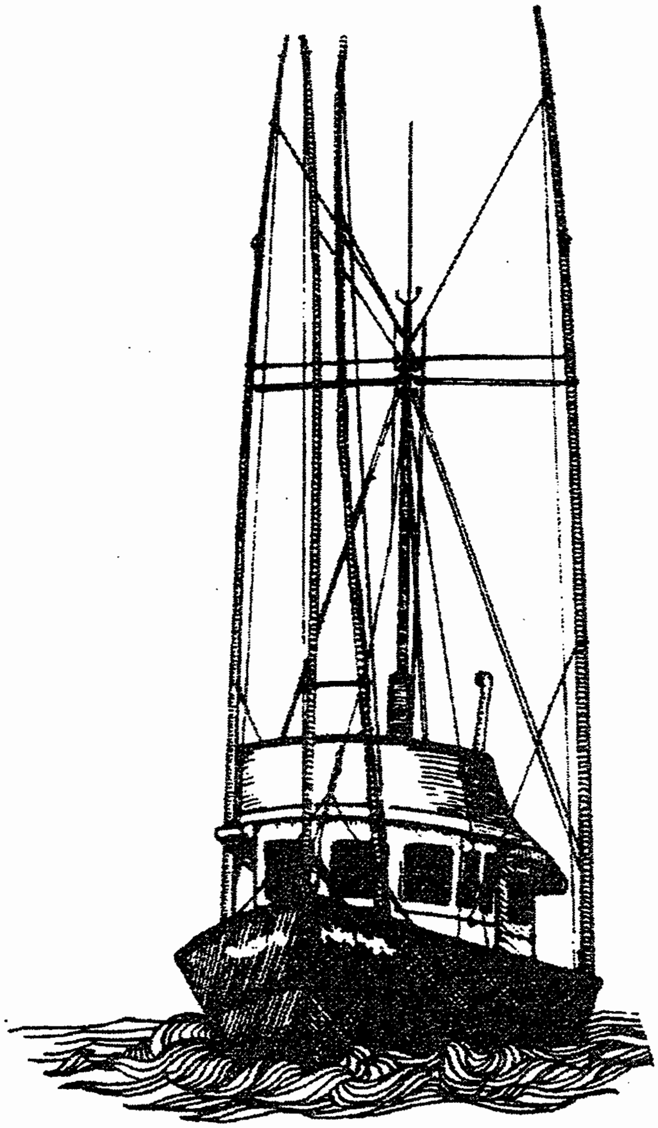
The Cost of Doing Nothing:

The Economic Burden of Salmon Declines in the Klamath Basin



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Preface

The supporting data for this report was prepared for The Institute for Fisheries Resources under the direction of the Institute's Conservation Program Director, Glen Spain. Data used in preparing this report is from several sources as cited.

Much of the data was compiled and the historic run size estimate methodology used in this report was developed by Dr. Hans Radtke, Natural Resource Economist, Yachats, Oregon in association with Shannon W. Davis, The Research Group, Corvallis, Oregon. Dr. Radtke is an associate professor on courtesy appointment at Oregon State University and is a recognized leader in input/output analysis and natural resource economics. As a freelance economist, he has worked on a variety of fishing industry related projects over many years. Mr. Davis is a systems research specialist with 15 years of experience in the field of planning.

We are also deeply indebted to Mr. David Bitts for the important historical information and overview provided in the sections on the history of Klamath Basin fisheries management (Appendix A) and the role that mitigation hatcheries play in the Klamath Basin (Appendix B)

This report was prepared using accepted methodologies and existing data with the understanding that technically sound and defensible approaches would be used. Because this philosophy was strictly adhered to in all aspects of this report, many of these estimates are very conservative. Less conservative assumptions would lead to much higher job loss and economic loss figures.

This is the second report in a series of three reports, including Report No. 1 (Columbia River Basin) and Report No. 3 (California Central Valley River Basins) using similar methodologies. A full explanation of the basic economic methodology used in all three reports is contained (for brevity) only in the Columbia River Basin Report (Report No. 1), rather than duplicated in all three. That report should be referred to for the details of our methodology.[1] Where other information was used, the source is indicated.

This report is prepared to assist in analysis and decision making and is based upon the best available information. The authors' interpretations and recommendations should prove valuable for that purpose, but no assurance can be given that decisions based on this data will fulfill expectations of market demands nor achieve any specific financial projections. Neither the study sponsor, nor any person acting on its behalf, makes any warranty of representation, express or implied, on the usefulness or accuracy of this information for commercial or any other business purposes.

Production layout for this report was done by Berkana Publications of Eugene, OR. The cover graphic is a stylized picture of a commercial salmon troller typical of the many family owned boats which make up the majority of the west coast salmon fleet.

The Institute for Fisheries Resources is a nonprofit public benefit corporation dedicated to the protection and restoration of marine and anadromous resources. The Institute is also affiliated with the Pacific Coast Federation of Fishermen's Associations (PCFFA), the largest organization of commercial fishermen on the west coast, whose many members have been leaders in the protection and restoration of salmon habitat throughout the region.

1. *"The Cost of Doing Nothing: The Economic Burden of Salmon Declines in the Columbia River Basin", Report No. 1 of 3 Institute for Fisheries Resources (October 1996). In particular see Appendix A of that report.*

 The issue of the ultimate cost to society of environmental destruction is one of the most important issues of our time. It is our hope that this report will shed some light on the very real costs of doing nothing to prevent that destruction in the Klamath River Basin—a basin that was once the third most productive salmon river system in western North America.

Primary funding for this report was generously provided by The David and Lucile Packard Foundation, with additional funding assistance from the W. Alton Jones Foundation, the True North Foundation, the Bullitt Foundation, the Flintridge Foundation and the Rockefeller Family Fund. These foundations have become leaders in the current effort to protect and restore the irreplaceable natural resources of the west coast. Their assistance and support for this effort is greatly appreciated.

in the first place, would be totally unnecessary. See Appendix A: "A Brief History of Klamath Basin Fisheries Management" for more details.

Wholesale destruction of salmon habitat, excessive water diversions and the impacts of dams have all combined to drive wild Klamath Basin salmon very close to extinction.[4] Other inland Klamath Basin fish, many dependent on the same habitats, are already on the Endangered Species List.[5] In spite of often heroic restoration efforts by commercial fishermen and many others, the overall trend in the Klamath Basin still appears to be toward extinction of salmon (and most other fish species) in large portions of the basin. This may continue to be the case until policy makers tackle the tough questions and address the underlaying land uses and water diversions causing salmon declines. The serious economic impacts of these declines has been widespread but generally ignored by policy makers.

The Cost of Doing Nothing and the Price of Extinction

There is a very real economic cost to society—in terms of lost jobs and forgone economic opportunities—of doing nothing to reverse the trend toward the decline of salmon in the Klamath Basin. This "cost of doing nothing" can in fact be quite high.

The easiest way to quantify this cost for Klamath Basin salmon is to compare the historic productive capacity of the river system with its current greatly diminished productivity, assuming all other things the same. This difference can then be quantified as the "net economic drag" created by the loss of these salmon runs in terms of today's dollars and today's lost jobs.

We make no effort in this report to allocate these impacts as among the three main sectors of the salmon fishing economy, although we know that commercial, recreational and Tribal fishermen all are being adversely affected by these declines throughout the entire southern Oregon and northern California region.[6] We can, however, estimate what the losses have been as a whole, as well as what the risk of future economic loss is if the current trend toward extinction is not reversed.

Using estimates derived from available habitat stream miles within the basin, and applying well accepted estimates of escapement and spawning, the estimated run size of salmon (in adult equivalents) that made up the pre-development Klamath Basin salmon runs would have been between about 0.66 to 1.1 million fish. These run sizes, if they were available today (and assuming only a 50% harvest rate), would have annually yielded about 4,218,750 to 7,462,500 pounds of salmon to harvesters from between 328,750 to 545,000 fish (see Table 3). Using an existing (and basin-specific) economic study prepared for the U. S. Department of Interior (see Table 4) which calculated the net economic contribution per

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4. *The American Fisheries Society report "Salmon at the Crossroads" (see footnote 2) identified several Klamath Basin salmon stocks as at risk of extinction. Coho salmon in the basin were listed under the Federal ESA as threatened on May 6, 1997 (62 Fed. Reg. 24,588).*

5. *The Lost River sucker (known to the Klamath Indians as the "tschum") and the short-nosed sucker fish (the "kuptu") are among the Klamath River fish species listed under both California and federal Endangered Species Acts. For federal listing as endangered see 53 Fed. Reg. 27,130 (July 18, 1988).*

6. *Separating out which portion of these job losses would impact which sector of the overall fishing economy would take a level of detail that is not readily available, including extensive coded-wire tag data that has never been compiled or correlated with economic data. This level of detailed analysis is beyond the scope of this report. All economic sectors are being affected and the total impact is the important number.*

every 1,000 harvested fish, we can then estimate the net economic contribution such a hypothetical pre-development harvest level could have generated. This is the overall economic potential of the basin in terms of salmon production, conveniently converted into today's dollars.

All the harvesting, processing, and related economic activities associated with the Klamath River salmon and steelhead fishery at these pre-development run levels, if available today (at this 50% harvest rate), could thus potentially generate regional economic benefits (in 1996 dollars) as follows:

- **Up to about $137.4 million/year in total personal income;**
- **Up to about 6,870 jobs, based on a full time equivalent annual job earning $20,000 per year ($10 per hour).**

The differences between these figures and today's dismal to nonexistent salmon harvests from the Klamath reflect the net economic damage done by these declines. These figures also therefore represent the net "cost of doing nothing" to reverse these declines.

> *The "cost of doing nothing" in the Klamath Basin ultimately may equal a potential economic loss of up to $137.4 million/year, which amounts to approximately 6,870 lost family wage jobs.* ***Roughly 3,780 of these jobs have already been lost*** *(representing $75.6 million/year in lost economic potential), and the remainder are being placed at risk by failure to protect salmon spawning and rearing habitat.*

Roughly 3,090 fishery jobs generated from this basin still exist. *However, up to roughly 3,780 fishery-related jobs have already been destroyed*—largely because of habitat destruction and consequent loss of wild salmon productivity within the basin. Most of the remaining jobs—mostly supported by hatchery releases, not wild fish—are also at considerable risk from continued loss of habitat. Ultimately both wild and hatchery fish must share the same habitat. Continued loss of habitat carrying capacity is destroying hatchery and wild fish alike.

On the positive side, this 3,780 job loss figure (the equivalent of $75.6 million/year in lost economic impacts) also represents the annual economic "dividend" which could potentially be derived from a social investment in measures to make the Klamath River Basin more fish friendly. These measures include better protection for riparian areas and the reallocation of water within the basin in ways that better support fish. While full restoration to historic river populations is perhaps no longer possible, nevertheless this figure demonstrates that the economic dividend of even partial restoration can still be substantial.

Many measures can be taken to minimize the adverse impacts of agricultural and forestry (such as water conservation and better road building practices) which in themselves have little or no impact on competing sectors while greatly increasing the economic dividend from restored fisheries. *It thus makes* *little economic sense* ***not*** *to restore salmon to as near as feasible to their once abundant levels.* Each additional salmon helps create additional jobs.

What is the Klamath Basin Salmon Fishery Worth?

The present value of an income stream received over time is that income stream's "net asset value." Standard calculations based on the potential income stream from the Klamath Basin salmon fishery shows that the *net asset value* of this fishery is *at least $4.5 billion.*[7] In other words, *maintaining the current regime of water system mismanagement and habitat destruction in the Klamath Basin may ultimately (if these salmon go extinct) cost society at least $4.5 billion in lost economic value from that fishery.* Using other less conservative discount assumptions would give values up to $13.8 billion (see Table 5), even without adding in any non-market benefits or any of the "secondary effects" and indirect costs caused by related ocean fishing closures triggered by weak stock management.[8]

A program of stringent protections for the remaining wild fish runs, coupled with an aggressive effort toward habitat restoration, dam retrofitting or retirement and water allocation reforms continues to make good economic sense. In addition to reducing existing and potential future conflicts between one industrial sector and another, such a restoration program would also help return real jobs and real economic value to the in-river and coastal economies in both Oregon and California which have been economically the most devastated as Klamath Basin salmon declined.

Benefits from salmon restoration would not be limited to the Klamath Basin alone. As an example, until recently Klamath River fall chinook salmon typically made up as much as **30% of all salmon harvested** between the ports of Coos Bay (OR) and Fort Bragg (CA) (Figures 4 and 5). Economic problems created by salmon habitat destruction in the Klamath Basin are thus problems for many coastal and inland communities throughout the whole region. It is these communities that now bear the brunt of the "externalized costs" of this destruction. Klamath Basin salmon restoration can thus benefit the entire regional economy.

Restoration of depressed Klamath Basin wild salmon stocks would also free up other ocean and in-river fisheries from the biological constraints of "weak stock management," and thus allow a number of more abundant fish stocks to be harvested. An economic analysis of this secondary factor is beyond the scope of this report, but would without doubt be substantial. The economic benefits of additional fish harvests in any form would cascade throughout the regional economy.

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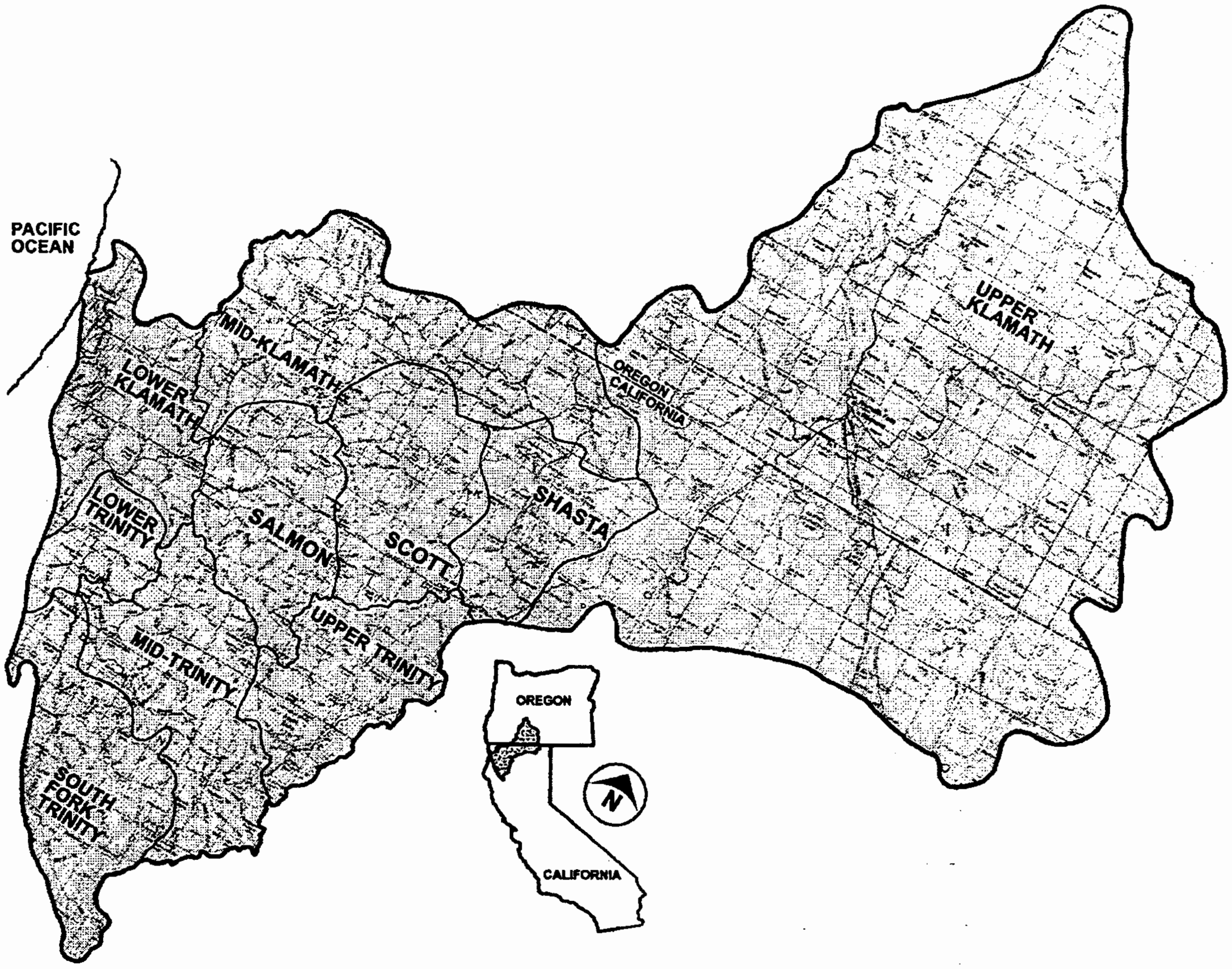
7. *In this case using a 3% annual discount rate over a term of 100 years (N=100). Other values can be derived using different assumptions (see Table 5). The calculated hypothetical figure of $4.347 billion (Table 5) is the mathematical result of many estimates and thus can only be expressed accurately to the nearest two digit significant figures, and thus becomes $4.5 billion to two significant figures.*

8. *These figures deliberately excludes all economic benefits allocated by Meyer (Table 4) to "non-market benefits" and so may be greatly understating the true societal value of this fishery. If added back in, these non-market economic benefits would bring the total annual personal income impacts to potentially as high as $374.86 million/year. Using the same discount assumptions (3% to 0% over a term of 100 years), the calculated net asset value of this fishery would then be from $11.85 billion to $37.486 billion. Thus our calculated net asset value of from $4.5 billion to $13.8 billion is a very conservative estimate.*

Figure 1
The Klamath River Watershed



Source: Adapted from Klamath Fishery Task Force Report (1991)

Introduction

"The increasing loss of fish habitat, to pollution, unwise development and other human activities, is the single largest long-term threat to the future viability of the marine fisheries of the United States...Protection of habitat is the cheapest investment the nation can make to sustain productive fisheries"[9]

Until recent times the Klamath River Basin was the third most prolific producer of wild salmon on the U.S. west coast. In just the last 140 years, however, many wild salmon runs throughout the Klamath Basin have been driven downward in numbers almost to the point of extinction. There is much discussion these days about what to do about it. Almost universally the costs of emergency restoration measures are widely acknowledged. Yet rarely is any attempt made by decision-makers to ascertain what these declines **have already cost or could potentially cost fishermen and fishing dependent economies in terms of lost jobs, lost economic opportunities and shattered lives.**

This report estimates the lost economic value to society, in terms of real jobs and dollars, which has *already been caused* by allowing valuable salmon and steelhead runs in the Klamath Basin to decline percipitously. These losses continue to be exacted from the regional economy each year. We also estimate the annual future economic damages if these declines are allowed to continue. This economic contribution is measured as household income potentially generated to harvesters (returns to owners, skippers, and crew members), to processors, and to supporting businesses. In economic terms, these are regional economic impacts measured by direct, indirect, and induced income generated by commercial salmon fishing activity annually.

Finally, we use the estimated annual income stream to derive the "net asset value" of the Klamath Basin salmon resource as a whole—in other words, the *real social cost* to society if something is not done to reverse the present trend toward salmon extinction. This net asset value is the net present value of the future annual income streams which *could* have been realized over the next one hundred years had these declines never taken place. The end result is a preliminary estimate of the "cost of doing nothing"—i.e., the economic costs to society of allowing the present declines to continue unabated. As it turns out, the economic losses to society which would result from salmon extinctions are enormous.

Any estimate of economic impacts and asset values are sensitive, among other things, to figures for annual landings, the proportion of the run size available for harvest, the time frame being considered, and the future discount rate and analysis period assumed. *The assumptions chosen for this report are relatively conservative.* Less stringent assumptions would simply result in higher loss figures and proportionately higher asset values which could potentially be lost.

Conditions have radically changed, of course, since the first settlement of the Klamath River Basin by Europeans. It is probably not possible to ignore all of the present demands on the river, nor to expect that the fishery runs can return to historic levels without major changes in present water use.

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9. From Hinman and Safina, 1992. Summary and Recommendations. In: R.H. Stroud (ed), "Stemming the Tide of Coastal Fish Habitat Loss." Marine Recreational Fisheries Symposium 14:245–249. National Coalition for Marine Conservation, Savannah, GA.

However, many realistic measures can still be taken to mitigate past practices and to help restore at least a large part of the currently depressed wild salmon runs in a cost-effective manner.

The economic potential of the salmon resource, once restored, to repay what may be a substantial social investment in restoration depends on the potential economic value of the salmon resource to be recovered. This value establishes the level of the "economic dividend" that could potentially be achieved through recovery. As seen from the analysis, the value of this potential economic dividend could be *quite large*—more than large enough, in fact, to make reasonable recovery efforts very cost effective.

Many of the current fish-destroying land use and water system management practices in the Klamath Basin are simply unnecessary. Many cost effective strategies have been proposed which would allow both crop irrigation, timber harvest, grazing and other human activities to co-exist with salmon. Many of these measures, however, will take a social investment of money and effort to get there.

Among other uses, these figures demonstrate that such an investment is just that—*an investment*, and not a true cost. There *will* be a real economic return on that investment—in effect a dividend from the sustainable use of this "natural capital." This dividend can repay this investment over time. Most of the changes required are one time costs. However, the economic dividend from salmon restoration will continue to benefit all future generations.

This report deals only with certain "hard" economic values which can be most easily quantified in terms of lost dollars and jobs. However, it should always be remembered that there are many other (non-market) social and cultural values which salmon also provide, but which are outside the scope of this report. Economics alone will not speak of the religious and cultural value of salmon to those whose lives and cultures are inextricably intertwined with this species. We should never forget that these other social values are often far more real so far as our daily lives are concerned than merely monetary ones.

