ROGUE SPRING CHINOOK SALMON CONSERVATION PLAN

Adopted by the Oregon Fish and Wildlife Commission
September 7, 2007

Oregon Department of Fish and Wildlife
3406 Cherry Avenue NE
Salem, OR 97303

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FOREWORD

The purpose of this document is to present a conservation plan for spring Chinook salmon (*Oncorhynchus tshawytscha*) that inhabit the Rogue Species Management Unit of southwest Oregon. Conservation plans are to be developed for each Species Management Unit of native fish in the state of Oregon, as outlined by the Native Fish Conservation Policy. This policy was adopted by the Oregon Fish and Wildlife Commission in 2003 in order to ensure the conservation and recovery of native fish in Oregon.

The Oregon Fish and Wildlife Commission adopted this conservation plan on September 7, 2007. Prior to adoption, the commission considered the two suites of management strategies (Alternative 8 and Alternative 9) that had received significant support from various entities. After hearing additional input on the two alternatives, the commission voted to adopt the conservation plan with Alternative 9 as the commission's preference for a suite of management strategies. As a result of commission adoption, portions of the conservation plan became Oregon Administrative Rules.

The Native Fish Conservation Policy states that the conservation of native fish is the principle obligation for fish management practices by the Oregon Department of Fish and Wildlife. The policy has three areas of emphasis: (1) avoid serious depletion of native fish, (2) actively restore and maintain native fish at population levels that provide ecological and societal benefits, and (3) ensure that opportunities for fisheries and other societal resource uses are not unnecessarily constrained when consistent with native fish conservation.

Conservation plans are intended to provide a basis for managing hatcheries, fisheries, habitat, predators, competitors, and pathogens in balance with sustainable production of naturally produced spring Chinook salmon in the Rogue Species Management Unit. The strategies and objectives within each section define the core management program and describe the fundamental direction that will be pursued. These are implemented through specific actions, which may include (but are not limited to) restoring or improving habitat, revisions to angling regulations, and revisions to hatchery operations. A wide variety of actions are described, but not all may be implemented because of funding uncertainties. An earlier draft of this plan was distributed for a 60 day comment period to the public and to a wide variety of interested parties. Portions of this plan will become Oregon Administrative Rule upon adoption by the Oregon Fish and Wildlife Commission. Definitions of technical terms and acronyms can be found in **APPENDIX A**.

This conservation plan complements *The Oregon Plan for Salmon and Watersheds*, which was adopted by the Oregon Legislature in 1997. Primary funds that supported work on the plan originated from the Pacific Coastal Salmon Recovery Fund, which is administered by NOAA Fisheries.

ACKNOWLEDGMENTS

An advisory committee was formed to aid the Oregon Department of Fish and Wildlife with the development of this conservation plan. Eight members of the advisory committee represented the public and served as a public advisory team. Six members of the advisory committee represented those state and federal agencies commonly involved with the management of fishery related issues in the Rogue River Basin, and served as a technical advisory team. A list of advisory committee members follows:

Public Representatives of the Advisory Committee
Steve Beyerlin, Gold Beach, Oregon Guides and Packers
Keith Coddington, Medford, Middle Rogue Chapter of Trout Unlimited
Jim Dunlevy, Medford, fishing guide
Vernon Grieve, Shady Cove, fishing guide
Redge Heth, Grants Pass, Southern Oregon Flyfishers
Mark Lottis, Gold Beach, Curry Sportfishing Association
Allen Rettman, Central Point, Rogue River Guides Association
Peter Tronquet, Medford, Native Fish Society

Agency Representatives of the Advisory Committee
Jim Buck, Trail, United States Army Corps of Engineers
Randy Frick, Medford, United States Forest Service
Dale Johnson, Medford, Bureau of Land Management
Lance Kruzic, Roseburg, NOAA Fisheries
Janelle McFarland, Central Point, Oregon State Police
Kirk Meyer, Central Point, Oregon State Police

