparian areas (see Ch. 2).

3.7 The Scott River and its tributaries are also a high priority for restoration because of their substantial salmon and steelhead production potential. Solutions to the major problems in the basin include:

a. Improving stream flows and restoring riparian zones (see Ch 2).
b. Using the recently completed sediment study to prioritize actions to control erosion of decomposed granite sands and identifying funds for their implementation.
c. Work with private timberland owners and others engaged in road construction and maintenance to insure that future activities do not continue to increase erosion (see Ch 2).

3.8 The Salmon River, a refuge area for spring chinook salmon and summer steelhead, has a greatly elevated erosion risk as a result of recent fires. Therefore, the following actions will be taken:

a. Assess erosion problems in the Salmon River Basin, paying particular attention to areas burned during the 1987 fires.
b. Implement measures to stabilize subbasins as soon as possible using the results of the erosion control study to prioritize actions.
b. Make certain that any continuing timber harvest activities by the USFS in the Salmon River Basin do not contribute further to current high erosion hazard.

3.9 The Task Force will work closely with the Yurok Tribe to improve anadromous fisheries resources on the Reservation and on ancestral territories. Actions on lower Klamath tributaries will include:

a. Seeking cooperative agreements with the major private landowners to evaluate slope stability and take appropriate measures to avoid soil loss and related negative impacts on salmon, steelhead and cutthroat trout.
b. Funding a study using aerial photographs, such as the RAPID method, to speed the evaluation of erosion factors.
c. Seeking further agreements to expand fisheries restoration efforts if erosion hazards are reduced or found to be at lower-than-believed levels.
d. Join with the Hoopa and Yurok Tribes in making Pine Creek a model watershed through implementing erosion control and other fisheries restoration measures and working to minimize impacts from future land use.

3-10 The Task Force will pursue the following actions with regard to the middle Klamath tributaries:

a. Encourage the USFS to expand cooperative efforts in mixed ownership drainages having decomposed granite soils, such as Beaver Creek and Cottonwood Creek, to control erosion and modify future timber harvests and road building to prevent erosion from continuing.
b. Study the feasibility and cost of removing the fish migration barriers at or near the mouth of middle Klamath tributaries such as Humbug Creek.

c. Find a solution to the problem of fish passage over the diversion structure on Horse Creek.
d. Seek cooperation from farmers and ranchers in securing adequate flows for fish in drainages such as Seiad and Cottonwood Creeks.

3.11 Fish screens should be installed wherever needed. Adequate funds for screen maintenance shall be provided. An evaluation of fish rescue efforts will be made to determine how many of the rescued fish survive.

3.12 Proposed projects to structurally increase fisheries habitat in any Klamath tributary will be evaluated as to whether:

a. The erosion potential in the watershed and the expected sediment yield would place the project at risk during moderate storm events (10 year interval or less).
b. The stream channel remains highly aggraded and, thus, likely to threaten the stability of the proposed structure.
c. The project is properly engineered in terms of its setting (gradient and channel type) and expected flows.
d. Habitat assessment has been conducted and the suspected limiting factors identified.
e. The proposed project has a clear goal of remedying the identified limiting factors.
f. The proposal includes methods to evaluate whether the goal of the project has been reached after project implementation (ideally, a demonstration of its positive cost-benefit performance).
g. The project budget includes cost estimates for maintenance.

3.13 The Task Force will undertake an affordable evaluation and monitoring program, one which employs accepted, standardized techniques, in order to acquire the information needed for adaptive management. Specifically, the Task Force will:

a. Fund, or find funding from such cooperators as the USFS, for completion of habitat typing and other quantitative habitat assessment of all basin streams having significant restoration potential.
b. Work with agencies such as the EPA, SWRCB, and USFS, which have water quality protection responsibilities, to monitor stream conditions of interest to the Restoration Program.

3.14 The Task Force will seek to mandate by law, minimum habitat standards.

CHAPTER 4

FISH POPULATION PROTECTION

ISSUES

* How do we identify the distinct salmonid stocks of the Klamath Basin and how do we protect their remaining genetic diversity?
* There is a need for the Klamath Fisheries Management Council to help protect the locally adapted stocks needed for population rebuilding while still providing for fisheries.
* Enforcement in the Klamath Basin is a huge problem: more wardens are needed, as well as stricter enforcement of possession limits.
* Is there a significant impact by high seas drift-netting on Klamath River salmon and steelhead?
* What is the impact of predators on salmon and steelhead populations?
* Should native stocks of steelhead be protected by catch-and-release regulations?
* We should judge the success of the Restoration Program on increases in native fish, not hatchery stocks.

INTRODUCTION

This section deals with the identification of anadromous fish stocks and trends in their run strength. Discussions concerning the protection of various stock groups from overharvesting, predation, and threats related to habitat destruction are also included.

> It may seem that the matter of depletion is overstressed in this report, since its progress has been evident for years. A condition of increasing depletion was not sufficiently evident on the Klamath, however to be convincing to those most interested. In fact, opinions to the contrary were commonly held, some asserting that the runs were gradually building up. There is very little exact information concerning....the Klamath River previous to 1912.
>
> J.O. Snyder

Thus wrote Dr. J.O. Snyder for the California Division of Fish and Game in 1931 about trends in run strength on the Klamath in the 1920's. The comments have a striking similarity to those of biologists around 1980. One need only substitute "1978" for 1912. The lack of exact information still holds true today for many of the river's fish stocks. Snyder was concerned that two- and three-year-old chinook salmon were dominating the ocean and river catch and that six-year-old fish had disappeared from the runs. It was not the first downturn in the river's fish populations (Hume in Snyder 1931).

Before Europeans settled in the Klamath Basin, the Yurok, Hoopa, and Karuk Indians had been sustained by the river's fishes for thousands of years. Weirs were constructed annually at various sites in the Hoopa Valley, at Red Cap Creek, and the largest at Cappell Creek below Weitchpec. Conservation of salmon populations was insured by use of harvest methods governed in accordance with a complex set of social and religious customs (Kroeber 1974). The behavior may have evolved from past experiences with food shortages after periods of overharvest (McEvoy 1986).

Mining was the first major impact of European culture on the Klamath watershed. The first wave of degradation changed the balance of the river's chinook stocks from predominantly spring chinook to fall chinook runs (Hume in Snyder 1931). The primary cause of the decline may have been the heavy sediment loads unleashed by hydraulic mining which filled the deep pools required by spring chinook for holding during summer (see effects of mining in Chapter 2). Sediment problems from mining were probably exacerbated by a large flood in 1861. Miners may have been heavily reliant on salmon as a food source. Snyder (1931) claimed that "large numbers of salmon were speared or otherwise captured as they neared their spawning beds, and if credence be given to the reports of old miners, there then appeared to be the first and perhaps major cause of early depletion." A splash dam was constructed across the Klamath at Klamathon in 1889 which blocked spring chinook passage into the upper Klamath basin until it was washed out by a flood in 1902 (Fortune et al. 1966). By 1892 spring chinook were thought to be almost extinct (Hume in Snyder 1931).

It is unlikely that the Indian harvest contributed substantially to the early decline of the spring run of chinook salmon. Spring chinook were not a high priority for subsistence harvest by Indians because the fish's high body fat made it unsuitable for drying and smoking. Because the river was often swollen and surging in the spring due to snow melt, spring chinook may have been difficult to harvest even with gill nets. The Yurok began to fish commercially at the mouth of the Klamath in 1876. Only Indians were allowed to fish and the first pack for the new canneries in the lower river was in 1881 (McEvoy 1986).

Gold mining in the Klamath Basin dwindled at the turn of the century due to decreased profits. As habitat began to recover, the fall chinook in the river started to rebound. The runs rebuilt to a peak in abundance around 1912, as indicated by the cannery pack (Snyder 1931). The Yurok began to modernize and increase their fishing efforts about 1915 and continued to do so until 1928 (McEvoy 1986).

Commercial gill net harvest in the Sacramento River was greatly reduced in the 1880's as a result of pressure from sport fishermen (McEvoy 1986). With the resurgence of salmon populations in both the Sacramento and the Klamath Rivers, the ocean troll fishery grew. Trolling efforts were fairly primitive, at first involving sailboats in the Monterey and San Francisco Bay areas. By 1915 boats with motors were in use, and both catch and effort were rising sharply (McEvoy 1986). Snyder and Schofield (1924) tagged salmon from the Klamath and noted that they were being caught as far south as Monterey. The combined efficiency of the new troll fishery, which by 1920 covered the entire coast, and the modern gill net fishery proved too much for the salmon. Snyder's observations were correct. Klamath stocks reached an extreme low in the early 1930's. The canneries on the river were ordered closed in 1933, and commercial fishing in the river was outlawed (Moffett and Smith 1950).

After Snyder's work, little information about Klamath River run sizes was collected. The California salmon troll fishery had declining catches through the 1930's reaching a record low in 1938 (McEvoy 1986). After World War II, the ocean salmon fishery rebounded strongly. Runs in the Klamath during the postwar period probably reflected this general trend. In 1955, alone, the sport catch on the river was estimated to be 95,000 chinook and 100,000 steelhead (Coots 1967).

Timber harvest activities were greatly increased after World War II. Disturbances associated with logging and the 1955 flood caused substantial damage to salmon and steelhead habitat. The flood and the poor ocean conditions (El Nino) in 1956-57 resulted in a downturn in salmon spawning escapement. The 1964 flood was a catastrophic event which caused major habitat losses throughout the Klamath River Basin. Entire watersheds turned into debris flows in some areas of the basin (MacCleery 1979). From 1964 to 1984, the river's anadromous fish declined further. The habitat loss above Trinity and Iron Gate dams, the reduced flows in the Trinity, lingering effects from the 1964 flood, further habitat degradation, continued fishing pressure, and natural cycles like El Nino and the 1976-77 drought drove the river's stocks to new lows.

From 1985 to 1988, salmon runs in the Klamath and Trinity Rivers rebounded, with particularly large returns to the Trinity River and Iron Gate hatcheries. Evidence suggests that many of the native stock groups of salmon, steelhead, and other anadromous fishes of the basin may not have experienced increases similar to the hatchery stocks of chinook and coho salmon. As in Snyder's day, opinions vary as to whether stocks in the river are building up or in further decline.

STOCK IDENTIFICATION

Ricker (1972) defined a stock as "the fish spawning in a particular lake or stream (or portion thereof) at a particular season, which ... to a substantial degree do not interbreed with any group spawning in a different place or in the same place at a different time." Through evolutionary time stocks adapt through natural selection to home streams and the wider environment experienced throughout their life history (Helle 1981). While some information has been gathered on chinook salmon (Oncorhynchus tshawytscha) and steelhead (Oncorhynchus mykiss) stocks since the Klamath River Basin Fisheries Resources Plan (CH2M Hill 1985), no attempt has been made to better understand the Basin's coho salmon (Oncorhynchus kisutch), coastal cutthroat trout (Oncorhynchus clarkii), green sturgeon (Acipenser medirostris), American shad (Alosa sapidissima), eulachon, or candlefish, (Thaleichthys pacificus), or Pacific lamprey (Lampetra tridentata) population groups.

Stock identification can be determined by using genetic information analyzed by a laboratory technique known as "gel electrophoresis" (Ryman and Utter 1986). Genetic changes are representative of the length of time that populations have evolved separately. The time it takes for genetic change or mutation seems to be fairly fixed at about 10,000 years for each easily detectable change (Wilson and Sarich 1966). Where stocks have been separated for a short period on an evolutionary time scale, different behaviors and physiological features necessary for survival, the animal's "phenotype," may change faster than its genetic structure, or "genotype." Electrophoresis is, therefore, actually a more appropriate tool for defining regional stocks which have been isolated from one another for longer periods, as opposed to finer stock-group distinction within basins (Eric Loudenslager personal communication).

No genetic basis for some traits, such as fall- and spring-run timing in chinook or steelhead stocks within the same basin, can be found (Riesenbichler and Phelps 1989). Varying physiological or behavioral characters may be better indicators of stocks within the Klamath Basin. Nicholas and Hankin (1988a) used the season-of-return to native stream, spawning date, age at maturity, ocean migration pattern, number and size of eggs, resistance to disease, and juvenile life history as characters with which to define stocks of chinook salmon of the Oregon coast.

Fishery managers tend to think of stocks in the broadest sense, such as "fall chinook" or "spring chinook." Using Ricker's definition, however, numerous stock groups tuned to the tributaries and geographic regions of the Klamath River seem to be present. The "stock concept" that recognizes that salmon and steelhead are divided into discrete subpopulations has wide acceptance in fisheries science (Berst and Simon 1981). Similar stock groups have been identified by Saunders (1981) for Atlantic salmon, including several stocks within one river system. Parkinson (1984) found distinct genetic strains of steelhead in all the British Columbia streams that he studied. His work suggests that the steelhead stocks that he studied had colonized a wide area as glaciers retreated in relatively recent geologic time. While the stocks he studied were very similar in overall genetic makeup, differences had evolved in local populations, even between adjacent streams.

Utter (1981) credited the evolution of genetic, morphological, and behavioral differences to reproductive isolation allowed by homing to natal streams. Recent work by Nicholas and Hankin (1988a) found distinct populations of chinook in every coastal drainage in Oregon, with some streams harboring several stocks.

Problems with the Current Concept of "Natural" Spawners

The current convention for both the Klamath River and Trinity River restoration programs is to call fish spawning outside the hatchery environment "natural" spawners. Tuss (USFWS 1988a) pointed out that surplus hatchery fish, straying up streams near the hatchery, or spawning in the main river below, contributed substantially to "natural" escapement. Recent investigations suggest that there can be substantial differences in growth and survival of offspring of native or locally adapted salmon and steelhead compared to those of hatchery fish spawned in the wild (Riesenbichler and McIntyre 1977, Altukhov and Salmenova 1986, Chilcote et al. 1986, Solazzi et al. 1983).

The use of the term "natural" to include both groups of fish obscures these differences and can mask whether the goal of preserving viable native populations is being met (USFWS 1988a). As an example, studies of chinook salmon spawning above

Junction City in the Trinity River indicated that 60 percent were first-generation Trinity River Hatchery fish in 1987 (Stempel 1988). This high degree of straying would overwhelm any genetic difference between hatchery stocks and other salmon present, yet these fish make up the majority of "natural" chinook salmon spawning in the Trinity River in this area. McIntyre et al. (1988) used a more restrictive definition of "natural fish" as those "produced by natural spawning, but with at least one parent of hatchery origin."

Many areas in the Klamath River Basin still have discrete groups of salmon and steelhead that are not of hatchery origin. These stocks may have been returning to the Klamath Basin for millions of years. In Oregon's Natural Production and Wild Fish Management Rules (Chilcote 1990), wild fish are defined as "any naturally spawning fish belonging to indigenous populations." Indigenous fish were those descended from ancestral populations which had spawned in the same geographic area prior to 1800, which excludes fish populations established by man. The term "native" will be used here when referring to the self-replicating populations that return to various tributaries and at various times that do not coincide with the range or timing of hatchery stocks. If this use of native were adopted, "natural" spawners might be those fish with run timing and distribution similar to hatchery fish.

Various salmon and steelhead stocks from outside the Klamath Basin have been imported and planted in basin tributaries. Fish from the large hatcheries within the basin have also been transplanted widely. Stock transfers of salmon and steelhead, or straying, do not necessarily change the genetic structure of locally adapted populations, however. If the introduced fish do not have critically important survival adaptations to the local environment, none of their offspring will survive, thereby preventing "gene flow" from occurring (Riggs 1990). Further, a few strays per generation will not cause appreciable genetic change, although large numbers of strays can change a local population. Genetic purity of stocks may not ultimately be the issue, however. If stocks remain self-perpetuating in various streams of the basin, they are adapted to local stream conditions. The may prove to be essential building blocks for restoring runs either through artificial culture or for recolonization after habitat restoration.

The current fall chinook population in Bluff Creek was established from Iron Gate Hatchery fish. Similar populations have been established in all tributaries from pond rearing programs (see Chapter 5). Whether these transplanted fish will be self-sustaining without continuing pond rearing programs is unknown.

Use Of Stock Groups For Recognition and Protection of Populations

McIntyre (1983) suggested the use of "management units" for salmon management that might represent from one to several stocks. He offered this option for stock groups in deference to the fact that management of all creeks on an individual basis, although ideal from a stock conservation and genetic preservation perspective, was not possible due to costs and logistics. Some fall chinook salmon stocks have been accepted de facto in management, such as those fish returning to the Shasta, Scott, and Salmon rivers and the South Fork of the Trinity. These populations have been monitored with weirs.

Detailed identification of stock diversity of anadromous fish in the Klamath Basin has yet to be attempted. What is offered below is a conservative approach using "stock groups" parallel to the concept of management units used by McIntyre (1983). These stock groups also meet Ricker's definition of run timing and destination and, where electrophoretic information and those characters used by Nicholas and Hankin (1988a) are available, they are used, as well. A complete listing is found in Table 4-1. The boundaries may seem arbitrary when one splits stock designation for fall chinook in small streams immediately upstream and downstream from Weitchpec, for example. If one considers geographic centers of these group boundaries, such as Blue Creek and Clear Creek, the differences can be more demonstrable. Snyder (1931) noted differences in run timing and body shape between these two stock groups calling the former "Blue Creekers" and the latter "hookbills."

The stock groups should be thought of as locally adapted subpopulations that may have evolved appropriate characteristics to survive in different regions of the Klamath Basin. Factors such as climate and geology vary widely over the basin, giving rise to varied fish habitat conditions. Adaptations to regional stream flows, water temperatures, stream gradients, as well as to the disease organisms present, may be captured in the genetic information that different runs possess. The stock groups proposed here cover wide areas. It is possible that considerable diversity, worthy of preserving, may be found on a smaller geographic scale between streams within these areas. A similar recognition of stocks is emerging from the Columbia River Basin Salmon and Steelhead Production Plan (Riggs 1990): "Because natural populations of salmon and steelhead have evolved somewhat independently in response to environmental conditions in different parts of a varied ecosystem like the Columbia River Basin, each population may represent an efficient production unit for its historic location and a potentially valuable resource for other similar locations." In implementing gene conservation for the Columbia Basin program, Riggs suggests that "stock assessment is fundamental to the process, but must not become an obstacle to the use of best available information" for planning and program implementation.

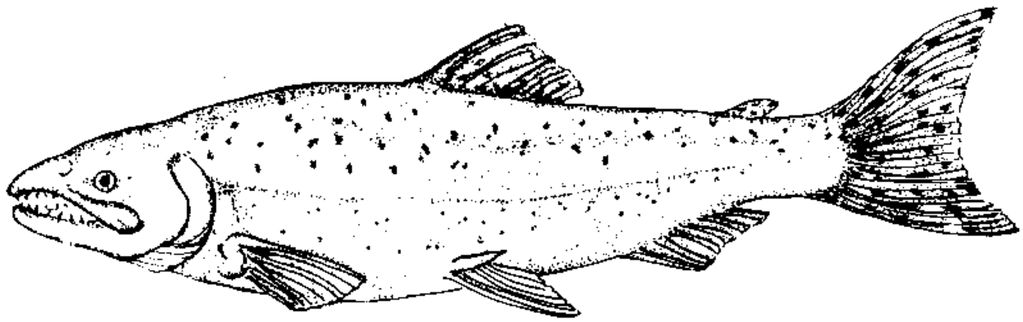
FALL CHINOOK

The evidence suggests that fall chinook stock groups in the Klamath River include those fish returning to: 1) Iron Gate Hatchery, 2) Bogus Creek, 3) the Shasta River, 4) the Scott River, 5) the Salmon River, in addition to the distinctly late runs to 6) the middle Klamath tributaries below Iron Gate Dam, and 7) the lower Klamath River tributaries below Weitchpec.

Electrophoretic Studies

Milner et al. (USFWS unpublished report), as by the National Council on Gene Resources (1982), found that genetic differences between Trinity and Klamath chinook were greater than the differences between four Sacramento River stocks tested. The differences between Klamath and Trinity River chinook reflect the fact that these populations have evolved separately for some time. The similarity of Sacramento tributary stocks may be the result of the continuing stock transfers between subbasins there.

Recent electrophoretic analysis of ocean troll catches have defined differences between the Klamath stock complex of fall chinook, those of other California coastal systems, Central Valley stocks, and those of southern Oregon (Gall et al. 1989).



Chinook salmon (Oncorhynchus tshawytscha)

More detailed work was conducted within the basin by Gall et al. (1989) as background. Samples were taken from Camp Creek, Bogus Creek, Horse Linto Creek, the Iron Gate Hatchery, the South Fork of the Trinity River, the Trinity River Hatchery, and rearing ponds holding "late run" fall chinook from the lower Klamath. The purpose of the study was not to determine the genetic relationships of chinook stocks within the Klamath Basin, but rather to distinguish basin stocks from others in the mixed-stock ocean harvest. All samples, however, showed some genetic differences from one another. Those closest geographically showed the greatest genetic similarity, although the differences were not statistically significant (Devon Bartley personal communication).

Life History Studies

Sullivan (unpublished) collected scales from adult fall chinook salmon captured at weirs on the South Fork of the Trinity River, Salmon River, Scott River, Shasta River, and Bogus Creek. The patterns of the innermost areas of the scales were analyzed to determine the early life history of each fish. He found that three life histories exist for fall chinook:

1. Type I, in which outmigration begins immediately and juveniles entered the ocean in the spring.
2. Type II, which spends the spring and summer in the river or estuary and enters the ocean in the fall.
3. Type III, which occurs only rarely, in which chinook juveniles spend an entire year in freshwater, entering the ocean as yearlings in spring.

Sullivan concluded that "major differences of relative frequencies of life history types were apparent between different tributaries studied." He found high frequencies of Type II life histories in the Scott and Salmon drainages. The South Fork of the Trinity and Shasta River fall chinook showed a higher incidence of Type I patterns. These differences may reflect a difference in genetic structure, but they may also be behavioral responses to environmental conditions. Do more Type I fish in the Shasta and South Fork Trinity simply reflect the fact that most juvenile chinook that remain in these streams fail to survive? Are Type II and Type III fish still present in these two stock groups and will they be reexpressed if habitat conditions improve? Life history patterns are used as partial criteria for stock group identification here, but further study is needed.

Most adults returning to spawn in upper Klamath tributaries and at Iron Gate Hatchery enter the river early (USFWS 1982, Hubbell et al. 1979). Migration peaks in the last week of August or toward the beginning of the first week in September. The time of entry into the Klamath for the various stock groups and the time of entry into their home streams follow characteristic patterns which may vary somewhat with river conditions. Rates of upstream migration may be effected by water temperatures, for instance, in the main stem of the Klamath. The following describe the fall chinook population groups.

Iron Gate

The hatchery stock may represent upper basin stocks that once returned to the Upper Klamath and its tributaries above Iron Gate Dam (Fortune et al. 1966). These fish arrive at the hatchery beginning in the third week in September, peak in abundance toward mid-October and have all arrived by the second week in November. Their average fecundity is about 3,100 eggs per female.

Bogus Creek

While straying has increased from Iron Gate Hatchery into Bogus Creek in recent years (Randy Baxter personal communication), Gall et al. (1989) still found genetic difference between Bogus stocks and those of the Iron Gate Hatchery. Mills et al. (unpublished) has found that the outmigration of juveniles begins in mid-February and continues through early June. Sullivan (unpublished) found that three-year-old Bogus Creek chinook returned to spawn at a smaller size than three-year-old Shasta, Scott, or Salmon River fish.

Shasta River

Department of Fish and Game operations at the Shasta Racks show that fall chinook enter the Shasta River from mid-September to mid-October. Snyder (1931) reported that spawning activity on the Shasta peaked in mid-October. CDFG reports from the operation of the racks suggest little straying from Iron Gate Hatchery, indicating a strong likelihood of the continuing genetic integrity of this stock group. Mills et al. (unpublished) found only early outmigration of juvenile chinook, beginning in early January and complete by the end of April.

Scott River

Weir operation by CDFG (Hubbell, et al. 1985) on the Scott indicated a peak in spawning run near the end of October. Again, incidences of straying are low, indicating little intermixing with Iron Gate Hatchery stocks. Sullivan (unpublished) found predominantly Type II life histories in the fall chinook returning to the Scott.

Salmon River

This major Klamath tributary has adult fall chinook returning as soon as early September. Large adults have also been seen spawning as late as January (J. West personal communication), which may represent a second fall chinook run in this system. Early life histories of Salmon River fall chinook were also predominantly Type II (Sullivan unpublished).

Middle Klamath Tributaries

Snyder (1931) described a late run of fall chinook for the area above the Trinity River's confluence with the Klamath, calling them "hookbills." He said that spawning took place between November and January. Leidy and Leidy (1984) also described a run of fall chinook in this region with this late timing. Current efforts by the Karuk Tribe to trap late fall chinook for breeding are directed at this stock group.

Lower Klamath Tributaries

Snyder (1931) noted that larger fish showed up at the mouth of the Klamath beginning in October and entered the lower river tributaries to spawn. Recent observations have noted spawning as late as January by this stock group (USFWS 1990c). The Indian fishermen called these fish "Blue Creekers." Snyder (1931) found them to be very similar to Smith River fish in body size, shape, and coloration. Gall et al. (1989) found these fish to be more similar genetically to Smith River or southern Oregon stocks than to other Klamath groups. USFWS (1990b) found that juvenile chinook outmigration extended from April at least through July (sampling ended in July) with peaks in mid-April and mid-June. Some yearling (Type III) chinook juveniles have been found in the lower Klamath tributaries (USFWS 1990a). Yurok Tribe enhancement projects are attempting to increase runs of these "Blue Creekers."

SPRING CHINOOK

The runs of spring salmon in the Klamath Basin were very important historically, outnumbering fall chinook stocks substantially (Hume in Snyder 1931). Snyder (1931) described a spring run that began in late March and continued through mid-June, followed by a summer run. Some spring chinook have returned as early as February, even in recent years (USFWS 1990d). Moffett and Smith (1950) described two distinct peaks at Lewiston, on the Trinity River, in spring chinook migrations prior to dam and hatchery construction. One run was most abundant in June, while the second peaked in August. Today's runs are supported in large part by the Trinity River Hatchery, which was founded on these ancestral stocks. These stocks return to the mouth of the Klamath River beginning in April and continue entering the river into July.

TABLE 4-1 Tentative stock groups of Anadromous Fishes on the Klamath River Basin.

FALL CHINOOK

- Upper Klamath (Iron Gate Hatchery)
- Bogus Creek
- Shasta River
- Scott River
- Salmon River
- Middle Klamath tributaries (from Weitchpec to Iron Gate Dam) *
- Lower Klamath tributaries (below Weitchpec) *
- Trinity River Hatchery/Upper Trinity (above Junction City)
- South Fork Trinity
- North Fork Trinity
- Middle Trinity tributaries (from South Fork to Junction City)
- Lower Trinity tributaries (South Fork to Weitchpec)

SPRING CHINOOK

- Upper Trinity/Trinity River Hatchery
- South Fork Trinity
- North Fork Trinity
- New River
- Salmon River
- Wooley Creek
- Elk Creek
- Clear Creek
- Dillon Creek

COHO

- Iron Gate Hatchery
- Trinity River Hatchery
- Lower Klamath tributaries
- Scott River
- Shasta River (?)
- Salmon River
- Middle Klamath tributaries
- Lower Trinity tributaries (?)

SUMMER STEELHEAD

- New River
- South Fork Trinity River
- North Fork Trinity River
- Canyon Creek
- Bluff Creek

TABLE 4-1 (Continued)

Salmon River
Wooley Creek
Elk Creek
Dillon Creek
Red Cap Creek
Clear Creek
Indian Creek

FALL/WINTER STEELHEAD (from Leidy and Leidy 1984, in part)

Upper Klamath (Iron Gate Hatchery)
Upper Trinity (Trinity River Hatchery)
Shasta River
Scott River
Salmon River
Middle Klamath tributaries
Lower Klamath tributaries
Lower Trinity tributaries (Weitchpec to North Fork)
Upper Trinity tributaries (North Fork to Lewiston Dam)
New River
North Fork Trinity River
South Fork Trinity River

CUTTHROAT TROUT: Lower Klamath tributaries

GREEN STURGEON: Unknown

PACIFIC LAMPREY: Unknown

EULACHON: Unknown

AMERICAN SHAD: East Coast in origin

* The stock boundaries used here are the same as used to define the basin areas in this Plan except for the Lower and Middle Klamath tributary fall chinook stocks, due to the information from Snyder (1931) and Gall et al. (1989).

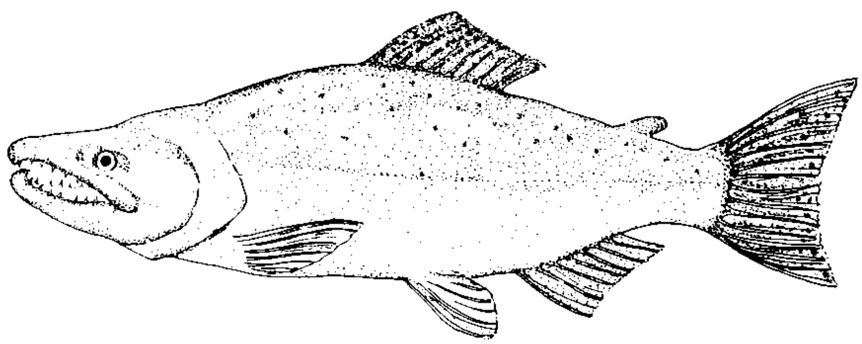
A few dozen spring chinook were still returning to the upper Klamath at the time that Iron Gate Hatchery was begun, 25 years ago (Curt Hiser personal communication). Fortune et al. (1966) described upper Klamath spring chinook stocks as having special abilities to migrate and home through Klamath Lake. From 1962 to 1968 the return of this distinct run of fish went unrecognized. Efforts to maintain these runs were begun in 1968, but were not successful and this stock group was lost (CH2M Hill 1985).

The Salmon River and its Wooley Creek tributary support what may be the last viable native spring chinook salmon population in the Klamath Basin. Streams that support summer steelhead in the mid-Klamath, such as Indian Creek, Elk Creek, and Clear Creek, have small, highly variable populations of spring chinook salmon.

Trinity River tributaries such as the North Fork, New River, the South Fork, and Canyon Creek also have runs of spring chinook. Canyon Creek is not included in the stock groups listed in Table 4-1 because it is suspected that its run is made up largely of hatchery strays. Salmon River stocks seem to enter this major tributary from mid-April to early June, but run timing may vary with river temperature and flows.

COHO SALMON

Snyder (1931) reported significant coho salmon runs, particularly in the lower Klamath Basin tributaries. He noted a migration of coho to the Klamathon Racks on the upper Klamath in the 1920's, although they were never used for broodstock at the Fall Creek Hatchery. More recently, Harry (1966) described coho salmon populations in the Shasta, Scott, and Salmon Rivers and some coho have been counted at weirs in these systems in recent years (CDFG unpublished). Coho once returned to the Stuart's Fork of the upper Trinity River (USFWS 1979) and native coho were trapped at a weir to establish a broodstock just prior to the completion of the Trinity River Hatchery (Bedell 1968). Moffett and Smith (1950) noted that coho spawned in smaller tributaries below the South Fork on the Trinity River.



Coho salmon (Oncorhynchus kisutch)

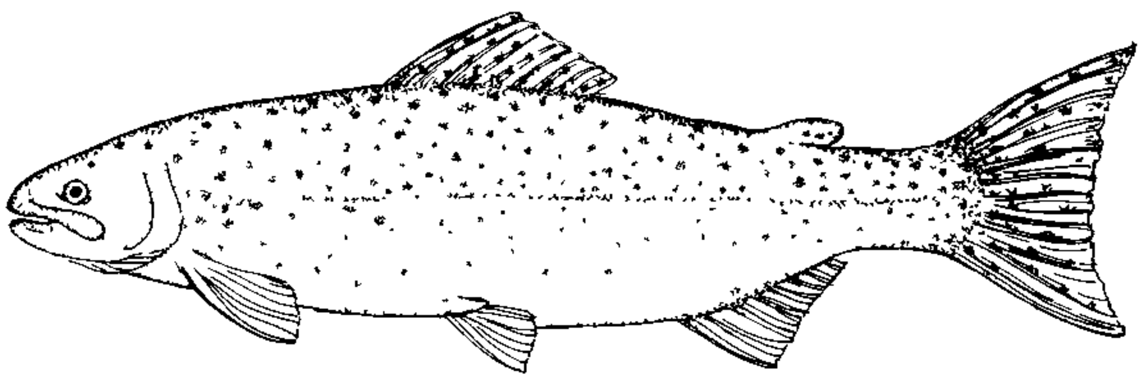
Hoopa Fisheries Department surveys (1988) note the incidence of adult and juvenile coho salmon in the Trinity River, but whether viable reproducing coho salmon populations still exist on the Reservation remains questionable. The question of whether native coho stocks remain in this area is somewhat clouded because of releases of Trinity River Hatchery coho in 1981-82 (Mike Orcutt personal communication). Native coho are still present in the Klamath tributaries below Weitchpec. Unpublished CDFG field reports note the presence of coho in Hunter Creek and Terwer Creek. Small numbers of coho juveniles are found in downstream migrant traps operated by USFWS (1990a) in creeks in this area. Native coho migration and spawning is later than hatchery populations, with adults captured in the lower river in November and December

(R. Pierce personal communication). In some years coho at the trapping station in Camp Creek outnumber the returning chinook salmon (Leaf Hillman personal communication).

The hatchery runs of coho for both Iron Gate and Trinity River hatcheries were created from broodstock from the Cascade Hatchery in the Columbia River Basin. This stock returns to the lower river in September and October, with the peak generally occurring in the second week of October (Hubbell 1979). Coho yearlings from Iron Gate Hatchery were transplanted to Indian Creek, Beaver Creek, and Elk Creek between 1985 and 1989 and have resulted in at least some spawning activity in Indian Creek (Dennis Maria personal communication).

STEELHEAD

Although steelhead are very important to the economy of the Klamath Basin, little is known about their stock groups. Distinguishing between steelhead stock groups by time of return to the river becomes very problematic (Roelofs 1983). Everest (1973) found that steelhead entering in early fall spawned with earlier returning summer steelhead in the Rogue River. Similarly, fall fish may sometimes wait until after the rains to move into their tributaries and spawning could overlap with early winter steelhead. "Half pounders," small, sexually immature steelhead that have spent less than one year



Steelhead (Oncorhynchus mykiss)

in the ocean, may be the offspring of fall, summer or winter steelhead stocks (Everest 1973). Half pounders run only in the Klamath, Rogue, Eel, and Mad Rivers (Barnhardt 1986). Ceratomyxa shasta, a deadly protozoan fish disease is present in the upper Klamath. Buchanan (in press) has found native trout in the Klamath above Iron Gate Dam to be resistant to this disease. Steelhead in the Middle and Upper Klamath would also be exposed to high levels of C. shasta and have evolved a resistance.

The only attempts to identify stocks of steelhead in the Klamath Basin using electrophoresis were conducted on the South Fork of the Trinity River. The study compared South Fork stock groups with those of the upper mainstem of the Trinity and found significant difference between stocks in the two streams (Baker 1988). Lesser differences were noted among steelhead juveniles in South Fork tributaries, but Baker pointed out that the diversity might be indicative of important local adaptations to environmental conditions.

Both Iron Gate and Trinity River hatcheries release steelhead that return in fall and winter. Trinity River Hatchery steelhead broodstock included stock imported from the Eel River, three Oregon hatcheries, and Washington hatchery Skamania steelhead (CH2M Hill 1985). Iron Gate Hatchery steelhead stocks were founded from native fish but some steelhead eggs from Trinity River Hatchery and the Cowlitz River Hatchery in Washington were imported (CH2M Hill 1985). Recently, large numbers of Iron Gate Hatchery steelhead have been transferred to Trinity River Hatchery (Bedell 1984, 1985). Studies by Satterthwaite (1988) indicated that half-pounders from both hatcheries were present in the Rogue River. This indicates that a native component remains in both hatchery broodstocks as pure non-native stocks would probably not exhibit the half-pounder life history.

Information about summer steelhead stock distributions is based on direct observations (Roelofs 1983, Gerstung 1989). Fall steelhead are joined with winter steelhead in this plan because of insufficient knowledge about discretely different migration patterns, times of spawning, or other characters that might help define separate stock groups. Information on fall steelhead migrations are based on weir counts. The designation of fall/winter steelhead stocks follows, for the most part, Leidy and Leidy (1984). First hand reports of adults in streams such as the Shasta and South Fork of the Trinity River, and the presence of juvenile steelhead in downstream migrant traps in the lower Klamath tributaries (USFWS 1990) were also used for these designations. Further research is needed, however, to better understand stock diversity and the life histories of the basin's steelhead. Revision of the groups listed below may be needed as further research is completed.

Fall/Winter Run

Weir records note migrations of steelhead during fall in the Salmon River, the Scott River, the upper Klamath, the upper Trinity, the South Fork of the Trinity, and the North Fork of the Trinity River. Larger tributaries that provide clear access for returning steelhead during fall flows include Elk Creek, Clear Creek, Indian Creek, and Independence Creek (J. West personal communication). USFWS (1990b) has noted steelhead returning to Blue Creek in October.

There is little information about the steelhead that enter Klamath Basin tributaries for spawning during high winter flows. They return when the river is swollen by winter rains and they spawn in remote tributaries that are often inaccessible to surveyors. Leidy and Leidy (1984) described winter runs similar to some of the stock groups suggested in this plan. Winter steelhead probably have the widest distribution of any salmonids in the basin because their time of return allows them free passage into many smaller streams.

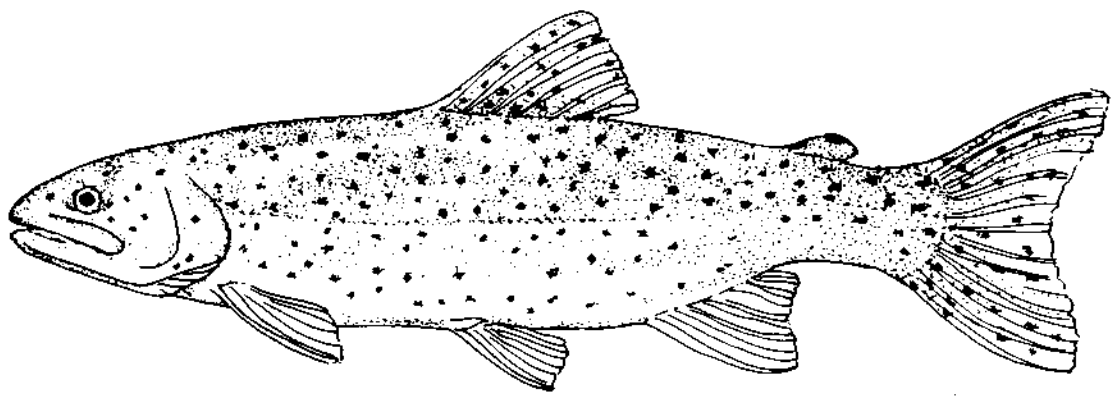
Summer Run

Summer steelhead return to the following tributaries in the Klamath Basin: the Salmon River, Wooly Creek, Redcap Creek, Elk Creek, Bluff Creek, Dillon Creek, Indian

Creek, Clear Creek, South Fork Trinity, North Fork Trinity, New River, and Canyon Creek (Roelofs 1983). A few summer steelhead have been seen in Blue Creek, the Scott River, Camp Creek, Grider Creek, and Ukonom Creek.

COASTAL CUTTHROAT TROUT

The lower Klamath tributaries harbor populations of cutthroat trout. This species is found only north of California's Eel River, but is commonly found in coastal streams from Oregon to British Columbia. Cutthroat trout of the Klamath are poorly studied, but they have been collected in seine samples taken in the estuary, downstream migrant traps on lower tributaries, and during electroshocking in Hunter Creek. Data on genetic diversity, life history or physiological features that would assist stock structure identification appears altogether lacking.

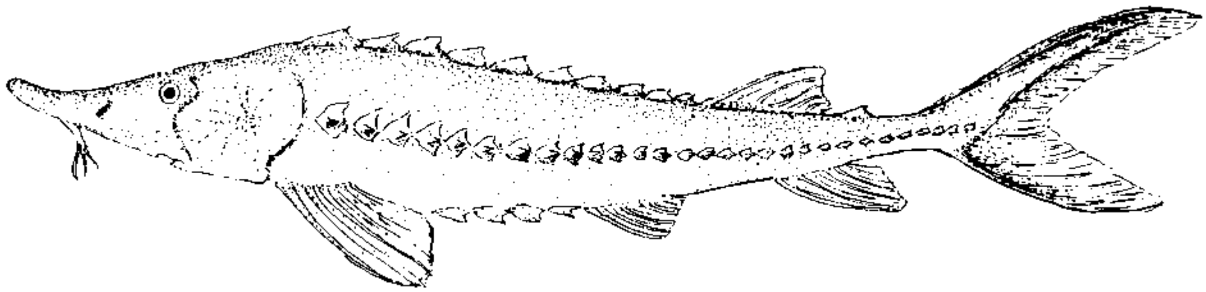


Coastal Cutthroat trout (Oncorhynchus clarkii)

Trotter (1987) described the life history of the coastal cutthroat species. He suggests that cutthroat in the southern areas of their range, like the Klamath, would enter the river from November through March. Adult size ranges from 11 to 18 inches. Juveniles may spend one to two years in streams or estuaries. Many cutthroat return to the river after just four months in the ocean and may, or may not, be sexually mature. If they survive their spawning journey, cutthroat will return to spawn again after several months in the ocean.

GREEN STURGEON

While the Klamath may contain the largest reproducing population of green sturgeon on the west coast (USFWS 1983), little is known about their genetics or population structure. Male green sturgeon reach sexual maturity at about 15 years of age and females at about age 20. These fish can spawn repeatedly after returning to the ocean for 2 to 8 years. Males may have a shorter interval between spawning. One specimen 60 years old was found in the Klamath. Juveniles usually leave the river before they are two years old and remain near the mouth of the Klamath for 6 to 8 years. Tag returns from the ocean show migrations of several hundred miles.

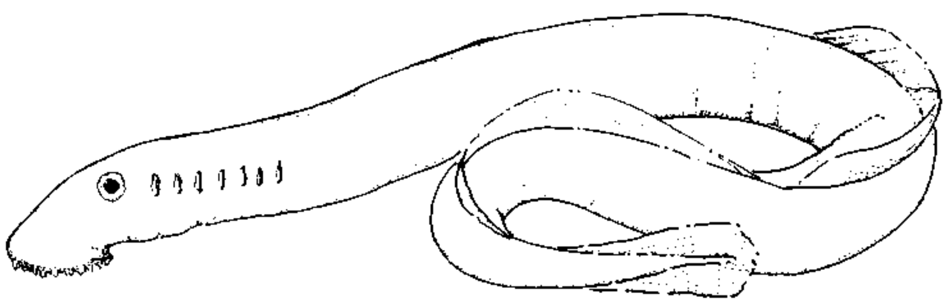


Green Sturgeon (Acipenser medirostris)

Adult sturgeon return to the river between March and June to spawn in the Trinity River, below Greys Falls, in the Klamath, mostly below Ishi Pishi Falls, and in the Salmon River. Green sturgeon have been seen all the way up the river to Iron Gate Dam (J. West personal communication). Prior to 1964, there were reports of green sturgeon in the South Fork of the Trinity River, but they are unknown in the river today. Whether fish using different areas of the river represent subpopulations or stocks or simply choose various spawning sites opportunistically is unknown (CH2M Hill (1985), Pat Foley, personal communication).

PACIFIC LAMPREY

The Pacific lamprey of the Klamath basin enter the river from March through June, spending some time in migration, hiding under stones and logs until mature (Moyle 1976). No correlations between time of entry and spawning destination have been observed. Most spawning takes place in spring and early summer, but Moffett and Smith



Pacific lamprey (Lampetra tridentata)

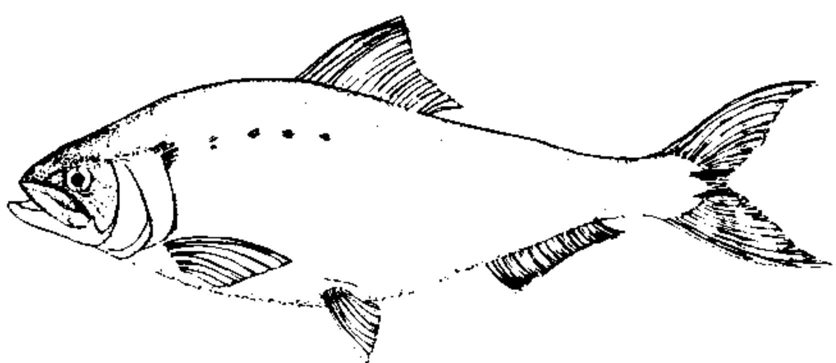
(1950) observed migrations as late as August and September in the upper Trinity. By alternately swimming and using their sucking disc to maintain position, lampreys can move upstream over waterfalls (Kimsey and Fisk 1964). Lampreys attach to stones and thrash their tales to dig nests. Females lay between 20,000 and 200,000 eggs depending on their size. Lampreys die after spawning.

Young lamprey are known as "ammocoetes" and they spend four to seven years in streams. In this immature phase, they are not predacious. Adults spend from 6 to 18 months in the ocean where they attach themselves to a wide variety of large fishes. Populations of Pacific lamprey trapped above Lewiston and Trinity dams have formed landlocked populations that predate heavily on the Kokanee salmon and other resident fish of Lewiston and Trinity Lakes. Dwarfed landlocked forms are also known in the Klamath River above Iron Gate Dam and in Upper Klamath Lake (Hubbs 1971). The stunted adults from Iron Gate Reservoir attach to adult salmon and steelhead being held for spawning at the hatchery. The lamprey has always been an important food source for Indians of the Klamath Basin, who used baskets to trap these fish during their migrations (Kroeber and Barrett 1960).

AMERICAN SHAD

American shad are members of the herring family and were imported from the Atlantic coast between 1871 and 1881, and planted in the Sacramento River. Other major plants were made in the Columbia River. American shad subsequently spread to the Klamath River and the rest of the Pacific coast between San Pedro, California and southeastern Alaska.

Adult American shad may grow up to 25 inches in length and weigh as much as five pounds. Females are larger than males, returning to the river after four years in the ocean. Males return after three. Spawning runs usually peak in May and June. It is inferred from their rapid increase in range after introduction to the west coast, that American shad migrate long distances up and down the coast. It is not know if these fish exhibit any degree of homing to streams where they were spawned.



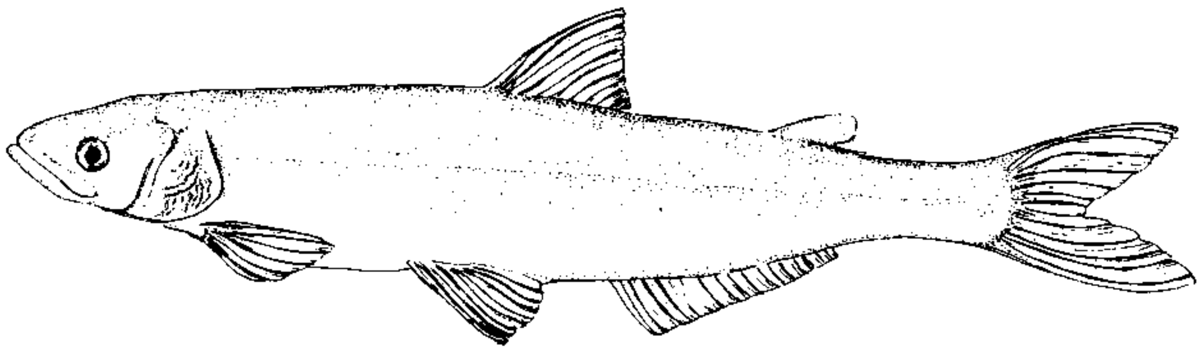
American shad (Alosa sapidissima)

American shad spawn in mass in the main channel of the river, usually at night. Each female can lay 30,000 to 300,000 eggs, depending on her size. Most adults die after spawning, but a few may survive and return to the ocean. Mortality is correlated to warm water temperatures at the time of spawning. Shad eggs are only slightly denser than water, so they remain partially suspended, gradually drifting downstream. Hatching takes 3 to 6 days, with juveniles gradually moving downstream and out to sea. Juveniles may spend several months in the delta of the Sacramento system, but the length of time juvenile American shad remain in the Klamath estuary is unknown.

The information above on American Shad was taken from Moyle (1976).

EULACHON

The eulachon, or candlefish, are compressed, elongate smelt that can grow to 12 inches in length. Adult fish more than eight inches long are, however, uncommon. Spawning occurs in March and April in the lowest 5 to 7 miles of the Klamath River. Females broadcast spawn about 25,000 eggs each in areas of pea-sized gravel or sand. Most fish die after spawning. The eggs adhere to the bottom until they hatch two to three weeks later. The small (4 to 5 mm) transparent larvae are quickly swept to the sea after hatching.



Eulachon (Thaleichthys pacificus)

Eulachon larvae are dispersed by the ocean currents. Some eulachon inhabit deep waters offshore and feed on copepods and crustaceans. After three years in the ocean, eulachon return to the river to spawn.

Again, the information presented on this species was taken largely from Moyle (1976).

POPULATION TRENDS OF ANADROMOUS FISHES

A substantial amount of information has been gathered during the last decade concerning the run strengths of fall chinook salmon in the Klamath River Basin. Some data has been collected on the returns of spring chinook salmon and for fall and summer steelhead. There is little information, however, upon which to judge trends in the populations of native coho salmon, fall/winter stocks of steelhead, and green sturgeon. Cutthroat trout, American shad, eulachon, and lamprey are totally unstudied as to their run strengths.

Fall Chinook

Fall chinook run strengths have been well studied since 1978 in the Klamath Basin (See addendum at the end of this chapter, provided by the California Department of Fish and Game, 1990). The escapement of adult fall chinook to the Klamath River drainage showed a sharp increase in 1986 and returns remained high in 1987 and 1988 (Figure 4-1). Graphs of population trends in this report follow the convention of the Klamath River Management Council (KFMC) and Pacific Fisheries Management Council (PFMC), which omits grilse salmon from spawning escapement estimates. Returns in 1989 dropped off and estimates for 1990 indicate extreme lows in both catch and escapement. Trends in self-reproducing wild populations have been obscured by the lack of separation of these fish from hatchery strays (USFWS 1988a), but data suggests that much of the resurgence in the fall chinook salmon population is owing to increased hatchery returns.

Many fall chinook salmon stray from the Iron Gate Hatchery on the upper Klamath River into Bogus Creek, which is immediately adjacent (Randy Baxter personal communication). Despite this straying, Bogus Creek returns have made up a strong component of what has been considered "natural" escapement in the Klamath Basin (Figure 4-2). Shasta River returns (Figure 4-3) show no increase since fishing pressure in the ocean was reduced in 1985. Escapement levels on the Shasta remain just a third of Basin population levels of the 1970's (USFWS 1979). The Scott River has failed to show improved returns since the reductions in harvest (Figure 4-4). The Salmon River is one of the only monitored populations not influenced by hatchery returns to show an upward trend (Figure 4-5). This increase suggests that harvest reductions are allowing some recovery where habitat is not limiting (USFWS 1988a).

On the Trinity River, fall chinook runs are becoming increasingly hatchery dominated. The ratio of hatchery to wild fall chinook on the Trinity was estimated in 1987 to be nearly 90-to-10 (USFWS 1988a). While returns have been high in the main stem of the Trinity below the hatchery, Stempel (1988) estimated that greater than 60 percent of the fish spawning in this area were first-generation hatchery fish. Levels of escapement on the South Fork, the native wild population monitored by a weir on the Trinity, have

Fig. 4-1. Fall chinook spawners

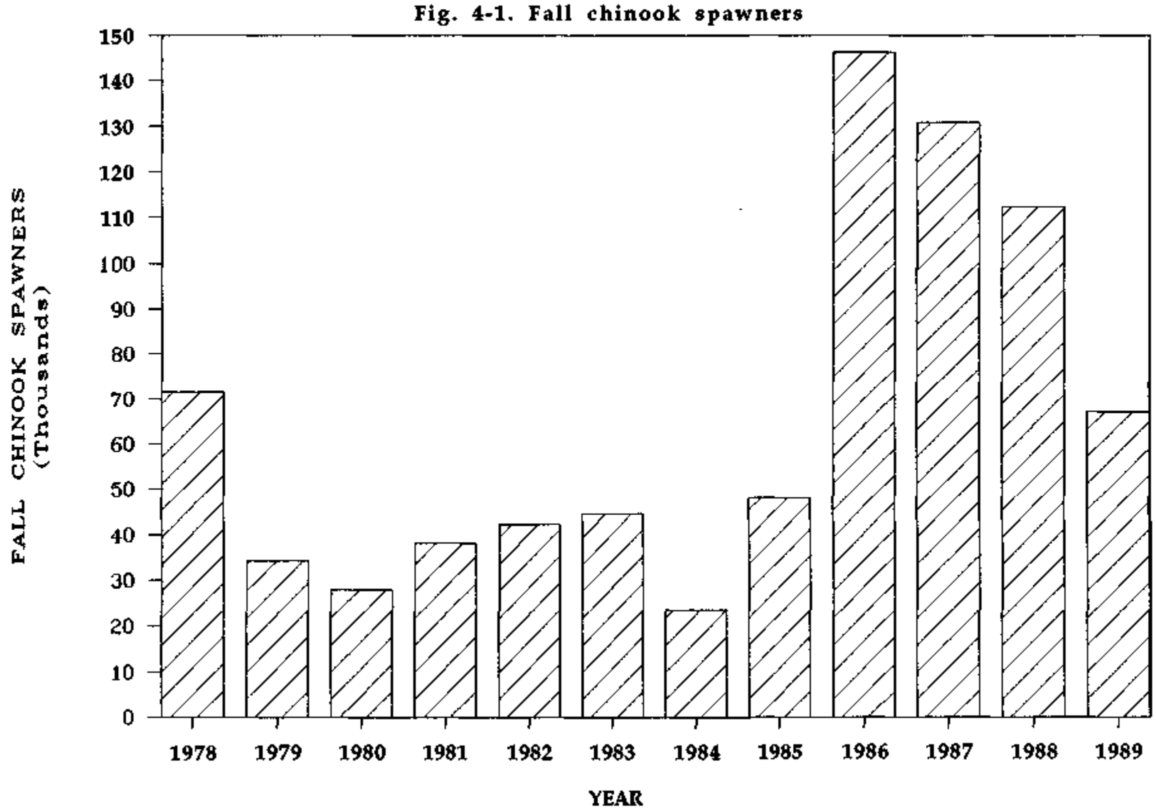


Fig. 4-2 Bogus Creek

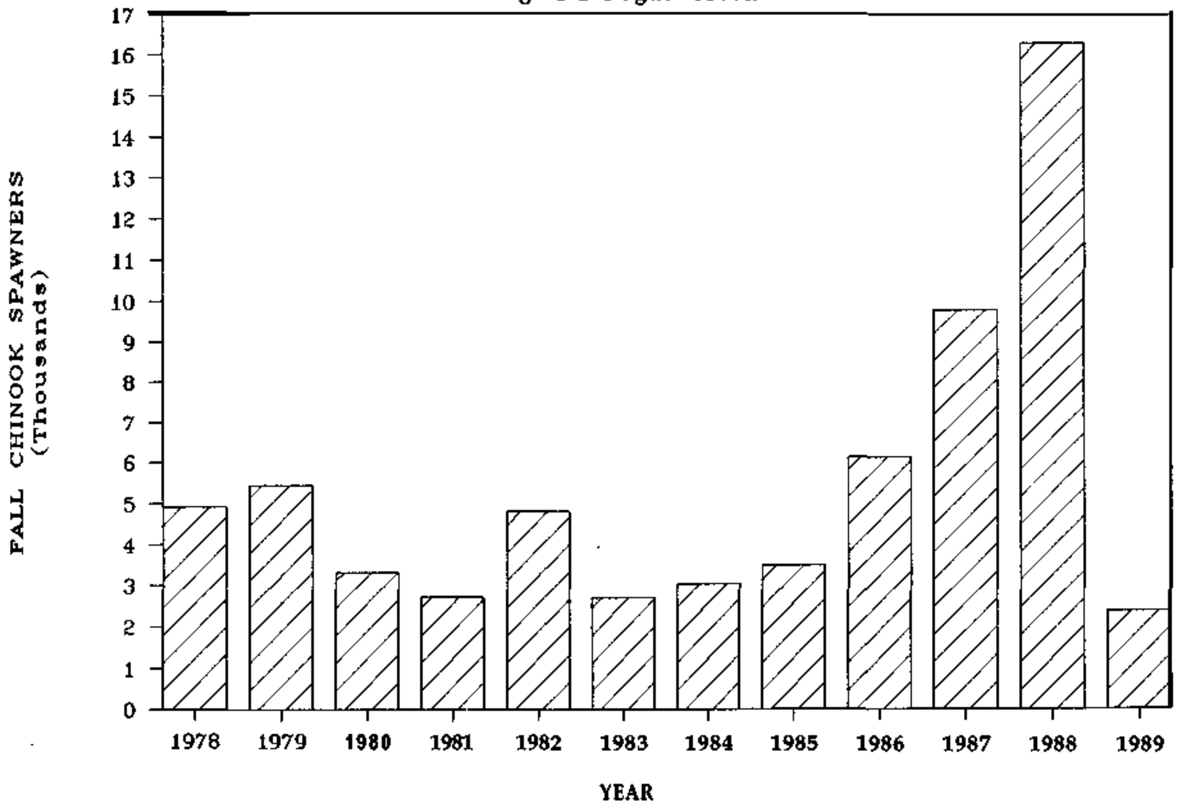


Fig. 4-3 Shasta River

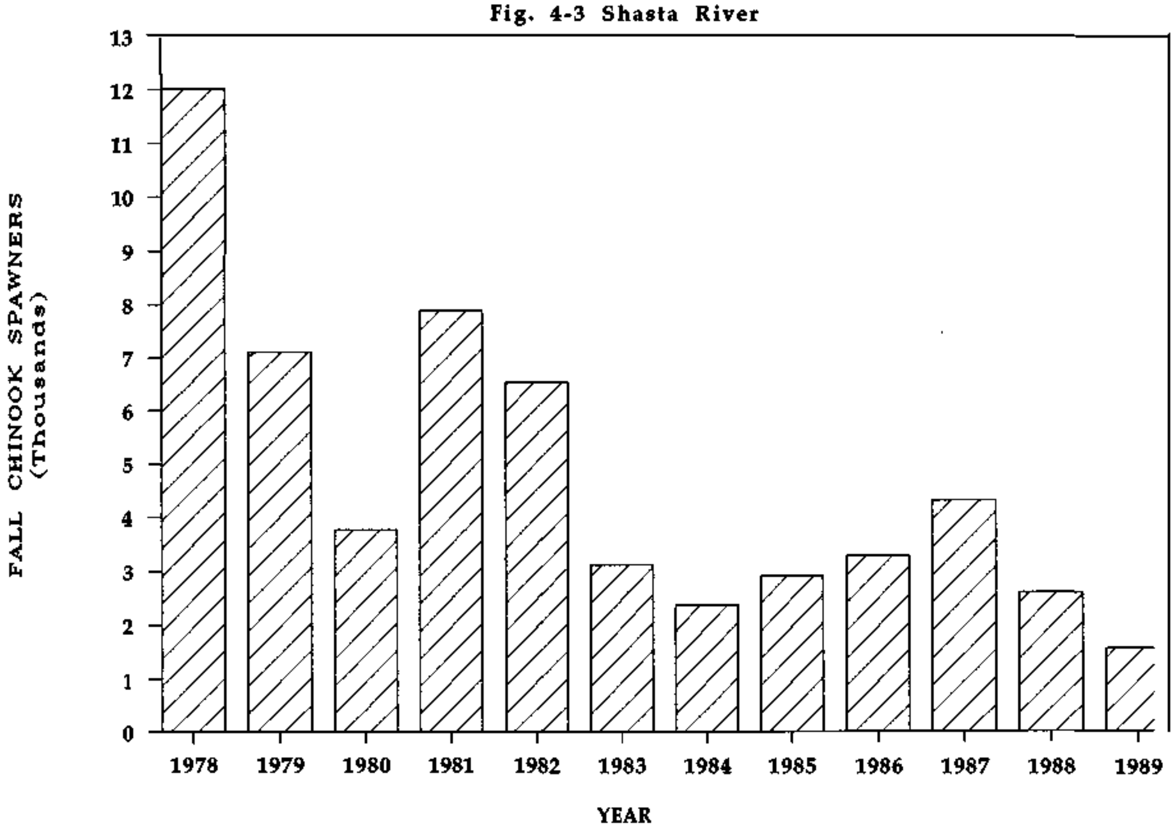


Fig. 4-4 Scott River

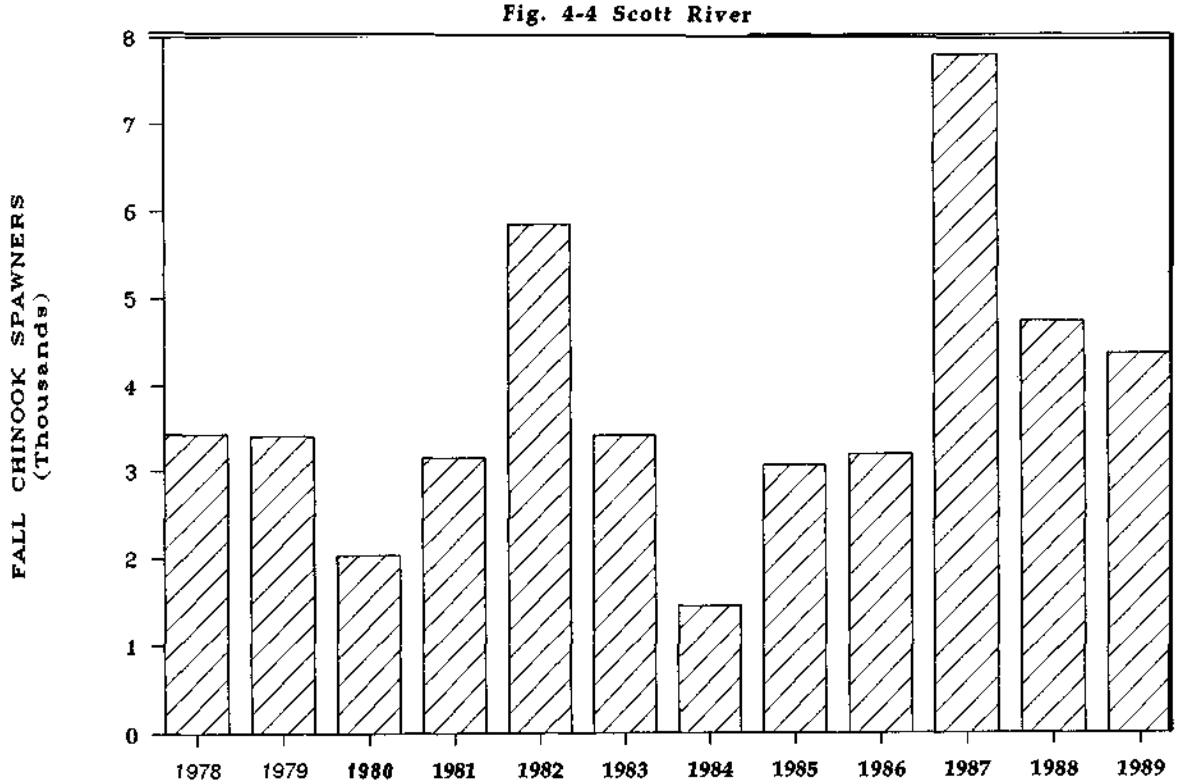
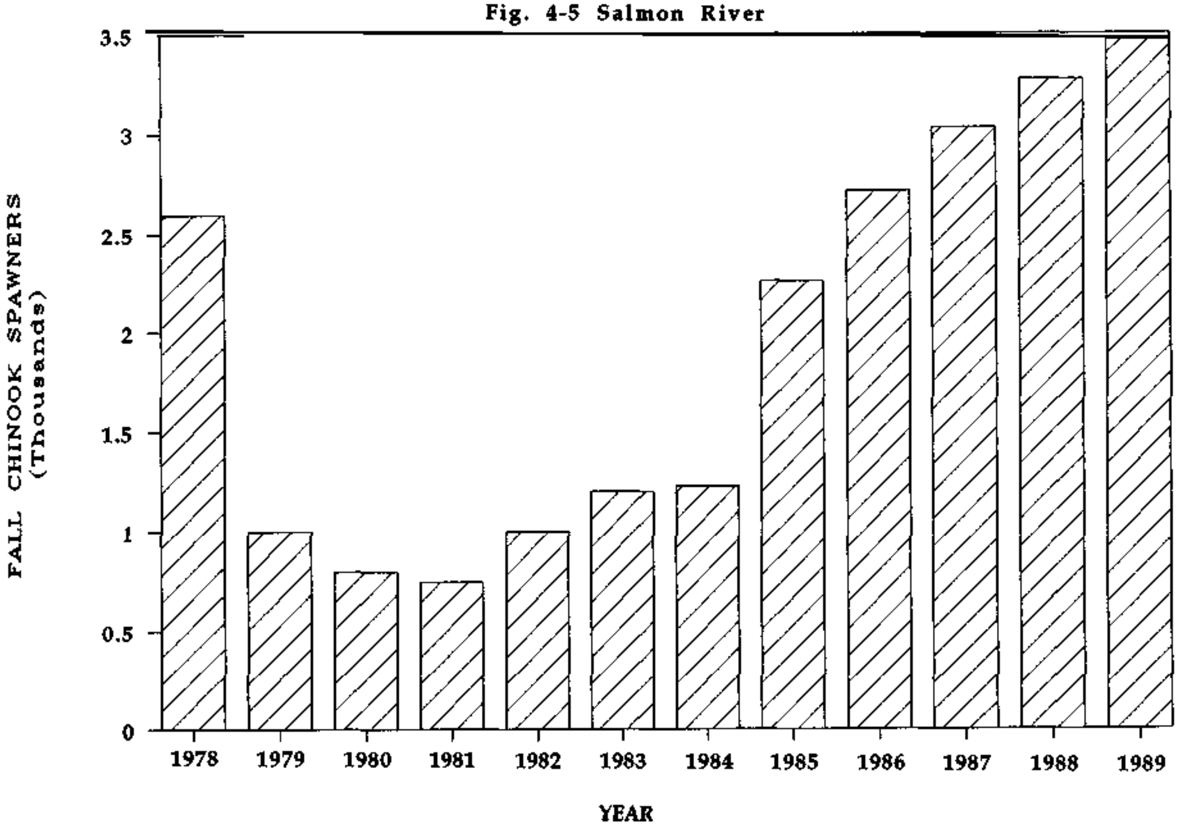


Fig. 4-5 Salmon River



been declining and estimated escapements for 1987 and 1988 were about 400 adults (CDFG unpublished). LaFaunce (1965) estimated that 3,600 fall chinook returned to the South Fork of the Trinity in 1964.