The plight of salmon in the Pacific Northwest and northern California is a microcosm of the failure of our modern technological society to define a workable relationship between Humanity and the rest of the natural world. Efforts in the Klamath Basin to rescue salmon are set against the background of a massive cultural effort to redefine that relationship before we drive the majority of today's species (and with them ourselves) to extinction. There are many lessons to be learned from salmon which will aid this process. It is our hope that this analysis will contribute to that effort.

The Klamath River Basin[10]

More than any other wild region I've known, the Klamaths have a venerable quality which is not synonymous with "pristine" "unspoiled," or other adjectives commonly applied to natural areas. These adjectives imply something of the smoothness and plumpness of youth, whereas the Klamaths are marked by the wrinkles and leanness of great age. Although their peaks and high plateaus have been marked by glacier they are at heart preglacial mountains, with elements of flora and fauna that reach back farther into the past than any place west of the Mississippi River. The Klamaths seem so old, in fact, that I'd call them a grandparent of the Sierra and Cascades instead of a sibling. Owing to winters mild enough and summers moist enough for species to grow together that are elsewhere segregated by elevation or latitude, several species that once grew throughout the West now survive only in the Klamaths.

—David Rains Wallace, "The Klamath Knot"

The Tragic History of Salmon Habitat Destruction

Flowing through the Klamath Mountains, the Klamath River is the second largest in California, draining approximately 15,600 square miles of northern California and southeast Oregon. It ranges in elevation from sea level at the mouth of the Klamath River to over 9,500 feet at the summit of Mt. McLoughlin in the Cascade Range. Over half of the area is mountainous and is composed of steep, rugged slopes which are highly subject to erosion. Extensive lowlands are found only in the southern Oregon or "Upper Basin" portion of the watershed—thus the headwaters of the basin are also precisely in those lands most useful for farming and so most subject to irrigation demands at the expense of salmon.

Historical accounts of the impact of European settlement in the Klamath provide a grim picture of the many assaults on salmon habitat, in addition to unregulated harvesting, which brought salmon in the basin to their current depressed status. Among the best historical summaries is the following:

> "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. The behavior may have evolved from past experience with food shortages after periods of overharvest.
>
> "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. The primary cause of the decline

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10. *Additional historical information can be found in "California's Chinook Salmon: Upstream Battle to Restore the Resource," Western Water, Water Education Foundation, November/December 1992.*

may have been the heavy sediment loads unleashed by hydraulic mining which filled the deep pools required by spring chinook for holding during summer. 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 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 basin until it was washed out by a flood in 1902. By 1892, spring chinook were thought to be almost extinct.

"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.

"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. The Yurok began to modernize and increase their fishing efforts about 1915 and continued to do so until 1928.

"Commercial gill net harvest in the Sacramento River was greatly reduced in the 1880's as a result of pressure from sport fishermen. 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. Snyder and Schofield 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."

Although the Klamath had already suffered much abuse, a biologist by the name of John Snyder (working for the California Division of Fish and Game) did a number of important fish surveys in the 1920's and 30's which has given us early baseline data by which to judge population trends. 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. After World War II, the ocean salmon fishery rebounded strongly. Runs in the Klamath during the postwar period probably reflected this general trend.

"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 Niño) 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. 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 Niño 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."[11]

A complicating factor in assessing wild salmon abundance is the widespread use of hatcheries to produce additional fish for harvest. Large hatchery-produced runs often mask wild salmon run declines, and until very recently the California Department of Fish and Game made little or no effort to distinguish between the two within the basin. Habitat loss, furthermore, is still pervasive throughout the basin. Grazing, logging and water diversions still continue in the basin in ways that exacerbate and perpetuate existing salmon habitat problems and prevent recovery. Many of these practices are also highly resistant to change because they are built into and sanctioned by customary land use patterns and archaic water and land use laws.

The topology within much of the southern portion of the basin is steep sloped and highly erodable. The commonly occurring granitic-type soils are especially sensitive to human disturbances such as logging and grazing. Soil erosion caused by human disturbance to these unstable slopes has added huge sediment loads to many salmon spawning streams which smothers eggs and juvenile salmon with silt.[12]

Historically the Klamath and its six major tributaries—the Trinity, Salmon, Scott, Shasta, Sprague and Williamson Rivers—supported the third largest Pacific salmon runs found in the lower 48 states. However, today at least 10 of the basin's 54 remaining salmon populations are at risk of extinction, with many others severely depressed.[13]

For millennia the Klamath and Trinity Rivers (Figure 1) also provided important salmon habitat for the Indian Tribal fishery. However the Hoopa, Karuk, Klamath and Yurok Tribes, who have fished the

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11. *Historical summary in this section is taken from "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. Citations within that report have been omitted for brevity.*

12. *See for instance the sediment budget load research of Dr. Sari Sommarstrom in her work assessing the impact of logging operations in the Scott Valley sub-basin of the Klamath, "Scott River Basin Granitic Sediment Study," Sommarstrom, S., E. Kellogg and J. Kellogg, prepared for the Siskiyou Resource Conservation District (November, 1990). Logging operations often have a synergistic impact—the sum of stream sedimentation washing down from either a clearcut or a logging road alone is often much less than that typically coming out of a combination of the two together.*

13. *From Nehlsen, W., et. al, ibid. (see note 2).*

Klamath and its tributaries for more than 10,000 years, now fear that these fish, upon which the very survival of their culture depends, will soon be gone forever.

The Klamath Basin is also visited every year by more migratory waterfowl than anywhere else in North America. Klamath Lake (in Klamath County, OR) is a major stop on the Pacific Flyway. The Klamath Basin National Wildlife Refuges provide feeding and resting grounds for about a million migrating ducks and geese each year. Four out of every five birds on the Pacific Flyway pass through these refuges. Of the 411 bird species that use the refuges, 25 are classed as endangered, threatened or of special concern and virtually all are protected under the Migratory Bird Treaty Act (16 U.S.C. 703 *et. seq.*). The shallow wildlife refuge lakes in the "Upper Basin" (which is that portion of the watershed above Iron Gate dam) are also constantly pitted against the needs of irrigators. In recent years waterfowl populations within the refuge areas have plummeted as agricultural water diversions repeatedly dried up the refuge lakes. Agricultural operations are also allowed within the wildlife refuge itself—about 22,000 acres of the wildlife refuge lands are currently leased for farming. Typical agricultural practices on these lands (including the extensive use of pesticides toxic to birds and other wildlife) routinely go on which are inconsistent with management of the wildlife refuge and thus in apparent violation of several federal laws.[14]

In 1994, the Pacific Fishery Management Council reviewed and reported on the underlying causes of the failure over the prior three years to meet the minimum spawner escapement goals of its Fishery Management Plan for Klamath River chinook. The Council concluded that in addition to problems with ocean survival and past harvest methodologies those causes also included: (1) low mainstem and tributary flows, exacerbated by irrigation diversion and drought; (2) hatchery operations, especially with regard to the size of juveniles at release and the magnitude and timing of releases, and; (3) habitat conditions such as degradations of spawning and rearing areas by siltation, loss of riparian cover, and large woody debris removal.[15]

Lack of Water and Lack of Upstream Passage

A major limiting factor for fish in the upper portion of the basin is sheer lack of in-stream water flows. The eastern portion of the basin is arid and subject to drought. Expanding agriculture in the upper basin increased pressure for dams to impound large volumes of water for exclusive human use. Dams in the Klamath River Basin were first built in the 1850's to supply water to mining and farming operations, and over the years these many small dams were replaced by several major ones with little or no thought to fish passage or the in-stream flow needs of fish and wildlife.

Increasing irrigation water demands eventually resulted in the "Klamath Irrigation Project" around the turn of the century. The avowed purpose of this large federal water delivery project was to capture

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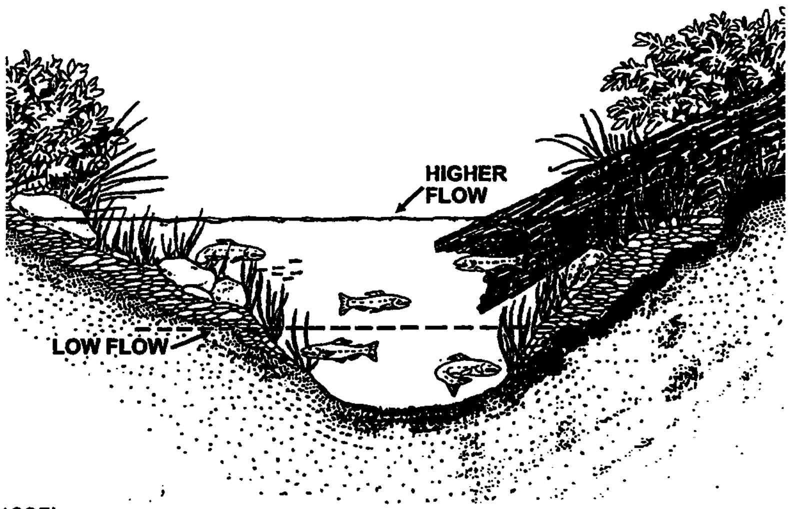
14. *A number of groups have brought suit alleging that these practices within the refuges violate (among other laws), The Kuchel Act (16 U.S.C. 695k* et. seq.*) which originally established these refuges, The National Wildlife Refuge System Administration Act (16 U.S.C. 688dd* et. seq.*), the Bald and Golden Eagle Protection Act (16 U.S.C. 668* et. seq.*) and the Migratory Bird Treaty Act (16 U.S.C. 703* et. seq.*). This action is now pending as case #S97-2274GEB-GGH in U.S. District Court in the Eastern District of California.*

15. *Pacific Fishery Management Council, "Klamath Fall Chinook Review Team Report," Portland, Oregon, December 1994.*

and deliver large volumes of federally subsidized water for agricultural development. In 1905, pursuant to an Oregon statute[16] 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 Project. Based on this statute, the Oregon Attorney General has recently issued an advisory opinion that these water rights can only be used for irrigation purposes, and that there is *no federal authority to apply any of this water to protection of fish and wildlife.*[17]

In other words, the irrigators in the Upper Klamath (Oregon) claim that all the water in the river can legally be confiscated by themselves *without any accommodation for fish or wildlife needs.* This flies directly in the face of several federal statutes (including the federal Endangered Species Act) and federal case law as well as jeopardizing the water rights of downriver users (such as the Yurok Tribe) under Tribal treaty rights guaranteeing them adequate water flows for fish.[18] Eventually there will be a major legal confrontation between these two incompatible water rights theories. Recent efforts by the Bureau of Reclamation to cut back deliveries on its long term water contracts in order to protect recently listed coho salmon have been challenged in court and are now in litigation.[19]

Figure 2:
Effect of Lower Streamflow on Amount of Fish Habitat



Source: Bottom, et. al. (1985)

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16. 1905 Oregon Laws, Chapter 228 in General and Special Laws of Oregon (pgs. 401–406).

17. Letter from Oregon Attorney General to Martha Pagel, Director, OR Water Resources Dept. dated March 18, 1996 (DOJ File No. 690-002-G0037-86-0010).

18. See also a letter dated March 6, 1996, to Interior Secretary Bruce Babbitt from the Law Firm of Alexander & Karshmer on behalf of the Yurok Tribe. Recent opinions by the U.S. Solicitor General's Office also indicate that federal treaty obligations should prevail over Oregon's state water laws.

19. Klamath Water Users Association, et. al. vs. Patterson, (Civil Case No. 97-3033-CO) recently filed in the U.S. District Court of Oregon. A number of fisheries groups, including the Institute for Fisheries Resources, have intervened in this case and it is currently in litigation.

In granting a license to Pacific Power and Light Company to operate Iron Gate Dam, the federal government did recognize the fishery needs for assured releases of water below the dam, making specific minimum releases a condition of the permit issued by the Federal Energy Regulatory Commission (FERC) for continued operation.

In recent years, however, the U.S. Bureau of Reclamation has often refused to provide even these FERC-minimum releases, let alone the larger flows probably necessary to satisfy the government's federal trust responsibility to the tribes and under the ESA. Instead, as has happened throughout the arid west (including California's Central Valley) the Bureau has continued to provide full water supplies to irrigators even during extended periods of drought at the expense of fish and wildlife and down river interests. The Bureau has even cut promised flows for fish and wildlife during the recent wet years of 1995 and 1996 in order to meet the continually growing demands of Klamath Basin irrigators.

As on the Sacramento River, Bureau officials did recently modify water releases from Upper Klamath Lake on the Klamath River, and from Lewiston Dam on the Trinity River, to improve water flow conditions for fall-run spawners. But on the Klamath, these downstream measures are complicated by the presence of two endangered freshwater fish in Upper Klamath Lake.[20] In 1992, the US Fish and Wildlife Service specified that certain lake elevations must be maintained to protect these fish. Such dilemmas and trade-offs between species, some say, are a fact of life. "If you manage for one fish, you sometimes shortchange other fish," said Randall Brown, chief of Oregon's Department of Water Resources Environmental Services Office.

Others, however, take issue with this argument and contend that it is not a matter of "either-or," but rather of how the water project system as a whole is operated. To date the Klamath Project (the largest federal water project in the basin) has been *operated almost solely in order to satisfy upper basin irrigation needs*, with fish and wildlife needs explicitly given a much lower priority. This one-sided management policy utterly ignores the economic losses to fishing-dependent communities downstream who continue to suffer as the salmon resource they depend upon economically is slowly strangled to extinction. The Bureau of Reclamation's irrigation policies still do not acknowledge that there are other major economic interests besides agriculture involved in how the basin's water is managed.

Gradually, pressure from fishing organizations and the general public has forced federal water agencies to begin to provide for the real water flow needs for fish throughout the basin. As could be anticipated, these issues are hotly contested and have become highly politicized.

To their credit, the 1998 management proposals by the Bureau of Reclamation have acknowledged their legal obligation to provide more water through the Klamath Project to protect downriver spawning and rearing areas for ESA listed coho salmon. The Bureau's most recent "Draft 1998 Klamath Operations Plan Environmental Assessment" flatly admits that FERC-required minimum flows "would likely jeopardize the continued existence of coho salmon, adversely modify this species' habitat and likely result in the listing of steelhead and chinook salmon." They also candidly admit that "Overall, all of the alternatives provide inadequate flow for salmon egg incubation, fry and juvenile rearing and outmigration during the period of April through June." Nevertheless, the Bureau is still

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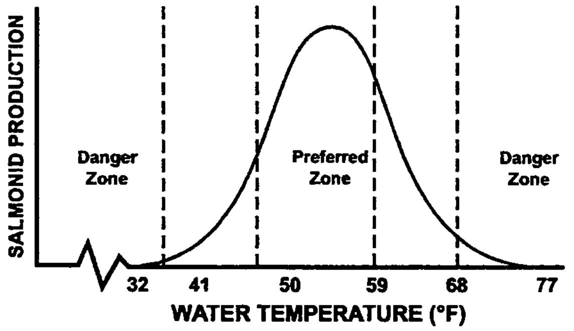
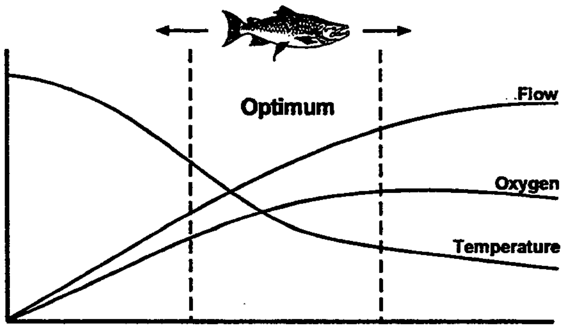
20. *The federally and California listed Lost River and shortnosed sucker fish (the "tschwan" and "kaptu" as they are known by the Klamath Tribes) were both historically very important not only as food sources but also to the religious life and culture of the Klamath Tribe which has occupied the Upper Klamath Basin for thousands of years.*

not proposing any options that would cure these obvious problems. Criticisms of the Bureau's management of the Klamath Project continue to be valid, though with some hope that things may be changing under the ESA.

Iron Gate Dam, the lowest of four mainstem Klamath dams, was built in 1956. Iron Gate is just below the Oregon border and is *quite literally impassable* for migratory salmon. All native salmon runs originating above Iron Gate dam are now extinct. More than 75 miles of mainstem river, plus all its tributaries as far as north of Upper Klamath Lake continue to be blocked by this dam. Habitat for about 9,000 chinook and 7,500 steelhead spawners is potentially available in this area.[21] Blocking this habitat represents a total lost economic value of $2.08 million/year ($252,170/1000 fish x 16,500 x 50% harvest rate) in accordance with the figures developed in this report.

Figure 3
Relationship of Water Temperature, Flow and Dissolved Oxygen on Salmon Survival





Source: Bottom, et. Al. (1985)
Note: Salmon can only exist within a limited range of conditions. Water much over about 59 (F°) in temperature greatly increases stress and reduces survival. Reducing overall stream flow makes the remaining water easier for sunlight to heat up. Increased water temperature in turn reduces dissolved oxygen, disrupts the food chain, and has a multitude of overall negative impacts on salmon reproduction and survival. Dissolved oxygen levels far below the minimum necessary to support fish are frequently observed below Iron Gate Dame and for some distance downstream. Less water in the system also means greater concentration of pollutants from agricultural or urban runoff. Stream flow issues are, therefore, intimately related to all other salmon survival factors.

21. *From "Long Range Plan for the Klamath River Basin Conservation Area Fishery Restoration Program,"* ibid., *pg. 2–72.*

Preventing Overfishing

There is no question that overfishing of Klamath Basin salmon occured in the past before there were any regulations in place to prevent it. However, salmon harvests are now regulated under both state law and federally (since 1976) under the Sustainable Fisheries Act (16 U.S.C. 1801 *et. seq.*) in an extensive effort to prevent any further overfishing.

Unfortunately, once in the ocean it is impossible to easily differentiate between individual salmon runs. Thus the weakest stock becomes the biological limiting factor on all other harvests. In other words, even though other stocks may be far more abundant, they cannot be harvested once the "cap" is reached on the weakest. This biological principle is called "weak stock management," and is now built into the very fabric of all fisheries management, both within the states and at the federal level.

Federal fisheries management coastwide is deeply affected by the decline of the Klamath River stocks under this "weak stock management" principle. The Sustainable Fisheries Act authorizes the federal fisheries off California, Oregon and Washington (i.e., outside the 3-mile limit of state waters to 200 miles) to be managed by the Pacific Fisheries Management Council (PFMC). Congress also set up a special management zone within the area in which Klamath river salmon are the most abundant, which is called the Klamath Management Zone (KMZ). A special federal body known as the Klamath Fishery Management Council was established in 1986 to help manage fishing impacts in the KMZ.[22] This body serves as an advisory body to the Secretary of Commerce and essentially exercises the same fisheries management functions over the KMZ that the Pacific Fishery Management Council (PFMC) does over the remainder of the west coast fishery beyond the 3-mile limit of state jurisdiction.[23]

Many of the relatively abundant salmon runs originating both north and south of the KMZ migrate through the KMZ area during at least part of their life cycle. The health of wild salmon originating within the KMZ thus becomes the most important limiting factor restricting harvests in and around the KMZ for the entire California, Oregon and Washington salmon fishery under the principles of weak stock management.[24]

For instance, when biologists predicted a very low return of Klamath River fall-run chinook spawners in 1992, federal and state officials *completely closed* all commercial ocean salmon fishing from Point Arena in Mendocino County north to Florence, Oregon. Commercial fishing was also severely limited from Point Arena south to Point San Pedro in central California from May through July to

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22. *The Klamath Fishery Management Council was established by 16 U.S.C. 460ss-2 under P.L. 99-552.*

23. *State jurisdiction is exclusive over inland waters to the shoreline, but concurrent with the federal Regional Fishery Management Councils' jurisdiction from the shoreline to 3 miles offshore. From 3 miles to the 200-mile limit of U.S. territorial waters exclusive management of federal fisheries rests in the various Regional Fishery Management Councils created under the Magnuson Fishery Conservation and Management Act of 1976 (16 U.S.C. 1801* et. seq.*; P. L. 94-265), now called the "Sustainable Fisheries Act."*

24. *The amount of lost fishery income related to these secondary impacts from Klamath Basin-decline driven ocean fishery closures is outside the scope of this report, and could not be easily ascertained without extensive research, including coded wire tag studies that have not yet been done. However, these impacts are (as seen from the example presented) obviously quite large. Had these secondary impacts also been factored into the job loss equation, the number of jobs lost or at risk would have been much greater than the relatively conservative figures actually used in this report.*

protect this weak stock. These closures continue today and are annually costing lost fishery income in the several tens of millions of dollars range on what are healthy runs of mostly hatchery origin. These opportunities simply had to be foregone in order to prevent accidental interceptions of these weak Klamath River stocks.

These emergency measures were probably necessary under weak stock management principles to boost spawning escapement in the Klamath at the time. However, although some limited recovery has since occurred, unless the ongoing decline of inland habitat is also halted and eventually reversed, there is little more that fisheries managers can do.[25] In other words, without improvements in salmon spawning and rearing habitat throughout the Klamath Basin, including the legal enforcement of adequate water flows from the Upper Basin, all fishing closures can do is postpone an inevitable extinction for a few short years.