The advisory committee met 25 times over a period of two years. During the first year of meetings, the advisory committee primarily reviewed and discussed information related to (1) the status of spring Chinook salmon in the Rogue Species Management Unit and (2) physical and biological factors known to, or could possibly affect the distribution, abundance, life history, and fishery yields of spring Chinook salmon. During the second year of meetings, advisory committee efforts primarily focused on working with ODFW to develop (1) statements related to desired status and conservation status, (2) potential actions that could be employed as part of this conservation plan, and (3) alternative suites of management strategies that could be employed in order to attain desired status. In addition, the advisory committee reviewed and commented on the first draft of this conservation plan, which was subsequently released for public comment.

A draft of the conservation plan was also distributed for independent scientific review to Oregon's Independent Multidisciplinary Science Team and to Dr. David Hankin, chair of the Fisheries Department at Humboldt State University in northern California. Comments received from the scientific reviews significantly improved the plan, particularly for proposed monitoring, evaluation, and research.

INTRODUCTION

This document constitutes a conservation plan for naturally produced spring Chinook salmon (NP CHS) in the Rogue Species Management Unit. A Species Management Unit (SMU) is a group of populations from a common geographic area that share similar life history, genetic, and ecological characteristics. ODFW has identified 33 SMUs of salmon and steelhead in the state of Oregon (ODFW 2006). SMU designations are temporary until conservation plans are developed for each individual SMU. In the coastal area south of Cape Blanco, ODFW (2006) designated a SMU for spring Chinook salmon (CHS) that solely covers that portion of the Rogue River basin located upstream of Gold Ray Dam. Gold Ray Dam is located near Medford, at river mile 126 (Figure 1).

Chinook salmon may enter the Rogue River on any given day of the year. Based on the findings of ODFW (1992), CHS are defined as those mature Chinook salmon that enter freshwater during the period of February through 15 July, and also pass the counting station at Gold Ray Dam before 16 August. Fall Chinook salmon (CHF) is defined as those mature Chinook salmon that enter freshwater after 15 July, and pass Gold Ray Dam after 15 August (ODFW 1992).

The following sections of this document are designed to present and discuss issues that are relevant to the historical and current status of these animals, define current and desired status, identify limiting factors, identify assessment needs, and to outline a variety of management options to be considered by the Oregon Fish and Wildlife Commission. Identification of management options is particularly important because ODFW basin plans are lacking south of Cape Blanco.

CONSTRAINTS

Actions proposed within this conservation plan must be in compliance with a variety of local, state, and federal laws; as well as state statutes and administrative rules, and memoranda of understanding among public agencies. Consequently, there are constraints that limit potential actions by ODFW, and those constraints need to be recognized within conservation plans adopted by the Oregon Fish and Wildlife Commission. A brief description of some of the general constraints, that need to be recognized within the plan, can be found in **APPENDIX B**.

BACKGROUND

Historical Context

Commercial fishing operations for salmon in the Rogue River began in the 1860s. Pack records from R.D. Hume's cannery near Gold Beach suggest that an average of 27,000 CHS were canned annually between 1877 and 1889. Annual estimates of canned CHS varied greatly, with estimates ranging from a low of 8,200 fish in 1878 to a high of 55,000 fish in 1890 (ODFW unpublished data). These fish were mostly caught with gillnets, although beach seines may have been used at times during low flow years. Some early-run summer steelhead may be included in the cannery pack records, and some CHS were consumed locally or were shipped fresh to markets (Rivers 1964). Gill net fisheries also operated in the Rogue River near Grants Pass. Legislative action terminated commercial fishing in the Rogue River during 1936.