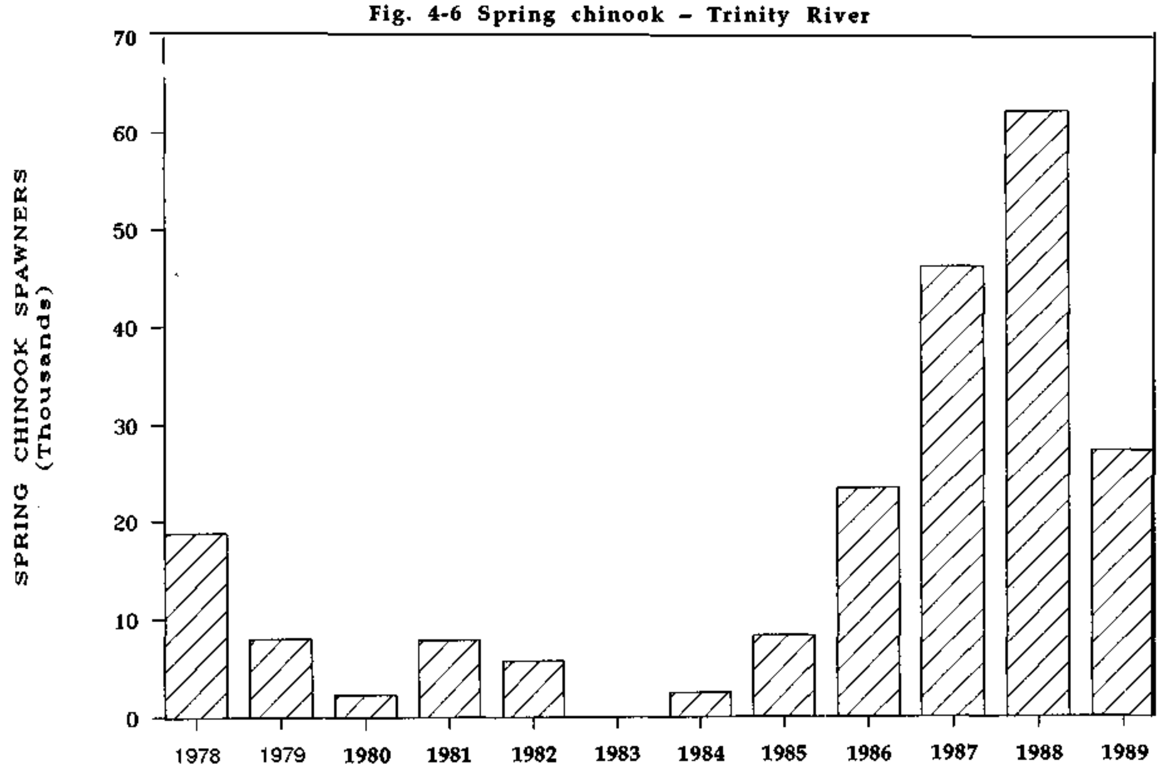
Data from which to determine the number of fall run chinook returning to the lower Klamath tributaries is, for the most part, unavailable. The 1988 escapement in Blue Creek was estimated to be 320 (USFWS 1990c). DeWitt (cited by USFWS 1979) estimated fall chinook escapement in Blue Creek in 1951 at between 5,000 and 10,000 fish. USFWS outmigrant traps catch very few chinook smolts in the smaller tributaries below Weitchpec, suggesting their low abundance (USFWS 1990).

Spawner surveys by the U.S. Forest Service on the middle Klamath tributaries, such as Red Cap and Camp creeks, suggest that escapement of the native late run fall chinook stocks are quite low (J. Boberg personal communication). Similar low redd and carcass counts have been found on Hoopa Valley Reservation tributaries and suggest low population levels of late run fall chinook (Hoopa Fisheries Reports 1984-88).

Spring Chinook

Runs of Trinity River hatchery-origin spring chinook showed a strong increase from 1985-1988 (Figure 4-6). While 1987 and 1988 were the highest returns in recent years, 1989 showed a decrease from the trend and 1990 showed further declines. USFWS (1990b) has found a strong relationship between pounds of juvenile spring

Fig. 4-6 Spring chinook - Trinity River

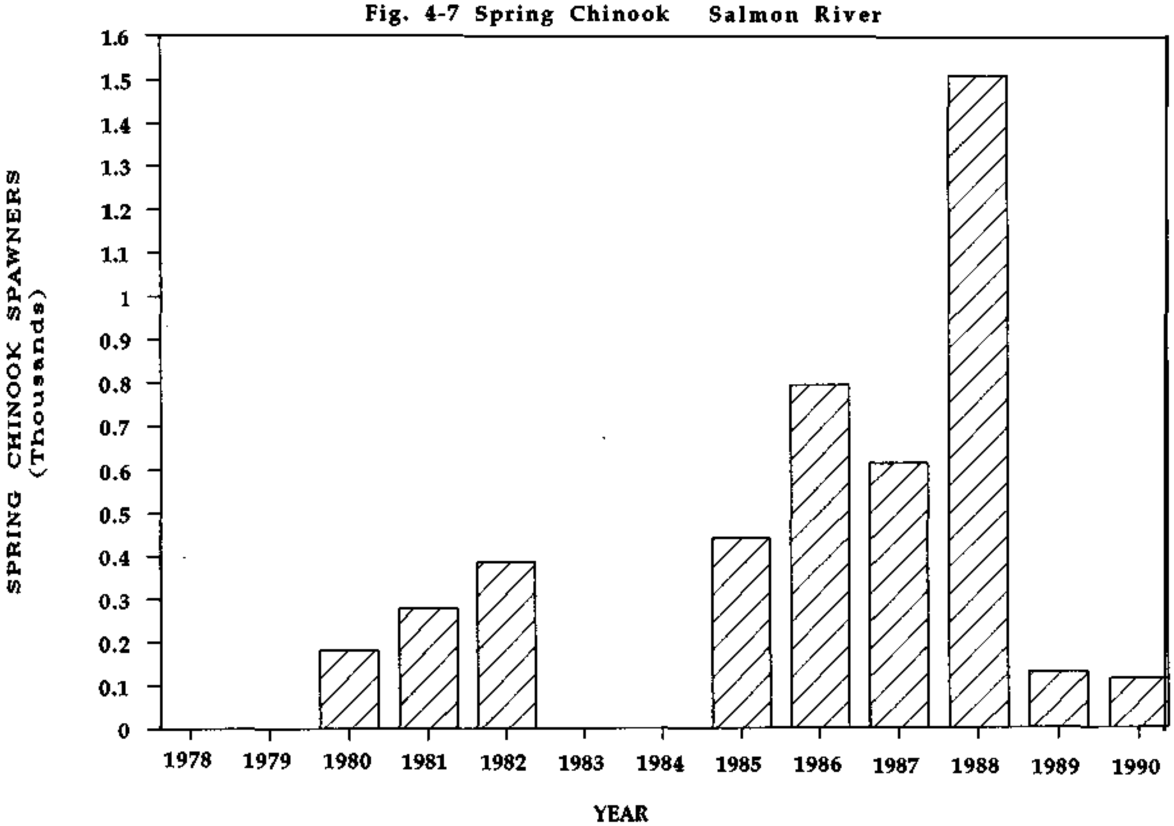


chinook released at Trinity River Hatchery and subsequent returns and projected lower escapement levels for 1990.

The native spring chinook on the South Fork of the Trinity River appear not to have recovered and, in fact, may be trending toward extinction. While 11,500 spring chinook spawned in the South Fork in 1964 (LaFaunce 1965), less than 50 spring chinook were sighted during extensive direct observation surveys in the summer of 1989 (USFS unpublished). The 1964 run size estimate may have been higher than average for the years of that period (Eric Gerstung personal communication).

California Department of Fish and Game and Klamath National Forest personnel have cooperated in assessing spring chinook runs in the Salmon River since 1980 (Figure 4-7). Data differ in their levels of confidence for the different years. In some years fairly complete counts by direct observation have been conducted, while in other index sections are checked and the counts expanded in order to estimate run size. Run strength seemed to be showing an increasing trend, peaking in 1988 at 1,500 adults, but runs in 1989 and 1990 were estimated at only 129 and 113, respectively (DesLaurier and West 1990). Klamath Basin native spring chinook stocks were described by an American Fisheries Society report as being at a "high risk of extinction" (Nehlsen et al. 1990). Returns to other tributaries such as Clear, Elk, and Indian Creeks are estimated to be as low as ten fish.

Fig. 4-7 Spring Chinook Salmon River



Coho Salmon

Coho were once abundant in the lower Klamath tributaries (Snyder 1931). The exact status of wild coho populations in the lower river today is not known. U.S. Fish and Wildlife Service outmigrant studies (1990a) indicate that very few juvenile coho are present in the smaller lower Klamath tributaries. Low numbers of juvenile coho have also been found in Blue Creek (USFWS 1990c).

No accurate assessment of coho is available for other areas of the Klamath Basin. Although coho are seen at the counting weirs operated on the Salmon, Scott, and Shasta rivers, these weir counts are not be good indicators of coho population levels. The weirs are operated primarily to count fall chinook and they are shut down before the native coho migrations would peak. Severe summer water quality problems may have eliminated the coho salmon stock groups adapted to the Shasta and Scott rivers, since juvenile coho usually spend a full year in their natal stream.

Coho salmon returns to Iron Gate Hatchery since 1970 have ranged from 91 to 2,893 fish, with an average of 1,300 (Hiser 1989). Trinity River Hatchery returns of coho since 1970 averaged 4,000, while ranging from 47 to 23,338 (Bedell 1989). Returns to the Trinity River Hatchery have been very strong in recent years, particularly 1985, 1987, and 1988.

Fall/Winter Steelhead

The populations of native steelhead that return to the Klamath River Basin in fall seem to be declining. Seining operations conducted by the California Department Fish and Game at Waukel Riffle showed a decreasing trend in half pounder to adult ratios between 1976 to 1982 from 67:33 to 50:50 (Hubbell 1979, Hubbell et al. 1985). Half pounder run sizes, as estimated by average number caught per seine haul, dropped by 75 percent between 1980 and 1982 (Hubbell et al. 1985). Over the same period the contribution of hatchery fish to the steelhead seine catch grew from 4 percent in 1977 (Hubbell 1979) to 12 percent in 1982 (Hubbell et al. 1985).

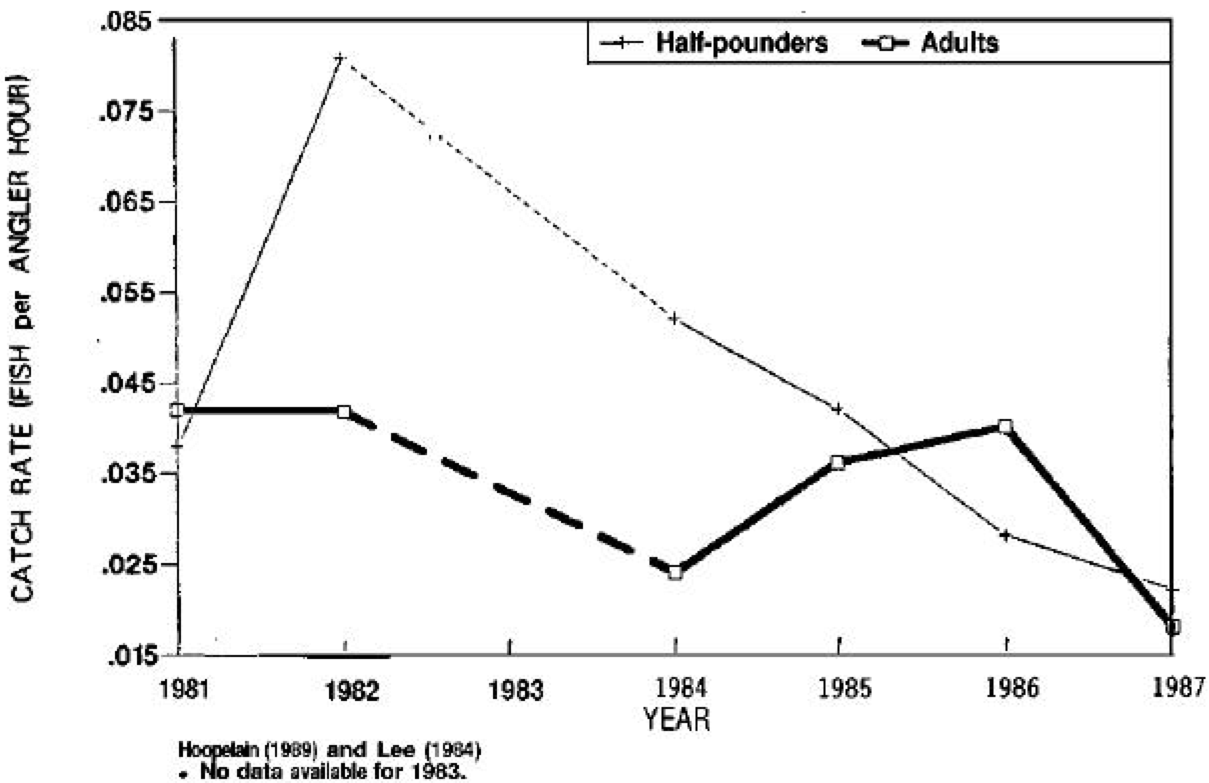
This combination of increasing hatchery contributions to catch, together with decreases in steelhead abundance was taken to represent "reductions in naturally produced fall steelhead" (Hubbell et al. 1985). The same report found that Iron Gate Hatchery steelhead did not survive well to adulthood. Reports from the CDFG seining operation since 1982 did not note the number of half-pounders bearing hatchery fin clips (Hopelain unpublished). Steelhead marking was discontinued at Iron Gate and Trinity River hatcheries in 1982. Consequently, trends in the contribution of hatchery and wild fall steelhead since 1982 are not documented.

The California Department of Fish and Game conducted creel censuses that measured catch per unit of effort from 1980 to 1982 (Lee unpublished) and from 1984 to 1987 (Hopelain unpublished). These data indicate that the catch per unit of effort of half-pounders dropped continuously during the period (Figure 4-8). The half-pounder catch rate of 0.081 fish per angler hour recorded by Lee (unpublished) in 1980 had dropped to

0.020 by 1987 (Hopelain unpublished). Adult steelhead catch rates decreased from 0.042 fish per angler hour to a low of 0.017 in 1987.

The continuing decline in catch per unit of effort would indicate that the decreasing trend in native steelhead production is continuing. Hopelain (unpublished) suggests that this may not be the case, but he offers no alternative hypothesis. (The possibility that reduced escapement of wild steelhead is related to interaction with hatchery fish is explored in Chapter 5). Hatchery steelhead are reared for a full year before their release, so they are sheltered from stream conditions. A decrease in suitable habitat for 1+ native steelhead could also be a cause for their relative decline (CDFG 1990).

Figure 4-8 – Trends of catch rates (fish/angler hour) for steelhead trout in the lower Klamath River, 1981-1987. *



Returns of adult steelhead to the Trinity River in fall and winter have been strong in some recent years. These increases coincide with increased returns to the Trinity River Hatchery. (For hatchery returns see Chapter 5). While there is a significant sport fishery for winter steelhead in years when streamflows permit, no indications of run strength or population trends are available for these fish. The U.S. Fish and Wildlife Service will be operating a weir during fall and winter months on the New River to attempt to get more information on fall and winter steelhead (Sandy Noble personal communication). This effort is being funded by the Trinity River Fish and Wildlife Management Program.

Summer Steelhead

The U.S. Fish and Wildlife Service (1983) characterized the Klamath Basin's summer steelhead as a "depleted stock of natural origin, possibly approaching threatened or endangered status." USFS and CDFG personnel have made partial counts of summer steelhead over the last several years (Table 4-2). Estimates are based on expansions of the counts from stream segments in most cases, and vary in their levels of precision. Returns were high in 1988 but dropped again in 1989 (Eric Gerstung personal communication). No clear trend for summer steelhead populations basinwide are apparent. DesLaurier and West (1990) expressed concern about population levels of summer steelhead on the Salmon River.

Some populations of summer steelhead, such as those in the North Fork of the Trinity River, the New River, and Clear Creek have remained at stable levels, and at levels sufficient to avoid genetic risk. Clear Creek may see increased sedimentation as a result of salvage logging, which Roelofs (1983) suggested can cause population declines of these fish.

Green Sturgeon

Green sturgeon are listed as rare and endangered in the USSR (Borodin et al. 1984) and rare in Canada (Houston 1988). While the Klamath population may represent one of the world's larger populations, little information on run strengths and population trends exist (Pat Foley personal communication). The only data collected on green sturgeon is the number taken annually in Indian gill nets since 1980. USFWS (1988a) reported 232 captured in 1988 and 191 in 1987. Both the 1987 and 1988 harvests were well below the 500 fish average taken over the monitoring period. The highest catch reported was that of 1981, when 835 green sturgeon were harvested.

Because green sturgeon do not reach maturity until an average age of 15 for males and 20 years for females, fish returning to spawn in 1981 would have been one of the last from brood years prior to 1964. Reduced harvest may reflect a decreasing trend in the green sturgeon population due to habitat problems following the 1964 flood. The construction of Trinity Dam and the subsequent diversion of more than 80 percent of the Trinity's flow may also have had a negative impact. Studies from the Columbia River have linked decreased flows to decreased white sturgeon populations (Craig Tuss personal communication).

Coastal Cutthroat Trout

No data.

Pacific Lamprey

No data.

Table 4-2 -- Summer Steelhead Population Estimates in Klamath Basin Tributaries 1977-1988
(Note: methods of estimation and levels of statistical precision vary)

Basin	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
N.F. Trinity River	nd	nd	320	454	225	116	159	179	nd	nd	nd	624
S.F. Trinity River	nd	nd	91	nd	nd	27	nd	nd	8	73	nd	26
New River	nd	nd	344	320	236	350	nd	355	nd	nd	nd	600
Canyon Creek	nd	nd	nd	6	4	20	3	9	10	nd	nd	32
Salmon River	nd	nd	nd	233	108	257	nd	nd	97	106	100	200
Wooly Creek	510	105	160	165	245	353	78	92	290	nd	280	379
Elk Creek	4	408	nd	90	47	249	nd	18	nd	nd	31	63
Indian Creek	nd	421	nd	nd	nd	16	nd	nd	nd	nd	nd	41
Clear Creek	nd	1810	79	241	270	618	258	156	162	428	512	678
Dillon Creek	nd	nd	nd	268	187	344	300	200	nd	nd	77	294
Red Cap Creek	nd	nd	nd	10	nd	45	12	11	18	nd	29	25
Bluff Creek	nd	nd	41	37	16	87	23	48	23	73	73	91

nd= No Data

Information Provided by Eric Gerstung CDFG

American Shad

No data.

Eulachon

Indian fishermen have noticed a dramatic decrease in candlefish populations in recent years (Merke Oliver, personal communication).

A MATTER OF URGENCY: PRIORITIES FOR STOCK RECOVERY

Some chinook salmon and steelhead stock groups in the Klamath basin have reached very low levels. Fisheries scientists have offered different suggestions as to what minimum number of fish is needed to maintain sufficient genetic diversity in a population so that it will not be lost. Suggestions of critical levels have ranged from a minimum of 500 fish to as few as 50 pair of spawners (Riggs 1990). These considerations in the past usually involved founding hatchery populations from existing stocks. More recently, however, they have been calculated to determine minimum viable populations to avoid species becoming extinct (Gilpin and Soule 1986). Utter (1981), in a study for the National Marine Fisheries Service, concluded that reproductively isolated populations of salmon and steelhead should be considered species, as that term is used in the Endangered Species Act of 1973 (ESA).

Immediate action is needed to avoid the loss of some Klamath Basin stock groups and the genetic diversity they possess. Table 4-4 shows which stock groups have been reduced to low levels, the reasons suspected for their decline, and the methods to be used to rebuild these "priority stocks for recovery." Petitions to list stock groups on the Columbia River under the ESA are currently under evaluation by the NMFS. A major objective of the Restoration Program is to obviate the need for the application of the ESA to Klamath River stocks. All management activities including habitat, harvest and hatchery production affect preservation of genetic resources (NWPPC 1990).

The low number of anadromous fish currently returning to the Klamath River is essentially the result of habitat degradation. Serious problems exist in many tributaries throughout the Basin. Taken together they contribute to large-scale ecological problems in the main river and the estuary. Although the effects of logging on fish habitat and the problems related to water quality and diversion are discussed in Chapters 2 and 3 of this Plan (Habitat Protection and Habitat Restoration, respectively), specific problems need to be reference in this section, as well.

Table 4-3 lists the habitat problems which frustrate the recovery of fish populations in the Basin. Most of the stock groups listed are known to be at very low levels, and some are in need of immediate habitat improvement to avoid their loss. Further habitat decline, linked to a major flood, is possible and could threaten some of the anadromous fish populations listed with extirpation.

Table 4-3 -- Habitat Problems Impeding Recovery or Posing Threats to Stock Groups

Basin	Stock Group	Habitat Problems
Lower Klamath	Late Run FCH Coho Winter SH CCTT	1) Deltas- migration barrier 2) Shifting Bedload- reduced spawning success 3) Increased Stream Temperatures- favors warm water fish species 4) Loss of Pool Habitat and Cover: critical habitat for 1+ SH, coho, and CCTT 5) Potential New Mass Wasting
Salmon River	Spring CH Summer SH Coho	1) Fire Damage/Salvage Logging- potential for large influx of decomposed granite leading to reduced spawning success, reduced rearing habitat, and reduced aquatic invertebrate production for fish food
Middle Klamath	Spring CH Summer SH Coho	1) Fire Damage/Salvage Logging- potential for large influx of sediment 2) Current High Sediment Loads- due to past and current land use, includes decomposed granite in some drainages
Scott River	Fall CH Coho	1) Decomposed Granite- reduced spawning success, rearing habitat, and aquatic invertebrate production for fish food 2) Excessive Diversion- blocks spawning and downstream migration, and decreases rearing habitat
Shasta River	Fall CH SH Coho (?)	1) Excessive Diversion- blocks spawning and downstream migration, and decreases rearing habitat 2) Very High Stream Temperatures- decreased juvenile survival 3) Poor Water Quality- decreased juvenile survival

CH = Chinook Salmon   SH = Steelhead   CCTT = Coastal Cutthroat Trout

Table 4-4 -- Stocks of Critical Concern That Need Management Attention

Sub-basin	Species	Recent Escapement	Historic Run Size	Limiting Factors	Recommended Task Force Strategy
Shasta	F CH	<500	30,000-70,000	Water Quality: D.O, temperatures Lack of Flows Harvest?	Restore Riparian Water Conservation Shift Harvest?
Lower Klamath (Blue Cr)	F CH (Late)	320	10,000	Massive Aggradation: decreased spawning success, loss of rearing	Change Practices Stabilize Slopes
	Coho	Unknown	Unknown	habitat, high stream temperatures Harvest?	Bioenhancement
Middle Klamath	F CH (Late)	Unknown	Unknown	1987 Fires: increased erosion Current High Erosion Rate: including decomposed granite in some areas Harvest?	Erosion Control Change Practices Bioenhancement
Salmon River	S CH	<150	Unknown	1987 Fires: increased erosion risk including decomposed granite	Erosion Control Shift Harvest?
	S SH	<150	Unknown	Harvest? Poaching	Stop Poaching Enhance Habitat
Scott River	Coho	Unknown	Unknown	Decomposed Granite Lack of flows High Water Temperatures	Erosion control Water Conservation Restore Riparian
Main Klamath	Green Sturgeon	Unknown	Unknown	Reduced Flows Massive Aggradation: pools filled?	Gather Information Aquaculture?
	Eulachon	Unknown	Unknown	Massive Aggradation: poor spawning success due to bedload shift?	Erosion Control?

The potential impacts of harvest and hatchery practices on priority stocks for recovery must also be determined and remedial actions pursued quickly. If populations that have only recently become depressed, such as the spring chinook on the Salmon River, are rebuilt quickly, then prospects for minimizing genetic loss and for effective recovery are greatly improved (Riggs 1990).

ROLE OF THE KLAMATH COUNCIL IN PROTECTING GENETIC DIVERSITY

At the same time that the Klamath River Basin Act created the Task Force to guide the restoration of the river's fish habitat, it also created the Klamath Fishery Management Council (KFMC) to guide the allocation of the available fish between the user groups in ways that would allow the rebuilding of the river's fish populations. The KFMC makes allocation recommendations to the Pacific Fishery Management Council (PFMC), which makes the annual harvest quota regulations. While no formal mechanisms have yet been developed to coordinate the work of the two statutory Klamath Basin bodies, they have some overlap in their memberships and even more overlap in the technical advisory groups that serve them. Consequently, informal coordination between the Task Force and Council occurs at a fairly effective rate. (See Chapter 7). The Trinity River Task Force senses similar needs for coordination, but its attempts to seek "advice and leadership of harvest managers on data needs" have reportedly met with "no formal response" (USFWS in press). The KFMC is drafting its own long range plan and will be seeking public comment on it in early 1991 (KFMC 1991).

The 11-member KFMC includes representatives of commercial fishermen, anglers, the Basin's Indian Tribes, the California Department of Fish and Game, Oregon Department of Fish and Wildlife, and the U.S. Secretaries of Commerce and Interior. By joining the user groups and agency personnel together, attempts are made "to minimize conflict, allocate the harvest to optimize commercial, recreational, and aesthetic benefits to the public, and to establish a process for decision-making that is logical, open, and well understood by the public (KFMC 1991)."

The KFMC is served by a Klamath River Technical Advisory Team (KRTAT) which studies the chinook salmon populations in an attempt to predict their run sizes. They computer-model the abundance of salmon cohort year-groups through time to determine the abundance of the different year classes, and, thereby to estimate their return to the river (KRTAT 1989). Harvest rate objectives are set at 65 percent to allow sufficient natural escapement to achieve maximum sustainable yield (MSY). The harvest model uses coded wire tagged hatchery fish to estimate populations and ocean distributions of Klamath Basin salmon stocks. Because the model indicates that the majority of Klamath Basin chinook salmon feed in the ocean between Port Orford, Oregon, and Shelter Cove, California, commercial harvest in this area has been tightly regulated. Some closures to protect Klamath stocks have extended as far south as Point Arena, California and as far north as Coos Bay, Oregon. The Fish and Wildlife Service (USFWS 1988a) suggested that harvest restrictions have helped to increase the escapement of Klamath Basin fall chinook salmon stocks.

THE CHALLENGE OF CONSERVING MIXED STOCK FISHERIES

Many of the Klamath Basin's locally adapted salmon populations have been reduced, primarily by habitat loss and degradation, and their ability to sustain harvests may remain low until habitat restoration has been accomplished. Problems arise in "mixed stock" ocean fisheries when hatchery stocks become a significant component of the catch and their range overlaps that of native populations (Thorpe and Mitchell 1981, Mc Donald 1981, Lichatowich and McIntyre 1987). All commercial salmon troll fishing and the ocean sportfishing effort on the West Coast target on salmon from the various rivers and from hatcheries as they mix in ocean areas to feed, hence these are mixed stock fisheries. "When mixed-stock fisheries harvest excess hatchery fish, they tend to overharvest the relatively unproductive natural populations. This problem tends to increase as the proportion of hatchery fish increases ... The problem may be acute for populations whose reproductive rate has been reduced by the degradation of their habitat" (Lichatowich and McIntyre 1987). Similar concerns exist for Klamath Basin native stock groups. Native stocks may have different ocean migration patterns and, therefore, a different sensitivity to harvest rates than hatchery fish, which are used as the basis of the Klamath Ocean Harvest Model (KOHM).

INDIAN FISHERIES ALSO INVOLVE MIXED STOCK HARVESTS

The quota for salmon harvest by the Yurok and Hoopa Tribes for commercial and subsistence purposes is set by the PFMC after consideration of the recommendations provided by the KFMC. The supervision and enforcement of the net fisheries in the river are conducted by the Bureau of Indian Affairs (BIA) and the Hoopa Tribe. Such harvests conducted in the river are known as "terminal" fisheries. Fishing effort can be shifted in terminal fisheries by changing their timing to coincide with run abundance or, in the alternative, to withhold fishing effort to decrease harvest when depressed stock groups might be migrating. Gill nets do not, of course, permit the live release of native fish and the selective retention of hatchery fish. This harvest method can, therefore, also pose mixed stock harvest problems for depressed stocks as they migrate with, and are harvested with, the more abundant hatchery fish.

Yurok

Fishery regulations are enforced on the Yurok Reservation below Weitchpec by the U.S. Bureau of Indian Affairs. The Yuroks have both a subsistence fishery and a commercial fishery. In recent years the opening date for the Yurok commercial fishery has been set by the BIA through a memorandum of understanding with CDFG. Fishing continues until the quota is attained. Fish caught in the commercial fishery can be sold only to one buyer designated by the BIA.

The Yurok subsistence fishery has had specific quotas for fall chinook salmon since 1985. Transporting more than 15 subsistence fish off the Reservation requires a permit. All subsistence fish transported must be marked. Transport of unmarked fish or sale of subsistence fish is prohibited. Indians caught violating regulations are brought before an Indian judicial system. CDFG retains sportfishing regulation and enforcement responsibilities on this section of the river. Control of the fishery will pass from the BIA to the Yurok Tribe to regulate when the Tribe has completed the formal process of organization. The U.S. Fish and Wildlife Service, under contract with the BIA, monitors the net harvest on the Yurok Reservation and reports catch information to the KFMC and PFMC.

Hoopa

The Hoopa Valley Tribe monitors the harvest of anadromous fish on the Hoopa Valley Reservation through its fisheries department. Quotas for chinook salmon are based upon pre-season allocations set by the KFMC and PFMC regulatory process. The duties of regulation and enforcement were transferred from the BIA to the Tribe in 1987. The enforcement of tribal fishing regulations are carried out by tribal law enforcement personnel and violations are prosecuted in the tribal Court. Catch statistics and pertinent biological information, such as length, weight, and incidence of tagged fish are gathered and shared with the PFMC and recorded in the Hoopa Fisheries Annual Report. A Memorandum of Agreement with the State empowers Hoopa law enforcement personnel to enforce CDFG sportfishing regulations on the Reservation.

Karuk

The Karuk Tribe has been granted fishing privileges in the half mile below Ishi Pishi Falls by the State of California. The Karuk do not have a specific quota, nor do they have an allocation from the KFMC. CDFG does not directly monitor the Karuk fishery, nor does the BIA. The Karuk Tribe is in the process of setting up a Karuk Fisheries Department which will determine the Karuk's needs for and uses of salmon, represent the Karuk concerning fishery management issues, and seek formal recognition for a Tribal fishery. The monitoring of the dip net fishery at Ishi Pishi Falls is being conducted by the Karuk Tribe in 1990-91, with funding from the Klamath River Task Force.

The Karuk consider the designated fishing area at Ishi Pishi to be owned by a group of families and to be both inappropriate and inadequate as a fishing place for all 2,000 tribal members. Lack of a specific harvest allocation and absence of representation on the KFMC also are seen as problems by the Karuk.

The Indian net harvest, like the mixed-stock ocean harvest, can have serious impacts on runs of locally adapted stocks that are depressed. Efforts in recent years to harvest surplus Trinity River Hatchery spring chinook have been made at times that wild spring chinook or summer steelhead were also migrating. Some of these populations are at very low levels. Commercial harvest for spring chinook in 1989 was set for June to avoid an impact on earlier running native fish. The impacts on summer steelhead are monitored closely and are considered to be slight (USFWS 1988a). The U.S. Fish and Wildlife Service stated, however, (USFWS 1990d) that "concerns regarding impacts on natural stocks of spring chinook by subsistence fisheries are real and should be addressed to provide increased protection for these stocks." Both USFWS (1989) and the KRTAT (1989) have warned that concentrating the Yurok commercial harvest of fall chinook early in the season has disproportionate impact on Iron Gate Hatchery fall chinook and upper Klamath native stocks.

Green sturgeon are often harvested directly with large mesh nets, or are taken incidentally by Indians while fishing for salmon. Catches of sturgeon have shown a decreasing trend since 1980 (USFWS 1988a). Because green sturgeon do not reach sexual maturity until they are 15 to 20 years old, the effects of overfishing might not be fully reflected for 15 to 20 years. An undated CDFG publication on green sturgeon indicates that fish tagged in the Klamath River "have been recaptured in Oregon and Washington rivers and bays." A substantial harvest of green sturgeon using gill nets occurs in Willapa Bay in Washington. Klamath River green sturgeon stocks, therefore, may be exposed to fisheries outside the basin. Increased monitoring efforts are needed to determine whether current harvest rates of green sturgeon are sustainable, including harvest in other areas, or whether they are putting the population at risk.

RIVER SPORTFISHING: QUOTAS, REGULATIONS, POTENTIAL PROBLEMS

While angling harvest quotas for chinook salmon are set by the PFMC, the State of California promulgates specific fishing regulations and enforces them. The KFMC may give harvest management suggestions to CDFG for sport harvesting in the river for all anadromous fish species of interest to the Restoration Program. With the exception of fall chinook salmon, the KFMC has yet to exercise that option.

State regulations require salmon fishermen in the Klamath Basin to possess a punch card. No other stream or river in the State has this requirement. Bag limits for steelhead were lowered in all areas of California in 1990, except for the Klamath and Trinity Rivers where three fish in possession is still allowed. There is a bag limit of five salmon grilse, but only two adult salmon over 22 inches may be taken. Two adults can be taken in combination with three jacks to reach a limit of five fish. Steelhead may be taken in addition to any salmon.

Regulations have been devised, as well, to protect summer steelhead and chinook and coho salmon in certain tributaries. No "trout" over 15 inches may be kept in tributaries of the Klamath, Trinity, Salmon, Scott or Shasta Rivers during trout season, in order to protect summer steelhead. Salmon can be taken legally by sportfishermen only in the main stems of the Klamath and Trinity Rivers, and not from any of the tributary streams.

The in-river sport catch of summer steelhead or native spring chinook in the mainstem of the Klamath and Trinity Rivers could have detrimental effects on remnant native spring chinook and summer steelhead populations. The South Fork of the Trinity was recently closed to fishing during the summer to protect both these species.

"Trout" fishing in the tributaries of the Klamath River could negatively impact salmon and steelhead juveniles, except where fishing occurs above barriers to anadromous fish migration. These larger salmon or steelhead juveniles have often survived adverse environmental conditions, are nearing a transition to the smolt phase, and are very important to future adult recruitment. The overharvest by anglers of the yearling steelhead released from Trinity River Hatchery has prompted CDFG to close the Trinity River to fishing from March 14 to the last Saturday in April.

THE IMPACTS OF POACHING ON DEPRESSED FISH STOCKS

Summer steelhead and spring chinook are extremely susceptible to poaching. They spend nearly all summer in deep pools and often are visible because of the excellent low-water clarity. Roelofs (1983) found that poaching was prevalent in several streams containing summer steelhead. USFS fisheries crews have also seen substantial indications of poaching activity while doing stream surveys in recent years (Jack West, personal communication). Large portions of spring chinook and summer steelhead runs often congregate in just a few pools, increasing their vulnerability and the risk of population loss from poaching. Both spring chinook and summer steelhead have continued to be taken illegally, even as populations approach extinction, on the South Fork of the Trinity River.

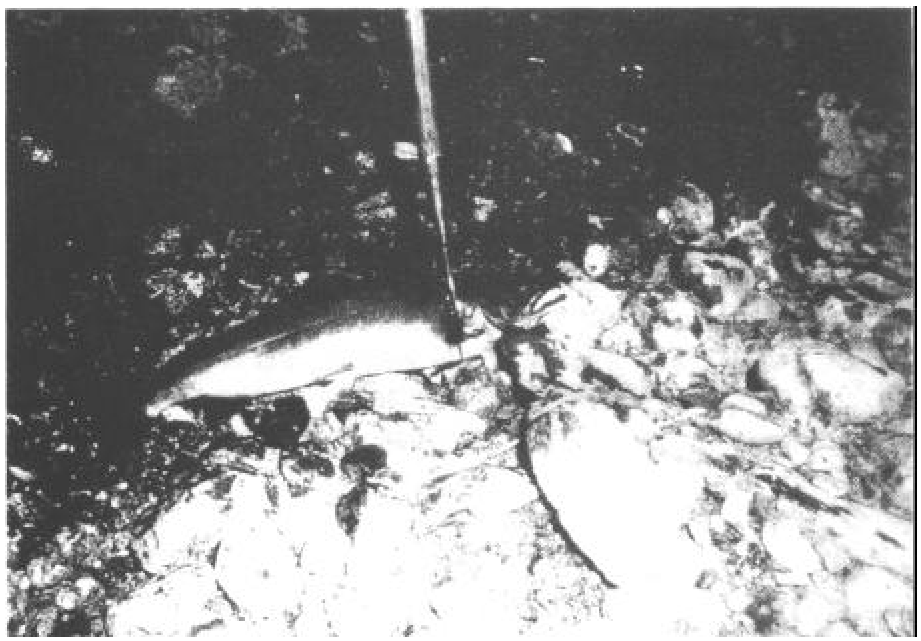


Figure 4-9 -- Low, clear streams leave spring chinook and summer steelhead vulnerable to poachers.

Green sturgeon are subjected to substantial illegal fishing pressure. The problem of sturgeon snagging was noted at Coon Creek on the Klamath River, where a slide made progress upstream difficult for spawning adults (USFWS 1982). The slide was altered by blasting to alleviate the problem. Poaching of this nature remains a problem on the Klamath at Akins Creek. Snagging of green sturgeon is often occurs in the areas where these fish are spawning. Poachers on Akins Creek are often armed, which makes it necessary for wardens to team up when policing this area. A second CDFG warden must come a considerable distance. Logistical and budget constraints make it difficult, therefore, to have enough enforcement presence to serve as a deterrent.

DO HIGH SEAS DRIFTNETS TAKE KLAMATH RIVER FISH?

Public concern has grown over the potential impact on the Pacific Northwest's salmon and steelhead of the high seas drift gill nets used by fishermen from Asian nations. In response to this concern, Congress passed the Driftnet Impact Monitoring, Assessment, and Control Act of 1987. The National Marine Fisheries Service subsequently began more intensive study and monitoring to assess the impacts of the driftnet harvest (US Dept. of Commerce 1989).

The Japanese have been using driftnets on the high seas since 1905. Large mesh nets were initially used to target blue fin tuna, a fishery that collapsed by 1940. Today, seven high seas driftnet fisheries are known to be operating in the North Pacific Ocean: the Japanese mothership salmon, Japanese landbased salmon; Japanese and Taiwanese large-mesh tuna and billfish fishery; the squid fisheries conducted by Japan, the Republic of Korea, and Taiwan. There are also unregulated driftnet fishing efforts conducted primarily by Taiwanese and Korean fishermen. The Japanese have greatly reduced their driftnet fisheries for salmon in response to the concerns of both the U.S. and the U.S.S.R. The squid fisheries are regulated by time and area closures, based on sea surface temperatures, in order to minimize the interception of salmonids.

Several factors led to a substantial increase in fishing pressure in recent years in all of the driftnet fisheries, including increased fuel costs, increased regulation of other fisheries, such as the Japanese salmon harvest, the reduced profitability of some traditional fisheries, and, of course, the inherent attraction of a high catch rate. The vessels have become larger, allowing them to operate in more adverse sea conditions and to increase their capacity. The lengths of the nets have increased substantially. Much of the area that is being fished is in international waters, so regulations and accords must be negotiated with the nations involved in the fishery. Japan, Korea, and Taiwan all have laws which prohibit keeping salmonids caught as "bycatch" in driftnet fisheries.

No clear estimates of salmonid bycatch are available. Low-level monitoring of the squid driftnet fishery has shown very low incidence of salmonids in catches. However, the tremendous amount of net used, the shifting of vessels between fisheries (ie. small mesh for squid to large mesh for albacore), and the network of resupply and trans-shipment vessels combine to make the harvesting capacity of these fisheries enormous and also difficult to monitor and control. Even with low catch rates the harvest of incidental salmonids could be very substantial. The effects on marine mammal and sea bird populations are also of great concern. NMFS is currently stepping up its monitoring efforts. (The information above was taken from a 1989 NMFS report to Congress).

In 1989 National Atmospheric and Oceanic (NOAA) special agents began a crackdown to eliminate illegally taken salmonids from the drift net fishery from the world market (Lewis 1990). Over 1.3 million pounds of illegally caught salmon was confiscated in 1989 alone. Ten million pounds of salmon taken from drift net fisheries was found to be "laundered" by shipping back through the United States and then to the Japanese market. The Lacy Act was invoked to prosecute a Japanese fish broker and his American associate who attempted to sell undercover agents 24 million pounds of illegally taken high seas salmon (Lewis 1990).

Because Klamath River chinook salmon feed in the ocean along the continental shelf from Newport, Oregon to Monterey, California (PFMC 1984), they are not exposed to the driftnet fisheries described above. Coho salmon migrations are thought to be along the continental shelf well within the United State's 200 mile Economic Enterprise Zone. What evidence we do have for most of the salmon stocks of the basin would indicate that it is unlikely that these fish are vulnerable to the driftnet fishery.

The ocean migration pattern of Klamath River steelhead stocks is not well studied but, Barnhardt (1986) reported that some stocks of steelhead from the Pacific Southwest region migrated north and south along the continental shelf. Satterthwaite (1988) documented the entry of substantial numbers of Klamath Basin steelhead half-pounders in the Rogue River and found that some of these fish subsequently return as adults to the Klamath drainage. This straying may indicate that these fish migrate along the nearshore, in which case they may not be exposed to the high seas driftnet fisheries.

Some larger winter steelhead from California coastal streams do have extended North Pacific migration patterns (Light et al. 1988). Klamath River winter steelhead, such as those returning to the lower river tributaries, could have migration patterns similar to the other California coastal stocks. If this is the case, these fish would appear to be the only stock group in the basin possibly at risk in the high seas driftnet fishery.

The United States maintains that it has "exclusive or, at a minimum, preferential rights to salmon from its waters on the high seas. These rights are not universally recognized by nations who are operating driftnet fisheries, but they are the basis for several laws passed by Congress to deal with this problem. The Lacy Act provides for prosecution of anyone trafficking in fish that are illegal to possess in a foreign country, such as driftnet-caught salmon in Japan. The Fishermen's Protective Act, or Pelly Amendment, directs the President to ban the importation of fish products from any nation whose actions diminish the effect of international fishery conservation. The 1989 Drift Net Act calls for participation by all driftnet fishing nations for a full monitoring program. If nations refuse, the Act calls for the Secretaries of State and Commerce to alert the President, thus triggering bans of fish imports called for by the Pelly Amendment. Countries wishing to participate in joint venture fisheries within the U.S.'s 200 mile zone must sign a Governing International Fishery Agreement which acknowledges U.S. jurisdiction over its salmon stocks, even in international waters. (The information above was taken from the Oceanic and Coastal Law Memo, July 1990).

1990 amendments to the Magnusen Fisheries and Conservation Act call for a ban on large scale driftnet fishing in the ocean (Fishery Conservation Amendment of 1990). The act directs the Secretary of State, in response in part to the 1989 Tarawa Declaration and United Nations Resolution No. 44225, to begin negotiations immediately to end large-scale high seas driftnet fishing. The Secretary is to report the progress on the negotiations to Congress within one year. The amendment also requires certificates of origin for any anadromous fish products imported into the United States (Rod McInnis personal communication).

THE EFFECTS OF NATURAL PREDATION ON KLAMATH STOCKS

Estimates of mortality of anadromous salmonids from natural predators runs as high as 98 percent (Fresh in Steward and Bjornn 1990). Great blue herons, belted kingfishers, mergansers, dippers, gulls, otters, garter snakes, various mammals, and other fish all eat juvenile salmonids. Predation in ocean nearshore areas is greatest by blue sharks, sea lions, and harbor seals, while sharks and lampreys may pose the greatest threat on the high seas (Ricker 1976).

Most predators are opportunistic and in some cases we give them an advantage. The reduced depth and cover in tributaries that have been degraded increases the vulnerability of juvenile salmonids. When water diversions isolate outmigrating juveniles in side channels of streams they become vulnerable to predation. When fish are captured and marked for run size estimation in the lower river or estuary, seals and sea lions take advantage of their disorientation (Hart 1987).

Figure 4-10 -- While bald eagles feed opportunistically on salmon carcasses, other birds have large impacts on juvenile salmon.

Research suggests that losses to predation may be greater for hatchery juveniles than for native fish (Larrson 1985), possibly due to inappropriate avoidance behavior, stress, and general unfamiliarity with new surroundings. Brown trout are known to prey on the releases of hatchery smolts in the Trinity River below Lewiston Dam (Paul Hubbell personal communication). Studies show that predation on hatchery releases below dams can be decreased by increasing streamflows (Hvidsten and Hansen 1988).

Salmonids released from hatcheries at a large size are potential predators on native juveniles, while fish stocked at a smaller size fall prey to larger native salmonid, cottids, and cyprinid fishes (Steward and Bjornn 1990). Releases of hatchery juvenile salmonids can cause increases in predation on native salmonids as well. High numbers of hatchery-released juveniles can cause predators to congregate and impact native and hatchery fish (Wood 1987). Cormorants are significant predators on the Klamath below Iron Gate Hatchery, but were not common in the area prior to hatchery construction (Hiser personal communication). Congregations of bird predators near hatchery release points is well documented. Smaller native fish, displaced in competition for space by larger hatchery fish, may be more conspicuous in suboptimal habitats and more subject to predation (Steward and Bjornn 1990).

Reductions in the mortality of juvenile salmonids by predator removal or reduction have been reported (Huntsman 1941). McEvoy (1987) suggested that reductions in sea otter populations dramatically increased abalone populations in California. Yuroks traditionally harvested marine mammals (McEvoy 1987), but today many of these species are protected by the Marine Mammals Protection Act. Clearly, the major reductions in recent decades of anadromous salmonids are largely a result of habitat alteration. To try to remedy the fish population declines by eliminating predators would be a misdirected effort and one which would create ill will for the Restoration Program. The weak, the sick, or otherwise poorly-adapted salmon and steelhead are weeded from the population for the betterment of the species. The predators are part of the web of life and they play ecological roles that are an integral part of the perpetuation of salmon and steelhead in the Basin.

INFORMATION NEEDED FOR IDENTIFYING, MONITORING KLAMATH STOCKS

Because the Restoration Program has as its principal objective the restoration of native fish populations, the information needed to monitor its success will be substantial. Monitoring escapements for widely dispersed smaller streams in stock group areas, like the middle Klamath, will require significant manpower. Some of the river's anadromous fish remain virtually unstudied. Steelhead life history, their ocean migration patterns, and population trends of the fall and winter runs remain unknown. Green sturgeon populations need more study and a subsequent management plan. Information concerning trends in abundance of cutthroat trout, lamprey, and candlefish should be gathered, as these fish are also indicators of the river's health and may be indicate the success of the Restoration Program. If we are to fully utilize the carrying capacity of the Klamath River ecosystem on a sustainable basis, we must know more about the biology of the stocks we are trying to restore.

MONITORING CHINOOK SALMON STOCK GROUPS

While identifying and managing diverse stock groups of anadromous fishes poses difficult challenges, the potential rewards are great. Monitoring is already conducted in all of the identified stock group areas for fall chinook on the Klamath River except for the Middle Klamath. At least one major tributary, such as Clear Creek or Dillon Creek, should be monitored through weir operation. While the Program may not be able to support the effort needed to do spawner estimates in many of the basin's smaller streams, it should be possible to coordinate volunteer efforts to help gather data.

The Department of Fish and Game currently uses volunteers from sportfishing groups to help with spawner counts in some smaller Middle Klamath tributaries (D. Maria personal communication). Restoration groups along California's North Coast have successfully used volunteers. High school students are interested in participating as the Program's educational effort takes hold. (The training of volunteers is discussed in Chapter 3).

The Department of Fish and Game's Natural Stocks Assessment Program has made some interesting findings concerning the carrying capacity of Bogus Creek (Mills et al. unpublished). Information from this program should be shared so that it can assist adaptive management. It may be time to shift efforts from this upper Klamath tributary to a productive middle Klamath tributary stock group. As more data is gathered on spawning escapement and smolt production in tributaries from other geographic areas, earlier estimates of carrying capacity (West et al. 1990 and Hubbell and Boydstun 1985) can be refined. The California Department of Fish and Game and the U.S. Fish and Wildlife Service's Fisheries Assistance Office in Arcata should communicate so that Fish and Wildlife's efforts on Blue Creek are added to the database of the Natural Stocks Assessment. Personnel from small scale rearing programs can be taught to operate downstream migrant traps and contribute information to the Natural Stocks Assessment Program, as well. Implementing consistent levels of constant fractional marking for all chinook salmon releases from both the Trinity and Iron Gate Hatcheries would enable the calculation of the proportion of native and hatchery stocks in the Klamath with much greater precision.

Direct observation efforts involving both agency staff and volunteers should continue for the critically important spring chinook population on the Salmon River. The radio tagging currently being conducted to determine movements, spawn timing, and other behavior of the spring chinook could assist the restoration of this run. The USFWS should continue its efforts to monitor the harvest of spring chinook in the lower river net fisheries. Native spring chinook in the Klamath once numbered in the hundreds of thousands. No estimates have yet been made for what levels of population could be achieved through restoration. Interim goals for escapement should be developed from recent trends in escapement and targets set for the basinwide restoration of the native runs.

More conclusive identification of stock groups of chinook salmon should be pursued using the criteria suggested by Nicholas and Hankin (1988a). Season of return to the Klamath and timing of entry into home streams can be determined by the seining in the lower river and the weir operations. Timing of spawning is already known for some stocks and could be gathered for others as spawner counts are expanded to new areas. Fecundity and egg size can be provided by small scale hatchery programs using native broodstock and new data added, as programs shift their site of operation or new facilities are opened. Coded wire tagging of all fish released from small scale programs may show different ocean migration patterns over time. Continued scale analysis such as Sullivan's (unpublished) work can tell us about life histories in various areas of the basin. Weirs operated by small scale rearing programs can be used to collect scales for analysis.

MONITORING THE OTHER FISH GROUPS

The data gaps on winter steelhead and coho salmon will not be as easy to fill as those for fall chinook salmon. Weir operation at the time these fish return will be difficult because of high flows (Bill Chesney personal communication). The Trinity River Task Force is funding operation of a weir on the New River in the winter of 1990-91 to monitor steelhead runs (S. Noble personal communication). The Klamath Task Force should follow these efforts and decide whether expanding weir operation later into the year to monitor coho and steelhead is practical on the Shasta, Scott, and Salmon Rivers. The biggest problem is the tendency of these fish to move with high flows when racks or weirs cannot be operated. Middle Klamath small scale native chinook enhancement programs, such as that on Camp Creek, can provide some information since they operate weirs during coho migrations and early winter steelhead runs. Spawner counts could help enumerate coho escapement, but reliable estimates of adult steelhead by spawning surveys are not possible.

The universal marking of steelhead began on the Trinity River in 1990 (USFWS in press). Marking all Iron Gate Hatchery steelhead would help unmask problems with residualism from both hatcheries and would allow for an accurate assessment of the contributions of hatchery and native steelhead from seining operations in the lower Klamath. Such marking would also help anglers to differentiate between hatchery and native steelhead and release the natives in order to help rebuild their population. Scale analysis has been used by ODFW to understand the life histories of steelhead better. Scale samples can be collected by guides and anglers, during seining and weir operations, and from the small scale rearing programs that handle steelhead. If rearing programs for steelhead are expanded they can provide other information on stock identification similar to that described above for chinook. The question of ocean migration patterns of Klamath steelhead must be answered if the risks associated with high seas driftnet fishing are to be fully understood.

The fishing guides on the Klamath are already mandated by CDFG to collect data on daily catches of salmon and steelhead. Current catch rates could be used as a baseline for the population levels of steelhead. Future catches could be used to judge the success or failure of the Restoration Program in rebuilding steelhead populations. Past studies of catch-per-unit effort in the lower Klamath by Lee (unpublished) and Hopelain (unpublished) should be made public. The desirability of resuming such studies as a tool for monitoring steelhead population recovery should also be considered.

Concern is growing over the health of the green sturgeon population in California and there is some question as to whether the population needs the special protections of the Endangered Species Act (Peter Moyle personal communication). More information is needed to formulate a management plan for this species. Because the green sturgeon is highly migratory, the study area would have to encompass the entire West Coast. An appropriate funding source would be the NMFS. Any such investigation should include the distribution of juveniles and larvae in various estuaries and bays, stock structure through analysis of the micro-constituents of bone samples, and identifying the source of sturgeon captured in Washington's Willapa Bay fishery (Sharon Kramer personal communication). Proper management of green sturgeon is crucial, as these fish are long-lived and extremely vulnerable to fishing pressure, habitat loss, and the other habitat factors which may limit stock reproductive success.

The candlefish may be an indicator of extreme changes in bedload in the lower Klamath River. Since the eulachon spawns in spring in the mainstem of the Klamath, changes in particle size distribution may be decreasing their spawning success. Indian fishermen have noted severe declines of this fish. The candlefish could serve as an indicator species for the Restoration Program in this regard. Since the eulachon has been important for subsistence in the past, it is likely the Yurok would assist studies concerning this fish.

The Restoration Program should explore opportunities to cooperate with colleges or universities to interest graduate students in gathering information concerning lamprey, shad, and cutthroat.

CONCLUSION

The success of the Klamath River Basin Fishery Restoration Program will ultimately be measured by its ability to return self-sustaining fish runs to the key areas of the Basin. The best chances for achieving such a goal involves the use of the fish stock groups that have evolved in the different regions of the Klamath Basin. While the stock groups proposed in this plan are based on incomplete information, there is sufficient evidence to suggest their validity. The Task Force should continue to update information regarding stock structure of all anadromous fishes of the basin, giving priority to chinook salmon, but move ahead on management and planning decisions while such information is being gathered. Those stock groups which are declining toward total loss should be targeted as priority stocks for recovery and necessary habitat improvement, harvest management, and hatchery production measures to reduce negative impacts on them should be taken immediately.

The current depressed condition of Klamath River anadromous fish populations reflects continuing problems with their habitat. Numerous tributaries and the lower Klamath River itself are only in the early stages of recovery from the 1964 flood. Because of continuing timber harvest on unstable soils, related road building on steep slopes and the 1987 fires, a major flood could cause a new episode of degradation which could eliminate some locally adapted stock groups altogether. Runs in the upper Basin tributaries continue to be depressed due to lack of water and poor water quality. The Klamath River could be characterized fairly as "ecologically stressed." Reform of the land uses which have caused these problems and appropriate habitat restorations must be implemented, with priority given to those stock groups most threatened (The solutions to problems related to habitat degradation are addressed in Chapters 2 and 3).

A strong and explicit working relationship must be forged between the Task Force and the Klamath Fisheries Management Council. While harvest may not be the primary cause for decline of the basins salmon stocks, it can pose a threat to the survival of greatly reduced stock groups. Each stock group described should be viewed as a natural production unit (Riggs 1990). A restored Shasta River fall chinook stock group, for instance, could provide an annual escapement of 6,000 to 18,000 fish on a sustainable basis (Hubbell and Boydsdun 1985) and a possible annual harvest of twice those numbers. By the Task Force bringing to the KFMC's attention the needs of priority stocks for recovery and stimulating appropriate action, problems similar to those in the Columbia Basin with the Endangered Species Act may be averted. The Council should also be encouraged to concern itself with the management of the river's other anadromous fishes, such as green sturgeon.

The monitoring of escapements and trends in run strengths must be expanded. Weir operation should be begun on a middle Klamath fall chinook stock group tributary. Spawner counts for chinook and coho salmon should be expanded to as many streams as possible. The continued monitoring of spring chinook and summer steelhead by direct observation will provide critically needed information to the Restoration Program and the KFMC. Appropriate programs to monitor fall and winter steelhead run trends must be implemented since these fish are vitally important to the economies of the Klamath Basin communities. The vulnerability of large winter steelhead from the Klamath Basin to high seas drift net fishing needs further exploration. The Task Force should follow the political process concerning problems related to the high seas drift net fishery, until questions about risks to the Basin's steelhead are resolved.

Green sturgeon have special needs due to the age structure-related vulnerability of their population. The NMFS should be requested to provide sufficient information and a management plan for the species should then be devised. Eulachon can provide the Task Force with an indicator of the health of the lower river and their decline should be stopped.

The California Department of Fish and Game's wardens do an impressive job in the Klamath Basin, given their limited numbers and the huge area for which they are responsible. In order to stop poaching however, a new level of cooperation with communities and other law enforcement personnel must be reached. As Basin communities become aware of the potential economic benefit of a successful Restoration program, they will take a more proprietary interest in their local fisheries resources.

POLICIES FOR FISH POPULATION PROTECTION

Objective 4: Strive to protect the genetic diversity of anadromous fishes in the Klamath River Basin.

4.1 Increases in populations of self-sustaining runs of fish separate in time or space from hatchery stocks, referred to here as "native" populations, will be the basis upon which the success of the Restoration Program will be judged.

4.2. The Task Force will work closely with the Klamath Fisheries Management Council to protect locally adapted anadromous fish stocks that return to all areas of the Klamath Basin, so that self-sustaining runs can be restored, with emphasis given to priority stocks for recovery.

4.3. The Task Force shall recognize the fish populations adapted to the various areas of the Klamath Basin as stock groups until further study indicates that finer or broader distinctions better serve the Klamath River Basin Fisheries Restoration Program. To this end, the following will be undertaken:

a. Fall chinook salmon escapement should continue to be monitored by use of weirs on the Shasta, Scott, and Salmon rivers and on Blue Creek, and an additional monitoring effort begun on a Middle Klamath tributary.
b. Native spring chinook populations shall continue to be monitored closely in the Salmon River and in the lower river net harvest.
c. CDFG will be requested to continue to monitor population trends of summer steelhead through direct observation surveys.
d. Study feasibility of weir operation later in the season to get more information on coho and steelhead.
e. The Task Force will provide training and supervision for community volunteers interested in conducting spawner surveys to help gather information about native salmon stocks, including coho.
f. Ask CDFG to analyze the angler success data currently collected from guides to provide a steelhead catch-per-effort baseline from which to measure the success of the Restoration Program.
g. Collect information on green sturgeon harvest.
h. Get the information suggested in Nicholas and Hankin (1988) with which to better identify stock groups, beginning with chinook salmon and proceeding on to all salmon and steelhead stock groups.
i. Include the fish counting methods suggested by Hankin and Reeves (1988) when habitat typing, in order to have consistent estimates of standing crops of juvenile fish.
j. Request NMFS to fund a study of green sturgeon, including its distribution, population structure, and level of harvest of Klamath stocks in other areas, to provide sufficient information so that a management plan for the Klamath green sturgeon can be devised.
k. Create incentives for graduate students and other qualified investigators on cutthroat trout, eulachon, and lamprey of the Klamath Basin.

4.4 The Task Force will work with the California Department of Fish and Game to:

a. Mark, by fin-clipping or other method, all hatchery steelhead at Iron Gate Hatchery as well as Trinity River Hatchery so that:
    1. Voluntary selective harvest will be possible.
    2. The problem of residualism can be investigated.
    3. The contributions of hatchery and native steelhead to returns can be determined.
b. Mark a consistent fraction of all hatchery chinook salmon to help in the Natural Stocks Assessment study of the native-to-hatchery relationship of Klamath Basin chinook stocks.
c. Share information gathered through research in a timely manner to enable adaptive management techniques.
d. Investigate the practicality of closing anadromous fish producing streams to "trout" fishing.
e. Promote genetic stock identification or DNA programs for ocean and river sampling to determine fish stock identification.

4.5 To strengthen law enforcement protection of Klamath Basin fish populations, the Task Force will

a. Encourage the formation of local citizen "watch groups" to help in the protection and monitoring of remnant fish populations throughout the basin.
b. Ask CDFG to seek cooperative agreements with other law enforcement agencies so that sheriffs' deputies, Forest Service and CDF officers, and highway patrolmen may be interested in helping wardens curb poaching.

4.6 The Task Force will encourage local judges to punish poachers to the full extent of the law. Where necessary, particularly to protect stocks in danger of becoming extinct, increases in penalties for poaching should be sought.

4.7 The Task Force will work towards determining spawning population levels appropriate to achieve optimal smolt production for all self-sustaining populations of anadromous salmonids in the basin.