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25. *Fisheries management agencies have no effective legal authority to halt or reverse habitat declines, only to regulate fisheries and fish harvests.*

Table 1
Summary of Habitat Constraints in the Klamath Basin

Subbasin	Anadromous Fish Present [a]	Sedimentation Problems	Low Flow Problems	Water Quality Problems	Unscreened Diversion in Anadromous Areas	Migration Barriers	Potential Hydroelectric Projects in Anadromous Areas
Upper Klamath	None			High temperatures, high nutrient levels in Klamath River		Iron Gate Dam	
Upper Trinity	None			None identified		Lewiston Dam	
Shasta	fall chinook steelhead coho Pacific lamprey	Throughout subbasin	Throughout subbasin	High temperatures and high nutrient levels in Shasta River below Lake Shastina	32 locations	None identified	Parks Creek Shasta River
Scott	fall chinook steelhead coho Pacific lamprey	Scott River below Etna Moffett Creek Mill Creek Sugar Creek French Creek Etna Creek Shackleford Creek	Throughout subbasin	High temperatures in lower Scott River	57 locations	None identified	Duzel Creek
Salmon	spring chinook fall chinook coho steelhead Pacific lamprey green sturgeon	None identified	None identified	High temperatures in lower Salmon River	Black Gulch Creek South Fork Salmon River	Salmon River (Nordheimer slide and falls) Black Bear Creek South Fork Salmon River	None identified
Mid-Klamath	spring chinook fall chinook coho steelhead Pacific lamprey	Klamath River from Iron Gate to Shasta River; locally on Dry, Tenmile, Elk, Indian, and Thompson Creeks	Horse Creek Seiad Creek	Hight temperatures and high nutrient levels in Klamath River	39 locations	South Fork Clear Creek East Fork Indian Creek Dillon Creek Walker Creek	Bogus Creek Dillon Creek Horse Creek East Fork Indian Creek Walker Creek
Lower Trinity	spring chinook fall chinook coho steelhead Pacific lamprey green sturgeon	Throughout subbasin	Trinity River Mill Creek Soctish Creek Supply Creek Hostler Creek	High temperatures in Trinity River; possible hazardous wastes in Trinity River, Hostler Creek, Supply Creek, and Mill Creek	Cedar Creek	None identified	Mill Creek Supply Creek Willow Creek
Mid-Trinity	spring chinook fall chinook coho steelhead Pacific lamprey green sturgeon	Trinity River Grass Valley Creek	Trinity River Weaver Creek Big Bar Creek Browns Creek Reading Creek Indian Creek	None identified	None identified	East Fork Weaver Creek Big French Creek	Big Bar Creek Big French Creek
South Fork Trinity	spring chinook fall chinook coho steelhead Pacific lamprey	Throughout subbasin	Hayfork Creek Tule Creek Ditch Gulch Creek Barker Creek Little Creek	High temperatures in lower South Fork Trinity River, Hay Fork Creek, and Rattlesnake Creek	20 locations	Grouse Creek Prospect Creek Rattlesnake Creek Tule Creek, Little Creek Little Creek, Big Creek	Ammon Creek Carr Creek Eltapom Creek Grouse Creek Plummer Creek
Lower Klamath	spring chinook fall chinook coho steelhead Pacific lamprey green sturgeon	Salt Creek Hunter Creek McGarvey Creek Ah Pah Creek State Creek Red Cap Creek	None identified	High temperatures in Klamath River	None identified	None identified	Bear Creek Pine Creek Tully Creek Blue Creek

[a] Other anadromous fish species are also present.
These species are considered the most important.

Estimates of Pre-Development Klamath River Salmon Run Size

Historically, salmon were an important food source and cultural symbol for the Indian tribes of California. "It's been a part of the culture, the religion and the diet for thousands of years," said Mike Orcutt, director of the fisheries department for the Hoopa Valley Tribe along the Trinity River. "The salmon runs were dependable and dried salmon provided food for the winter."[26] However, virtually no reliable data exists concerning the magnitude of historic Native American harvest levels on the Klamath and Trinity Rivers.

The California Department of Fish and Game (CDFG) first set the Klamath Basin fall run chinook spawning escapement goal at 115,000 in 1978. This rebuilding goal was based on Klamath Basin escapement estimates for the early 1960s and includes 97,500 natural and 17,500 hatchery spawners.[27] The PFMC later adopted this goal, which however has never been met.[28] By 1983, the goal was modified downward to include a "rebuilding schedule" whose first step, to be in place for four years, was a goal of 68,900 spawners, with the 115,000 goal to be in place by 1995.[29]

Soon into the rebuilding plan it became obvious, however, that even though these goals were only a small fraction of the original run size that they still could not be met within the present seriously degraded state of inland habitat. Therefore, in 1986 and long before any of these goals could be met, a whole new methodology was introduced by which the fishery itself was to be managed (see Appendix A, "A Brief History of Klamath Basin Fisheries Management" for more details on how current fishery management practices evolved). Nevertheless these remain the "official" rebuilding goals for salmon in the basin.

Coho runs from the North coast numbered about 150,000 annually in the 1940's decade, while steelhead runs were estimated to be about 300,000.[30] Since no other information is available on coho and steelhead, a factor of 50 percent harvest rate is used in our calculations as an estimate of what would be potentially available. Thus the estimate is that the Klamath River could have supported harvests of up to 75,000 coho and 150,000 steelhead at that time.

For purposes of analysis some assumptions needed to be made about species/run composition of the chinook salmon harvested, since their economic value varies by species/run. Acknowledging

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26. *"California's Chinook Salmon: Upstream Battle to Restore the Resource," Water Education Foundation, Western Water, November/December 1992.*

27. *Boydstun, L.B., "Draft Evaluation of Klamath River Fall Chinook Escapement Options," Memorandum, September 8, 1988, California Fish and Game.*

28. *"An Assessment of the Current Carrying Capacity of the Klamath River Basin for Adult Fall Chinook Salmon", Hubbell and Boydstun, CDFG, Sept. 1985.*

29. Ibid., *see also "Final Framework Amendment for Managing the Ocean Salmon Fisheries...", PFMC, October 1984, p. 3-20.*

30. *"An Environmental Tragedy: Report on California Salmon and Steelhead Trout," State of California, California Department of Fish and Game, March 15, 1971.*

differences, for purpose of analysis species of harvested chinook are thus assumed to be in the same proportion as in the Sacramento system (i.e. 5% late fall, 10% winter, 37% spring and 48% fall).

There are no generally accepted estimates of pre-development salmon run sizes for California rivers except for the Fisher estimates of Central Valley stocks.[31] For the Columbia River study, the Northwest Power Planning Council made its estimates based on review of habitat and on historical catch records. However, using the number of square miles of viable salmon habitat in a basin as a factor and interpolating production numbers from similar basins where data is more complete, it is possible to arrive at workable estimates of pre-development runs of up to 4 million fish in the Sacramento/San Joaquin system and 1.1 million in the Klamath system (Table 2). These are the figures assumed for purposes of our analysis.

Table 2
Comparison Between Three River Systems: Columbia River, Sacramento/San Joaquin System, and Klamath River, in Terms of Total Square Area, Salmon Habitat Miles, Best Estimate of Historical Harvests, and Present Escapement

	Total Salmon Habitat Land Area in Basin	Pre-Development Habitat Stream Miles	Historic Record Harvests (No. of Fish)	Estimated Pre-Development Runs	Escapement Goal
Columbia River System	163,000 sq. miles to 260,000 sq. miles /1	14,666 miles of stream /1	3 to 3.6 /4, record canning pack 630,000 cases, about 40 million pounds	10–16 million fish	varies for stocks in the Columbia
Sacramento/ San Joaquin System	38,340 sq. miles /2	6,000 miles of stream /3	12 million pounds /5, average 5 million pounds from 1873–1910	1.95 million /6 to 4.0 million fish /7	122,000–180,000 /9 (mostly hatchery)
Klamath River System	9,691 sq. miles	no estimates	no estimates	0.66 to 1.1 million fish /8	97,500 natural, 17,500 hatchery /10

Notes:
1. Prior to development, over 163,000 square miles of salmon and steelhead habitat existed in the Columbia River. (Compilation of Information on Salmon and Steelhead Losses in the Columbia River Basin. Appendix D of the 1987 Columbia River Basin Fish and Wildlife Program. Northwest Power Planning Council. Portland, Oregon. Page 87.) The Columbia River drains a watershed that is 260,000 square miles. (Bonneville Power Administration. "The World's Biggest Fish Story: The Columbia River's Salmon." Backgrounder. July 1987. Page 4.)
2. John Snyder. California Department of Water Resources.
   Sacramento = 26,548 square miles
   San Joaquin = 11,792 square miles
   Delta = 4,154 square miles
   Personal communication, January 1996.
3. The California Department Fish and Wildlife feels this estimate made in 1928 is too high. ("An Environmental Tragedy." Report on California Salmon and Steelhead Trout. Assembly Concurrent Resolution #64/1970 Session. March 1971. California Department of Fish and Game.)
4. High years:
   1892 = 3.3

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31. *Fisher, Frank W., "Past and Present Status of Central Valley Chinook Salmon," Conservation Biology, Vol. 8, No. 3, September 1994.*

1895 = 3.3
1898 = 3.3
1911 = 3.1
1918 = 3.6
1919 = 3.1
1923 = 3.2
1924 = 3.1
1926 = 3.0

Radtke, Hans D. and Shannon W. Davis. "Lower Columbia River/Young's Bay Terminal Fisheries Expansion Project." Salmon For All. January 1996.

In 1882, the California commercial salmon catch reached its historic peak of 12 million pounds. (E.R.G. Pacific, Inc. "The Economic Issues Associated with the Commercial Salmon Fisheries and Limited Entry in California." A Report to the California Commercial Fishing Review Board. October 1986. Page 1.)

6. Fisher, Frank. "Past and Present Status of Central Valley Chinook Salmon." Conservation Biology. Volume 8, No. 3. September 1994.
7. This estimate is based on the Columbia River Basin land area ratio to Sacramento/San Joaquin land area. This may be a high estimate, especially when compared to Frank Fisher's estimate of 1.95 million fish from the Columbia River.
8. Based on the land area ratios, the Klamath area could have had a pre-development run size of about 0.65 to 1 million fish.
9. Includes natural and hatchery fish. ("Review of 1994 Ocean Salmon Fisheries." Pacific Fishery Management Council. Portland, Oregon. 1994. Page 8.)
10. Although natural production from the Klamath system includes both spring and fall runs, only the dominant fall run is managed by the PFMC. ("Review of 1994 Ocean Salmon Fisheries." Pacific Fishery Management Council. Portland, Oregon. 1994. Page 11.) The escapement goal has been changed to 33%–34% in 1987 with a floor of 35,000. "Natural" as defined by the California Dept. of Fish and Game is not, however, the same as "wild." "Natural" as CDFG uses it may include any hatchery-origin fish so long as it is found outside the hatchery (see discussion in the body of this report).

Surprisingly, there has been little effort to determine the actual population size of the remaining wild salmon runs still left in the Klamath. Thus it is very difficult to determine whether in fact these populations are still declining or by how much. In fact, the current data collection and stock classification system used by the California Department of Fish and Game (CDFG) actually obscures this data. CDFG now classifies **all** fish found in hatcheries as "hatchery fish" *regardless of origin*. What is worse, all fish that are found **outside** of hatcheries **during any given sample period** are classified de facto as "natural fish," *again regardless of genetic origin*. It is obvious that some wild fish may stray into hatcheries, but more important is the fact that the vast majority of hatchery fish *never make it back to their hatchery of origin,* and thus would (if found anywhere just short of the hatchery) be classified by CDFG as "natural fish."

This practice blurs and obscures important genetic differences between hatchery stock (often imported) and the remnant wild stocks, leads to genetic dilution of the hard-won survival traits of the overall wild fish population, and almost completely masks actual wild stock declines. Since these "natural" fish are often confused in the literature with truly indigeneous "wild" stocks, this practice can also easily lead to gross over-estimates of native fish populations. This in turn allows grossly inflated estimates of the success of agency stock reseeding practices and rosy estimates of the total fish present in the system.

However, "natural" fish are not "wild" fish as geneticists define them. Only a comparison between pre-development genetically indigenous *wild* fish and current genetically indigenous *wild* fish populations gives a meaningful estimate or a true "before and after picture" of the extent of indigenous wild salmon stock declines.

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It is clear, though, that the majority of the returning Klamath Basin salmon are now hatchery reared fish, rather than wild fish. However, hatchery fish—unlike their wild counterparts—require the continual input of human dollars and energy to generate them, and are thus more costly to society than their wild counterparts. Hatchery production costs must first be subtracted to get their net economic value. These costs also vary from year to year depending upon widely fluctuating survival rates. In years of good ocean conditions when survival rates are relatively high, hatchery program costs can be amortized over a larger number of returning adults. However, in years of very poor ocean conditions (or when other habitat factors seriously affect smolt survival) the costs of hatchery production must then be amortized over a much smaller number of harvestable fish.

Hatcheries are used most often to compensate for habitat that for all practical purposes can never be restored (as above an impassable dam) as a way to continue to produce at least some fish for sport and commercial harvest. This type of "mitigation hatchery" serves an important economic function. Without mitigation hatcheries there would be nothing coming from many river systems because their native runs have long since been destroyed. However, the belief that hatcheries can adequately and forever substitute for salmon genetically adapted for millions of years for survival in the wild may be a false dream. Precipitous declines of wild salmon runs throughout the region is fundamentally *a biological and social problem* caused by widespread habitat destruction and the way we misuse our own technology.

While hatcheries play (and should continue to play) an important role in maintaining commercially harvestable populations in many areas, hatchery programs should be managed to *supplement and maintain* wild runs, not to *replace* them. Protection and restoration of wild runs puts a limit on land use activities which destroy watersheds, and thus imposes a limit on corporate greed. All too often the mere existence of a hatchery simply becomes a politically expedient excuse to avoid protecting wild fish habitat at all.[1]

Also, hatcheries cost money to run. Even productive hatcheries are now finding it harder to find funding in an era of severely declining state and federal budgets. Hatchery programs can suffer from genetic problems, disease, stress on juvenile fish from overcrowding, behavioral problems with hatchery-reared fish failing to adapt to wild conditions, and many other problems. Overproduction in some years may lead to precipitous declines in both hatchery and wild returns in other years. Also, hatchery programs which are run without careful attention to genetic impacts or competition effects on wild salmon populations can potentially be devastating to the genetic integrity of wild runs.[2]

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1. *This report does not attempt to quantify the job base currently being maintained by the existing hatchery production programs in the Klamath. Unfortunately, the data available to us will not allow us to make that assessment unless a great deal more information about the costs of each of these hatchery programs on a per smolt and per returning adult basis is obtained.*

2. *For the most recent criticism of hatchery production programs see the National Research Council report "Upstream: Salmon and Society in the Pacific Northwest," National Academy Press (1996), which concluded among other things that: "Despite some successes, hatchery programs have been partly or entirely responsible for detrimental effects on some wild runs of salmon." For a good summary of all the scientific*

Artificial hatchery production rarely duplicates the high survival rates and genetic adaptability of wild fish. Neither can hatcheries adequately substitute for the loss of natural spawning and rearing habitat.[3] Nor can hatchery production really get fishery management out of the "weak stock management" and ESA downward spirals it has gotten itself into, since these problems are based on wild fish which still continue to decline. Finally—as a matter of political realism—shrinking agency budgets will mean many hatchery programs are likely to be closed simply for lack of funds.

These and many other factors make ultimate reliance by the fishing industry on hatchery programs unstable in the long term. *Ultimately, the only way to "hedge bets" biologically and economically so as to assure a future west coast salmon fishery is to maintain and restore (to as great an extent as possible) the wild salmon runs which are uniquely adapted to long term survival.*

Hatcheries must still be used where necessary to mitigate for permanent loss of habitat and in order to maintain a commercial fishery in the interim, but within an overall policy of genetic conservation <u>coupled with an aggressive program of habitat protection and restoration</u>.

For a more detailed summary of Klamath Basin hatchery practices and problems, refer to Appendix B, "The Role of Hatcheries in the Klamath Basin."

How Much is the Klamath Salmon Fishery Worth?

Because most jobs in the fishing industry are seasonal rather than full-time, published employment figures of commercial and recreational fishing may be misleading. Therefore, full-time equivalent employment numbers must be calculated by dividing the estimated total personal income generated by fishing activity by a representative annual personal income average. In the Pacific Northwest, a $20,000 per year wage or salary is a fair representation of a full-time equivalent job when considering all jobs that are generated by an activity, from crewmen to waitresses to lawyers.

Each fish harvested produces a net economic benefit to society as it travels through the chain of commerce from the boat to the consumer's table. The combined sums of all those benefits is the 'net personal income impact' of that one fish.[4] These values have been quantified for the Klamath Basin in previous studies. For instance, in a recent study entitled "Fishery Values of the Klamath Basin—A

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literature on hatchery and supplementation programs generally and the many problems they face, refer to U.S. Dept. of Energy, Bonneville Power Administration Technical Report 1990 (September, 1990), "Analysis of Salmon and Steelhead Supplementation," (Document DEO/BP-92663-1).

3. *Destroying in-stream salmon habitat destroys both hatchery and wild fish alike. Once released into the wild, hatchery fish use the very same feeding and sheltering habitat as do wild fish. Destroying stream habitat for wild fish will also decrease survival rates of hatchery fish—a double whammy which threatens to collapse both wild and artificial runs simultaneously. Allowing the destruction of the wild stocks which have genetically adapted to a particular river system for millions of years also extinguishes the very best gene pool from which to replenish that river's hatcheries.*

4. *In other words, the sum of all the direct, indirect and induced economic activity generated by that product as it makes its way through the chain of commerce.*

Report to CH2M Hill," by Meyer Resources, Inc., May 1984, printed in "Klamath River Basin Fisheries Resource Plan," U.S. Department of the Interior, February 1985, an estimate was made of the potential annual benefits associated with a catch of 1,000 adult Klamath salmonids to be $252,170 including all direct, indirect and induced market-based economic benefits expressed in 1996 dollars (see Table 4).

However, Meyer's study made no effort to assess historic run sizes. Using the numbers developed in this report by Radtke is appropriate as the best available estimate of the biological potential of the Klamath Basin for salmon production. We therefore combine Meyer's figures with the estimated pre-development run sizes derived in Table 2 to give us a number for the "net economic benefit" which is missing from the salmon-based economy due to recent declines and losses.

Assuming the escapement estimates developed above of between 657,500 to 1,090,000 million adult equivalents to be accurate, and assuming only a 50% harvest rate, this would indicate under Meyer's methodologies that the Klamath should be able to produce a total annual income stream of between $82,900,878/year and $137,432,650/year in *market-based* salmon related economic benefits alone (i.e., excluding any of Meyer's non-market values) when expressed in 1996 dollars.

From this we can easily calculate that a total job base (at $20,000/job, which is at or near regional median income) of *between 4,145 to 6,870 family wage jobs could potentially be supported by fishing in or generated by this basin. This is the potential economic productivity of the Klamath as a salmon producer in today's economy. It is also a measure of the potential number of jobs which are at risk if salmon declines in the basin continue.*

At a pre-development run size of about 1.1 million fish in the Klamath Basin (and again at a 50% harvest rate) it may be calculated that about 0.55 million fish could have been available for harvest at a sustainable level, compared to 250,000 to 300,000 fish that have been harvested from the Klamath Basin in recent years. By not attaining the potential habitat productivity of the Klamath Basin for producing salmon, the Pacific Northwest and northern California region is therefore sacrificing between 250,000 to 300,000 additional fish. Using Meyer's estimates for the economic value per 1,000 adult harvested salmon (Table 4), this may be equated to *about 3,150 to 3,780 annual family wage jobs that are lost to the in-river and coastal salmon fishing economy as a direct result of the Klamath River Basin's damaged habitat.*[5]

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[5]. *The range difference results from differences in run size, which vary naturally depending on variations in ocean conditions and other factors.*

to 300,000 additional fish. Using Meyer's estimates for the economic value per 1,000 adult harvested salmon (Table 4), this may be equated to *about 3,150 to 3,780 annual family wage jobs that are lost to the in-river and coastal salmon fishing economy as a direct result of the Klamath River Basin's damaged habitat.*[35]

Using the same methodologies and then applying various discount rate assumptions such as in Table 5, the estimated net asset value of the Klamath Basin salmon fishery as a whole (assuming this kind of potential income stream over time) should be at least $4.5 billion (to the nearest significant figure), using a relatively conservativc 3% discount rate. In other words, the net value to society of the "natural capital" that these Klamath Basin wild salmon runs represent could be at least $4.5 billion under standard (even conservative) economic assumptions.

We use the term "at least" because using other less conservative (but still quite justified) discount assumptions gives values as high as $13.8 billion. Also, none of the indirect market benefits derived from potential additional harvest opportunities on other (non-Klamath) salmon which would likely be available once "weak stock management" constraints are removed (as they would be once weak stocks are restored) are calculated into these figures. These secondary benefits are outside the scope of this study but are likely to be substantial.

This figure also excludes **all** economic benefits allocated by Meyer (Table 4) to the category of "non-market benefits" and so may be greatly understating the true social value of this fishery. Once added back in these non-market economic benefits would bring the total annual personal income impacts to potentially as high as $374.86 million/year. Using the same relatively conservative discount assumptions (3% over a term of 100 years), the calculated net asset value of this fishery would then be potentially *at least $11.85 billion up to $37.486 billion/year* assuming a less convervative 0% discount rate.

We have omitted these non-market values only because there is as yet no broadly accepted methodology for calculating them, not because they are unimportant. However, this omission means our calculated minimum net asset value of $4.5 billion is probably a very conservative estimate.

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35. The range difference results from differences in run size, which vary naturally depending on variations in ocean conditions and other factors.