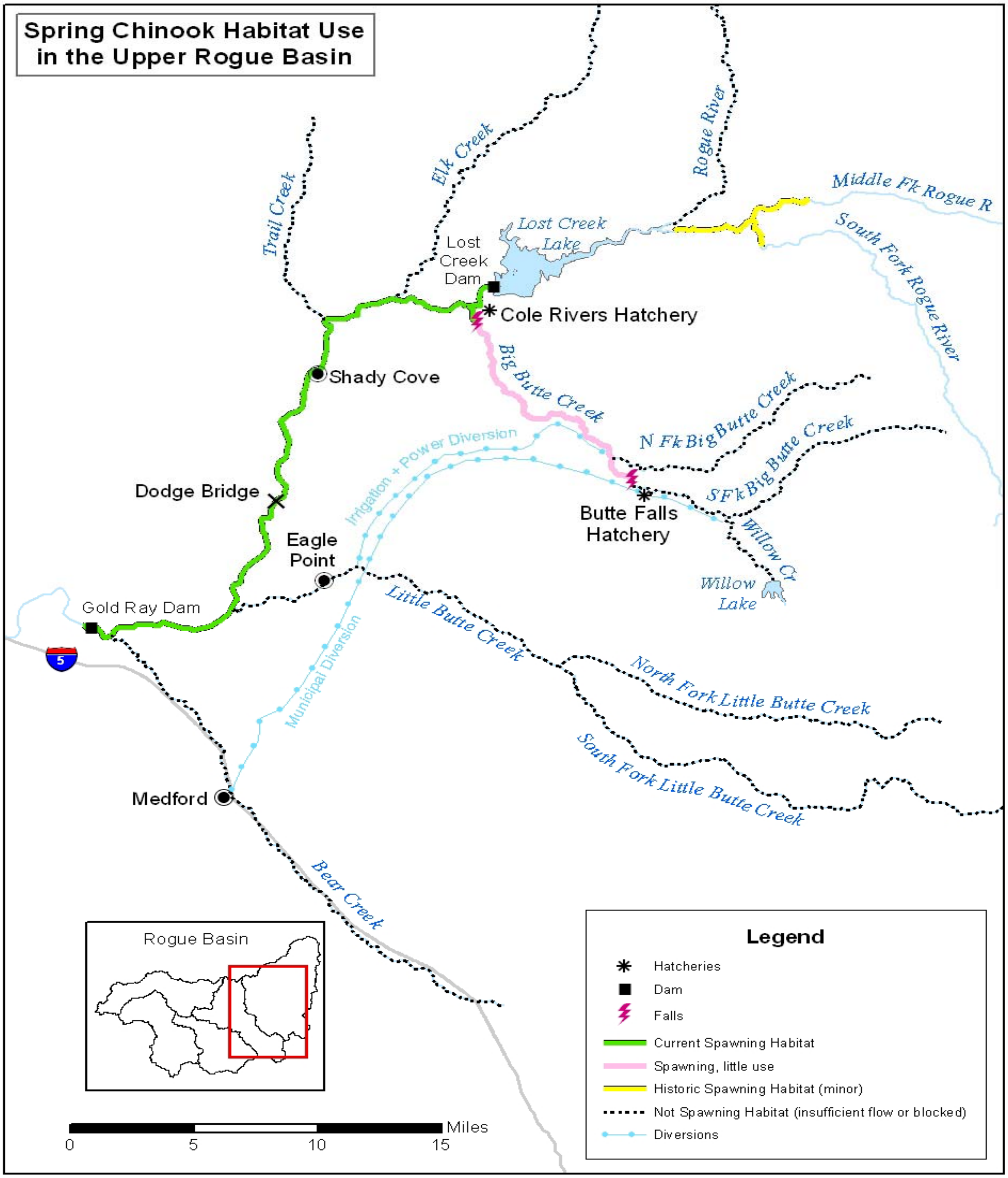

Figure 1. Map of the Rogue River Basin.