4.8 The Task Force will support the ban on the use of large-scale driftnets for fishing on the high seas.

Klamath River Basin Fall Chinook Salmon Spawner Escapement, In-river Harvest and Run-size Estimates, 1978-1992a

SPAWNER ESCAPEMENT

	1978			1979			1980		
Hatchery Spawners	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Iron Gate Hatchery (IGH)	915	6,925	7,840	257	2,301	2,558	451	2,412	2,863
Trinity River Hatchery (TRH)	1,325	6,034	7,359	964	1,335	2,299	2,256	4,099	6,355
Subtotals	2,240	12,959	15,199	1,221	3,636	4,857	2,707	6,511	9,218
Natural Spawners									
Trinity River basin (above Willow Creek, excluding TRH)	4,712	31,052	35,764	3,936	8,028	11,964	16,837	7,700	24,537
Salmon River basin	1,400	2,600	4,000	150	1,000	1,150	200	800	1,000
Scott River basin	1,909	3,423	5,332	428	3,396	3,824	2,245	2,032	4,277
Shasta River basin	6,707	12,024	18,731	1,040	7,111	8,151	4,334	3,762	8,096
Bogus Creek basin	651	4,928	5,579	494	5,444	5,938	1,749	3,321	5,070
Main Stem Klamath River (excluding IGH)	300	1,700	2,000	466	4,190	4,656	867	2,468	3,335
Misc. Klamath tributaries (above Hoopa and Yurok Reservations)	735	2,765	3,500	147	1,068	1,215	500	1,000	1,500
Hoopa and Yurok Reservation tribs.	-- b	-- b	-- b	100 c	400 c	500 c	250 c	400 c	650 c
Subtotals	16,414	58,492	74,906	6,761	30,637	37,398	26,982	21,483	48,465
Total Spawner Escapement	18,654	71,451	90,105	7,982	34,273	42,255	29,689	27,994	57,683

IN-RIVER HARVEST

	1978			1979			1980		
Angler Harvest	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Klamath River (below Hwy 101 bridge)	122	854	976	216	484	700	835	727	1,562
Trinity River basin (above Willow Creek)	-- d	-- d	-- d	765	1,157	1,922	2,456	998	3,454
Balance of Klamath system	1,960	840	2,800	1,200	500	1,700	2,600	2,771	5,371
Subtotals	2,082	1,694	3,776	2,181	2,141	4,322	5,891	4,496	10,387
Indian Net Harvest e									
Klamath River (below Hwy 101 bridge)	--	--	--	--	--	--	495	9,605	10,100
Klamath River (Hwy 101 to Trinity mouth)	--	--	--	--	--	--	272	1,528	1,800
Trinity River (Hoopa Reservation)	--	--	--	--	--	--	220	880	1,100
Subtotals	1,800	18,200	20,000	1,350	13,650	15,000	987	12,013	13,000
Total In-river Harvest	3,882	19,894	23,776	3,531	15,791	19,322	6,878	16,509	23,387

IN-RIVER RUN

	1978			1979			1980		
Totals	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
In-river Harvest and Escapement	22,536	91,345	113,881	11,513	50,064	61,577	36,567	44,503	81,070
Angling Mortality (2% of harvest) f	42	34	76	44	43	87	118	90	208
Net Mortality (8% of harvest) f	144	1,456	1,600	108	1,092	1,200	79	961	1,040
Total In-river Run	22,722	92,835	115,557	11,665	51,199	62,864	36,764	45,554	82,318

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Klamath River Basin Fall Chinook Salmon Spawner Escapement, In-river Harvest and Run-size Estimates, 1978-1992a

SPAWNER ESCAPEMENT

	1981			1982			1983		
Hatchery Spawners	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Iron Gate Hatchery (IGH)	540	2,055	2,595	1,833	8,353	10,186	514	8,371	8,885
Trinity River Hatchery (TRH)	1,004	2,370	3,374	4,235	2,058	6,293	271	5,494	5,765
Subtotals	1,544	4,425	5,969	6,068	10,411	16,479	785	13,865	14,650
Natural Spawners									
Trinity River basin (above Willow Creek, excluding TRH)	5,906	15,340	21,246	8,149	9,274	17,423	853	17,284	18,137
Salmon River basin	450	750	1,200	300	1,000	1,300	75	1,200	1,275
Scott River basin	3,409	3,147	6,556	4,350	5,826	10,176	170	3,398	3,568
Shasta River basin	4,330	7,890	12,220	1,922	6,533	8,455	753	3,119	3,872
Bogus Creek basin	912	2,730	3,642	2,325	4,818	7,143	335	2,713	3,048
Main Stem Klamath River (excluding IGH)	1,000	3,000	4,000	1,000	3,000	4,000	200	1,800	2,000
Misc. Klamath tributaries (above Hoopa and Yurok Reservations)	500	1,000	1,500	600	1,500	2,100	140	1,270	1,410
Hoopa and Yurok Reservation tribs.	-- b	-- b	-- b	-- b	-- b	-- b	-- b	-- b	-- b
Subtotals	16,507	33,857	50,364	18,646	31,951	50,597	2,526	30,784	33,310
Total Spawner Escapement	18,051	38,282	56,333	24,714	42,362	67,076	3,311	44,649	47,960

IN-RIVER HARVEST

	1981			1982			1983		
Angler Harvest	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Klamath River (below Hwy 101 bridge)	536	1,714	2,250	1,252	3,539	4,791	60	750	810
Trinity River basin (above Willow Creek)	1,456	3,174	4,630	2,554	2,321	4,875	116	2,360	2,476
Balance of Klamath system	5,260	1,095	6,355	8,678	2,479	11,157	175	1,125	1,300
Subtotals	7,252	5,983	13,235	12,484	8,339	20,823	351	4,235	4,586
Indian Net Harvest e									
Klamath River (below Hwy 101 bridge)	912	23,097	24,009	290	4,547	4,837	12	800	812
Klamath River (Hwy 101 to Trinity mouth)	1,104	8,405	9,509	1,195	8,424	9,619	121	5,700	5,821
Trinity River (Hoopa Reservation)	449	1,531	1,980	314	1,511	1,825	30	1,390	1,420
Subtotals	2,465	33,033	35,498	1,799	14,482	16,281	163	7,890	8,053
Total In-river Harvest	9,717	39,016	48,733	14,283	22,821	37,104	514	12,125	12,639

IN-RIVER RUN

	1981			1982			1983		
Totals	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
In-river Harvest and Escapement	27,768	77,298	105,066	38,997	65,183	104,180	3,825	56,774	60,599
Angling Mortality (2% of harvest) f	145	120	265	250	167	417	7	85	92
Net Mortality (8% of harvest) f	197	2,643	2,840	144	1,159	1,303	13	631	644
Total In-river Run	28,110	80,061	108,171	39,391	66,509	105,900	3,845	57,490	61,335

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Klamath River Basin Fall Chinook Salmon Spawner Escapement, In-river Harvest and Run-size Estimates, 1978-1992a

SPAWNER ESCAPEMENT

Hatchery Spawners	1984 Grilse	1984 Adults	1984 Totals	1985 Grilse	1985 Adults	1985 Totals	1986 Grilse	1986 Adults	1986 Totals
Iron Gate Hatchery (IGH)	764	5,330	6,094	2,159	19,951	22,110	1,461	17,096	18,557
Trinity River Hatchery (TRH)	766	2,166	2,932	18,166	2,583	20,749	3,609	15,795	19,404
Subtotals	1,530	7,496	9,026	20,325	22,534	42,859	5,070	32,891	37,961
Natural Spawners									
Trinity River basin (above Willow Creek, excluding TRH)	3,416	5,654	9,070	29,454	9,217	38,671	20,459	92,548	113,007
Salmon River basin	216 g	1,226 g	1,442 g	905	2,259	3,164	949	2,716	3,665
Scott River basin	358	1,443	1,801	1,357	3,051	4,408	4,865	3,176	8,041
Shasta River basin	480	2,362	2,842	2,227	2,897	5,124	683	3,274	3,957
Bogus Creek basin	465	3,039	3,504	1,156	3,491	4,647	1,184	6,124	7,308
Main Stem Klamath River (excluding IGH)	200	1,350	1,550	156	468	624	196	603	799
Misc. Klamath tributaries (above Hoopa and Yurok Reservations)	150	990	1,140	646	4,214	4,860	606	4,919	5,525
Hoopa and Yurok Reservation tribs.	-- b	-- b	-- b	50 h	80 h	130 h	-- b	-- b	-- b
Subtotals	5,285	16,064	21,349	35,951	25,677	61,628	28,942	113,360	142,302
Total Spawner Escapement	6,815	23,560	30,375	56,276	48,211	104,487	34,012	146,251	180,263

IN-RIVER HARVEST

Angler Harvest	1984 Grilse	1984 Adults	1984 Totals	1985 Grilse	1985 Adults	1985 Totals	1986 Grilse	1986 Adults	1986 Totals
Klamath River (below Hwy 101 bridge)	175	548	723	1,479	2,427 i	3,906	704	2,456	3,160
Trinity River basin (above Willow Creek)	393	736	1,129	5,442	154 i	5,596	3,438	12,039	15,477
Balance of Klamath system	384	2,056	2,440	4,274	1,001 i	5,275	5,266	6,532	11,798
Subtotals	952	3,340	4,292	11,195	3,582 i	14,777	9,408	21,027	30,435
Indian Net Harvest e									
Klamath River (below Hwy 101 bridge)	132	11,878	12,010	132	5,700	5,832	191	15,286	15,477
Klamath River (Hwy 101 to Trinity mouth)	183	5,622	5,805	476	3,925	4,401	377	5,033	5,410
Trinity River (Hoopa Reservation)	140	1,170	1,310	947 j	1,941 j	2,888 j	286	4,808	5,094
Subtotals	455	18,670	19,125	1,555	11,566	13,121	854	25,127	25,981
Total In-river Harvest	1,407	22,010	23,417	12,750	15,148	27,898	10,262	46,154	56,416

IN-RIVER RUN

Totals	1984 Grilse	1984 Adults	1984 Totals	1985 Grilse	1985 Adults	1985 Totals	1986 Grilse	1986 Adults	1986 Totals
In-river Harvest and Escapement	8,222	45,570	53,792	69,026	63,359	132,385	44,274	192,405	236,679
Angling Mortality (2% of harvest) f	19	67	86	224	72	296	188	421	609
Net Mortality (8% of harvest) f	36	1,494	1,530	124	925	1,049	68	2,010	2,078
Total In-river Run	8,277	47,131	55,408	69,374	64,356	133,730	44,530	194,836	239,366

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Klamath River Basin Fall Chinook Salmon Spawner Escapement, In-river Harvest and Run-size Estimates, 1978-1992a

SPAWNER ESCAPEMENT

	1987			1988			1989		
Hatchery Spawners	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Iron Gate Hatchery (IGH)	1,825	15,189	17,014	609	16,106	16,715	831	10,859	11,690
Trinity River Hatchery (TRH)	2,453	13,934	16,387	4,752	17,352	22,104	239	11,132	11,371
Subtotals	4,278	29,123	33,401	5,361	33,458	38,819	1,070	21,991	23,061
Natural Spawners									
Trinity River basin (above Willow Creek, excluding TRH)	5,949	71,920	77,869	10,626	44,616	55,242	2,543	29,445	31,988
Salmon River basin	118	3,832	3,950	327	3,273	3,600	695	2,915	3,610
Scott River basin	797	7,769	8,566	473	4,727	5,200	1,188	3,000	4,188
Shasta River basin	398	4,299	4,697	256	2,586	2,842	137	1,440	1,577
Bogus Creek basin	1,208	9,748	10,956	225	16,215	16,440	444	2,218	2,662
Main Stem Klamath River (excluding IGH)	65	863	928	164	2,982	3,146	214	1,011	1,225
Misc. Klamath tributaries (above Hoopa and Yurok Reservations)	237	3,286	3,523	418	4,167	4,585	248	3,239	3,487
Hoopa and Yurok Reservation tribs.	-- b	-- b	-- b	55 k	820 k	875 k	40 k	600 k	640 k
Subtotals	8,772	101,717	110,489	12,544	79,386	91,930	5,509	43,868	49,377
Total Spawner Escapement	13,050	130,840	143,890	17,905	112,844	130,749	6,579	65,859	72,438

IN-RIVER HARVEST

	1987			1988			1989		
Angler Harvest	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Klamath River (below Hwy 101 bridge)	146	2,455	2,601	124	3,367	3,491	137	1,328	1,465
Trinity River basin (above Willow Creek)	923	9,433	10,356	2,735	9,341	12,076	209	3,054	3,263
Balance of Klamath system	4,367	8,281	12,648	2,552	9,495	12,047	1,921	4,393	6,314
Subtotals	5,436	20,169	25,605	5,411	22,203	27,614	2,267	8,775	11,042
Indian Net Harvest e									
Klamath River (below Hwy 101 bridge)	36	39,978	40,014	138	36,914	37,052	0	37,130	37,130
Klamath River (Hwy 101 to Trinity mouth)	117	8,136	8,253	173	9,667	9,840	120	4,961	5,081
Trinity River (Hoopa Reservation)	262	4,982	5,244	267	5,070	5,337	71	3,474	3,545
Subtotals	415	53,096	53,511	578	51,651	52,229	191	45,565	45,756
Total In-river Harvest	5,851	73,265	79,116	5,989	73,854	79,843	2,458	54,340	56,798

IN-RIVER RUN

	1987			1988			1989		
Totals	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
In-river Harvest and Escapement	18,901	204,105	223,006	23,894	186,698	210,592	9,037	120,199	129,236
Angling Mortality (2% of harvest) f	109	403	512	108	444	552	45	176	221
Net Mortality (8% of harvest) f	33	4,248	4,281	46	4,132	4,178	15	3,645	3,660
Total In-river Run	19,043	208,756	227,799	24,048	191,274	215,322	9,097	124,020	133,117

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Klamath River Basin Fall Chinook Salmon Spawner Escapement, In-river Harvest and Run-size Estimates, 1978-1992a

SPAWNER ESCAPEMENT

	1990			1991			1992		
Hatchery Spawners	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Iron Gate Hatchery (IGH)	321	6,704	7,025	65	4,002	4,067	3,737	3,581	7,318
Trinity River Hatchery (TRH)	371	1,348	1,719	205	2,482	2,687	211	3,779	3,990
Subtotals	692	8,052	8,744	270	6,484	6,754	3,948	7,360	11,308
Natural Spawners									
Trinity River basin (above Willow Creek, excluding TRH)	241	7,682	7,923	382	4,867	5,249	2,563	7,139	9,702
Salmon River basin	596 l	4,071 l	4,667 l	143	1,337	1,480	547	778	1,325
Scott River basin	236	1,379	1,615	146	2,019	2,165	965	1,873	2,838
Shasta River basin	118	415	533	10	716	726	66	520	586
Bogus Creek basin	53	732	785	20	1,261	1,281	556	598	1,154
Main Stem Klamath River (excluding IGH)	59	505	564	8	572	580	234	366	600
Misc. Klamath tributaries (above Hoopa and Yurok Reservations)	30	694	724	9	495	504	153	280	433
Hoopa and Yurok Reservation tribs.	17 k	118 k	135 k	0 k	382 k	382 k	59 k	474 k	533 k
Subtotals	1,350	15,596	16,946	718	11,649	12,367	5,143	12,028	17,171
Total Spawner Escapement	2,042	23,648	25,690	988	18,133	19,121	9,091	19,388	28,479

IN-RIVER HARVEST

	1990			1991			1992		
Angler Harvest	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
Klamath River (below Hwy 101 bridge)	58	291	349	19	314	333	13	20	33
Trinity River basin (above Willow Creek)	22	328	350	94	1,177	1,271	158	314	472
Balance of Klamath system	2,020	2,934	4,954	573	1,892	2,465	3,949	668	4,617
Subtotals	2,100	3,553	5,653	686	3,383	4,069	4,120	1,002	5,122
Indian Net Harvest e									
Klamath River (below Hwy 101 bridge)	13	3,648	3,661	7	3,902	3,909	124	1,152	1,276
Klamath River (Hwy 101 to Trinity mouth)	141	3,447	3,588	25	5,016	5,041	200	3,687	3,887
Trinity River (Hoopa Reservation)	36	811	847	30	1,280	1,310	42	946	988
Subtotals	190	7,906	8,096	62	10,198	10,260	366	5,785	6,151
Total In-river Harvest	2,290	11,459	13,749	748	13,581	14,329	4,486	6,787	11,273

IN-RIVER RUN

	1990			1991			1992		
Totals	Grilse	Adults	Totals	Grilse	Adults	Totals	Grilse	Adults	Totals
In-river Harvest and Escapement	4,332	35,107	39,439	1,736	31,714	33,450	13,577	26,175	39,752
Angling Mortality (2% of harvest) f	42	71	113	14	68	82	82	20	102
Net Mortality (8% of harvest) f	15	632	647	5	816	821	29	463	492
Total In-river Run	4,389	35,810	40,199	1,755	32,598	34,353	13,688	26,658	40,346

(continued next page)

a/ Prepared December 13, 1990. All figures are California Department of Fish and Game counts/estimates unless otherwise indicated. All figures for Iron Gate and Trinity River hatcheries represent counts of fish entering those facilities. All spawner escapement figures for the Shasta River basin for 1978-1987, plus those for the Bogus Creek basin for 1980-1990 are based on counts made at counting stations located near the mouths of those streams. All remaining spawner escapements and all harvest figures are estimates developed from data obtained through ongoing field investigations in the Klamath-Trinity system. Figures for years through 1989 are final; 1990 figures are preliminary, subject to revision.

b/ Figure not available.

c/ U.S. Fish and Wildlife Service (USFWS) estimate.

d/ In 1978, the Klamath River system sport salmon fishing season was closed August 25. There was essentially no sport harvest of fall chinook in the Trinity River basin in 1978.

e/ USFWS estimates for years through 1982; 1983 through 1990 estimates jointly made by USFWS and Hoopa Valley Business Council Fisheries Department (HVBCFD).

f/ Factors for non-landed catch mortality calculated by the Klamath River Technical Advisory Team (KRTAT, 1986, "Recommended Spawning Escapement Policy for Klamath River Fall-run Chinook").

g/ U.S. Forest Service estimate.

h/ HVBCFD estimate. Estimate for streams in Hoopa Valley Indian Reservation only.

i/ In 1985, the Klamath River system sport salmon fishing season was closed to the taking of all salmon below the U.S. Highway 101 bridge from September 9 through December 31; the Klamath from the U.S. Highway 101 bridge to Iron Gate Dam and the Trinity River from its mouth to Lewiston Dam were closed to the taking of salmon 22 inches and longer from September 23 through December 31, 1985.

j/ Estimates for Hoopa Valley Indian Reservation portion of catch (=947 grilse and 1,941 adults) are of catch occurring during open fishing periods only.

k/ Estimates jointly made by USFWS and HVBCFD.

CHAPTER 5

FISH POPULATION RESTORATION

This chapter addresses the role of artificial propagation in augmenting fish populations in the Klamath River Basin. It also discusses the side effects of such programs, including disease, and potential impacts of artificially cultured fish on wild fish populations.

ISSUES

* Do we need more hatcheries?
* Do we need small scale rearing programs to help more young fish survive over winter?
* Concern that rearing fish in hatchboxes may not achieve desired effect if habitat quality remains poor.
* Concern that the "quick fix" of massive hatchery programs may have negative side effects and lead to eventual disaster.
* The need to return the river to a native stock base rather than the present artificial hatchery base.
* Concern that hatchery planting may exceed the carrying capacity of the river leading to decreased survival of both hatchery and native juvenile salmon and steelhead.

HISTORY

> When this county was first settled by man, all of our rivers and streams were stocked to the limit with rainbow trout ... salmon and other species of fish. But, in common with the bison and other wild game, they were ruthlessly slaughtered by man for food and gain. We have now come to the time where natural fish producing streams, lakes and rivers throughout the West have disappeared.
>
> A.J. Sprague

With these words, in a front page article in the Klamath Falls Northwestern in 1913, Mr. Sprague, a newly arrived hatchery manager, called for a new agenda. Natural production in the Klamath River was washed up. A look back at the time makes his perspective understandable. Hydraulic mining was wreaking havoc with fish habitat, timber harvest had begun, water diversion for agricultural was on the rise and Copco Dam was under construction and would block migration to a major portion of the upper Klamath Basin. No regulatory process seemed capable of stopping this juggernaut of progress. Mr. Sprague was sure we had the solution though ... "I can see no failure. By a hearty cooperation, we can get a real hatchery on Spencer Creek and stock the streams of Klamath County with millions of fish annually. This would bring in a vast amount of revenue through the influx of Eastern sportsmen."

The move to use hatcheries to offset habitat destruction and over-fishing was begun in the 1870's and Livingston Stone spoke of "the struggle to keep ahead of man's harmful actions on rivers, streams, and lakes to the detriment of fish and fishing" (McEvoy 1986). The first salmon hatchery in the Klamath Basin was established at Fort Gaston on the Hoopa Reservation in 1889 (Schofield 1929). It used chinook eggs from Redwood Creek and the Sacramento River and was closed in 1898 because of its remote locale (Schofield 1929).

A second hatchery was opened shortly after on an unspecified lower Klamath tributary and operated for several years (Schofield 1929). Again eggs used for the program were from Sacramento River, Redwood Creek, and Rogue River stocks. Large chinook salmon runs were established in Hunter and High Prairie Creeks while the hatchery was operated but they ceased when hatchery operations were discontinued (Schofield 1929). These fish were never planted above the mouth of Hunter Creek (Snyder 1931).

Upper basin stocking programs were begun in 1890 by the U.S. Bureau of Fisheries (Fortune et al. 1966). No hatchery was established at this time, however chinook fry and yearlings were planted through 1893 then in 1898, 1903, and 1908. Sacramento River stocks were used which puzzled Snyder (1931): "Just why it was deemed necessary to import fish to the Klamath, or why a stream where depletion was already apparent should be further robbed does not appear." Coho salmon were stocked in 1895. The 1908 plant included rainbow and Eastern brook trout. The California Fish Commission also stocked the Klamath intermittently between 1896 and 1916 with chinook fry from the Mt. Shasta Hatchery.

The U.S. Fisheries Bureau set up a fish trapping facility at Klamathon in 1910. The Klamathon Racks blocked upstream migration of chinook and coho into the upper Klamath drainage. Finally the Fisheries Bureau established a hatchery at Hornbrook in 1912, and by 1914 chinook and coho salmon of Klamath River origin were being raised and planted by this facility. Operation ceased in 1919.

The hatchery mentioned above on Spencer Creek was largely a trout hatchery. Migration of salmon and steelhead was blocked to this area of the basin first by the Klamathon Racks and in 1917 by Copco Dam.

The most long lasting fish cultural endeavor in the Klamath Basin was built at Fall Creek in 1920 to offset blocked migration at Copco Dam (Bryant 1923). Snyder looked on the hatchery as an opportunity to "demonstrate that artificial production may maintain the species, at least on a par with natural propagation elsewhere in the basin." The California Department of Fish and Game assumed operation of this facility from its inception. From 1920 through 1948 an average of 3,400,000 native chinook fingerlings were planted annually. Chinook eggs were also transferred from Fall Creek to the Mt. Shasta Hatchery and returned to the Klamath as fry (Dennis Maria personal communication). Smaller contributions from Prairie Creek Hatchery (Redwood Creek) were planted in the 1940's and early 1950's (Fortune et al. 1966). An average of 600,000 fingerling steelhead from native stock were also planted at Fall Creek Hatchery. Although coho salmon were trapped with chinook at Klamathon, they were never spawned (Bryant 1923).

Snyder (1931) was concerned in the late 1920's that artificial production was unable to supply fish to keep pace with rising harvest. He also noted that the Shasta River, even in a degraded condition was producing as many or more fish than artificial propagation at Fall Creek Hatchery, which was the only hatchery in the basin. The California Department of Fish and Game in 1945 conceded "that artificial production of anadromous salmonids has not proven more efficient than natural production, nor has it been found economically justifiable" (Van Cleve 1945 as cited in McEvoy 1986).

As dams were built on the Klamath and Trinity Rivers in the early 1960's, however, large hatcheries were the only solution to mitigate for habitat lost upstream of these structures. In the late 1970's small scale hatchbox and rearing pond programs were initiated to increase fish production in lower basin tributaries.

LARGE SCALE ARTIFICIAL PROPAGATION FOR MITIGATION AND ENHANCEMENT

Iron Gate and Trinity River Hatcheries are the two large scale artificial propagation facilities in the Klamath River Basin. Both were constructed to offset losses due to large dams which blocked migration to former spawning areas. Both facilities have been able to substantially increase production in recent years.

Iron Gate Hatchery

Iron Gate Hatchery was constructed below Iron Gate Dam to mitigate for lost habitat blocked by the dam. Construction costs were paid by Pacific Power and Light Company (PPL) and operation of the facility was assumed by the California Department of Fish and Game. PPL still pays 80 percent of operation costs while CDFG covers the remaining 20 percent.

Production

The Iron Gate Hatchery Operational Plan (CDFGa no date) sets the production goals for mitigation and enhancement shown in Table 5-1. Goals for total egg take for fall chinook salmon are to incubate 18,000,000 fall chinook eggs, which represents the rearing capacity of incubation trays. Eggs taken in excess of 15,000,000 can be shipped to supply the programs elsewhere in the state such as Oroville Reservoir. Hatchery guidelines call for the release of 6,000,000 fall chinook fingerlings for mitigation and 1,400,000 yearlings for enhancement. Annual goals for coho salmon call for collecting 500,000 eggs to enable rearing of 75,000 yearlings for mitigation. Steelhead targets are an egg take of 1,000,000 to ultimately yield 200,000 yearlings.

The actual hatchery production from 1979 to 1988 is listed in Table 5-2. Coho and steelhead planted as yearlings have averaged 119,796 and 311,531 per year respectively. Minor numbers of fingerlings of these species are included in figures below in some years. Yearlings of coho and steelhead raised above mitigation goals would be CDFG contributions for enhancement purposes. Fall chinook have shown dramatic rises in number of fingerlings planted. From 1979 to 1984 fingerling plants averaged 1,685,439 annually and jumped to an average of 10,632,777 in the years since 1985.

Fall chinook yearlings have stayed relatively constant and averaged 1,110,421 per year. The number of juvenile salmonids released from Iron Gate Hatchery, particularly since 1985, is substantially greater than that contemplated in the Hatchery's operating guidelines. No yearling chinook were raised at Iron Gate Hatchery during 1990 due to CDFG budget restrictions.

TABLE 5-1 -- Production Goals for Mitigation and Enhancement at Iron Gate Hatchery.

	Fall Chinook	Coho	Steelhead
Eggs for Mitigation	15,000,000	500,000	1,000,000
Eggs for Enhancement	3,000,000	-0-	-0-
Goal for Total Eggs	18,000,000	500,000	1,000,000
Fingerlings (Mitigation)	6,000,000	-0-	-0-
Fingerlings (Enhancement)	-0-	-0-	-0-
Yearlings (Mitigation)	-0-	75,000	200,000
Yearlings (Enhancement)	1,400,000*	-0-	-0-

* Rearing to take place as follows: 900,000 at IGH, 300,000 in pond program, and 180,000 at Fall Creek Hatchery.

From Iron Gate Hatchery Reports (Hiser 1978-89).

TABLE 5-2 -- Annual Production of Juvenile Salmon and Steelhead at Iron Gate Hatchery, 1979-1989.

	Fall Chinook		Coho	Steelhead	
	Fingerlings	Yearlings	Juveniles*	Juveniles	Total
1979-80	1,325,868	1,015,185	51,000	341,804*	2,733,857
1980-81	1,033,965	1,474,920	200,132*	372,010	3,081,027
1981-82	885,066	1,023,000	121,856	314,530*	2,344,452
1982-83	782,530	1,002,003	120,672*	145,140*	2,050,345
1983-84	2,960,652	899,062	78,042	574,150*	4,511,906
1984-85	3,124,552	1,330,290	23,059	185,700	4,663,601
1985-86	12,513,039	928,000	179,760	249,000	13,869,799
1986-87	9,730,200	1,065,093	205,000	316,450	11,316,743
1987-88	11,656,560	1,055,000	135,000	335,000	13,181,560
1988-89	10,511,570	1,129,240	143,400	219,000	12,003,110

* Years in which there were some fingerlings included in plants.
From Iron Gate Hatchery Reports (Hiser 1978-89).

<u>Returns</u>

Returns of adult salmon and steelhead to the Iron Gate Hatchery from 1979-1988 are shown in Table 5-3. Fall chinook have shown a substantial upswing during this period. While average returns for 1979-81 were 2,672, returns rose to an average of 8,388 for 1982-84, and to 18,599 for 1985-88. The increase in escapement to Iron Gate

Hatchery may have been in part as a result of reduction in harvest. Favorable ocean conditions also contributed to increased escapements of both hatchery and native stocks. Returns of fall chinook often include a few Trinity River Hatchery adults, some from Cole River Hatchery on the Rogue River and, rarely, fish from the Sacramento River.

Yearling chinook planted return to the hatchery at a rate of 3.5-to-1 over fingerlings. Average annual contributions to the fisheries and escapement from Iron Gate Hatchery releases between 1979-84 were 7,330 for fingerlings and 25,560 from yearling releases (Bill Chesney personal communication). A high percentage of Iron Gate Hatchery yearling chinook releases mature at age four.

Coho returns from 1979-1988 have ranged widely from a low of 289 in 1983 to a high of 2,893 in 1987. Average run size has been 1,851. Steelhead returns to Iron Gate Hatchery have averaged 2,577 during the same period. Coho from Cole River Hatchery on the Rogue sometimes return to Iron Gate.

TABLE 5-3

Adult Salmon and Steelhead Returning to Iron Gate Hatchery, 1979-1988.

Year	**Fall Chinook**	**Coho**	**Steelhead**
1979	2558	2401	1657
1980	2863	2051	1247
1981	2595	997	2261
1982	10186	1629	2703
1983	8885	289	832
1984	6094	1005	1385
1985	22110	2677	3165
1986	18557	1025	2834
1987	17014	2893	3770
1988	16715	1692	3343

From Iron Gate Hatchery Reports (Hiser 1984-1989).

Planting Procedures, Stock Transfer

Before 1985, Iron Gate Hatchery fall chinook were sometimes planted as far downstream as Klamath Glen. These outplantings were conducted on an experimental basis. After evaluating the program, returns were not found to be higher than those juvenile chinook released at the hatchery so the practice was discontinued (D. Maria personal communication). Most plants of fall chinook are now done at the hatchery, although stocks are transferred to support pond rearing programs downstream. Release time for the 6,000,000 chinook fingerlings raised to 90 to the pound has been changed from June and July to no later than May 31. This earlier release date mimics the pattern of migration for native stocks and allows the hatchery fingerlings to avoid warmer river temperatures (T. Mills personal communication). If water conditions are appropriate, fingerlings may be held until June 15 to attain optimal size. Yearling chinook are released in October. Recent transfers have also been made to establish a landlocked fishery in Oroville Lake and for a rearing project on the central coast.

From the 1,000,000 eggs collected annually, selection of 250,000 fingerlings occurs before September 1, with the ultimate goal of rearing 200,000 steelhead juveniles to yearlings. Steelhead yearling releases have been in April and May at Iron Gate Hatchery. Recent transfers of steelhead fingerlings to the Perch Creek rearing ponds in 1988 and 1989 were 10,000 and 12,000. The fish are then raised to yearling size. In 1985 and 1986, 430,000 steelhead eggs were transferred to the Trinity River Hatchery. Transfer of steelhead eggs between Iron Gate and Trinity River Hatcheries is no longer allowed (CDFGb no date).

Coho yearlings have been released in March and April. From 1986 to 1988 40% of the coho yearlings were planted at the hatchery. The remainder were transplanted into Indian Creek, Elk Creek, and Beaver Creek. Iron Gate coho were planted in the Salmon River in 1985. 450,000 and 850,000 surplus coho eggs were shipped to the Mad River Hatchery in 1986 and 1987, respectively.

To insure that production goals are met, excess eggs are taken and excess fry are reared. As these juvenile fish grow, they begin to exceed the rearing capacity allotted. A portion of the excess juvenile chinook are removed from each raceway and released to the river at the hatchery site. Each group has had some fraction marked by clipping the adipose fin and implanting coded wire tags to monitor performance (Bill Chesney personal communication). Excess juvenile steelhead have been released above Iron Gate Dam in the past, but planting of steelhead in Iron Gate Lake has been discontinued (Curt Hiser personal communication).

Broodstock

Iron Gate Hatchery has used Klamath River fall chinook stocks for broodstock exclusively. Attempts to establish a spring chinook run from native stock when the hatchery was first founded were unsuccessful. Insufficient numbers of native coho were returning to the hatchery site when Iron Gate Dam was completed, so coho stocks were founded with eggs imported from the Trinity River Hatchery, Cascade Hatchery in Oregon, and Mt. Shasta Hatchery (CH2M Hill 1985). Since Mt. Shasta Hatchery is on the Sacramento, which does not have coho salmon, the coho from this source may have been from another California stream, such as the Noyo River (Bob Corn personal communication). While native steelhead were trapped for broodstock at Iron Gate Hatchery when it was opened, steelhead eggs were imported from the Trinity River Hatchery to supplement those fish captured locally. Trinity River steelhead continued to contribute to Iron Gate egg takes through straying (Marshall 1974). Cowlitz River steelhead from Washington were also introduced to attempt to increase the size of steelhead returning to the hatchery (Riley 1969).

Each year broodfish are selected from a representative return of both early and later returning chinook. Steelhead arriving after January 1 are spawned separately from those returning earlier to maintain wide run timing. All excess adults of all species are returned to the river except those bearing coded wire tags which are sacrificed to retrieve the tag.

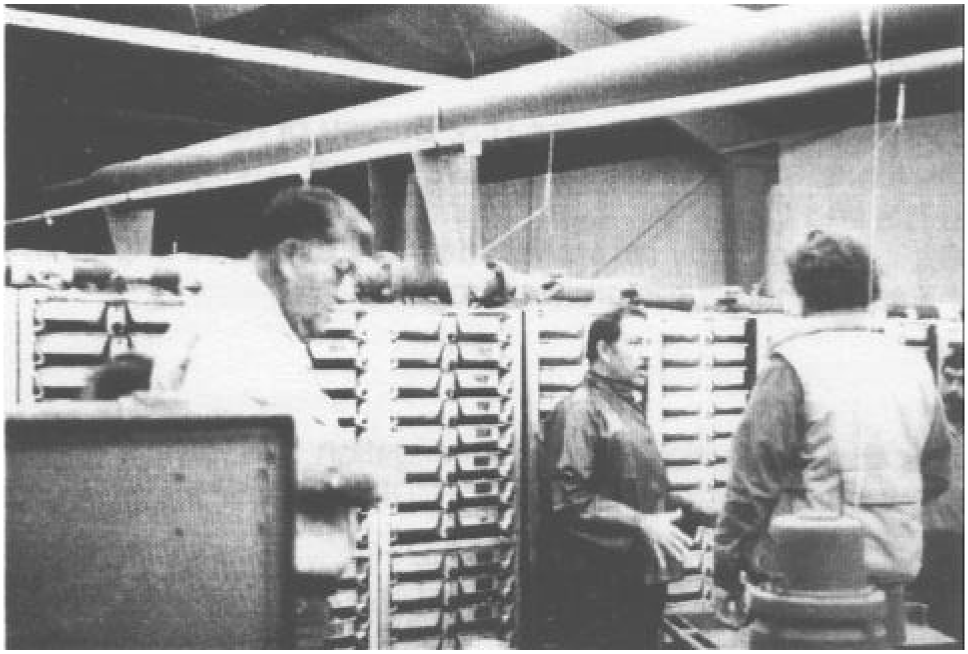


Figure 5-1 -- Iron Gate staff show visitors the hatchery. The hatchery's incubator trays can hold up to 18 million eggs.

Disease and Operational Problems

Disease and operational problems with the protozoan pathogen, Ceratomyxa shasta, were experienced shortly after Iron Gate Hatchery was opened and periodic outbreaks continued into the early 1980's (CH2M Hill 1985). Other diseases present include Columnaris disease, an external and gill infection caused by the bacteria Flexibacter columnaris (Amos 1985), bacterial gill disease, Flavobacterium sp. (Wakabayashi et al. 1980), and soft shell and white spot. Both the latter diseases are thought to be caused by the bacteria Cytophaga (Wood 1974). Iron Gate Hatchery coho have had chronic problems with soft shell necessitating large egg takes to insure that production goals are met (CDFGa no date). Bacterial kidney disease (BKD), which is caused by Renibacterium salmoninarum (Amos 1985), has been found at Iron Gate Hatchery in recent years but no significant losses have occurred (Mel Willis personal communication).

Water for Iron Gate Hatchery is drawn from 70 feet below the surface of the reservoir to obtain cool water. Low oxygen levels in the water are remedied by using an aeration device but organic material in the water remains high. PPL conducted an experiment in 1986-88 where intake water was filtered for a few incubation trays and an increase of 15 percent in survival resulted (Curt Hiser personal communication). Long term plans of PPL include filtering all water used by the hatchery.

Approximately 500,000 fall chinook fingerling died shortly after release in June 1987 when stream temperatures below Iron Gate Dam were substantially warmer than the temperatures in the hatchery ponds (Sacramento Bee 1987). Thermal stress may have caused the high mortality of the fish that were released. Earlier release dates now preclude a recurrence of this problem.

Trinity River Hatchery

Trinity River Hatchery was built by the U.S. Bureau of Reclamation to offset losses in salmon and steelhead habitat above Lewiston and Trinity Dams. The California Department of Fish and Game has been responsible for operating the facility since its inception in 1963. The hatchery recently underwent extensive improvements as part of the Trinity River Basin fisheries restoration program.

Production

Table 5-4 lists the production goals for mitigation and enhancement set out in the Trinity River Hatchery Operational Guidelines (CDFG no date).

TABLE 5-4 -- Production Goals for Mitigation and Enhancement at the Trinity River Hatchery.

	Chinook			
	Fall	**Spring**	**Coho**	**Steelhead**
Eggs for Mitigation	6,000,000	3,000,000	1,200,000	2,000,000
Eggs for Enhancement	-0-	-0-	-0-	-0-
Goal for Total Eggs	6,000,000	3,000,000	1,200,000	2,000,000
Fingerlings (Mitigation)	2,000,000	1,000,000	-0-	-0-
Fingerlings(Enhancement)	-0-	-0-	-0-	-0-
Yearlings (Mitigation)	500,000	400,000	500,000	800,000
Yearlings (Enhancement)	400,000	-0-	-0-	-0-

Actual production totals from 1979 to 1988 at Trinity River Hatchery are listed in Table 5-5. Fingerling plants of spring and fall chinook combined averaged 1,360,748 from 1979 through 1984. From 1985 to 1988 plants increased to an average of 5,285,053. Yearling plants have not shown similar increases but have averaged 1,206,324 from 1979-1988. In 1988 only 93,300 yearling chinook were planted. From 1979 to 1988 the average number of coho juveniles planted was 670,531 annually. Plants ranged from a high of 1,198,696 in 1981 to a low of 156,150 in 1984. Numbers of steelhead juveniles planted range from a low of 237,000 in 1983 to a high of 925,000 in 1987. Average annual releases from 1979-1988 have been 585,658.

Returns

Chinook returns to the Trinity River Hatchery increased dramatically between 1985 and 1988 as a result of reduced ocean harvest. Improved streamflow releases from the federal Central Valley Project's Trinity Reservoir and favorable ocean conditions also are believed to have contributed to the increase in escapement (USFWS in press). Average combined returns of spring and fall chinook from 1979 to 1984 were 5,923 adults. The average return jumped to 28,619 from 1985 to 1988.

TABLE 5-5 -- Annual Production of Juvenile Salmon and Steelhead at the Trinity River Hatchery, 1979-1989.

	SCHF	SCHY	FCHF	FCHY	CY	SY
79-80	416,900	400,866	409,632	786,857	609,396*	385,211*
80-81	-0-	123,728	1,481,045	712,450	451,983*	459,694*
81-82	1,249,475	35,128	939,300	971,873	1,198,496*	976,913*
82-83	151,875	358,268	430,930	1,093,613	1,150,076*	677,169*
83-84	-0-	2,575,335	860,813	332,292	560,298	237,000
84-85	-0-	34,457	510,000	1,165,781	156,150	678,425
85-86	3,296,310	563,970	1,149,598	2,055,925	901,913	450,122
86-87	2,172,362	492,860	3,601,289	1,018,440	908,738*	536,743
87-88	2,803,226	86,048	2,350,205	982,784	347,256	925,100
88-89	1,938,914	-0-	2,921,982	93,300	421,100	530,200

* Years in which some fingerlings were included in the plants. In the other years, all the fish in the totals are yearlings.

SCHF = spring chinook fingerlings
SCHY = spring chinook yearlings
FCHF = fall chinook fingerlings
FCHY = fall chinook yearlings
CY = coho yearlings
SY = steelhead yearlings

From Trinity River Hatchery Reports 1984-1989 and CH2M Hill (1985).

The range of coho adult returns to the hatchery has varied from a low of 706 in 1983 to 23,338 in 1987. Some years, such as 1984, the run was composed largely of jacks. Average coho returns have been 8,232. Steelhead returns to the hatchery have been erratic, dropping to a low of 142 in 1984 but reaching a high of 3,780 in 1986. Returns of steelhead were very good in 1989 (Paul Hubbell personal communication). The higher levels of return in three out of the last four years seem to indicate a trend toward better success with steelhead performance at Trinity River Hatchery.

Table 5-6 lists the returns to the Trinity River Hatchery from 1979 to 1988.

<u>Planting Procedures, Stock Transfers</u>

Fingerling chinook are released from Trinity River Hatchery in June while yearlings are released in October and November. Prior to 1986, chinook were planted downstream in the Trinity River as far as Willow Creek, but more commonly at Junction City and Lime Point. Trinity River Hatchery fall chinook were supplied for rearing programs on the Hoopa Reservation through 1987. While hatchery renovations were underway, chinook were reared at Sawmill Ponds just downstream from the hatchery and released in the immediate area. All releases now occur at the hatchery. Ambrose and Sawmill Ponds were activated in 1987 to rear excess juveniles from the large egg take that year.

Yearling chinook planted by Trinity River Hatchery have contributed at a consistently higher rate than fingerlings to both the fisheries and to escapement (Serge

Birk personal communication). Some chinook were held for over a year and released in February. Adults from these yearling-plus releases returned to the river at a high rate but at a much smaller size (Alan Baracco personal communication). This program has been discontinued.

Coho and steelhead were widely transplanted prior to 1984 in the Trinity Basin as far down as Weitchpec and in the Hayfork and South Fork of the Trinity drainage. All releases of both species now are made only at the hatchery. Coho are released in March and steelhead are released in March and April. Prior to 1984, plants of both species were a mixture of fingerlings and yearlings. Now steelhead and coho are raised to yearling size before release. Steelhead not attaining a size of six inches by release time are raised for a second year in the hatchery.

TABLE 5-6

Adult Salmon and Steelhead Returning to Trinity River Hatchery, 1979-1988.

Year	Spring & Fall Chinook	Coho	Steelhead
1979	4,070	4,041	382
1980	7,258	3,323	2,019
1981	5,874	4,523	1,007
1982	7,669	4,798	715
1983	6,923	706	603
1984	3,744	8,861*	142
1985	23,902	11,786	461
1986	27,947	8,132	3,780
1987	26,240	23,338	3,007
1988	36,386	12,816	817

* 7,611 of the coho return were jacks.

From Trinity River Hatchery Annual Reports 1984-1989.

Broodstock

Trinity River Hatchery chinook salmon are largely of native origin, although some Sacramento River and Washington stocks were used in the early years of operation. In 1982, 2,500,000 Iron Gate Hatchery fall chinook eggs were imported, but since most were not viable due to disease (Beddell 1985), genetic implications were probably insignificant. Such practices are no longer allowed (Bob Corn personal communication).

Coho stocks were derived from Cascade Hatchery in Oregon. Native steelhead were used for original broodstock for the hatchery but problems with low returns caused significant importation of steelhead from Iron Gate Hatchery, Cedar Creek Hatchery on the Eel River, three Oregon hatcheries, and Washington's Skamania Hatchery. Iron Gate Hatchery eggs were imported as recently as 1984-85.

Disease and Operational Problems

Diseases present at Trinity River Hatchery include enteric red mouth which is caused by the bacteria Yersinia ruckeri, bacterial kidney disease (BKD), white spot and infectious hematopoetic necrosis (IHN), a viral disease. Seven million coho eggs were found to be at risk to IHN in 1985 and destroyed as a precautionary measure (Bob Corn personal communication). IHN has caused losses of between one and two million chinook salmon annually during spring at Trinity River Hatchery over the last few years (Bill Wingfield personal communication). This problem seems to have been resolved by use of an anti-viral compound, iotophore. No losses were experienced during the spring of 1990 after all eggs had been treated with this substance (Bill Wingfield personal communication). IHN is most severe at temperatures from 40-54 F. (Amos 1985). The hatchery has also recently been equipped with heaters so water temperatures can be raised (Serge Birk personal communication).

Bartley and Gall (1990) recently reported that crosses between chinook and coho salmon ("conooks") were occurring in the Klamath River Basin and particularly at or below Trinity River Hatchery. Chevassus (1979), in a review of the literature, found natural crossing of chinook and coho to be extremely rare. The earlier run timing of the hatchery strain of coho versus original native coho stocks, the large runs of both coho and fall chinook in recent years, and the limited amount of spawning area below the hatchery may be the combination of factors that led to this occurrence.

Hendrick et al. (1987) also noted the crosses occurring at Trinity River Hatchery and described changes in resistance to disease that may be related to the hybridization. They noted that coho were not susceptible to IHN at the hatchery or anywhere in their range. Experiments were conducted by Hendrick et al. (1987) and it was discovered that while pure coho were resistant to IHN, chinook had some susceptibility, and the hybrid conooks had almost no resistance to IHN. Hybridization could lead to increased losses of fish at Trinity River Hatchery to IHN. Bartley (personal communication) indicates that hybrids may retain external characteristics of chinook or coho but sometimes have mixes of both. Thus, the problem of intermixing hybrids into broodstocks could elude graders and continue to exacerbate the problem.

Spring chinook holding in the Trinity River above Junction City during the summer had a high mortality rate in the recent years of high escapement (1986-88). The exact cause of this problem is unknown but USFWS (1990c) used an estimate of 50 percent mortality before spawning for those fish passing above the CDFG Junction City weir. Possible causes include overcrowding and harassment by poachers while the fish are holding during summer (USFWS in press). Two large holding pools have recently been dredged by the Trinity River Restoration Program to try and decrease overcrowding stress.

Increased disease monitoring for Trinity River Hatchery fish and native Trinity River fish is being proposed for 1991 (Foote 1990).

SIDE EFFECTS OF LARGE SCALE HATCHERY PROGRAMS

While Iron Gate and Trinity River Hatcheries are necessary to mitigate for the fish production lost above dams, large scale hatchery operations can have negative side effects. Hatcheries can cause problems for survival of wild populations of the Klamath Basin due to 1) increased competition causing decreased native fish survival, 2) interbreeding of "non-adapted" hatchery adults with native fish, causing reduced survival of offspring, 3) introduction of diseases, and 4) in the worst case, massive hatchery programs can cause stocks to collapse. Examples of the latter problem are taken from case studies elsewhere. Increased fishing pressure in a mixed stock fishery can also be a substantial problem, and is addressed separately in Chapter 4.

Competition Between Hatchery Fish and Native Fish

In the Mainstem Klamath River

Thermal problems in the mainstem of the Klamath River (see Chapters 3 & 4) may be causing a substantial shortage in suitable habitat for outmigrating salmonid juveniles. Sullivan (unpublished) and Mills et al. (unpublished) have found that native chinook and hatchery chinook juveniles move down the main Klamath River throughout the summer. T. Mills (personal communication) has found large concentrations of juvenile salmonids congregated at the mouth of coldwater feeder streams, such as Blue Creek. Young hatchery chinook with fin clips have also been found holding upstream in these cold tributaries in late summer. Migrations of large numbers of juveniles have been noted moving up Indian Creek from the Klamath in summer when the river temperatures were high (Phil Baker personal communication).

In several published reports, fisheries biologists have found that high concentrations of fish result in increased competition for food and space and can decrease survival of both hatchery and native fish (Salo and Baliff 1958, Steward and Bjornn 1990). This phenomenon is termed "density-dependent rearing mortality." When planted, hatchery smolts are larger than native fish so they may displace native fish through competition (Smith et al. 1985). Stempel (1988) felt that problems related to competition between hatchery and native juveniles could be occurring in the main stems of both the Trinity and Klamath River resulting in reduced survival of native fish.

Studies by Mills et al. (unpublished) found that numbers of fall chinook salmon smolts coming from Bogus Creek varied widely between years. While Mills et al. (unpublished) has estimated outmigration of over 1,000,000 smolts in years of optimal escapement, after the storm of February 1986, he estimated that only 27,000 juvenile chinook were produced. In the spring of 1986, Iron Gate Hatchery released over 9,000,000 smolts. Forces of competition due to shear numbers may move the system toward hatchery dominated runs in years when over-wintering conditions are particularly severe.

Royal (1972) found that the survival rates of hatchery steelhead smolts decreased as distance from the ocean and numbers of fish planted increased. Lichatowich and McIntyre (1987) attributed this to higher density related mortality during migration. Chapman (1989) found that hatchery releases of juvenile chinook drew native chinook and steelhead downstream with them, which he termed "the pied piper effect." Noble, as cited in Royal (1972) also asserted that density dependent factors from planting in excess of carrying capacity can effect other species. The effects of large releases of chinook could be playing a role in decreasing native steelhead populations. Competition with hatchery fish may be much greater on those native stocks from upstream areas, such as the Shasta River, that are exposed to competition for a greater distance in the Klamath during outmigration.

Studies in the Trinity River found that steelhead released at less than six inches did not emigrate. Kerstetter and Keeler (1976) found that the timing of peaks in blood hormone levels that stimulated outmigration were different in native Trinity River steelhead than in hatchery steelhead. They felt that not releasing the fish when hormonal cues would have stimulated outmigration led to this "residual" behavior. Current Iron Gate Hatchery practices (CDFGa no date) call for taking 1,000,000 eggs and rearing 200,000 yearlings. All steelhead in excess of this goal are released to the river at a size less than six inches. If these fish manifest the same behavior as was exhibited on the Trinity, they may be living in the main river, competing for space and food with native fish, and even predating on both hatchery and native outmigrating juveniles. Large residuals have been reported by anglers (Dick Sumner personal communication) and guides have reported an increasing catch of 8 to 10 inch juvenile steelhead during winter (Bob Young personal communication). It is possible that competition from residuals could be one of the factors leading to the poor production of wild steelhead in the Klamath River. Observations on the lower river during 1978-82 indicated that hatchery steelhead may spend one additional year in the river after release, then migrate to the ocean (Dennis Lee personal communication).

In the Tributaries

Iron Gate Hatchery coho were outplanted in Elk, Grider, and Beaver creeks in the Middle Klamath region from 1986-88. Smith et al. (1985) said similar programs in Oregon "lacked biological benefit." Although stocked streams reared more juveniles, researchers observed that native juveniles were displaced by hatchery fish. Further, when hatchery adults returned to spawn with native fish, juvenile recruitment was greatly reduced due to less well-adapted offspring (Smith et al. 1985).

In the Estuary

Studies by CDFG (unpublished) indicate that chinook juveniles did not spend extended periods in the estuary of the Klamath in 1983-85. Sullivan (unpublished) found no scale patterns in fall chinook to indicate extended estuarine rearing as well. In contrast, Snyder, reported in 1931 that juvenile chinook lingered in the estuary and showed their most rapid growth there. Estuarine studies in Oregon (Reimers 1973) found that high densities of chinook juveniles increased intraspecific competition that resulted in early ocean entry. Without the period of rapid growth in the estuary by fall chinook, the chances for survival decreased (Reimers 1973). The estuary appears to be an area where density-dependent rearing mortality could be decreasing the survival of both native and hatchery chinook. Nicholas and Hankin (1988b) suggested that some Oregon coastal rivers probably could not support increases from hatchery production because of the limited capacity of their estuaries.

In the Ocean

McGie (1984), used the Ricker model to study the population crash of coho in Oregon in 1980, and concluded that density-dependent mortality occurred at sea between hatchery coho in years of poor upwelling. Riesenbichler and Emlen (1988), using the Beverton-Holt population model and data from Oregon coho, predicted that attempts to double present run size on the Columbia River by doubling smolt output would not succeed. Their study predicted that doubling current smolt output from 30 million to 60 million would only increase returns from the current run size of 1 million by 140,000 fish in good upwelling years and by only 80,000 in poor years. Since coho salmon from both Iron Gate and Trinity River Hatcheries are of Columbia River origin, they may be showing similar ocean migration patterns to those described in the case study above. Chinook from both hatcheries show considerable variation in ocean migration, as monitored by coded wire tags, and it is unlikely that chinook stocks from the Klamath are manifesting this problem.

Interbreeding Between Hatchery Fish and Native Fish

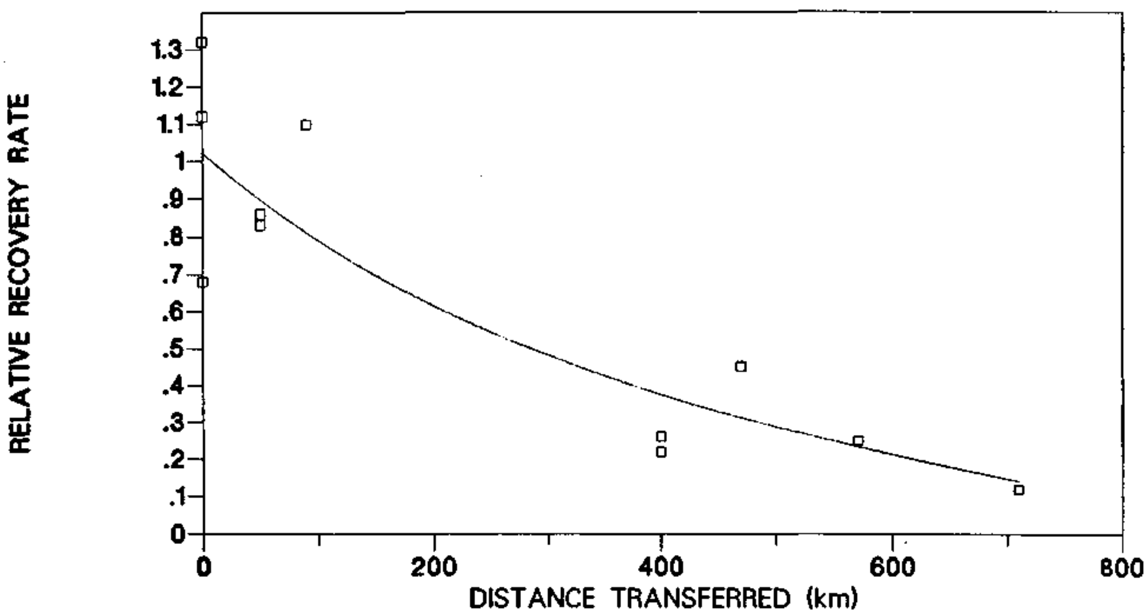
When hatchery broodstocks have non-native components or are inbred, they decrease the smolt production of native populations as they stray into streams to spawn with locally adapted stocks (Riesenbichler and McIntyre 1977, Chilcote et al. 1982, Royal 1972, Solazzi et al. 1983, Ryman and Utter 1987). Local populations may develop special adaptations to local watershed conditions (Ricker 1972). Even if the introduced stock is from a basin that has similar selective pressures, it may have evolved different genetic solutions to the same problem (McIntyre et al. 1988). Almost any survival trait is controlled by several genes referred to as a "co-adapted gene complex" (Shields 1982). Because the gene coding was evolved separately for the native and introduced fish, "mingling of two different gene networks (mixing stocks) may disrupt the effectiveness of either" (McIntyre et al. 1988).

The Use of Non-Native Broodstocks

Riesenbichler (1988) found that the survival of transplanted coho salmon decreased in a linear fashion with the distance planted from their native watershed (Figure 5-2). The original coho broodstocks at both major hatcheries in the Klamath Basin were from Cascade Hatchery stocks in Oregon. The distance between their stream of origin, the Columbia River, and the Klamath River is over 800 km. The productivity of the stock is thus predicted to be very low (Figure 5-2). Problems with low productivity and erratic patterns of return of hatchery coho after introduction may have been attributable to the inappropriate adaptations of this stock. Recent improved performance of this stock may reflect adaptations to the hatchery environment (or domestication) allowing better survival under these artificial conditions. Problems with interaction with native populations may still occur, however.

Oregon hatchery programs used coho salmon large central facilities for all of the Oregon coast. As these hatchery coho, lacking adaptations to local conditions, strayed back to spawn with wild stocks, fewer viable smolts were produced (Solazzi et al. 1983). The program of outplanting coho fingerlings and yearlings in Elk, Beaver, and Indian Creeks may have had a negative impact on any wild stocks still remaining in those basins. While this program is currently being monitored to determine if the planting has led to increased self-sustaining coho production, Withler (1982), in a review of the literature, found that the introductions of Pacific anadromous salmonids, using non-native broodstock, have been unsuccessful in producing new self-reproducing populations anywhere on the West Coast.

Figure 5-2 -- Relative (to local fish) recovery rate for transferred hatchery coho salmon versus distance transferred. Rates are based on recoveries in the fisheries and at the hatchery.



Data from Riesenbichler 1988.

Outplanting also causes increased straying (Royal 1972) so that the impacts of this stock, poorly adapted for local stream conditions, could be felt over a wide area. The number of non-native fish spawning with a local population is a key determinant of whether genetic damage will occur (Riggs 1990). Steelhead were planted away from the Trinity River Hatchery, as far downstream as the estuary, to encourage ocean migration (Bedell 1972). Substantial numbers of these steelhead, which had non-native broodstock components, strayed to Iron Gate Hatchery as a result (Marshall 1974). Offsite releases are no longer accepted practice at Trinity River Hatchery except for chinook salmon pond rearing programs.

The Klamath River has periodic high levels of the protozoan disease organism Ceratomyxa shasta. Marsh areas and lakes are thought to be optimal conditions for this protozoan although the life cycle of the organism remains unknown. All stocks of rainbow trout in the areas above Iron Gate Dam are resistant to this disease (Buchanan in press). Locally adapted steelhead stocks in the vicinity of Iron Gate Hatchery should also have evolved almost total resistance. Studies on the Nehalem River in Oregon found that introductions of Trask River coho decreased the viability of native Nehalem coho stock substantially because the introduced Trask fish lacked resistance to Ceratomyxa shasta (Kapuscinski 1984). Problems with disease outbreaks at Iron Gate Hatchery occurred as a result of introductions of steelhead strains that were not resistant to this disease. Periodic problems with losses of large numbers of hatchery steelhead continued into the early 1980's (CH2M Hill).

Carlton (1989) has found that chinook salmon at Iron Gate Hatchery have a 4 percent susceptibility to Ceratomyxa while Trinity River Hatchery chinook have a 12 percent susceptibility. Similar studies (Hubbell 1979) on steelhead found similar resistance of Iron Gate Hatchery steelhead and Trinity River Hatchery steelhead (12 percent). It is possible that Iron Gate Hatchery steelhead have less resistance to C. shasta than hatchery chinook because of the earlier non-native steelhead introductions and straying of Trinity River Hatchery fish. Therefore, there may be a difference in resistance between hatchery steelhead and native steelhead as well. Shasta strain rainbow trout were used to test for the presence of C. shasta at Iron Gate Hatchery during the summer of 1990, since this strain of trout is 100 percent susceptible to the disease. The disease organism was present, all Shasta rainbows died, but steelhead losses were not high (Mel Willis personal communication).

Problems with Inbreeding

Even when hatchery broodstock is derived from local populations, inbreeding or improper broodstock management can result in considerable decline in genetic diversity of hatchery stocks (Allendorf and Phelps 1980, Ryman and Stahl 1980, Vuorinen 1984). These fish subsequently have decreased ability to survive in the wild (Phillip and Kapuscinski 1988). If genetic diversity decreases to very low levels reproductive capability drops. This condition is known as "inbreeding depression" and may require broodstock replacement. Inbreeding can result from initial broodstock being too small in size (less than 100 pairs) or subsequent generations of returns to the hatchery declining below these levels (Allendorf and Ryman 1987). Both hatcheries have had years when coho returns have dipped below 100 pairs.

Inadvertent selection, such as taking spawn from only early run fish or those large fish, can also lead to inbreeding (Allendorf and Ryman 1987). The amount of genetic diversity retained by a stock can be measured by a statistical method and is termed "effective population size" (Simon 1988). The number that results from genetic tests and statistical analysis is equivalent to an estimate of the number of fish in the founding broodstock. Despite large founding broodstocks and subsequent returns to some Oregon hatcheries in the thousands, Waples and Teel (1989) found that several large salmon hatcheries had effective population sizes that were substantially less than the founding broodstock and the average number of fish handled. Because of the large number of fish handled, the interchange between Bogus Creek native fish and hatchery broodstock, and current practices at Iron Gate Hatchery, problems with maintaining effective population size for chinook and steelhead seem unlikely. The draft Trinity River Restoration Mid-program Review (USFWS in press) stresses the need for conserving gene resources through appropriate practices at Trinity River Hatchery. The operation of the Trinity Hatchery is currently under review (Chuck Lane personal communication).

Disease Introductions: A Side Effect of Large Scale Fish Culture

The introduction of broodstock or eggs from outside the basin represents an increased threat of introduction of non-endemic disease organisms (PNFHPC 1989). Because native fish are not resistant to such diseases, introductions can be potentially devastating. CDFG guidelines no longer allow fish from outside to be introduced into the Klamath drainage.

Problems with IHN at Trinity River Hatchery have been evident since the hatchery opened in 1963. Problems became particularly acute with regard to chinook in the early 1980's. The movement of Trinity River Hatchery fish below the North Fork of the Trinity was discontinued (CDFGb no date).

Native late run fall chinook were captured in 1987 in the Trinity at Hoopa and the females tested positive for IHN. The conclusion drawn was that IHN was probably present in the system before its discovery at Trinity River Hatchery. Stock transfers were resumed for pond rearing programs in Hoopa in 1989 (Bill Wingfield personal communication).

The introduction of non-native steelhead into the Iron Gate Hatchery broodstock and widespread straying of Trinity River Hatchery steelhead, which also had non-native components, may have conferred some level of reduced resistance to Ceratomyxa shasta to native steelhead populations. Steelhead adults in excess of Iron Gate Hatchery needs were transferred to the Shasta River, Scott River, and other smaller Klamath tributaries. Trinity River Hatchery steelhead strayed to Iron Gate Hatchery at a high rate in the early 1970's (Marshall 1974). It is likely that they also strayed regularly into the wild to spawn.

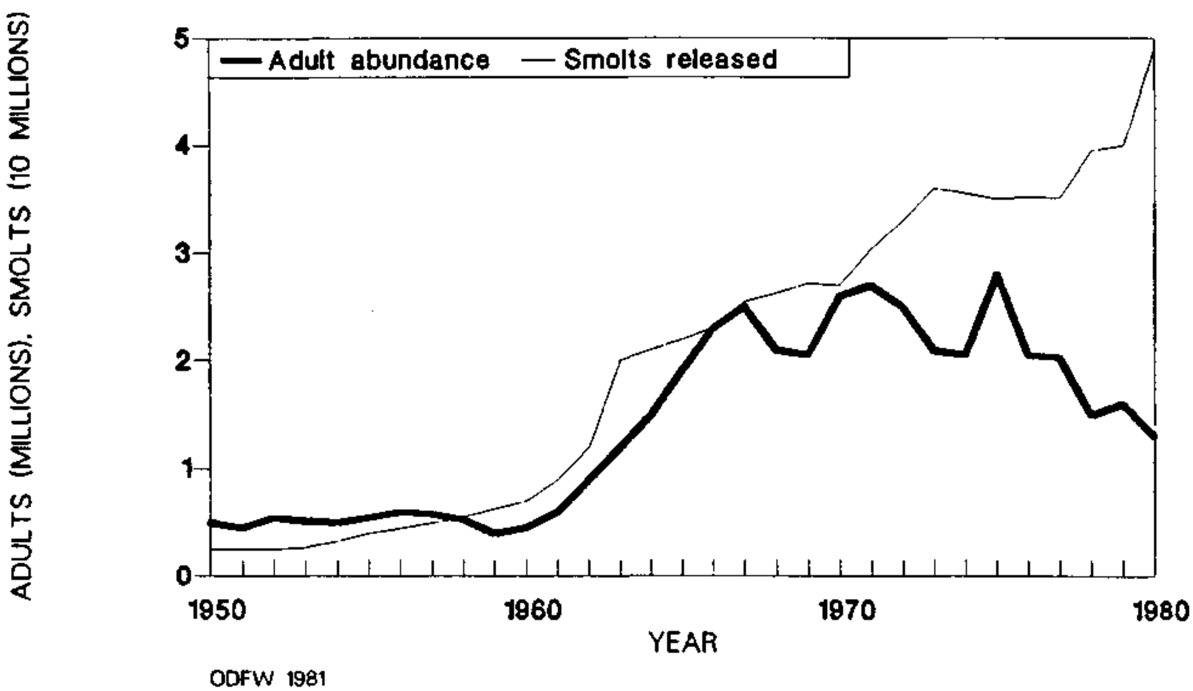
Although no large scale pen rearing projects exist or are planned in the Klamath Basin at present, they could potentially pose the largest threat of disease introductions (Whiteley 1989, Sattaur 1989). Escape from pen rearing projects is a constant problem and escaping fish can introduce diseases directly into native populations as they stray into streams (Sattaur 1989), or reduce resistance of locally adapted populations to diseases already present. Pen rearing projects must use extremely high quantities of antibiotics. Strains of disease organisms may evolve in the rearing pen effluent that are therefore not treatable with currently available antibiotics (Whiteley 1989).

Stock Collapses Associated With Increased Smolt Production

The combined production of the Trinity River and Iron Gate Hatcheries of salmon and steelhead fingerlings and yearlings has increased substantially in recent years. Average plants from 1979 to 1984 were about 6 million fingerlings and yearlings of all species combined. From 1985 to 1988 the average annual plantings totaled 19,500,000. Increases in the number of juvenile salmonids planted do not always succeed in commensurate increases in adults returning to the river.

Oregon instituted a program of coho salmon enhancement using large centralized hatcheries in 1966. As the plants of coho presmolts increased through 1976, ocean harvest and returns increased (Figure 5-3). In 1981 Oregon coho populations crashed (Donaldson 1981). Follow-up studies found that hatchery coho juveniles had a lower survival rate, both in fresh water and in the ocean, and that the ratio of hatchery to wild coho had increased from 50:50 before intensive planting to 85:15 at the time of the study (Solazzi et al. 1983 and Nicholsen 1986). The significance of this latter finding was that native fish populations had been seriously harmed by the hatchery program. The native fish decline led to nearly total dependence on the hatchery coho and to much greater fluctuations in available fish in years of poor upwelling. Riesenbichler and Emlen (1988) and McGie (1984) both concluded that density-dependent factors were inhibiting hatchery fish survival in the ocean.

Figure 5-3 Trends of coho salmon abundance compared with smolts released from hatcheries (3-year moving average) in OPI Area, 1950-1980.



Stock collapse also occurred in British Columbia hatchery-supported runs of fall chinook (Paul Starr unpublished data). Again, an increasing production trend of hatchery chinook smolts at first brought increasing returns to the fisheries. As smolt plantings continued to increase, catches began to drop off sharply (Figure 5-4). The percentage of the hatchery fish in the Canadian catch remained high despite the drop in numbers of hatchery fish harvested, indicating a decrease in natural production. Canadian Department of Fisheries and Oceans staff also noted a sharp decline in the survival of hatchery smolts to adults as the numbers of fish reared and released increased (Figure 5-5).

Figure 5-4 -- Trends of Canadian production of hatchery chinook salmon (Calculated from CWT recoveries).*

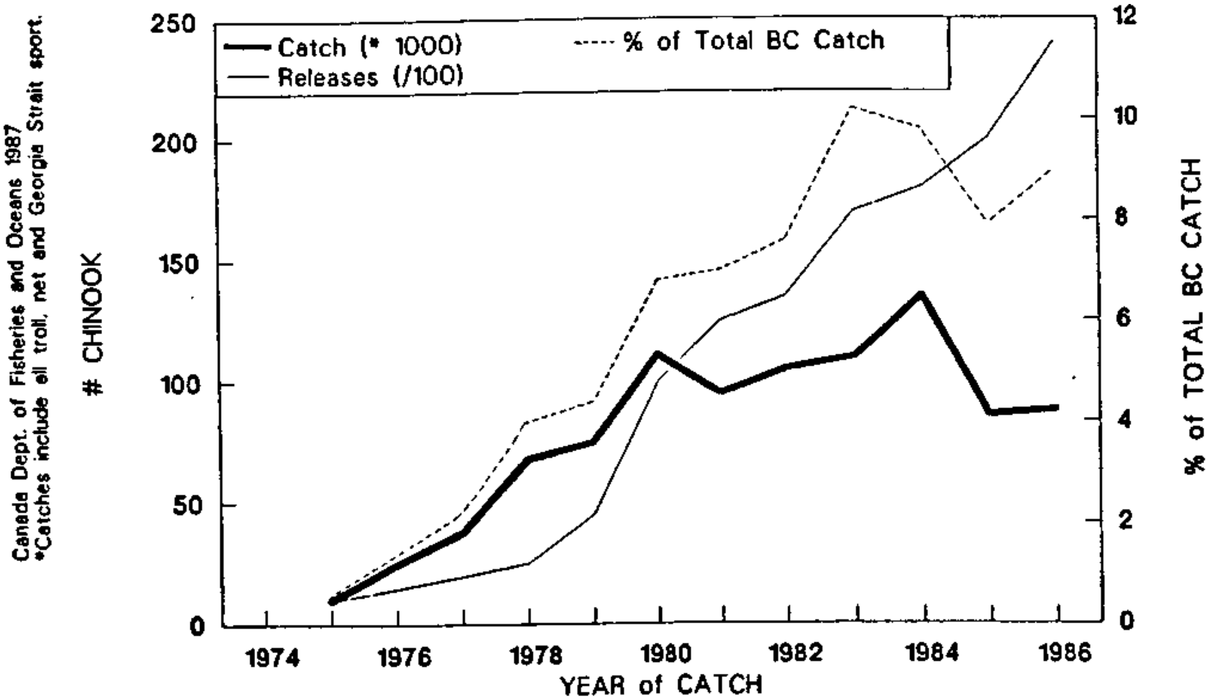
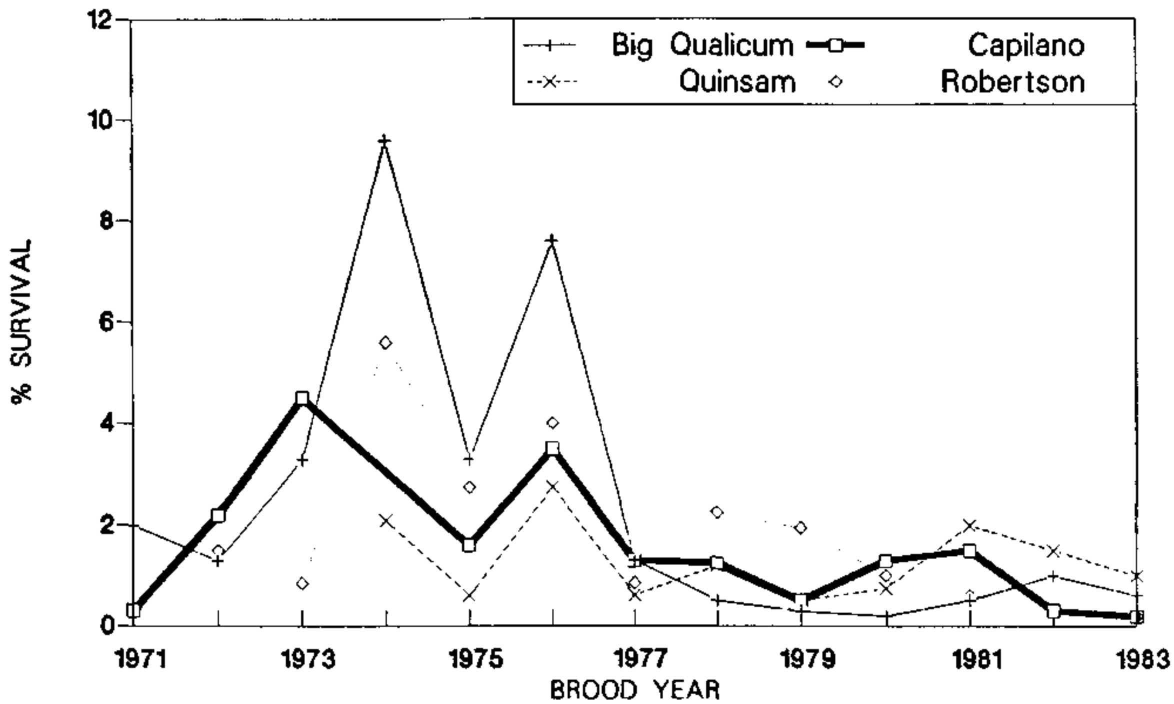


Figure 5-5 -- Trends of total survivals of hatchery chinook salmon for four Canadian hatcheries, calculated from CWT recoveries, 1971-1983.*



Canada Dept. of Fisheries and Oceans 1984
* All survivals include catch and escapement. Data points for brood years 1982 and 1983, and 1981 for Quinsam, are estimated from partial recoveries

Given the ecological problems of the main stems of the Trinity and Klamath Rivers (Stempel 1988), it is possible that the increased numbers of juveniles produced at Iron Gate and Trinity River Hatcheries could have adverse impacts on native juveniles. Poor habitat quality in the estuary may also cause problems with competition, particularly for chinook juveniles. While plants of fall chinook juveniles have increased substantially, adults returns have not shown commensurate increases. Ocean conditions may be responsible for the poor adult returns (Mel Odemar personal communication). Because the increases in planting were only began in 1985, not enough year classes have been completed to determine whether any inverse relationship between the number of hatchery fish planted and survival to adulthood. Trends should be monitored to insure that density dependent rearing mortality does not negatively impact survival of hatchery and native juveniles in the river and the estuary.