Table 3
Annual Potential Harvests Which Could Be Derived from Historic Salmon and Steelhead Run Sizes in the Klamath Basin

Species	Estimated Pre-Development Run Size - Range /1	Harvest (at 50% of Run Size) - Range	Average Weight per Fish (pounds)	Total Fish Weight (pounds) - Range
Late Fall Chinook	22,500 - 45,000	11,250 - 22,500	15.0	168,750 - 337,500
Winter Chinook	45,000 - 90,000	22,500 - 45,000	15.0	337,500 - 675,000
Spring Chinook	160,000 - 320,000	80,000 - 160,000	15.0	1,200,000 - 2,400,000
Fall Chinook	205,000 - 410,000	102,500 - 205,000	15.0	1,537,500 - 3,075,000
Coho	75,000 - 75,000	37,500 - 37,500	9.0	337,500 - 337,500
Steelhead	150,000 - 150,000	75,000 - 75,000	8.5	637,500 - 637,500
Total	657,500 - 1,090,000	328,750 - 545,000		4,218,750 - 7,462,500

Notes: Based on square mile comparisons between Columbia River and estimates of historic species comparison of the Sacramento River for chinook. Coho and steelhead estimates are based on Northern California harvest rates.

Table 4
Potential Annual Benefits Associated with a Catch of 1,000 Adult Klamath Salmonids (from Meyer) in 1984 Dollars

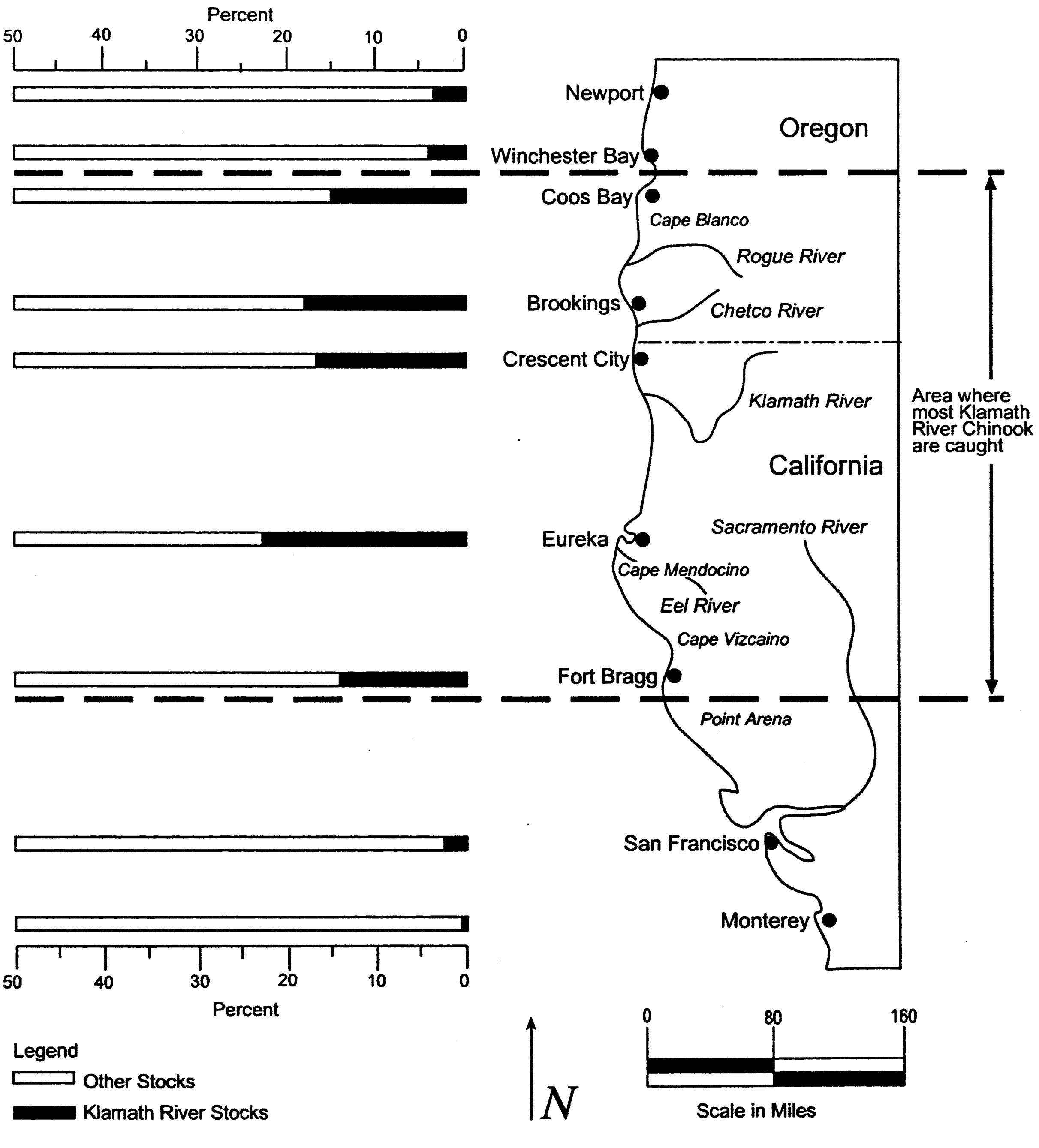
Benefiting Group	Business Benefits in Dollars	Non-Market Benefits in Dollars (based on restorative activity)	Subsistence, Cultural, Religious, & Social Benefits
Commercial Fishermen			Supports way of life Provides 7,000 to 7,500 lbs of food
• Chinook	22,090		
• Coho	14,040		
Sport Fishermen			Provides 7,000 to 7,500 lbs of food
• Chinook/coho	28,730	128,080	
• Steelhead		172,370	
Indian Peoples			Maintains cultural and religious well-being Provides 7,000 to 7,500 lbs of food
• Chinook	22,090		
• Coho	14,040		
Coastal Communities			Provides 7,000 to 7,500 lbs of food Supports basic community way of life
• Commercial chinook	10,030		
• Commercial coho	6,380		
• Sport fish	56,510		

MARKET BENEFITS = $173,910 (expressed in 1984 dollars [36])

Note: One problem with using that figure today was that it was in 1984 dollars. In order to convert that into 1996 dollars one must use an escalation factor derived from the increases in the Consumer Price Index since that

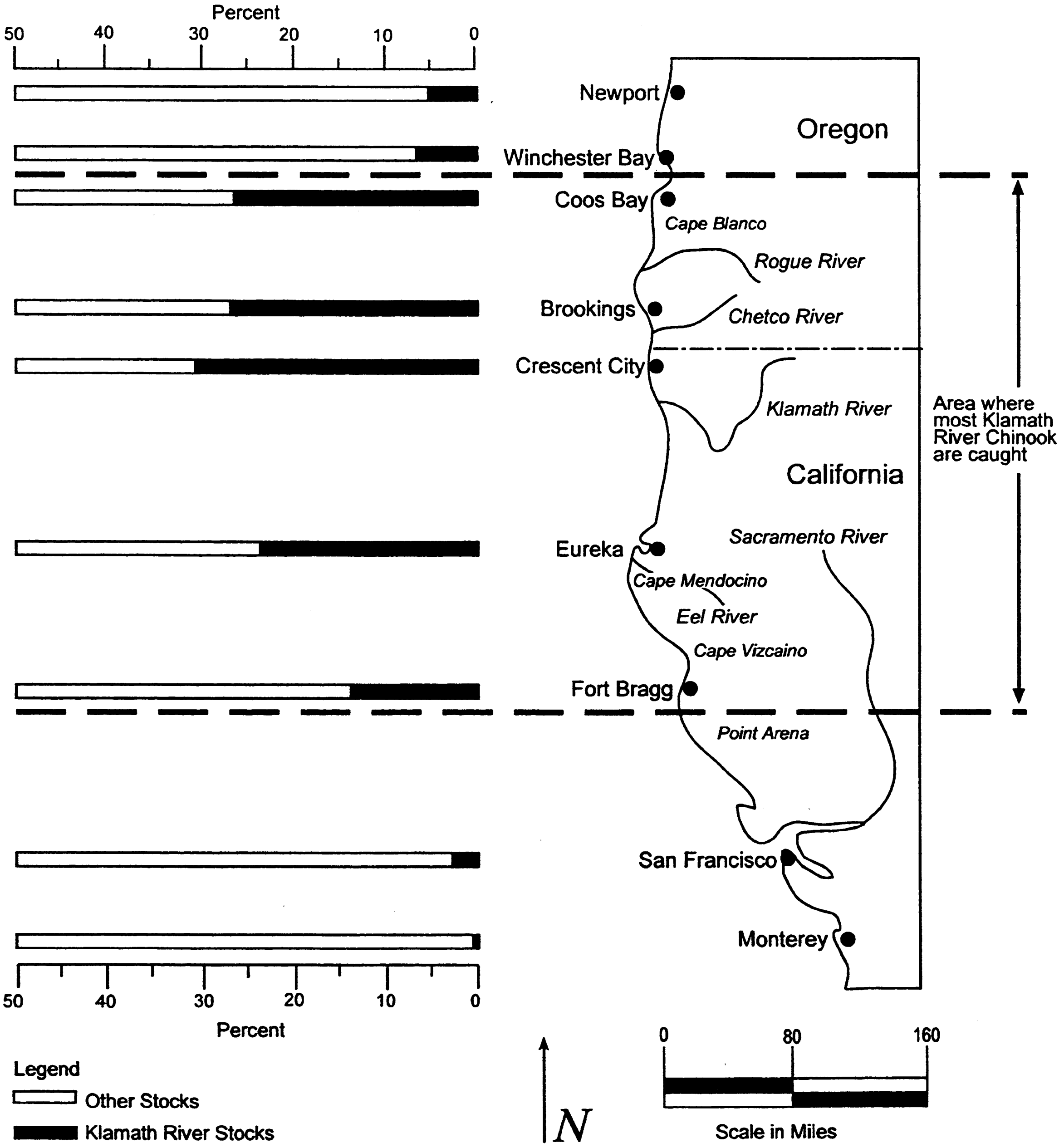
36. *The Meyer report relied heavily on recreational and aesthetic non-market benefits to estimate total economic values of restoration. However, these values are inherently less certain and more speculative than purely market values. The decision was therefore made in this report to use commercial value as our sole indicator of economic value because it is the most easily quantifiable using well established methodologies.*

Figure 4
Distribution of Recoveries of Coded Wire Tagged Klamath Fall Chinook in the 1979–1983 Ocean Fisheries



Source: US Dept. of Interior (1985), maps prepared by CH2M Hill.

Figure 5
Contribution of Coded Wire Tagged Klamath Fall Chinook by Port in the 1979–1982 Ocean Fisheries



Source: US Dept. of Interior (1985), maps prepared by CH2M Hill.

Sustaining Long Term Restoration

In recognition of the importance of the Klamath Basin to the entire west coast fishery, there are several federal Klamath Basin fish habitat restoration efforts currently underway. These include:

The Klamath River Basin Fisheries Restoration Task Force (16 U.S.C. 460ss-3 et. seq. (P.L. 99-552 (October 27, 1986) as amended by P.L. 102-570)—Created the Klamath River Basin Conservation Area Restoration Progam and the Klamath River Basin Fisheries Task Force to develop and implement salmon restoration programs within the basin as a whole. Congressional funding authorizations for this entity continue until the year 2006, but are dependent upon annual appropriations.

The Trinity River Basin Fish and Wildlife Task Force (created by P.L. 98-541 (October 24, 1984) as amended by P.L. 104-143)—Created as a federal task force to "restore the fish and wildlife populations to levels approximating those which existed immediately before" various dams and water diversion projects on the Trinity River which damaged fish and wildlife resources. Its designated projects included rehabilitation of fish habitats between Lewiston and Weitchpec Dams and the modernization of the Trinity River Fish Hatchery. Congressional funding was authorized only for a ten year year period until 1995, then extended by P.L. 104-143 only until October 1, 1998, with some additional program changes. All funds are dependent, however, upon annual Congressional appropriations.

The Upper Klamath Basin Working Group (established by Division B, Title II, Section 201 of H. R. 3610 (Omnibus Consolidated Appropriations for Fiscal Year 1997) from the 104th Congress, signed into law on September 30, 1996)—This newly formed "Working Group" is empowered to "propose ecological restoration projects, economic development and stability projects, and projects designed to reduce the impacts of drought conditions" in the Upper Klamath Basin (i.e., above Iron Gate Dam), and is supposed to coordinate its activities with both the Klamath River Basin Fisheries Task Force and the Trinity River Basin Fish and Wildlife Task Force. Funding is authorized until 2001, but is once again subject to annual Congressional appropriations.

In addition, an inter-state coordinating and dispute resolution body was created by the Klamath River Basin Compact in 1957, composed of three members: a California representative, an Oregon representative and a federal representative (non-voting) in order to: (a) 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; (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.

The Klamath River Basin Compact became effective on September 11, 1957. The exact terms of the Compact can be found in several places, including in the Oregon Revised Statutes (ORS) at 542.620 and as ratified by the State of California in Chapter 113, California Statutes 1957 (signed by the California Governor on April 17, 1957). The actual powers of the Klamath River Compact Commission are fairly limited, however, and its authority has not been much used in recent years.

institutions necessary to carry out a decades-long watershed restoration project on a well-organized and sustainable basis simply do not yet exist. Habitat restoration has to become firmly institutionalized and sustainable over decades if it is going to succeed.

Reliance on in-stream restoration projects alone will also not lead to recovery. The fundamental land use practices which are powering salmon habitat destruction must also be corrected, or otherwise any gains due to in-stream restoration efforts will eventually be swamped by continued watershed-wide deterioration. Most in-stream restoration projects are at best only short-term emergency measures intended to buy enough time to allow longer-term natural watershed healing processes to take place. However, this natural watershed healing process is frequently inhibited or blocked by land use practices (including excessive timber harvest, overgrazing, mining pollution and confiscation of in-stream water flows for human use) which then prevent any natural recovery.

Natural ecosystems can tolerate a wide range of disturbances and eventually recover. However, the **magnitude** of human disturbances in salmon producing watersheds can now be *two to three orders of magnitude more* than these natural systems were adapted to tolerate.[41]

Additionally many small-scale impacts can have a combined "cumulative impact" which is far greater than natural watershed restoration processes can easily overcome (at least on less than a geologic time scale). Other impacts may result in a "change of state" which can become a stable (and change resistant) ecosystem in its own right. For instance, in arid areas the removal of large riparian conifers by logging, when combined with later riparian grazing, can *permanently alter* the vegetation types of that riparian area in ways that make it highly unlikely that conifers will ever naturally re-establish themselves within any conceivable human time scale.

In summary, it is not enough to have the will and means to begin salmon restoration efforts in a serious way. In order to be successful these efforts must be targeted carefully for the greatest long-term public benefit, must take upland and other land use practices into account and mitigate those impacts, must help re-establish and accelerate natural watershed healing processes, and must be institutionalized so that they can be fully sustained over what in human terms is a very long period of time.[42]

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biennial budgets by their state Legislature. The longest term institutionalized restoration effort to date (the Klamath River Basin Fisheries Restoration Task Force) has only a 20 year term, of which approximately 10 have already elapsed.

41. *See for instance Sommarstrom.* et. al. *(1990),* op. cit. *(note 9). In that study erosion from logging roads was calculated to be up to 200 times (2 orders of magnitude) more than what would have naturally occurred.*

42. *Salmon restoration is dependent to some degree on the restoration of old growth conifer forests in riparian areas in the Pacific Northwest and northern California. Fully 2/3 of salmon habitat in these states is on private lands. Since old-growth forests are now for all practical purposes non-existent on private lands, the process of re-establishing such forests on private lands will take (at a minimum) about 120 years. This is the time frame salmon restoration programs should be conducted in.*

Table 6
A Partial List of Agencies and Tribes with Jurisdiction Over Fishery and Habitat Management in the Klamath Basin

FEDERAL

- Department of the Interior
  - US 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 conversation Service (SCS)

ENVIRONMENTAL PROTECTION AGENCY (EPA)

- Department of the Army
  - Army Corps of Engineers (ACE)
- Department of Energy
- Federal Energy Regulatory Commission (FERC)
- Klamath Basin Ecosystem Restoration Office (ERO)—inter-agency

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 & Fire Protection (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)
- Water Resources Department (WRD)
- Environmental Quality Department
- Division of State Lands

REGIONAL OR COMPACT COMMISSION

- Klamath River Basin Compact Commission
- Pacific States Marine Fisheries Commission

LOCAL

- Counties
- Resource Conservation Districts (RCD)
- Cities

Source: Klamath River Basin Fisheries Task Force, "Long Range Plan for the Klamath River Basin Conservation Area Fishery Restoration Program," (January, 1991), adapted from page 7–14.

APPENDIX A

The California Salmon Fishery—Historical Overview

We should include a somewhat detailed discussion on California based chinook landings in order to describe the historical harvests. Most descriptions of California salmon harvests only include salmon caught off California waters. However, California-produced chinook are harvested in several areas by several methods. These are:

- Commercial harvest off California coast
- California recreational harvest (ocean and in-river)
- Oregon commercial harvest
- Oregon ocean recreational harvest

Once all of these harvests are included in the figures for California based landings, there is a significant increase in total landings. For example, if the recreational California landings are added to California commercial landings between 1962 and 1990, this should show an additional 0.8 to 1.3 million pounds of chinook produced by California rivers. In addition, 50 percent of all Oregon chinook landings (commercial and recreational) should be added to the total average of about 7 million pounds of chinook caught commercially in California (Table A-2). On average about 1.5 million pounds of chinook from California waters contribute to the Oregon fisheries (about 20 percent of all California chinook). The total average poundage harvested from California-produced fish is therefore about 10 million pounds.

Utilizing a 10 pound average per fish, this would indicate that in recent history the West Coast harvest of California chinook has been about 1 million fish. When salmon are harvested, for every one salmon that is retained, one salmon is released. The mortality rate of these non-retained fish is about 25 percent. If this mortality is included as a harvest, the total annual harvest may be about 1.25 million fish per year. These 1.25 million fish may weigh 12.5 million pounds (at a 10 pound average). When fish were harvested in pre-development years and in early settlement history (in-river), they may have averaged about 15 to 17 pounds each. That would indicate that recent historic runs of 1.25 million chinook could be compared to up to 20 million comparable pounds that have actually been harvested in the past.

Commercial Salmon Fishery[43]

Establishment of California's catch monitoring ("fish ticket") system in 1916 provided the means to collect comprehensive commercial landings data over time. Although in-river landings of salmon were significant from 1916 to 1957 (the year the Sacramento/San Joaquin in-river commercial fishery was closed), they exceeded ocean landings in only one year—1918 (Table A-1).

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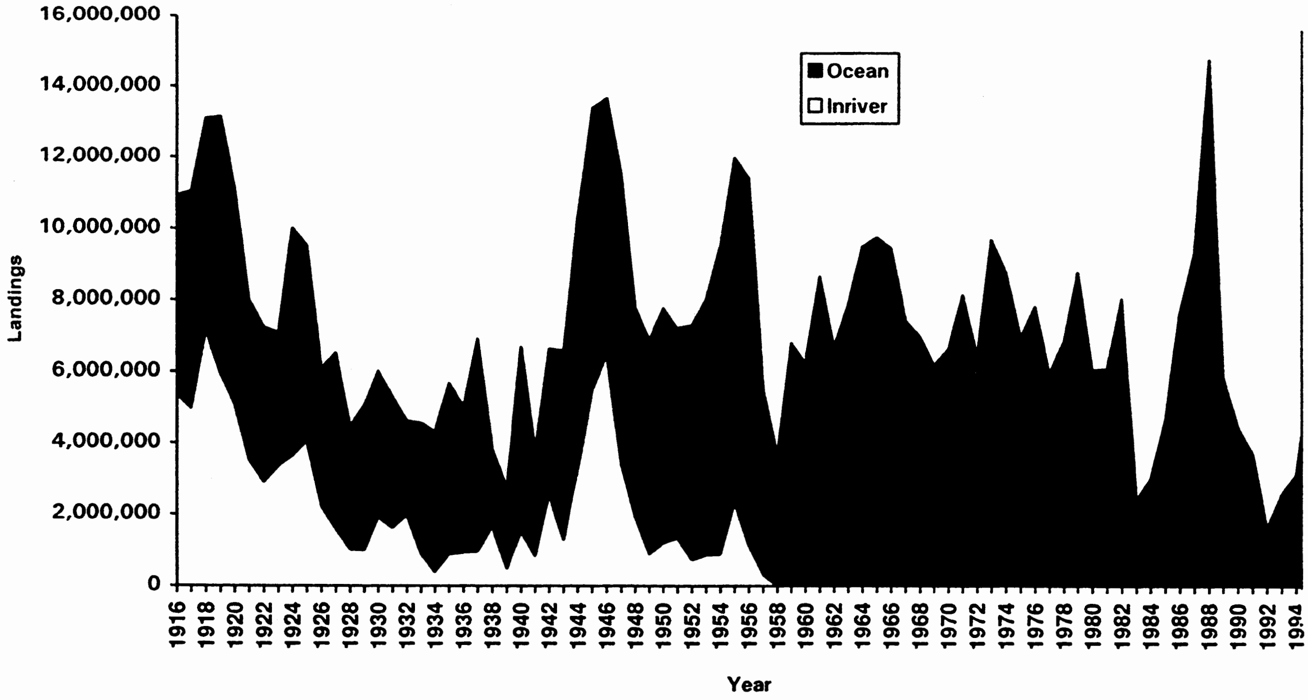
43. Taken from: Thompson, Cynthia J. and Kenneth R. Sakai, "The Indian, Commercial and Sport Fisheries for Salmon and other Anadromous Fishes of the Central Valley: An Historical Perspective," National Marine Fisheries Service, Southwest Fisheries Science Center, La Jolla, California, 1995.