Runs of CHS were probably not present in any of the other coastal river basins in Oregon south of Cape Blanco. Landing records and interviews of operators of commercial fishing gear fail to mention any presence of CHS in the rivers of Curry County, other than in the Rogue River (Collins 1892; Bureau of Fisheries 1911; Cobb 1930).

Directed surveys of fishery resources in the Rogue River Basin began in the 1940s, and were conducted by the Oregon State Game Commission (OSGC). Findings from this project were reported by Rivers (1946). Included in this work was the construction of a fish counting station at Gold Ray Dam, which began operation in the spring of 1942. More extensive surveys of fish populations, stream habitat, and recreational fisheries were conducted by the OSGC and the United States Fish and Wildlife Service during 1949-1954. Findings from this project can be found in a series of unpublished reports (USFWS 1955a; USFWS 1955b; USFWS 1955c; USFWS 1955d). Fisheries surveys were initiated in the Rogue River Basin during the 1940s and 1950s primarily as a result of regional interest in the construction of reservoirs for the multiple purposes of flood control, hydroelectric power, and water supply.

Interest in the construction of flood control projects intensified after a major flood event in December of 1955. The United States Army Corps of Engineers (USACE) conducted an investigation of concerns related to project development and recommended to the United States Congress that three dams be constructed in the Rogue River Basin. Primary project purposes identified by the USACE included flood control, fish and wildlife enhancement, irrigation, and water supply. Secondary purposes included power generation, recreation, and water quality enhancement. Congress authorized the proposed project in 1962, including the construction of Lost Creek Dam, Applegate Dam, and Elk Creek Dam (United States Congress 1962).

Lost Creek Dam was to be constructed on the mainstem of the Rogue River at river mile 157 (Figure 1), while Applegate Dam and Elk Creek Dam were to be constructed on tributaries of the Rogue River. Each dam was to be primarily operated for flood control purposes, with the reservoir levels not to exceed specified elevations on given dates (United States Congress 1962). Storage accrued during reservoir filling was to be dedicated to specific purposes. Lost Creek Dam was completed in 1977, and the reservoir first filled in 1978. Applegate Dam was completed in 1979 and Elk Creek Dam has yet to be completed.

Of the three USACE dams authorized by Congress, Lost Creek Dam was projected to have the greatest impact on CHS in the Rogue River. The dam and associated facilities blocked approximately 33% of the spawning habitat of CHS (USACE 1967). To mitigate for the loss of spawning habitat, the USACE built and funds the operation of Cole M. Rivers Fish Hatchery. In addition, planners projected that reservoir operation would also result in the enhancement of anadromous salmonids resources in downstream areas. Fishery benefits were expected to accrue by operating the dam to (1) decrease peak flow in winter, (2) increase flow in summer, and (3) decrease water temperature in summer. Based on the recommendations of federal and state fishery management agencies, no provisions were made for fish passage around Lost Creek Dam or Cole M. Rivers Hatchery, which is located immediately downstream from Lost Creek Dam (Figure 1).

To regulate the outflow temperature from Lost Creek Lake, the USACE designed an intake structure capable of withdrawing water from five different levels of the reservoir. Selective opening of intake ports allows for mixing of water from various temperature strata in the reservoir. Choice of outflow temperature is greatest in early summer when the reservoir is full and is thermally stratified. Control of release temperature diminishes in late summer as reservoir level decreases and the highest intake ports become dewatered. Control of release temperature becomes minimal in autumn after the reservoir destratifies (USACE 1983).

Guidelines for the release of stored water from Lost Creek Dam were intended to be flexible, reflecting annual variations in water yield and user demand. When the reservoir fills, 180,000 acre-feet of storage is available for flow augmentation (USACE 1972). Of this total, 125,000 acre-feet were authorized for fishery enhancement (United States Congress 1962). The remaining 55,000 acre-feet of storage was dedicated to other uses: irrigation supply, municipal and industrial supply, and environmental enhancement. Dedicated storage that is not purchased is also available for downstream enhancement of fishery resources (USACE 1972).