SMALL SCALE ARTIFICIAL REARING PROJECTS

Small-capacity rearing ponds and hatchery programs have been attempted throughout the Klamath Basin (Table 5-7). Ponds have been used largely to rear Iron Gate Hatchery fish from the fingerling stage to yearlings, but several are making the transition now to capturing, hatching, and rearing local stocks. Pond programs usually get Iron Gate juvenile chinook in May and release them from the site in October. Trinity River Hatchery fall chinook have also been transplanted for rearing at Hoopa.

Cooperation Marks Current Efforts

Several small-scale programs are operated in the upper middle region of the Klamath Basin in cooperation between the Karuk Tribe and California Fish and Game, with the department providing supervision. These are the Indian Creek, Elk Creek, and Grider Creek rearing ponds.

The rearing project at Camp Creek, near Orleans, has enjoyed the cooperation of several entities. The Six Rivers National Forest and CDFG helped capitalize rearing facilities, CDFG supervises and the Karuk Tribe has cooperated in supplying staff. Emphasis has shifted from pond rearing Iron Gate fall chinook to capturing native late run chinook for broodstock since 1986. Due to low numbers of returning late fall run adults, the Camp Creek facility has not been at capacity. The U.S. Forest Service built permanent rearing ponds at Bluff Creek and helped with siting ponds at Red Cap Creek. CDFG funds and supervises programs at these two sites in the lower middle Klamath Basin, and the Karuk again provide staffing. Spawning migrations in Bluff Creek were completely blocked by channel changes caused by the 1964 flood. A fish pass was constructed to aid fish upstream migration. After several years of the pond rearing programs using Iron Gate Hatchery fall chinook, spawning activity was re-established.

The Perch Creek ponds are operated to raise steelhead by the Orleans Rod and Gun Club and supervised by CDFG. Some broodstock for this program was procured by angling in the Salmon River but Iron Gate strain steelhead were imported in order to fully utilize the production capabilities.

In the lower Klamath, the Yurok have begun tank and cage rearing programs, initially using Iron Gate fall chinook. All Iron Gate chinook were transported upstream to Indian Creek for release (Ronnie Pierce personal communication). Initial capitalization for rearing facilities was provided by CDFG and the BIA in 1986. Native late fall run chinook broodstock are now being captured to a limited extent at weirs in Hunter Creek and Pecwan Creeks but mostly in the main river with gill nets. The expenses involved in fish capture have been funded by the BIA. Incubation has occurred at Spruce Creek and at Cappell Creek. Grow-out ponds are then stocked with these fish at High Prairie Creek, Cappell Creek, and Omagar Creek. Some fingerlings are transferred to Pecwan Creek and Hunter Creek for cage rearing.

Current funding for rearing comes from the Klamath River Task Force. The depleted state of native late run fall chinook and the resultant difficulty in capturing the broodstock has kept this program from realizing its potential as yet, but some adult chinook from early plants have returned to Hunter Creek (Pierce 1988).

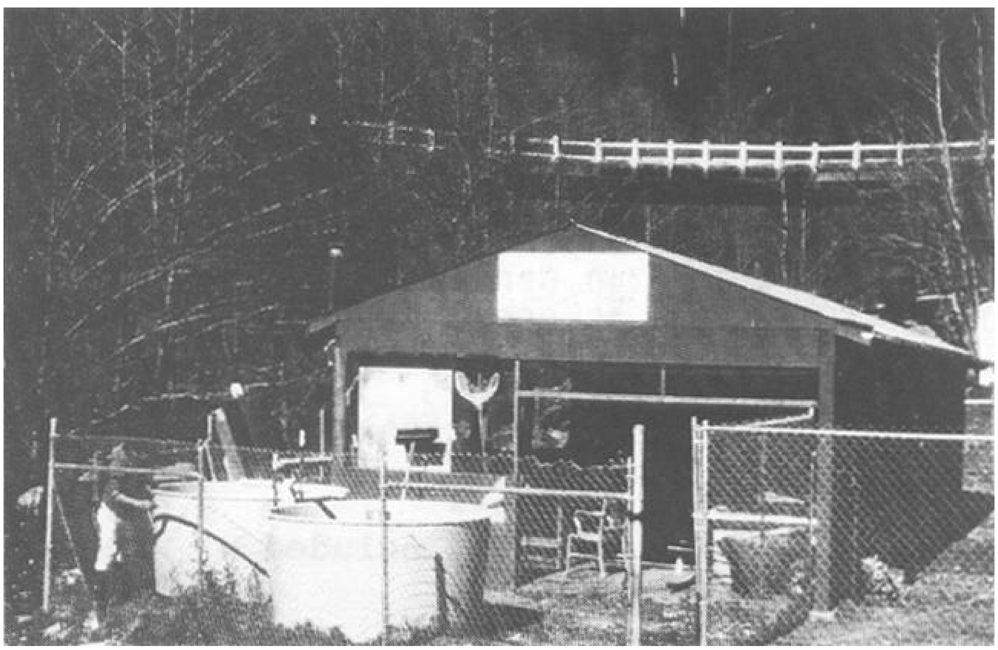


Figure 5-6 -- Small-scale rearing facilities, like this one operated by the Yurok Tribe at Cappell Creek, use locally-adapted salmonids as broodstock.

Small scale facilities are also being operated on the lower Trinity River on the Hoopa Square and at Horse Linto Creek. The Hoopa Fisheries Department has operated small scale artificial culture facilities since its inception (Hoopa Fisheries Annual Reports 1984-1989). Initial efforts were aided by USFWS and were geared toward pond rearing of Trinity River Hatchery fall chinook from fingerling to yearling size. Fall chinook fingerlings were supplied in some years by Iron Gate Hatchery when concerns over IHN made Trinity River Hatchery fish unavailable. Steelhead from Iron Gate Hatchery were also reared in 1985. Current Hoopa Fisheries enhancement is geared toward capture of late run fall chinook broodstock. The program has succeeded in increasing natural spawning in streams on the Reservation. Spawning counts in 1989 were higher than any recorded in recent years with a high percentage of the carcasses bearing coded wire tags from the program (Mike Orcutt personal communication).

The project at Horse Linto Creek appears highly successful. Operated jointly by the Pacific Coast Federation of Fishermen's Associations and the USFS, with supervision from CDFG, the program captures late run fall chinook broodstock and has released an average of 25,000 yearlings over the last three years. All fish have been fin-clipped and coded wire tagged to avoid using artificially-reared fish as broodstock in succeeding years. Slides within the watershed have been stabilized and spawning areas increased through use of instream structures. Once this newly restored habitat is fully seeded by the hatching and rearing program, artificial propagation may no longer be needed and efforts can be focused on another watershed.

TABLE 5-7 -- Rearing Ponds and Small Scale Hatcheries in the Klamath River Basin.

	Species	Pond Capacity	Av Number Reared	Incubation
Grider Creek	F CH IGH	40,000	34,426	No
Indian Creek	F CH IGH	80,000	74,134	No
Elk Creek	F Ch IGH	40,000	31,205	No
Bluff Creek	F CH IGH	80,000	68,761	No
Red Cap Creek	F CH IGH	40,000	38,173	No
Camp Creek I	F CH IGH	40,000	27,533	No
Camp Creek II	F CH Late	40,000	14,836	Yes
Pearch Creek	SH Natives	10,000	10,000	Yes
Cappel Creek	F CH Late*	100,000	17,035	Yes
Pecwan Creek	F CH Late*	5,000-20,000**	16,200	No
Omagar Creek	F CH Late	20,000	15,000	No
Hunter Creek	F CH Late	20,000**	9,000	No
Spruce Creek	F CH Late	20,000	Included w/ Hunter Cr.	Yes
High Prairie Cr	F CH Late	20,000	15,000	No

* Have used some Iron Gate juveniles.
** Cage rearing programs.

A spawning channel has been operated by CDFG, in cooperation with the Klamath National Forest, on Kelsey Creek in the Scott River drainage since 1985. A ladder was built into the lower area of the creek where chinook had been unable to access. The first year brood fish were captured in the main river, but thereafter an average of nine pair of chinook and three pair of coho have used the channel. After emergence, fish were held in a dammed portion of the creek and fed to yearling size in 1986 and 1987. No staff is hired now for supplemental feeding. The channel has also had considerable use from spawning steelhead.

A combination hatchbox and pond rearing facility was operated on the South Fork of the Salmon River between 1985 and 1987. The average annual production at this site, which was a PCFFA/CDFG joint venture, was about 12,000 yearling chinook. Problems with trapping fall chinook, cold winter water temperatures and warm summer water temperatures led to the closing of the site. Ponds were set up along the North Fork of the Salmon River but never used. Ah Pah Creek was the site of a combination hatchbox and rearing pond facility from 1985 to 1987, but operation there has been discontinued.

Opportunities for Project Expansion and Development

Rearing ponds were formerly operated by the Karuk Tribe and CDFG on Thompson and Beaver Creeks in the upper middle Klamath region, but operations ceased in 1984. These sites are currently under consideration for reopening. The Salmon River may also have sites more appropriate for small scale facilities than the ones tried in 1985. CDFG is currently exploring options for renewed efforts in that drainage (John Hayes personal communication).

The rearing of green sturgeon is under study in the lower river for commercial purposes (Pat Foley personal communication). Green sturgeon would be captured for this venture using gill nets and their spawn would be removed surgically. After stitching the body cavity closed, the adult fish could be released. These fish spawn approximately every three years, so adults would continue to contribute to natural green sturgeon production in the future.

POTENTIAL SIDE EFFECTS FROM HATCHBOX AND POND REARING PROGRAMS

While hatchbox programs offer native salmon and steelhead a higher chance of survival through the critical egg-to-fry life stage, these operations can pose threats to the remnant populations that are the target of restoration. Atlantic salmon restoration workers reported that when plants of fry exceeded carrying capacity, that survival of fish planted decreased sharply (Gee et al. 1978). Since there were no remaining native stocks in the stream, effects were limited to those fish planted. In Klamath tributaries, wild stocks could be negatively impacted (Smith et al. 1985) if too many fish were planted for available habitat. Expanding one portion of the remnant population through artificial means, while increasing mortality due to crowding of those fish naturally produced, can decrease genetic diversity without increasing smolt output, if habitat is limiting.

When dealing with small remnant populations, genetic diversity can be decreased or lost if broodstock management is handled incorrectly (Phillip and Kapuscinski 1988, Nelson and Soule 1986). If fish from artificial rearing programs are not marked and are "crossed back" with each other in subsequent generations, they can become inbred much faster than large hatchery populations (Allendorf and Ryman 1986). Thus the genetic integrity of the local population, and its ability to survive long term, could be compromised. Fin clipping and coded wire tagging have not been practiced universally in hatchbox and rearing programs heretofore. There have been no clear guidelines for broodstock handling to maintain genetic diversity.

Transplanting chinook for pond rearing over wide geographic areas serves to homogenize the genetic material of the various sub-populations of chinook in the Klamath system. Runs of chinook salmon stemming from pond rearing programs using Iron Gate Hatchery stocks show compressed run and spawning times (J. West personal communication). As we expand this stock, returns to the river will be similarly compressed. Ocean migration patterns may be different with various stocks so the ocean "pasture" may ultimately reach carrying capacity if all Klamath Basin chinook production were of hatchery origin (Riesenbichler and Emlen 1988). Gall et al. (1989) found some indication of genetic differences from various areas of the basin. To maintain genetic diversity and survival characteristics of smaller sub-populations, Krueger et al. (1981) stress the importance of using fish for rearing from adjacent areas that are genetically and ecologically similar to the host population.

Figure 5-7 -- Juvenile salmonids can be coded wire tagged and finclipped on site at small scale hatcheries by this CDFG mobile crew.

Although Iron Gate Hatchery fall chinook are from native broodstock, as they are transferred further from their area of origin, they may prove less able to survive and reproduce. Rainfall, streamflows, temperatures, and numerous other factors are quite different in the lower river than in the upper Klamath Basin. Highly unstable bedload in creeks feeding the lower river have been documented by Payne and Associates (1989). Similar conditions in Oregon and Washington have selected for late run fish that spawn after peak flood events (Frissell and Liss 1987, Cederholm 1983). Since Iron Gate fall chinook are early spawners, they may contribute early spawning tendencies to the local population that would confer a disadvantage under current environmental conditions. While pond rearing programs using Iron Gate Hatchery fall chinook help short term goals for increasing fish for harvest, they may be counterproductive to the goal of maintaining genetic diversity.

Pond rearing programs in the Hayfork drainage of the South Fork of the Trinity River using rescued steelhead smolts had a significant problem with fish remaining as residents after release. If future projects for pond rearing rescued steelhead are funded by the Restoration Program, a strategy must be devised to avoid problems with residualism.

FISH RESCUE

Every year juvenile salmonids become trapped in side channels and pools that become isolated as streams dry up. The California Department of Fish and Game policy calls for rescue of juvenile salmon and steelhead but only when "suitable rearing areas are available with the capacity to rear rescued fish to smolts without impairment of other ... populations" (CDFG Commission no date). Some fish rescue operations are operated in conjunction with diversion screen programs on the Shasta and Scott Rivers. Many of these fish were formerly transferred to rearing ponds at Bogus Creek but now they are released into the mainstems of the Shasta, Scott, or Klamath Rivers.

In 1989 the fish rescue team collected 455,762 stranded salmonids, most of them steelhead. A pilot program was initiated to rear rescued Scott River steelhead in ponds on Kidder Creek in 1990. Water quality problems caused a loss of all the fish.

HOW MUCH GENETIC DIVERSITY IS NEEDED?

> It is if man had been suddenly appointed managing director of the biggest business of all, the business of evolution ... whether he is conscious of what he is doing or not, he is in point of fact, determining the course of evolution on this Earth. That is his inescapable destiny, and the sooner he realizes it and starts believing in it, the better for all concerned.
>
> Julian Huxley (1957)

Rich (1939) argues that the best path to maintaining a species was to preserve as many local populations as possible. Therefore, we should save the populations in as many creeks in the Klamath Basin as possible. The CDFG stock transfer policy (draft 1987) states that "the Department ... will maintain the genetic integrity of all identifiable stocks of salmon and steelhead in California." Local populations in the Klamath Basin do show some genetic variation (Gall et al. 1989), but the significance of genetic traits remains a mystery. Some of these changes might be a result of random drift and confer no selective advantage (Parkinson 1984). Others may be key traits for survival that govern behavior or confer resistance to disease. If these latter traits are lost as sub-populations in the basin are extirpated, re-colonization of some of the Basin's streams may be extremely difficult. Atlantic salmon restoration programs have only met with success in re-establishing self-sustaining natural spawning populations where proximate locally adapted stocks were available for broodstock (Saunders 1981).

There is no clear answer to the question as to how much diversity will insure future survival. Preserving genetic diversity was likened by McIntyre et al. (1988) to maintaining a diverse financial portfolio. Just as the economic climate is difficult to predict, so are swings in the natural environment. As one maintains a diverse portfolio, economic swings will effect only a portion of one's wealth. Maintaining stock diversity will allow similar stability in returns in the face of environmental change. As diverse stocks have different outmigration and spawning times, different ocean migration patterns, resistance to disease and other attributes, they can better collectively withstand droughts, floods, El Nino events, and long term environmental change.

A considerable amount of genetic diversity has been lost already and some of what remains is embodied in remnant runs. Scudder (1989) suggests that remnant populations, restricted to marginal habitats, are very important to the survival of the species overall. These greatly reduced populations can serve as genetic repositories due to a process termed "centripetal gene flow" (Scudder 1989), in which the fish remaining retain effective population size of the large ancestral population. Large effective population size is an important factor in artificial production programs (Simon 1988). Remnant stocks may also harbor solutions to intensive selective pressure which could significantly contribute to survival of the wider population if it meets similarly harsh environmental factors. Even if remnant populations from smaller tributaries are too small for founding broodstocks, other breeding programs from adjacent drainages could avoid inbreeding by including just one individual every few generations from these small isolated groups (Simon 1988).

Fisheries managers have argued that if any stock transfers have occurred in the past to a stream, then the salmon or steelhead there are no longer a pure genetic strain and therefore special efforts to preserve that stock are no longer warranted. When stock introductions have ceased and the population has continued to survive on its own, it has retained sufficient adaptive traits to be of value (Riesenbichler and Phelps 1989). While it may or may not have changed from its original genetic makeup, stocks founded from these remaining runs stand a much better chance of taking hold, and becoming self reproducing, than stocks introduced from another area.

Maintaining the fullest genetic diversity in both Trinity River and Iron Gate Hatchery broodstocks is critical for the long term stability of hatchery production in the basin.

The Economic Considerations of Using Locally-Adapted Stocks

Stock transfer studies in the Klamath basin were conducted by Snyder and Schofield (1924). Sacramento River chinook introduced at Fall Creek Hatchery showed a return to the ocean fishery of just 0.04 percent as opposed to 0.73 percent for native stocks. Return to the river of just 0.012 percent was exhibited by the Sacramento fish, while natives returned at a rate 10 times higher (0.12 percent). The return on investment in hatchery programs is, therefore, substantially higher if well-adapted stocks are used.

The restoration of wide spread self-reproducing salmon and steelhead populations relies on preventing further losses of genetically diverse locally adapted populations (Krueger 1981, National Council on Gene Resources 1982). The rebuilding of wild steelhead populations from remnant stocks is meeting with some success in Idaho (Thurow 1987). The long term savings of being able to discontinue small scale rearing programs after restoration is complete and having the salmon and steelhead return without human intervention or funds in perpetuity is staggering.

CONCLUSION

While artificial production in the Klamath Basin has been occurring for 100 years, it was only a fraction of natural production until quite recently. Now, returns to hatcheries are beginning to contribute major portions of the river's production for the first time. Hatcheries should be operated to mitigate for losses in production due to irretrievable loss of habitat above dams. As runs have increased to both Iron Gate and Trinity River Hatcheries since 1985, far more juvenile salmon and steelhead have been produced than are called for in hatchery guidelines. California Department of Fish and Game policies state that "it is recognized that natural production provides the great bulk of the State's salmon and steelhead resources. The Department's goals of maintaining and improving this production shall not become subservient to the goals of publicly operated rearing programs." If the level of releases at the large hatcheries in the Klamath Basin are exceeding the carrying capacity of the river and the estuary, they may be an impediment to restoring the river's wild populations.

Appropriate levels of planting at hatcheries can be determined by testing different levels of release and gauging commensurate levels of return to the fisheries and to the river. Without discovering what the optimal number of hatchery juveniles are for release, we may raise more juveniles at the hatchery than is cost effective and unintentionally move the river toward much greater hatchery dependence. Cohort analysis of returns from years of very high fingerling releases (1985-88) should help unmask density dependent factors that appear to be decreasing survival of release groups. Such a study will indicate the correct level for fingerlings releases. Important work is proceeding on the Trinity to determine the relationship between increased streamflows and the survival of fish from the hatchery releases.

Yearling releases yield much higher contributions to the fisheries and to spawning escapement than do those of fingerlings. Releases of fingerlings also pose a higher risk of impacting native juveniles through competition in the river or in the estuary than do yearlings. The Task Force should cooperate with CDFG to study what level of hatchery production for mitigation and enhancement provides the highest return to fisheries without posing problems for the recovery of native salmon and steelhead populations. The Trinity River Task Force is working to define optimal release strategies at the hatchery to minimize impacts on native fish and meet mitigation goals.

Another dimension of the Trinity River Mid-Program Review is the testing of methods to decrease the tendency of steelhead smolts to remain in the river or become residuals. Similar tests should be conducted at Iron Gate Hatchery because of negative effects residuals exert through competition on native steelhead and possible problems of predation on both hatchery and native juveniles. Pond rearing programs to increase survival of fish rescued from dry stream channels or fish screens also need some method of avoiding problems with residualism. Studies are also needed to determine the level of resistance of Iron Gate Hatchery steelhead to Ceratomyxa shasta.

Small scale rearing facilities programs can help accelerate the rebuilding of wild stocks diversity, but if operated incorrectly can actually accelerate loss of appropriately adapted stocks through inbreeding. Small scale programs need to recognize they may be handling threatened stock groups. Policies are being developed by CDFG for the operation of small scale rearing programs. Parallel policies need to be adopted by tribal governments and the BIA. A Task Force technical work group should work with CDFG to make sure that policies adequately provide for the conservation of gene resources. All small scale rearing operations sponsored by the Restoration Program should strictly adhere to such rules, especially as they pertain to brood handling to avoid irretrievable losses of genetic resources. Although facilities involved are temporary, they should be state-of-the-art, and technical assistance should be available to all project operators. The cost-effectiveness of small scale rearing programs can be improved and additional benefits for the program derived by also rearing coho salmon and steelhead.

While some habitat has been lost due to dams, much of the degraded habitat can be restored. Unlike Atlantic salmon restoration on the East Coast, where habitat problems were so serious and long-standing that most native stocks had been lost, the Klamath retains many of its wild strains of salmon and steelhead. As the river and its tributaries are reshaped through natural processes and accelerated by the Restoration Program, these fish will return to areas of improved habitat once inhabited by their ancestors. The last decade has seen native chinook populations on the northern Oregon coast rise to their highest levels in a century. Nicholas and Hankin (1989) attribute this to natural habitat recovery and the presence of sufficient remaining genetic diversity in local stocks for the populations to rebound. With commitment and creativity, the Klamath River Basin Fisheries Task Force can achieve similar results.

POLICIES FOR FISH POPULATION RESTORATION

Objective 5.A: Iron Gate Hatchery and Trinity River Hatchery should be operated to produce salmon and steelhead to mitigate for the losses of habitat above their dams and, at the same time, strive to reduce impacts on native fish.

5.A.1 The Task Force's Technical Team will work with CDFG to insure that the Basin's large-scale hatcheries operate to mitigate for loss of habitat above dams while limiting their impacts on wild stocks and maintaining the long term viability of hatchery broodstock. In coordination with Trinity River Task Force, the Task Force will:

a. Determine the optimal levels and composition of hatchery releases that can best achieve mitigation goals while minimizing impacts on native stocks.
b. Identify opportunities for enhancement and harvest supplementation using surplus hatchery eggs where it can be assured that there would be no disease transmission, genetic harm, in-river density dependent effects, or adverse harvest impacts to native stocks.
c. Encourage the continuation of hatchery practices that will maintain the fitness of hatchery broodstock and decrease undesirable impacts of straying on native fish.
d. Conduct a study to determine the resistance of Iron Gate Hatchery steelhead broodstock to Ceratomyxa shasta.
e. Support the CDFG in its effort to secure a water supply filter for Iron Gate Hatchery.

Objective 5.B: Small-scale rearing programs should be temporary measures, primarily for the purpose of accelerating the rebuilding of locally-adapted native salmon and steelhead populations, and operated to maintain the genetic integrity of such populations. Ideally, small-scale rearing programs should be operated in conjunction with habitat restoration projects.

5.B.1 Those parties having management authority over small scale rearing and pond programs in the Klamath River Basin shall, through coordinated planning, formulate independent guidelines for activities which will avoid negative effects on the genetic characteristics of native stocks. (The relevant parties, in this instance, are the Yurok, Hoopa, and Karuk Tribes and the State of California, acting through the California Department of Fish and Game.)

5.B.2 The guidelines for small-scale facilities will, to the extent possible, be consistent in content. The guidelines will be developed in accordance with the best known biological practices and their development shall be guided by a technical advisory committee, appointed by the Task Force, having expertise in genetics and fish culture. The small-scale facilities guidelines shall consider, but need not be limited to:

a. Procedures for trapping, rearing, incubating, and transferring fish, and for the control of fish diseases.
b. Broodstock management rules that ensure the maintenance of genetic integrity and the diversity of the stocks handled.

c. Requirements that an appropriate number of fish produced by small scale rearing and enhancement programs are marked and coded wire tagged so that ocean migration may be determined and that inbreeding can be avoided.
d. Methods by which to determine release strategies for pond reared steelhead from rescue programs in order to minimize residual behavior.
e. Methods to by which to evaluate program success.

5.B.3 The Task Force shall encourage small-scale fish rearing project operators to participate in research to determine:

a. Habitat quality to assess appropriate stocking levels.
b. Early life histories of fish cultured so that appropriate time for release can be determined.
c. Those levels of spawning escapement that represent "full seeding" so the Task Force may determine when populations have recovered sufficiently to close or move a facility.

5.B.4 The Task Force will explore means of improving the cost effectiveness of those small-scale rearing programs now targeting late-run fall chinook by capturing other species, such as coho and steelhead, where such efforts would contribute to Restoration Program objectives.

5.B.5 The Task Force will explore the need for green sturgeon population restoration measures.

5.B.6 The Task Force will support the continuation of fish rescue efforts in the middle Klamath Basin and the Scott and Shasta rivers as a viable tool for providing additional salmon and steelhead production.

CHAPTER 6

EDUCATION AND COMMUNICATION

ISSUES

* Education is essential to the Restoration Program's success.
* Unless landowners and water users can be interested in participating, it is unlikely the Restoration Program will succeed.
* Communication must reach all levels of the Basin's public, not just "decision-makers."
* Interpretive visitor facilities are needed at well-traveled coastal and inland locations.
* Reliable and timely information about fish and their habitat needs will directly benefit the Basin's land and water managers.

INTRODUCTION

The Klamath River Basin Fisheries Task Force has identified education and communication as essential to the success of the Restoration Program. The Task Force's technical advisors have recommended that education and communication elements be developed for three principal Program audiences: school children; special interest groups, including fishermen; and the general public. This chapter discusses the objectives, methods, priorities, and administrative requirements of each of the proposed Restoration Program education and communication elements.

Soon after its organization in 1987, the Task Force created a four-member subcommittee to prepare an information and education strategy for the Restoration Program. The subcommittee subsequently submitted a draft information and education program for Task Force consideration. That draft program has been reviewed and found to be well thought out. Currently, the development of a curriculum of salmon and steelhead studies for elementary school classes is underway, as is the public communication program.

The subcommittee's program is presented here, in a slightly modified form, as a suitable strategy to guide the Restoration Program's education and communication efforts.

OBJECTIVE

The objective of the education and communication element -- to promote public interest in the Klamath River Basin's anadromous fish, their beneficial use, habitat requirements, and to gain support for the Restoration Program's plans and efforts to restore fish habitat and numbers -- has been adopted by the Task Force as a primary Program goal.

APPROACH

The education and communication element has two distinct components, an education component to be pursued through the public school system and a communication component to reach both general and special interest audiences. Each component, in turn, will involve four core subjects: the environmental requirements of anadromous fish, opportunities for the restoration of the Basin's fish habitats, the beneficial uses that we make of fish, and the conservation measures necessary to protect those beneficial uses.

EDUCATION COMPONENT

The education component is directed primarily at the public school system. Many of today's northwestern California school children will become direct beneficiaries of the Restoration Program. A sixth grader introduced to the Klamath River Education Program in 1990 will be 30 years old when the present Restoration Program authorization expires.

Education Priorities

An understanding of the life history of anadromous salmonid fish is essential to appreciating their habitat needs or our conservation responsibilities. Therefore, the life history of salmonids and their environmental requirements is the highest priority subject of the school system educational component.

Education Methods

Generally

K-12 curricula to cover the core subjects of life history, environmental needs and restoration, and management will be developed for grades 4-6, 7-8, high school, and, finally, kindergarten through grade 3. The curriculum development effort began in late 1989, directed at grades 4-6 and will be completed within five years.

Mentor teachers from school districts within the four Basin counties will be trained in the use of the curriculum materials and methods. Program funds can be used creatively in combination with state environmental education grant funds to enable mentor teachers to travel from their own schools to those of other teachers interested in developing fishery restoration education skills. Mentor teachers for grades 4-6 were trained in 1989 and 1990.

Humboldt State University has a docent program in which students in fisheries majors serve as "salmon and steelhead education guides" for school groups visiting the Mad River Hatchery. A memorandum of understanding between the Restoration Program and the University would enable an expansion of this program to the Klamath River Basin. The Humboldt State model could be expanded, as well, to other post-secondary schools in the region.

Video materials conveying information about the Restoration Program and supporting subjects can be developed and distributed to the Basin's schools.

Classroom aquarium projects have proved enormously popular since they were first introduced in the region through a California Department of Education environmental education grant in 1986. With appropriate concern for egg availability and stock transfer protocols, these "hands on" hatching and rearing experiments can teach children a lot about the environmental needs of young salmon and steelhead. The cost per incubation unit and the accompanying materials is about $125.

Many of the schools in the region are located near streams suitable for the "Adopt-a-Steam" program pioneered in the Pacific Northwest. In this program, neighborhood streams become "living classrooms" where, with the help of the curriculum and Restoration Program specialists, children may even have the opportunity to undertake a modest instream restoration or demonstration project. The Klamath Restoration Program could model its program after the Trinity Task Force's pilot project for adopting watersheds. This "adopt-a-watershed" program envisions school children adopting continually larger portions of a watershed as they proceed through higher grade levels at school. In this way, the educational programs for school children would correspond to the "total watershed" approach stressed for the overall restoration project.

The Restoration Program should enable development of a mobile information and education unit similar to the Terwilliger Center's "Nature Van," which brings environmental education materials and exhibits to San Francisco Bay area schools. A trailer or camper unit could contain anadromous fish life history displays, as well as information concerning the history and status of the Basin's fish populations and the uses we have made, and continue to make of them.

Restoration

Field trip destinations will include damaged habitats and restoration sites.

Management

High school teachers should be kept up to date on the Restoration Program so that they can provide opportunities for especially interested students to observe meetings of the Klamath Fishery Management Council and the Pacific Fishery Management Council, to learn more about the salmon harvest management process.

With cooperation from agencies and business owners, students should visit fish buying stations and processing facilities.

COMMUNICATION COMPONENT

The communication component is directed at both the general public and at special interest audiences. Only through the provision of complete and timely information can we expect the public to contribute its support to the Restoration Program. Said another way, absent complete and timely information we can expect the public interest and support to wither and the Restoration Program to fail.

Communication Priorities

Information about habitat protection and restoration efforts should be given high priority. Contrary to the common notion that "no news is good news," the public is starved for some good news about environmental stewardship. In fact, there is so much potential interest in fish and wildlife restoration that there is a temptation to count our chicks (actually, our fingerlings) before they hatch. There is increasing concern that the interest in instream structures, for example, can create the public perception that streams can be "fixed" almost as easily as they can be damaged. For this reason, the communication component should draw on equal parts of fisheries and watershed management professionalism and communication polish.

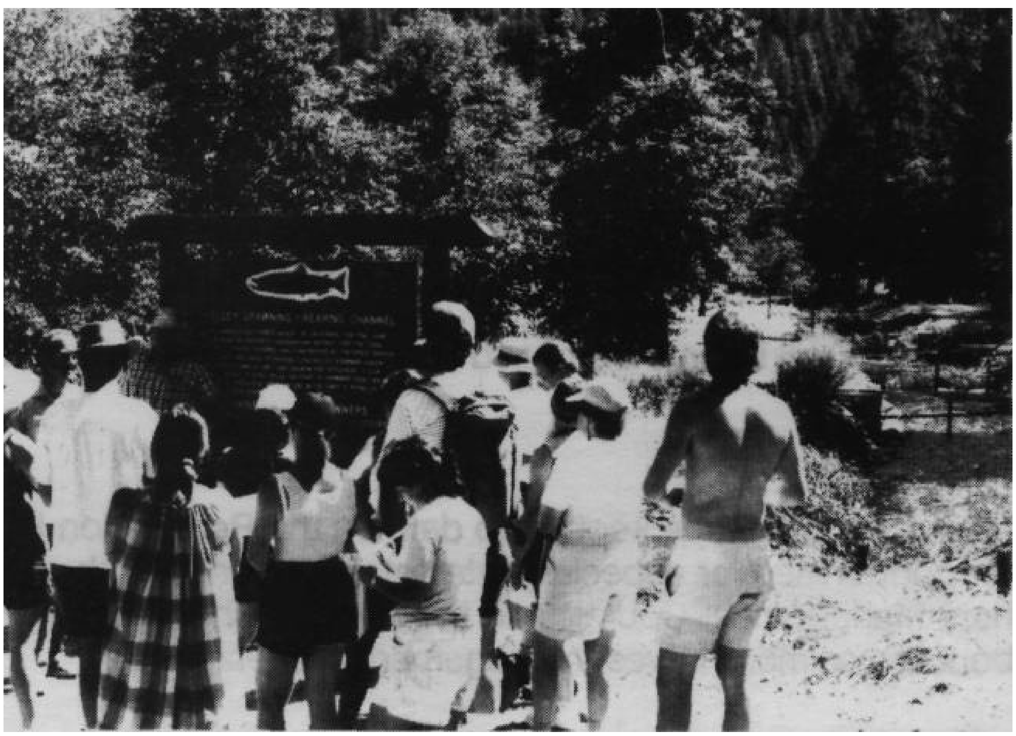


Figure 6-1 -- The Klamath National Forest has developed a self-guided tour of the Kelsey Creek spawning channel in the Scott River drainage. The Forest Service's Jay Power answers questions from teachers during a Klamath River Educational Program summer institute.

Communications Methods

Restoration

Presentations to community and special interest groups, explaining the progress of the restoration effort, should be continued. Presentations utilizing a slide/tape "Introduction to the Klamath Restoration Program" began in 1990 and will be continued in the future. Additional slide programs focusing on completed restoration projects will be developed, shown to the public, and continually updated.

Northern California and southern Oregon journalists are interested in fishery matters and have made themselves known to the Task Force and the Restoration Program managers and participants. They deserve good stories. Newspaper and television coverage of live events -- the completion of a fish passage project, the release of fish from a rearing facility, schoolchildren in their "Adopt-a-Stream" classroom -- have infinitely greater appeal than press releases about scheduled meetings or meeting results.

The Restoration Program should build an inventory of high quality photos and other "visual" materials to assist both print and television journalists in creating attractive and informative stories. Television journalists are continually looking for good film of salmon or steelhead leaping cascades, or spawning. Very little of this kind of material is readily available.

Exhibits and displays concerning the Restoration Program should be developed for high traffic areas, including the National Park visitor center near Orrick; the Interstate 5 rest stop north of Yreka; the Yreka Creek Greenway visitor center; and the Iron Gate, Mad River, and Prairie Creek hatcheries. Exhibits should be updated regularly, not allowed to "yellow," and should be moved from sites with low seasonal visitation to those with better traffic.

Brochures, pamphlets, and fact sheets concerning the Restoration Program should be developed, as well as a "public summary" of this long-range Plan. Information about the Basin's fisheries and restoration efforts should be distributed at workshops, public meetings, fairs, visitor information and service centers.

A progress "report to the people" should be created during fiscal year 1992-93, after five full years of Restoration Program effort. The report should credit the Program with those accomplishments it can honestly claim, and be forthright about factors that continue to frustrate the Program's objectives. The objective of "adaptive management" is, after all, problem recognition and correction.

Harvest Management

Interpretive displays describing the value of salmonids to various user groups and clarifying the difference between smolt and trout are needed in the basin. The public should be informed regularly of the seasons, bag limits, and quotas necessary to achieve the objectives of the Restoration Program. The public should be informed regularly concerning the meetings of the Klamath Fishery Management Council, its plans and the actions it takes on restoration issues.

Life History and Environmental Requirements of Anadromous Fish

Contacts with the media should focus on the life history of the Basin's anadromous fish and emphasize concern for their environmental requirements. Interpretive displays, brochures, and other publications should be developed and placed in high traffic areas to explain the life history and environmental requirements of anadromous fish.

COMMUNICATION WITH SPECIAL INTEREST GROUPS

Groups having special interests in the Klamath River Basin Restoration Program can be broadly divided in two: those who are primarily interested in fish and those engaged in land and water uses in the Basin. The cooperation of both groups will be essential to the success of the Program. Both groups deserve timely and accurate information about habitat restoration efforts, the environmental requirements of the fish and the role of harvest management in accomplishing the Restoration Program objectives. Educational programs targeted at these groups will require specific funding.

Special Interest Group Communication Priorities

Coastal Fishermen

The coastal fish-interested community includes the commercial fishermen and Indian fishers, and their onshore support businesses and work forces, all of whom are particularly concerned with the interrelationship of harvest management policies to the Restoration Program. This group needs clear and timely information about user group harvests, in-river run estimates, and wild and hatchery escapement data.

Inland Fishermen

The inland fish-interested community consists of anglers and Indian fishers, who have greater contact with habitat problems and habitat restoration efforts. This "up-river" community has been traditionally concerned with the effects of ocean and lower river harvests on escapement to upstream areas. The Restoration Program should strive to provide inland fish interests with timely and accurate information about downstream and ocean harvests to relieve the traditional inter-regional conflicts and to promote basin-wide cooperation.

Land and Water Users

Effective communications with landowner and water user groups will be one of the Restoration Program's most challenging, and fruitful, areas of endeavor. These communications have already begun and have been largely positive. Forest landowners have joined in discussions concerning development of this long range Plan, for example, and planning team members have explained the Restoration Program and the long range planning process at meetings of professional foresters. The local Resource Conservation Districts (RCD) are important partners solving resource problems at the local level. The Klamath River Fishery Resource Office staff interpretive specialist regularly attends RCD meetings, and the Soil Conservation Service supports RCD partnerships as time and budgets allow. This sort of people-to-people contact must be maintained on a priority basis.

Special Interest Group Communication Methods

In addition to the communication methods described above for general audiences, the following additional efforts should prove effective in working with special interest groups.

Video materials are easy to create and can convey a great deal of information quickly to meetings of sportsmen, water managers, stockmen, miners, timberland managers and others. Video presentations are well suited to explaining the life history and environmental requirements of the Basin's anadromous fish.

Field trips can bring biologists, Task Force members, restoration specialists and landowners together to see, first hand, problem sites and examples of effective habitat protection and renewal. University, Department of Forestry and Soil Conservation Service specialists can assist in the development of field trips and can strengthen the cooperative relationship between land and water users and the Restoration Program.

Awards should be made to businesses, landowners or support groups that make special efforts to assist the Restoration Program.

DEVELOPMENT AND ADMINISTRATION REQUIREMENTS

The Restoration Program already has the services of an interpretive specialist. This person will also serve to coordinate communication and education activities throughout the basin. These services should be continued throughout the life of the program.

The development under contract of teachers' guides and student anadromous fish learning activities, begun in 1989 for grades 4 through 6, should be continued until materials are available for all grade levels.

The services of a publications professional will be required for the development of the progress report-to-the-people (fiscal years 1992-93).

POLICIES FOR EDUCATION AND COMMUNICATION

Objective 6: Promote public interest in the Klamath River Basin's anadromous fish, their beneficial use and habitat requirements and gain support for the Restoration Program's plans and efforts to restore fish habitat and population numbers.

6.1. The Task Force will maintain support for public school programs by:

a. Continuing to develop a curriculum and field activities for schools in the Klamath River Basin and adjacent counties.
b. Encouraging local school districts to make these materials part of the regular curriculum, once the materials are fully developed.
c. Sponsoring workshops and conferences on salmonid conservation to keep teachers interested and updated about the Restoration Program.
d. Budgeting $5,000-10,000 a year for the operation and maintenance of classroom education projects once the current five-year development process is complete. Teachers should be encouraged to submit proposals to continue the development, operation and innovation of the Program, or for special projects.

6.2. The Task Force will support communications with the public by:

a. Supporting 4-H youth education projects involving riparian restoration.
b. Continuing to encourage the development of interpretive programs on the Yurok Reservation near the mouth of the Klamath River, at the Interstate 5 rest stop north of Yreka and within Yreka itself.
c. Assembling a suitable display for county fairs.
d. Working with angler groups, resort owners, guides, and county fish and game advisory committees to promote angler awareness of the Restoration Program's goals and objectives.
e. Cosponsoring workshops and seminars on water conservation with Resource Conservation Districts to assist the agricultural community.
f. Conducting workshops for state, county, and private road maintenance personnel concerning stream protection needs.
g. Setting up meetings between fisheries biologists and miners to explain the environmental requirements of fish and to learn more about mining activities.
h. Joining with the Klamath Basin tribes in sponsoring a conference about the Indian fisheries.
i. Cosponsoring workshops or "tailgate sessions" with foresters, road engineers, timber and equipment operators concerning watershed protection needs.
j. Providing public information services (e.g. Newsletters, Flyers) for the Klamath Fishery Management Council.

CHAPTER 7

PROGRAM ADMINISTRATION

This chapter will seek to define the institutional structure and methods needed to implement the Klamath Basin Fisheries Restoration Program: Task Force Operations, Staffing, Funding, Information Sharing, Coordination, and Project Selection.

ISSUES

* Task Force composition and decision-making process.
* What level of staffing is necessary for administering the program.
* Need to stimulate new non-Federal financial contributions to fishery restoration.
* Need for Task Force, Council, and Trinity River Task Force's activities to be complimentary.
* How to reconcile the fishery management objectives of all agencies claiming jurisdiction over Klamath River anadromous fish.
* Better coordination and cooperation desired.
* How to best share data and information developed or used by the Program.
* Need to have project selection be driven by needs of system rather than by proposals received.

TASK FORCE OPERATIONS

Functions

Congress determined that the Task Force --

1) shall assist the Secretary in the formulation, coordination, and implementation of the program;
2) shall assist and coordinate its activities with, Federal, State, and local governmental or private anadromous fish restoration projects within the Area;
3) shall conduct any other activity that is necessary to accomplish the objectives of the program; and
4) may act as an advisor to the Council.

Membership

The Task Force's original composition was defined by Congress in the 1986 Klamath Act. Any changes in representation must be approved by Congress, as was done in 1988 when the Karuk and Yurok tribal representatives were specified in an amendment. Presently, the 14 member Task Force consists of representatives of the commercial salmon fishing industry, the in-river sport fishing community, the Hoopa Valley Tribe, the Yurok Tribe, the Karuk Tribe, the California Department of Fish and Game, the Oregon Department of Fish and Wildlife, the Department of the Interior, the National Marine Fisheries Service, local government (Del Norte, Humboldt, Siskiyou, and Trinity counties), and the Department of Agriculture.

Concern has been expressed by some that the composition does not include all of the natural resource users in the Basin which may be affected by the Restoration Program (i.e., farmers and ranchers, timber industry, miners, environmentalists, and all of the pertinent natural resource agencies (i.e., California Department of Water Resources, California Department of Forestry, Regional Water Quality Control Board, Bureau of Indian Affairs, and Soil Conservation Service)). To directly represent all of these interests, an additional nine members would be necessary. The current 14 member Task Force is already quite large and increasing its size by as many as nine members could make decision-making unwieldy.

When the Klamath Act was developed, the authors attempted to provide a mix of interests which the Task Force now represents, and not solely fishery users or solely agencies (like the Trinity River Task Force). Since membership is limited "to minimize expense and logistical difficulties," Congress encouraged the Task Force to "take full advantage of the experience and technical expertise of the bureaus, departments, or other subdivisions of the member agencies or other interested and knowledgeable parties" (USHR 1986).

Decision-Making

The "Operating Procedures" of the Task Force require that all of its decisions must be made by unanimous consent, although the Act only imposed this requirement on the Council. As described in the House of Representative's report on the Klamath Bill in Congress, the intent of the "unanimity" procedure is "to ensure that recommendations to the Secretary have the necessary support to encourage full implementation by the respective agencies." Consensus decision-making has reportedly been successfully used in other fishery related committees, such as the Salmon Stamp Committee and the Timber/Fish/Wildlife (T/F/W) Program in Washington. The T/F/W process includes explicit "Ground Rules" which each of the participants agree to work under, with the intent to develop a "Win/Win" result.

How this consensus decision-making process is carried out can affect the outcome of many issues. At present, no action is the result if any objection is raised by a Task Force member. There is concern that consensus decision-making must be used more creatively to better resolve the more difficult and contentious issues. If narrow or parochial viewpoints dominate, then it may be impossible for the Task Force to agree on or implement a long-range plan, or the Program may be reduced by "vetoes" to the lowest common denominator of innocuous and ineffective actions. On the other hand, an occasional inability to reach consensus can be expected and does not mean that the Task Force is failing.

Committees

The Task Force has decided to form committees of its members or their appointees "in order to facilitate the mission of the Task Force." Its "Operating Procedures" define their mission, tasks, membership, and operations. In addition, the Federal Advisory Committee Act (FACA) sets standards and uniform procedures to govern the operation and administration of the Task Force and Council, as well as each committee. Each non-agency member is eligible for reimbursement of travel expenses.

To date, two committees have been used only on an interim basis (Mission/Goals, and Education) and two are now regular standing committees:

> Technical Work Group (TWG): This group was initially used to inventory pre-Task Force restoration projects in the Klamath Basin. Providing technical and scientific consultation to the Task Force, it was used to objectively rate project proposals for Task Force funding in FY89 and FY90. This task will be continued, along with others: preparing annual work plans, assisting in drafting the annual budget, and other technical assignments.
>
> Budget Committee: Made up of Task Force members, its mission is to draft annual and multi-year budgets for the Program and other requested budgetary tasks.

Final decisions are made in every case by the Task Force and not by the Committees. For an illustration of how the Project Selection Process works, see Figure 7-3.

The Trinity River Task Force meets quite infrequently and has delegated much of its planning and review functions to the Technical Coordinating Committee (TCC), with several subcommittees then making recommendations to the TCC (e.g., Grant Proposal Subcommittee). Final decisions on project funding are made by the Program Field Office and Task Force, which must follow the latest Three Year Action Plan adopted by the Task Force.

Program and Plan Reviews

During the 20 year effort, modifications will inevitably need to be made in this Plan and the Program. Changes in philosophy, restoration techniques, priorities, budgets, and other assumptions of the Plan will occur and adjustments must be made to the new realities. Through the process of "adaptive management," these uncertainties of the future should be recognized and incorporated into the planning process.

Other fishery restoration programs have completed, or are in the process of completing, mid-program or five-year reviews: Trinity Basin Fish and Wildlife Program, Salmonid Enhancement Program (SEP) in British Columbia, and the Columbia River Basin Fish and Wildlife Program. Progress reports are presented to the public, in most cases, which summarize the actions taken, the numbers of fish produced, the benefits and costs involved, and other measurable variables. Evaluations have usually been internal rather than external.

STAFFING

According to the Klamath Act, the Secretary of the Interior and the Director of the California Department of Fish and Game "shall provide the Task Force with the administrative and technical support services necessary for the effective functioning of the Task Force."

Klamath River Fishery Resource Office (KRFRO)

Representing the Secretary of the Interior, the U.S. Fish and Wildlife Service (USFWS) has established an office for the Program in Yreka, California, near the upper part of the Klamath Basin. This Klamath River Fishery Resource Office was originally intended to be "operation central" for the Restoration Program, offering the services necessary to carry out the operations of the Task Force and the Council.

The currently proposed staffing plan is shown in Figure 7-1. As can be seen, the positions include three fishery biologists and two non-biologists.

The Project Leader supervises the Program's administration: staffing the Task Force and Council meetings and responding to their requests, reviewing progress on restoration projects, coordinating with other USFWS offices (Portland, Sacramento, Arcata, and Weaverville), and overseeing the Klamath River Fishery Resource Office. This staff leader is to act as a communication link and central coordination point for biological aspects of the Program.

A Senior Scientist serves to ensure technical evaluation of the restoration program, to maintain quality control for biological work, and to monitor adherence to, and accomplishment of, the biological aspects of the Plan.

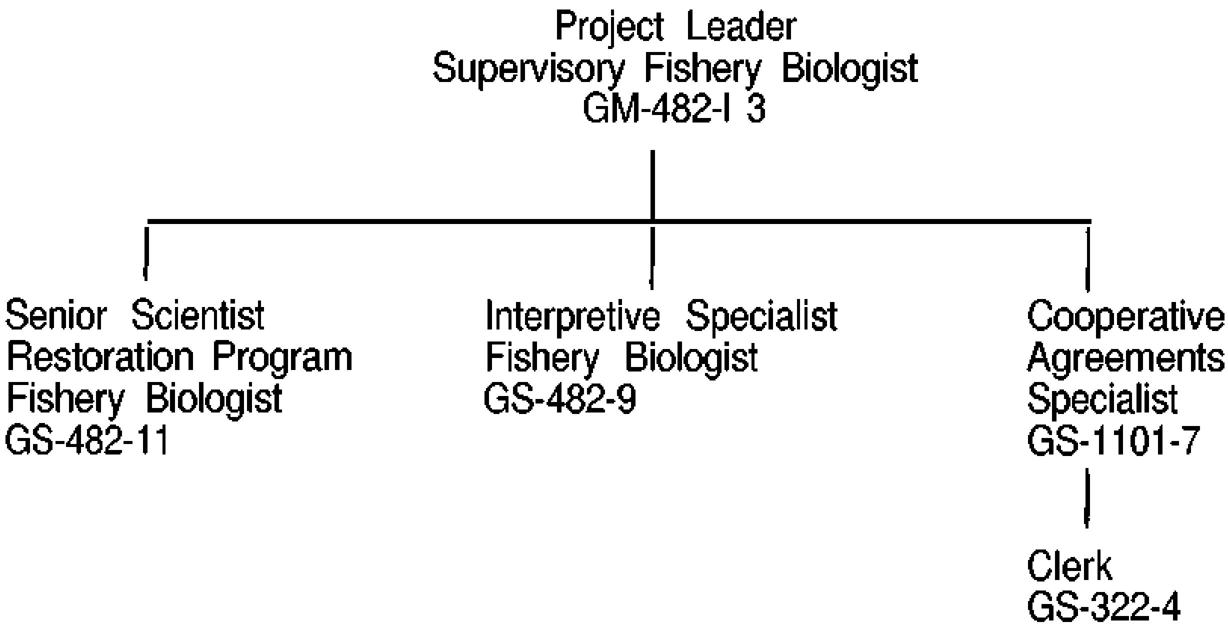
An Interpretive Specialist performs community education and publicity, and serves to monitor adherence to, and accomplishment of, the education aspects of the Plan. Funding comes from the "Education" rather than the "Administration" budget category of the Task Force.

The Cooperative Agreements Specialist is in charge of the administrative details of the projects funded through the Task Force, mainly the processing of cooperative agreements and invoices.

A Clerk performs the necessary clerical functions of the office and the meetings.

Concern has been voiced about the Program budget being "top heavy" in administration. In comparison to the Trinity Basin Program, much less staff is involved in the Klamath Program. However, the proportion of the budget for Administration has ranged from 22% to 35% of the $1.0 million Federal share in recent years (Table 7-1). Of this amount, $80,000 goes to the USFWS Portland office for contract administration, and $20-25,000 goes to non-staffing costs (e.g., travel, lodging, and meals for Task Force and Council meetings).

Figure 7-1 -- Klamath River Fishery Resource Office Staffing, 1990.



To successfully implement the Program, a proper balance is needed between the costs of administration and implementation. If adequate communication and coordination is to occur, for example, the Task Force should expect a fair proportion of costs for phone bills, photocopying, and travel. Implementation of the Plan is not all construction projects and studies, either. As a policy planning document, much of the implementation will also be through staff helping to carry out the policies. Examples include: providing comments for the Task Force (based on the Plan's policies) on pertinent habitat protection issues (e.g., USFS Land Management Plans and EIS's, CDFG suction mining regulations), setting up local meetings or workshops with landowners, establishing and updating a restoration data base, seeking new funding sources, and attending coordination meetings with other agencies.

In addition, a balance is needed between the amount of time spent by staff on Task Force and Council matters. It is presently unclear what the proportion should be; in 1989, an estimated 80% of staff time was spent on Council's needs. To date, the Council and its Technical Advisory Team meet more frequently than the Task Force and its committees due to pressing annual deadlines for recommendations to the Pacific Fisheries Management Council (PFMC). The Task Force will need increasing staff time as more projects are approved and the Long Range Plan becomes implemented.

California Department of Fish and Game

The Department primarily offers staffing through its existing employees (biologists and contracting specialists) who are assigned to the Inland Fisheries Division's Fishery Restoration Program. A portion of their time is allocated to reviewing

Klamath River Basin Proposals, awarding and administering these contracts, and performing field evaluations. CDFG's biologists also offer data collection and technical assistance to the Council.

With the Department's current budgetary difficulties, expansion of staff numbers or time commitments will require new sources of funding.

FUNDING

The Restoration Program is dependent on both Federal and non-Federal sources of funding.

Federal Portion

Between October 1, 1986 (FY 1987) and September 30, 2006 (FY 2006), Congress has authorized to be appropriated to the Department of the Interior an amount of $21.0 million for the "design, construction, operation, and maintenance" of the Program.

As shown in Table 7-1, the Federal expenditure for FY89 and FY90 has averaged very close to the $1.0 million expected of it. These two years represent the first ones during which the Task Force was "fully" functioning. During the initial start-up years, no projects were funded and administrative costs amounted to $40,000 in FY87 and $130,000 in FY88. These funds were provided through the U.S. Fish and Wildlife Service's regular operating budget and were not appropriated under the Act.

While not guaranteed, the Program has been fortunate in receiving its full appropriation from Congress each year that it has been requested. Whether unallocated funds can be carried over to the next fiscal year is still uncertain at this point, based on Federal fiscal policies. This issue has yet to be tested. Concern has also been raised about the additional uncertainty of receiving the full appropriation from Congress during particularly lean Federal budget years.

Since the $300,000 or so of annual administrative costs were considered to represent a large share of the Program's Federal cost-share, additional administrative augmentation monies are being sought by the Portland office of the U.S. Fish and Wildlife Service in future Interior Department proposals for the President's budget. Additional funds for the Council's operations have also been suggested as a possibility, as considerable administrative time is spent assisting the Council.

Non-Federal Portion

The Klamath Act stipulates that "50 percent of the cost of the development and implementation of the program must be provided by one or more non-Federal sources on a basis considered by the Secretary (of the Interior) to be timely and appropriate." "Non-Federal source" is defined to include State or local government, any private entity, and any individual. Federal money received by a State or local government cannot be considered a non-Federal source to carry out the program.

Besides the outlay of cash contributions, the value of in-kind contributions and real and personal property "for the purposes of implementing the program" can be included by the Secretary of the Interior. Volunteer services in carrying out surveys, censuses, and other scientific studies are specifically mentioned as one form of in-kind contribution. What qualifies for in-kind contributions will be officially defined in a Federal Register rulemaking on the subject, following a public comment period, recommendation by the Task Force, and approval by the Secretary of the Interior.

The California Department of Fish and Game (CDFG) has been looked to by the Task Force for providing much of the non-Federal funding portion. As can be seen in Table 7-2, the amount of its annual share for Klamath Basin projects has fluctuated since the Program began in 1986, averaging around $300,000 in recent years. In addition to funding projects, CDFG also contributes staff time (about $50,000 in FY88-89). If State-approved restoration projects do not get implemented, the remaining funds do not carry over for Klamath Basin use the next year but revert to statewide use. CDFG has no funds set aside for the Klamath Basin (M. Odemar, CDFG, personal communication).

Continued funding from CDFG is always a concern. As more fishery restoration projects get approved in other basins of the State (e.g., Sacramento, Russian), competition for limited State funds increases. For the Trinity River Restoration Program, the State is required to pay 15% of the restoration budget (minus certain projects) in cash, not through funded projects. Current funding for stream and fish restoration is primarily derived from voter initiative bond acts approved in the 1980's (Propositions 19, 70, and 99), each of which has specific constraints on how the funds can be spent. State funds in many cases are earmarked for construction projects and cannot be used for studies, monitoring, or assessments.

Other Funding Sources

There is a need to seek and keep record of other non-Federal contributions besides those of California Department of Fish and Game. If significant non-Federal matching cannot be demonstrated, the Federal funding of the Program could be jeopardized in future Congressional budgets. In addition, the $1.0 million dollar annual cost-share which is to be provided by each of the sources (Federal and non-Federal) should also be considered as a minimum, not a maximum, amount to be spent on fish restoration in the Klamath Basin. Other sources of Federal and non-Federal funds for possible use in implementing the Klamath Program are listed in Table 7-3.

To count as a non-Federal contribution to the Program, the Task Force has decided that the project must be consistent with this Plan (or pre-1990, with the CH2M-Hill action plan); and be approved by the Task Force, even if no funds are received through the Task Force.

TABLE 7-1

Klamath Basin Fishery Restoration Program
Fiscal 1989-1990 **Federal** Funding Levels
U.S. Fish and Wildlife Service
Klamath River Fishery Resource Office

Category	FY89	%	FY90	%	Total
Administrator Program	$ 218,760	22%	$ 319,000	35%	$ 537,760
Plan Program	$ 140,135	14%	- 0 -	0	$ 140,135
Educate	$ 87,000	9%	$ 127,265	14%	$ 214,265
Get Information	$ 410,905	41%	$ 266,348	29%	$ 677,253
Artificial Propagation	$ 83,200	8%	$ 109,653	12%	$ 192,853
Manage Habitat	$ 60,000	6%	$ 85,867	9%	$ 145,867
TOTAL	$ 1,000,000		$ 908,133[1]		$ 1,908,133

[1] A total of $ 1,000,000 will likely be spent before the completion of the fiscal year.

TABLE 7-2

Klamath Basin Fishery Restoration Program Projects
Fiscal Year 1986 to 1989 **State** Project Funding[1]
California Department of Fish and Game

Category	FY86-87	FY87-88	FY88-89	FY89-90
Habitat Restoration	$ 498,700	$ 269,750	$ 273,100	$ 249,538
Artificial Propagation	$ 125,400	$ 25,400	$ 25,423	$ 82,800
Education	$ - 0 -	$ - 0 -	$ 16,000	$ - 0 -
TOTAL	$ 624,100	$ 295,150	$ 314,523	$ 332,338

[1] Does not include staff time

Additional new funding sources (See Table 7-3) which may be explored include:

- Through state legislative or voter initiative action, new bond acts (like Proposition 19, 70, or 99) could be adopted which would provide funds to help implement the Klamath Program.
- In the Columbian River Basin, Congress authorized an energy surcharge on hydropower revenues to help pay for fish restoration projects. The Sacramento River Management Plan has suggested a similar approach to provide additional implementation funds, which it estimates could amount to several million dollars each year at a 0.05 cent per kilowatt hour set-aside. The Upper Klamath River has three power plants in California and three in Oregon. Such action would require federal or state legislative action.
- A Klamath River Basin Stamp for sport fishing licenses could be offered for sale, with proceeds to be dedicated to Klamath fish restoration. Administration could be done through the California Department of Fish and Game, much like the Salmon Stamp program of the commercial salmon fishermen.
- Obtain a timber harvest surcharge tax for all timber cut on private and public lands in the Klamath Basin. At present, California collects a tax on all timber at the time it is cut (the Timber Yield Tax Act), so the administrative mechanism is in place. state and federal legislation would be needed to authorize such a tax.

INFORMATION SHARING

A $42 million, 20 year Program will be developing and collecting a great deal of raw data and analyzed information over its lifespan. How to best get this information out to restoration workers, biologists, the public, and others is an important issue.

Several information sharing efforts are already underway by the Klamath Fishery Resource Office:

- A **database** was developed for inventorying completed fishery restoration projects in the Basin using existing DBase III+ software.
- A collection of pertinent fisheries management and habitat restoration documents which could be expanded and catalogued into a useful **technical library**. (The Trinity Program is also developing a formal reference library.)
- As part of the Education project, the staff Interpretive Specialist will be producing a periodic **newsletter** about the Program's progress, to be sent to a wide audience.

A Habitat and Population Database

The Restoration Program and its cooperators have no central information system, no "database," from which to evaluate the condition of anadromous fish in the Klamath

TABLE 7-3 — Potential Funding Sources For Implementation of the Klamath River Basin Restoration Program.

Administrator	Fund Name	Purposes
Federal		
U.S. Forest Service (USFS)	Knutsen/Vandenburg (KV)	Resource improvement
	Appropriated funds	Resource improvement
	Excess timber receipts	Resource improvement
Environmental Prot. Agency/State Water Res. Control Bd. (EPA/SWRCB)	Sect. 319(h)(5) Clean Water Act Sect. 205(j) (5)	Nonpoint pollution sources
Agricultural Stability Conservation Service (ASCS)	Agricultural Conservation Program (ACP)	Streambank stability
Dept. Interior/Bureau Indian Affairs	Anadromous Fish	Habitat studies, fish restoration
Tribal		
Bur. Indian Affairs (BIA)	PL 93438, Indian Self-Determination	Resource management
State of California		
Dept. of Fish and Game/ Wildlife Conservation Board (CDFG/WCB)	Prop. 19	Stream rehabilitation
	Prop. 70	Salmon streams
	Prop. 99	Habitat restoration
	Bosco-Keene	Fish restoration work
Dept. of Forestry (CDFFP)	CA Forest Improvement Program (CFIP)	Reforestation, fish habitat
Dept. Water Resources (DWR)	Urban Streams Rest. Program (Prop. 70)	"Urban" creek work
Coastal Conservancy	Prop. 19, 70, 99	Habitat restoration projects visitor center
Local		
Co. Fish & Game Adv. Comm.	Fish & Game Propagation Fund (Fine Monies)	Habitat improvement, education, rearing
Private		
Commercial Salmon Trollers Adv. Comm.	Salmon Stamp (CDFG)	Salmon habitat, rearing or education
California Trout	Prop. 70 (CDFG)	Steelhead streams
Resource Renewal Institute	Water Heritage Trust	Water rights & use
Nature Conservancy	Conservancy Trust	Land acquisition

River Basin or the effectiveness of the Program. A great deal of information concerning historic and present Klamath River fish and fish habitat exists, scattered about in the "gray literature" of government files and reports. More of it is being created every day and scattered beyond the current reach of the Restoration Program. While such information could bring an enormous benefit to the Program, it will take a focused effort by the Program to create that benefit.

With the increasing sophistication and flexibility of computer software and the decreasing costs of both software and hardware, the opportunity exists to develop a practical database for storing the field data developed through the Program. Floppy disks of raw data are already being submitted to the Klamath River Fishery Resource Office as part of completed project final reports. Data from other sources could also be incorporated. Such a useful database could then be shared with other agencies, groups, and individuals.

Options for Databases

Since available software and hardware is changing almost overnight, only a brief description of some of the best options are presented here.

The U.S. Environmental Protection Agency (EPA) Reach File is a water quality assessment and monitoring system maintained by both the EPA and the State Water Resources Control Board (SWRCB). Data is maintained on the map-based "Reach File," which assigns every stream reach in the nation its own unique catalog number. In this way, data gets posted to the right "Grouse" or "Indian" creek. In addition, data can be aggregated for several reaches, an entire stream or a stream system.

In the Columbia River Basin Program, a System Planning Model was developed by its Monitoring and Evaluation Group. Together with a Smolt Density Model, a Tributary Parameter Model, and the EPA reach file, this analytical procedure attempts to predict the production of salmon and steelhead based on various scenarios for each subbasin. It basically takes stream width measurements in different reaches along with very rough fish values, and then makes hypothetical improvements in tributaries to indicate hypothetical gains in fish numbers. If different questions are to be answered on the Klamath, the Program would have to reinvest in software and programming to manipulate the data.

Geographic Information Systems (GIS) are becoming more and more commonly used by resource management agencies as well as by private timber companies. GIS combines two software technologies: data-base management and digital mapping. As a result, it has the ability to select, manipulate, and analyze data in both a spatial (two or three dimensions) and tabular format and interrelate the two. Natural resource data can be overlaid. One current GIS application is the effort by the Resource Agency's Timberland Task Force (Board of Forestry, CDFG, and others) to develop a GIS database statewide for helping make resource allocation decisions. Remote sensing images, such as from Landsat or aerial photos, can be digitized and added as one of the overlays for up-to-date watershed analysis.

Specific fisheries software, such as LSR Group's STREAM SURVEY, is also available. STREAM SURVEY, for example, is being used by the Oregon Department of Fish & Wildlife (ODFW), which is developing a standardized stream survey format to be used with the software. Using a DBase III+ format for IBM compatible computers, the software adapts the stream classification methodology developed by Peter Bisson et al. (1981) and an expansion of another one developed by John Anderson of BLM Oregon. Its programs work together to store, analyze and report from as many as 200 variables of collected physical and biological data.

Each National Forest in the Basin has developed databases for storing and analyzing the habitat typing data which it collects, using DBase IV (Six Rivers NF), or ORACLE and LOTUS 1-2-3 (Klamath NF) software.