Figure A-1
Commercial Salmon Landings in California (pounds), During the Years 1916–1995



Source: Thompson, Cynthia J. and Kenneth R. Sakai, "The Indian, Commercial and Sport Fisheries for Salmon and other Anadromous Fishes of the Central Valley: An Historical Perspective," National Marine Fisheries Service, Southwest Fisheries Science Center, La Jolla, California, 1995.

Table A-1
California Commercial Salmon Landings (Pounds), by Area, 1916–1995

Year	Eureka	San Francisco	Other Monterey	Total Ocean	Sacrm/San Ocean	Other Joaq Rivers	GRAND Rivers	TOTAL
1916					5,592,216	3,450,786	1,896,592	10,939,594
1917					6,085,997	3,975,487	999,097	11,060,581
1918					5,933,346	5,938,029	1,221,813	13,093,188
1919					7,208,382	4,529,222	1,408,123	13,145,727
1920					6,066,190	3,860,312	1,207,317	11,133,819
1921					4,483,105	2,511,127	996,700	7,990,932
1922					4,338,317	1,765,066	,131,741	7,235,124
1923					3,736,924	2,243,945	1,109,391	7,090,260
1924					6,374,573	2,640,110	1,000,586	10,015,269
1925					5,481,536	2,778,846	1,265,371	9,525,753
1926					3,863,677	1,261,776	958,626	6,084,079
1927					4,921,600	920,786	669,543	6,511,929
19								
28					3,444,306	553,777	480,483	4,478,566
1929					4,033,660	581,497	429,714	5,044,871

Table A-1 (continued)

Year	Eureka	San Francisco	Monterey	Other Ocean	Total Ocean	Sacrm/San Joaq Rivers	Other Rivers	GRAND TOTAL
1930					4,085,650	1,213,698	703,546	6,002,894
1931					3,666,841	941,605	686,065	5,294,511
1932					2,649,204	1,264,987	703,990	4,618,181
1933					3,657,661	454,253	446,520	4,558,434
1934					3,921,530	397,572	0	4,319,102
1935	3,499,610	1,053,787	219,700	15	4,773,112	888,868	0	5,661,980
1936	3,479,716	447,548	144,924	1,020	4,073,208	949,179	0	5,022,387
1937	3,834,568	1,208,414	891,083	931	5,934,996	974,871	0	6,909,867
1938	1,853,715	117,549	199,474	183	2,170,921	1,668,376	0	3,839,297
1939	1,673,151	434,626	125,498	0	2,233,275	496,933	0	2,730,208
1940	3,369,492	1,177,086	613,224	24	5,159,826	1,515,588	0	6,675,414
1941	2,413,368	375,766	153,662	3,198	2,945,994	844,963	0	3,790,957
1942	2,255,862	1,642,017	164,931	462	4,063,272	2,552,944	0	6,616,216
1943	2,162,368	2,021,208	1,101,934	0	5,285,510	1,295,424	0	6,580,934
1944	3,791,094	2,646,714	575,579	7,434	7,020,821	3,265,143	0	10,285,964
1945	4,627,714	2,431,954	816,303	36,783	7,912,754	5,467,960	0	13,380,714
1946	4,544,037	2,079,449	569,350	2,120	7,194,956	6,463,245	0	13,658,201
1947	5,868,577	1,485,657	738,469	11,401	8,104,104	3,380,484	0	11,484,588
1948	4,033,992	1,544,479	230,248	20,658	5,829,377	1,939,801	0	7,769,178
1949	2,601,390	2,455,543	468,757	422,994	5,948,684	899,090	0	6,847,774
1950	2,221,509	2,868,570	769,705	687,294	6,547,078	1,202,890	0	7,749,968
1951	2,022,365	3,165,400	679,128	2,637	5,849,530	1,343,171	0	7,192,701
1952	2,490,809	2,937,533	1,093,955	14,558	6,536,855	738,081	0	7,274,936
1953	2,949,816	3,314,547	790,970	81,082	7,136,415	869,696	0	8,006,111
1954	3,928,941	3,380,182	974,303	314,237	8,597,663	900,961	0	9,498,624
1955	4,811,641	3,936,028	606,469	302,858	9,656,996	2,320,746	0	11,977,742
1956	6,311,608	2,938,586	752,969	271,739	10,274,902	1,139,585	0	11,414,487
1957	3,324,111	1,308,864	431,215	112,719	5,176,909	321,824	0	5,498,733
1958	1,599,019	1,675,040	277,181	105,601	3,656,841	0	0	3,656,841
1959	1,851,924	4,582,942	269,688	64,608	6,769,162	0	0	6,769,162
1960	2,437,406	2,889,532	815,778	78,729	6,221,445	0	0	6,221,445
1961	4,134,991	3,701,733	654,577	146,696	8,637,997	0	0	8,637,997
1962	4,193,530	2,050,993	308,369	119,969	6,672,861	0	0	6,672,861
1963	3,778,433	3,493,591	512,354	74,808	7,859,186	0	0	7,859,186
1964	5,423,263	3,507,464	378,421	172,067	9,481,215	0	0	9,481,215
1965	5,484,287	3,652,201	491,899	109,388	9,737,775	0	0	9,737,775
1966	6,936,426	2,238,476	188,518	83,575	9,446,995	0	0	9,446,995
1967	5,287,540	1,761,930	242,882	109,377	7,401,729	0	0	7,401,729
1968	4,064,343	2,198,806	572,605	116,177	6,951,931	0	0	6,951,931
1969	3,359,570	1,722,027	821,740	247,569	6,150,906	0	0	6,150,906
1970	3,947,351	1,912,462	542,978	208,731	6,611,522	0	0	6,611,522
1971	5,633,210	2,112,796	270,772	100,100	8,116,878	0	0	8,116,878
1972	3,369,156	2,503,404	420,664	130,065	6,423,289	0	0	6,423,289
1973	5,700,647	2,226,719	1,412,520	329,098	9,668,984	0	0	9,668,984
1974	5,125,901	2,774,925	614,111	234,477	8,749,414	0	0	8,749,414
1975	4,312,855	1,734,880	721,102	156,245	6,925,082	0	0	6,925,082
1976	4,840,103	1,725,479	1,009,241	211,465	7,786,288	0	0	7,786,288
1977	3,380,522	1,748,007	602,578	196,926	5,928,033	0	0	5,928,033
1978	4,100,813	1,441,550	861,201	407,426	6,810,990	0	0	6,810,990

Table A-1 (continued)

Year	Eureka	San Francisco	Monterey	Other Ocean	Total Ocean	Sacrm/San Joaq Rivers	Other Rivers	GRAND TOTAL
1979	5,903,142	2,234,562	510,742	101,332	8,749,778	0	0	8,749,778
1980	3,148,475	2,062,847	699,787	112,120	6,023,229	0	0	6,023,229
1981	3,225,901	2,095,280	608,375	116,608	6,046,164	0	0	6,046,164
1982	3,841,351	2,830,544	1,044,747	285,216	8,001,858	0	0	8,001,858
1983	1,128,486	551,599	580,432	154,366	2,414,883	0	0	2,414,883
1984	803,778	1,684,711	445,629	48,538	2,982,656	0	0	2,982,656
1985	2,008,285	2,153,997	410,461	71,663	4,644,406	0	0	4,644,406
1986	2,920,869	2,782,632	1,069,250	831,395	7,604,146	0	0	7,604,146
1987	4,336,614	3,877,908	706,058	385,323	9,305,903	0	0	9,305,903
1988	5,223,748	7,226,164	1,825,712	485,134	14,760,758	0	0	14,760,758
1989	1,878,026	2,677,876	968,796	298,075	5,822,773	0	0	5,822,773
1990	965,531	2,034,445	1,118,147	321,104	4,439,227	0	0	4,439,227
1991	624,003	1,955,803	750,219	371,642	3,701,667	0	0	3,701,667
1992	22,782	999,439	345,230	259,336	1,626,787	0	0	1,626,787
1993	234,166	1,354,906	678,239	309,219	2,576,530	0	0	2,576,530
1994	36,000	2,189,000	831,000	77,000	3,103,000	0	0	3,103,000
1995	8,000	2,784,000	3,162,000	89,000	6,044,000	0	0	6,044,000

Source: Thompson, Cynthia J. and Kenneth R. Sakai, "The Indian, Commercial and Sport Fisheries for Salmon and other Anadromous Fishes of the Central Valley: An Historical Perspective," National Marine Fisheries Service, Southwest Fisheries Science Center, La Jolla, California, 1995.

1916–1990 data obtained from CDFG (1935, 1937, 1940, 1942, 1944, 1946, 1947, 1949, 1951, 1952, 1953, 1954, 1956, 1958, 1960a, 1960b, 1961, 1963, 1964, 1965a, 1965b, 1967, 1968a, 1968b, 1970, 1971, 1973, 1974, 1975, 1976, 1977, 1979, 1990). 1991–1993 data obtained from unpublished CDFG summaries.

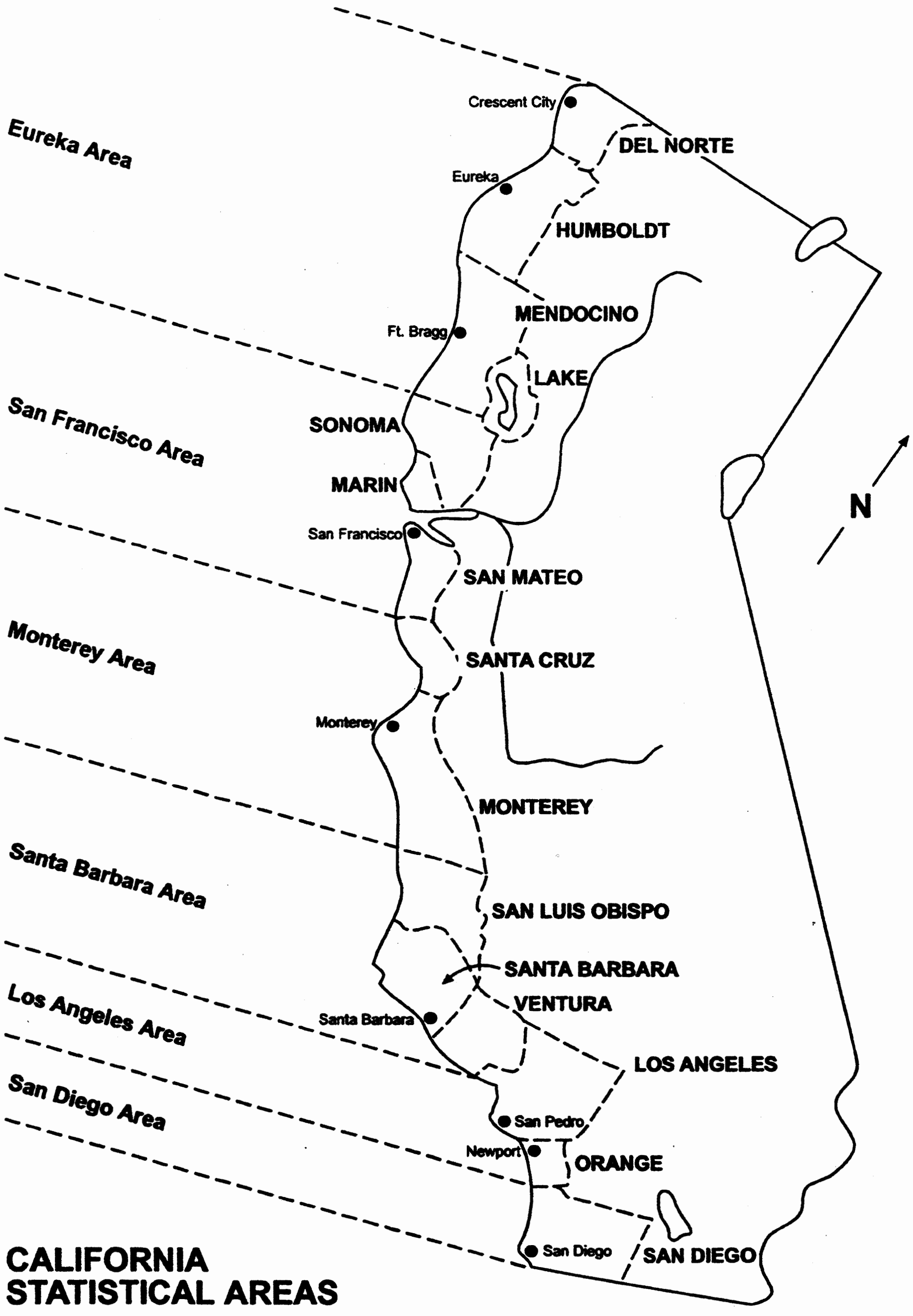
1994–1995 are data from PFMC "Review of Ocean Salmon Fisheries."

Note: Areas are depicted in Figure A-2.

By 1850 a commercial salmon fishery was operating in the lower Sacramento and San Joaquin Rivers, Suisun Bay and San Pablo Bay. Gillnetting, which was introduced by Italian immigrants, was the predominant method of harvest. The first salmon cannery on the west coast began operating on the Sacramento River in 1864. The fishery expanded rapidly, with demand and prices fueled by the gold rush and railroad construction. Annual landings in excess of nine million pounds were experienced during 1880–1883. By 1883 there were 21 canneries in California. Landings subsequently declined, experienced a temporary resurgence during 1907–1910, then declined precipitously during the World War I years. After the last cannery closed in 1919, the river fishery declined somewhat but remained active until 1957, when gill and trammel nets were prohibited in San Francisco Bay and Delta. This legislative action effectively closed the Sacramento/San Joaquin commercial fishery. Scientists attribute the decline of the river fishery to water development projects, competition from ocean trollers and sport fishermen, mining and logging pollution, siltation and industrial waste discharge.

During the late 1800s, the river fishery also expanded northward from the Sacramento/San Joaquin to other coastal rivers (i.e. the Mad, Eel, Klamath, and Smith Rivers). Landings statistics for these other rivers prior to 1916 are not available, although the commercial fishery on these rivers apparently operated on a smaller scale and was more short-lived than the Sacramento/ San Joaquin commercial fishery. The Mad River was closed to commercial fishing in 1919, the Eel in 1922, and the Klamath and Smith in 1933.

Figure A-2
California Statistical Areas



The ocean salmon fishery began operating in the 1880's in Monterey Bay. The first vessels were sailboats utilizing troll gear. In about 1908, some Sacramento River fishermen began using powered gill net vessels to troll in Monterey Bay. Use of this more efficient method of trolling spread northward to Point Reyes by 1914 and Eureka and Crescent City by 1916. Power girdies introduced in the 1920s and 1930s replaced the arduous manual labor required to pull the lines out of the water, and were in widespread use by the late 1940s. With closure of the Sacramento/San Joaquin River commercial fishery in 1957, the commercial salmon fishery became an exclusively ocean fishery.

During 1916–1943, ocean landings ranged from 2.2 to 7.2 million pounds and averaged 4.5 million pounds per year. Landings experienced a general upward shift during 1944–1982, ranging from 3.7 to 10.3 million pounds and averaging 7.3 million pounds per year. Since 1983 the fishery has experienced record high and low landings. Landings in 1983 (the most severe El Niño year of the century) were the lowest since 1939, totalling 2.4 million pounds. Landings subsequently increased to a record high of 14.8 million pounds in 1988 and declined to a new record low of 1.6 million pounds in 1992. Although landings increased to 2.6 million pounds the following year, 1993 was still one of the lowest landings years in the history of the ocean fishery (rivaled only by 1938–1939, 1983 and 1992). The highly variable landings experienced in recent years have been attributed to factors such as the 1986–1992 drought and severe El Niño conditions.

Recent water reforms within the Central Valley Project (prompted first by the ESA listings of the California delta smelt and the winter run chinook, and then institutionalized by the passage of the Central Valley Project Improvement Act of 1992[44]) have helped restore salmon outmigrant water flows to the Central Valley and Delta areas, and these new flow regimes have doubtless also been major factors in recent improvement in central California salmon harvests in 1995 and 1996.

Historically, 2.5 to 5.0 million salmon may have been produced by California river systems annually. At a harvest rate of about 50 percent, the recent harvests of about 1.25 million fish (1962–1990) would indicate that in recent years the annual harvests have been within the range of those possible for pre-development runs. However, the vast majority of these harvested fish would have been of hatchery origin. The once abundant wild runs have now been seriously depressed by widespread habitat loss, water diversion and dams, particularly in the Sacramento and San Joaquin River Basins of the California Central Valley area but also in many portions of the Klamath Basin.

The California Central Valley winter run chinook run was first classified as "threatened" under the federal Endangered Species Act in 1989 (first by emergency rule published in the Federal Register at 54 Fed. Reg. 32085 (August 4, 1989) then permanently at 55 Fed. Reg. 46515 (November 5, 1990)), but then shortly afterwards was reclassified as "endangered" after percipitous declines continued (59 Fed. Reg. 440–450 (January 4, 1994)). This unique run is slowly improving but is still highly vulnerable. Several other historic Central Valley runs (once the mainstay of commercial salmon harvests for much of the coast) are now thought to be extinct.

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44. The Central Valley Project Improvement Act (CVPIA) of 1992 was adopted as Title XXXIV of P.L. 102–575 (October 30, 1992), now codified as 106 U.S. Statutes at Large 4600, Sections 3401 et. seq. The Central Valley Project is the largest federal water project ever undertaken but has had devastating impacts on wild salmon populations in the Sacramento/San Joaquin River systems and some portions of the Trinity River system in the Klamath Basin. The CVPIA makes major reforms in the way water is delivered within the Project to provide for restoration of severely depressed salmon fisheries.

During 1974–1993, most (88%) of the Oregon chinook harvest was landed (in decreasing order) in Brookings, the Columbia River and Coos Bay; 78% of the combined chinook and coho harvest occurred in Coos Bay, Newport and the Columbia River. About 75% of total salmon fishing effort occurred in Coos Bay, Newport and Brookings (Table A-5).

Table A-2
Absolute (# Fish) and Relative (%) Distribution of Salmon Party/Charter Boat Harvest, by Area, 1947–1993

	Cresc City/ Eureka/ Ft Bragg		SanFran Bay/Delta		Bodega/ Princeton		Sta Cruz/ Moss Lndg/ Monterey		All Else		
Year	#	%	#	%	#	%	#	%	#	%	Total #
1947	5,018										
1948	11,209										
1949	23,057										
1950	56,337										
1951	71,970										
1952	86,472										
1953	98,723										
1954	119,911										
1955	9,951	8%	87,609	68%	8,295	6%	22,999	18%	124	0%	128,978
1956	10,286	9%	63,359	55%	3,721	3%	36,428	32%	711	1%	114,505
1957	6,400	14%	25,547	57%	766	2%	11,634	26%	354	1%	44,701
1958	1,716	3%	42,205	80%	1,265	2%	6,258	12%	1,232	2%	52,676
1959	2,448	4%	47,961	86%	809	1%	4,140	7%	587	1%	55,945
1960	4,211	11%	30,122	79%	293	1%	2,363	6%	952	2%	37,941
1961	2,136	5%	33,765	79%	428	1%	5,439	13%	1,197	3%	42,965
1962	6,161	7%	74,223	85%	888	1%	5,522	6%	818	1%	87,612
1963	7,271	10%	63,032	87%	497	1%	917	1%	740	1%	72,457
1964	8,711	9%	77,027	84%	1,445	2%	1,663	2%	3,175	3%	92,021
1965	4,421	9%	45,293	88%	497	1%	408	1%	1,058	2%	51,677
1966	6,309	9%	62,178	89%	912	1%	227	0%	525	1%	70,151
1967	5,916	7%	71,337	84%	1,078	1%	3,023	4%	4,117	4%	84,946
1968	7,162	6%	111,900	88%	2,213	2%	1,806	1%	4,503	4%	127,584
1969	7,705	7%	100,510	90%	810	1%	1,847	2%	517	0%	111,389
1970	7,086	7%	89,176	91%	596	1%	501	1%	942	1%	98,301
1971	15,081	12%	112,423	86%	611	0%	549	0%	2,148	1%	130,812
1972	8,220	5%	141,753	94%	534	0%	244	0%	844	0%	151,595
1973	7,379	6%	114,516	92%	765	1%	668	1%	1,348	1%	124,676
1974	7,039	7%	97,789	91%	703	1%	533	0%	1,878	2%	107,942
1975	2,933	4%	68,363	93%	833	1%	698	1%	1,030	1%	73,857
1976	5,355	8%	57,412	87%	829	1%	1,085	2%	1,414	2%	66,095
1977	2,046	4%	52,265	93%	929	2%	502	1%	415	0%	56,157
1978	2,474	5%	41,414	91%	866	2%	691	2%	201	0%	45,646
1979	3,300	5%	62,918	90%	1,499	2%	2,143	3%	44	0%	69,904
1980	2,402	4%	59,366	92%	1,302	2%	1,236	2%	194	0%	64,500

Table A-2 (Continued)

	Cresc City/ Eureka/ Ft Bragg		SanFran Bay/Delta		Bodega/ Princeton		Sta Cruz/ Moss Lndg/ Monterey		All Else		
Year	#	%	#	%	#	%	#	%	#	%	Total #
1981	1,708	3%	58,980	90%	2,727	4%	2,128	3%	86	0%	65,629
1982	2,827	3%	92,876	91%	3,778	4%	2,098	2%	977	1%	102,556
1983	2,765	5%	49,200	89%	1,638	3%	1,207	2%	750	1%	55,560
1984	1,856	3%	65,707	92%	2,006	3%	1,905	3%	17	0%	71,491
1985	6,266	6%	90,240	83%	9,270	9%	2,552	2%	7	0%	108,335
1986	6,075	7%	66,041	74%	6,035	7%	9,734	11%	794	1%	88,679
1987	11,155	9%	93,132	74%	9,085	7%	12,755	10%	75	0%	126,202
1988	9,735	9%	81,032	72%	14,857	13%	7,179	6%	237	0%	113,040
1989	11,310	10%	73,523	66%	13,812	12%	12,388	11%	80	0%	111,113
1990	7,922	9%	57,156	65%	10,178	12%	12,565	14%	510	0%	88,331
1991	11,241	21%	26,564	49%	5,829	11%	9,372	17%	686	1%	53,692
1992	1,242	3%	32,276	74%	3,476	8%	6,266	14%	124	0%	43,384
1993	2,603	4%	51,030	73%	9,686	14%	6,202	9%	123	0%	69,644
1955–1993 Avg.	5,919	7%	68,493	82%	3,225	4%	5,125	6%	8981%		83,659

Source: Thompson, Cynthia J. and Kenneth R. Sakai, "The Indian, Commercial and Sport Fisheries for Salmon and other Anadromous Fishes of the Central Valley: An Historical Perspective," National Marine Fisheries Service, Southwest Fisheries Science Center, La Jolla, California, 1995.