Each potential database needs to be carefully scrutinized for its strengths and limitations before adoption by the Task Force. Criteria for selection of the appropriate database should include:

- Expense.
- Compatibility with other computers and software.
- Accessibility by agency and non-agency users.
- Technical skills needed for data entry and reprogramming.
- User friendly for daily use.
- Standardized queries so the same questions are being asked.
- Ability to transfer data from other programs so data would not need to be reentered (automated data loading).

Benefit of the EPA Reach File System

Of all the existing data systems of possible interest to the Restoration Program, the one offering the greatest potential benefit (especially to the present habitat typing efforts) is the water quality assessment and monitoring system maintained by the SWRCB and the EPA. The reasons are:

- The water quality assessment and monitoring program will be continued and steadily improved throughout the coming decades to enable the states and the Federal government to evaluate their effectiveness in implementing the Federal Clean Water Act.
- Cold water fish production has been designated as a "beneficial" water use in the Clean Water Act basin plan prepared by California for the Klamath River, including its Shasta, Scott, Salmon, and Trinity tributaries.
- There is strong interest on the part of state and Federal water quality managers in obtaining information about the condition of fish habitat in the region's streams and in updating that information in their annual assessments.

- o State-Federal Clean Water Act protection efforts, including financial and technical assistance, will be targeted increasingly on degraded streams where designated beneficial uses are shown to be inadequately protected.
- o The Clean Water Act assessments of Klamath River basin streams have not tapped the abundant "gray literature" concerning the area's fish and fish habitat. Many of the basin's streams are being listed as "unimpaired" despite studies which show their fish habitat to be severely degraded, often by sedimentation and other "nonpoint" pollution sources.
- o The Restoration Program can help organize the missing information and contribute it on an ongoing basis to the State-Federal data system. This will not only give direction to State-Federal Clean Water Act efforts but will provide a database for evaluating the effectiveness of the Program as well.

AGENCY AND TRIBAL JURISDICTIONS

The Klamath Basin has been referred to by some observers as "the most agencied basin." A brief description is offered below of each agency and tribal government involved in the management of fisheries and other natural resources in the Klamath River Basin, with a listing providing in Table 7-4. Discussion can also be found in the preceding chapters.

Federal

The Federal role in fisheries management began in 1871 when Congress created the Office of the Commission of Fish and Fisheries to investigate the declining numbers of food fishes in the U.S. lakes and coastal waters. A year later the first Federal hatchery was established to restore food fishes. The Federal role has since expanded considerably, but is still primarily limited to Federal lands, waters, and projects.

Department of the Interior

A representative of the Secretary of the Interior is a member of both the Klamath River Basin Fisheries Task Force and the Klamath Fishery Management Council.

U.S. Fish and Wildlife Service (USFWS). The Service is recognized as the Department's principal fact-finding arm and scientific authority on inland fishery resource matters, including anadromous fish when they reside in inland waters. Its responsibilities include facilitating the restoration of depleted, nationally significant fishery resources (of which the Pacific anadromous salmonids are one), mitigating fishery resources damaged by Federal water resource projects, administering the Endangered Species Act, and assisting with management of fishery resources on Federal and Indian lands. Jurisdiction over anadromous species in inland waters is shared with the National Marine Fisheries Service (see below).

Table 7-4 -- A List of Agencies and Tribes with Jurisdictions for Fishery and Habitat Management in the Klamath River Basin (primarily the California portion).

Federal
- Department of the Interior
  - U.S. Fish and Wildlife Service (USFWS)
  - Bureau of Indian Affairs (BIA)
  - Bureau of Land Management (BLM)
  - Bureau of Reclamation (BuRec)
  - Geological Survey (USGS)
- Department of Commerce
  - National Marine Fisheries Service (NMFS)
  - Pacific Fishery Management Council (PFMC)
- Department of Agriculture
  - Forest Service (USFS)
  - Soil Conservation Service (SCS)
- Environmental Protection Agency (EPA)
- Department of the Army
  - Corps of Engineers (ACE)
- Department of Energy
  - Federal Energy Regulation Commission (FERC)

Tribal
- Hoopa Valley Tribe
- Yurok Tribe
- Karuk Tribe
- Klamath Tribe

State of California
- Resources Agency
  - Department of Fish and Game (CDFG)
  - State Water Resources Control Board (SWRCB)
  - North Coast Regional Water Quality Control Board (RWQCB)
  - Department of Forestry and Fire Prevention (CDF)
  - Department of Water Resources (DWR)
  - California Coastal Commission
  - California Conservation Corps (CCC)
  - State Lands Commission (SLC)
- University of California Cooperative Extension (UCCE)

State of Oregon
- Department of Fish and Wildlife (ODFW)

Regional
- Klamath River Basin Compact Commission

Local
- Counties
- Resources Conservation Districts (RCD)
- Cities

The USFWS has two offices serving the Klamath Basin: the Klamath River Fishery Resource Office in Yreka, which provides the administrative function of the Program, and the California Coastal Fisheries Resource Office in Arcata, which offers monitoring and evaluation of chinook salmon runs in the Klamath River, the monitoring of Indian net harvest levels on reservation lands in the lower river, and general technical assistance.

Bureau of Indian Affairs (BIA). The Bureau's mission is to develop, apply, and preserve a national policy for the conservation of tribal fishery resources. In its role as the agency primarily responsible for assisting tribes in the administration of Indian trust property, the BIA operates on the basis of a government-to-government relationship with the tribes. The BIA funds fisheries studies and projects as well as law enforcement on reservation lands in the Klamath Basin. Since the passage of the Hoopa-Yurok Settlement Act in 1988, the role of the BIA is in transition. The tribes will become more autonomous and self-regulating as their own government. Funds may then go directly from Congress to the tribal government for use in fisheries studies, projects, and enforcement.

Bureau of Land Management (BLM). The BLM administers the public domain lands on the basis of multiple use and sustained yield concepts as described in the Federal Land Policy and Management Act. In addition to producing commodities such as timber and minerals, the Bureau is also responsible for protecting and conserving fish, wildlife, and watersheds. Coordination with California Department of Fish and Game on habitat management is done through Sikes Act Cooperative Agreements. In the Basin, BLM lands are scattered but primarily located in the eastern portion and along the upper Klamath River. The river area above Copco Lake is being studied by BLM for inclusion in the National Wild and Scenic Rivers System. Local offices are found in Redding, California, and Klamath Falls, Oregon.

Bureau of Reclamation (BuRec). In the Klamath Basin, the Bureau's primary role is administering the Klamath Irrigation Project near Klamath Falls, Oregon. One of the first reclamation projects in the country, the Klamath Project has drained, diked, rerouted, and irrigated farmlands in the Upper Basin since 1906. Through the Klamath River Basin Compact, water rights for existing and future irrigated lands in the project area were guaranteed. The agency has also investigated water development sites in other subbasins.

In the Trinity Basin, the Bureau is operator of the Trinity River Project (Lewiston Dam) and is also administrator for the Department of the Interior of the Trinity River Basin Fish and Wildlife Management Program.

Geological Survey (USGS): The Survey collects continuous streamflow data at the gauge stations located throughout the Basin, in conjunction with the California Department of Water Resources. USGS also conducts studies on the hydrology and geology of the area upon request.

Department of Commerce

The Department of Commerce is charged with regulation and administration of interstate commerce in commercial fisheries. Since the passage of the Magnuson Fishery Conservation and Management Act of 1976, the Secretary of Commerce has had responsibility for managing the ocean salmon fisheries between three and 200 miles off the coast.

National Marine Fisheries Service (NMFS). The basic mission of NMFS is to protect and promote the wise and full use of marine fisheries, to bring the country's marine fisheries to an improved state of health and productivity, and to benefit consumers and industry in the process. NMFS administers the Magnuson Act for the Secretary of Commerce and has authority over anadromous fish in marine waters. Besides performing research for fisheries management needs, the NMFS scientists review and comment on public and private water and land development projects that may affect anadromous marine and estuarine fish. They also provide technical advice and assistance to permit applicants and regulatory agencies involved in these projects.

A representative of NMFS serves on both the Klamath Fishery Management Council and the Klamath River Basin Fisheries Task Force.

Pacific Fishery Management Council (PFMC). This interstate council, created by the 1976 Act, makes annual recommendations to the Secretary of Commerce for ocean salmon management off the coasts of California, Oregon, and Washington. In 1978, the PFMC issued a Fishery Management Plan (FMP) for the Commercial and Recreational Salmon Fisheries, which is amended periodically. Its proposal for harvest seasons and quotas, once adopted by the Secretary, has a direct effect on the quantity of chinook and coho salmon harvested by commercial and ocean sport fishermen operating out of Fort Bragg, Eureka, Trinidad, Crescent City, Brookings, and other local ports. The PFMC has a professional staff in Portland, a Scientific and Statistical Committee (SSC), a Salmon Technical Team (STT), a citizen Salmon Advisory Subpanel (SAS), and a Salmon Select Group (SSG) made of representatives of the other three groups. It meets annually in March and April to decide on that season's salmon fishing season.

Recommendations to the PFMC regarding quotas, seasons and strategies are made annually by the Klamath Fishery Management Council, with help from its Technical Advisory Team. The PFMC also has a representative on the Klamath Fishery Management Council.

Department of Agriculture (USDA)

A representative of the USDA sits as a member of the Klamath River Basin Fisheries Task Force.

U.S. Forest Service (USFS). The agency administers national forest lands under the mandates of many laws, including the Multiple Use-Sustained Yield Act and the National Forest Management Act. It has primary responsibility for management of anadromous fish habitat on its lands, while the California Department of Fish and Game has primary management responsibility for the anadromous fish populations. A nationwide USFS fisheries program, "Rise to the Future," has focused local efforts on habitat monitoring and improvement. Coordination between USFS and CDFG for habitat improvement is provided by the Sikes Act Cooperative Agreement and a Memorandum of Understanding. Much of the agency decision-making is decentralized, with directives starting at the Washington, D.C. office, followed by the regional offices, each national forest, and finally each ranger district. Locally, the forests include Klamath National Forest in Siskiyou County, the Six Rivers National Forest in Humboldt and Del Norte Counties, and the Winema National Forest in Klamath County.

Soil Conservation Service (SCS). The SCS provides private landowners with technical assistance in soil and water conservation. Working through the local Resource Conservation Districts, the SCS office helps develop specific measures to rectify erosion problems, to improve irrigation practices, or to better manage farm, range, and forest soils. Soil scientists also prepare and interpret soil surveys on private lands. Its regional office is located in Red Bluff and a local office in Yreka.

Environmental Protection Agency (EPA)

Created in 1970, the EPA was charged with mounting a coordinated attack on the nation's environmental problems. Functions include: setting and enforcing Federal environmental standards; conducting research on the causes, effects, and control of environmental problems; and assisting state and local governments. Most pertinent to fisheries is EPA's responsibility for administering the Clean Water Act. While EPA has designated much of the administration to the State Water Resources Control Board (SWRCB), the Agency retains final authority (e.g., approval of Best Management Practices for timber harvesting after certification by the SWRCB). Water quality assessment is promoted through the EPA Reach File database system. Its regional office is in San Francisco.

Department of the Army

Army Corps of Engineers (ACE). The agency has done flood control studies and projects in the basin (e.g., levees along Klamath River near Klamath Glen). The Corps also has jurisdiction over projects involving the location of a structure in, or the excavation or discharge of dredge or fill material into, "navigable water." Most of the perennial streams in the Basin qualify, as do the coastal wetlands. This permit authority is derived from Section 404 (hence the term "404 permit") of the Clean Water Act. The Corps' regional office is in San Francisco.

Department of Energy

Federal Energy Regulatory Commission (FERC). Established in 1977 as the successor to the Federal Power Commission (FPC), FERC issues and enforces licenses for construction and operation of non-Federal hydroelectric power projects. In the Klamath Basin, FERC oversees several such licenses (e.g., Iron

Gate) and will be making the final decision on conditions for their relicensing upon expiration of their current hydropower licenses. FERC's regional office for California projects is located in San Francisco.

Tribal

The following description is provided by Ronnie M. Pierce, acting as clearinghouse for tribal statements.

There are three Federally recognized tribes in the lower reaches of the Trinity Basin; the Yurok, Hoopa, and Karuk tribes: and the Klamath Tribe in the upper reach of the Klamath River.

Tribes are sovereign governments with the powers "to adopt and operate under a form of government of the Indians' choosing, to define conditions of tribal membership, to regulate domestic relations of members, to prescribe rules of inheritance, to levy taxes, to regulate property within the jurisdiction of the tribe, to control the conduct of members by municipal legislation, and to administer justice" (Getches, et al. 1979).

Jurisdictional issues in Indian law are generally confined to "Indian Country" wherein tribal and Federal laws normally apply and state laws do not normally apply. Indian Country is defined as: (a) all land within the limits of any Indian reservation under the jurisdiction of the United States government, notwithstanding the issuance of any patent, and including rights-of-way running through the reservation, (b) all dependent Indian communities within the borders of the United States whether within the original or subsequently acquired territory thereof, and whether within or without the limits of a state, and (c) all Indian allotments, the Indian title to which have not been extinguished, including rights-of-way through same" (18 U.S.C.A., 1151, 1948).

The term "Indian Country" is not confined to trust lands within the boundaries of an Indian reservation. Indian country includes fee patent land within the boundaries of a reservation, and tribally owned fee land outside of reservation boundaries.

Indian law is dynamic by nature, and tribal jurisdictions within the Basin are often challenged. The basic principal of Indian law supported in major decisions regarding jurisdiction is that: " ... powers which are lawfully vested in an Indian tribe are not, in general, delegated powers granted by express acts of Congress, but rather inherent powers of a limited sovereignty which has never been extinguished" (Getches, et al. 1979).

Tribal jurisdictions will undoubtedly be further clarified and the tribes' active participation in the restoration planning process under the Act is with the understanding that nothing in this Plan is intended to, or shall, affect the jurisdiction or rights of any Indian tribe; including any claims to jurisdiction which may be contrary to Indian law made by other entities described in this section.

Hoopa Valley Tribe

The 2,000 member Hoopa Valley Tribe occupies the Hoopa Valley Reservation along the lower Trinity River. The Hoopa Reservation is a 12 mile square (roughly 89,000 acres) straddling the Trinity River from Tish Tang Creek to the Klamath River. The Reservation was established under an 1864 Act of Congress. This Act has been interpreted by Federal and California courts, and by the Interior Department, as reserving tribal fishing rights in the Trinity River. These fishing rights include the right to regulate on-reservation fishing by tribal members. The State of California has no authority to regulate on-reservation fishing by Indians.

In addition, the Hoopa Valley Tribe's general, inherent civil regulatory authority entails the right to regulate land use and other activities within the Reservation that affect the fishery; this on-reservation regulatory authority of the tribe frequently extends to activities of non-members of the tribe on privately owned lands within the Reservation. Under its authority over Reservation territory, the tribe engages in a wide array of watershed, habitat, and fishery restoration activities. Tribal laws are enforced in the tribe's own court system. The tribe also participates in a variety of fishery management groups that affect off-reservation habitat and fishery activities.

The Hoopa-Yurok Settlement Act of 1988, P.L. 100-580, separated the Hoopa Valley Reservation from the Yurok Reservation on the lower Klamath River, and confirmed the Hoopa Valley Tribe's right to govern its Reservation.

Yurok Tribe

The Yurok Reservation is a long narrow strip of land along the lower 40 miles of the Klamath River; from the River's mouth to Weitchpec, at the northern border of the Hoopa Valley Reservation. The Yurok Tribe, though Federally recognized, to date has had no formal governing body. With the Settlement Act now in place, the tribe is forming its own government which will assume tribal management authority over their Reservation. Tribal resource and fisheries management programs are of the highest priority with the tribe.

Karuk Tribe

Having their Federal recognition "status" confirmed in 1979, the Karuk Tribe of California is organized under its 1985 constitution and is governed by an elected Tribal Council. In addition to 400 acres of tribal trust lands, the Karuk ancestral territory is considered to be the lands and tributary streams along the Klamath River from Hopkins Creek to Seiad Creek. The Karuk Tribe has an established Fisheries Department which is currently involved in stream enhancement and pond rearing programs, as well as harvest monitoring activities.

Klamath Tribe

In 1986, the Klamath Indian Tribe Restoration Act was passed by Congress to reinstate this Oregon tribe to its Federally recognized status. Federal recognition had been terminated by the U.S. Government in 1954. Its previous reservation lands near

Upper Klamath Lake were converted during termination to Federal and private ownership. Official tribal rolls in 1989 indicated a membership of 2,522. A 1981 Federal court Consent Decree confirmed the tribe's retention of management responsibilities for fishing and habitat management on the former Reservation. It currently has biologists, technicians, game management officers, and water rights attorneys on its staff.

State of California

In 1870, the California Legislature created the Board of Fish Commissioners, the first wildlife conservation agency in the nation. Its original purpose was to establish "fish breederies" for the stocking of streams, to construct fish ladders, and to conserve fish. During the ensuing 120 years, the State's role in fisheries management has significantly broadened in scope and now involves a number of other agencies.

The Resources Agency

This Agency is charged with administering policies, laws, and regulations for the State's natural resources. It consists of several departments, boards, and commissions with at least some type of involvement with salmon and steelhead.

Department of Fish and Game (CDFG). The Department of Fish and Game is charged with the protection, propagation, preservation and investigation of fish and wildlife resources in the State. Functions include protection and propagation of fish, review of EIRs, enforcement of fishing regulations, education, and research. Principle sources of funding are revenues from fishing and hunting licenses, a special tax on commercial fishing, and Federal aid, although General Fund money has been used since 1978 for supporting nongame fish and wildlife programs. The CDFG also has State responsibility for protecting rare and endangered species, recommending adequate stream-flows to preserve fish and wildlife for water permits, enforcing certain water pollution prohibitions, regulating streambed alterations, protecting fish spawning areas, timber harvest review, and operating State fish hatcheries. Federal and private projects needing Federal permits are reviewed by CDFG as a requirement of the Federal Fish and Wildlife Coordination Act.

Locally, pertinent fisheries efforts are administered through the Inland Fisheries Division of the State Office (Klamath-Trinity Program, including the Natural Stocks Assessment Project; Ocean Salmon Coordination) and by the Regional Office (Region 1: Hatcheries Management, Fish Management, Habitat Improvement, Environmental Services). Field offices serving the Klamath Basin are located in Yreka, Weaverville, Arcata, and Eureka, in addition to Iron Gate Hatchery.

A representative of CDFG is the official representative of the State of California on the Task Force and Council.

Fish and Game Commission. The Commission adopts the general policies which govern the conduct of the CDFG, while the Director uses the policies for guidance and is responsible to the Commission for administration of the CDFG. Harvest management responsibilities include: setting terms and conditions for issuance of fishing permits and licenses; determining seasons, methods, and areas for sport fishing; and regulating commercial fishing.

Wildlife Conservation Board (WCB). The Board's efforts are mainly limited to acquiring land and to developing facilities or habitat for fish and wildlife. Projects include fishing access sites, hatcheries, egg-taking stations, fish ladders, stream clearance, and habitat improvement. Funds come from State horse-racing revenues, Federal sources, and State bond acts (e.g., Proposition 19).

State Water Resources Control Board (SWRCB). This agency's responsibility is for the State's water quality and water rights programs. Its water quality authority is derived from the State Porter-Cologne Water Quality Control Act as well as the Federal Clean Water Act, since the U.S. Environmental Protection Agency has designated the SWRCB to carry out its policy. After the State Board adopts general policies and programs, the North Coast Regional Water Quality Control Board (RWQCB) implements them through developing regional plans and issuing and enforcing waste discharge permits (the revised Water Quality Control Plan for the North Coast Region was adopted in 1989). The Regional Board staff also performs water quality studies and reviews private Timber Harvest Plans with CDF & CDFG.

Water rights permits and licenses to appropriate water from streams and lakes are issued only by the SWRCB, which also must consider the preservation and enhancement of fish and wildlife.

Department of Forestry and Fire Protection (CDF). Under policies set by the Board of Forestry (BoF), the CDF oversees the protection and conservation of the State's forestlands. CDF's duties involve the regulation of logging operations on non-Federal lands (the Z'Berg-Nejedley Forest Practice Act of 1973); operation of State forest nurseries; technical assistance to landowners on forest, brush, and watershed management; and conducting studies on reforestation, range improvement, watershed, and other wildland management. Fishery values and stream habitat must be considered in its forest management activities, with CDFG and RWQCB staff now participating in field review of Timber Harvest Plans.

Department of Water Resources (DWR). The Department of Water Resources is primarily the water supply agency of the State. It develops the California Water Plan; oversees the State Water Project; promotes water conservation, reclamation, and recycling; performs studies; develops flood control measures; operates stream gages with USGS; and regulates dam safety. In adjudicated river basins, DWR provides watermaster service at the request of the water rights holders. The California Water Commission (CWC) is advisory to the Director of the Department and gives final approval for loans and grants for local projects.

California Coastal Commission. Based on the California Coastal Act, the Commission establishes policies governing land use activities in the Coastal Zone (averaging 1000 feet inland, plus significant estuaries). Specific land use policies are implemented locally through a county Local Coastal Plan (LCP), which must provide protection of the marine environment and land resources.

Coastal Conservancy (CC). The Conservancy is primarily an agency which funds selected projects approved by the Commission and in compliance with a certified LCP. For fisheries, its authority includes providing funds to state and local agencies and non-profit groups to correct the degradation of natural areas; providing funds to State agencies for the establishment of buffer zones around fragile park and natural areas; and making loans to the Department of Parks and Recreation for the acquisition of key park areas.

California Conservation Corps (CCC). The Corps provides public service assistance in the areas of resource management and conservation while its young members (ages 18-23) get on-the-job training. These public service projects may be requested by local, State, or Federal agencies, subject to review and approval by the Secretary of Resources. Its fisheries-related projects include barrier removal, instream structures, riparian planting, erosion control, and assisting community rearing pond programs.

State Lands Commission (SLC). Charged with exclusive management jurisdiction over State-owned lands, the SLC oversees public interest in coastal tide and submerged lands and beds of navigable rivers. The legal definition of "navigable" has caused some ambiguity in the SLC's role in rivers like the Klamath and its tributaries.

University of California (UC)

The University of California provides higher education and research as well as some public service programs.

Cooperative Extension, Sea Grant Marine Advisory Program. As an outreach of the National and California Sea Grant Programs, the Marine Advisory Program serves coastal resource users through education and technical assistance. Its marine advisors operate out of local farm advisor offices and directly communicate with fishermen, fish processors, and fish propagators, among others. Their methods include producing publications, holding conferences and seminars, informing the media, and attending local fisheries meetings. Sea Grant also funds fisheries research related to salmon and steelhead. In addition, Cooperative Extension has an Aquaculture Program based in Davis and Bodega Bay which can provide fish enhancement groups with disease and pathology information. Local Marine Advisors are located in Crescent City and Eureka.

Cooperative Extension, Farm Advisor. Operating similarly to Marine Advisors, the Farm Advisor (and Forest Advisor) offers educational and technical assistance to farmers, ranchers, and timberland owners. Resource management advice pertinent to fisheries includes irrigation practices, grazing and riparian management, and timber harvesting practices. Local offices are found in Yreka and Eureka.

State of Oregon

Department of Fish and Wildlife (ODFW)

Created in 1975 with the merger of the Fish Commission and the Wildlife (Game) Commission, the Department manages both the commercial and sport fisheries of Oregon. A seven-member Fish and Wildlife Commission, through the Director, oversees the agency's staff and budget. Funding comes from fishing license revenues, the State general fund, and Federal support. The Fish Division's functions are administratively divided into three programs: fish propagation, freshwater resources (steelhead), and marine resources (salmon management). In addition, the Habitat Division focuses on habitat conservation. Statewide Management Plans for individual species identify priorities, objectives, and policies to guide future management: coho salmon (1982), steelhead (1986), and chinook salmon (in progress). Current emphasis includes fish restoration and enhancement projects (particularly through the volunteer Salmon and Trout Enhancement Program (STEP)), salmon management coordination with the Pacific Fisheries Management Council (PFMC), hatchery maintenance, habitat protection, and research.

A representative of ODFW is the official member for the State of Oregon on the Task Force and the Council.

Regional

Klamath River Basin Compact Commission

Created by the Klamath River Basin Compact in 1957, the Commission is composed of three members: a California representative (Department of Water Resources), an Oregon representative (State Engineer), and a Federal representative (with no vote). The Commission administers the Compact, which has the following purposes: 1) to facilitate and promote the development of water in the Upper Klamath Basin for domestic, irrigation, fish and wildlife, recreation, industrial, hydroelectric, navigation and flood prevention uses; and 2) to further intergovernmental cooperation and to prevent controversies over water uses in the two states. If agreement cannot be reached between the two state members, an arbitration forum is created.

Local

Counties

The Board of Supervisors is the governing body of each county. Its five elected members enact legislation to govern the county; determine policies for county departments, commissions, and special districts (including land use policies for private lands); hear appeals from decisions of the Planning Commission; and adopt an annual budget. All of the counties look to the California Department of Fish and Game for advice on stream and fisheries protection measures in their decision-making process.

Each county also has a Fish and Game Advisory Commission (or Committee), whose role it is to advise the Supervisors on the use of the County Fish and Game Preservation Fund. This fund is derived from the fines charged violators of the California Fish and Game Code, half of which return to the county where the violation occurred. The collected money must be spent only for "the propagation and conservation of fish and wildlife," and may include educational and youth activities relating to fish and game. The committees' members also advise the Board on policy matters related to fish and wildlife.

Del Norte County. Land use policies for the area are defined in the County's Local Coastal Plan (1984) and General Plan (1976). Coastal jurisdiction extends up to Blake's Riffle (below Tarup Creek), in which a special zone (Resource Conservation Area) with restrictive conditions for allowable land uses is applied to estuary, riparian, and wetland sites. A Use Permit would be required for gravel mining on private lands under County Ordinance (SMARA). The county does not claim jurisdiction on BIA tribal trust lands within the Yurok Reservation or the Resighini Rancheria.

Humboldt County. The County General Plan (1985) includes natural resource policies addressing streamside management, riparian buffers, and sensitive habitats, which are used for development standards in discretionary projects needing county approval. For lands within the county's jurisdiction between Somes Bar and Blue Creek, zoning is either Timber Production Zone (TPZ) or unclassified (P).

Siskiyou County. Siskiyou County encompasses most of the Klamath Basin, although only 37% of its lands are in private ownership. Of these lands, about 13% are crop or pasture lands and 55% are woodlands. The County General Plan's (1980) goal is to protect the county's critical natural resources and still allow room for adequate growth and development. Urban growth is occurring mainly along the I-5 corridor, gradually moving north and infilling existing urban areas. Through its Land Use Element, ordinances and Specific Area Plans (e.g., Scott Valley), the county has standards for geologic and erosion hazards, riparian setbacks, and gravel removal operations. It also comments on water rights applications.

Resource Conservation Districts (RCDs)

The Districts are authorized to carry out a resource conservation program to help landowners, groups, and local, State and Federal officials conserve soil and water. Their focus is on private lands, where they encourage conservation practices to prevent or control soil erosion, control water runoff, protect water quality, reclaim water, and "treat each acre of land according to its need." Each district is governed by a five-member Board of Directors who are locally elected (or appointed by the County Board of Supervisors if candidates are not contested). Technical assistance for the RCD's activities is offered through the staff of the USDA Soil Conservation Service.

Within the Klamath Basin are the following districts: Shasta Valley RCD, Siskiyou (Scott Valley) RCD, and Butte Valley RCD. No RCDs are located in the lower Klamath Basin (Humboldt & Del Norte counties).

Cities

Governed by a City Council, each incorporated city has similar responsibilities as the county. Policies related to fisheries (e.g., streams, riparian zones, water quality, and runoff) would be located in their respective general plans.

Etna, Fort Jones, Happy Camp, Montague, and Yreka. Each of these cities is located on or near an anadromous fish stream. To date, only the City of Yreka has taken an active fish restoration role by participating in the Yreka Creek Greenway Project.

COORDINATION

"Coordination" is one of the most often mentioned words or functions in the Klamath Act. The lack of it in the past and the need for it in the future were widely acknowledged. In particular, the Task Force's role includes coordination:

- Of the Restoration Program.
- Of its activities with Federal, Tribal, State, and local governmental or private anadromous fish restoration projects within the Klamath Basin Conservation Area.
- Between the Task Force and the Council.
- Between the Klamath Task Force and the Trinity Task Force.

Before offering coordination options, an understanding is needed of what inhibits coordination in the first place.

Barriers to Coordination

Improved inter-agency coordination is always a desirable goal yet the inherent nature of large governmental organizations often precludes it. Several organizational behavior theories offer insight into why interagency coordination is so difficult (Downs 1967).

Behavior of Large Organizations. Certain "laws" offer explanations of behavior:

a. Law of Interorganizational Conflict. Every large organization is in partial conflict with every other social agent it deals with.
b. Law of Decreasing Coordination. The larger any organization becomes, the poorer is the coordination among its actions.
c. Law of Diminishing Control. The larger any organization becomes, the weaker is the control over its actions exercised by those at the top.
d. Law of Imperfect Control. No one can fully control the behavior of a large organization.

Communication Barriers. Since communication helps to improve cooperation, ways to improve communication (within an agency as well as between agencies) are important. Certain observations on organizational communications are also offered (Downs 1967):

a. The vast majority of all communications in large organizations are unofficial or informal.
b. Conflicting organizations (or sub-sections) will tend to avoid subformal channels and communicate only formally. However, closely cooperating sections will rely primarily upon subformal communications.
c. When two organizations are in strong conflict, "informal networks of communication may be substantially closed to members of the other by orders of top-echelon officials, a feeling of mutual hostility at all levels, or a tactical need to keep procedures and ideas concealed so as not to yield any competitive advantage in the conflict."
d. An official in one organization is not usually familiar with the subformal communications networks in another organization, which limits his ability to communicate effectively. However, this difficulty can be overcome: "smart officials eat as many lunches with counterparts in other bureaus as they do with colleagues in their own bureaus."

One can conclude from these "rules" of organizational behavior that institutional obstacles to coordination and communication will always be present yet individuals can be effective coordinators and communicators if they learn the right channels.

Conflicting Missions and Constituencies. Each natural resource agency has evolved with a separate history and often a separate constituency, as well as having been given distinct mandates. The "pluralism" of the American society is therefore reflected in conflicting agency goals and lack of a coordinated direction. Some feel strongly that this pluralism in agencies is a positive trait too; a diversity of agency approaches may lead to some innovations and ambiguity should be tolerated in healthy institutions (Grodzins, in Henning, 1974).

One political historian noted that Federal natural resource agencies "had been born variously of a national crisis, a public outrage, a scientist's insight or a President's dream -- but all reflected that hoary first principle of American government: when something itches, scratch it" (White, in Henning, 1974).

Overlapping Missions, or "Turf Defense". More than one agency may have legal or implied jurisdiction of a certain resource or activity. Rather than share or redefine the responsibility, each one will tend to defend its maximum role. Such a defense can be caused by a competition for limited funds, the individual's or agency's desire for self-preservation, the perceived threat to its powers, or other reasons.

Coordination Methods

Coordination does not happen by a document or a person stating that it will happen, nor does it happen by having every agency represented at the same table. When coordination does occur, a combination of methods are usually used. Following is a list of several formal and informal methods of coordination possible among the various agencies and tribes, as well as others.

Agency Agreements

The Klamath Act instructs the Secretary of the Interior to enter into a Memorandum of Agreement with the Federal, State, and local agencies and tribal governments having jurisdiction over the various activities planned by the Task Force. This agreement shall "specify the program activities for which the respective signatories to the agreement are responsible and shall contain such provisions as are necessary to ensure the coordinated implementation of the program." (460ss-1.(b)(4))

To date, such a long-term Memorandum of Agreement (MOA) between all of the agencies and tribes has not been developed. Instead, they have been using short-term individual Cooperative Agreements between the USFWS and each agency in defining how a specific restoration activity is to be carried out when Task Force funds are being used. For example, a cooperative agreement with the U.S. Forest Service is made for a particular period of time with the U.S. Fish and Wildlife Service to detail methods and authorize expenditures for stream habitat typing in certain locations, which is a project considered necessary by the Task Force to implement its Program.

Similar procedures are being used for the coordination requirement of the Trinity River Basin Fish and Wildlife Restoration Act. Only when a need arises is a formal agreement prepared. If no Federal or State funding is provided to complete the proposed project, then the agreement is cancelled. Difficulties in anticipating and guaranteeing each agency's specific role over the long-term implementation of the program were the main reasons for not literally following the Act's wording.

Memorandums of Agreement have been signed for other Klamath Act purposes: (1) Cooperative Enforcement Agreement (1989) between BIA and CDFG for law enforcement services, as required by the Act "to strengthen and facilitate the enforcement of Area fishery harvesting regulations," and (2) MOA between BIA and CDFG relating to the Indian commercial harvesting of spring-run chinook in the Klamath River for the 1989 season.

Other examples of agency agreements are: Sikes Act Cooperative Agreements between the U.S. Forest Service and California Department of Fish and Game over the use of Sikes Act funds for fish and wildlife projects; Joint Exercise of Powers Agreements (JPA) are formal agreements in California between two or more public agencies of any power common to them, with the Eel-Russian River Commission JPA by four counties an example; Memorandum of Understanding (MOU) is an outline of each participant's authority to be involved a general program, such as the California Coordinated Resource Management and Planning MOU signed by 14 State and Federal agencies.

These general types of agency agreements have been criticized for being "like a treaty between nations" which limit policy innovations or other commitments and end up becoming superficial efforts (Henning 1974). However, without them, many agencies cannot officially commit themselves to long-term participation in an interagency effort.

Joint Management Plans

Two or more agencies or tribal governments can adopt Joint Management Plans to address and coordinate a resource over which they each have some management authority. An example is the Summer Steelhead Management Plan adopted by the Mendocino National Forest and the California Department of Fish and Game for the Middle Fork Eel River (Jones and Ekman 1980).

Committees

Another method often used to promote coordination is appointing a representative of each pertinent agency or tribe on a committee. The Trinity River Basin Task Force is an example, with 14 Federal, State, local, and tribal representatives as members. While this approach does require each agency to sit together at the same table at least once a year, it does not necessarily improve communication or coordination.

Short term efforts, like Coordinated Resource Management Plans (CRMP), often begin with committees composed of agency, group, and citizen members who meet frequently and then end up signing an agreement to help implement the agreed upon plan.

Legislative Consultation Requirements

A formal mechanism for comment by one agency on another agency's proposed action is provided through several State and Federal directives. For example, the California Environmental Quality Act (CEQA) requires a "clearinghouse" review by all pertinent agencies of environmental impact reports, while the National Environmental Policy Act (NEPA) provides a similar function for Federal projects. Another example is the Federal Fish and Wildlife Coordination Act. However, these reviews are only triggered by major projects which may have a significant impact on the environment, and such consultations do not necessarily lead to better resource management coordination on a daily basis.

Informal Coordination

Cooperation among field people of different agencies or tribes is a fairly common approach to coordination and, often, a very effective one in the short term. Mid-level managers can also communicate with their colleagues in other agencies through the subformal networks discussed above, and bypass the organizational barriers that may exist. However, without the official sanction of the agencies/tribes involved, such informal action may not have the power to be sustained for the long-term but only last as long as the individuals involved (Henning 1974).

Improving communication through periodic meetings, workshops, and conferences on fishery restoration and related topics can be one of the most effective informal means of coordination. Personal contacts are made, information is shared, and insights are gained.

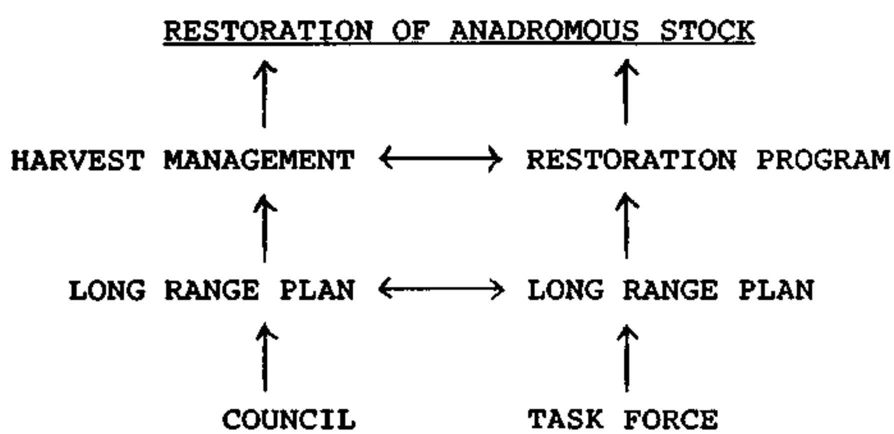
Council Coordination

How to best coordinate the efforts of the Task Force and the Council is another concern. The Council is developing its own long-term plan and policy, as the Klamath Act required, concurrently with this Plan. It is still unclear how the two plans will mesh to create the Restoration Program but Figure 7-2 generally describes the relationship of the two efforts.

The Council is primarily responsible for recommendations on in-river and ocean harvest allocation of Klamath and Trinity Basin anadromous fish populations. While the Task Force Plan addresses fish population trends, problems (including harvesting) and some solutions (Chapters 3 and 4), it defers to the Council for specific harvesting recommendations on all species.

The Council is in need of "the best scientific information available" (states the Act) upon which to base its recommendations to the harvest managers, and the Task Force is in the position to fund some of the needed studies. Their interdependence necessitates close cooperation and communication.

Figure 7-2 -- Relationship of the Long-Range Plans of the Task Force and Council.



PROJECT SELECTION PROCESS

Project proposals to implement the Klamath Basin Fisheries Restoration Program are solicited separately each year by the U.S. Fish and Wildlife Service (Klamath River Fishery Resource Office) and by the California Department of Fish and Game.

Application Procedure and Criteria

The Klamath River Fishery Resource Office will draft a Request for Proposals (RFP), based on the annual Action Plan of the Long-Range Plan, to be accomplished in the upcoming fiscal year. The RFP will be distributed to the public. The selection process is described in Figure 7-3.

The California Department of Fish and Game's fish habitat restoration activities are directed by policies in Section 1501 of the Fish and Game Code. CDFG has developed its own evaluation process for proposals submitted to its annual Fishery Restoration Program. Currently, the CDFG has established criteria for the selection of fishery restoration projects in the Klamath River Basin (excluding the Trinity Basin):

1. Consideration will be given in descending order of species priority, to projects benefiting fall-run chinook salmon, steelhead trout, spring-run chinook salmon, and other species or subspecies of fishes.
2. Highest priority will be given to projects which will result in increased natural production of the target species. Artificial propagation projects will also be considered.

Evaluation Process

Proposals submitted directly to CDFG are copied and sent to the appropriate CDFG unit biologist or other CDFG representative for comment and ranking. A Priority Rating System is used for each proposed project. For habitat rehabilitation projects, the rating categories include: biological soundness, technical merit, contractor's past performance, required funding, required CDFG staff assistance, and cost/benefit ratio.

The local CDFG biologist's priority ratings and comments are submitted to the regional headquarters, and then combined into a regional priority list to be transmitted to the Inland Fisheries Division in Sacramento. Those that would best be funded under the Klamath Program's Federal funds (e.g., studies) are then submitted to the Klamath River Fisheries Resource Office for further review. The others are either approved directly by the Director of the California Department of Fish and Game or are sent to the appropriate funding source (i.e., Salmon Stamp Committee, Wildlife Conservation Board, Advisory Committee on Salmon and Steelhead Trout) for final selection.

Proposals submitted directly to the Klamath River Fishery Resource Office are grouped into major categories (e.g., Habitat Restoration, Education). These proposals and those received through CDFG's program for the Klamath Basin are directed to the Task Force's Technical Work Group (TWG) for ranking during a several day session. Proposers are asked during the first day to expand on information contained in written proposals, to respond to questions from the TWG, and to negotiate any needed changes. A second session is open only to the Technical Work Group, Task Force Budget Committee, and Klamath River Fishery Resource Office support staff. The proposals are then rated, individually and privately, using numerical rating criteria. The ratings are totaled and averaged for each project and ranked by averaging the rating within each category. The Budget Committee draws the line within each category to fit the available Federal funding. Only those projects above the funding cutoff line will be recommended to the Task Force as part of the annual work plan. At a Task Force public meeting, the Task Force makes the final decision. Unsuccessful proposers can appeal to the Task Force at that meeting. Figure 7-3 describes the above process.

Congress also requested that, "to the extent practicable," any restoration work of the Program be performed by unemployed commercial fishermen, Indians, and other persons whose livelihood depends upon the Basin's fishery resources (Section SS-1(b)(3). One of the difficulties in carrying out this request, such as recruiting these people in specific projects, has been the USFWS contracting procedures for "sole-source" awards. Giving preference to one group is difficult for the Federal government to implement, as competition is preferred in deciding the best project proposal. The Task Force has asked the USFWS to provide a waiver of sole-source constraints for Klamath funds. In contrast, the State of California has ways of selecting projects for these workers.

Project Administration Procedures

The U.S. Fish and Wildlife Service uses several types of legal arrangements to obtain agreements with those agencies, groups, and individuals who are implementing the Restoration Program:

<u>Cooperative Agreements</u> between the Service and states, Federally-recognized tribes, counties, and other levels of government.

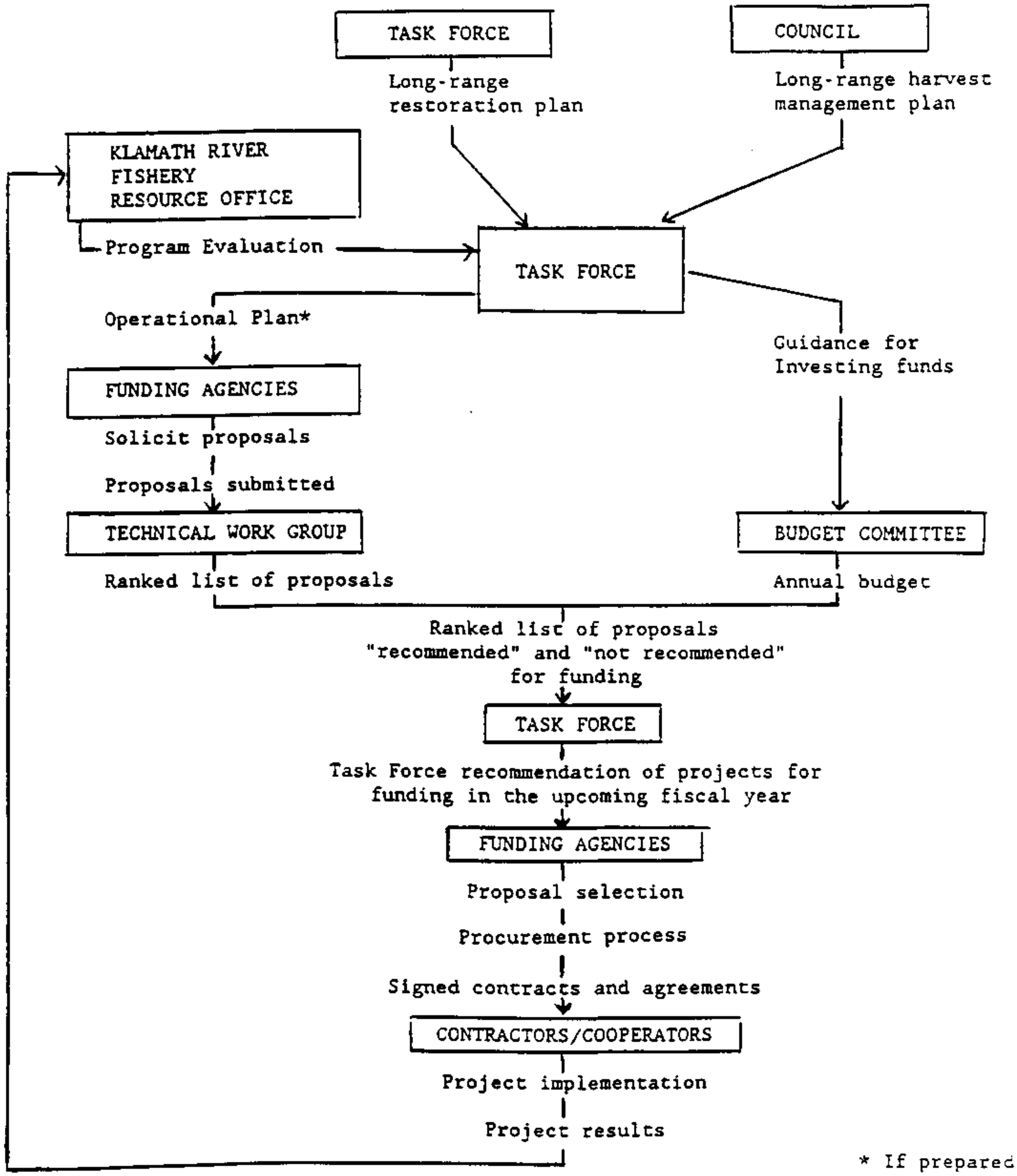
<u>Interagency Agreements</u> between the Service and other Federal agencies.

<u>Contracts</u>, including:

> <u>Sealed-bid procurements</u>. These are not used very often in acquiring professional services.
>
> <u>Negotiated procurements</u>, which are typically used to contract for professional services such as studies or planning. The time required between a request for contracting and the contract award is typically 4-6 months.

Projects funded through CDFG will have contracts written which are then sent to the contractor for signature. After receipt by CDFG, the contract is sent to the Department of General Services (DGS) for approval. When DGS returns the contracts to CDFG, a Notice to Proceed can be written and sent to the contractor so work can begin. This process has proven to be very lengthy and work may not be completed during the same year in which funds were requested.

Figure 7-3 -- Klamath Fishery Restoration Program Project Selection Process.



POLICIES FOR PROGRAM ADMINISTRATION

Objective 7: Provide adequate and effective administration to successfully implement the Restoration Plan and Program.

7.1. Involve interests or agencies not represented on the Task Force through several methods:

a. Decision-making: Task Force members should each try to reflect public interest and equity values in their decisions and not just the views of their organization.
b. Technical Work Group membership: Appointments of technical specialists from other agencies or groups should be made to this Task Force subcommittee, which solicits and evaluate project proposals.
c. Public Involvement: Task Force should continue seeking public opinion at its meetings but also develop or support working groups to address different problems or problem areas. Coordinated Resource Management and Planning (CRMP) is another method to involve a wide spectrum of participants.
d. Cooperative or interagency agreements should be used to carry out restoration activities with non-Task Force agencies, which may be jointly funded.

7.2. Ensure the decision-making process will work well.

a. Arrange a training session for the Task Force in the consensus decision-making process.
b. As an option, use the "abstention" position when a member does not feel strongly enough about a proposal to vote "no," yet cannot support the proposal.
c. Adoption of rules similar to the "T/F/W Ground Rules," under which each member agrees to work.
d. Actively seek to negotiate a compromise that considers the needs of all parties.
e. Retain the consensus approach to decision-making.

7.3. Assign Committees, made up of Task Force and Technical Work Group members or representatives, to monitor each of the Plan's major components: Habitat Protection and Management, Habitat Restoration, Population Protection (includes liaison with Council), Population Restoration, Education and Communication, and Administration. Committees shall report at each Task Force meeting about progress of policy implementation.

7.4. Formally evaluate plan and program progress and provide for amendments to the Plan.

a. A Program Review shall be done every 5 years during the Program's lifespan. The first Program Review should begin in 1995, followed by reviews in the years 2000 and 2005.

b. An Annual Progress Report appropriate for public review shall briefly summarize the results of Task Force actions and projects to date, including an accounting of the costs. Both Federally and non-Federally funded projects should be included.
c. Plan Amendments shall be provided for on a regular basis, as new information and conditions arise. Policy changes should be based on new findings in the text.

7.5. The Task Force will use any or all of the following options to fulfill staffing needs:

a. Continue using permanent USFWS staff:
    1. Review all administrative functions every 2 to 5 years to ensure that they are fulfilling their original purpose, and to evaluate whether the original purpose needs to be revised and updated.
    2. Council and Task Force Chairs shall consult together annually about the appropriate balance of staff time needed in the coming year.
    3. Evaluate need for a Watershed Specialist (as used in the Trinity Program).
b. Use consultants under contract to implement selected portions of the Plan.
c. Make greater use of Task Force Committees and the Technical Work Group to help implement the Plan.

7.6. Ensure adequate funding is available to implement the Plan.

a. Inform interested parties of other funding opportunities as they arise, and encourage the use of these funds to implement the activities of the Operational Plan, where needed.
b. Facilitate the coordination of interstate funding needs in the Klamath Basin.
c. Maintain files in the Klamath River Fishery Resource Office on each funding source and provide access to the public.
d. Pursue additional new funding sources, if needed.

7.7. Promote and provide opportunities for information sharing.

a. Klamath River Fishery Resource Office should develop a catalogued technical library as the repository for completed project reports, historical and recent Klamath Basin references, and other pertinent restoration materials.
b. Klamath River Fishery Resource Office should regularly produce a newsletter for continuous communication about ongoing and completed projects and their results, as well as other related topics.
c. The Technical Work Group should evaluate and recommend the best software option(s) for data storage and retrieval obtained through Task Force funded projects.
d. Staff or the TWG should thoroughly investigate the use of the EPA/SWRCB water body monitoring data system as a basic file for Klamath River fish and fish habitat information. Evaluate and apply the system's potential for stimulating Clean Water Act efforts, including technical and financial assistance, of direct interest to the Restoration Program. Request financial assistance from the EPA to explore and establish Program use of its Sect.205(b) water body data system.

e. Support publication of the results of Task Force-funded projects in the scientific literature, periodicals for the general public, and a Klamath River Fishery Resource Office Technical Report Series.
f. Encourage the dissemination of Program information, as well as the seeking of pertinent information from other areas, through conferences, workshops or similar means.

7.8. Improve the understanding of agency jurisdictions.

a. Resolve conflicts (existing or potential) resulting from overlapping jurisdictions by pursuing the coordination methods described in the text.
b. Continue clarifying the jurisdictions claimed by each agency involved with fishery or habitat management in the Klamath River Basin.
c. Encourage the expansion of jurisdiction in habitat activities having "underlapping" authority or little protection.

7.9. Ensure effective coordination through the following:

a. Support a combination of formal and informal methods for coordinating the implementation of the Program.
b. Develop a long-term, enduring Memorandum of Agreement among the various agencies and tribes, as required in the Act.
c. Promote local workshops and conferences on topics related to the Restoration Program.
d. Committees of the Task Force, Council, and the Trinity Task Force should meet with each other at least once a year to share progress reports and discuss mutual needs. Conclusions will then be shared with each policy-making body.
e. Monitor non-Program restoration and research work in the Basin.
f. Use the Task Force meeting as a forum for progress reports from the various agencies, tribes, and groups.
g. Promote the use of Coordinated Resource Management Plans (CRMP) to cooperatively implement projects or to better define a long-term coordination strategy in certain areas. Involve as broad a spectrum of participants as needed.
h. Provide adequate resources for coordination.

7.10. Ensure a practical and equitable project selection process.

a. Project solicitation by the USFWS Klamath River Fishery Resource Office shall be based on the annual Action Plan. This Action Plan shall be developed annually by the TWG, for approval by the Task Force, to define any necessary actions to implement the policies of this Plan. To the extent feasible, the CDFG projects for the Klamath Basin should also follow the Action Plan.
b. The Klamath River Fishery Resource Office should develop a complete Project Application Manual describing the project selection process and selection criteria to assist project proponents.
c. Clarify intent of Congress on the preferential employment requirement of the Act.

d. Cooperative Agreements with tribes or for work on Reservations shall be consistent with the Indian Self-Determination Act (PL 93-638), and Tribal Employment and Contracting Rights Ordinances (TECRO).
e. Seek coordination of project selection processes (e.g., timing and criteria) with Salmon Stamp Committee and CDFG.

7.11. Provide comments on proposed public and private projects within the Basin that have the potential for affecting the implementation and success of the Restoration Plan and Program.

a. The Klamath River Fishery Resource Office shall serve as the clearinghouse for all notices for proposed outside projects within the Basin.
b. The Task Force shall respond to those projects deemed to have the greatest potential for impact on the Restoration Plan and Program.
c. Task Force members are encouraged to respond to proposed projects on an individual basis consistent with the approved policies of the Task Force.

CHAPTER 8

CONCLUSIONS

INTRODUCTION

This long-range plan for the Klamath Restoration Program not only updates the 1985 Klamath River Basin Fisheries Resource Plan, it virtually replaces it by redirecting its principal thrusts. This closing chapter first summarizes the new plan's overall nature, then follows with a presentation of the major conclusions and recommendation of each key chapter. Finally, the Plan's goals, objectives, policies and, in some instances, project priorities, are presented in the "step-down" manner in which the Plan will be maintained during the Restoration Program's formative years.

OVERALL

Overall, this plan:

- Recognizes the public policy and investment linkage between the 1986 act of Congress that launched the Klamath River Basin Restoration Program and the 1988 California legislation (SB-2261) that calls for the restoration of anadromous fish throughout the state.

- Presents explicit goals, objectives and policies that recognize the necessarily long-term nature of the Klamath Basin Restoration Program.

- Emphasizes the need for both fish habitat protection and fish habitat restoration from a total watershed, not simply an instream, perspective.

- Recognizes that instream structures improve fish habitat in specific and limited ways and that they are not a panacea for the underlying causes of fish habitat degradation.

- Recognizes that habitat typing and fish population estimates should precede all but the most obviously needed restoration projects.

- Recognizes that the success of the Restoration Program will depend largely on the support and cooperation of the Basin's landowners and water users.

- Stresses the importance of education and communication in promoting the public understanding of, and sustained support for, the Restoration Program.

- Contemplates the on-going evaluation of habitat and monitoring of fish populations throughout the Basin.

- Addresses the need for improving laws and regulations that do not provide sufficient protection for fish and fish habitat.

- Advocates the protection of all stock groups of anadromous fish in the Basin.

- Provides for the maintenance of the genetic integrity of wild fish stock.

- Provides both formal and informal means of coordinating Program efforts with interested public and private groups.

- Calls for the periodic reevaluation and, where experience indicates the need, redirection of the Plan and Program (i.e., adaptive management).

- Is presented in a "step-down" structure that attempts to relate specific policies and project priorities to the Plan's specific stated goals and objectives.

Habitat Protection and Management

1. The first priority of the Plan is the protection of watershed and stream habitat in order to address the cause of habitat degradation rather than just the symptoms.

2. While greatly improved in recent years, timber harvest practices are still observed to be causing harm to local stream habitat. A quantitative surveillance and evaluation of the impact of current practices, particularly of the State Forest Practice Rules, has not been done yet and is needed to identify where additional improvements need to be made and how effective they are. The Task Force can contribute to this evaluation process and then seek the needed changes in State and Federal regulations.

3. The Task Force will request needed timber harvest policy and rule changes to protect riparian vegetation, highly erodible soils, and presently unimpaired streams supporting sensitive wild fish populations.

4. Timely monitoring and evaluation information on both stream habitat quality and anadromous fish locations can assist foresters in preparing more complete and accurate timber harvest plans.

5. Aquatic impacts of suction dredge mining are partially controlled through existing regulations, which include the closure of summer steelhead streams. The California Department of Fish and Game also needs to extend the season opening to July 1 to protect steelhead eggs and fry, and to require dredgers to restore the streambed contours. Studies are needed to evaluate the potential impacts of concentrated or frequent dredging activity and of the larger suction dredges (6 to 10 inches). Education of miners could help prevent such adverse impacts as undercutting streambanks, removal of large woody debris and boulders, and the destruction of riparian vegetation.

6. Gravel, lode and placer mining impacts need to be anticipated and prevented through the existing regulatory agencies.

7. Agricultural management practices have reduced water quality and impaired anadromous fish habitat, particularly in the Scott and Shasta River drainages, through the removal of riparian vegetation, the runoff of fertilizers and animal wastes from fields into streams, as well as past stream channelization.

8. While progress is being made by concerned farmers and ranchers, the Task Force will help speed up the process in several ways: improved communication about causes and solutions, encouragement of "best management practices", promotion of riparian fencing, investigation of conservation easements and by offering some funding. Trends in water quality and riparian cover need to be monitored and evaluated.

9. Salmon and steelhead have been blocked for 80 years from their historic spawning grounds in the upper Klamath River Basin above Copco Dam. Previous analyses have recommended against providing fish access over the dams, with the most recent study having been done in 1966. Providing access to return anadromous fish to their former habitat needs to be evaluated again, considering current knowledge and conditions.

10. While Iron Gate Dam eliminated the extreme flow fluctuations in the mainstem Klamath caused by Copco's releases, adverse impacts on the aquatic habitat from Iron Gate Dam and Reservoir are a concern of this plan. The upcoming federal relicensing of this hydroelectric project provides an opportunity to identify ways to improve its operation to benefit the Restoration Program.

11. Although most of the Klamath River and its tributaries are protected from additional large dams through the State and Federal Wild and Scenic Rivers Acts, other portions are still vulnerable to new water storage and small hydroelectric projects. The Task Force will oppose any further storage or diversion projects that will adversely impact anadromous fish.

12. To protect the streamflows of the Klamath and Trinity Rivers Basins, the Task Force will oppose the exportation or marketing of any additional water.

13. Stream diversions for irrigation have reduced the salmon and steelhead populations of the Scott and Shasta Rivers to subsistence levels.

14. Through the cooperation of the farmers and ranchers, alternative practices could be implemented to provide a benefit to both the water users and the fishery. The Task Force is committed to creative solutions which will not substantially decrease agricultural productivity nor pose undue hardship on ranchers and farmers.

15. California water law for the Klamath Basin needs to be changed to provide 1) incentives for water conservation -- away from the "use it or lose it" philosophy; 2) instream water rights for fish; and 3) for water rights holders to sell their conserved water to an entity designated to protect instream uses.

Habitat Restoration

16. The Task Force will involve the citizens of the Basin communities, not just the established agencies, in the restoration of the region's anadromous fish habitat.

17. Given the substantial role that sediment plays in the degradation of the Basin's fish habitat, the Task Force will give high priority to the evaluation of erosion areas and to their abatement.

18. The Task Force will work closely with the Trinity River Restoration Task Force in that Task Force's efforts to maintain sufficient streamflow to rebuild the Trinity's natural anadromous fish production. The Task Force should work to maintain Klamath River flows below Iron Gate Dam at least at their present levels. Dependable streamflow down both rivers is essential to the health of the estuary.

19. High priority will be given to habitat restoration in the Shasta and Scott Rivers. The potential for fall chinook and steelhead production is great in both rivers.

20. Extreme care will be taken to prevent further damage to the Salmon River watershed. The area serves as a refuge for irreplaceable wild stocks of spring chinook salmon and summer steelhead.

21. The Task Force will pursue cooperative agreements with landowners in the lower Klamath Basin, in particular, that provide for the analysis of erosion problems and the development of watershed stabilization measures.

22. Barrier removal and modification provides the greatest benefit among the Basin's instream habitat restoration projects. Projects serving both salmon and steelhead will be given highest priority. These projects should leave as much large woody debris in the channel as possible.

23. Screening of the Basin's water diversions should be expedited. Fish rescue efforts should be evaluated to determine if they are justified in terms of the survival of the rescued fish.

24. Consideration of structural approaches to habitat restoration other than barrier removal/modification and screening will be based upon the specific criteria discussed in this plan.

Fish Population Protection

25. The Restoration Program should be judged ultimately on its success in restoring runs of anadromous fish that successfully spawn, grow and survive outside hatchery environments or hatchery influences. These have been referred to as "wild" fish in this plan's text.

26. The Task Force will work with the Klamath Fishery Management Council to protect locally-adapted anadromous fish stocks that spawn in diverse portions of the Basin.

27. The Task Force will regard the fish populations that utilize diverse portions of the Basin as "stock groups" until analyses indicate that finer or broader distinctions better serve the objectives of the Restoration Program.

28. The Task Force will work with the California Department of Fish and Game toward the marking of all steelhead produced in the Basin's hatcheries to enable voluntary selective harvest of hatchery fish. Constant fractional marking of hatchery salmon should be continued to assist the assessment of the Basin's natural stocks and to enable selective harvest if it is needed.

29. The Task Force will promote anti-poaching campaigns through expanded law enforcement, strengthened court actions and neighborhood "stream watch" groups.

Fish Population Restoration

30. Through its Technical Team, the Task Force will continue to work with the California Department of Fish and Game to assure that the Basin's fish hatcheries achieve their mitigation goals without creating adverse effects on wild stocks. Areas of concern include the levels of hatchery releases, the fate and health of imported hatchery broodstock, the planting of hatchery fish into different or distant stock groups, and the practicality of marking all hatchery fish to strengthen stock assessments and evaluation of hatchery/wild population interactions.

31. Through its Technical Team, and in consultation with the Indian tribes involved with fish restoration and the Department of Fish and Game, the Task Force will recommend guidelines, for adoption and implementation by the tribes and the Department, for the operation of small fish rearing programs.

32. The Task Force shall improve the cost-effectiveness of those small scale rearing programs that now focus only on fall run chinook salmon by encouraging the culture of coho, steelhead and other species where it would contribute to Restoration Program objectives.

33. Given their uncertain condition, the Task Force will give high priority to green sturgeon restoration opportunities.

Education and Communication

34. The Task Force will continue its funding of salmon and steelhead classroom and field studies curricula and the development of a corps of mentor teachers within the Basin counties and school districts. The curricula should be complete and the mentor teachers recruited and trained no later than 1994.

35. The Task Force will schedule level funding throughout the life of the Restoration Program to sustain the interest of Basin counties and school districts in updating and improving the salmon and steelhead teaching methods and materials. This will enhance the chances that the salmon and steelhead-related studies will be integrated over time into the permanent curricula of the region's schools.

36. Restoration Program personnel will continue regular communications with the region's television and print journalists and should enhance coverage of the Restoration Program by building an inventory of professional quality film, videotape, photos and other visual and graphic materials and by making these materials available to journalists for use in television, magazine and newspaper stories.

37. The Task Force shall commission a summary of the Restoration Program for wide public distribution.

38. The Task Force will schedule preparation of a progress "report to the people" to be released in 1993, a the end of five full years of Restoration Program effort.

Program Administration

39. To date the Restoration Program has been funded with $1.0 million a year from the Federal government, through the U.S. Fish and Wildlife Service, and at least $330,000 of non-Federal money from the California Department of Fish and Game. There are additional existing sources of Federal and non-Federal funding which could be made available to the Restoration Program, as well as potential sources which could be developed (e.g., new state bond acts, a Klamath River fishing stamp).

40. The sharing of the data and information gathered during the 20-year life of the Restoration Program can be facilitated through: a technical library in the Klamath River Fisheries Resource Office, a periodic newsletter, workshops and conferences, publications and computer databases. One of the databases with the greatest potential benefit to the Program is the water quality assessment and monitoring system maintained by the U.S. Environmental Protection Agency on the U.S. Geological Survey "Reach" file. This benefit will grow in the years ahead as the State Water Resources Control Board adapts its water quality assessment record-keeping to the EPA/Reach system.

41. Coordination of all fishery restoration entities and activities in the Klamath River Basin will require a combination of formal and informal agreements and methods.

STEP-DOWN STRUCTURE
OF THE RESTORATION PROGRAM'S LONG-RANGE PLAN

Goal I: Restore, by 2006, the biological productivity of the Klamath River Basin in order to provide for viable commercial and recreational ocean fisheries and in-river tribal (subsistence, ceremonial and commercial) and recreational fisheries.

Objective 2.A. Protect stream and riparian habitat from potential damages caused by timber harvesting and related activities.

2.A.1. Improve current timber harvest practices through the following:

a. Instigate local workshops and seminars on timber harvest methods, including erosion control and stream and riparian protection methods for timber operators and foresters by working with appropriate resource agencies and groups.
b. Develop salmonid habitat protection and management standards and guidelines (by the Technical Work Group) for agency endorsement and use.
c. Develop educational materials addressing stream protection measures for use by foresters, timber operators, and their employees.
d. Obtain existing fish habitat data and place into a data base system which can be easily accessed by agencies and field users.
e. Encourage foresters, land owners, and timber harvesters to view the existing regulations as minimum rather than maximum expectations.
f. Promote communication between timberland managers and salmon and steelhead users.
g. Foster Coordinated Resource Management and Planning in mixed ownership watersheds with important fish habitat (e.g., Blue Creek, Beaver Creek, French Creek, and others).

2.A.2. Contribute to evaluating the effectiveness of the current timber harvest practices in protecting stream habitat through:

a. Development of an index of habitat integrity to better understand the possible cumulative effects.
b. Incorporation of fish habitat and population data into clean water assessments of the State Water Resources Control Board and E.P.A.
c. Monitoring the recovery of stream habitat in logged watersheds.
d. Evaluating watershed and riparian conditions in logged areas.

2.A.3. If the results of the above and other evaluations reveal inadequacies, promote the necessary changes in:

a. The State's Forest Practice Rules and administrative actions.
b. The U.S. Forest Service's policies in its Land Management Plans, Best Management Practices, and administrative actions.

2.A.4. Anticipate potential stream protection problems by requesting:

a. Surveillance monitoring programs, which "208" certification requires, be conducted as soon as possible in Klamath Basin streams by the State Board of Forestry and the U.S. Forest Service.
b. Modification of the State Forest Practices Rules to:
    1. Protect highly erodible soils like the decomposed granitic soils.
    2. Incorporate watershed planning in THP reviews.
    3. Provide adequate protection of riparian areas.
    4. Allow for a longer review period for THPs in critical watersheds.
    5. Provide a meaningful level of cumulative impact analysis.
    6. Provide damaged fish habitat adequate time to recover before new timber harvesting or roads occur in watersheds that are over threshold.
c. Policies in the US Forest Service's Land Management Plans and changes in administrative actions to:
    1. Give first priority to protection of salmonid habitat which is presently unimpaired (e.g., Clear Creek, Dillon Creek).
    2. Protect highly erodible soils like the decomposed granitic soils.
    3. Provide damaged fish habitat adequate time to recover before new timber sales or roads occur in watersheds that are over threshold.
    4. Ensure the survival of anadromous salmonids through adequate protection of their habitat.
    5. Provide adequate protection of riparian areas.
    6. Provide a meaningful level of cumulative impact analysis.
7. Ensure the land base allocation and protective measure for water quality and fish habitat are adequate.

Objective 2.B. Ensure that mining activities do not cause habitat damage.

2.B.1. Seek to minimize impact of suction dredge mining on salmon and steelhead habitat and populations by:

a. Communicating with miners about fish habitat needs and possible impacts of dredging through personal contact as well as preparing a clear and concise illustrated handout to be distributed with suction dredge permits.
b. Evaluating the impacts of concentrated dredging activity, where cumulative effects may pose serious problems.
c. Supporting evaluation of the effects of the larger suction dredges (6 to 10 inch) on salmonid habitat.
d. Supporting CDFG in maintaining complete closure (no exceptions) of essential summer steelhead streams: Wooley Creek, Dillon Creek, and Clear Creek.
e. Requesting that the California Department of Fish and Game:
    1. Change the season's beginning date from June 1 to July 1 to protect winter-run steelhead eggs and fry, which may still be in the gravels during early summer.
    2. Require miners dredging in the river to mark the dredged site for safety reasons, and notify fishermen through the licensing process.

    3. Promote a better record-keeping system through the permit process for collecting data on the numbers, locations, and sizes of dredge activity.

f. Based on the results of research, pursuing any necessary improvements in regulations and education to adequately protect the habitat.

2.B.2. Seek effective protections of salmonid habitat from potential impacts of other mining practices (gravel, lode, placer) by:

a. Promoting education of miners.
b. Supporting needed evaluations and monitoring.
c. Working with the appropriate regulatory agencies in establishing permit conditions.
d. Ensuring minimum reclamation standards be adopted, implemented and enforced.
e. Supporting a mandatory form of financial assurance (e.g., bond) to assure reclamation of mines.
f. Promoting the abatement of any water quality and habitat problems associated with abandoned mining operations.
g. Requesting lead SMARA agencies to assess penalties and fines for non-compliance with SMARA statute provisions, and also for failure to comply with reporting requirements.

2.B.3. Promote communication between miners and salmon and steelhead users.

Objective 2.C. Protect and improve the water quality of stream habitat from adverse agricultural practices.

2.C.1. Seek opportunities for farmers and ranchers to reduce their impact on stream water quality:

a. Instigate local workshops and seminars with local Resource Conservation Districts, County Farm Advisor, Soil Conservation Service, California Department of Fish and Game, Farm Bureau, Cattleman's Association, and others.
b. Encourage "best management practices" to reduce the amounts of animal waste and fertilizers entering watercourses, initially focusing on demonstration projects.
c. Promote the fencing of riparian areas in vulnerable sites to protect existing vegetation, to provide for natural regeneration, and to protect new plantings.
d. Explore the option of conservation easements to protect riparian zones.
e. Make funding available to help implement improvements which will provide a significant benefit to the fisheries.
f. Investigate and pursue other sources of financial assistance (e.g., ASCS, CDFG, SWRCB).
g. Promote communication between the farmers and ranchers and the salmon and steelhead users.

2.C.2. Monitor and assess stream quality to help evaluate the location, extent, and trends of water quality and riparian problems related to agricultural practices, particularly in the Shasta River, while coordinating with pertinent agencies.

Objective 2.E. Protect salmon and steelhead habitat from harmful effects of water and power projects in the Klamath Basin.

2.E.1. Support the evaluation of existing large water storage projects in the basin to determine their effect on limiting factors for anadromous fish production, including the following:

a. Reevaluate (from the 1966 study) the currently available spawning and rearing habitat located above Iron Gate Dam, where needed.
b. Monitor water quality, including water temperatures, above, within, and below the Copco and Iron Gate reservoirs, for a five year period to determine the effects of water storage and powerplant operations on downstream habitat conditions.
c. Evaluate the instream flow needs, using state-of-the-art methods, of each salmon and steelhead run and life stage affected by flows released from Iron Gate Dam.
d. Examine the impact of Lake Shastina on Shasta River's water quality problems.

2.E.2. Identify and implement methods to rectify habitat problems identified in #1 above, including the following:

a. Access above Iron Gate and Copco Dams to the Upper Klamath Basin.
b. Water quality above and below Iron Gate Dam.
c. Instream flow and habitat below Iron Gate Dam.
d. Water quality and flow from Lake Shastina.

2.E.3. Promote adequate fish protection requirements in the relicensing conditions for the Iron Gate Hydroelectric Project and other power projects by the Federal Energy Regulatory Commission.

2.E.4. Advocate inclusion and enforcement of effective conditions for salmonid habitat protection on small and large hydroelectric projects and other water storage projects.

2.E.5. Oppose further large water storage projects until habitat problems caused by existing projects are rectified, and proof is available that any proposed project will not contribute to habitat problems.

2.E.6. Oppose the additional exportation (through water marketing or other means) of water from the Klamath River or Trinity River Basins, which is necessary to restore and protect anadromous fish populations.

2.E.7. Require water flows adequate to achieve optimal productivity of the basin.

2.E.8. Seek the establishment of law that mandates minimum streamflow standards.

2.E.9. Advocate improved streamflow releases from the Trinity River Project which will better mimic the natural or pre-dam streamflow patterns.

Objective 2.F. Protect the instream flow needs of salmon and steelhead in streams affected by water diversions.

2.F.1. As a first priority, seek opportunities for stream diverters to reduce their impact on salmon and steelhead habitat:

a. Involve landowners in the Scott and Shasta Valleys in developing solutions to the instream flow and water quality problems of the Scott and Shasta Rivers and their tributaries.
b. Develop an inventory of water conservation practices for agricultural users in the basin, and seek their implementation by working with the local Resource Conservation Districts, County Farm Advisor, Soil Conservation Service, Farm Bureau, Cattleman's Association, and other interested groups (e.g., through workshops, seminars, County Fair displays).
c. Promote more efficient water delivery practices in order to avoid serious waste of water in unlined ditches.
d. Support effective screening of all diversions.
e. Actively support needed changes in state water rights law so:
    1. Water right holders will not be penalized for conserving water.
    2. Instream uses like fish can have water rights.
    3. Water right transfers can be made to instream uses.
f. If the above changes in water rights law occur, then support the purchase of water rights from willing sellers for the purpose of instream flow improvements.
g. Contribute financial support to water conservation measures which will provide significant benefit to the fisheries.
h. Investigate other sources of financial assistance which can help implement improved practices or purchase water rights (e.g., ASCS, DWR, Water Heritage Trust).
i. Promote communication between water users and salmon and steelhead users.
j. Evaluate the instream flow needs of the Scott and Shasta Rivers and their tributaries.

2.F.2. If fish population trends in a tributary system are found to be at critically low levels by the Task Force, the following policies will be instituted, along with necessary harvest restrictions:

a. Pursue appropriate agency solutions.
b. Exercise water allotment rights to provide emergency instream flows.

2.F.3. In the year 1995, if adequate progress towards improving instream flow conditions for salmonids has not been made as a result of Policy 2.F.1, then seriously pursue the available alternatives:

a. Seek enforcement of the conditions of the Scott River Adjudication through operation of Watermaster Service, including compliance with the October 15 diversion deadline for stream appropriations.
b. Encourage legal action by the US Forest Service to enable it to achieve the minimum fish flows required in the Scott River Adjudication.
c. Ask the State Water Resources Control Board to enforce the water rights condition pertaining to "unreasonable " use of water in agricultural irrigation practices in the Klamath River Basin.

2.F.4. In the year 2000, if adequate progress towards improving instream flow conditions for salmonids has not been made as a result of Policies 2.F.1. and 2.F.3., then investigate the option of reallocation of water rights under the public trust doctrine for protection of fish habitat.

Objective 3: Restore the habitat of anadromous fish of the Klamath River Basin by using appropriate methods that address the factors that limit the production of these species.

3.1 The Klamath River Basin Fisheries Restoration Task Force should solicit the support and cooperation of all the citizens of the Klamath River Basin in its mission to restore anadromous fisheries resources. The communities can be involved by:

a. Holding training sessions on restoration techniques and opportunities.
b. Holding training sessions to increase understanding of the contract and bid process to encourage local firms and groups to get involved.
c. Giving preference to projects that have strong local participation.
d. Encouraging the formation of local restoration groups to "adopt" subbasins and become advocates for fisheries resources and the Restoration Program.

3.2 Because large scale contributions of sediment continue to have substantial negative impacts on the ecosystem of the Klamath River, the Task Force will focus on evaluating areas where erosion continues to be a problem, and will work to solve the problem by:

a. Entering into formal long-term cooperative agreements with the U.S. Forest Service, Resource Conservation Districts, Indian Tribes other agencies.
b. Entering into Cooperative Resource Management Plans (CRMPs), with public and private landowners, with the objective of reducing erosion from their land.
c. Working with resource agencies such as the State Water Resources Control Board, the California Department of Forestry and the Environmental Protection Agency to identify problems, monitor progress on the abatement of sediment problems, and, where necessary, step up enforcement of clean water laws.

d. Exploring the feasibility of using a GIS system and the EPA Reach File to track the fate of sediment basinwide.

3.3 Technically sound habitat restoration measures which benefit depressed stock groups of concern will receive priority consideration for funding.

3.4 The Klamath River Task Force will support the Trinity River Task Force in its efforts to restore adequate streamflow for fisheries resources in the Trinity subbasin.

3.5 The Task Force will work to gain the release of flows of adequate quality and quantity for fishery resources from Iron Gate Dam.

3.6 The Shasta River should be given high priority in the Restoration Program because of its significant potential to produce fall chinook salmon and steelhead. Adequate streamflow for fish are needed here, together with the restoration of riparian areas.

3.7 The Scott River and its tributaries are also a high priority for restoration because of their substantial salmon and steelhead production potential. Solutions to the major problems in the basin include:

a. Improving stream flows and restoring riparian zones.
b. Using the recently completed sediment study to prioritize actions to control erosion of decomposed granite sands and identifying funds for their implementation.
c. Work with private timberland owners and others engaged in road construction and maintenance to insure that future activities do not continue to increase erosion.

3.8 The Salmon River, a refuge area for spring chinook salmon and summer steelhead, has a greatly elevated erosion risk as a result of recent fires. Therefore, the following actions will be taken:

a. Assess erosion problems in the Salmon River Basin, paying particular attention to areas burned during the 1987 fires.
b. Implement measures to stabilize subbasins as soon as possible using the results of the erosion control study to prioritize actions.
c. Make certain that any continuing timber harvest activities by the USFS in the Salmon River Basin do not contribute further to current high erosion hazard.

3.9 The Task Force will work closely with the Yurok Tribe to improve anadromous fisheries resources on the Reservation and on ancestral territories. Actions on lower Klamath tributaries will include:

a. Seeking cooperative agreements with the major private land owners to evaluate slope stability and take appropriate measures to avoid soil loss and related negative impacts on salmon, steelhead and cutthroat trout.

b. Funding a study using aerial photographs, such as the RAPID method, to speed the evaluation of erosion factors.
c. Seeking further agreements to expand fisheries restoration efforts if erosion hazards are reduced or found to be at lower-than-believed levels.
d. Join with the Hoopa and Yurok Tribes in making Pine Creek a model watershed through implementing erosion control and other fisheries restoration measures and working to minimize impacts from future land use.

3-10 The Task Force will pursue the following actions with regard to the middle Klamath tributaries:

a. Encourage the USFS to expand cooperative efforts in mixed ownership drainages having decomposed granite soils, such as Beaver Creek and Cottonwood Creek, to control erosion and modify future timber harvests and road building to prevent erosion from continuing.
b. Study the feasibility and cost of removing the fish migration barriers at or near the mouth of middle Klamath tributaries such as Humbug Creek.
c. Find a solution to the problem of fish passage over the diversion structure on Horse Creek.
d. Seek cooperation from farmers and ranchers in securing adequate flows for fish in drainages such as Seiad and Cottonwood Creeks.

3.11 Fish screens should be installed wherever needed. Adequate funds for screen maintenance shall be provided. An evaluation of fish rescue efforts will be made to determine how many of the rescued fish survive.

3.12 Proposed projects to structurally increase fisheries habitat in any Klamath tributary will be evaluated as to whether:

a. The erosion potential in the watershed and the expected sediment yield would place the project at risk during moderate storm events (10 year interval or less).
b. The stream channel remains highly aggraded and, thus, likely to threaten the stability of the proposed structure.
c. The project is properly engineered in terms of its setting (gradient and channel type) and expected flows.
d. Habitat assessment has been conducted and the suspected limiting factors identified.
e. The proposed project has a clear goal of remedying the identified limiting factors.
f. The proposal includes methods to evaluate whether the goal of the project has been reached after project implementation (ideally, a demonstration of its positive cost-benefit performance).
g. The project budget includes cost estimates for maintenance.

3.13 The Task Force will undertake an affordable evaluation and monitoring program, one which employs accepted, standardized techniques, in order to acquire the information needed for adaptive management. Specifically, the Task Force will:

a. Fund, or find funding from such cooperators as the USFS, for completion of habitat typing and other quantitative habitat assessment of all basin streams having significant restoration potential.
b. Work with agencies such as the EPA, SWRCB, and USFS, which have water quality protection responsibilities, to monitor stream conditions of interest to the Restoration Program.

3.14 The Task Force will seek to mandate by law, minimum habitat standards.

Objective 4: Strive to protect the genetic diversity of anadromous fishes in the Klamath River Basin.

4.1 Increases in populations of self-sustaining runs of fish separate in time or space from hatchery stocks, referred to here as "native" populations, will be the basis upon which the success of the Restoration Program will be judged.

4.2. The Task Force will work closely with the Klamath Fisheries Management Council to protect locally adapted anadromous fish stocks that return to all areas of the Klamath Basin, so that self-sustaining runs can be restored, with emphasis given to priority stocks for recovery.

4.3. The Task Force shall recognize the fish populations adapted to the various areas of the Klamath Basin as stock groups until further study indicates that finer or broader distinctions better serve the Klamath River Basin Fisheries Restoration Program. To this end, the following will be undertaken:

a. Fall chinook salmon escapement should continue to be monitored by use of weirs on the Shasta, Scott, and Salmon rivers and on Blue Creek, and an additional monitoring effort begun on a Middle Klamath tributary.
b. Native spring chinook populations shall continue to be monitored closely in the Salmon River and in the lower river net harvest.
c. CDFG will be requested to continue to monitor population trends of summer steelhead through direct observation surveys.
d. Study feasibility of weir operation later in the season to get more information on coho and steelhead.
e. The Task Force will provide training and supervision for community volunteers interested in conducting spawner surveys to help gather information about native salmon stocks, including coho.
f. Ask CDFG to analyze the angler success data currently collected from guides to provide a steelhead catch-per-effort baseline from which to measure the success of the Restoration Program.
g. Collect information on green sturgeon harvest.

h. Get the information suggested in Nicholas and Hankin (1988) with which to better identify stock groups, beginning with chinook salmon and proceeding on to all salmon and steelhead stock groups.
i. Include the fish counting methods suggested by Hankin and Reeves (1988) when habitat typing, in order to have consistent estimates of standing crops of juvenile fish.
j. Request NMFS to fund a study of green sturgeon, including its distribution, population structure, and level of harvest of Klamath stocks in other areas, to provide sufficient information so that a management plan for the Klamath green sturgeon can be devised.
k. Create incentives for graduate students and other qualified investigators on cutthroat trout, eulachon, and lamprey of the Klamath Basin.

4.4 The Task Force will work with the California Department of Fish and Game to:

a. Mark, by fin-clipping or other method, all hatchery steelhead at Iron Gate Hatchery as well as Trinity River Hatchery so that:
    1. Voluntary selective harvest will be possible.
    2. The problem of residualism can be investigated.
    3. The contributions of hatchery and native steelhead to returns can be determined.
b. Mark a consistent fraction of all hatchery chinook salmon to help in the Natural Stocks Assessment study of the native-to-hatchery relationship of Klamath Basin chinook stocks.
c. Share information gathered through research in a timely manner to enable adaptive management techniques.
d. Investigate the practicality of closing anadromous fish producing streams to "trout" fishing.
e. Promote genetic stock identification or DNA programs for ocean and river sampling to determine fish stock identification.

4.5 To strengthen law enforcement protection of Klamath Basin fish populations, the Task Force will:

a. Encourage the formation of local citizen "watch groups" to help in the protection and monitoring of remnant fish populations throughout the basin.
b. Ask CDFG to seek cooperative agreements with other law enforcement agencies so that sheriffs' deputies, Forest Service and CDF officers, and highway patrolmen may be interested in helping wardens curb poaching.

4.6 The Task Force will encourage local judges to punish poachers to the full extent of the law. Where necessary, particularly to protect stocks in danger of becoming extinct, increases in penalties for poaching should be sought.

4.7 The Task Force will work towards determining spawning population levels appropriate to achieve optimal smolt production for all self sustaining populations of anadromous salmonids in the basin.

4.8 The Task Force will support the ban on the use of large-scale driftnets for fishing on the high seas.

Objective 5.A: Iron Gate Hatchery and Trinity River Hatchery should be operated to produce salmon and steelhead to mitigate for the losses of habitat above their dams and, at the same time, strive to reduce impacts on native fish.

5.A.1 The Task Force's Technical Team will work with CDFG to insure that the Basin's large-scale hatcheries operate to mitigate for loss of habitat above dams while limiting their impacts on wild stocks and maintaining the long term viability of hatchery broodstock. In coordination with Trinity River Task Force, the Task Force will:

a. Determine the optimal levels and composition of hatchery releases that can best achieve mitigation goals while minimizing impacts on native stocks.
b. Identify opportunities for enhancement and harvest supplementation using surplus hatchery eggs where it can be assured that there would be no disease transmission, genetic harm, in-river density dependent effects, or adverse harvest impacts to native stocks.
c. Encourage the continuation of hatchery practices that will maintain the fitness of hatchery broodstock and decrease undesirable impacts of straying on native fish.
d. Conduct a study to determine the resistance of Iron Gate Hatchery steelhead broodstock to Ceratomyxa shasta.
e. Support the CDFG in its effort to secure a water supply filter for Iron Gate Hatchery.

Objective 5.B: Small-scale rearing programs should be temporary measures, primarily for the purpose of accelerating the rebuilding of locally adapted native salmon and steelhead populations, and operated to maintain the genetic integrity of such populations. Ideally, small-scale rearing programs should be operated in conjunction with habitat restoration projects.

5.B.1 Those parties having management authority over small scale rearing and pond programs in the Klamath River Basin shall, through coordinated planning, formulate independent guidelines for activities which will avoid negative effects on the genetic characteristics of native stocks. (The relevant parties, in this instance, are the Yurok, Hoopa, and Karuk Tribes and the State of California, acting through the California Department of Fish and Game.)

5.B.2 The guidelines for small-scale facilities will, to the extent possible, be consistent in content. The guidelines will be developed in accordance with the best known biological practices and their development shall be guided by a technical advisory committee, appointed by the Task Force, having expertise in genetics and fish culture. The small-scale facilities guidelines shall consider, but need not be limited to:

a. Procedures for trapping, rearing, incubating, and transferring fish, and for the control of fish diseases.

b. Broodstock management rules that ensure the maintenance of genetic integrity and the diversity of the stocks handled.
c. Requirements that an appropriate number of fish produced by small scale rearing and enhancement programs are marked and coded wire tagged so that ocean migration may be determined and that inbreeding can be avoided.
d. Methods by which to determine release strategies for pond reared steelhead from rescue programs in order to minimize residual behavior.
e. Methods to by which to evaluate program success.

5.B.3 The Task Force shall encourage small-scale fish rearing project operators to participate in research to determine:

a. Habitat quality to assess appropriate stocking levels.
b. Early life histories of fish cultured so that appropriate time for release can be determined.
c. Those levels of spawning escapement that represent "full seeding" so the Task Force may determine when populations have recovered sufficiently to close or move a facility.

5.B.4 The Task Force will explore means of improving the cost effectiveness of those small-scale rearing programs now targeting late-run fall chinook by capturing other species, such as coho and steelhead, where such efforts would contribute to Restoration Program objectives.

5.B.5 The Task Force will explore the need for green sturgeon population restoration measures.

5.B.6 The Task Force will support the continuation of fish rescue efforts in the middle Klamath Basin and the Scott and Shasta rivers as a viable tool for providing additional salmon and steelhead production.

Objective 6: Promote public interest in the Klamath River Basin's anadromous fish, their beneficial use and habitat requirements and gain support for the Restoration Program's plans and efforts to restore fish habitat and population numbers.

6.1. The Task Force will maintain support for public school programs by:

a. Continuing to develop a curriculum and field activities for schools in the Klamath River Basin and adjacent counties.
b. Encouraging local school districts to make these materials part of the regular curriculum, once the materials are fully developed.
c. Sponsoring workshops and conferences on salmonid conservation to keep teachers interested in and updated about the Restoration Program.
d. Budgeting $5,000-10,000 a year for the operation and maintenance of class-room education projects once the current five-year development process is complete. Teachers should be encouraged to submit proposals to continue the development, operation and innovation of the Program, or for special projects.

6.2. The Task Force will support communications with the public by:

a. Supporting 4-H youth education projects involving riparian restoration.
b. Continuing to encourage the development of interpretive programs on the Yurok Reservation near the mouth of the Klamath River, at the Interstate 5 rest stop north of Yreka and within Yreka itself.
c. Assembling a suitable display for county fairs.
d. Working with angler groups, resort owners, guides, and county fish and game advisory committees to promote angler awareness of the Restoration Program's goals and objectives.
e. Cosponsoring workshops and seminars on water conservation with Resource Conservation Districts to assist the agricultural community.
f. Conducting workshops for state, county, and private road maintenance personnel concerning stream protection needs.
g. Setting up meetings between fisheries biologists and miners to explain the environmental requirements of fish and to learn more about mining activities.
h. Joining with the Klamath Basin tribes in sponsoring a conference about the Indian fisheries.
i. Cosponsoring workshops or "tailgate sessions" with foresters, road engineers, timber and equipment operators concerning watershed protection needs.
j. Providing public information services (e.g. Newsletters, Flyers) for the Klamath Fishery Management Council.

Policies for Program Administration

Objective 7: Provide adequate and effective administration to successfully implement the Restoration Plan and Program.

7.1. Involve interests or agencies not represented on the Task Force through several methods:

a. Decision-making: Task Force members should each try to reflect public interest and equity values in their decisions and not just the views of their organization.
b. Technical Work Group membership: Appointments of technical specialists from other agencies or groups should be made to this Task Force subcommittee, which solicits and evaluate project proposals.
c. Public Involvement: Task Force should continue seeking public opinion at its meetings but also develop or support working groups to address different problems or problem areas. Coordinated Resource Management and Planning (CRMP) is another method to involve a wide spectrum of participants.
d. Cooperative or interagency agreements should be used to carry out restoration activities with non-Task Force agencies, which may be jointly funded.

7.2. Ensure the decision-making process will work well.

a. Arrange a training session for the Task Force in the consensus decision-making process.

b. As an option, use the "abstention" position when a member does not feel strongly enough about a proposal to vote "no," yet cannot support the proposal.
c. Adoption of rules similar to the "T/F/W Ground Rules," under which each member agrees to work.
d. Actively seek to negotiate a compromise that considers the needs of all parties.
e. Retain the consensus approach to decision-making.

7.3. Assign Committees, made up of Task Force and Technical Work Group members or representatives, to monitor each of the Plan's major components: Habitat Protection and Management, Habitat Restoration, Population Protection (includes liaison with Council), Population Restoration, Education and Communication, and Administration. Committees shall report at each Task Force meeting about progress of policy implementation.

7.4. Formally evaluate plan and program progress and provide for amendments to the Plan.

a. A Program Review shall be done every 5 years during the Program's lifespan. The first Program Review should begin in 1995, followed by reviews in the years 2000 and 2005.
b. An Annual Progress Report appropriate for public review shall briefly summarize the results of Task Force actions and projects to date, including an accounting of the costs. Both Federally and non-Federally funded projects should be included.
c. Plan Amendments shall be provided for on a regular basis, as new information and conditions arise. Policy changes should be based on new findings in the text.

7.5. The Task Force will use any or all of the following options to fulfill staffing needs:

a. Continue using permanent USFWS staff:
    1. Review all administrative functions every 2 to 5 years to ensure that they are fulfilling their original purpose, and to evaluate whether the original purpose needs to be revised and updated.
    2. Council and Task Force Chairs shall consult together annually about the appropriate balance of staff time needed in the coming year.
    3. Evaluate need for a Watershed Specialist (as used in the Trinity Program).
b. Use consultants under contract to implement selected portions of the Plan.
c. Make greater use of Task Force Committees and the Technical Work Group to help implement the Plan.

7.6. Ensure adequate funding is available to implement the Plan.

a. Inform interested parties of other funding opportunities as they arise, and encourage the use of these funds to implement the activities of the Operational Plan, where needed.

b. Facilitate the coordination of interstate funding needs in the Klamath Basin.
c. Maintain files in the Klamath River Fishery Resource Office on each funding source and provide access to the public.
d. Pursue additional new funding sources, if needed.

7.7. Promote and provide opportunities for information sharing.

a. Klamath River Fishery Resource Office should develop a catalogued technical library as the repository for completed project reports, historical and recent Klamath Basin references, and other pertinent restoration materials.
b. Klamath River Fishery Resource Office should regularly produce a newsletter for continuous communication about ongoing and completed projects and their results, as well as other related topics.
c. The Technical Work Group should evaluate and recommend the best software option(s) for data storage and retrieval obtained through Task Force funded projects.
d. Staff or the TWG should thoroughly investigate the use of the EPA/SWRCB water body monitoring data system as a basic file for Klamath River fish and fish habitat information. Evaluate and apply the system's potential for stimulating Clean Water Act efforts, including technical and financial assistance, of direct interest to the Restoration Program. Request financial assistance from the EPA to explore and establish Program use of its Sect.205(b) water body data system.
e. Support publication of the results of Task Force funded projects in the scientific literature, periodicals for the general public, and a Klamath River Fishery Resource Office Technical Report Series.
f. Encourage the dissemination of Program information, as well as the seeking of pertinent information from other areas, through conferences, workshops or similar means.

7.8. Improve the understanding of agency jurisdictions.

a. Resolve conflicts (existing or potential) resulting from overlapping jurisdictions by pursuing the coordination methods described in the text.
b. Continue clarifying the jurisdictions claimed by each agency involved with fishery or habitat management in the Klamath River Basin.
c. Encourage the expansion of jurisdiction in habitat activities having "underlapping" authority or little protection.

7.9. Ensure effective coordination through the following:

a. Support a combination of formal and informal methods for coordinating the implementation of the Program.
b. Develop a long-term, enduring Memorandum of Agreement among the various agencies and tribes, as required in the Act.
c. Promote local workshops and conferences on topics related to the Restoration Program.

d. Committees of the Task Force, Council, and the Trinity Task Force should meet with each other at least once a year to share progress reports and discuss mutual needs. Conclusions will then be shared with each policy-making body.
e. Monitor non-Program restoration and research work in the Basin.
f. Use the Task Force meeting as a forum for progress reports from the various agencies, tribes, and groups.
g. Promote the use of Coordinated Resource Management Plans (CRMP) to cooperatively implement projects or to better define a long-term coordination strategy in certain areas. Involve as broad a spectrum of participants as needed.
h. Provide adequate resources for coordination.

7.10. Ensure a practical and equitable project selection process.

a. Project solicitation by the USFWS Klamath River Fishery Resource Office shall be based on the annual Action Plan. This Action Plan shall be developed annually by the TWG, for approval by the Task Force, to define any necessary actions to implement the policies of this Plan. To the extent feasible, the CDFG projects for the Klamath Basin should also follow the Action Plan.
b. The Klamath River Fishery Resource Office should develop a complete Project Application Manual describing the project selection process and selection criteria to assist project proponents.
c. Clarify intent of Congress on the preferential employment requirement of the Act.
d. Cooperative Agreements with tribes or for work on Reservations shall be consistent with the Indian Self-Determination Act (PL 93-638), and Tribal Employment and Contracting Rights Ordinances (TECRO).
e. Seek coordination of project selection processes (e.g., timing and criteria) with Salmon Stamp Committee and CDFG.

7.11. Provide comments on proposed public and private projects within the Basin that have the potential for affecting the implementation and success of the Restoration Plan and Program.

a. The Klamath River Fishery Resource Office shall serve as the clearinghouse for all notices for proposed outside projects within the Basin.
b. The Task Force shall respond to those projects deemed to have the greatest potential for impact on the Restoration Plan and Program.
c. Task Force members are encouraged to respond to proposed projects on an individual basis consistent with the approved policies of the Task Force.

Goal II: Support the Klamath Fishery Management Council in development of harvest regulation recommendations that will provide for viable fisheries and escapement.

Goal III. Recommend to the Congress, state legislatures, and local governments the actions each must take to protect the fish and fish habitats of the Klamath River Basin.

Goal IV: Inform the public about the value of anadromous fish to the Klamath River region and gain their support for the Restoration Program.

Goal V: Promote cooperative relationships between lawful users of the Basin's land and water resources and those who are primarily concerned with the implementation of the Restoration Plan and Program.

GLOSSARY

AFS: American Fisheries Society, professional society for fisheries biologists.

adaptation: changes populations of organisms make over evolutionary time to adjust to environmental changes.

alevin: larval salmon or steelhead from the time of hatching to the time of absorption of the yolk sac. Alevins remain in the gravel.

adaptive management: changing program strategies to reflect findings of monitoring and research to insure that resources are invested in methods that are achieving greatest success.

alkaline: substances with a pH greater than 7.0 that form corrosive substances in water, a high concentration of hydroxyl (OH) ions.

ammoecete: immature lamprey residing in fresh water.

anadromous: fish born in fresh water, migrating to the ocean during adult phase but returning to fresh water to spawn.

anaerobic: processes not requiring oxygen or an environment lacking oxygen.

aquatic invertebrates: animals without skeletal structures that reside in the water such as insects, snails, crayfish, and amphipods.

artificial culture (propagation): any human assisted spawning and rearing of fish in any type of hatchery facility.

BIA: U.S. Bureau of Indian Affairs (Department of the Interior).

BKD: bacterial kidney disease, caused by Renibacterium salmoninarum, which attacks the kidneys and often leads to mortality when smolting is attempted.

basic: alkaline

bedload: sediments too heavy to be transported constantly but which shift during high flows.

behavior: anything an organism does involving action and response to its environment.

boulder cluster: instream structure to redirect water flow and create pools or pocket water for fish spawning and rearing habitat.

broodstock: adult fish retained for artificial propagation; stock on which a hatchery population is founded.

bulk gravel sampling: analyzing a grab sample or freeze core of spawning gravels to determine the amount of fine sediment present.

CCC: California Conservation Corp.

CDF: California Department of Forestry.

CDFG: California Department of Fish and Game.

CDWR: California Department of Water Resources.

coded wire tag (CWT): microscopic piece of metal implanted in nose of salmon or steelhead with code indicating origin of fish (all coded wire tagged salmon must have an adipose fin clip).

carrying capacity: the maximum number of organisms a particular habitat can support throughout a year without damage to either organisms or habitat.

centripetal gene flow: theoretical concept that remnant fish runs from collapsed fish populations may retain a large effective populations (Ne) embodying the genetic diversity of ancestral population.

<u>Ceratomyxa shasta</u>: protozoan which can be lethal to salmon, steelhead, and trout. Thought to reproduce in marsh areas but the free living form has not been identified and the life cycle of the organism remains unknown.

check dam: structure constructed in gullies to prevent soil loss; used extensively after fires.

cohort: a group of fish all spawned in the same year.

Columnaris: fish disease caused by Flexibacter columnaris, which attacks the gills and exterior of salmon or steelhead.

conservation: the preservation, or wise use of, natural resources, as forests, fisheries, etc., for recreational or economic use.

constant fractional marking: marking a consistent percentage of releases from all hatcheries.

cottid: fish which are members of the sculpin family (Cottidae); freshwater forms often called bullheads.

counting weir: fence or series of panels across a stream to allow counting of migrating salmon or steelhead; fish are often tagged to use in spawning escapement estimates.

cover: vegetation or other features that provide shelter for fish.

culvert: a closed passage way (such as a pipe) under roadways which drains surface water; replacing undersized culverts is a key erosion prevention measure.

cumulative effects: damage occurring as a result of watershed disturbance, often triggered by flood events, with sediments persisting in streams over a prolonged period of time and impacting all downstream areas.

cyprinid: fish belonging to the minnow family, Cyprinidae, the largest family of fresh water fish in North America; includes minnows, dace, shiners, and chubs.

dace: fish belonging to the minnow family; adapted to warm water conditions.

debris flow: slurry of rock, water, mud, and organic debris moving down mountain slopes and stream courses.

decomposed granite: sand and fine sediment from loosely consolidated granite rocks which reduces spawning success of salmon and steelhead when present in streams.

delta: a fan shaped deposit of sand and gravel found at the mouth of a stream.

detritus: organic matter partially from disintegrated rock but usually at least in part from dead plants or animals.

digger log: log placed near a stream margin to scour a pocket primarily for rearing habitat; often secured to bank by imbedding or with cable.

direct observation: teams of divers with masks and snorkles counting fish.

dissolved oxygen (D.O.): the amount of oxygen dissolved in water.

drainage: a watershed.

drift net: a gill net supported upright in water by floats attached to the upper edge and sinkers along the bottom so as to be carried by the current or tide.

EPA: United States Environmental Protection Agency.

EPA Reach File: inventory of stream systems used by the EPA based on USGS 1:100,000 maps.

ecosystem: community of organisms in a given area together with their physical environment and its characteristic climate.

electrofishing: using an electric current to sample fish populations.

electrophoresis: using different electrical characteristics of amino acid sequences from proteins from tissues (of fish) to determine genetic make up.

enhancement: production of additional fish at a hatchery over and above fish produced at the facility for mitigation.

erosion: movement of soil by water and wind.

escapement: number of fish which escape harvest or natural mortality and return to spawn.

estuary: the mouth of the river where fresh water and salt water mix; influenced by tides.

eutrophic: lake classification used to describe bodies of water with high levels of nutrients in proportion to their volume of water.

fecundity: fertility; number and size of eggs (in fish).

fin clip: removing a fin from a hatchery reared salmon or steelhead to allow identification in biological studies or for selective harvest in mixed stock fisheries.

fingerling: a juvenile fish that has reared in fresh water and attained a size of 24 inches. Usually has parr marks and is the life history stage between a fry and a smolt (referred to as parr on the Atlantic Coast).

fish ladder: a stair-stepped fishway that helps fish pass over obstacles such as low dams or diversions.

fish screen: screen used to block migration of downstream migrants into agricultural diversions.

fishway: a man made structure to help fish move around obstacles in streams.

flow: the direction of water movement in a stream or river; the volume of fluid that flows through a passage of any given section in a unit of time.

fry: recently hatched salmon or steelhead that have absorbed their yolk sac and emerged from the gravel.

GIS: geographic information system; any map-based land or resource inventory system.

gabion: a wire basket filled with rocks formerly used as spawning weirs but now used primarily to stabilize banks.

gene: the chemical unit of hereditary information that can be passed on from generation to generation.

gene flow: the spread of genes from one breeding population to another by interbreeding (requires some survival of hybrid individuals).

genetic diversity: the range of genetic differences among individuals or groups of organisms.

genotype: the genetic composition of an individual.

gill net: a net suspended vertically in the water used to catch fish by the gills, preventing them from backing away and escaping. Different sized mesh are used for different species or size classes of fish.

geomorphology: the science of surface landforms and their interpretation on the basis of geology and climate.

gradient: degree of slope or steepness of a stream or geologic feature.

grilse: a young salmon in the sea or which returns to the river to spawn after only one year in the ocean. Males are also known as jacks.

habitat: the native environment of an animal or a plant providing food, water, and shelter; the kind of place that is natural for the growth of an animal or a plant.

habitat typing: a stream inventory technique which classifies the wetted stream channel into high and low gradient riffles, runs, glides, pocket water, and various types of pools. Usually done in conjunction with fish population estimation using direct observation.

half-pounders: immature steelhead that have spent less than one year in the ocean and accompany adults on their spawning run; may be of either summer or fall/winter stock group; exist in only the Rogue, Klamath, Eel, and Mad Rivers.

hatchery fish: fish originating from a hatchery or other artificial culture facility.

homing: behavior that leads adult salmon or steelhead to return to their stream or lake of origin to spawn.

hybridizing: interbreeding between fish of different subpopulations or between species.

hydrology: study of distribution, circulation, and properties of water.

IFIM: instream flow incremental methodology; method of determining the change in available habitat for fish associated with changes in flow; usually used below dams to judge effects of reduced flows; also called instream flow studies.

IHN: infectious hematopoetic necrosis, a viral disease that afflicts salmon and steelhead.

inbreeding: breeding through a succession of parents that are closely related potentially resulting in reduced fitness.

inbreeding depression: decreased fertility of a hatchery stock resulting from inbreeding.

irrigation diversion: water drawn from streams to water land for crops or livestock.

KFMC: Klamath Fisheries Management Council; allocates harvestable surplus of anadromous fish from the Klamath River between user groups.

KW: Kilowatt

KRTAT: Klamath River Technical Advisory Team which serves KFMC.

KOHM: Klamath Ocean Harvest Model formulated by KRTAT for KFMC to judge stock abundance to help in setting harvest levels.

k-dam: instream structure built in the shape of a "k" to retain spawning gravels and to create rearing habitat.

Landsat: satellite orbiting the Earth that relays images back that can be used to assess weather, geologic features, land use patterns, or vegetation types.

large woody debris: logs or large pieces of trees that fall into streams and form important habitat elements for fish; also called large organic debris (LOD).

life history: various life stages of an animal and variations in behavior or migrations associated with each.

limiting factors: those conditions in a stream or ecosystem that inhibit population growth.

log weir: log placed across a stream to trap spawning gravels and create a jump pool below; mimics natural recruitment of large woody debris.

longitudinal profile: measurement taken from a fixed height lengthwise in a stream which indicates changes in sediment supply.

macroinvertebrates: larger aquatic organisms without skeletal structures such as snails, insect larvae and adults, crayfish, and crustaceans.

maximum sustainable yield (MSY): the greatest number of fish that can be taken without reducing the number of individuals necessary to propagate the species.

mass wasting: down hill movement of massive amounts of soil or rock, carried by gravity but often triggered by flooding or intense rainfall.

mitigation: to make less severe; fish planted at hatcheries to offset losses of salmon and steelhead production in areas blocked by dams.

mixed stock fishery: any fishery conducted on fish stocks from several river basins, or from hatchery and native populations, as they intermix in a lake or in the ocean.

multispectral images: information relayed from Landsat in the spectrum of visual light but also in infrared and ultraviolet.

mutation: genetic change.

NCIDC: Northern California Indian Development Council (Eureka, California).

NMFS: National Marine Fisheries Service (Department of Commerce).

native fish: self-replicating populations of salmon and steelhead that return to various tributaries at various times that do not coincide with the range or timing of hatchery stocks

natural fish: (as used in this Plan) those fish spawning outside a hatchery but with run timing and distribution indicating that they are strays from hatcheries, ie. salmon spawning in the Trinity River near Lewiston below Trinity River Hatchery.

nonpoint source pollution: pollution that enters waterways from a broad land surface area as a result of land management; such as sediment from logging deposited in stream channels.

NTU: Nephelometric Turbidity Unit.

ODFW: Oregon Department of Fish and Wildlife.

O&M: operation and maintenance.

outplanting: transportation and release of juvenile fish away from the hatchery site.

PCFFA: Pacific Coast Federation of Fishermen's Associations.

PFMC: Pacific Fisheries Management Council.

PPL: Pacific Power and Light Company.

pH: measure of hydrogen ions that determine the acidity or alkalinity of a solution, the pH scale ranges from 114 with 7.0 being neutral; the scale is logarithmic, with a change of 1.0 representing a tenfold increase and a change of 2.0 representing a hundredfold increase.

phenotype: the actual characteristic appearance or behavior of an organism produced by the genotype in conjunction with the environment.

planting: releasing of hatchery fish.

pools: deeper and slower waters in a stream or river.

population: group of interbreeding individuals of a specific kind, in a given area, at a given time.

priority stocks for recovery: those stock groups having significant production potential but that have been reduced to levels where further decreases in population may cause losses in genetic diversity. All steps necessary to avoid further declines should be taken by the Restoration Program immediately.

putting a road to bed: reshaping an old roadway to conform to the angle of the adjacent hill, removing culverts, and mulching and planting the old road surface.

RAPID: riparian aerial photographic inventory of disturbance (Grant 1987); technique using aerial photos to discern changes in stream channel widths related to sediment transport.

RCD: Resource Conservation Districts.

radio tagging: implanting radio transmitters in adult salmon or steelhead to monitor the rate of migration and time and place of spawning.

redd: a nest in the stream substrate in which salmon and trout lay their eggs.

residualism: loss of behavioral or physiological compulsion to perform anadromous migration.

riffle: fast shallow waters of a stream; low gradient riffles are less than 2% gradient while high gradient riffles are from 2 - 7%.

riparian area: wet soil areas directly influenced by a stream, lake, or wetland.

riprap: rock covering used to protect stream banks from erosion.

SCS: United States Soil Conservation Service (U.S. Department of Agriculture).

STEP: Salmon Trout Enhancement Program; a volunteer program to help salmon, steelhead and trout in Oregon.

SWRCB: State Water Resources Control Board (California).

salmonid: any fish belonging to the family Salmonidae which includes all trout, char, salmon, and whitefish.

scale analysis: analyzing the spacing of rings on a fish scale to determine age of a fish or its early life history.

scour: removal of gravel or other material by moving water.

sediment: solid particles of soil or rock transported and deposited by water.

sediment budget: a quantitative statement of the rates of production, transportation, and delivery of sediment in a basin.

smolt: a juvenile salmon or steelhead that has attained readiness to migrate to sea; parr marks are lost and silver color taken on; gills and kidneys change from retaining to excreting salt.

stock (n): a species or population of fish that maintains itself over time in a defined area.

stock (v): to provide; to plant or release.

stock transfer: transporting stocks of fish from their native home range.

strays: fish from a hatchery that do not return to the hatchery and instead spawn in the wild; salmon and steelhead that return to spawn in other than their home stream.

substrate: inorganic material that forms the bottom of a stream.

suckers: fish belonging to the family Catostomidae with soft rayed fins and a toothless mouth with sucker-like protractile mouth and thick lips.

Task Force: in this text refers to Klamath River Basin Fisheries Restoration Task Force.

troll: to draw a fishing line with baited hook or lure through the water from the stern of a moving boat.

USFS: United States Forest Service (U.S. Department of Agriculture).

USFWS: United States Fish and Wildlife Service (U.S. Department of the Interior).

USGS: United States Geological Survey (U.S. Department of the Interior).

water bar: ditches or boards which cross a road at an angle and divert water flow to prevent gully formation.

water quality: characteristics of water that help determine its usefulness for whatever purpose desired.

watershed: all the land area that drains into a particular body of water.

watershed rehabilitation: using erosion control to decrease soil loss from hillsides and to decrease sediment supply to streams.

weirs: structures spanning a stream; used by Indians to temporarily block spawning migrations to enable harvest, such as Cappell weir; used for instream structures (see log weir) and to estimate populations of salmon (see also counting weir).

white spot: bacterial disease of the egg thought to be caused by Cytophaga sp.

year class: all fish arising from the hatch of a given year; syn. cohort.

yearling: juvenile hatchery salmon or steelhead reared at the hatchery for one year before release.

BIBLIOGRAPHIC REFERENCES

Allendorf, F.W. and N. Ryman. 1986. Genetic management of hatchery stocks. In: Population Genetics and Fisheries Management. Eds. N. Ryman and F. Utter. University of Washington Press. Seattle, Washington.

Ahnert, G. 1990. Gold in dredge tailings. California Mining Journal (Jan.), pp. 29-31.

Albers, J.P. 1966. Economic deposits of the Klamath Mountains. pp. 51-62 In: Geology of Northern California. Calif. Div. of Mines and Geology, Bulletin 190. San Francisco, 508p.

Altukhov, Y.P. and E.A. Salmenova. 1986. Stock transfer relative to natural organization, management, and conservation of fish populations. In: Population Genetics and Fisheries Management. Eds. Ryman and Utter. University of Washington Press. Seattle, Washington.

American Fisheries Society. 1982. The best management practices for the management and protection of western riparian stream ecosystems. Western Div., 45p.

American Public Health Association. 1987. Standard methods for the examination of water and waste water, 16th edition. Amer. Waterworks Assoc., Water Pollution Control Federation, Washington D.C.

Amos, K.H. 1985. Procedures for the detection and identification of certain fish pathogens (third edition). Fish Health Section of American Fisheries Society, Corvallis, Oregon. 114 p.

Anderson, J. 1986. Stream classification methodology. In: Monitoring western Oregon records of decision. U.S. Bureau of Land Management Manual Supplement. Portland.

Anderson, J.W. 1988. Design and location of instream structures. In: A Training in Stream Habitat Rehabilitation, Ore. AFS, Ashland Ore.

Arvola, T.F. 1976. Regulation of logging in California. Calif. Div. of Forestry. Sacramento, 98p.

Averill, C.V. 1946. Placer mining for gold in California. Calif. Div. of Mines and Geology, Bulletin 135. San Francisco, pp. 293-303.

Baker, B.M. Genetic variability of steelhead trout populations in the South Fork of the Trinity River, California. M.S. Thesis. Humboldt State Univ., Arcata, Calif.

Barnhardt, R.A. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest), steelhead. USFWS Biol. Rep. 82 (11.60). U.S. Army Corp of Engineers, TR EL-82-4.

Barnhardt, R.A. 1989. Symposium Review: Catch and Release Fishing, a Decade of Experience. North American Journal of Fisheries Management. 9:7480.

Barrett, T. and P. Livermore. 1983. The conservation easement in California. Island Press. Covelo CA, 173p.

Bartley, D.M., G.A. Gall, and B. Bentley. 1990. Biochemical genetic detection of natural and artificial hybridization of chinook and coho salmon in Northern California. Trans. of the American Fisheries Soc. 119: 431-437.

Bearss, E.C. 1981. History resource study. Hoopa-Yurok fisheries suit, Hoopa Valley Indian Reservation. Del Norte and Humboldt Counties, California. National Park Service, Denver. 443p.

Bedell, G.W. 1980-89. Annual Report for Trinity River Salmon and Steelhead Hatchery. California Dept. of Fish and Game, Inland Fisheries Div, Sacramento, Ca.

Bell, M.C. Fisheries handbook of engineering requirements and biological criteria. Corps of Engineers, Portland, Ore.

Berst, A.H. and R.C. Simon (eds.). 1981. Proceedings of the Stock Technical Report of Fisheries and Aquatic Sciences Concept Symposium. Canadian Jour. of Fisheries and Aquatic Sciences. 38 (12).

Beschta, R.L., R.E. Bilby, G.W. Brown, L.B. Holtby, and T.D. Hofstra, 1987. Stream temperatures and aquatic habitat: fisheries and forestry interactions. pp. 191-232 In: Streamside management: Forestry and fishery interactions. Inst. For. Res., Univ. Wash., Contribution 57. Seattle.

Binns, N.A. 1986. Habitat, macroinvertebrate and fishery response to stream improvement efforts in the Thomas Fork Bear River drainage, Wyoming. Pages 105-116. In: J.G. Miller (ed), Proc. of the Fifth Trout Stream Habitat Improvement Workshop. Lock Haven Univ., Lock Haven, Penn.

Bisson, P.A., J.L. Nielsen, R.A. Palmason and L.E. Grove. 1981. A system of naming habitat types in small streams, with examples of habitat utilization by salmonids during low streamflow. In: Proceedings from a symposium on Acquisition of Aquatic Habitat Inventory Information. Amer. Fish. Soc., Portland, Ore., pp. 62-73.

Bjornn, T.C., M.A. Brusven, M.P. Molnau, J.H. Mulligan, R.A. Klamt, E. Chacho, and C. Schaye. 1977. Transport of granitic sediment in streams and its effects on insects and fish. Univ. Idaho: Forest, Wildlife and Range Experiment Station, Bulletin No. 17. Moscow ID, 43p.

Borodin, A.M., A.G. Bannikov, and V.Y. Sokolov. 1984. Krasnaia Kniga SSSR. Second edition, Vol 1, Moscow, USSR. p.204-205.

Bottom, D.L., P.J. Howell, and J.D. Rodgers, 1985. The effects of stream alterations on salmon and trout habitat in Oregon. Oregon Dept. of Fish and Wildlife, Portland. 70p.

Bovee, K.D. 1982. A guide to stream habitat analysis using the instream flow incremental methodology. Instream Flow Information Paper No. 12. USFWS. FWS/OBS 82/86.

Boyle, J.C. 1976. Fifty years on the Klamath. Klocker Printery, Medford, 59p.

Brock, W. 1987. Enhancement of rearing habitat for juvenile steelhead trout by boulder placement in a tributary of the Klamath River. M.S. Thesis, Humboldt State University, Arcata, Calif.

Brown, G.W. 1988. Forestry and water quality. Oregon State Univ. Book Stores. Corvallis, 142p.

Bryant, H.C. 1923. Salmon Fish Cultural Operations on the Klamath River. California Fish and Game Bulletin 9(1):19-23.

Buchanan, D. In press. Klamath Basin Trout. From ODFW studies on: Diversity Within and Between Rainbow Trout in Oregon River Basins. Oregon Department of Fish and Wildlife, Research Station, Corvallis, Oregon.

Burghduff, A.E. 1934. Stream improvement. Cal. Fish and Game Bull. Vol. 37:113-118.

Burns, J.W. 1972. Some effects of logging and associated road construction on Northern California streams. Trans. Amer. Fish. Soc. 101(1):1-17.

Calhoun, A. 1966. Habitat protection and improvement. In: A. Calhoun (ed): Inland Fish Management. Cal Fish and Game, Sacramento, Calif.

California Advisory Committee on Salmon and Steelhead Trout. 1988. Restoring the balance. 1988 annual report. Sausalito, 84p.

California Assembly. 1957. Problems relative to the lower Klamath River. Interim Committee on Fish and Game. Sacramento.

California Assoc. of Resource Conservation Districts. 1990. California Coordinated Resource Management and Planning Handbook. Sacramento, 18p.

California Board of Forestry. 1987. Final report of the Forest Practice Rules assessment team to the State Water Resources Control Board. Sacramento.

California Dept. of Conservation. 1989. SMARA: Review of implementation; Alternatives for SMARA restructuring. Sacramento, 8p.

California Dept. of Fish and Game. 1934. Stream Survey of the Scott River - from Klamath National Forest Boundary to Callahan. 3p.

California Dept. of Fish and Game. 1965. California Fish and Wildlife Plan. Volume III, Part B-Inventory. Sacramento, pp. 369-375.

California Dept. of Fish and Game. 1974. Stream flow needs for anadromous salmonids in the Scott River Basin, Siskiyou County - A summarized report. 27p.

California Dept. of Fish and Game. 1976. Scott River Adjudication, State Water Resources Control Board's Proposed Principles for allocating water. Memorandum to Chief of Operations from R.J. O'Brien, Region 1 Manager, Redding, 3p.

California Dept. of Fish and Game. 1980a. Scott River Waterway Management Plan. Prepared with EDAW, et al. Sacramento. 120p.

California Dept. of Fish and Game. 1980b. Salmon River Waterway Management Plan. Sacramento.

California Dept. of Fish and Game. 1982. Inventory of instream flow requirements related to stream diversions. Bulletin 216, Sacramento. 301p.

California Dept. of Fish and Game. 1990a. Comments on the Long-Range Plan for the Klamath River Basin Conservation Area. Inland Fisheries, Sacramento, California.

California Dept. of Fish and Game. 1990b. Requests for proposals for the California Dept. of Fish and Game Inland Fisheries Division, 1990-91 Fishery Restoration Program. Sacramento, Calif. February 1990, 15p.

California Dept. of Fish and Game. No date. Iron Gate Hatchery: Production Goals and Constraints. Inland Fisheries, Sacramento, Calif.

California Dept. of Fish and Game. No date. Trinity River Hatchery: Production Goals and Constraints. Inland Fisheries, Sacramento, Calif.

California Dept. of Fish and Game. No date. Sturgeon. Wildlife Leaflet, Sacramento, Calif. 2p.

California Dept. of Forestry and Fire Protection. 1986. Recommended mitigation measures for timber operations in decomposed granite soils with particular reference to Grass Valley Creek and nearby drainages. 9p.

California Dept. of Forestry and Fire Protection. 1988. California's forests and rangelands: growing conflict over changing uses. Forest and Rangeland Resources Assessment Program. Sacramento, 348p.

California Dept. of Transportation. 1989. Draft supplemental environmental impact statement: U.S. 101 Bypass Redwood National Park and Prairie Creek Redwoods State Park. Eureka, 36p.

California Dept. of Water Resources. 1963. Land and water use in Shasta-Scott Valleys hydrographic unit. Bulletin No. 94-5, Vol. I & II. Sacramento.

California Dept. of Water Resources. 1964. Klamath River Basin investigation. Bull. No. 83. Sacramento.

California Dept. of Water Resources. 1965. North coastal area investigation. Bulletin 136. Sacramento.

California Dept. of Water Resources. 1981. Klamath and Shasta River spawning gravel enhancement study. CDWR, Northern District, Red Bluff, Calif.

California Dept. of Water Resources. 1982. South Fork of the Trinity River salmonid enhancement study. CDWR, Northern District, Red Bluff, Calif. 175pp.

California Dept. of Water Resources. 1982a. Watershed management for unstable and erodible areas in North Coastal California. Northern District. Red Bluff, 68p.

California Dept. of Water Resources. 1982b. Update, analysis of recently proposed hydropower projects in California, including environmental impacts. Div. of Planning. Sacramento, 107p.

California Dept. of Water Resources. 1986a. Shasta/Klamath rivers water quality study. Northern District. Red Bluff, 406p.

California Dept. of Water Resources. 1986b. Crop water use in California. Bulletin 113-4. Sacramento.

California Dept. of Water Resources. 1987. California water: looking to the future. Bulletin 160-87. Sacramento, 122p.

California Dept. of Water Resources. 1988. Agricultural drought guidebook. Office of Water Conservation. Guidebook No. 6. Sacramento. 68p.

California Dept. of Water Resources. 1989. Summary of operations for watermaster service in Northern California – 1988 season. Red Bluff, 108p.

California Resources Agency. 1989. Upper Sacramento River Fisheries and Riparian Habitat Management Plan. Upper Sacramento River Fisheries and Riparian Habitat Advisory Council. Sacramento, 158p.

California State Water Resources Board. 1954. Interim report on Klamath River Basin Investigation, (Water utilization and requirements). Sacramento.

California State Water Resources Control Board. 1974. Report on water supply and use of water - Scott River Stream System, Scott River Adjudication. Sacramento.

California State Water Resources Control Board. 1980. Scott River Adjudication Decree No. 30662, Superior Court for Siskiyou County. Scott River stream system within California in County of Siskiyou. Sacramento, 152p.

Carlton, A. 1989. *Ceratomyxa shasta* geographic and seasonal distribution in northern California and comparative salmon strain susceptibility. M.S. Thesis. Humboldt State University, Arcata, Calif.

Cederholm, C.J. 1983. Clearwater River wild steelhead spawning timing. Proceedings of Olympic Wild Fish Conference. Peninsula College, Port Angeles, Washington.

Cederholm, C.J. and E.O. Salo. 1979. The effects of logging road landslide siltation on salmon and trout spawning gravels of Stequaleho Creek and the Clearwater River Basin, Jefferson Co., Washington 1972-1978. Fisheries Research Institute, Seattle, Washington.

Cederholm, C.J., W.J. Scarlett, and N.P. Peterson. 1988. Low Cost Enhancement Technique for Winter Habitat of Juvenile Coho Salmon. North American Journal of Fisheries Management. 8:438-441.

CH2M Hill. 1985. Klamath River Basin Fisheries Resource Plan. Prepared for the Bur. of Indian Affairs. Dept of the Interior.

Chamberlin, T.W. 1982. Timber harvest. Influence of forest and rangeland management on anadromous fish habitat in western North America. U.S. Forest Service Gen. Tech. Rept. PNW-136. Portland, 30p.

Chandler, G.L. and T.C. Bjornn. 1988. Abundance, Growth, and Interactions of Juvenile Steelhead Relative to Time of Emergence. Transactions of the American Fisheries Society. 117:432-443

Chevassus, B. 1979. Hybridization in salmonids: results and perspectives. Aquaculture 17:113-128.

Chilcote, M.W., S.A. Leider, J.J. Loch. 1986. Differential reproductive success of hatchery and wild summer steelhead under natural conditions. Trans. Amer. Fish. Soc. 115:726-735.

Chilcote, M. 1990. Final Natural Production and Wild Fish Management Rules. Memo 3/18/90. Oregon Department of Fish and Wildlife. Portland, Ore.

Clay, C.H. 1961. Design of fishways and other fish facilities. Canada Dept. of Fisheries and Oceans, Ottawa, Canada.

Coats, R.N., T.O. Miller, and D.W. Kallstrom. 1979. Assessing cumulative effects of silvicultural activities. John Muir Institute. Napa, 160p.

Coats, R.N. and T.O. Miller. 1981. Cumulative silvicultural impacts on watersheds: a hydrologic and regulatory dilemma. Environmental Management. 5(2):147-160.

Cobourn, J. 1989. Is cumulative watershed effects analysis coming of age? J. Soil and Water Conserv. (July-Aug): 267-270.

Columbia Basin Fish and Wildlife Authority. 1990. Columbia River Basin Salmon and Steelhead Integrated System Plan, Draft. Portland, 449p.

Coots, M. 1967. Angler's guide to the Klamath River. Cal Dept. of Fish and Game. Sacramento, Calif.

Cordone, A. and D.W. Kelley. 1961. The influence of inorganic sediment on the aquatic life of streams. California Fish and Game 47(2):189-228

COSEWIC, Committee on the Status of Endangered Species in Canada (see Houston 1988)

Cumming, A.M. 1907. Angling on the Klamath. Sunset Magazine, pp. 577-583.

DesLaurier, G.C. and J.R. West. 1990. 1990 Adult Spring Chinook and Summer Steelhead Census, Salmon River, California. Klamath National Forest, Yreka, Calif.

Donaldson, J.R. 1981. Comprehensive plan for production and management of Oregon's anadromous salmon and trout. Part II: coho salmon plan. Oregon Dept. of Fish and Wildlife. Portland Oregon.

Dong, A. E., K.W. Beatty, and R. C. Averett. 1974. Limnological study of Lake Shastina, Siskiyou County, California. U.S. Geological Survey, Water Resources Investigations 19-74. Menlo Park, 59p.

Downs, A. 1967. Inside bureaucracy. Little, Brown and Co., Boston 292p.

Duhnkrack, N.E. 1984. Oregon's incentive approach to riparian area protection. Oregon Environmental Foundation. Portland, 76p.

Dunne, T., and L.B. Leopold. 1978. Water in environmental planning. W.H. Freeman and Co., San Francisco. 818p.

Dunne, T., W. Dietrich, N. Humphrey, and D. Tubbs. 1981. Geologic and geomorphic implications for gravel supply. pp. 75-100 In: Proceedings Conf. Salmon-Spawning Gravel: A renewable resource in the Pacific Northwest? Washington State Univ., Pullman, 285p.

Earth Science Associates. 1980. Lower Klamath River Basin Investigation. Prepared for the USDI Bureau of Indian Affairs. Palo Alto, @200p.

Echiverra, J. 1989. Rivers at Risk: The Concerned Citizens Guide to Hydropower. American Rivers, Washington D.C.

Elmore, W. 1988. Arid region streams: analysis of failures and successes in riparian restoration. In: Proceedings of Annual Ore AFS Meeting, Ashland, Ore.

Erman, D.C., J.D. Newbold, and K.B. Roby. 1977. Evaluation of streamside bufferstrips for protecting aquatic organisms. California Water Resources Center, U.C. Davis, Contribution No. 165. Davis, 48p.

Everest, F.H. Evaluation of fisheries for anadromous salmonids produced on Western National Forests. Fish. Bull. of Amer. Fish Soc. Vol. 2(2); 6 p.

Everest, F.H. 1973. Ecology and management of summer steelhead in the Rogue River. Ore. State Game Comm. Fisheries Resource Report No. 7. Project AFS 31. 48p.

Everest, F.H., F.B. Lotspeich, and W.R. Meehan. 1982. New perspectives on sampling, analysis, and interpretation of spawning gravel quality. In: N.B. Armantrout (ed.): Acquisition and utilization of aquatic habitat inventory information, p.325-333. Western Div. AFS, Portland, Ore.

Everest, F.H. and J.R. Sedell. 1984. Evaluating effectiveness of stream enhancement projects. In: T. Hassler (ed.), Proc. Pacific Northwest Stream Habitat Management Workshop. Cal. Coop. Fish. Unit, Humboldt State Univ., Arcata, Calif. pp 246-256.

Everest, F.H., G.H. Reeves, J.R. Sedell, D. Hohler, and T. Cain. 1986. The effects of enhancement on steelhead trout and coho salmon smolt production, habitat utilization and habitat availability in Fish Creek, Oregon, 1983-1986. Annual Report to BPA, 1986.

Everest, F.H., R.L. Beschta, J.C. Scrivener, K. Koski, J.R. Sedell, and C.J. Cederholm. 1987. Fine sediment and salmonid production: a paradox. pp. 981142 In: Streamside Management: Forestry and Fishery Interactions. Univ. Wash. Inst. For. Res., Contrib. No. 57, Seattle.

Fast, D.E., J.D. Hubble, and B.D. Watson. 1988. Yakima River spring chinook - the decline and recovery of a Mid-Columbia natural spawning stock. In: Proceedings of 1988 Northeast Pacific Chinook And Coho Workshop. Ed. B. Shepard. American Fish. Soc. 283p.

Finlayson, B.J. and L. Verrue. 1983. Toxicities of butoxyethanol ester and propylene glycol butyl ether ester formulations of 2,4-D to juvenile salmonids. California Dept. of Fish and Game, Rancho Cordova, 24p.

Fletcher, J.E. and M. King. 1988. Attitudes and Preferences of Anglers in the State of California. California Department of Fish and Game. Sacramento, California.

Fontaine, B. 1988. Biological evaluation of fish habitat improvement projects. In: A Training in Stream Habitat Rehabilitation. Oregon AFS.

Fontaine, B.L. 1987. An evaluation of the effectiveness of instream structures for steelhead trout rearing habitat in Steamboat Creek basin. M.S. Ore. State Univ., Corvallis, Ore. 68p.

Foote, J.S. 1990. Disease survey proposal for salmonid populations in the Trinity River. USFWS memo. Coleman Fish Hatchery, Anderson, Calif.

Fortune, J.D., A.R. Gerlach, and C.J. Hanel. 1966. A study to determine the feasibility of establishing salmon and steelhead in the Upper Klamath Basin. Oregon State Game Commission and Pacific Power and Light. 129p.

Freese, J.L. 1982. Possible problems associated with gold-dredging in the Trinity River drainage. pp. 45-46 In: Habitat Disturbance and Recovery, Proceedings of a Symposium. California Trout. San Francisco, 90p.

French, H. 1915. Siskiyou County, California. Siskiyou County Board of Supervisors and the Panama-Pacific International Exposition Commission. Yreka, 36p.

Frissell, C.A. and W.J. Liss. 1987. Classification of stream habitat and watershed systems in south coast Oregon streams. Report for ODFW. Oregon State University, Corvallis, Oregon.

Frissell, C.A. and T. Harai. 1988. Life history patterns, habitat change, and productivity of fall chinook stocks of southwest Oregon. In: Proceedings of 1988 Northeast Pacific Chinook and Coho Workshop. Ed. B. Shepard. American Fisheries Soc.

Frissell, C.A. and R. Nawa. 1989. Cumulative impacts of timber harvest on fisheries: "All the king's horses and all the king's men...." pp. 33-35. In: C. Toole (ed.), Proc. Seventh Annual Cal. Salmon, Steelhead, Trout Restoration Conf. Cal. Sea Grant Pub. No. UCSGEP-89-02, 52p.

Furniss, M.J. and T. Roelofs. In Press. Forest roads and anadromous fish: how to have both. In: Anadromous Salmonids in the West. Amer. Fish. Soc., 7p.

Gall, G.A., B. Bentley, C. Panattoni, E. Childs, C. Qi, S. Fox, M. Mangel, J. Brodziak and R. Gomulkiewicz. 1989. Chinook Mixed Stock Fishery Project. University of California. Davis, Calif.

Gangmark, H.A. and R.G. Bakkala. 1960. A comparative study of unstable and stable (artificial channel) spawning streams for incubating salmon at Mill Creek. Cal Dept Fish & Game. 46:37-49.

Gee, A.S., N.J. Milner, and R.J. Hemsworth. 1978. The effect of density on mortality in juvenile Atlantic salmon (Salmo salar). Journal of Animal Ecology 47:497-505.

Gerstung, E. 1989. Summer steelhead survey totals from 1977-1988. California Department of Fish and Game file report, Sacramento, Calif.

Getches, D. et al. 1979. Federal Indian Law - Cases and Materials. West Publishing Co., 258p.

Gilpin, M.E. and M.E. Soule. Minimum Viable Populations: Processes of Species Extinction. In: Michael Soule (ed.): Conservation Biology: The Science of Scarcity and Diversity, Univ. of Michigan Press. pp 19-36.

Goines, A.L. 1988. Burn area rehabilitation narrative report -- Draft. Klamath National Forest. Yreka.

Goldfarb, W. 1984. Water law. Butterworth Publishers, Boston. 233p.

Governor's Commission to Review California Water Rights Law. 1978. Final Report. Sacramento, 264p.

Grant, G. 1988. The RAPID technique: a new method for evaluating downstream effects of forest practices on riparian zones. Gen. Tech. Report PNW-GTR-220. Portland, Ore: USDA Forest Service, Pacific Northwest Forest Research Station. 36 p.

Green, P.F. 1982. Government regulation in the forests: impacts of the 1973 California Forest Practice Act. Inst. of Govt. Affairs, Env. Quality Series No. 36, U.C. Davis. Davis, 45p.

Griffith, J.S. and D.A. Andrews. 1981. Effects of a small suction dredge on fishes and aquatic invertebrates in Idaho streams. No. Amer. J. Fish. Mgt. 1:21-28.

Hagans, D.K. Unpublished. Methodology for assessing watershed conditions and implementing an erosion control program. Prepared for Trinity Field Office of USFWS, Weaverville, Calif.

Hagans, D.K., W.E. Weaver, , and M.A. Madej. 1986. Long term on-site and off-site effects of logging and erosion in the Redwood Creek basin, Northern California. In: Papers presented at the American Geophysical Union meeting on cumulative effects (1985 December); National Council on Air and Streams, Tech. Bull. No. 490, pp. 38-66.