CDFG summaries of logbook data provided by party/charter boat operators. Salmon harvest estimates include both chinook and coho.

Recreational Fishery

Ocean Sport Fishery

Statistics on the early years of this fishery are available from several sources. Despite the fact that the data represent self-reported voluntary information, they are nevertheless the best available indicator of general trends in the charter boat segment of the fishery. Salmon charter boat landings have apparently experienced wide fluctuations over time, averaging 83,659 fish per year during 1947–1993. About 82% of total statewide salmon harvest occurred in the San Francisco Bay/Delta during those years (Table A-2). Salmon has historically accounted for a significant percentage of total charter boat harvest of all species in Crescent City/Eureka/Fort Bragg and in the San Francisco Bay/Delta regions. However, this percentage has tended to decline over time, as boat operators have diversified their operations to include other target species.

Mixed landings of chinook and coho are often made on ocean sport trips targeting salmon. The contribution of chinook to total salmon harvest varies geographically, increasing as one moves southward from Crescent City to Monterey Bay. The percentage of total salmon harvest consisting of chinook during 1962–1993 was 38%–39% in Crescent City/Eureka, 46% in Fort Bragg, and 93%–95% in San Francisco/Monterey.

Average annual chinook landings in the ocean sport fishery were significantly lower in Oregon (34,322 fish, 1966–1996 average) according to Table A-6 than in California (83,659 fish, 1955–1993 average) (Table A-2).

In-River Sport Fishery

Beginning in the 1990/01 season, the California Department of Fish and Game (CDFG) sponsored an annual creel census on the Sacramento, Feather and American Rivers which provide estimates of harvest and effort for all major species caught on those rivers. Creel census studies for earlier years were sporadic. Because results from the few available historical studies are not necessarily comparable to more recent estimates, due to differences in sampling design, it is difficult to evaluate long run trends in harvest or effort. However, the recent creel studies conducted by the CDFG do enable us to characterize recent fishing patterns on the Sacramento, Feather and American Rivers.

The American River accounts for a larger share of the salmon caught (41%) and kept (43%) than either of the other two rivers, while the Sacramento River accounts for a majority of the salmon fishing effort (54%). Although salmon fishing activity is lowest on the Feather River, the Feather still accounts for a significant proportion of salmon harvest (23%) and effort (18%). Again, however, almost all of these fish are of hatchery origin, as only remnant wild populations still exist in those rivers.

Beginning in 1977, the California Department of Fish and Game's Trinity River Project has made annual estimates of chinook harvest on the Trinity River. Survey results reveal wide fluctuations in harvest, ranging from annual highs of 10,000+ fish during 1986–1988, to annual lows in the hundreds experienced in more recent years. Available data for recent years indicate that salmon harvest has been quite low on the Trinity River (Table A-4) compared to the Sacramento, Feather and American Rivers (Table A-3).

Oregon and California Salmon Production/Harvest Interactions[45]

Because California origin salmon stocks migrate northward, they are also harvested in Oregon and considerable economic benefit also accrues to the Oregon economy from this California origin resource. Significant amounts of chinook salmon are landed commercially in Oregon, though in lesser amounts than in California. During 1952–1993, annual Oregon landings averaged 1.9 million pounds and ranged from 0.463 to 5.2 million pounds (Table A-5). California ocean landings over the same period averaged 7.0 million pounds and ranged from 1.6 million to 14.8 million pounds (Table A-1).

According to Don Bodenmiller of the Oregon Department of Fish and Wildlife and to genetic identification studies, about 50% of the coho caught in California waters originate in Oregon streams,

45. *This section is taken from "California's Chinook Salmon: Upstream Battle to Restore the Resource," Western Water, Water Education Foundation, November/December 1992.*

and about 60% of the chinook harvested off the Oregon coast south of Cape Falcon originate from California streams.[46]

Some genetic sampling studies indicate that the percentage of Oregon chinook landings for fish originating in California may actually be higher, particularly off southern Oregon ports. For instance, a 1995 genetic stock identification program for a fairly large sample of fish caught in a test chinook fishery off the Rogue River in southern Oregon found that (in that 446 fish sample) *99% of all the chinook encountered came from California*, with 94% of the total from the California Central Valley.[47] While this data is likely an anomoly, a similar 1994 chinook test fishery found that 50% of the fish caught came from California, with at least 16% from the Klamath. As Oregon stocks have declined over the years, and as Central Valley and Klamath hatchery fish migrated in to replace them, the percentage of fish landed in Oregon that originated in California likely increased over time.

A Brief History of Klamath Basin Fisheries Management

This subject divides itself readily into two parts: a) allocation of salmon harvest; and, 2) salmon escapement policies. Both have been increasingly formalized over the past twenty years. In this section we will briefly summarize the early years, then concentrate on more recent events and policies within the Klamath Basin which affect this resource.

Salmon Harvest Allocation

The Native American Tribes on the Klamath and Trinity Rivers caught salmon for ceremonial and subsistence needs as well as for trade for thousands of years before European settlers "discovered" the river and its fisheries. Conflicts between Tribes over salmon before European contact almost certainly did occur, but are beyond the scope of this report.

Europeans discovered gold as well as fish in both the Trinity and Scott Rivers (the Scott is a major upriver tributary of the Klamath) during the gold rush. The Trinity River was subjected to hydraulic mining in the area from Weaverville to Junction City around the time of the Civil War, with devastating effects on its fisheries—and on the Tribes that depended upon them.[48] Among the many other impacts of mining, the Scott River was dredged to bedrock and its river bottom virtually turned upside down early in the twentieth century.[49]

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46. *Personal communication from Don Bodenmiller to Hans Radtke, 1994.*

47. *This data was reported in a letter dated February 29, 1996, from Rob Kaiser, Ocean Salmon Management Program for the Oregon Department of Fish and Wildlife titled, "Rogue Ocean Troll Chinook Fishery, July, 1995: Results of Genetic Testing for Stock Contribution in Fishery." The report is available from the Oregon Department of Fish and Wildlife.*

50. *See historical notes in* Matts v. Arnett*, 412 US 481 (1973), Appendix pg. B5.*

49. *Historic information from a presentation by Mike Bryan, 4th generation Scott Valley farmer, to Klamath Basin Restoration Symposium, Yreka, CA, March 11, 1997.*

By the late nineteenth century commercial salmon canning operations were running in the Klamath estuary. The canneries were owned by Europeans, while much of the harvesting was done by Indians using gillnets. These operations eventually shut down, but another commercial cannery was operating by the mid-1920's, with gillnetting by both Indian and European fishermen. Gillnetting for commercial purposes in the Klamath was entirely shut down, however, by the State of California in 1933.

However, by the mid-1930's a thriving ocean troll salmon fishery had developed to replace the inriver fishery.[50] The ocean troll fishery originally began with a small number of boats using sail power, but grew rapidly with the development of reliable small marine engines, which in addition to driving the boat provided power to run the trolling cables up and down. In 1957 California banned all in-river commercial salmon fisheries and provided that all commercial salmon fishing was to be done solely by ocean trolling.

Meanwhile anglers had also discovered the Klamath and Trinity. Lodges and guide services catering to steelhead fishermen developed upriver, and salmon fishermen flocked to the estuary in such numbers that after WWII a Coast Guard station had to be established on the estuary to prevent skiff fishermen from getting into the breakers and to rescue those that did. [51]

Commercial gillnetting by Native Americans was banned from 1933 until 1976. While it still occurred clandestinely, to what extent and at what level of catch will probably remain unknown. Indian rights to fish were the subject of several court cases during this period, including *Matts v. Arnett, Arnett v. Five Gillnets,* and *Hoopa Valley Tribe v. Baldrige.*

In 1977, the Pacific Fisheries Management Council (PFMC) was established as one of several Regional Fisheries Management Councils pursuant to the newly adopted Fishery Conservation and Management Act (then known as the "Magnuson Act," now known as the "Sustainable Fisheries Act") which established federal authority to manage and regulate all ocean fisheries from 3 to 200 miles offshore of California, Oregon, and Washington.[52] The PFMC is composed of the Fish & Game Department Directors of Oregon, Washington, California, and Idaho, the Regional Director of the National Marine Fisheries Service, a Tribal representative from a Tribe with federally recognized fishing rights, and seven additional members of the public (at least one of whom must be appointed from each state) with interests or expertise in fisheries. Of these public members, traditionally one has

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50. *A salmon troller runs several thin cables with heavy leads so that they hang down in the water; each cable has beads at intervals to which leaders are clipped. The leaders, with lures or baits attached to hooks, trail behind the cables. The boat moves this array through the water at two or three knots. The gear is "run" by reeling up the cables and unclipping and coiling the leaders as they arrive at the boat, removing fish (if any) from the hooks as they come up. By controlling the placement, depth and type of hook, this methodology can be very selective.*

51. *Historical information from conversations with Jim Walters, Eureka charter boat operator, who served in the U. S. Coast Guard on the Klamath River in the late '40s.*

52. *The Fishery Conservation and Management Act of 1976 (P.L. 94-265, 16 U.S.C. 1801 et. seq.), was signed into law on April 13, 1976, and went into effect on March 1, 1977. The Act was officially retitled "The Magnuson Fishery and Conservation Act" in 1980 by Public Law 95-561 in honor of the late Senator Warren Magnuson, who was instrumental in its development and passage. The most recent amendments were adopted by the 104th Congress (P.L. 104 - 208, Div. A, Title I, 101(a), 110 Stat. 3009-41), and also changed the name of the Act to the "Magnuson- Stevens Fishery Conservation and Management Act of 1996," though it is now officially known as the "Sustainable Fisheries Act" (P.L. 104-297, 110 Stat. 3559).*

been drawn from Idaho, one from Washington, two from Oregon, and three from California. The public members are also supposed to be broadly representative of commercial and sportfishing interests as well as the general public. The Regional Councils are advisory to the Secretary of Commerce, but in practice most of their recommendations are followed. National Standard One of the Magnuson Act charges regional councils to "prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery..."[53]

One of PFMC's first actions was to re-open the commercial gillnet fishery in the Klamath estuary. That fishery was allowed to run through the middle of the '78 salmon season when it was abruptly shut down by armed federal agents. The gillnet fishery remained officially shut down for commercial purposes through 1985.

In the early 1980's, the ocean troll fishery experienced a series of closures intended to conserve declining Klamath fall run chinook salmon, which were perceived as failing to meet spawning escapement goals. In 1985, the "Klamath Management Zone" (KMZ) area (from Humbug Mountain in Oregon to Punta Gorda in California—about 150 miles) was completely closed to ocean salmon trolling for the first time.[54] At the same time the PFMC was realizing that: a) the ocean fisheries were capable of taking all the harvestable surplus of a given run of fish above spawning escapement needs; and, b) the Klamath was the only river south of the Columbia with the potential for a major inriver catch—the gillnet fishery—in addition to the ocean catch.[55] Clearly something had to give. Some sort of reallocation of the harvestable fish among ocean commercial, sportsfishing, and Native American fisheries became necessary.

In 1985, the PFMC established the Klamath River Salmon Management Group (KRSMG) as an *ad hoc* advisory body charged with recommending a more equitable allocation of the harvestable fish, consistent with spawning escapement objectives. To the KRSMG table came representatives of California and Oregon trollers, ocean and inriver sports fishermen, Native American fishermen, and the state and federal agencies with management responsibilities in the Klamath.[56]

The group agreed early on that its task was to reach consensus on an allocation formula that would provide a viable fishery for each interest, and that each interest would share proportionally the benefits when stocks were abundant and the sacrifice when stocks were scarce.

KRSMG reached an allocation agreement in time for the 1986 ocean fishing season: ocean fisheries would, in abundant years, be managed to catch 35% of the Klamath fall run age-4 fish in the ocean (compared with about a 66% ocean harvest rate for a wide-open ocean fishery); the remainder of the harvestable surplus would be taken inriver. Sub-allocations between ocean sports and commercial fishermen on the one hand and inriver sports and Native American fishermen on the other followed, with the Indian gillnet fishery to take about 80% of the inriver share. Whenever required to meet escapement goals, each fishery was to be proportionally reduced. PFMC thankfully accepted this recommendation from the KRSMG, but shifted the allocation slightly in favor of ocean fisheries.

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53. 16 U.S.C. '1851(a)(1).

54. Review of 1986 Fisheries, appendix C, Table C-1, PFMC.

55. At that time sports fishermen on the Klamath were taking only up to about 10% of the inriver run.

56. Information from David Bitts, who participated in the KRSMG and KFMC beginning Jan. '86, and who has sat on the KFMC since Feb. '92.

The next year the KRSMG modified the agreement slightly in favor of inriver fisheries (the ocean share then dropped to 32.5%) and extended the overall agreement for five years. The group's members believed at that time that the allocation dispute was settled, and that all parties could then turn their efforts towards improving the basin's overall habitat productivity so there would be more fish for everyone. Ocean fishermen believed, based on the technical information about ocean catch then available, that they had secured, at least in abundant years, a traditional (May 1–Sept. 30) fishery outside the KMZ, with some fishing to be allowed inside the KMZ as well.

Unfortunately, shortly after the agreement was signed it was discovered that ocean fisheries outside the KMZ were capable of taking about 40% of the Klamath-origin fish in the ocean instead of the 25% that had been formerly thought. This meant that even in the best of times no commercial fishing would be allowed in the KMZ without compensating closures outside it. Efforts to renegotiate the agreement in light of the new information failed, but in 1987 and for the duration of the agreement (through 1991), the PFMC allocated slightly higher shares to ocean fisheries than called for in the agreement as compensation. Unfortunately this did not sit well with inriver fishing interests.

Two additional unanticipated factors exacerbated the existing hard feelings: 1) ultimately there were far more Klamath fish than predicted in 1986, 1987 and 1988—but ocean fisheries, because they worked on a percentage-based formula, were able to take advantage of the abundance, while inriver fisheries, managed instead for quotas based on the predicted abundance, were not; and, 2) measures to constrain the ocean harvest rate (being new and experimental) turned out to be less effective than anticipated, so that ocean fisheries exceeded their target harvest rates for the first six years of harvest rate management.

Following passage of the Klamath River Restoration Act in 1986,[57] the informal KRSMG was replaced in 1988 by the Klamath Fisheries Management Council (KFMC), with basically the same players and charge as the earlier group, but with a slightly different organizational format: the KFMC is organized under the Interior Department's Fish and Wildlife Service, while the PFMC is organized under the authority of the National Marine Fisheries Service, a subdivision of the U. S. Department of Commerce. The KFMC is charged with recommending a spawning escapement policy, determining the harvestable surplus, and recommending a harvest allocation for Klamath Basin fall chinook salmon to the PFMC for its consideration as part of its federal fisheries management duties coastwide.

For 1992, there was no allocation agreement, the old one having run its unhappy course. However, the scarcity of Klamath fish that year almost made the matter moot. So few Klamath fish were expected that the option of allowing no fishing at all was seriously considered. In the end, PFMC allowed *"de minimus"* fisheries for that year—an 8% ocean harvest rate, and a total inriver catch of about 8,000 fish—even though there were not enough fish to meet the spawner escapement floor had there been no fishing. The logic was that totally closing fisheries would do more harm to the fisheries than a very low rate of harvest would do to the resource. This notion was fortunately borne out (though more by luck

57. The Klamath River Restoration Act (1986) (P.L. 99-552, 100 Stat. 3082, later amended by P.L. 100-653, 102 Stat. 3830). Codified as 16 U.S.C. '460ss through '460ss-6. The KFMC is created and governed by 16 U.S.C. '460ss-2.

than foresight) when the very small 1992 spawning escapement later produced a large brood of at least 400,000 age-3 fish.[58]

In the spring of 1993, the Secretaries of Interior and Commerce agreed that the Yurok and Hoopa Tribes (two of the four federally recognized Tribes in the Klamath Basin) were entitled to up to half the allowable harvest of each run of Klamath salmon. Implementing this ruling (which has since survived a court challenge by ocean fishermen)[59] also required reducing the maximum allowable ocean harvest rate of Klamath fall run age-4 year chinook from about 37% to about 21%.[60] This reallocation further extended the KMZ closures another sixty miles in each direction: in California, the commercial fishery can take its maximum share of Klamath fish (equally split with Oregon trollers after the KMZ sports fishermen take their quota) without quite having a full season below Point Arena. In Oregon, eliminating any significant fishing off Coos Bay required closures off Newport, at least until 1997 when the virtual disappearance of the Coos Bay commercial salmon fleet allowed re-opening that area to the handful of survivors.

Commercial fishermen have chosen to shape their seasons in this manner in order to maximize their total catch—in other words, they seek to harvest some Klamath share while still retaining access to as many non-Klamath fish as possible by still fishing outside the KMZ. They could choose instead to fish entirely *within* the KMZ, but because Klamath fish are a much higher percentage of the total catch there that choice would actually *minimize* total catch coastwide, because it would then require disproportionate compensating closures below Point Arena and above Coos Bay, where Klamath fish make up less than 5% of the catch.

However, the end result of the current allocation scheme for ocean fisheries is that the "old KMZ" ports of Port Orford, Gold Beach, Brookings, Crescent City, Trinidad, and Eureka can never expect more than token commercial salmon harvest opportunities at best. The "new KMZ" ports of Coos Bay, Bandon, Shelter Cove, and Fort Bragg may do a little better, but not much, not in all years, and not without some costs in terms of closures farther away and some reduction in coastwide total catch. In California, the ports of Bodega Bay and San Francisco must also often be closed during peak fishing times.

Thus increasing Klamath fall-run chinook productivity is now essential to keeping Coos Bay, Bodega Bay and San Francisco viable as salmon ports, or to have any meaningful fishing opportunity off Fort Bragg and Shelter Cove. *In other words, the productivity of the Klamath Basin salmon runs has now become a limiting factor for salmon fisheries for much of the rest of the coast. The only way this can be effectively done is to improve the productivity of spawning and rearing habitat within the Klamath Basin itself.*

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58. *Preseason Report I, 1997, PFMC, Table II-4. Too many fish in the river system can also have serious ecosystem repercussions, including leading to increasing inter and intra-species competition by overwhelming the carrying capacity of the river, which can in turn lead to later population 'crashes.'*

59. *Parravano v. Babbitt, 70 F3d 539 (9th Cir. 1995), cert. den. 116 S.Ct 2546 (1996).*

60. *Preseason Report II, 1996, PFMC. This report also gives target harvest rates for 1996, with the largest* predicted *Klamath abundance to date.*

Overall, and especially since the passage of the Magnuson Act, there are now strong controls over potential overfishing. Inland habitat losses and lack of adequate instream water flows, however, have taken an increasing share of the potential salmon production out of the system altogether, usually long before the fish even get to the ocean.[61] Habitat and water impacts have also been by far the hardest problems to correct. However, both ocean and inriver fishing interests have a clear economic self interest in seeing that habitat problems and the lack of inland flows are addressed throughout the Klamath Basin. The salmon productivity of the Klamath Basin now controls much of the rest of the coast wide salmon fishery.

With the granting of a 50% share of the harvestable fish, federal recognition of the Yurok Tribe (and that Tribe's official organization), and the passage of the Native American Self-Governance Act, the Hoopa and Yurok Tribes have taken over management of their fisheries from the Bureau of Indian Affairs and the U. S. Fish and Wildlife Service. Both Tribes have expressed a strong interest in habitat restoration and restoration of adequate flows for fisheries, which on both rivers can only come through reduction of flows to other users (primarily agricultural irrigators) by the Bureau of Reclamation.

Unfortunately, the reallocation of half the harvestable fish to the Yurok and Hoopa Tribes has had a very serious impact on ocean commercial salmon fisheries and the coastal communities that sustain them, most profoundly in the region from Fort Bragg to Coos Bay. In years when fisheries must be curtailed to meet the escapement floor, that curtailment can extend well below San Francisco and north to Cape Falcon. At the same time, the assumption of management responsibilities by the Tribes may have a net positive effect on management of both the Tribal fisheries and the basin's habitat. Federally guaranteed fishing rights for the Tribes also imply the right to adequate instream flows and healthy stream habitat so that salmon can continue to exist in the basin in harvestable numbers. These implied water rights have to date been largely ignored by federal agencies. The Tribes in recent years have been increasingly vocal advocates of major flow and habitat restoration efforts throughout the basin and have become more willing to back up those rights in federal court.

Escapement policy

Before the PFMC was established in 1977, escapement policy was largely left to chance. Fisheries took what they took, and if there weren't enough to sustain a cannery in the river, it would close. If ocean fishermen couldn't catch enough to make expenses plus a bit, they would tie up or go tuna fishing. Traditional Tribal fishing methods were either less efficient or more selective than modern gillnets, thus intrinsically providing for a fairly large escapement.

The California Department of Fish and Game (CDFG) set the first Klamath Basin fall run chinook spawning escapement goal at 115,000 in 1978.[62] The PFMC later adopted this goal. However, because of the difficulty in meeting this goal, by 1983 the goal had been modified downward to include a

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61. *Trinity Dam, for example, blocks about 80% of the original Trinity River spawning habitat and has allowed the diversion of 80% or more of basin water flows once available to salmon.*

62. *An Assessment of the Current Carrying Capacity of the Klamath River Basin for Adult Fall Chinook Salmon, Hubbell and Boydstun, CDFG, Sept. 1985.*

"rebuilding schedule" whose first step, to be in place for four years, was a goal of 68,900 spawners, with the 115,000 goal to be in place by 1995.[63]

It became obvious, however, that these ambitious spawning escapement goals could not be met with the present seriously degraded state of inland habitat. Extensive habitat loss coupled with other factors such as reduced flows, increased water temperatures, etc., from human activities has seriously reduced the carrying capacity of the entire river system. Therefore, in 1986 and long before any of these goals could be met, a whole new methodology was introduced. While developing its allocation agreement, the KRSMG also developed an escapement policy called **harvest rate management**, whose core concept is that, rather than a target *number* of spawners, the goal should be a *percentage* of the actual population; specifically, that at least one-third of each brood should survive to spawn. The *maximum* allowable harvest rate would then be the complement of the survival rate, or two-thirds.

In addition, a *minimum* number of natural spawners, in this case 35,000, would be imposed as a "floor" to protect weaker broods and ensure their ability to rebound quickly under favorable environmental conditions. If "full fishing" (i.e., a total harvest rate by all fisheries combined of two thirds) would result in less than 35,000 natural spawners, fisheries would be reduced (proportionally, under the allocation agreement) to the extent necessary to provide at least 35,000 natural spawners.[64]

The KRSMG recommended this policy to the PFMC, which adopted it provisionally, then incorporated it officially into the Framework Plan as part of Amendment Nine to that plan in 1989.[65] With very minor changes, harvest rate management is in place today as the official PFMC escapement policy for Klamath fall chinook.

Harvest rate management would seem to require fairly accurate predictions of stock abundance in order to achieve any degree of management success. However, to date no one seems to know how to make such predictions accurately. Age-3 abundance is predicted from the number of early returning age-2 fish (also known as "jacks") estimated in the river the previous fall; in turn, age-4 abundance is estimated from the number of age-3 fish. Both predictors have been way off in both directions. Many suggestions for improved accuracy have been examined, but so far none have proven themselves. Unfortunately, to date no one has come up with a better predictive methodology.[66]

Ocean commercial fisheries have been managed, beginning in 1986, for an **ocean harvest rate** of age-4 Klamath fall run chinook salmon, defined as the percentage of all age-4 Klamath fish in the ocean taken by ocean fisheries (about 5/8ths of Klamath fall-run chinook salmon typically return as 4 year olds.) The ocean harvest rate (OHR) for each year is derived by first determining the total allowable harvest rate based on total predicted abundance, then applying the current allocation formula to it. These numbers are run through the harvest rate model (developed by the U. S. Fish and Wildlife Service), which then spits out the allowable ocean harvest rate, the inriver run size, number of natural spawners, and (beginning in 1993) the Tribal and the non-Tribal allowable catch in numbers.

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63. Ibid., *see also Final Framework Amendment for Managing the Ocean Salmon Fisheries, PFMC, October 1984, pg. 3–20.*

64. *Klamath River Salmon Management Long-Term Harvest Sharing Agreement, Item #5, July, 1987.*

65. *Amendment Nine to Salmon Framework Plan, PFMC, 1989.*

66. *Preseason Report I, 1997, PFMC, Table II-4.*

Ocean fisheries are managed by using time, area and gear limitations to achieve the desired harvest rate. Managers' ability to shape ocean fisheries by time, area and gear limitations in order to achieve a target Klamath harvest rate has improved considerably since about 1990. The harvest rate actually achieved has been under the target in four of the past six years, somewhat over one year, and double the predicted amount in one year.[67]

One feature of this method of management is that the ocean fisheries' ability to hit a target harvest rate is somewhat independent of stock abundance and the accuracy of its prediction. This seems desirable, and would be better were it not that inriver fisheries are still managed by a quota system linked only to the predicted abundance.

A weakness of harvest rate management with a spawning floor is that, while it should provide for adequate spawning escapement to the basin as a whole, it does not address the distribution of spawners *within* the basin. For example, the Klamath Underescapement Review[68] Team discovered in 1993 that, while the 33% escapement goal had been met or exceeded for the Basin as a whole, the Klamath River side had fallen under the goal with about a 25% escapement rate, while the Trinity River side had greatly exceeded the 33% escapement goal and was over 40%.[69] This difference is thought to occur because of developmental differences between fish from the two river systems. Klamath-side fish tend to mature at age 4, while Trinity-side fish tend to mature at age 3—thus both ocean and inriver fisheries would tend to target Klamath-side fish more heavily. The Yurok Tribe has responded to this news with changes in its own fishery practices designed to target Trinity River stocks more heavily while relieving effort on Klamath River stocks.[70]

In a situation where one stream within a basin is not receiving adequate escapement, managing fisheries to address this problem would require carrying the concept of weak-stock management to its logical extreme. If Blue Creek, for example, is only getting a handful of spawners while the rest of the basin is getting plenty, should fisheries be managed to put more fish into Blue Creek? What would that imply for the rest of the basin? For fisheries generally? And what does this (hypothetical) situation say about conditions in Blue Creek? Is it reasonable to suppose that fisheries have somehow inadvertently more heavily targeted Blue Creek fish?

When harvest rate management was first adopted, estimates of the optimum spawning capacity of the Klamath Basin ranged so widely that that number was for all practical purposes simply unknown.[71] One of the advantages of the new management system was that it would produce (over time) a wide range of spawning numbers, with the opportunity to evaluate the productivity of different numbers of spawners and eventually figure out the optimum spawning capacity of the basin in its present condition.

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67. *Preseason Report I, 1997, Table II-3.*

68. *The overfishing review policy of PFMC provides that whenever a managed stock of salmon fails to meet its escapement goal for three consecutive years, a review of the causes of the shortfall shall be conducted. The Klamath basin fell short of 35,000 natural spawners in '90, '91, and '92, causing the formation of a Klamath Review Team whose product is the Klamath River Fall Chinook Review Team Report, PFMC, December 1994.*

69. Ibid., *Appendix C, p. 9.*

70. *Report to the KFMC by Troy Fletcher, head of the Yurok Tribe Fisheries Department, Spring of 1994.*

71. *See Hubbell and Boydstun,* op. cit. *p. 7.*

To everyone's astonishment, extremely high spawning numbers were seen in the first three years of harvest rate management. Within ten years, a tenfold range in natural spawning numbers was observed. Comparing the productivity of those ten broods, plus the six or so before them, shows little relationship between number of spawners and number of recruits produced. An analysis of the spawner/recruit relationship done by Mike Prager of NMFS for the Technical Advisory Team of the KFMC suggests (it will take forty or more years to be sure) that *under current habitat conditions* the optimum spawning capacity may be very close to the current floor of 35,000 natural spawners.[72] All the "power broods" (age-3 populations over 400,000) came from escapements actually *below* the floor. None of the big escapement years have yet produced more than an average number of recruits, though the 1995 brood may become the first.

All this strongly suggests that the number of spawners may not be the principal factor driving production today, but rather that the carrying capacity of instream spawning and rearing habitat is the primary limiting factor. It may in fact be the case that instream waters flows in the Klamath Basin are a far more important factor in determining brood survival than previously acknowledged. In a recent Klamath Basin hydraulic study, for instance, it was determined that prior to the existence of irrigation water diversions for the Klamath Project in the Upper Basin, the Klamath Basin above Keno appears to have provided approximately 30% to 40% of the late spring and summer flows at the mouth of the Klamath River. Loss of these flows today may thus be a serious limiting factor on downstream salmon survival all the way to the estuary.[73] In a salmon survival study recently commissioned by the States of Oregon and California, it was also noted that:

> "Diversion of water is potentially one of the most serious factors adversely affecting salmon in western Oregon and northern California... [W]ater rights and attendant diversions have a potentially strong effect on salmon and represent an important constraint on fisheries management." [74]

In other words (at least above a given 'floor') the limiting factors on fishery recruitment (and thus on harvests) may be related far more to habitat quality and instream flows than to other factors such as the total number of spawners in each brood year.

While this history is too brief to draw conclusions with certainty, a few comments may be made with some confidence. Fisheries managers appear to be learning about the escapement needs of the Klamath Basin as they go, and our production expectations for it may be more realistic now than they were ten or fifteen years ago. In the meantime, it does not appear that fisheries management and escapement policies have damaged the long-term productivity of the fishery, especially compared to the habitat changes wrought by dams and water management policies, among other agents. The level of scrutiny of fisheries management from parties with very divergent interests is very high and the process is very public. The KFMC provides a forum for these parties to express their concerns, and to have them examined—and for the most part addressed—by fisheries managers.

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72. *Preliminary Analysis of Klamath River Fall-Run Chinook Salmon: Stock, Recruitment, Environment, and Yield, Klamath Technical Advisory Team, Sept. 1996, pp 9-10.*

73. *"Initial Assessment of Pre- and Post-Project Hydrology on the Klamath River and Impacts of the Project on Instream Flows and Fishery Habitat," Balance Hydrologics, Berkeley, CA, 1996; prepared for the Yurok Tribe.*

74. *Status and Future of Salmon of Western Oregon and Northern California, Center for the Study of the Environment (the so-called "Botkin Study"), May, 1995.*

Ultimately, however, there is little more fisheries managers can do other than manage fishermen. The current legal regime does not allow them to address or correct instream flow problems nor to reverse the history of widespread habitat degradation the basin has already faced. When salmon losses are caused not by overfishing, but by rampant and pervasive habitat destruction and water diversions (as is largely the case today) there is really very little fisheries managers can do. Ultimately it is up to fishermen (and their political representatives) to address, and to try to correct, the more pervasive problems of loss of inland water and habitat. Unless habitat factors can be controlled, and the impacts of habitat loss reversed, no amount of management of fishing impacts will ultimately prevent either economic or biological extinction.

The Impact of the Federal Endangered Species Act

In recent years coastal coho salmon have been candidates for listing under the federal Endangered Species Act, and as a result coho "bycatch" and incidental catch of coho has been severely restricting fisheries managers coastwide. There has been no directed coho fishery allowed for the commercial salmon fishing fleet in the lower 48 states since 1994, and for many years prior harvest opportunities had been greatly reduced.

Wild coho runs are most severely depressed in the southern most portion of their current range (northern California and southern Oregon). The federal agency which has jurisdiction over ESA listing decisions regarding anadromous fish is the National Marine Fisheries Service (NMFS), which is part of the U. S. Department of Commerce.[75]

NMFS classifies salmon within a species into subspecies called "evolutionarily significant units," or "ESU's." These are intended to be groupings of geneticially distinct subspecies of salmon which are geographically isolated but can interbreed. This classification system is a compromise between implementing ESA protections down to the smallest scale stock-by-stock level (there are hundreds of distinct salmonid stocks coastwide), or alternatively limiting protection only to the species level coastwide, thereby allowing widespread extinction of subspecies. The ESA, in fact, mandates protection of subspecies as well as whole species in appropriate cases.[76]

As a result of litigation and under court order, NMFS listed the so-called "Central California Coast Evolutionary Significant Unit (ESU)" for coho salmon as "threatened" under the federal ESA on October 31, 1996. This listing covers the coastal area from the San Lorenzo River (near Santa Cruz,

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75. Terrestrial species are under the jurisdiction of the U.S. Fish and Wildlife Service, which is in the U.S. Department of Interior.

76. The federal Endangered Species Act at 16 U.S.C. 1523(15) defines "species" as follows: "The term 'species' includes any subspecies of fish or wildlife or plants, and any distinct population segment *of any species or vertebrate fish or wildlife* which interbreeds when mature*." (emphasis added) ESU's are an effort to define "distinct populations segments" for purposes of protection of those genetically distinct populations which are in need. The NMFS ESU policy has been published as "Policy on Applying the Definition of Species under the Endangered Species Act to Pacific Salmon" at 56 Fed. Reg. 58612 (November 20, 1991). The ESU classification system is controversial, however, because it may result in too little protection for individual salmon stocks faced with extinction whenever other surrounding stocks within the same ESU are not.*

MISSING TEXT BETWEEN PAGES 47 – 55 FROM ORIGINAL DOCUMENTS

As a result of litigation and under court order, NMFS listed the so-called "Central California Coast Evolutionary Significant Unit (ESU)" as "threatened" under the federal ESA on October 31, 1996. This listing covers the coastal area from the San Lorenzo River (near Santa Cruz, CA) to Punta Gorda in northern California.[1] A decision to list what are called the "Southern Oregon/Northern California ESU" and the "Oregon Coast ESU" further north was, however, postponed in the midst of considerable political controversy.[2] Finally, in May of 1997, NMFS listed the coho in the Southern Oregon/Northern California ESU as threatened (which includes the Klamath Basin) but declined to list the Oregon Coast ESU, citing the existance of a statewide recovery effort in Oregon as cause not to list, a decision which was later upheld in court but which is still in litigation.[3]

The Umpqua River searun cutthroat trout (*Oncorhynchus clarki clarki*, technically classed as a salmonid and not a trout) was listed under the federal ESA on August 9, 1996, for the limited area of the Umpqua River basin in southern Oregon.[4] There is no commercial or sport fishery on this species, and the primary impacts driving these declines are clearly habitat related.[5] Protections for this species may also benefit coho, chinook and other salmonids in these same streams.

Steelhead (*Oncorhynchus mykiss*) were proposed by NMFS for coastwide listing under the federal ESA on August 9, 1996. NMFS identified at least 23 distinct steelhead stocks as already extinct, with another 43 facing a moderate to high risk of extinction in the near future.[6] Steelhead are not a commercially fished species, and so are harvested (if at all) only by the recreational fishery. Steelhead (like coho) are also very sensitive to changes in their spawning and rearing habitat and other inland habitat degradations and face similar declines. Some stocks of steelhead were listed on August 11, 1997,

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1. *Final listing decision for the coho "Central California Coast" ESU was published in the Federal Register at 61 FR 56138–56149 on October 31, 1996.*

2. *Postponement decisions for coho listings were published in the Federal Register at 61 FR 56211–56213, also on October 31, 1996.*

3 *Coho were formally listed in the Klamath Basin on Southern Oregon/Northern California ESU on May 6, 1997, published in the Federal Register at __ FR ________.*

4. *Listing decision for the searun cutthroat trout (*Oncorhynchus clarki clarki*) was published by NMFS in the Federal Register on August 9, 1996, at 61 FR 41514–41522.*

5. *The searun cutthroat trout has never been commercially fished because it migrates very close to the shore well inside areas where commercial harvests are allowed to take place. Recreational fishing on the species has been closed for many years, although there may be some incidental harvest impacts in catch and release fisheries for other species in the area. The watershed in which it exists has been heavily logged for many years, many local streams are over appropriated for human use, and there are a wide variety of other habitat related impacts within the basin as well which are likely driving these declines.*

6. *NMFS identified 15 separate steelhead ESU's from northern Washington to southern California. The proposed listing decision was published in the Federal Register at 61 FR 41541-41561 (August 9, 1996).*

but the stocks in the "Klamath Mountains Province ESU" were deferred for listing decision for an additonal six months, which means a decision is due in February of 1998.[7]

The National Marine Fisheries Service (NMFS) is currently considering a petition for the coastwide listing of chinook salmon under the federal ESA.[8] In addition, NMFS is undergoing its own comprehensive reviews of the status of all salmon and anadromous trout populations in Washington, Oregon, Idaho and California.[9] NMFS is now scheduling all salmonid listing decisions to be completed by December, 1998.

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7 *Final steelhead listing decisions were published on August _, 1997 at __ FR __________.*

8. *Several chinook salmon runs are already listed under the federal ESA, most notably the winter run chinook of the California Central Valley, and also the Snake River spring/summer chinook and Snake River fall chinook in the Columbia River. The Columbia River runs were recently reclassified from "threatened" status to "endangered" in a decision published in the Federal Register on December 28, 1994, at 59 FR 66784-66787. There is evidence that some other chinook runs may need protection as well. Many chinook runs, however, are relatively abundant. Chinook salmon are generally less inland habitat sensitive than coho or steelhead because they spend their juvenile stage in the lower river systems in areas that are usually less impacted by such issues as logging, grazing and water diversions. They also migrate out to sea relatively quickly as compared to other salmonid species. This is why it is not uncommon to find river systems in which coho and steelhead are severely depressed while chinook salmon from the same river system may be relatively abundant. Chinook, coho and steelhead are all different species with very different habitat needs and different life histories..*

9. *Notice of this comprehensive review program was published in the Federal Register on September 12, 1994, at 59 FR 46808-46810. However, NMFS is many months behind in its scheduled reviews. NMFS inaction has provoked several lawsuits in an effort to require it to meet statutory listing decision deadlines it has frequently been unable to meet.*

Table A-3
Number of Fish Kept and Caught Per Season by Species and River and Number of Angler Hours Per Season by Target Species and River, Averaged Over 1990/1991–1993/1994 Seasons

FISH KEPT

Species	Sacramento	Feather	American	All Rivers
Salmon	9,817	5,857	10,281	25,955
Steelhead	2,128	1,692	1,376	5,196
Trout	7,203	175	880	8,258
Shad	20,272	7,783	6,471	34,526
Striped Bass	31,542	2,339	1,162	35,043
Sturgeon	2,320	0	0	2,320
Catfish	20,630	1,302	0	21,932
TOTAL	93,912	19,148	20,170	133,230

FISH CAUGHT

Species	Sacramento	Feather	American	All Rivers
Salmon	10,155	6,760	11,939	28,854
Steelhead	5,997	3,537	2,217	11,752
Trout	37,971	614	2,994	41,578
Shad	58,967	28,535	15,940	103,442
Striped Bass	201,763	8,459	2,183	212,406
Sturgeon	22,533	0	0	22,533
Catfish	29,119	1,879	0	30,998
TOTAL	366,505	49,784	35,273	451,562

ANGLER HOURS

Target Species	Sacramento	Feather	American	All Rivers
Salmon	307,870	111,090	140,675	559,635
Steelhead	23,591	35,999	41,788	101,378
Trout	120,728	2,928	10,437	134,093
Shad	95,788	56,390	23,342	175,520
Striped Bass	981,476	48,568	17,927	1,047,971
Sturgeon	462,808	2,562	0	465,370
Catfish	124,319	11,765	2,775	138,859
Any Fish	193,310	48,787	40,596	282,693
All Species	2,309,890	318,089	277,540	2,905,519

Source: Thompson, Cynthia J. and Kenneth R. Sakai, "The Indian, Commercial and Sport Fisheries for Salmon and other Anadromous Fishes of the Central Valley: An Historical Perspective," National Marine Fisheries Service, Southwest Fisheries Science Center, La Jolla, California, 1995.

Table A-4

Number of Fall Run Chinook Caught on the Trinity River, by Year

Year	Chinook Harvest (# Fish)
1977	5,464
1978	0
1979	1,922
1980	3,454
1981	4,630
1982	4,875
1983	2,476
1984	1,129
1985	5,596
1986	15,477
1987	10,356
1988	12,076
1989	3,263
1990	350
1991	1,271
1992	472
Avg.	4,551

Source: Thompson, Cynthia J. and Kenneth R. Sakai, "The Indian, Commercial and Sport Fisheries for Salmon and other Anadromous Fishes of the Central Valley: An Historical Perspective," National Marine FisheriesService, Southwest Fisheries Science Center, La Jolla, California, 1995. Kano, in press.

Note: Fishery closure in 1978.