Hall, J.D. and N.J. Knight. 1981. Natural variation in abundance of salmonid populations in streams and its implications for design of impact studies. U.S. EPA, Corvallis, Ore. EPA-600/S3-81-021. 85p.

Hall, J.D. 1984. Evaluating fish response to artificial stream structures: problems and progress. pp. 214-220 In: T. Hassler (ed), Proc. of Pacific Northwest Stream Habitat Management Workshop. Cal. Fish. Coop. Unit, Humboldt State Univ., Arcata, Calif.

Hampton, M. 1988. Development of habitat preference criteria for anadromous salmonids of the Trinity River Basin. Trinity River Flow Evaluation Program, Lewiston, Calif.

Hampton, M. 1989. Considerations for analysis of factors limiting salmonid populations. In: C. Toole (ed), Proc. Seventh Annual Cal Salmon, Steelhead, Trout Restoration Conf. Cal. Sea Grant Pub. No. UCSGEP- 89-02, 52p.

Hankin, D.G. 1986. Sampling designs for estimating the total number of fish in small streams. USDA Forest Service, Pacific NW Research Station, Res. Paper. PNW 360. Portland, Ore. 23p.

Hankin, D. and G. Reeves. 1988. Estimating total fish abundance and total habitat area in small streams based on visual estimation methods. Can. Jour. of Fish and Aquat. Sci. 45: 834-844.

Harry, G.Y. 1966. Status of major North American stocks of Pacific salmon and steelhead. Pacific Salmon Interagency Council. Department of Interior.

Hart, C.J. 1987. Predation by harbor seals, Phoca vitulina, on tagged adult chinook salmon and steelhead trout in the lower Klamath River, California. Administrative Report no. 87-18, CDFG Inland Fisheries, Sacramento, California.

Hartsough, B.R. 1989. Timber harvesting options and factors affecting impacts on watercourses. pp. 39-41 In: Proceedings of the Seventh California Salmon, Steelhead, and Trout Restoration Conference. Calif. Sea Grant Publication No. UCSGEP-89-02, Davis, 52p.

Harvey, B.C., K. McCleneghan, J.D. Linn, and C.L. Langley. 1982. Some physical and biological effects of suction dredge mining. Calif. Dept. of Fish and Game Laboratory Report No. 82-3. Rancho Cordova, 20p.

Hassler, T.J. (Ed.) 1984. Pacific Northwest Stream Habitat Management Workshop. Cal. Coop. Fish. Unit, Humboldt State University, Arcata, Calif. 329 pp.

Hassler, T.J., W.L. Somer, and G. R. Stern. 1986. Impacts of suction dredging on anadromous fish, invertebrates and habitat in Canyon Creek, California Final Report, CA Coop. Fish. Res. Unit, Humboldt State Univ., Arcata, 135p.

Hays, S.P. 1974. Conservation and the Gospel of Efficiency: The Progressive Conservation Movement, 1890-1920. Atheneum. New York, 297p.

Hedgpeth, J.W. 1944. The passing of the salmon. Scientific Monthly 59:370-378

Hedrick, R.P., S.E. LaPatra, J.L. Fryer, T. McDowell, and W.H. Wingfield. 1987. Susceptibility of coho (Oncorhynchus kisutch) and chinook salmon (Oncorhynchus tshawytscha) hybrids to experimental infections with infectious hematopoetic necrosis virus (IHNV). Bull. of the European Assoc. of Fish. Pathology. 7(4), 97.

Helle, J.H. 1981. Significance of the stock concept in artificial propagation of salmonids in Alaska streams. Can Jour. of Fish. and Aquat. Sci. 38: 1665-1671.

Helley, E.J. and V.C. LaMarche. 1973. Historic flood information for northern California streams from geological and botanical evidence. U.S. Geological Survey Prof. Paper 485-E, Washington D.C., 16p.

Henning, D.H. 1974. Environmental policy and administration. American Elsevier Co., New York, 205p.

Hewlett, J.D. 1982. Principles of forest hydrology. Univ. of Georgia Press. Athens, GA, 183p.

Hicks, B.J, J.D. Hall, P.A. Bisson, and J. R. Sedell. In Press. Responses of salmonid populations to habitat changes caused by timber harvest. Ch. 15 in: The Influence of Forest and Rangeland Management on Salmonids and Their Habitat. Amer. Fisheries Soc., Bethesda, M.D.

Hillman, T.W, J.S. Griffith, and W.S. Platts. 1987. Summer and Winter Habitat Selection by Juvenile Chinook Salmon in a Highly Sedimented Idaho Stream. Transactions of the American Fisheries Society. 116:185-195.

Hiser, C.A. 1978-89. Annual Report from Iron Gate Salmon and Steelhead Hatchery. California Dept. of Fish and Game. Inland Fisheries Div. Sacramento, Ca.

Hoopa Fisheries Department. 1984-1988. Annual Reports of the Hoopa Fisheries Department. Hoopa Valley Business Council, Hoopa, Calif.

Hopelain, J.S. Unpublished. A four year summary of angler creel census on the lower Klamath, 1984-1987. California Department of Fish and Game, Inland Fisheries Division. Sacramento, California.

Horral, H.M. 1981. Behavioral stock-isolating mechanisms in Great Lakes fishes with special reference to homing and imprinting. In: Proceedings of the Symposium on the Stock Concept. Can. Jour. Fish and Aquat. Sci. 38 (12): 1481-1496.

House, R. 1984. Evaluation of improvement techniques for salmonid spawning. In: T. Hassler (ed) Pacific Northwest Stream Habitat Improvement Workshop. Cal. Coop. Fish. Unit. Humboldt State University, Arcata, Calif.

Houston, J.J. 1988. Status of green sturgeon in Canada. Can. Field Naturalist 102(2): 286-290.

Hubbell, P.M. 1979. Fisheries Investigations. Performed for Trinity River Basin Fish and Wildlife Task Force. Priority Work Item No. 5. CDFG. Sacramento, Ca.

Hubbell, P.M., L.B. Boydstun, J.W. Grondalski, B. Huebach. 1982. Fisheries Investigations. Performed for Trinity River Fish and Wildlife Task Force. Priority Work Item No. 5. California Dept. of Fish and Game. Sacramento, Ca.

Hubbell, P.M. and L.B. Boydsdun. 1985a. An Assessment of the Carrying Capacity of the Klamath Basin for Adult Fall Chinook. California Dept. of Fish and Game, Inland Fisheries Div., Sacramento, Calif. 17p.

Hubbell, P.M., D.P. Lee, M. Zuspan, D. Maria, B. Huebach. 1985b. Fisheries Investigation - Trinity River. California Dept. of Fish and Game. Anadromous Fisheries Branch. Sacramento, Ca.

Hubbs, C.L. 1971. Lampetra (Entosphenus) lethophags, new species, the non-parasitic derivative of the Pacific lamprey. Trans San Diego Nat. Hist. Soc. 16(6): 125-164.

Hume, J.M.B. and E.A. Parkinson. 1988. Effects of Time of Release on the Survival and Growth of Steelhead Fry Stocked in Streams. North American Journal of Fisheries Management. 8:50-57.

Huntington, C.W. 1988. Benefit-Cost Analysis of Fish Screening and Rescue Activities in the Klamath River Drainage in California. Clearwater Biostudies, Inc. Sherwood, Ore. 12p.

Huntsman, A.G. 1941. Cyclical abundance and birds versus salmon. Journal of the Fisheries Research Board of Canada 5:227-235.

Huxley, J.S. 1957. New Bottles For New Wine. Harper Bros. New York, N.Y. 318p.

Hvidsten, N.A. and L.P. Hansen. 1988. Increased recapture rate of adult Atlantic salmon, Salmo salar, stocked as smolts at high water discharge. Journal of Fish Biology. 32:153.

Jackson, F. 1963?. The Scott Valley Story. unpublished manuscript. (retired District Conservationist, Soil Conservation Service Etna), 10p.

Johnson, S.L., M.F. Solazzi and J.D. Rogers. 1987. Development and evaluation of techniques to rehabilitate Oregon's wild coho salmon. Annual Progress Report 1987. Fish Div. ODFW, Portland, Ore

Jones and Stokes, Inc. 1976. "Case Study #1: Iron Gate Dam, Klamath River". pp. 19-35 In: Assessment of effects of altered stream flow characteristics on fish and wildlife. Part B: California, Case Studies. Prepared for U.S. Fish and Wildlife Service, Fort Collins, Colo.

Jones, J.R. 1953. Saddle Bags in Siskiyou. News-Journal Print Shop. Yreka, 417p.

Jones, W.E. and E. Ekman. 1980. Summer steelhead management plan, Middle Fork of the Eel River. CDFG and Mendocino National Forest. Yountville and Willows. 48p.

Kapuscinski, A.R. 1984. Genetics concerns in salmon and steelhead conservation and enhancement. Genetics Workshop for Enhancement Planning Team. Oregon State University. Newport, Oregon.

Kapuscinski, A.R. and D.P. Phillip. 1988. Fisheries genetics: issues and priorities for research and policy development. Fisheries. Vol. 13, No. 6:4-10.

Kelsey, H.M. 1980. A sediment budget and an analysis of geomorphic process in the Van Duzen River Basin, North Coastal California, 1941-1975. Geol. Soc. Am. Bull. 91(4):1119-1216.

Kelsey, H.M., M. Raines, and M.J. Furniss. 1989. Sediment Budget for Grouse Creek Basin, Humboldt County, California. USDA Forest Service, Eureka, Calif. 78p.

Kerstetter, T.H. and M. Keeler. 1976. Smolting in steelhead trout, Salmo gairdneri; a comparative study of populations in two hatcheries and the Trinity River, Northern California, using gill Na, K, ATPase assays. Sea Grant Report, HSU/FG -9.

Kesner, W. 1984. Protecting U.S.F.S. instream water rights in the Scott River Adjudication - a brief analysis. Klamath National Forest. Yreka, 4p.

Kesner, W.D. and R.A. Barnhardt. 1972. Characteristics of fall-run steelhead trout (Salmo gairdneri gairdneri) of the Klamath River system with emphasis on the half-pounder. California Fish and Game Bull. 58(3): 204-220.

Kimsey, J.B. and L.O. Fisk. 1960. Keys to freshwater and anadromous fishes of California. Cal. Fish and Game. 46(4):453-479.

Klamath Fishery Management Council. 1991. Draft Strategic Plan for Management of Harvests of Anadromous Fish Populations of the Klamath River Basin. 26pp + App.

Klamath River Basin Fisheries Task Force. 1990. Operating Procedures. Amended 1/31/90. Yreka, 12p.

Klingman, P.C. 1984. Evaluating hydraulic needs for design of stream habitat modification structures. P. 191-213. In: T. Hassler (ed) Pacific Northwest Stream Habitat Improvement Workshop. Cal. Coop. Fish. Unit, Humboldt State Univ., Arcata, Calif.

Kojan, E. 1976. Mass erosion sensitivity analysis, Hitchcock Creek Zone, South Fork Mountain, Shasta-Trinity National Forest. USDA Forest Service Project no. 14447.

Kroeber, A.L. and S.A. Barrett. 1960. Fishing among the Indians of Northwestern California. Anthro. Records 21(1):270p.

KRTAT. 1989. Status Report on Items Under Team Review and Request for KFMC Reviews of Team Concerns. Memo from KRTAT to KFMC. Oct. 23, 1989.

Kuonen, N. 1988. The Klamath River Basin Compact. Klamath River Compact Commission. Unpub. manuscript. Klamath Falls, 5p.

LaFaunce, D.A. 1967. A king salmon spawning survey of the South Fork of the Trinity River, 1964. Cal. Dept. of Fish and Game, Marine Res. Admin. Report 67-10. 13 p.

LaFaunce, D.A. 1975. Case history of the South Fork of the Trinity River. Cal. Fish and Game Region 1, Memorandum. 4p.

Lamberti, G.A. and S.V. Gregory. 1989. The importance of riparian zones to stream ecosystems. In: C. Toole (Ed): Proc. of Annual Cal. Salmon, Steelhead and Trout Restoration Fed Meeting. Marine Advisory Sea Grant, Eureka, Ca.

Larrson, P.O. 1985. Predation on migrating smolts as a regulatory factor in Baltic salmon, Salmo salar, populations. Journal of Fish Biology. 26:391-397.

Leary, R.F., F.W. Allendorf, S.R. Phelps, and K.L. Knudsen. 1987. Genetic Divergence and Identification of Seven Cutthroat Trout Subspecies and Rainbow Trout. Transactions of the American Fisheries Society. 116:580587.

Lee, D.P. Unpublished. Progress Report, 1980-82 Seasons: Lower Klamath River steelhead and salmon tagging study. CDFG Inland Fisheries, Sacramento, Calif.

Lee, J.J. 1989. Aquatic Insect Community Structure in Eight Northern California Streams. M.S. Thesis. Humboldt State University, Arcata, Calif.

Leidy, R.A. and G.R. Leidy. 1984. Life Stage Periodicities of Anadromous Salmonids in the Klamath River Basin, Northwestern, California. U.S. Fish and Wildlife Service, Ecological Services, Sacramento, California. 38p.

Leopold, L. 1981. The topology of impacts. pp. 1-13 In: Cumulative Effects of forest management on California watersheds. Univ. Calif. Div. Ag. Sci. Special Publ. 3268. Berkeley.

Lewis, W.C. 1990. Report on High Seas Salmon Interception. Presented at the 52nd Annual Meeting of the Pacific Fishery Biologists. NMFS Office of Enforcement, Pacific Area Operations Division, Seattle, Washington.

Lichatowich, J.A. and J.D. McIntyre. 1987. Use of hatcheries in the management of Pacific anadromous salmonids. American Fisheries Society Symposium. 1: 131-136.

Light, J.T., S. Fowler, and M. Dahlberg. 1988. High seas distribution of North American steelhead as evidenced by recoveries of marked or tagged fish. Fish. Research Institute, Univ. of Wash., Seattle. FRI-UW-8816. Lisle, T. and K. Overton. 1988. Utilizing channel information to reduce risk in developing habitat restoration projects. In: A Training in Stream Rehabilitation. Oregon AFS.

Lisle, T.E. 1981. The recovery of stream channels in north coastal California from recent large floods. In: K. Hashagen (ed) Habitat Disturbance and Recovery Proceedings. Cal Trout, San Francisco, Calif. p 31-41.

Lloyd, D.S. 1987. Turbidity as a Water Quality Standard for Salmonid Habitats in Alaska. North American Journal of Fisheries Management. 7:34-45.

Lloyd, D.S., J.P. Koenings, and J. D. LaPerriere. 1987. Effects of Turbidity in Fresh Waters of Alaska. North American Journal of Fisheries Management. 7:18-33.

Long, S.G. 1984. Manual of revegetation techniques. USDA Forest Service, Equip. Dev. Cntr. Missoula, Mont. 145p.

LSA Associates. 1990. Conclusions and recommendations for strengthening the review and evaluation of timber harvest plans. Final Report. Pt. Richmond, CA. 13p.

LSR Group 1989. Stream Survey computer program. Charleston OR.

MacCleery, D.W. 1974. Logging on South Fork Mountain, a look at past activities and implications for future management of the area. USDA Forest Service, Shasta-Trinity National Forest, Redding, Calif.

Mack, S. 1958. Geology and ground-water features of Scott Valley, Siskiyou County, California. U.S. Geological Survey, Water Supply Paper 1462. Washington, D.C., 95p.

Major, R.L., K.H. Moser, and J.E. Mason. 1972. Identification of stocks of Pacific Salmon by means of scale features. In: The Stock Concept in Pacific Salmon. H.R. MacMillan Lectures Fisheries. Vancouver, B.C.

Marshall, L. 1970. Annual Iron Gate Salmon and Steelhead Hatchery Report, Fifth Year of Operation, 1969-70. CDFG Inland Fisheries Division, Region 1, Redding, Sacramento, Calif.

Mason, J.C. 1976. Response of underyearling coho to supplemental feeding. J. Wildlife Mgmnt. 40:775-778.

Matthews, S., M.J. Furniss and T. Leskin. 1990. A study of plant materials suitable for use in watershed and wildlife habitat improvement in the Trinity River watershed, California. USDA, Forest Service, Eureka, Cal.

Mattole Restoration Council. 1989. Elements of Recovery: an inventory of upslope sources of sediment in the Mattole River watershed with prescriptions for restoration. MRC, P.O. Box 160, Petrolia, Ca. 95558. (Funded by California Dept. of Fish and Game.)

McBeth, F.T. 1950. Lower Klamath Country. Anchor Press. Berkeley.

McCain, M., D. Fuller, L. Decker and K. Overton. In Press. Stream habitat classification and inventory procedures for northern California. USDA Forest Service, Pacific Southwest Region, San Francisco, Calif.

McCashion, J.D. and R.M. Rice. 1983. Erosion of logging roads in Northwestern California: How much is avoidable? Journal of Forestry (Jan.):23-26.

McCleneghan, K.C. and R.E. Johnson. 1983. Suction dredging gold mining in the Mother Lode region of California. California Dept. of Fish and Game, Envir. Services Rept. 83-1. Rancho Cordova, 16p.

McCreary Koretsky Engineers. 1967. Report on Comprehensive Planning Study - Siskiyou Soil Conservation District. San Francisco. 120p.

McDonald, J. 1981. The stock concept and its application to British Columbia salmon fisheries. Can. J. of Fish and Aquat. Sci. 38: 1657-1664.

McEvoy, A. F. 1986. The fisherman's problem: ecology and law in the California fisheries, 1850-1980. Cambridge University Press, New York. 368p.

McGie, A.M. 1984. Evidence for density-dependence among coho salmon stocks in the Oregon Production Index Area. p.37-49. In W.G. Percy (ed.): The influence of ocean conditions on the production of salmonids in the north Pacific. OSU, Sea Grant Pub.

McIntyre, J.D. 1983. Differentiation of anadromous salmonid stocks. In: Olympic Wild Fish Conference. Eds J.M. Walton and D.B. Houston. Peninsula College, Port Angeles, Washington. Library of Congress Catalog Number 84-62057.

McIntyre, J.D., J.M. Emlen, and R.R. Riesenbichler. 1988. Management of genetics of stocks of Pacific salmon. U.S. Fish and Wildlife Service, National Fisheries Research Institute File Doc. Seattle, Washington

McNeil, W.J. and W.H. Ahnell. 1964. Success of pink salmon spawning relative to size of spawning bed materials. USFWS Spec. Sci. Rep. 469. 15p.

Meehan, W.R., F.J. Swanson, and J.R. Sedell. 1977. Influences of riparian vegetation on aquatic ecosystems with particular reference to salmonid fishes and their food supply. pp. 137-145 In: Symposium on the Importance, Preservation and Management of the Riparian Habitat. Tucson.

Metlar, G.M. 1856. Northern California, Scott and Klamath Rivers. (Siskiyou County Library, Yreka.)

Meyer, P.A. 1980. A benefit display methodology for habitat development proposals. Cntr for Natural Areas, Oak View, Calif. 60p.

Miller, E. 1989. Letter from The Klamath Tribe to Bill Shake, Chairman, Klamath River Basin Fisheries Task Force, Chiloquin, OR, 10/27/89, 2p.

Mills, T.A., M.S. Pisano, and M.G. Zuspan. Unpublished. Natural Stocks Assessment Project: 1987-88 Report. Inland Fish. Div., Klamath-Trinity Program. Sacramento, Calif.

Mills, T.J. Unpublished. Juvenile life history patterns of South Fork Trinity River fall chinook salmon as determined by adult scale analysis. Cal Dept. of Fish and Game, Inland Fish. Div. Report No. 881988 Sacramento, Calif.

Minckley, W.L., D.G. Buth, and R.L. Mayden. 1989. Origin of broodstock and allozyme variation in hatchery reared bonytail, an endangered North American cyprinid fish. Transactions of the American Fisheries Society. 118:131-137.

Moffett, J.W. and S.H. Smith. 1950. Biological investigation of the fisheries resources of the Trinity River. U.S. Dept of the Interior, USFWS. Special Scientific Report-Fisheries No. 12.

Morashima, G.S. 1983. Wild fish: realities of management. In: J.M. Walton and D.B. Houston (eds.): Proceedings of Olympic Wild Fish Conference. Peninsula College, Port Angeles, Wash.

Moyle, P. 1976. Inland fishes of California. Univ. Calif. Press. Berkeley, pp. 113-132.

Murray, C.B. and M.L. Rosenau. 1989. Rearing of Juvenile Chinook Salmon in Nonnatal Tributaries of the Lower Fraser River. Transactions of the American Fisheries Society. 118:284-289.

Murray, R. 1967. The Lewiston Trapping Facility, Second Year of Operation, 1959-60. CDFG Inland Fisheries Division, Region 1, Redding, Sacramento, Calif.

Myers, K.W., C.K. Harris, C.M. Knudsen, R.V. Walker, N.D. Davis, and D.E. Rogers. 1987. Stock Origins of Chinook Salmon in the Area of a Japanese Mother Ship Salmon Fishery. Transactions of the American Fisheries Society. 7:459-474.

Myers, K.W. and D.E. Rogers. 1988. Stock Origins of Chinook Coho Salmon in Incidental Catches by Groundfish Fisheries in the Eastern Bering Sea. North American Journal of Fisheries Management. 8:162-171.

National Council on Gene Resources. 1982. Anadromous Salmonid Genetic Resources Assessment and Plan for California. Cal Gene Resources Program. Berkeley, California.

Nawa, R. 1987. Misuse of stream structures by the U.S. Forest Service. The Osprey: p 4-6. Federation of Flyfishermen, Hoquiam, Wash.

Nehlsen, W., J.E. Williams, J.A. Lichatowich. 1990. Pacific Salmon at the Crossroads: West Coast Stocks of Salmon, Steelhead, and Sea-run Cutthroat Trout at Risk. Western Division of the American Fisheries Society, Portland, Ore.

Nelson, K. and M. Soule. 1986. Genetical conservation of exploited fishes. In: Population Genetics and Fisheries Management. Eds. Ryman and Utter. University of Washington Press. Seattle, Washington.

Nicholas, J.W. and D.G. Hankin. 1988a. Chinook Salmon Populations in Oregon Coastal River Basins. Descriptions of Life Histories and Assessment of Recent Trends in Run Strengths. Funded by ODFW. Ore St. Univ. Extension Ser. Corvallis, Ore.

Nicholas, J.W. and D.G. Hankin. 1988b. Variations in distribution of juvenile chinook salmon in Oregon coastal river basins: implications to future stock transfer practices. In: Proceedings of 1988 Northeast Pacific Chinook and Coho Workshop. Ed.: B. Shepard. American Fisheries Society.

Nicholas, J.W. and D.G. Hankin. 1989. Chinook Salmon in Oregon Coastal River Basins: A Review of Contemporary Status and the Need for Fundamental Change in Fisheries Management Strategy. In Proceedings: Wild Trout IV. Trout Unlimited. Vienna, Virginia.

Nickelson, T.E. 1986. Influence of upwelling, ocean temperature, and smolt abundance on marine survival of coho salmon in the Oregon production area. Can Jour. of Fish. and Aquat. Sci. 43: 527-535.

North Coast Regional Water Quality Control Board. 1989. Water Quality Plan for the North Coast Region. Santa Rosa.

Northwest Power Planning Council. 1987. Columbia River Basin Fish and Wildlife Program. Portland, 246p.

Northwest Power Planning Council. 1990. Public Review Draft: Integrated System Plan for Salmon and Steelhead Production in the Columbia River System. Columbia Basin Fish and Wildlife Authority, Portland, Oregon. 448p.

Northwest Renewable Resources Center. 1987. Timber/Fish/Wildlife Agreement. Final Report. Seattle, 57p.

O'Connel, M.F. and C.E. Bourgeois. 1987. Atlantic Salmon Enhancement in the Exploits River, Newfoundland, 1957-1984. North American Journal of Fisheries Management. 7:207-214.

Ocean and Coastal Law Memo. 1990. United States Law and Policy Regarding High Seas Driftnets in the North Pacific Ocean. Ocean and Coastal Law Center, University of Oregon, Eugene, Ore. 97403. Distributed by Sea Grant Program, Corvallis, Ore. Issue 34 July 1990.

Olson A.D. and J.R. West. 1990. Evaluation of Instream Fish Habitat Restoration Structures in Klamath River Tributaries, 1988/89. USDA Forest Service, Yreka, Calif. 96097.

Palmisano, A.N. and C.V. Burger. 1988. Use of a Portable Electric Barrier to Estimate Adult Chinook Salmon Escapement in a Turbid Alaskan River. North American Journal of Fisheries Management. 8:475-480.

Parkinson, E.A. 1984. Genetic variation in populations of steelhead trout (Salmo gairdneri) in British Columbia. Can. J. Fish. Aquat. Sci. 41: 1412-1420.

Patterson, D. 1976. Evaluation of habitats resulting from streambank protection projects in Siskiyou and Mendocino Counties, California. U.S. Soil Conservation Service, Red Bluff, 15p.

Payne, T.R. and Assoc. 1989. Lower Klamath River tributary delta study. U.S. Department of the Interior, Bureau of Indian Affairs. Redding, Calif. 25p.

Peven, C.M. and S.G. Hays. 1989. Proportion of Hatchery and Naturally Produced Steelhead Smolts Migrating Past Rock Island Dam, Columbia River, Washington. Journal of North American Fisheries Management. 9:5359.

PFMC. 1990. Pre-season Report I: Stock abundance analysis for 1990 ocean salmon fisheries. PFMC. Portland, Ore.

Pierce, R. 1988. Klamath River Salmonid Restoration Plan, Hoopa Valley Reservation Extension. Bureau of Indian Affairs, Klamath, Calif. 15 p.

Platts, W.M., R.J. Torquemada, M.L. McHenry and C.K. Graham. 1989. Changes in Salmon Spawning and Rearing from Increased Fine Sediment to the South Fork of the Salmon River, Idaho. Transactions of the American Fisheries Society. 8:274-283.

Platts, W.S. and W.F. Megahan. 1975. Time trends in channel sediment size composition in salmon and steelhead spawning areas: South Fork of the Salmon River, Idaho. USDA Forest Service Gen. Rep. Intermountain Forest and Range Experiment Station, Ogden, Utah.

Platts, W.S. 1981. Effects of livestock grazing. Influence of forest and range-land management on anadromous fish habitat in western North America. U.S. Forest Service Gen. Tech. Rept. PNW-124, 25p.

Platts, W.S. 1982. Livestock and riparian-fishery interactions: what are the facts? Transactions of the 47th North American Wildlife and Nat. Resources Conf. p507-15.

Platts, W.S., W.F. Megahan, and G.W. Minshall. 1983. Methods for evaluating stream, riparian, and biotic conditions. U.S.F.S. Gen. Tech. Report. INT-221. Ogden, Ut.

Platts, W.S. 1984a. Determining and evaluating riparian stream enhancement needs and fish response. In: T. Hassler (ed), Pacific Northwest Stream Habitat Management Workshop. Cal. Coop. Fish. Research Unit, Humboldt State, Univ. Arcata, Calif.

Platts, W.S. 1984b. Welcoming address. Proceedings: Pacific northwest stream habitat management workshop. California Coop. Fish. Research. Arcata, pp. 1-2

Platts, W.S. and R.L. Nelson. 1988. Fluctuations in Trout Populations and Their Implications for Land-Use Evaluation. North American Journal of Fisheries Management. 8:333345.

PNFHPC (Pacific Northwest Fish Health Protection Committee) 1989. Model Comprehensive Fish Health Protection Program. 1002 N.E. Holladay Street, Portland, Oregon, 97232-4181.

Puckett, L. 1982. Preliminary evaluation of the Scott River anadromous salmonid fishery. Cal. Dept. of Fish and Game, Memorandum to John Hayes. Redding. 9p.

Randolph. 1990. U.S. Forest Service Sues for Instream Flows. Flyfisherman. May 1990, 21(3): 3-6.

Reeves, G.H. and T.D. Roelofs. 1982. Rehabilitating and enhancing stream habitat: field applications. USDA Forest Service, Gen. Tech. Report PNW-140, Portland, Ore.

Reeves, G.H. 1985. Competition between redside shiners and steelhead trout in the Umpqua River, Oregon. Doctoral thesis, Oregon State University, Corvallis, Ore.

Reeves, G.H. 1988. Project and habitat analysis. In: A Training in Stream Rehabilitation. Oregon AFS, Ashland, Ore.

Reeves, G.H., F.H. Everest, and T.E. Nickelson. 1988. Identification of physical habitat limiting the production of coho salmon in western Oregon and Washington. USDA Forest Service, Pacific Northwest Research Station, Portland, Ore. PNW-GTR-245.

Reimers, P.E. 1973. The length of residence of juvenile chinook salmon in Sixes River, Oregon. Ore. Fish. Comm. Report. 4 (2): 1-43. Portland, Ore.

Reiser, D.W. and T.C. Bjornn. 1979. Habitat requirements of anadromous salmonids. Influence of forest and rangeland management of anadromous fish habitat in western North America. USDA Forest Service Gen. Tech. Rep. PNW-96, Portland.

Reiser, D.W. and R.G. White. 1988. Effects of Two Sediment Size Classes on Survival of Steelhead and Chinook Salmon Eggs. North American Journal of Fisheries Management. 8:432-437.

Resource Renewal Institute. 1988. The Water Heritage Trust. Sausalito, CA. 18p.

Rich, W.H. 1939. Local populations and migration in relation to conservation of Pacific salmon in the Western States and Alaska. Fish Commission of Oregon, Contribution 1. (Reprinted from the Migration and Conservation of Salmon, No. 8, Amer. Assoc. for the Advancement of Science, Science Press, Lancaster, Pennsylvania.)

Ricker, W.E. 1972. Heredity and environmental factors effecting certain salmonid populations. In: Stock Concept of Pacific Salmonids. H.R. MacMillan Lecture on Fisheries. Vancouver, B.C.

Ricker, W.E. 1976. Review of the growth rate and mortality of Pacific salmon and non-catch mortality caused by fishing. Journal of the Fisheries Board of Canada. 33:1483-1524.

Riesenbichler, R.R. and J.D. McIntyre. 1977. Genetic Differences in growth and survival of juvenile hatchery and wild steelhead trout. J. Fisheries Res. Board of Can. 34:123-128.

Riesenbichler, R.R. 1988. Relation between distance transferred from natal stream and recovery rate for hatchery coho salmon. North American Journal of Fisheries Management. 8:172-174.

Riesenbichler, R.R. and J.M. Emlen. 1988. A re-evaluation of models predicting density-dependent survival at sea for coho salmon. In: B.G. Shepard (ed.): Proceedings of 1988 Northeast Pacific Chinook and Coho Salmon Workshop. Western Div. AFS. Pacific NW Chapter, Penticton, B.C., Canada.

Riesenbichler, R.R. and S.R. Phelps. 1989. Genetic variation in steelhead from the north coast of Washington. Can. J. of Fish. Aquat. Sci. 46: 66-73.

Riggs, L. 1990. Principles for genetic conservation and production quality. Northwest Power Planning Council contract no. C90-005. Portland, Oregon.

Riley, J. 1967. Annual Report for Iron Gate Salmon and Steelhead Hatchery, First Year of Operation, 1965-66. CDFG Inland Fisheries, Region 1, Redding, Calif.

Roelofs, T.D. 1983. Current Status of Summer Steelhead Stocks and Habitat, and Recommendations for Their Management. U.S. Forest Service, Region 5. San Francisco, California.

Rosgen, D.L. 1985. A stream classification system. In Riparian Ecosystems and Their Management: Reconciling Conflicting Uses. First Annual North American Riparian Conference, Tucson, Ariz.

Royal, L.A. 1972. An Examination of Anadromous Trout Program of the Washington State Game Program. Mimeographed Report. Wash. Department of Game. Olympia, Washington.

Ryman, N. and G. Stahl. 1981. Genetic perspectives of identification and conservation of Scandinavian stocks of fish. Can. J. Fish. and Aquat. Sci. 38: 1562-1575.

Ryman, N. and F. Utter. 1986. Population Genetics and Fisheries Management. Washington Sea Grant Program. Univ. of Washington Press. Seattle, Washington. 420p.

Salo, E.O. and W.H. Bayliff. 1958. Artificial and natural production of silver salmon (Oncorhynchus kisutch) at Miner Creek, Washington. Washington Dept. of Resources Bull. No. 4. Olympia, Wash.

Satterthwaite, T.D. 1988. Influence of maturity on straying rates of summer steelhead into the Rogue River, Oregon. California Fish and Game 74 (4): 203-207.

Saunders, R.L. 1981. Atlantic salmon (Salmo salar) stocks and management implications in Canadian Atlantic provinces and New England, USA. Can. J. of Fish. and Aquat. Sci. 38: 1612-1625.

Savage, J.L. 1986. Restoration and Enhancement of Pacific Salmonids. Marine Recreational Fisheries, Vol. p53-67.

Savory, A. 1988. Holistic resource management. Center for Holistic Resource Management. Albuquerque NM, 512p.

Sedell, J.R. and K.J. Luchessa. 1981. Using the historical record as an aid to salmonid habitat enhancement. pp. 210-223 In: Symposium on acquisition and utilization of aquatic habitat inventory information. WDAFS, Portland, Oregon.

Sedell, J.R., P.A. Bisson, F.J. Swanson, and S.V. Gregory. 1988. What we know about large trees that fall into streams and rivers. In: From the Forest to the Sea: A Story of Fallen Trees. USDA, Forest Service and U.S. Dept. of the Interior, BLM. Gen. Tech. Report PNW-GTR-229. Portland, Ore.

Seelbach, P.W. and G.E. Whelan. 1988. Identification and Contribution of Wild and Hatchery Steelhead Stocks in Lake Michigan Tributaries. Transactions of the American Fisheries Society. 117:444-451.

Shaw, P. and J. Maga. 1943. The effect of mining silts on yield of fry from salmon spawning beds. California Fish and Game 29(1):29-41.

Shields, W.M. 1982. Philopatry, Inbreeding, and the Evolution of Sex. State University of New York Press, Albany, N.Y.

Silcox, F.A. 1936. Fish stream improvement handbook. USFS, Washington D.C.

Simenstad, C.A. 1983. The ecology of estuarine channels of the Pacific Northwest coast: a community profile. USFWS. FWS/OBS 83/05.

Simon, R.C. and P.A. Larkin. 1972. The Stock Concept in Pacific Salmon. H.R. MacMillan Lectures in Fisheries. Vancouver, B.C.

Simon, R.C., J.D. McIntyre, H. Hemminigson. 1986. Family size and effective population size in a hatchery coho salmon population. Canadian Journal of Fisheries and Aquatic Sciences 43: 2434-2442.

Simon, R.C. 1988. Seven Avenues for Redress of Fish Hatchery Problems Involving Restricted Genetic Variability. Proceedings of the American Fisheries Society Bioenhancement Seminar. Portland, Ore.

Siskiyou Soil Conservation District. 1969. Twenty year report. Etna CA, 6p.

Slaney, P.A. and A.D. Martin. 1987. Accuracy of Underwater Census of Trout in a Large Stream in British Columbia. North American Journal of Fisheries Management. 7:117-122.

Smith, E.A., B.A. Miller, J.D. Rogers, M.A. Buckman. 1985. Outplanting Anadromous Salmonids - A Literature Survey. Oregon Department of Fish and Wildlife for Bonneville Power Administration. Project No. 85-68.

Smith, G.E. 1982. Small hydroelectric development in California: the role of the Department of Fish and Game. CA Dept. of Fish and Game, Environ. Serv. Admin. Rep. No. 82-4. Sacramento, 28p.

Smith, O.R. 1939. Placer mining silt and its relation to salmon and trout on the Pacific Coast. Trans. Am. Fish. Soc. 69:135-139.

Snyder, J.O. and E.C. Schofield. 1924. An experiment relating to the homing of chinook salmon. Cal Fish and Game Bull, Vol. 10, no. 1. 9p.

Snyder, J.O. 1931. Salmon of the Klamath River. California Department of Fish and Game. Fisheries Bulletin No. 34. 130p.

Snyder, J.O. 1934. Klamath River spawning conditions in 1932. California Fish and Game 20 (1):70-72.

Solazzi, M.F., S.L. Johnson, T.E. Nickelsen. 1983. The effectiveness of stocking hatchery coho pre-smolts to increase rearing densities of juvenile coho in Oregon coastal streams. 14 p. Oregon Dept. of Fish and Wildlife. Portland, Oregon.

Sommarstrom, S. 1981. Local-State coordination for gravel management in spawning streams. pp. 49-54 In: Habitat disturbance and recovery, Proc. of a Symposium. California Trout. San Francisco, 90p.

Sommarstrom, S., E. Kellogg and J. Kellogg. 1990. Scott River Watershed Granitic Sediment Study. Report of the Siskiyou Resource Conservation District to U.S. Fish and Wildlife Service, Cooperative Agreement 14-16-001-89506. 122p.

Starr, Paul. No date. Trends in smolt production at British Columbia hatcheries and its relationship to smolt survival and contributions to the fisheries. Canadian Dept. of Fisheries and Oceans File Report, Nanaimo, B.C.

Stempel, M. 1988. Possible implications of integrating hatchery and natural production of salmon and steelhead in the Trinity River Basin. USFWS, Weaverville, California.

Stern, G.R. 1985. Effects of suction dredge mining on anadromous salmonid habitat in Canyon Creek, Trinity County, California. M.S. Thesis, Humboldt State Univ., Arcata.

Steward, C.R. and T.C. Bjornn. 1990. Supplementation of salmon and steelhead stocks with hatchery fish: a synthesis of published literature. Idaho Cooperative Fisheries and Wildlife Research Unit, Univ. of Idaho, Moscow, Id. 83843. Tech. Report 90-1.

Stuart, G. 1925. Prospecting for gold from Dogtown to Virginia City, 1852-1864. Reprinted in 1977 by University of Nebraska Press, Lincoln.

Sullivan, C.M. Unpublished. Juvenile life history of Klamath River basin fall chinook salmon as determined by adult scale analysis. California Department of Fish and Game. Sacramento, Calif.

Taft, A.C. and L. Shapovalov. 1935. Biological survey of the streams and lakes of the Klamath and Shasta National Forests. Dept. of Commerce, Bur. of Fishes, Washington D.C.

Taft, A.C. 1933. California steelhead trout problems. California Fish and Game 19:192-198.

Taft, A.C. and L. Shapovalov. 1935. A biological survey of streams and lakes in the Klamath and Shasta National Forests of California. U.S. Bur. Fisheries. Stanford Univ., Palo Alto. 63p.

Tarzwell, C.M. 1938. An evaluation of the methods and results of stream improvement in the southwest. No. Amer. Wildlife Conf. 3: 339-364.

Templeton, A.R. 1986. Co-adaptation and outbreeding depression. In: Soule (ed), Conservation Biology: The Science of Scarcity and Diversity. Sinauer Assoc., Sunderland, Mass.

Thomas, V.G. 1985. Experimentally determined impacts of a small, suction gold dredge on a Montana stream. No. Amer. J. Fish. Mgt. 5:480-488.

Thorpe, J.E. and K.E. Mitchell. 1981. Stocks of Atlantic Salmon (Salmo salar) in Britain and Ireland: discreteness, and current management. Can. J. Fish. Aquat. Sci. 38: 1576-1590.

Thurow, R. 1987. Evaluation of the South Fork of the Salmon River Steelhead Trout Fishery Restoration Program. Idaho Dept of Fish and Game. Performed for DOI. Contract No. 14-16-0001-86505.

Trinity River Task Force Technical Coordinating Committee. 1990. Trinity River Fish and Wildlife Management Program, Three Year Action Plan, Fiscal Years 1991-1993. Weaverville, 46p.

Trotter, P.C. 1987. Cutthroat: Native Trout of the West. Colorado Associated University Press, Boulder, Colorado. 218 p.

Turner, J. 1981. Instream flow - quantity and quality. pp. 55-56 In: Proc. Conf. Habitat disturbance and recovery. California Trout. San Francisco.

U.S. Army Corps of Engineers. 1979. Klamath River Basin, Oregon: Reconnaissance report. San Francisco, 173p.

U.S. Bureau of Land Management. 1989. Draft eligibility and suitability report for the Upper Klamath Wild and Scenic River Study. Klamath Falls, OR.

U.S. Congress. 1986. Federal Advisory Committee Act, as amended. Title 5, United States Code, Appendix. Washington, D.C.

U.S. Department of Commerce. 1989. Report to Congress on the nature, extent, and effects of driftnet fishing in waters of the North Pacific. Pursuant to Sect. 4005 of Public Law 100-220, the Driftnet Monitoring and Control Act of 1987.

U.S. Department of the Interior, Heritage Conservation and Recreation Service, 1980. Proposed designation of five California rivers in the National Wild and Scenic Rivers System, Final Environmental Impact Statement. San Francisco, 2 volumes.

U.S. Department of the Interior, Office of the Solicitor. 1989. Expenditure of funds for the Klamath River Basin Fishery Restoration Act. Memorandum to Regional Director, U.S. Fish and Wildlife Service. Jan. 20, 1989. Portland, 8p.

U.S. Environmental Protection Agency. 1986. Reach File Manual. Draft. Washington, D.C

U.S. Fish and Wildlife Service. 1979. Hoopa Valley Indian Reservation: Inventory of reservation waters fish rearing feasibility study and a review of the history and status of anadromous fishery resources of the Klamath River basin. Fish. Assistance Office, Arcata, Calif.

U.S. Fish and Wildlife Service. 1982. Klamath River Fisheries Investigation Program - Annual Report 1982. Fisheries Assistance Office, Arcata, Calif.

U.S. Fish and Wildlife Service. 1982. Manual of stream channelization impacts on fish and wildlife. Biological Services Program. FWS/OBS-82/24. Washington, D.C., 166p.

U.S. Fish and Wildlife Service. 1983. Regional Fisheries Resource Plan. Portland, Ore.

U.S. Fish and Wildlife Service. 1988a. Klamath River Fisheries Assessment Program - Annual Report 1988. Fish. Assistance Office, Arcata, California.

U.S. Fish and Wildlife Service. 1988b. Inventory of fisheries restoration projects in the Klamath Basin. USFWS Klamath Field Office, Yreka, Cal.

U.S. Fish and Wildlife Service. 1989. Fish and wildlife concerns regarding FERC projects in California. Memorandum from J. McKevitt to C. Emmerling of FERC. Div. of Ecological Services. Sacramento, 5p.

U.S. Fish and Wildlife Service. 1989. Klamath River Fisheries Assessment Program: juvenile salmonid production monitoring. Fish. Assistance Office, Arcata, Calif.

U.S. Fish and Wildlife Service. 1990. Klamath Fisheries Assessment Program: Investigations on lower tributaries Klamath River. Fish. Assistance Office, Arcata, Calif.

U.S. Fish and Wildlife Service. 1990a. Request for proposals for Fiscal Year 1991, Klamath Fisheries Restoration Program. Yreka. April 1990, 8p.

U.S. Fish and Wildlife Service. 1990b. "Operate Klamath Field Office", Project proposal, Klamath Fishery Restoration Program, Fiscal Year 1991. Yreka, 3p.

U.S. Fish and Wildlife Service. 1990c. Klamath Fisheries Assessment Program: Investigations on Blue Creek. Fish. Assistance Office, Arcata, Calif.

U.S. Fish and Wildlife Service. 1990d. Klamath-Trinity River Basin spring chinook salmon stock evaluation and run-size forecast. USFWS Fish. Assistance Office, Arcata, Calif. 31 p.

U.S. Fish and Wildlife Service. 1990e. Mid-Program Review of the Trinity River Restoration Program. Trinity Field Office, Weaverville.

U.S. Fish and Wildlife Service. In Press. Trinity River Basin Fish and Wildlife Restoration Program Mid Program Review. Trinity Field Office of USFWS, Weaverville, Calif.

U.S. Forest Service. 1974. Timber Management Plan, Klamath National Forest. Yreka.

U.S. Forest Service. 1979. Water quality management for National Forest System lands in California. Best Management Practices. Regional Office, San Francisco.

U.S. Forest Service. 1983(?). Water quality planning for forest roads, Sacramento Valley Basin, California. With USDA Soil Conservation Service River Basin Planning Staff. Special Study No. 1B Extension. San Francisco.

U.S. Forest Service. 1984. Regional guide for the Pacific Southwest Region. Region 5. San Francisco.

U.S. Forest Service. 1989a. Grider fire recovery project: final environmental impact statement. Klamath National Forest, Yreka.

U.S. Forest Service. 1989b. King-Titus fire recovery project: draft environmental impact statement. Klamath National Forest, Yreka.

U.S. Geological Survey. 1941-89. Stream discharge data for Klamath River Basin. Menlo Park.

U.S. House of Representatives 1986. Klamath and Trinity River Basins Restoration Report, to accompany H.R. 4712. Report 99-894, Part 1. Committee on Merchant Marine and Fisheries. Washington, D.C., 24p.

U.S. Senate. Permanent Fact Finding Committee on Natural Resources. 1963. Second progress report to the Legislature - the Iron Gate Dam project - its effect on the Klamath River fishery. 71p.

U.S. Soil Conservation Service. 1972. Water, land, and related resources. North Coastal area of California. Appendix 2: Sediment Yield and Land Treatment. Klamath, Trinity, and Smith River Basins. River Basin Planning Staff. Berkeley, 152p.

U.S. Soil Conservation Service. 1976. Canal flow -- Scott Valley Irrigation District. Unpublished data for 1973-1976. Etna, 1p.

U.S. Soil Conservation Service. 1983. Soil survey of Siskiyou County, California - central part. Yreka, 291p.

U.S. Soil Conservation Service. 1985. Soil survey of Klamath County, Oregon - southern part. Klamath Falls.

University of California at Los Angeles. 1980. California's North Coast Wild and Scenic Rivers - analysis of inter-agency planning and technical issues. Environmental Science and Engineering Dept., Rep. 80-35.

Utter, F.M. 1981. Biological criteria for definition of species and distinct intraspecific populations of anadromous salmonids under the U.S. Endangered Species Act of 1973. Canadian Jour. of Fisheries and Aquatic Sci. 38:1626-1635.

Vincent, E.R. 1987. Effects of Stocking Catchable-Size Hatchery Rainbow Trout on Two Wild Species in the Madison River and O'Dell Creek, Montana. North American Journal of Fisheries Management. 7:91-105.

Wagner, H. 1979. Why Wild Coho? Oregon Wildlife. ODFW. Portland, Oregon

Wakabayashi, H., S. Egusa, J.F. Fryer. 1980. Characteristics of filamentous bacteria isolated from gill disease of salmonids. Canadian Journal of Fisheries and Aquatic Sciences 37:1499-1504.

Wales, J.H. 1950. Management of king salmon spawning in the Klamath River, Siskiyou County. Calif. Div. of Fish and Game. Memorandum. 11p.

Wales, J.H. and M. Coots. 1950. Second report on the effect of the Klamath River water fluctuations upon the salmonid fishes. California Div. of Fish and Game, memorandum to U.S. Bureau of Fish Conservation. 6p.

Waples, R.S. and D.J. Teel. In Press. Conservation genetics of Pacific Salmon: temporal changes in allele frequency. Conservation Biology.

Water Heritage Trust. 1988. The Water Heritage Trust. Resource Renewal Institute. Sausalito, 18p.

Weaver, W., D. Hagans, and M, Madej. 1986. Managing forest roads to control cumulative erosion and sedimentation effects. pp. 119-124 In: Proc. California Watershed Management Conference. Sacramento.

Weaver, W. and D.K. Hagans. 1990. Watershed Assessments for Erosion Control, Erosion and Prevention and Rehabilitation with the Goal of Fisheries Restoration. Pacific Watershed Associates, McKinleyville, Ca. p.5.

Weaver, W.E. et al, 1987. An evaluation of experimental rehabilitation work, Redwood National Park. Technical Report No. 19. Arcata, 164p.+

Wells, H.L. 1881. History of Siskiyou County, California. D.J. Stewart & Co., Oakland (reprinted in 1971). 240p.

Wertheimer, A. 1988. Hooking Mortality of Chinook Salmon Released by Commercial Trollers. North American Journal of Fisheries Management. 8:346-355.

West, J.R. 1983. Scott River fisheries information. Klamath National Forest, Etna. 2p.

West, J.R. 1984. Enhancement of salmon and steelhead spawning and rearing conditions in the Scott and Salmon Rivers, California. In Hassler (ed.): Proceedings of Pacific Northwest Stream Habitat Management Workshop, Fisheries Cooperative Unit, Humboldt State University, Arcata, California.

West, J.R., O.J. Dix, A. Olson, M.V. Anderson, and J.H. Power, 1990. Evaluation of fish habitat condition and utilization in Salmon, Scott, Shasta, and Mid-Klamath sub-basin tributaries 1988/89. USDA Forest Service, Yreka, Calif. 96097. Under contract with USFWS Klamath Field Office, Yreka, Calif. no. 14-16-0001-89508.

Whiteley, A.H. 1989. Food Additives Used in Salmon Netpen Rearing. Personal comments to the California Legislature of A.H. Whiteley, Professor Emeritus, Univ. of Washington, Seattle, Wash.

Wilson, A. and V. Sarich. 1966. A Molecular Approach to the Question of Human Origins. Science, Dec. 23, 1966 154:1563-1566.

Winans, G.A. 1989. Genetic Variability in Chinook Salmon from the Columbia River Basin. North American Journal of Fisheries Management. 9:47-52.

Winget, R.N. and F.A. Mangum. 1979. Biotic Condition Index: Integrated biological, physical and chemical stream parameters for management. USDA Forest Service, Intermountain Region, Ogden, Utah. 51 p.

Withler, F.C. 1982. Transplanting Pacific Salmon. Canadian Tech Report of Fisheries and Aquatic Sciences 1079. 27p.

Wood, C.C. 1987. Predation of juvenile Pacific salmon by the common merganser (Mergus merganser) on eastern Vancouver Island. Canadian Journal of Fish and Aquatic Sciences. 44:941-949.

Wood, J.W. 1974. Diseases of Pacific salmon; their prevention and treatment, pp. 22-24. Washington State Department of Fisheries Olympia, Washington.

Woodward, C.C. and R.J. Strange. 1988. Physiological Stress Responses in Wild and Hatchery and Wild Rainbow Trout. Transactions of the American Fisheries Society. 116:574-579.

Yee, C.S. and T.D. Roelofs. 1980. Planning forest roads to protect salmonid habitat. Influence of forest and rangeland management on anadromous fish habitat in western North America. U.S. Forest Service Gen. Tech. Rep. PNW-109. Portland, 26p.

Ziemer, P.E. 1962. Steep-pass fishway development. Informational leaflet No. 12, Alaska Dept. of Fish and Game, Juneau, AK

Ziemer, R.R. 1981a. Management of steepland erosion: an overview. J. Hydrology (New Zealand) 20(1): 8-16.2

Ziemer, R.R. 1981b. Storm flow response to road building and partial cutting in small streams in northern California. Water Resources Res. 17(4): 907-917.

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PHOTO AND ILLUSTRATION CREDITS
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Line drawings of Klamath River
Basin fishes. — Klamath River Educational Program

APPENDIX A:

PUBLIC LAW 99-552

KLAMATH RIVER BASIN ACT

Public Law 99-552
99th Congress

An Act

Oct. 27, 1986
[H.R. 4712]

To provide for the restoration of the fishery resources in the Klamath River Basin, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

16 USC 460ss.

SECTION 1. FINDINGS.

The Congress finds that—

(1) the Klamath and Trinity Rivers have been placed under the California and National Wild and Scenic Rivers Systems to protect their outstanding anadromous fishery values;

(2) the Klamath and Trinity Rivers provide fishery resources necessary for Indian subsistence and ceremonial purposes, ocean commercial harvest, recreational fishing, and the economic health of many local communities;

(3) floods, the construction and operation of dams, diversions and hydroelectric projects, past mining, timber harvest practices, and roadbuilding have all contributed to sedimentation, reduced flows, and degraded water quality which has significantly reduced the anadromous fish habitat in the Klamath-Trinity River System;

(4) overlapping Federal, State, and local jurisdictions, inadequate enforcement of fishery harvest regulations, and ineffective fishery management have historically hampered fishery conservation efforts and prevented the Federal Government and the State of California from fulfilling their responsibilities to protect the rivers' anadromous fishery values;

(5) the Klamath-Trinity fall chinook salmon populations have declined by 80 percent from historic levels and steelhead trout have also undergone significant reductions;

(6) Klamath River Basin Fisheries Resource Plan has been developed by the Secretary acting through the Bureau of Indian Affairs;

(7) the Klamath Salmon Management Group, a group of agencies with fishery management responsibility, has established, in cooperation with the users of the Klamath-Trinity River Basin fishery resources, a sound framework for the future coordination of fishery harvest management;

(8) a new Klamath-Trinity River Basin Management authority, composed of the Klamath Salmon Management Group and representatives of users of the fishery resources of the Klamath-Trinity River Basin, is needed to ensure more effective long-term coordination of the Klamath-Trinity River fisheries under sound conservation and management principles that ensure adequate spawning escapement; and

(9) the Secretary has the authority to implement a restoration program only in the Trinity River Basin and needs additional authority to implement a restoration program in cooperation with State and local governments to restore anadromous fish

populations to optimum levels in both the Klamath and Trinity River Basins;

SEC. 2. KLAMATH RIVER BASIN CONSERVATION AREA; FISHERY RESOURCES RESTORATION PROGRAM. 16 USC 460ss-1.

(a) ESTABLISHMENT OF KLAMATH RIVER BASIN CONSERVATION AREA.—The Secretary shall designate the anadromous fish habitats and resources of the Klamath River basin as the Klamath River Basin Conservation Area (hereafter in this Act referred to as the "Area").

(b) KLAMATH RIVER BASIN CONSERVATION AREA RESTORATION PROGRAM.—

(1) ESTABLISHMENT.—The Secretary shall, in consultation with the task force established under section 4, formulate, establish, and implement a 20-year program to restore the anadromous fish populations of the Area to optimum levels and to maintain such levels. The program shall be based on the Klamath River Basin Fisheries Resource Plan referred to in section 1(6) and shall be known as the Klamath River Basin Conservation Area Restoration Program.

(2) PROGRAM ACTIVITIES.—In carrying out the objectives of the program, the Secretary, in cooperation with the task force established under section 4, shall—

(A) monitor and coordinate research evaluating the Area anadromous fish populations and administer and evaluate the success of activities described in subparagraph (B); and Research and development.

(B) take such actions as are necessary to—

(i) improve and restore Area habitats, and to promote access to blocked Area habitats, to support increased run sizes;

(ii) rehabilitate problem watersheds in the Area to reduce negative impacts on fish and fish habitats;

(iii) improve existing Area hatcheries and rearing ponds to assist in rebuilding the natural populations;

(iv) implement an intensive, short-term stocking program to rebuild run sizes while maintaining the genetic integrity and diversity of Area subbasin stocks; and

(v) improve upstream and downstream migration by removal of obstacles to fish passage and the provision of facilities for avoiding obstacles.

(3) RESTORATION WORK.—To the extent practicable, any restoration work performed under paragraph (2)(B) shall be performed by unemployed— Indians.

(A) commercial fishermen;

(B) Indians; and

(C) other persons whose livelihood depends upon Area fishery resources.

(4) MEMORANDUM OF AGREEMENT.—In order to facilitate the implementation of any activity described in paragraph (2) over which the Secretary does not have jurisdiction, the Secretary shall enter into a memorandum of agreement with the Federal, State, and local agencies having jurisdiction over such activities, and the Area Indian tribes. The memorandum of agreement shall specify the program activities for which the respective signatories to the agreement are responsible and shall contain such provisions as are necessary to ensure the coordinated implementation of the program. Contracts. State and local governments. Indians.

16 USC 460ss-2. **SEC. 3. KLAMATH FISHERY MANAGEMENT COUNCIL.**

(a) ESTABLISHMENT.—There is established a Klamath Fishery Management Council (hereafter in this Act referred to as the "Council").

(b) FUNCTIONS.—

(1) The Council shall—

(A) establish a comprehensive long-term plan and policy, that must be consistent with the goals of the program, for the management of the in-river and ocean harvesting that affects or may affect Klamath and Trinity River basin anadromous fish populations;

(B) make recommendations, that must be consistent with the plan and policy established under subparagraph (A) and with the standards in paragraph (2)—

(i) to the California Fish and Game Commission regarding in-river and offshore recreational harvesting regulations,

(ii) to the Oregon Department of Fish and Wildlife regarding offshore recreational harvesting regulations,

(iii) to the Pacific Fishery Management Council regarding ocean harvesting regulations,

(iv) to the Bureau of Indian Affairs regarding regulations for harvesting in the Area by non-Hoopa Indians, and

(v) to the Hoopa Valley Business Council regarding regulations for harvesting in the Area by members of the Hoopa Indian Tribe; and

(C) conduct public hearings on any regulation referred to in subparagraph (B) (i) through (v).

(2) Any recommendation made by the Council under paragraph (1)(B) regarding harvesting regulations shall—

(A) be based upon the best scientific information available;

(B) minimize costs where practicable, and avoid unnecessary duplication of regulations;

(C) take into account and allow for variations among, and contingencies in, fisheries, fishery resources, and catches; and

(D) be designed to achieve an escapement that preserves and strengthens the viability of the Area's natural anadromous fish populations.

(c) MEMBERSHIP AND APPOINTMENT.—The Council is composed of 11 members as follows:

(1) A representative, who shall be appointed by the Governor of California, of each of the following:

(A) The commercial salmon fishing industry.

(B) The in-river sportfishing community.

(C) The offshore recreational fishing industry.

(D) The California Department of Fish and Game.

(2) A representative of the Hoopa Indian Tribe who shall be appointed by Hoopa Valley Business Council.

(3) A representative, who shall be appointed by the Secretary, of each of the following:

(A) The non-Hoopa Indians residing in the Area.

(B) The Department of the Interior.

(4) A representative, who shall be appointed by the Secretary of Commerce, of each of the following—

(A) The National Marine Fisheries Service.

(B) The Pacific Fishery Management Council.

(5) A representative, who shall be appointed by the Governor of Oregon, of each of the following:

(A) The commercial salmon fishing industry.

(B) The Oregon Department of Fish and Wildlife.

(d) CONSULTATION REQUIREMENT.—The appointments required under subsection (c) shall be made in consultation with the appropriate users of Area anadromous fish resources.

(e) QUALIFICATIONS.—Council members shall be individuals who are knowledgable and experienced in the management and conservation, or the recreational or commercial harvest, of the anadromous fish resources in Northern California.

(f) TERMS.—

(1) IN GENERAL.—The term of a member is 4 years.

(2) SERVICE.—Members of the Council serve at the pleasure of the appointing authority.

(3) VACANCIES.—Any vacancy on the Council shall be filled in the manner in which the original appointment was made. Any member appointed to fill a vacancy occurring before the expiration of the term for which his predecessor was appointed shall be appointed only for the remainder of such term. A member may serve after the expiration of his term until his successor has taken office.

(g) TRANSACTION OF BUSINESS.—

(1) DECISIONS OF COUNCIL.—All decisions of the Council must be by unanimous vote of all of the members.

(2) CHAIRMAN.—The Council shall elect a Chairman from among its members.

(3) MEETINGS.—The Council shall meet at the call of the Chairman or upon the request of a majority of its members.

(h) STAFF AND ADMINISTRATION.—

(1) ADMINISTRATIVE SUPPORT.—The Secretary and the Director of the California Department of Fish and Game shall provide the Council with such administrative and technical support services as are necessary for the effective functioning of the Council.

(2) INFORMATION.—The Secretary and the Director of the California Department of Fish and Game shall furnish the Council with relevant information concerning the Area.

(3) ORGANIZATION.—The Council shall determine its organization, and prescribe the practices and procedures for carrying out its functions under subsection (b).

(i) FEDERAL OR STATE EMPLOYEES.—Any Council member who is an officer or employee of the United States or the State of California at the time of appointment to the Council shall cease to be a Council member within 14 days after the date on which he ceases to be so employed.

(j) EXPENSES.—

(1) TRAVEL EXPENSES.—While away from their homes or regular places of business in the performance of services for the Council, Council members shall be allowed travel expenses, including a per diem allowance in lieu of subsistence, in the same manner as persons employed intermittently in the

Government service are allowed travel expenses under section 5703 of title 5 of the United States Code.

(2) LIMITATION ON SPENDING AUTHORITY.—No money authorized to be appropriated under section 6 may be used to reimburse any agency or governmental unit (whose employees are Council members) for time spent by any such employee performing Council duties.

16 USC 460ss-3.

SEC. 4. KLAMATH RIVER BASIN FISHERIES TASK FORCE.

(a) ESTABLISHMENT.—There is established a Klamath River Basin Fisheries Task Force (hereafter in this Act referred to as the "Task Force").

(b) FUNCTIONS.—The Task Force—

(1) shall assist the Secretary in the formulation, coordination, and implementation of the program;

(2) shall assist, and coordinate its activities with, Federal, State, and local governmental or private anadromous fish restoration projects within the Area;

(3) shall conduct any other activity that is necessary to accomplish the objectives of the program; and

(4) may act as an advisor to the Council.

(c) MEMBERSHIP AND APPOINTMENT.—The Task Force is composed of 12 members as follows:

(1) A representative, who shall be appointed by the Governor of California, of each of the following:

(A) The commercial salmon fishing industry.

(B) The in-river sport fishing community.

(C) The California Department of Fish and Game.

(2) A representative of the Hoopa Indian Tribe who shall be appointed by the Hoopa Valley Business Council.

(3) A representative of the Department of the Interior who shall be appointed by the Secretary.

(4) A representative of the National Marine Fisheries Service who shall be appointed by the Secretary of Commerce.

(5) A representative of the Department of Agriculture who shall be appointed by the Secretary of Agriculture.

(6) A representative of the Oregon Department of Fish and Wildlife who shall be appointed by the Governor of Oregon.

(7) One individual who shall be appointed by the Board of Supervisors of Del Norte County, California.

(8) One individual who shall be appointed by the Board of Supervisors of Siskiyou County, California.

(9) One individual who shall be appointed by the Board of Supervisors of Humboldt County, California.

(10) One individual who shall be appointed by the Board of Supervisors of Trinity County, California.

(d) COUNCIL MEMBERSHIP NOT A BAR TO TASK FORCE APPOINTMENT.—An individual who is a member of the Council is not ineligible for appointment as a member of the Task Force.

(e) TERMS.—

(1) IN GENERAL.—The term of a member of the Task Force is 4 years.

(2) SERVICE.—Members of the Task Force serve at the pleasure of the appointing authorities.

(3) VACANCIES.—Any vacancy on the Task Force shall be filled in the manner in which the original appointment was made. Any member appointed to fill a vacancy occurring before the

expiration of the term for which his predecessor was appointed shall be appointed only for the remainder of such term. A member may serve after the expiration of his term until his successor has taken office.

(f) TRANSACTION OF BUSINESS.—

(1) DECISIONS OF TASK FORCE.—All decisions of the Task Force must be by unanimous vote of all the members.

(2) CHAIRMAN.—The members of the Task Force shall select a Chairman from among its members.

(3) MEETINGS.—The Task Force shall meet at the call of the Chairman or upon the request of a majority of its members.

(g) STAFF AND ADMINISTRATION.—

(1) ADMINISTRATIVE SUPPORT.—The Secretary and the Director of the California Department of Fish and Game shall provide the Task Force with the administrative and technical support services necessary for the effective functioning of the Task Force.

(2) INFORMATION.—The Secretary and the Director of the California Department of Fish and Game shall furnish the members of the Task Force with relevant information concerning the Area.

(3) ORGANIZATION.—The Task Force shall determine its organization, and prescribe the practices and procedures for carrying out its functions under subsection (b).

(h) MEMBERS WHO ARE FEDERAL OR STATE EMPLOYEES.—Any Task Force member who is an officer or employee of the United States or the State of California at the time of appointment to the Task Force shall cease to be a member of the Task Force within 14 days of the date on which he ceases to be so employed.

(i) LIMITATION ON SPENDING AUTHORITY.—No money authorized to be appropriated under section 6 may be used to reimburse any Task Force member or agency or governmental unit (whose employees are Task Force members) for time spent by any such employee preforming Task Force duties.

SEC. 5. ENFORCEMENT.

Contracts.
California.
State and local governments.
16 USC 460ss-4.

(a) MEMORANDUM OF AGREEMENT.—In order to strengthen and facilitate the enforcement of Area fishery harvesting regulations, the Secretary shall enter into a memorandum of agreement with the California Department of Fish and Game. Such agreement shall specify the enforcement activities within the Area for which the respective agencies of the Department of Interior and the California Department of Fish and Game are responsible and shall contain such provisions as are necessary to ensure the coordinated implementation of Federal and State enforcement activities.

SEC. 6. APPROPRIATIONS.

16 USC 460ss-5.

(a) AUTHORIZATION.—There are authorized to be appropriated to the Department of the Interior during the period beginning October 1, 1986, and ending on September 30, 2006, $21,000,000 for the design, construction, operation, and maintenance of the program. Monies appropriated under this subsection shall remain available until expended or October 1, 2006, whichever first occurs.

(b) COST-SHARING.—

(1) 50 percent of the cost of the development and implementation of the program must be provided by one or more non-Federal sources on a basis considered by the Secretary to be

timely and appropriate. For purposes of this subsection, the term "non-Federal source" includes a State or local government, any private entity, and any individual.

Gifts and property. Real property.

(2) In addition to cash outlays, the Secretary shall consider as financial contributions by a non-Federal source the value of in kind contributions and real and personal property provided by the source for purposes of implementing the program. Valuations made by the Secretary under this paragraph are final and not subject to judicial review.

Voluntarism.

(3) For purposes of paragraph (2), in kind contributions may be in the form of, but are not limited to, personal services rendered by volunteers in carrying out surveys, censuses, and other scientific studies.

Regulations.

(4) The Secretary shall by regulation establish—

(A) the training, experience, and other qualifications which such volunteers must have in order for their services to be considered as in kind contributions; and

(B) the standards under which the Secretary will determine the value of in kind contributions and real and personal property for purposes of paragraph (2).

State and local governments.

(5) The Secretary may not consider the expenditure, either directly or indirectly, with respect to the program of Federal moneys received by a State or local government to be a financial contribution by a non-Federal source to carry out the program.

16 USC 460ss-6.

SEC. 7. DEFINITIONS.

As used in this Act—

(1) The term "program" means the Klamath River Basin Conservation Area Restoration Program established under section 2(b).