Table A-5

Ocean Commercial Troll Chinook Landings in Oregon (Pounds), by Port Area, 1952–1993

Year	Columbia River	Tillamook	Newport	Coos Bay	Brookings	TOTAL
1952	718,485	7,499	1,278,153	682,037	149	2,686,323
1953	453,423	9,377	804,365	408,142	210	1,675,517
1954	452,679	29,296	685,075	755,582	1,578	1,924,210
1955	457,488	49,574	1,343,608	1,364,677	4,171	3,219,518
1956	414,015	31,001	1,395,470	1,978,046	7,382	3,825,914
1957	154,865	22,240	913,766	1,532,563	7,167	2,630,601
1958	80,672	31,261	592,955	879,732	10,715	1,595,335
1959	64,674	14,382	180,895	197,012	6,008	462,971
1960	82,372	10,300	367,383	764,233	103,732	1,328,020
1961	99,629	8,946	350,324	351,907	416,539	1,227,345
1962	72,132	3,616	116,546	227,931	177,086	597,311
1963	164,193	9,042	103,705	797,014	330,248	1,404,202
1964	103,522	14,056	71,083	305,262	133,751	627,674

Table A-5 (Continued)

Year	Columbia River	Tillamook	Newport	Coos Bay	Brookings	TOTAL
1965	48,264	12,589	160,534	202,364	148,132	571,883
1966	157,447	18,770	168,249	345,689	107,001	797,156
1967	179,635	34,911	231,507	472,814	197,072	1,115,939
1968	190,483	54,291	98,678	548,344	101,614	993,410
1969	94,041	46,977	147,254	665,887	247,311	1,201,470
1970	212,121	47,959	283,208	838,341	303,399	1,685,028
1971	141,418	31,994	109,958	250,325	467,015	1,000,710
1972	77,149	40,656	225,850	551,945	408,129	1,313,729
1973	75,968	73,652	943,617	2,035,741	332,343	3,461,321
1974	159,516	76,447	457,626	1,427,260	169,554	2,290,403
1975	106,208	71,137	337,954	1,671,150	396,877	2,583,326
1976	268,247	98,622	367,345	908,973	278,390	1,921,577
1977	200,087	285,263	726,587	1,640,634	612,374	3,464,945
1978	165,698	91,745	569,943	774,914	291,320	1,893,620
1979	101,322	50,807	490,038	1,074,447	863,353	2,579,967
1980	107,260	63,764	497,379	1,119,843	383,263	2,171,509
1981	128,918	75,998	302,643	414,453	651,408	1,573,420
1982	170,055	59,226	312,481	1,344,839	463,651	2,350,252
1983	65,563	33,194	196,522	222,844	137,189	655,312
1984	27,195	17,027	164,319	223,883	117,386	549,810
1985	69,162	37,360	378,764	1,540,033	4,530	2,029,849
1986	60,878	119,301	751,141	2,128,245	310,678	3,370,243
1987	79,240	419,386	997,314	3,328,250	353,926	5,178,116
1988	35,601	340,995	1,230,624	2,491,161	286,929	4,385,310
1989	49,310	303,218	775,688	2,233,156	169,691	3,531,063
1990	27,123	139,281	387,547	1,566,881	59,312	2,180,070
1991	9,000	110,000	267,000	292,000	18,000	695,000
1992	17,000	108,000	676,000	206,000	7,000	1,013,000
1993	5,000	86,000	460,000	182,000	28,000	761,000
Avg.	151,120	75,932	498,074	974,918	216,990	1,917,035
% Dist. of Avg.	8%	4%	26%	51%	11%	100%
Chinook+Coho Avg.	472,615	464,706	1,469,325	2,166,926	406,052	4,979,624
% Dist. of Chinook+Coho Avg.	9%	9%	30%	44%	8%	100%
Chinook as % of Chinook+Coho Avg.	32%	16%	34%	45%	53%	39%

Source: Thompson, Cynthia J. and Kenneth R. Sakai, "The Indian, Commercial and Sport Fisheries for Salmon and other Anadromous Fishes of the Central Valley: An Historical Perspective," National Marine Fisheries Service, Southwest Fisheries Science Center, La Jolla, California, 1995. 1952–1990 data obtained from PFMC (1993). 1991–1993 data obtained from PFMC (1995).

Table A-6
Ocean Recreational Chinook Harvest in Oregon (# Fish), by Port Area, 1966–1993

Year	Columbia River	Tillamook	Newport	Coos Bay	Brookings	TOTAL
1966						37,400
1967						42,800
1968						25,100
1969						31,800
1970						42,900
1971						29,600
1972						44,100
1973						60,984
1974	16,244	2,015	3,367	2,943	9,892	34,461
1975	47,770	1,712	5,035	10,355	10,568	75,440
1976	44,578	2,283	4,500	14,543	13,162	79,066
1977	20,149	1,510	2,572	22,401	11,460	58,092
1978	7,890	833	2,068	4,826	7,178	22,795
1979	7,542	981	1,431	4,537	6,411	20,902
1980	5,503	1,574	1,829	5,307	4,801	19,014
1981	11,516	1,895	2,412	4,455	8,897	29,175
1982	8,235	1,360	3,495	10,088	15,538	38,716
1983	3,440	692	1,608	6,583	12,354	24,677
1984	61	1,110	1,922	4,854	9,045	16,992
1985	3,567	2,610	4,092	9,456	36,142	55,867
1986	1,948	471	2,186	5,918	11,843	22,366
1987	4,019	3,515	6,374	18,873	25,814	58,595
1988	481	2,698	5,332	8,057	21,698	38,266
1989	1,435	873	1,824	6,642	21,257	32,031
1900	3,317	1,230	2,658	6,544	12,732	26,481
1991	1,000	700	900	5,100	6,800	14,500
1992	500	1,500	4,100	3,800	,600	12,500
1993	900	300	400	1,100	3,800	6,500
1974 –1993 Avg.	9,505	1,493	2,905	7,819	12,600	34,322
1974–1993 Chinook+Coho Avg.	52,083	23,338	65,336	81,742	32,922	255,422
Chinook as % of Chinook+Coho Avg.	18%	6%	4%	10%	38%	13%

Source: Thompson, Cynthia J. and Kenneth R. Sakai, "The Indian, Commercial and Sport Fisheries for Salmon and other Anadromous Fishes of the Central Valley: An Historical Perspective," National Marine Fisheries Service, Southwest Fisheries Science Center, La Jolla, California, 1995. 1966–1990 data obtained from PFMC (1993). 1991–1993 data obtained from PFMC (1995).

APPENDIX B

The Role of Hatcheries in the Klamath Basin

Both the Klamath and Trinity Rivers end, as far as upstream migration of anadromous fish is concerned, at impassable dams: Iron Gate Dam on the Klamath, and Lewiston Dam on the Trinity. Each of these is a flow-regulating dam built to even out the pulses of water coming from even larger (and also impassable) power-generating dams upstream. Each of them has a hatchery immediately below it, built to mitigate for the loss of spawning habitat above the dam. This section will give a brief history of these hatcheries, including their purpose, mitigation goals, performance, some past problems in the programs and how those problems were corrected, and some ongoing management difficulties they currently face.

The Iron Gate Hatchery (IGH)

The current facility, just below Iron Gate Dam, was completed by Portland Power and Light (operators of the upstream hydropower dams) in February, 1966, with the California Department of Fish and Game (CDFG) taking over operations in March, 1966. A temporary fish trapping station had been in operation since 1962.[10] The hatchery is eight miles east of Hornbrook in Siskiyou County, California, about a hundred yards above the confluence of Bogus Creek with the Klamath River, and about seven river miles above the confluence of the Shasta River with the Klamath. The country there is semi-arid high plateau.

Iron Gate Hatchery was built and is operated to mitigate for the loss of spawning habitat above Iron Gate Dam, which itself was built to even out the flow pulses from the Copco hydropower dam further upstream. Before Iron Gate Dam was built flood pulses from Copco were a real hazard downstream, occasionally even washing away unsuspecting fisherman. These sudden pulses were also highly destructive to downstream riparian habitat.

The mitigation responsibility for Iron Gate Dam is considered to be 4.9 million fingerlings released, but for many years the *de facto* policy seems to have been to release as many fish as the hatchery could take and rear. However, in some years, "as many as..." falls far short of the original mitigation responsibility. Although IGH has shipped eggs elsewhere, there is no clear indication that it has received eggs or fish that originated elsewhere.

IGH has a water supply problem in dry or warm years: the pool behind Iron Gate Dam is only about 80 feet deep and not very large, and it is fed by water released from a series of broad, shallow reservoirs. Thus there are times when an adequate flow of sufficiently cool water for downstream salmon streams is simply not available. The hatchery manager may face a very difficult juggling act in late spring if he is to: a) raise the fingerlings on hand to the appropriate

[10] Iron Gate Hatchery Annual Report, Anadromous Fish Branch Annual Reports, CDFG the reports cited are from the 1970's.

size; b) release them at the right time; and, c) avoid temperature shock when the fish hit the river.11

END OF MISSING TEXT BETWEEN PAGES 47 – 54 FROM ORIGINAL DOCUMENTS

[11] Phone conversations by David Bitts with IGH Manager Bob Rawstron of CDFG, late summer 1986 (following reports of massive fish kill).

to: a) raise the fingerlings on hand to the appropriate size; b) release them at the right time; and, c) avoid temperature shock when the fish hit the river.[85]

The hatchery had serious problems in the spring of 1986 when a large number of just-released fish died in the river. IGH had received about 20,000 king salmon in the fall of 1985 (7,500 would have supplied enough eggs to meet the mitigation goal), and part of the problem may have been that the hatchery tried to rear too many fingerlings for the conditions of the river at that time.

There were four years of big returns to IGH (and three to TRH) in the mid-1980's, and releases from the two hatcheries in those years jumped from an average 6 million in the three years before (well short of the combined mitigation goals) to an average of almost 20 million.[86] Those big releases turned out, however, not to be very productive: with dropping total harvest rates, the Klamath system still fell well short of its "floor" escapement goal of 35,000 natural spawners in 1990, 1991 and 1992. During the Klamath Underescapement Review process in 1993, CDFG made some changes in hatchery policy as a result of lessons learned from the big releases of 1985-1989. This issue will be discussed at greater length under the Trinity River Hatchery subsection below.

A "natural spawner" in the Klamath Basin is defined as a fish that spawns in gravel, regardless of its origin. During the big returns of the 1980's, a high percentage of the "natural spawners" came from hatcheries. Some biologists have complained that "inferior" hatchery fish were driving indigenous wild fish out of the river and that failure to distinguish between wild and hatchery stock in data collection masks some serious declines of wild fish in the basin.

The situation at IGH and Bogus Creek (which is only 100 yards downstream from the hatchery) appears to be that fish mingle freely between the creek and the hatchery. In fact, counters at the Bogus Creek weir reported in 1995 that the number of fish per hour through the weir went from 8 to 40 when the hatchery gate were closed,[87] while coded-wire tag analysis of the fish entering IGH indicated that half of them came from elsewhere.[88]

By 1993, Iron Gate Hatchery was again experiencing large returns of fall chinook above and beyond those needed for broodstock. The question then became what to do with the excess fish? Egg take was limited by then to 10 million[89] but just four thousand females can supply that number. Rather than destroy them, IGH managers decided to mark the excess fish with an identifying fin clip and returned them back to the river. This turned out to be an unpopular practice, because: 1) some of the returned fish strayed at least as far as the Shasta River (in 1995 at least), leading to concerns about dilution of its natural stocks with "inferior" hatchery fish; and, 2) it was feared that fish returned back to the river would be double counted, thus giving false confidence about the numbers of such fish and statistically skewing data used to determine whether the all important escapement floor had been met.[90]

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85. *Phone conversations by David Bitts with Bob Rawstron of CDFG, late summer 1986 (following reports of massive fish kill).*

86. *Klamath River Fall Chinook Review Team Report, Appendix I, Table I-2.*

87. *Conversations by David Bitts with weir operators, Oct. 1995.*

88. *Conversation by David Bitts with Alan Baracco of CDFG, Oct. 1995.*

89. *Iron Gate Hatchery Production Goals and Constraints, Farley and Elliott, CDFG, July 1993.*

90. *These concerns were raised at the KFMC, Fall 1995--Spring 1996 meeting.*

In response to these concerns, by 1996 IGH managers had decided not to release any excess fish that returned to their hatchery. Excess fish would be donated to charity or otherwise disposed of.[91] With the Trinity River Hatchery doing the same, by 1996 for the first time counts of "natural" spawners were free of adult fish that had first entered a hatchery and then been returned to the river. Thus the only natural spawners released from a hatchery from 1996 on will be those earlier released as smolts or yearlings in the ordinary course of hatchery operations, not as adults.

Trinity River Hatchery (TRH)

Trinity Dam presents a completely different type of problem for anadromous fish than Iron Gate Dam. Trinity Dam blocks access to at least 80% of the historic salmon spawning habitat of the entire Trinity Basin. Roughly the same percentage of the total inflows to Trinity Lake are also diverted to the Central Valley for irrigation. Nevertheless, when Congress authorized the Trinity River Project one of its conditions was that the natural runs of fish would be restored to pre-Project levels—yet with at best 20% of the original habitat and flows to work with![92] This goal recurs in the Trinity River Restoration Act of 1984, and in its later reauthorization. With so little natural habitat and flow left for instream restoration, clearly any effort to rebuild run sizes back up to pre-Project levels must rely heavily on hatchery mitigation—and may be problematic even then.

Built by the Bureau of Reclamation to mitigate for the habitat lost by construction of Trinity and Lewiston Dams, Trinity River Hatchery has been operated by the California Department of Fish and Game (CDFG) with funding from the Bureau of Reclamation since May, 1963.[93] It is interesting to compare its record with that of Iron Gate Hatchery, given the different weights of their roles in their respective basins: from 1971-81, IGH released an average of 4.4 million fingerlings and 430,000 yearlings, while TRH released an average of 1.2 million fingerlings and about 700,000 yearlings.[94]

TRH also has an ample year-round supply of cold water, and the physical room to expand its facility should that be desirable. Its major intrinsic problems have instead been with predation and disease.

Annual reports from the 1970's cite problems with mink, loons, gull, herons, kingfishers, and "especially" great blue herons as major predators on TRH fingerlings.[95] Otters, raccoons, and brown trout also eat TRH fish either before or shortly after their release.

Disease has also been a serious problem for this hatchery. For instance, all the fingerlings of the 1990 brood year at TRH had to be destroyed to prevent spreading their diseases (primarily IHN and bacterial kidney disease (BKD)) throughout the system.[96] This example illustrates why fisheries cannot

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91. From Iron Gate Hatchery/Trinity River Hatchery Production Goals and Constraints, Farley and Elliott, CDFG, 1996.

92. Adams, Garth. Net Economic Benefit of Restoring Trinity River Salmon and Steelhead, (masters' thesis) 1984.

93. From Trinity River Hatchery Annual Reports, CDFG (those cited are from the 1970s).

94. From Recommended Spawning Escapement Policy for Klamath River Fall-Run Chinook, Klamath River Technical Team, February, 1986, Table III-3.

95. From Trinity River Hatchery Annual Reports, CDFG for the 1970's.

96. From information reported to Klamath Review Team in 1993.

rely on hatcheries alone: all hatcheries are at risk of major loss to disease at any time, due to inherent problems created by crowded conditions in incubators and raceways. Such events have to be anticipated, and hatchery managers (and hatcheries themselves) should not be censured when they occur—provided prudent measures have been employed to prevent disease and deal with outbreaks.

Genetic intermixing from basin to basin and state to state, though now recognized as a serious problem, was very common in many hatchery programs in the past. As late as the mid-1970's, Trinity River Hatchery was importing steelhead from Washington, and exporting coho and steelhead to other California streams. In 1971, TRH imported fall-run chinook eggs and fingerlings from IGH.[97] However, by the mid-1980's such "inter-basin transfers" were recognized as a serious mistake and are now proscribed.[98]

When the big runs of returning fish started in 1986 as a result of better ocean conditions, Trinity River Hatchery was simply unable to handle the flow. Thousands of returning adult salmon were simply denied entrance to the hatchery, consequently spawning just below it in large but ultimately unproductive numbers. In response to the emergency, private efforts were made to enlarge the hatchery's rearing capacity. Temporary rearing ponds were excavated, and production of fingerlings tripled over the previous few years.[99] Interestingly, this increase in production actually had a negative effective—the big broods of 1986—1989 produced *progressively fewer* adult recruits than prior years had done with smaller broods. Indeed, the 1990 brood year (with *no* contribution from TRH fingerlings) was more productive in terms of adult returns than 1988 or 1989 had been with far larger hatchery releases.[100]

In assessing the cause of this problem, hatchery overproduction together with both decreased biological carrying capacity of the river and competition between hatchery-produced and wild juveniles were identified as contributing factors by the Klamath Review Team in 1993.[101] Hatchery policies were afterwards changed to include a cap on broodstock egg take and on total hatchery releases following this review.[102] The U.S. Fish and Wildlife Service also began studying ways to minimize instream competition between hatchery and natural fish. Among other things, investigators discovered that a strong correlation existed between the size of hatchery fish at release and the speed of their

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97. *From Trinity River Hatchery Annual Reports,* op. cit.

98. *Information from discussions at the KFMC in late 1980's and from* 1993 Production Goals and Constraints, op. cit. *The problem with inter-basin genetic transfers is that each river basin's salmon stocks are uniquely genetically adapted to that basin's river conditions. The extent to which homing behavior in salmon is genetically determined versus learned is still uncertain, and it is most likely a combination of the two. Disrupting the natal genetic strains with outside genes may disrupt that and other important survival behavior, leading to much reduced survival rates.*

99. *Information from David Bitts, who assisted in those projects.*

100. *From the* Preseason Report I, 1997, *Pacific Fishery Management Council (PFMC), Table II-4.*

101. *Quoting from the* Klamath River Fall Chinook Review Team Report, *Appendix J:* "The combination of decreased carrying capacity related to the drought in main river environments, a shallow Klamath River estuary, extremely high hatchery releases and the slow migration rate *[of the too-small hatchery fish]* of release groups may have acted together to cause very low survival rates for both hatchery and natural chinook salmon juveniles from brood year 1986–1988." *(original quote in italics)*

102. *Farley and Elliott, 1993,* op. cit.

downstream migration (the faster they migrate through, presumably the less the competition).[103] By 1996, hatchery policy included minimum release size standards in an effort to reduce intra-species competition.

Other potential genetic problems seem to have been adequately addressed. For instance, both Iron Gate Hatchery and the Trinity River Hatchery take broodstock fish at different times from throughout the whole run (as opposed to taking fish until the incubators are full, then closing the gates—which would tend to genetically alter the run timing in favor of early-returning fish). This seems to have been standard practice for some time.

Both Iron Gate and Trinity River hatcheries mark production runs of fish with coded wire tags (CWT's) to assess the effectiveness of different feeding, rearing, and release regimes. These tags are recovered from adult fish taken in fisheries, encountered as spawned-out carcasses instream, or returning to the hatcheries. Statistical expansions from the tag recoveries are then done as a primary tool for fisheries and escapement monitoring. Marked hatchery fish are thus used as statistical surrogates for calculating the size of the runs as a whole in fisheries management.

The proportion of natural to hatchery stocks can also be estimated from inriver tag-and-recovery operations. Without the monitoring tool provided by CWT marking, it would be impossible to know the ocean harvest rate of Klamath fish, for example, or the distribution of those fish in the ocean, or the percentage of total ocean landings that are Klamath fish. It would also be impossible to determine the relative success rates of adult recruitment from natural versus hatchery spawners.

Until the dams are modified or removed we must either learn to live with hatchery fish in mitigation, or learn to live with a lot fewer fish. Hatchery operators in the Klamath Basin have learned from experience, however, and have changed their operations accordingly—though sometimes only in response to public pressure.

Those who depend on continued robust runs of salmon must continue to pay attention to hatchery operations, suggesting improvements as the need appears, while working persistently to improve flow and habitat conditions for naturally produced fish. In other words, we must strive to do the best we can with what we still have. As long as these dams remain, and as long as most dams have no fish passage, then for better or worse dams and mitigation hatcheries are inevitably going to be a large part of what we still have to work with. We must therefore continue to improve them, though never losing sight of the need for restoration of habitat wherever possible. Since the carrying capacity of instream habitat affects both hatchery and wild fish alike, habitat protection—and where possible habitat restoration—must continue to be a high priority for fishermen.

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103. Joe Polos of USFWS was the lead investigator in these studies. Information is also from the Klamath River Fall Chinook Review Team Report, Appendix I.

Glossary of Terms Used in This Report

Anadromous — Fish species that hatch from eggs in fresh water and then migrate into the ocean, returning back as adults to fresh water to spawn. Species generally lumped together under the term "salmonids" are the most common family of anadromous fish.

Escapement — The total number of salmon "escaping" (returning) from the ocean to spawn in fresh water streams. A minimum escapement number is needed in each generation in order to continue the species at the same population levels (i.e., at least a 1-to-1 replacement from one generation to the next). Harvest levels are established only on the surplus above and beyond the minimum escapement levels required for replacement.

Ex-vessel price — the price per pound of salmon landed at the docks, as paid by the processor. This market price is only a small fraction of the total economic value to society generated by salmon because it is only at the beginning of a long chain of market transactions. However, the "ex-vessel price" establishes the market flow from that point onward, and careful records have been kept for many years.

Gear type — salmon are harvested with various types of gear, which use different boat and crew configurations, and thus have different impacts on the economy. Personal income impacts of harvested salmon thus vary by gear type used. Some of these gear types include "troll" (hooks on lines), "purse seine" (a towed net system), and "gillnets" (an alternative net system mostly used in-river). Economic analysis of fishery personal income impacts often needs to take into account the type of gear used to land the fish.

Salmon — any of 7 major species which are members of the genus *Oncorhynchus*, which includes chinook or king salmon (*Oncorhynchus tshawtscha*), coho or silver salmon (*Oncorhynchus kisutch*), coastal searun cutthroat (*Oncorhynchus clarki clarki*), steelhead (*Oncorhynchus mykiss gairdneri*), chum salmon (*Oncorhynchus keta*), pink salmon (*Oncorhynchus gorbuscha*), and sockeye salmon (*Oncorhynchus nerka*). As a genus these species are also often lumped together and called "salmonids."

Smolt — juvenile salmon making or about to make the transition from fresh water living to ocean conditions where they will mature to adulthood.

Stocks — the stock is the basic unit of salmon fishery management. Because salmon return to their native streams to spawn, salmon within the same species can be further subdivided into genetically distinguishable subspecies, each of which is uniquely adapted genetically to its natal stream system or group of tributaries. The "stock" concept is loosely defined and is undergoing scrutiny as to whether it recognizes the genetic uniqueness of individual stream populations on a fine enough level to conserve genetic diversity (National Research Council 1996), but is still commonly used.

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