(2) The term "Secretary" means the Secretary of the Interior.

Approved October 27, 1986.

LEGISLATIVE HISTORY—H.R. 4712:

HOUSE REPORTS: No. 99-894, Pt. 1 (Comm. on Merchant Marine and Fisheries).
CONGRESSIONAL RECORD, Vol. 132 (1986):
Sept. 30, considered and passed House.
Oct. 3, considered and passed Senate.
WEEKLY COMPILATION OF PRESIDENTIAL DOCUMENTS, Vol. 22 (1986):
Oct. 27, Presidential statement.

○

APPENDIX B

EVALUATION OF PRIOR KLAMATH RIVER BASIN FISH RESTORATION PROJECTS

1989 Klamath Field Review Comments

The following comments are based primarily upon field observations made by Scott Downie and Andy Kier during the summer and autumn of 1989. Some of the review was made accompanied by personnel responsible for the projects and their comments are incorporated as well. In many streams individual project sites are linked and/or similar in nature. This review generalizes these in its comments and ratings, but notes exceptions where required. Grades A-F were assigned, but like all grades lacking set criteria and good base-line information, they are somewhat subjective. Evaluations were based upon the observed or perceived physical response made by the stream to the project, whether or not the project satisfied the objectives of the proposal, and whether or not the project appeared to have durable structure and function without maintenance or modification. Biological evaluation was impossible except to note observed fish at the time of the review. Cost effectiveness is again somewhat subjective without more front-end information, but based upon personal experience an attempt to measure product for cost entered into grade assignment.

GENERAL:

1000, 1001, 1003: The racks on Bogus Creek, Scott River & Shasta River were all operational Summer 1989.

1002: The Salmon River weir operations were modified during our review period in response to public input:

1. The trap and weir will be staffed 24 hours/day.
2. Weir and trap operations will cease at 73 F.
3. Fishing will not be allowed below weir.
4. An alternate site will be developed ASAP.

LOWER KLAMATH SUBBASIN:

<u>Ah Pah</u> Creek (11006, 07, 08, 09, 10, 18-$123,928): A CCC, DFG, & Simpson Timber Co. project to provide improved access for adults into upper Ah Pah Creek, and to control sedimentation from failing banks in the treatment area. In October 1989, the Hewitt Ramp structures were successfully passing coho and steelhead adults and juveniles through a previous adult barrier section. Large wood and boulder cover elements had been placed in the associated pools. Treated banks were armored with rock filled gabions and planted with alder, willow and conifers. No evidence of sediment production to the stream from these treated slopes was observed. The workmanship and construction are sturdy and of high quality. Grade A. (Since we visited Ah Pah Creek the day after the RNP bypass failure, the stream was loaded with suspended sediments)

Bluff Creek (11022, 23, 24, 31, 32-$212,000): Access provided through lower Bluff Creek's former barrier section is still passing adults and juveniles following the February 1986 flood event. The boulder weirs and boulder clusters near the yearling rearing facility are providing limited spawning improvement, but they do contain pockets of gravel utilized by spawners. Both the weirs and clusters have provided some good quality summer rearing habitats, and also refuge areas during winter flows. Two cluster groups are now buried under large streambank failures. These events could have been exacerbated by the placement of the boulders too close to the now failed right bank. No large wood or brush cover elements were utilized in the structures, although some were available. Personnel explained that the extreme velocities and power at high discharges prevented incorporating these organic components into their instream structures on Bluff Creek. Grade C.

Camp Creek (11029, 30-$125,000): Six boulder weirs were constructed by USFS to trap spawning gravels. Two of the six weirs are now scattered boulder clusters, having been rearranged by the stream. The surviving weirs have provided gravels and are being used by fish. The boulder groups, both designed and incidental, are providing some good quality rearing habitats and some pockets of gravel used for spawning salmonids. Grade C.

Cappell Creek (11027-$125,000): BIA artificial propagation project. Project has operated for one year. It has released 17,035 CWT chinook. Typical of the lower river hatchery programs, securing desired numbers of late running chinook brookstocks in very difficult. A lot of money in terms of fry produced, but the facility start-up costs are now over and the annual cost will be much less than the initial investment. Grade C.

Hunter Creek (11001, 11002, 11013-$19,328): A CCC, DFG, and Simpson project to improve Hunter Creek on a basin scale. CCC now have a thorough instream assessment and instream structure plan prepared by Clearwater Biostudies, Inc. under contract to them. Instream structure work is now underway by CCC crews. The construction is of excellent quality and design. All upper stream barrier work is now completed. The dry lower reaches of the stream pose a dewatered, complete barrier to all adults running before early November in most years (T. Payne, 1989). Some concern over future land management's effect on the stream in the event of a major flood occurrence. Grade B.

McGarvey Creek (11025, 11014, 11003-$24,264): Status of the hatch box project is not known. The barrier work is all done and passing fish. Grade C.

Pecwan Creek (11021, 11036, 11028-$50,000): A total of 21,626 yearling chinook were released from 1982-84 from this facility. They were from Iron Gate stocks and deemed not suitable for the restocking goals of the project area. Since 1985, the facility's production is not well documented, but 27,000 for the period 1985-88 is estimated. None of the releases from this site have been CWT. The Pecwan site has been used as a broodstock source for Cappell Creek as well. Grade D.

Red Cap Creek (11033, 34, 35-$70,000): USFS project has produced some impressive results. Failing banks have been armored and vegetated. A series of over thirty boulder weirs and clusters have provided some high quality spawning and rearing habitats. Large wood cover element shave been used somewhat in the project. The project reach is in a stream section of former generally poor habitats and low utilization by salmonids; they were abundant during our visits. There is a yearling pond adjacent to the treatment section. Grade A.

Richardson Creek (11026-$25,000): This project removed a barrier to salmonids and is functional. Seemed expensive. Grade C.

Salt Creek (11000, 11012-$18,944): CCC successfully stabilized failing banks. All barrier work is completed and functional. One of the few upslope erosion control projects in the review has controlled the sediment output from the roadway. There is a lot of product here for the money. Grade. A.

Surpur Creek (11005-$3,456): CCC removed barriers at a bargain price. Still functional. Grade. A.

Tarup Creek (11004, 11011, 11015, 16, 17-$77,024): CCC has a plan for the creek and instream treatments done under contract by Inter-Fluv Inc. The work outlined in the plan is now completed, and is of very high quality and design for the most part. The work involved barrier modification, instream structures, revegetation upslope as well in the riparian zone, and some upslope erosion control (one site upslope was quite major, in fact). Tarup, regardless of all these improvements, has a low flow access problem in its delta. Grade B.

Pine Creek (10019, 20-$-0-): Not reviewed.

Various streams (11019, 20-$550,000): This is the CCC operation fund for the Lower Klamath program. This ongoing general fund was not deemed suitable for field review or rating. However, our general observation of the CCC/DFG Lower Klamath program has certainly produced a positive impression of their work and approach.

MIDDLE KLAMATH SUBBASIN:

Beaver Creek (6000-05, 6035, 6053, 6065, 6066-$124,400): The boulder cluster groups and weirs constructed on Beaver Creek are not well utilized at this time. Silts and sediments have impacted the quality of the gravel associated with the structures to the extent that some cementing has occurred. Therefore, it is believed that utilization by spawners has also been effected. The structures designed for the provision of rearing habitats have done better, and some of course do both, some neither. Grade C. The rearing facility (6035) was closed in 1985, but there is now talk of re-opening it. 1980-4 releases averaged 29,423 yearling chinook of Iron Gate origin. Grade. C. The gravel seeding occurred in 1985 (6052) and no evaluation was considered possible in 1989, nor was any proffered by staff. The two screens (6065-66) are functional, but require regular upkeep and periodic thorough maintenance. Grade B.

Bluff Creek (6036-$-0-): This is one of the Klamath system's highest production cooperative rearing facilities. It has averaged 66,462 chinook yearlings for the past three years. These fish are of Iron Gate origin. Although adult runs are up in Bluff Creek, there is little baseline data, and until the current brood no CWT's were done on the ponded fish. Grade B.

Bogus Creek (6046-47, 6053-54, 6061-$94,750): Bogus Creek is heavily utilized by naturally spawning chinook of Iron Gate Hatchery origin as well as by stocks of its own. The projects designed to provide more and/or better gravels for these fish have met with apparent success, since in almost all cases the projects are used by the spawners, but so is everything else. What that means in real incremental gains that can be credited to particular habitat treatment is therefore difficult to assess. CWT and DSM evaluation programs are ongoing. Grade C.

Camp Creek (6037-$-0-): This rearing facility switched from Iron Gate chinook stocks to natal stocks in 1987. Yearling releases dropped from an average of 27,533 to 14,573 after the change. This can be attributed to the difficulty in trapping adults in an open, high discharge system. Still, the fact that they are now utilizing later running stocks that are adapted to Camp Creek's flow regime and conditions counts for a great deal. The natal brood have been marked with alternating maxillary clips (right one year, left the next) prior to release and some have been recovered as adults. Grade B+.

China Creek (6008, 09-$9,300): Not reviewed. Report is that the access is good throughout the stream now. No report on the status of the structures.

Clear Creek (6010, 6068, 69-$66,400): Fish and Game's barrier removal is providing access successfully. Report is that access is good throughout Clear Creek at this time. Grade B.

Coon Creek (6056-$30,000): This ladder passes steelhead, but DFG is not certain about coho. It also requires some light upkeep. Grade B.

Cottonwood Creek (6049-$22,966): Gravel placed on these weirs needs to re-seeded periodically at the cost of $2,000 each time. Grade D. (6057-$6,000): Not reviewed. (6055-$5,000): Ladder is on line and working will. Grade B. (6058, 60-$29,500): These screens are all on line and operational, but require light periodic maintenance which is conducted by the Yreka Screen Shop on a rotating basis. Grade B. (6070-$1,200): The potholes blasted to trap gravel have trapped sand instead, so the goal of creating spawning habitat was not met. However, fry, usage and survival seem to be good in the resultant pools. Not a high cost projects. Grade C. (Total Cottonwood Creek budget: $64,666)

Dillon Creek (6071-$5,000): This functional project opened five miles of good habitat now utilized by steelhead and chinook. Grade A.

Doolittle Creek (6011-$2,300): The treated log jam has not reformed and access is still good for steelhead. Grade C.

Elk Creek (6012, 6014-$41,000): The boulder weirs and clusters are now all installed and need flows for evaluation of performance. (6034, 6045-$10,000): The washout pond has averaged 31,205 released iron Gate chinook yearlings since 1984. Grade B. (Total Elk Creek budget: $51,000)

Grider Creek (6015, 6016, 6038-$18,500): The falls are now passing fish successfully. Grade A. The boulder weirs have been successful in trapping spawning gravel and are being used by chinook. Grade A. The ponds have grown an average of 34,426 Iron Gate chinook yearlings since 1987. Grade B.

Horse Creek (6062, 6064, 6074-$35,000): The three screens are installed and operational, but require light maintenance. Yreka Screen Shop provides this on an alternating basis. Grade B. The log jam is no longer an access problem. Grade A. (Extant diversion dam is a major problem on this creek)

Humbug Creek (6017, 6018-$5,300): The boulder weirs are not successful and are physically failing. Grade F. The log weirs have worked well and are providing spawning and rearing habitat. Grade A. In any event, ten miles of good quality habitat are blocked to salmonids by dredge tailing in lower Humbug Creek.

Independence Creek (6019-$5,000): The stream's mouth is still open and fish access it. Grade B.

Indian Creek (6006, 6020-28, 6039, 6040, 6067, 6072-$200,600): All modified former barriers are now passing fish. Grade A. The recent instream structures all appear to be performing to design; biological evaluation is underway now. Grade B. The spawning channel is used extensively by steelhead, and to a lesser extent by coho, but not by chinook. It is also a maintenance item (i.e. supplemental gravel). Grade D. The rearing ponds have averaged 74,134 Iron Gate yearlings since 1985. Grade B.

Irving Creek (6029-$9,300): The use of small boulders to construct inadequately sized structures resulted in no net gain from this project. Grade F.

Iron Gate Hatchery (6033-$-?-): The hatchery is modifying its operations to better cope with problems associated with temperatures, density, and release timing according to the hatchery manager. Grade C.

Badger Flat and Tree of Heaven (6050, 6051-$136,000): These spawning channels have both been unsuccessful due to design flaws. They require constant maintenance which is not possible during usage. Gravel seeding is an ongoing project. Grade F.

Little Bogus Creek (6048-$20,000): These seeded weirs were not reviewed, but they are reported to be intensely utilized by spawners. However, some maintenance is also required.

Pearch Creek (6041-$-0-): These ponds are operated by the Orleans Rod and Gun Club and have good public involvement and educational value. About 9,000 steelhead of Salmon River origin are reared here. A lot of enthusiasm and local stocks. Grade A.

Red Cap Creek (6042-$-0-): This rearing pond has averaged 37,862 Iron Gate chinook yearlings since 1985 and is operated in a system that has also had significant habitat improvement projects recently completed. A CWT program would help evaluate both of these aspects of the Red Cap Creek endeavor. Grade B.

Seiad Creek (6030, 6031, 6073-$5,100): The barrier project has been successful. Grade A. The weir projects were not found and therefore not reviewed.

Thompson Creek (6032, 6043-$5,000): The rearing ponds were closed in 1985. The instream structures were not reviewed.

West Branch Creek (6007-$5,000): The weirs are used by steelhead for spawning, according to local observers; they seem functional. Grade C.

Wilson Creek (6007-$-0-): This private rearing facility was not reviewed. According to locals, it is not in use at this time.

SALMON RIVER:

Black Bear Creek (5000-$11,000): This USFS project successfully provided access for steelhead into the creek, and it is currently being utilized. Grade A.

Kelly Gulch (5002, 5003-$9,500): This project was not reviewed, but USFS staff reported that the barrier was still not passing all fish attempting to access the system. Their evaluation is underway now.

Knownothing Creek (5004-06, 5021-$153,114): The removal of the diversion dams and other barriers resulted in doubling the chinook and coho runs into the creek. Grade A. The weirs (5006) were not completed at the time of the review. Delays were incurred because the rock was overshot resulting in boulders too small for the structures. Grade F.

Nordheimer Creek (5507, 5008-$90,000): The log weirs (5007) failed. Grade F. The fishway (5008) is successful and passing fish. Grade A.

Salmon River (5023, 5024-$8,000): This selective barrier was modified at a very reasonable cost and has improved access for all fish. Grade A.

East Fork Salmon River (5013-$60,000): This project was not reviewed; USFS is evaluating now.

South Fork Salmon River (5001, 5009-12, 5014-15, 5022-$176,200): (5001) The Blind Horse Creek weirs have not all been successful in providing spawning habitat. Many are trapping silt rather than spawning gravel. Rearing habitats are being provided by most of them, however. Grade D. (5009) This natal stock bioenhancement facility was located at a site with poor water temperature conditions for intense fish culture. Broodstock acquisition was also very difficult. The facility is now closed (equipment will be relocated in the watershed, if possible). The project released 36,667 natal chinook smolts in the period from 1985 to 1987. Grade D. The boulder group projects were undergoing evaluation during the review period for biological response. The initial physical evaluation was not conclusive because many of the projects had not been subject to higher flows. Grade C. (5022) The "rough passage" area currently allows fish to pass without undue struggle. Grade B.

Specimen Creek (5016-$500): Steelhead now pass the treated log jam barrier. Another jam has formed above this site and requires monitoring and possible modification. Grade B.

St. Claire Creek (5017-20-$15,000): Steelhead now pass the modified barrier. The log weirs are holding gravel and in use by spawners. Juvenile cover is good associated with the weirs as well as the cover elements used in the project. The boulder weirs and clusters are also in place and in use. Grade A.

SCOTT RIVER:

Scott River and tribs. (4031-4334 [not inclusive]-$2,715,810): These Soil Conservation District projects primarily involved placing rip-rap armor at 304 different sites in the upper Scott system. Not all were reviewed, and although the rock is stable and in place, many were found to lack streamside vegetation that would provide important shade and cover for the stream and aquatic life. Some others were buried in decomposed granite, sand or silt and therefore had little benefit for fish by way of providing complex micro-habitats. The value of these projects would be much greater if some of these items were addressed. Grade C.

French Creek (4001, 4016-18-$32,000): The sediment check dam initially filled in one storm event. It was excavated but refilled during the next runoff event. A high maintenance approach that treats the symptoms of the watershed's chronic erosion problem. Grade F. The screens are all in place and functional, but are dependent upon periodic light upkeep provided by the Yreka Screen Shop. Grade B.

Kelsey Creek (4002-04-$147,500): The weirs work well and are used by all species for spawning and rearing. Grade A. The USFS spawning channel has not performed as hoped. Problems have occurred relating to channel liner failure. The average number of pairs using the channel during the period 1985-88 were: nine chinook, three coho, and twelve steelhead. In 1989 no usage was observed. It is also a very costly installation. Grade D-.

Kidder Creek (4020-21-$26,000): Both screens are in place and functional, but are dependent upon periodic maintenance provided by the Yreka Screen Shop. Grade B.

Patterson Creek (4019-$9,000): This screen is in place and functional, but is dependent upon periodic maintenance provided by the Yreka Screen Shop. Grade. B.

Scott River (4405-06, 4012-15-$94,800): Although the gravels were 'cleaned,' the sedimentation problem returned the next year. This treatment does not address the problem, but rather the symptoms and would require constant maintenance. Grade F. The boulder groups were not installed after gauging the rapid sedimentation rate. The four screens are in place and functional, but are dependent upon periodic maintenance provided by the Yreka Screen Shop. Grade B.

East Fork Scott River (4010-11-$20,000): These two screens are in place and functional, but are dependent upon periodic maintenance provided by the Yreka Screen Shop. Grade B.

Shakleford Creek (4009, 4022-4030 incl., 4323, 4329-$343,720): (4009) The bank armor was not surveyed, but is reported to be stabilizing the soft banks . The fishery benefits are not known. (4022-30) These nine screens are in place and functional, but are dependent upon periodic maintenance provided by the Yreka Screen Shop. Grade B. (4323, 4329) The rip-rap bank armor is in place, but needs vegetation and cover elements added to increase fishery values. Grade C.

Tompkins Creek (4007-08-$6,500): The weirs are installed but are not highly utilized because of the recruited fine sediments now accumulated on them. Grade D. The fishway has provided access and is currently functional. Grade B.

SHASTA RIVER:

Parks Creek (3018-$42,000): These four screens are in place and functional, but are dependent upon periodic maintenance provided by the Yreka Screen Shop. Grade B.

Shasta River (3000-04, 3005-08, 3009-17-$519,000): (3000-04) These weirs have deteriorated over the past few years due to the use of undersized boulders in construction. Only about 10% of the effective structures remain. In 1989 only 32 redds were observed on the weirs. Very expensive ($363,000) spawning gravel. Grade D. The four fishways (3005-08-$17,000) are all currently passing fish. Grade B. The nine screens \93009-17-$139,000) are in place and functional, but are dependent upon periodic maintenance provided by the Yreka Screen Shop. Grade B.

UPPER KLAMATH RIVER:

Fall Creek (2000-$-0-): The Fall Creek hatchery facility is on line and ready to augment Iron Gate's production. The site has very good water quality and can be instrumental in relieving crowding problems at Iron Gate.

APPENDIX C

A FINANCIAL FEASIBILITY ENVELOPE
FOR KLAMATH BASIN PLANNING

Prepared by
Meyer Resources, Inc.

A Financial Feasibility Envelope for Klamath Basin Planning

I. Introduction

Little research effort has been expended to date to understand and quantify social, economic and cultural values linked to fisheries in the Klamath basin. Typically, fisheries and other agencies have spent several million dollars annually on biophysical projects, while slapping in whatever socio-economic data was handy at the back end of analysis. This mode of analysis has largely left articulation of socio-economic values to the "public" and to particular interest groups. Such articulation has been sincere and often compelling. It has been neither rigorous nor scientific, however, and has failed to resolve the difficult user issues that exist between fisheries, or between fishery and non-fishery interests. A brief synopsis of required initial remedial work is appended.

Compounding the difficulty of lack of socio-economic data is the fact that, at present, no quantitative restoration targets for the Klamath have been enunciated beyond a generalized intention to "double stocks." Without such quantified targets, socio-economic analysis of a traditional "impact" variety has little in the way of anticipated real effects to relate to.

Notwithstanding these deficiencies, it is possible to provide some socio-economic guidance of use to Klamath restoration planners. Meyer Resources, Inc. (1989) developed estimates of economic benefit from fisheries restoration that can provide some policy level reference for the Klamath.

That work, commissioned by the California Salmon and Steelhead Advisory Committee, stops short of comprehensiveness in several important areas; most notably, failure to estimate benefits for Indian peoples, for commercial fishing communities, or for concerns over the existence of Klamath fishery resources. Further, the data there assembled was based on sometimes differing methodologies, and consequently cannot be used to allocate fisheries between user groups. Finally, Meyer Resources, Inc. (1989) developed joint values for the Klamath/Trinity system, and Trinity values needed to be backed out for our present analysis.

Viewing the above qualifications, and data at hand, it is still possible to develop an array of some, but not all, of the benefits that would accrue from differential levels of restorative success in the basin, and to identify associated levels of feasible investment. This will provide planners with an envelope of potential financial feasibility values by which initial investment decisions and subsequent monitoring of program results can be bounded.

II. Assumptions Important to the Analysis

1. Klamath/Trinity Value Apportionment

The relative apportionment of fishery production between Klamath and Trinity sub-basin varies by year, by species, and according to the ratio of artificially spawned to naturally spawned stocks.

For this analysis, we took the two-basin production totals for chinook, coho and steelhead contained in Meyer Resources, Inc.(1988), and reduced them by 45 percent, the ratio of Trinity production to total Klamath/Trinity production indicated for fall chinook in Table 4-1 from CH2M Hill (1985). This procedure is arbitrary, and will obviously need to be adjusted as firm planning target numbers for Klamath basin fishery restoration come on line. The procedure is sufficient, however, to begin to consider economic feasibility in the face of the difficulties cited earlier.

2. Selection of Restorative Increments for Planning

Our feasibility envelope approach also requires specification of potential levels of restorative success in Klamath fisheries. For this analysis, levels of +25%, +50%, +75%, and +100% were selected. Combining Steps (1) and (2) provides the Klamath system fishery baseline and potential increments specified in Table 1.

Table 1

Klamath System Adult Fisheries Stock and Increments

	------------------thousands of adult fish----------------		
Stock	**Chinook**	**Coho**	**Steelhead**
Klamath baseline	153	24	12
25% increment	38	6	3
50% increment	76	12	6
75% increment	115	18	9
100% increment	153	24	12

3. Values Included in the Analysis

This analysis considers market economic values for commercial fisheries and for businesses servicing sport fisheries. It also incorporates non-market values for sport fishermen. As noted, it is limited to fisheries on three species; chinook, coho, and steelhead, and does not include Indian or commercial fishing/community values. Unit values are as stated in Meyer Resources, Inc. (1988).

4. Comparing Present and Future Values

Discounting refers to the procedure by which economists balance the relative importance placed on fishery benefits in the near term versus those occurring in the more distant future. A positive discount rate values the present more highly than the future. A negative discount rate values the future more highly than the present. A zero discount rate values the present and the future equally. Lind. et. al. (1982) have identified that discount rates should not be confused with interest rates, which indicate the required rate of return on investment. Lind recommends a discount rate of 3 percent for projects in the public policy sphere, with sensitivity at 2 percent and at 4.6 percent. The California Energy Commission (Wilson, 1981), also recommends a central discount rate of 3 percent, with sensitivity over a range of 1 percent to 4 percent.

Bonneville Power Administration's environmental planning office utilizes a discount rate of 3 percent, with sensitivity analysis of 1 percent and 10 percent. Finally, the Salmon and Steelhead Advisory Committee to the California Legislature recommends discounting of fishery restoration projects a 1% and 0%, with sensitivity analysis at -1% and 3%. In this analysis, we will discount potential future fishery benefits from restoration of Klamath fish stocks at 0%, 1%, 2%, 3%, and 4.6%.

III. Analytical Results

Feasibility results utilizing previously discussed data sources and assumptions are provided in Tables 2 through 4. Table 2 estimates the present value of benefit from Klamath fishery restoration, in market economic, and then in market plus non-market, economic terms, for each identified success rate/discount rate combination. Table 3 identifies the maximum level of annual investment that each success/discount rate benefit estimate would justify, assuming investment in fishery restoration takes place on a straight line basis from 1991 to 2006 (a 16 year period). Table 4 reduces that feasible maximum investment estimate to yield an 8.75 percent return on capital, a return utilized by some government agencies (and sometimes confused with a discount rate).

Table 2

Estimates of Potential Benefit from Restoration
of Klamath Fisheries

Rate of Restorative Success

Discount Rate	25%		50%		75%		100%	
	Market+ Value	Market Non-Mkt Value	Market+ Value	Market Non-Mkt Value	Market+ Value	Market Non-Mkt Value	Market+ Value	Market Non-Mkt Value
	--------millions of dollars in present value terms--------							
0	63	218	126	435	189	653	252	871
1	42	146	85	294	127	440	170	587
2	30	103	60	207	89	309	119	412
3	22	75	44	151	62	222	87	301
4.6	14	49	28	97	42	146	56	194

Table 3

Maximum Feasible Annual Investment
Klamath Fisheries Restoration

Rate of Restorative Success

Discount Rate	25%		50%		75%		100%	
	Market+ Value	Market Non-Mkt Value	Market+ Value	Market Non-Mkt Value	Market+ Value	Market Non-Mkt Value	Market+ Value	Market Non-Mkt Value
	--------millions of dollars in present value terms--------							
0	4.0	13.7	7.9	27.3	11.8	40.8	15.7	54.4
1	2.9	8.0	5.7	19.9	8.6	29.8	11.5	39.8
2	2.2	7.6	4.4	15.2	6.5	22.7	8.7	30.3
3	1.8	6.0	3.5	12.0	5.2	18.0	6.9	23.9
4.6	1.3	4.4	2.5	8.7	3.8	13.1	5.1	17.5

Table 4

Maximum Feasible Annual Investment to Obtain a 8.75% Return
Klamath Fisheries Restoration

Rate of Restorative Success

Discount Rate	25%		50%		75%		100%	
	Market+ Value	Market Non-Mkt Value	Market+ Value	Market Non-Mkt Value	Market+ Value	Market Non-Mkt Value	Market+ Value	Market Non-Mkt Value
	--------millions of dollars in present value terms--------							
0	3.7	12.6	7.3	25.1	10.9	37.6	14.4	50.0
1	2.7	9.2	5.2	18.3	7.9	27.4	10.6	36.6
2	2.0	7.0	4.0	13.9	6.0	20.9	8.0	27.9
3	1.7	5.6	3.2	11.0	4.8	16.6	6.3	15.7
4.6	1.2	4.0	2.3	8.0	3.5	12.1	4.7	11.5

IV. Conclusion

As noted, the comprehensiveness of the socio-economic data set available to the Klamath fisheries is significantly limited. Further, benefit estimates associated with fisheries restoration can be affected by assumptions employed. Even under a "most adverse" scenario, however, where only market benefits are considered, where only a 25 percent improvement in stock levels over the restoration program is assumed, and where the upper range discount rate of 4.6 percent is employed, an annual investment in excess of $1 million seems justified. More substantial success levels would justify higher maximum investment rates.

These estimates will, of course, need to be adjusted as real data concerning restoration rates becomes available to the Task Force -- for as the program progresses, it will be necessary to base evaluation of economic feasibility less on assumption and more on observation of actual fishery returns due to restorative efforts. Such adjustments will alter the calculations presented here, but are unlikely to extend beyond the bounds of the feasibility envelope identified in this analysis.

V. References

Bonneville Power Administration, 1986. Calculation of Environmental and Benefits Associated with Hydropower Development in the Pacific Northwest. Portland, DE-AC79- 83BP11546.

CH2M Hill, 1985. Klamath River Basin Fisheries Resource Plan. A Report to the U.S. Department of Interior, Redding, CA.

Lind, Robert C., Kenneth J. Arrow, Gordon R. Corey, Partha Dasgupta, Amartya K. Sen. Thomas Stauffer, Joseph E. Stiglitz, J.A. Stockfish, and Robert Wilson, 1982. Discounting for Time and Risk in Energy Policy. Resources for the Future, Washington, D.C.

Meyer Resources, Inc. 1988. Benefits from Present and Future Salmon and Steelhead Production in California. A Report to the California Advisory Committee on Salmon and Steelhead. Davis, CA.

Wilson, J. 1981. 1981/82 Non-residential Building Standards Development Project: Economic Assumptions for Building Standards Cost Effectiveness. California Energy Commission, Sacramento, CA.

APPENDIX D

LONG RANGE PLAN FOR THE

KLAMATH RIVER BASIN CONSERVATION AREA

FISHERY RESTORATION PROGRAM

ENVIRONMENTAL ASSESSMENT

FINAL

Prepared for the Klamath River Basin
Fisheries Restoration Task Force

Under P.L. 99-552
Klamath River Basin Fishery
Resources Restoration Act

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KLAMATH RIVER BASIN CONSERVATION AREA
FISHERY RESTORATION PROGRAM
LONG RANGE PLAN

FINAL ENVIRONMENTAL ASSESSMENT

I. PURPOSE AND NEED FOR ACTION Purpose

The purpose of this Environmental Assessment is to analyze the possible environmental effects of the Long Range Plan for the Klamath River Basin Conservation Area Fishery Restoration Program (May 1990). This Restoration Program is seeking to rebuild the anadromous fish populations to optimum levels and, in doing so, should have a widespread beneficial effect on the Klamath River Basin's environment.

Need for Action

The anadromous fish population of the Klamath River Basin has declined significantly from historic levels due to a variety of causes. Recognizing this problem, Congress decided to stimulate a concerted rebuilding effort by adopting the Klamath River Basin Fishery Resources Restoration Act in 1986 (Public Law 99-552).

The intent of the Klamath Act is to restore the salmon and steelhead fish populations to optimum levels in the Klamath River Basin through a 20-year (1986-2006) federal-state cooperative program. To advise the Secretary of Interior on the restoration program, the Act created the Klamath River Basin Fisheries Task Force, which is composed of 14 representatives of federal, tribal, state and local government, as well as commercial and sport fishing interests. In addition, the Klamath Fisheries Management Council was established to address the ocean and in-river harvesting of Klamath and Trinity River Basin anadromous fish populations, a major element of the program.

The Trinity River, the Klamath's principle tributary, is covered under a separate restoration program authorized by Congress in 1984 under PL 98-54. Funded for 10 years, the Trinity River Basin Fish and Wildlife Management Program is guided by the Trinity River Basin Task Force.

Providing initial guidance for the program has been the 1985 report "Klamath River Basin Fisheries Resource Plan", prepared for the U.S. Bureau of Indian Affairs by the consulting firm of CH2M-Hill. While the recommended actions of the 1985 plan were used as the basis for the first two years of the program, the Task Force recognized the need to update and expand the plan, primarily to:

- add new biological information and new concepts in fishery restoration;
- take into account the extensive fishery restoration work accomplished in the Klamath River basin since 1985; and
- reduce the scope of the program proposed in the 1985 plan from $60.5 million (excluding Trinity Basin) to the $42 million level contemplated in the Klamath Act.

Additionally, comments received during the public scoping period on the Long Range Plan and Environmental Assessment were consistent in advocating a new direction in fisheries restoration. This revised approach would seek to address the causes of the degraded stream habitat and depressed fish populations, with less emphasis on the symptoms. The proposed Plan incorporates such a change in direction.

Administration of the Program is conducted by the U.S. Fish and Wildlife Service through its Klamath Field Office in Yreka. The State of California's participation is administered by the California Department of Fish and Game in Sacramento.

II. ALTERNATIVES INCLUDING THE PROPOSED ACTION

Three practicable alternatives are evaluated:

A. No action (Existing Plan)
B. Proposed Long Range Plan
C. No Restoration Program

A. No Action Alternative (Existing Plan)

This alternative assumes no change ("status quo") from the direction the Task Force was taking before the Long Range Plan was drafted, during the period 1987-1989. The 1985 Klamath River Basin Fisheries Resource Plan was used as the primary reference and guideline for Task Force decisions on project selection. It is an action plan, listing specific restoration projects to be developed for each sub-basin. Primary habitat emphasis was on physical solutions, since instream structures were the main focus of habitat restoration in the early 1980s. The 1985 Plan also lacks specific goals and objectives for which the actions are to collectively attain.

The basic categories of the 1985 Plan are as follows:

- o Habitat Restoration
  - oo instream structures
  - oo watershed stabilization
  - oo diversion screening
  - oo riparian rehabilitation
  - oo debris removal
  - oo adjudicated flow enforcement

- o Artificial Propagation
  - oo Hatchery review
  - oo Rearing ponds
  - oo Stocking program

- o Harvest Management
    - oo Population monitoring
- o Administration
    - oo Coordination mechanism

Some of these recommendations have been implemented (i.e., new fish counting stations, water diversion screening).

B. Proposed Long Range Plan Alternative

The current draft Long Range Plan for the Klamath River Basin Conservation Area Fishery Restoration Program (May 1990) proposes a comprehensive approach. It is a policy plan, listing goals, objectives and policies to give long-term direction for the program. While the new plan built upon the previous one, recent field evaluation of many of the local instream structures revealed limitations with this restoration solution. As a result, the proposed plan refocuses the Restoration Program to include:

- o Habitat Protection and Management oo timber harvesting oo mining
    - oo agricultural practices
    - oo water and power projects
    - oo stream diversions
- o Habitat Restoration
    - oo watershed and stream habitat inventories
    - oo biological assessment of fish communities
    - oo watershed rehabilitation
    - oo riparian treatments
    - oo instream structures
    - oo barrier removal
- o Population Protection
    - oo population trend monitoring
    - oo biological information
    - oo genetic integrity emphasis
- o Population Restoration
    - oo hatchery practice upgrading
    - oo rearing pond practice guidelines
    - oo stock transfer policy
- o Education and Communication
    - oo public school curriculum
    - oo community education and involvement
    - oo land and water user communication

- o Program Administration
  - oo Task Force operations and Staffing
  - oo funding
  - oo coordination and agency jurisdictions
  - oo information sharing

The major differences between the 1985 Plan and the proposed Long Range Plan are identified below:

Alt. A; 1985 Plan	Alt. B; 1990 Long Range Plan
Action plan	Policy plan
Not addressed	Habitat Protection
Not addressed	Education and communication
Instream structures	Instream structures only if watershed and habitat assessments show need
Short-term stocking	Stocking, hatchery and rearing pond policies protect genetic integrity
No action	Harvest Management Plan (by Klamath Fisheries Mgt. Council)

C. No Restoration Program Alternative

This alternative assumes that the Klamath River Basin Conservation Area Restoration Program is not implemented due to the absence of funding. This scenario could occur if Congress declines to appropriate funds and/or non-Federal sources become unavailable. Without the Federal share of the Program's budget, staffing and other administrative needs for implementation could not continue. Without the non-Federal share currently provided by the California Dept. of Fish and Game, most of the stream restoration and rearing pond projects in the Basin would not be built or operated. The 1986 Klamath Act would remain in place, absent the anticipated $42 million.

In all practicality, some restoration work would still occur through other efforts (e.g., U.S. Forest Service, private landowners, volunteers) although the magnitude would be substantially smaller and the time to accomplish restoration would be much longer.

Other Alternatives

Other alternatives discussed but dismissed as impractical or infeasible include: only hatcheries and stocking; only instream structures; only education; only habitat protection. These were all rejected because they did not reflect the intentions of the Klamath Act.

III. AFFECTED ENVIRONMENT

Project Area

As a requirement of the Klamath Act, the Secretary of the Interior designated the anadromous fish habitat and resources of the entire Klamath Basin in the states of California and Oregon as the Klamath River Basin Conservation Area. This Area establishes the scope of the restoration program (see Figure 1).

While the Klamath River Basin (excluding the Trinity River portion) encompasses over 8 million acres in both California and Oregon, anadromous fish are presently blocked from reaching historic spawning grounds in the upper Klamath sub-basin above Iron Gate Dam (river mile 192). This lower portion of the Conservation Area includes only about 2.8 million acres. The Upper sub-basin is presently very important to the water quality and water supply needs of the lower Klamath River anadromous fish.

Specially Designated Areas

Much of the Klamath River and its major tributaries are included in both the Federal and State Wild and Scenic Rivers Systems: mainstem Klamath (from mouth to 100 yards below Iron Gate Dam; Scott River (from mouth to Shackleford Creek); mainstem Salmon River (from mouth to Cecilville); North Fork Salmon River; and Wooley Creek, a tributary to Salmon River. In addition, the upper Klamath River between the J.C. Boyle Dam and the state border is designated a part of the Oregon State Scenic Waterways Act.

Several federally-designated Wilderness Areas are located all or partly within the Basin: Trinity Alps, Marble Mountain, Russian, Siskiyou, and Red Buttes. The Pacific Crest Trail, part of the National Trails System, also crosses through the region.

Anadromous Fish Population

The anadromous fish species which are being addressed in the Restoration Program are:

- oo chinook salmon (Oncorhynchus tshawytscha)
- oo coho salmon (0. kisutch)
- oo steelhead (O. mykiss)
- oo coastal cutthroat trout (0. clarkii)
- oo green sturgeon (Acipenser transmontanus)
- oo American shad (Alosa sapidissima)
- oo eulachon or candlefish (Thaleichthys pacificus)
- oo Pacific lamprey (Lampetra tridentata)

Endangered or Threatened Species

Lists of endangered, threatened or sensitive species possibly found within the Klamath River Basin Conservation-Area are presented in Table 1 (Fish and Wildlife) and Table 2 (Plants).

Klamath River Basin
California and Oregon

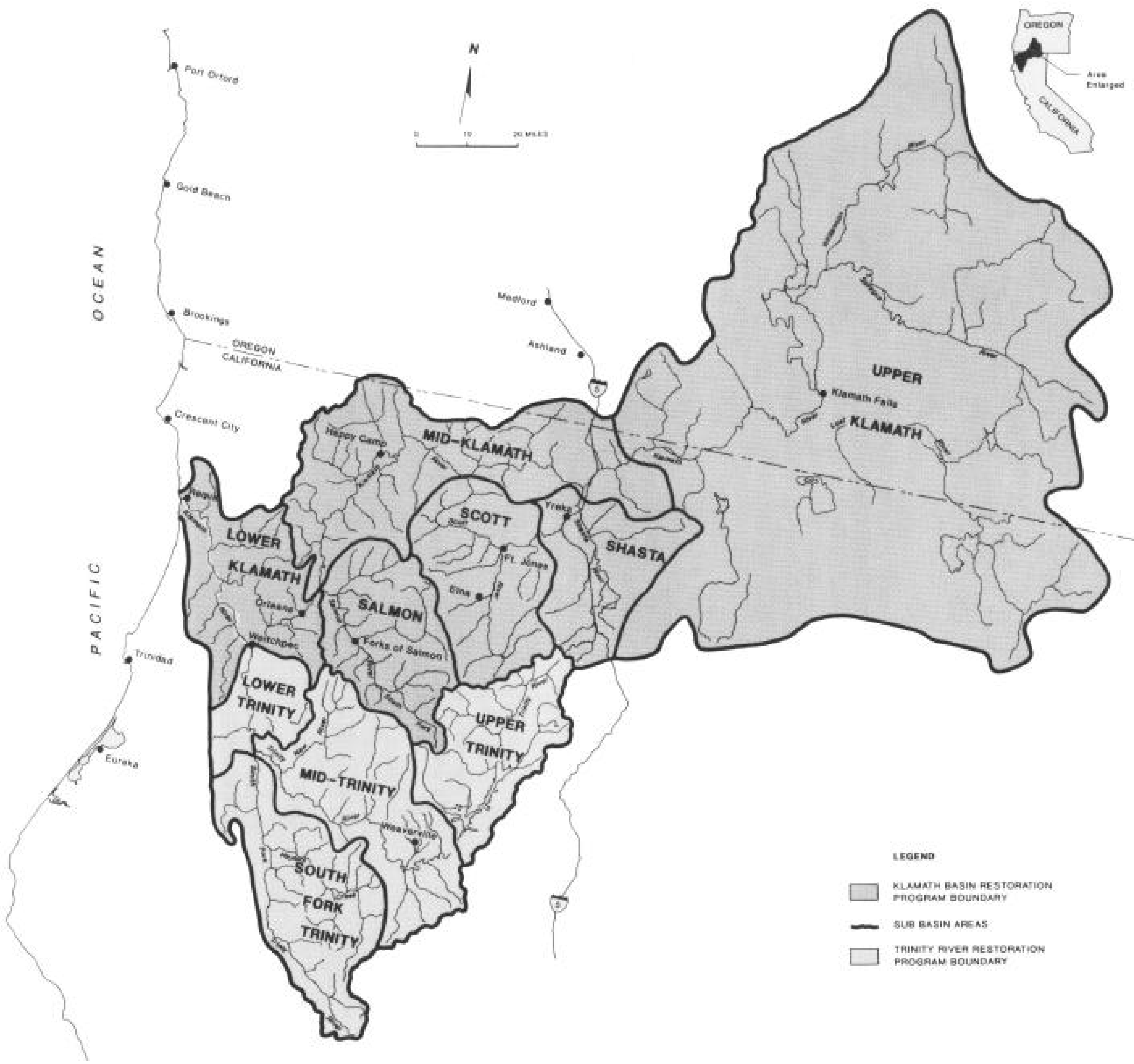

Figure 1 Location of Klamath River Basin California and Oregon

Both aquatic and terrestrial types are included since the Restoration Program addresses watershed as well as riparian and instream issues. The Klamath Basin is renowned for its plant diversity: 25 species of cone-bearing trees and 30 different flowering plants rarely found elsewhere are located on the Klamath National Forest alone.

Responsibility for determining current species status rests with three different agencies, under their respective Endangered Species Acts: the California Dept. of Fish and Game; the Oregon Dept. of Fish and Wildlife; and the U.S. Fish and Wildlife Service. Over the 20 year lifespan of the Klamath Basin Fisheries Restoration Program (1986-2006), the status and number of animal and plant species will likely change.

Presently, two fish species (Lost River and shortnose suckers) and two bird species (bald eagle and peregrine falcon) are listed as "endangered" on Federal and State Lists. The northern spotted owl is the only animal with "threatened" status on the Federal List, although several species are so listed by the states. While no local plants are federally listed, four plant species are listed as endangered and one as rare in California. Numerous other animal and plant species are considered "sensitive" and are being studied and monitored (identified as C1, C2, FS, SS, or SC in Tables 1 and 2).

Cultural Resources

Two Indian Reservations, the Hoopa Valley and the Yurok, are located in the lower Klamath River area. The Karuk Indian Tribe also has some tribal lands near Happy Camp, while the Klamath Tribe of Oregon is settled in the Upper Klamath Basin. Ancestral territories for these tribes and others extend throughout the region. In addition to a commercial salmon fishery (Hoopa and Yurok) , the tribes have found fishing at the very heart of their religion, economy, culture, and subsistence.

Concurrently, salmon fishing is a family tradition in the coastal communities of Eureka, Trinidad, Crescent City, Fort Bragg and Brookings. The ocean commercial salmon fishermen and women respect and rely upon the salmon for nourishment and income. Additionally, the ocean commercial salmon industry contributes significant amounts of time and monies into the restoration of the resource upon which they depend.

Floodplains and Wetlands

The anadromous streams have floodplains of varying width. In mountainous tributaries, the floodplain would be very narrow while in the flatter areas of the Scott and Shasta Rivers, the 100 year floodplain zone encompasses much of each valley. Wetlands are also found adjacent to these streams, particularly in the valleys and in the Klamath River estuary.

Table 1

Status of Threatened, Endangered, and Sensitive Animal Species
Found in the Klamath River Basin Conservation Area

Species	CA	OR	Federal
Birds[1]			
Bald Eagle	E	T	E
Peregrine Falcon	E	E	E
Northern Spotted Owl	SC	T	T
Ferruginous Hawk		SC	C2
Long-billed Curlew		SC	C2
Greater Sandhill Crane	T	SC	SS
Northern Goshawk	SC	SC	SS
Swainson's Hawk	T	SC	
Lewis' Woodpecker		SC	FS
Mammals[1]			
Wolverine	T	T	C2
Townsend's Big-eared Bat	SC	SC	C2
Spotted Bat			C2
White-footed Vole	SC		C2
Lynx			C2
Pine marten		SC	SS
Fisher	SC	SC	SS
Herptiles[1]			
Del Norte Salamander	SC		C2
Siskiyou Mountain Salamander	T	SC	C2
Shasta Salamander	T		C2
Olympic Salamander	SC	SC	
Tailed Frog	SC	SC	
California Red-legged Frog	SC	SC	C2
Northwestern pond turtle			C2
Fish			
Lost River Sucker	E	SC	E
Shortnose Sucker	E	SC	E
Klamath Largescale Sucker	SC	SC	C2
Bull Trout	E	SC	C2
Redband Trout			C2
Jenny Creek Sucker			C2
Slender Sculpin			C2
Summer Steelhead	SC	Ext.	SS
Klamath River Lamprey	SC		
Coho Salmon	SC	Ext.	
Chinook Salmon (Spring-run)	SC	Ext.	
Invertebrates			
Trinity Bristle Snail	T		C2
Karok Indian Snail			C1
Siskiyou Caddisfly			C2
Fischer's Caddisfly			C2
Klamath Caddisfly			C2
Schuh's Homoplectra Caddisfly			C2
Franklin's Bumblebee			C2
Behren's Silverspot Butterfly			C2

Table 2

Threatened, Endangered, and Sensitive Plant Species
Located in the Klamath River Basin Conservation Area

Species	Status: Federal	Status: CA
Northcoast sand-verbena (Abronia umbellata ssp. breviflora)	C2	
Henderson's Bent grass (Agrostis microphylla var. hendersonii)	C2	
Waldo Rock Cress (Arabis aculeiolata)	SS	
Koehler's Rock Cress (A. koehleri var. leichtlinii)	C2	
Preston Peak Rock Cress (Arabis serpentinicola)	C2	
Crater Lake Rock Cress (Arabis suffretescens)	C2	
Klamath Manzanita (Arctostaphylos klamathensis)	C2	
Applegate Milk Vetch (Astragalus applegatei)	C2	
Peck's Milk Vetch (Astragalus peckii)	C2	
Pumice Grape Fern/Moonwort (Botrychium pumicola)	C1	
Greene's Mariposa Lily (Calochortus greenei)	C2	
Long-bearded Mariposa Lily (C. longebarbatus)	C2	
Shasta River Mariposa Lily (C. monanthus)	C1*	
Siskiyou Mariposa Lily (Calochortus persistens)	SS	R
Wilkin's Harebell (Campanula wilkinsiana)	SS	
Greentinged Paintbrush (Castilleia chlorotica)	C2	
Siskiyou Paintbrush (Castilleja elata)	SS	
Steen's Paintbrush (C. steenensis)	C2	
Ashland Thistle (Cirsium ciliolatum)	C2*	E
Talus Collomia (Collomia debilis var. larsenii)	SS	
Mt. Mazama Collomia (Collomia mazama)	C2	
Pallid Bird's-beak (Cordylanthus tenuis ssp. pallescens	C2	
(Cypripedium montanum)	C2	
Golden Draba (Draba aureola)	SS	
Mt. Eddy/Shasta Draba (Draba carnosula)	C2	
Siskiyou Fireweed (Epilobium siskiyouense)	SS	
Trinity Buckwheat (Eriogonum alpinum)	SS	E
Crosby's Buckwheat (E. crosbyae)	C2	
Cusick's Buckwheat (E. cusickii)	C2	
Klamath Mtn. Buckwheat (Eriogronum hirtellum)	SS	
Prostrate Wild Buckwheat (E. prociduum)	C2	
Umpqua Green-gentian (Frasera umpquaensis)	C2	
Gentner Mission-bells (Fritillaria gentneri)	C2	
Scott Mountain Bedstraw (Galium serpenticum ssp. scotticum)	SS	
Mendocino Gentian (Gentiana seticrera)	C2	
Boggs Lake Hedge-hyssop (Gratiola heterosepala)	C2	E
Mt. Ashland Horkelia (Horkelia hendersonii)	C2	
Pickering's Ivesia (Ivesia pickeringii)	SS	
Heckner's Lewisia (Lewisia cotyledon var. heckneri	C2	
Howell's Lewisia (Lewisia cotyledon var. howellii)	C2	
Stebbin's Lewisia (Lewisia stebbinsii)	C2	

Table 2 (continued)

Species	Status Federal	Status CA
Bellinger's Meadowfoam (Limnanthes floccosa ssp. bellingerana)	C2	
Large-flowered Wooly Meadowfoam (L. floccosa ssp. grandiflora)	C2	
Dwarf Wooly Meadowfoam (L. f. ssp. pumila)	C1	
Slender Meadowfoam (L. gracilis var. gracilis)	C2	
Cook's Lomatium (Lomatium cookii)	C1	
Peck's Lomatium (Lomatium peckianum)	C2	
Mt. Ashland Lupine (Lupinus aridus ssp. ashlandensis)	C2/SS	
The Lassies Lupine (Lupinus constancei)	C2	
Howell's Microseris (Microseris howellii)	C2	
Pygmy Monkeyflower (Mimulus pygmaeus)	C2	
The Lassies Sandwort (Minuartia decumbens)	C2	
Wolf's Evening-primrose (Oenothera wolfii)	C1/C2	
Howell's Lousewort (Pedicularis howellii)	SS	
Beardtongue (Penstemon glaucinus)	C2	
Tracy's Beardtongue (Penstemon tracyi)	C2	
Red-root Yampa (Perideridia erythrorhiza)	C2	
Narrow-leaved Yampa (Perideridia leptocarpa)	SS	
Cooke's Phacelia (Phacelia cookei)	C2	
Scott Mtn. Phacelia (Phacelia dalesiana)	C2	
Scott Valley Phacelia (Phacelia greenia)	C2	
Yreka Phlox (Phlox hirsuta)	C2	E
Coral-seeded Allocarga (Plagiobothry hirtus var. corallicarpus)	C2*	
Oregon Semaphore Grass (Pleuropogon oregonus)	C2	
Crested Potentilla (Potentilla cristae)	SS	
Showy Raillardella (Raillardella pringlei)	SS	
So. Oregon Buttercup (Ranunculus austro-oreganus)	C2	
Columbia Cress (Rorippa Columbia)	C2	
Tracy's Sanicle (Sanicula tracyi)	C2	
Pale Yellow Stonecrop (Sedum laxcum ssp. flavidum)	C2	
Applegate Stonecrop (Sedum oblanceolatum)	C2	
Canyon Creek Stonecrop (S. obtusatum ssp. paradisium)	C2	
Marble Mtn. Catchfly (Silene marmorensis)	C2	
Howell's Tauschia (Tauschia howellii)	C2	
Salmon Mountains Wakerobin (Trillium ovatum ssp. oettingeri)	SS	

Abbreviations: Ext. - Extirpated * - possibly extinct
R = Rare Species; T = Threatened Species; E = Endangered Species
C1 = Fed. Candidate Species, Category 1 (Sufficient data to list)
C2 = Fed. Candidate Species, Category 2 (More data needed)
FS = U.S. Fish and Wildlife Service Sensitive Bird Species
SS = Sensitive Species designated by U.S. Forest Service .
SC = Special Concern/Sensitive Species designated by State
[1] Many more species are of Special Concern by Calif. or Oregon

IV. ENVIRONMENTAL CONSEQUENCES

While the intent of the proposed Long Range Plan for the Klamath Fishery Restoration Program is to improve the status quo condition of the area's anadromous populations and their habitat, the environmental effects of the proposal and the two alternatives need to be discussed. There are differences in approach between Alt. A and Alt. B, and Alt. C essentially means no restoration, but the environmental effects of the three are quite similar.

The effects are not being evaluated on a site-specific basis at this time. Certain construction projects (e.g., fish ladder, sediment trap, bank stabilization) may require additional environmental evaluation as well as various permits (e.g., U.S. Army Corps of Engineers' "404" permit, California Dept of Fish and Game's 1603 Agreement) when they are being specifically proposed for a particular site. The Restoration Program is seeking a programmatic "404" permit from the Corps of Engineers to cover instream projects in the entire Klamath Basin.

Fishery Resources

Although both Alternative A and B intend to increase the anadromous fish populations, several potential scenarios could lead to reduced numbers, particularly of native stocks.

Artificial Propagation and Stocking: This effort includes hatcheries, rearing ponds, and hatchboxes and the stocking of local streams with the artificially produced fish.

1) "Genetic Pollution" from interbreeding of non-adapted hatchery adults with wild fish (Allen, 1985);
2) Habitat competition between wild and outplanted stocks;
3) Disease introduction from hatcheries to streams;
4) Stock collapse from hatchery overproduction;
5) Balance of species shifted due to species favoritism.

Each of these issues is discussed in the proposed Plan and policies are recommended to try to prevent or minimize the potential impacts. Alternatives A and C do not address these impacts. The degree to which the above problems could occur is related to the amount of artificial production and stocking.

Habitat Restoration; This effort involves improving present conditions through instream structures, watershed rehabilitation, riparian zone restoration, and stream flow improvement. Potential adverse impacts to fish include:

1) Bank erosion from flows deflected by instream structures could reduce habitat quality downstream;
2) Construction work instream could prevent salmon or steelhead from spawning if done at the wrong time;
3) Heavy equipment working on instream or bank stabilization projects could remove riparian vegetation, and thereby increase stream temperatures;
4) Machinery used near streams could spill small amounts of fuel oil into the stream and impair water quality.

These possible effects are being mitigated by U.S. Forest Service and California Dept. of Fish and Game guidelines for instream habitat restoration projects. All three alternatives would be affected by these agency guidelines.

Threatened, Endangered and Sensitive Species

The restoration projects recommended by Alternative A or B are not foreseen to adversely impact the identified threatened or endangered species. Of the sensitive species listed, only the three anadromous species (i.e., coho salmon, spring-run chinook salmon, and summer steelhead) will be directly affected. Their populations will benefit since these stocks are the ones targeted for rebuilding. An indirect benefit may include increasing the food supply for the endangered bald eagle and improving the habitat for the listed aquatic species.

At the time a specific project is proposed, additional information will be collected and assessed, including an update on the status of any endangered, threatened, or sensitive species in or near the site. Impacts will be evaluated through the Section 7 consultation requirement of the Federal Endangered Species Act.

Floodplains and Wetlands

Restoration work in anadromous fish streams may involve the floodplain area as well as wetlands (e.g., riparian fencing, spawning channels, rearing ponds, instream structures). Since the intent of any such project is to work with the natural system, no effects are anticipated which would adversely alter the floodplain or wetland environment.

Cultural Resources

Archeological and historical resources will be evaluated at the time a specific project is proposed. It is not anticipated that access to religious or ceremonial sites with be blocked. Since representatives of three local Indian Tribes are members of the project review committee (the Technical Work Group) and the Task Force, potential impacts may better be identified at an early stage.

Increasing the population of anadromous fish of the Klamath Basin will provide significant social, cultural and economic benefits to the local Indian Tribes in the basin and to the ocean salmon fishing communities on the coast.

Recreation

Sport fishing for the targeted species will profit from their increased populations expected from both Alt. A and Alt. B. By rehabilitating watershed and stream habitat and improving water quality, the scenic and recreational values of the region will increase from Alt. B, less so from Alt. A, and not increase from Alt. C.

Farmlands and Timberlands

No farmlands are anticipated to be converted to another use as a result of any of the alternatives, but the proposed Plan's habitat protection policies (i.e., for Agriculture and Water Diversions) could affect cropping patterns and livestock distribution. Public and private timberlands could be affected by timber harvesting policies requesting improved stream habitat protection. While such practices may be different from past practices, they would be similar to those applied on timberlands elsewhere.

Water Quality

No new negative impacts on water quality are expected. The Iron Gate Hatchery and local rearing ponds will continue to operate. The North Coast Regional Water Quality Control Board has identified the following potential waste discharges from these propagation facilities: fish fecal material, uneaten fish food, salt, antibiotics, anesthetics, and cleaning agents. Settling ponds are used to remove solids prior to discharge. Since the operations of these facilities may enhance beneficial water uses, the Board has determined that it may waive waste discharge requirements for fish hatcheries and rearing ponds, provided that the discharge complies with certain conditions.

Beneficial effects on water quality are likely to result from the habitat protection, restoration and education policies in the proposed Plan. In the Shasta River, for example, the fall chinook salmon population is continuing to decline and poor water quality (i.e., temperature and dissolved oxygen) is considered to be one of the main contributing factors. By addressing livestock management, riparian restoration and streamflow conditions, the implementation of the Plan may be able to reverse the fishery decline in the Shasta River.

Coastal Zone Management

The lower 8 miles or so of the Klamath River (to Tarup Creek) and the adjacent lands are within the Coastal Zone, as defined in the Local Coastal Plan for Del Norte County. Projects anticipated in the area (which is zoned "Resource Conservation" by the County) include both continuing ones, such as rearing ponds and barrier removal, and new ones, such as watershed stabilization and a visitor center near Highway 101. If any Task Force-sponsored projects are to be located on private land, they will also need to be evaluated for "consistency to the maximum extent practical" with the California Coastal Act by the California Coastal Commission (as required under the federal consistency rule of the Federal Coastal Zone Management Act).

Consistency with Other Flans

The Six Rivers, Klamath, Winema and Fremont National Forests encompass the majority of the basin. Providing long-term guidance for the four forests is their Land and Resource Management Plans. Since two of these plans are being done simultaneously with the proposed Task Force Plan (Six Rivers and Klamath N.F.), consistency is being sought to the extent possible. In addition, coordination is assisted by having a representative of the U.S. Dept. of Agriculture as a member of the Klamath Fisheries Task Force.

The California Dept. of Fish and Game is in the process of developing a statewide plan and program (as the result of Senate Bill 2261 of 1988) with the objective of doubling the state's anadromous fish production by the end of the century. The proposed Plan (Alt. B) is intended to represent the Klamath River Basin component of the statewide plan.

The Yurok, Hoopa and Karuk Tribes are also developing fishery restoration programs concurrently. Any actions to take place on Reservation lands or in Indian Country will be developed in consultation, coordination and cooperation with the Tribes.

Energy

Although none of the alternatives propose to increase energy consumption, the proposed Plan seeks to improve the operation of existing hydroelectric projects on the Klamath River to benefit the anadromous fish. One result could be a decline in electrical generation. In addition, new large dams are opposed until existing habitat problems can be corrected.

Other Issues

It is not anticipated that the alternatives will have any impact on air quality, solid wastes, or noise. Some slight beneficial effects may result from the policies of the proposed Plan (e.g., Habitat Protection - Timber, Agriculture) on: hazardous waste, drinking water, pesticides, and significant scientific resources.

Human Environment

Although the proposed Plan seeks to promote cooperation with the fishing interests and the land and water users of the Basin, some people may not agree or support all of the Plan's policies since changes to the status quo are recommended. The potentially controversial aspects of the Plan pertain to alternative management practices for: timber harvesting, mining, agriculture, water diversions, water and power projects, and native fish stocks.

On the other hand, increasing the anadromous fish population will benefit the sport, tribal, and commercial fishermen as well as the local communities supporting these fisheries. Improving the water quality of local streams will also improve the human environment.

Short and Long Term Effects

The infusion of up to $2 million each year into the Klamath Basin for fisheries restoration work is the primary short-term effect of the proposed Plan and Alt. A. Initial projects having immediate visible effects include instream structures, rearing pond production, and riparian fencing.

Since watershed improvement (e.g., revegetation, streamflows) and education will take time for results to be seen, the fish population increase will be the eventual long term effect. The life cycles of salmon and steelhead are from 3-5 years per generation.

Comparison of Alternatives

Table 3 offers a qualitative comparison of the potential effects of the three alternatives.

Table 3

COMPARISON OF POTENTIAL EFFECTS OF ALTERNATIVES

Issue	Alt. A 1985 Plan	Alt. B Proposed Plan	Alt. C No Program
Fisheries	+ 1	+ 2	- 1
Endangered Species	+ 1	+ 1	0
Cultural Resources	+ 1	+ 1	0
Floodplains/Wetlands	0	0	0
Recreation	+ 1	+ 2	0
Farmlands/Timberlands	0	- 1	0
Water Quality	0	+ 2	0
Energy	0	- 1	0
Consistency	+ 1	+ 2	0
Human Environment	+ 1	-1/ + 1	0

Code: A qualitative rating is assigned to each issue to provide a comparative evaluation of potential effects:

0 = no effect
+1 = some beneficial effect
+2 = significant beneficial effect
-1 = some negative effect
-2 = significant negative effect

V. CONSULTATION AND COORDINATION WITH OTHERS

Public

Public scoping sessions were held in Eureka on September 7, 1989 and in Yreka on October 12, 1989 to identify: 1) issues which the Plan needed to address, and 2) the possible impacts which could result from such a Plan. The Eureka scoping meeting was noticed in the Federal Register on July 8, 1989. Nearly 200 people attended the two sessions. In addition to direct testimonies, 40 letters were submitted from interested people.

A Public Review of the draft Long-range Plan and draft Environmental Assessment occurred during the period of June 11, 1990 to September 15, 1990. Public hearings on the documents were held in Yreka on July 25 and in Eureka on July 26, 1990. The Task Force also received public comments during its meeting in Yreka on December 5, 6 and 7, 1990.

Organizations and Agencies Commenting

California Coastal Commission
California Dept. of Transportation
California Office of Planning and Research, State Clearinghouse
California Regional Water Quality Control Bd., No. Coast Region
California Salmon, Steelhead and Trout Restoration Federation
California Trout
Commercial Fishermen's Wives of Humboldt County
Crescent City Commercial Fishermen's Wives Assoc.
Great Northern Corporation
Hoopa Valley Tribe
Humboldt Fish Action Council
Klamath Alliance for Resources and the Environment
Klamath River Concerned Citizens
Klamath River Miners Association
Marble Mountain Audubon Society
Ouzel Enterprises
Pacific Coast Guides Association
Salmon River Concerned Citizens
Salmon River Mining Council
Shasta Valley Resource Conservation District
Sierra Club
Siskiyou Fly Fishers
Siskiyou Resource Conservation District
Tehama Fly Fishers
The Klamath Tribe
Trinidad Fishermen's Marketing Association
United Anglers of Northern California
U.S. Fish and Wildlife Service
U.S. Forest Service, Klamath National Forest

Agencies Consulted for the Environmental Assessment Preparation

U.S. Fish and Wildlife Service

Ron Iverson, Klamath Field Office - General
Chuck Lane & Bill Brock, Trinity Field Office - General
Peggy Cole, Sacramento Office - Endangered Species
Merle Richmond, Portland Office - Environmental Assessments

U.S. Forest Service

Jack West, Klamath National Forest - Impacts
Linda West, Klamath National Forest - Environmental Assessments
Jerry Barnes, Six Rivers National Forest - Alternatives, Impacts
Hart Welsh, Redwood Sciences Laboratory - Wildlife
Maria Knight, Klamath National Forest - Plants
Brent Frazier, Winema National Forest - Plants, Animals

California Dept. of Fish and Game

Phil Baker, Region 1 - Fisheries
Susan Ellis, Nongame Heritage Program - Endangered species
Karen Fleming, Natural Diversity Database - Endangered species

Oregon Dept. of Fish and Wildlife

Clair Puchy, Nongame Wildlife Program - Endangered species

KLAMATH RIVER BASIN FISHERY RESTORATION PROGRAM

ENVIRONMENTAL ASSESSMENT BIBLIOGRAPHY

Allen, G. H. 1985. Artificial propagation in North Coastal California citizen-operated salmon and steelhead restoration and mitigation programs. pp. 5-66 In: Report of the Third Annual California Salmon and Steelhead Restoration Conf., U.C. Sea Grant Publ. No. UCSGMAP85-4, Davis.

California Dept. of Fish and Game. 1988. Natural diversity data base - special plants. Sacramento. 58p.

--------------------. 1990. Natural diversity data base - special animals. Sacramento. 22p.

California Water Quality Control Board, North Coast Region. 1989. Public report on proposed action to amend the Water Quality Control Plan for the North Coast Region to incorporate policy on the regulation of fish hatcheries, fish rearing facilities and aquaculture operations. Santa Rosa, 13p.

Oregon Dept. of Fish and Wildlife. 1989. Oregon lists of threatened and endangered species; sensitive wildlife species. Portland. 7p.

U.S. Bureau of Land Management. 1990. Final eligibility and suitability report for the Upper Klamath Wild and Scenic River Study. Klamath Falls.

U.S. Dept. of the Interior. 1985. Klamath River Basin Fisheries Resource Plan. Prepared by CH2M Hill, Redding.

U.S. Fish and Wildlife Service. 1989. Restoration of Atlantic salmon to New England rivers. Final E.I.S., Newton Corner, MA.

--------------------. 1990a. Species list for the Klamath River Long Range Fisheries Restoration Plan. Memorandum from Sacramento Field Office to Klamath Field Office. 7/19/90. 4p.

--------------------. 1990b. Species list for 20-year fisheries restoration program. Memorandum from Portland Field Station to Klamath Field Office. 9/21/90. 4p.

U.S. Forest Service. 1990. Sensitive plant list for the Klamath National Forest. Yreka.

FINDING OF NO SIGNIFICANT IMPACT

LONG RANGE PLAN FOR THE
KLAMATH RIVER BASIN CONSERVATION AREA
FISHERIES RESTORATION PROGRAM
CALIFORNIA AND OREGON

The U.S. Fish and Wildlife Service proposed to adopt a long range plan to provide policy guidance for its Fishery Restoration Program. This 20 year Federal/State cooperative program is seeking to rebuild the anadromous fish populations to optimum levels and, in doing so, should have a wide-spread beneficial effect on the Klamath River Basin's environment. Site specific projects will be environmentally assessed at the appropriate time.

Alternatives evaluated include: (A) no action (existing plan); (B) proposed Long Range Plan; and (C) no restoration Program.

Study of the environmental and socio-economic effects of the proposed Plan has shown them not to represent a negative impact on the quality of the human environment.

Based on a review and evaluation of the information contained in the supporting reference cited below, I have determined that the proposed Long Range Plan for the Klamath River Basin Conservation Area Fishery Restoration Program is not a major Federal action which would significantly affect the quality of the human environment within the meaning of Section 102 (2)(C) of the National Environmental Policy Act of 1969. Accordingly, the preparation of an environment impact statement on the proposed action is not required.

Reference: Environmental Assessment

Regional Director

Date: APR [illegible]