The authorizing document also outlined minimum outflow and maximum water temperature to be released from Lost Creek Dam, but clearly stated these guidelines should be modified as additional information became available: "It should also be noted that project operation plans must be sufficiently flexible to permit desirable modifications in scheduled fishery releases, within the limits of storage provided therefore, if experience and further study indicates such action to be desirable for overall project benefits" (United States Congress 1962). Uncertainty related to the scheduling and efficacy of releases to meet fishery allocations lead the USACE to fund the Lost Creek Dam Fisheries Evaluation Project. This project was conducted by ODFW during the period of 1974-96, with field sampling terminated in 1994. A completion report for work with CHS was finalized and printed in 2000 (ODFW 2000). A description of the Lost Creek Dam Fisheries Evaluation Project can be found in **APPENDIX C**.

Findings and recommendations outlined in the completion report for CHS (**APPENDIX C**), along with completion reports for other races of anadromous salmonids, are used by ODFW to develop annual and seasonal recommendations for releases from Lost Creek Lake. In relation to the development of reservoir management strategies, ODFW's foremost priority since 1997 has been to protect and enhance NP CHS (Table 1).

Table 1. Current ODFW fishery management objectives as related to reservoir releases from Lost Creek Lake. Objectives are listed in order of priority, and have remained unchanged since 1997.

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1. Minimize pre-spawning mortality among adult CHS
2. Minimize dewatering losses of young salmonids
3. Minimize dewatering of CHS redds
4. Minimize early emergence by CHS fry
5. Minimize pre-spawning mortality among adult CHF
6. Increase survival rates of juvenile salmonids during the summer
7. Minimize the proportion of adult CHF that pass Gold Ray Dam
8. Minimize the effects of flow augmentation on the summer steelhead fishery in the canyon.

About one-third of the spawning habitat of CHS was blocked by the construction of Lost Creek Dam. Releases of hatchery fish are designed to mitigate for blocked spawning habitat, with a goal of producing a level of harvest that compensates for a loss of 13,020 natural spawners (USACE 1990). Currently, an average of 1.6 million CHS are raised annually at Cole M. Rivers Hatchery. These fish are released directly into the Rogue River during the period of August through October. Cole M. Rivers Hatchery began operation in 1973, and also releases coho salmon, summer steelhead, and winter steelhead directly into the Rogue River. Prior to 1973, CHS scheduled for release into the Rogue River were reared at Butte Falls Hatchery. A brief history of hatchery operations, as related to releases of CHS in the Rogue River, can be found in **APPENDIX D**.

General Aspects of Life History

The life history strategy of spring Chinook salmon in the Rogue SMU has been well documented (ODFW 2000). Adults enter freshwater from late winter through early summer, and migrate upstream at an average rate of about three miles per day. Older adults enter freshwater earlier than younger adults. After passing Gold Ray Dam at river mile 126, the average rate of migration slows to less than one mile per day. Also within this area, adult CHS cease to migrate and will "hold" until the onset of spawning. The period between the end of migration and spawning can be as long as five months. Virtually all adults hold in the Rogue River until onset of spawning, although some enter one tributary stream just prior to spawning.

Spawning takes place from the middle of September through the end of October (ODFW 2000). Spawning time is related to time of freshwater entry, with early-run CHS spawning earlier than late-run counterparts. In addition, early-run CHS spawn farther upstream as compared to late-run counterparts. The preponderance of spawning occurs in the Rogue River. Spawners are also consistently found in the lowest mile of Big Butte Creek (Figure 1), and some enter other tributary streams during those infrequent years when flows in tributary streams increase significantly during late September and early October (Rivers 1964).

Eggs and sac-fry incubate in the gravel during the winter and spring (ODFW 2000). Fry emergence from the gravel begins in January and ends in late April or early May. Fry reside primarily in the area upstream of Gold Ray Dam, and begin to migrate downstream as smolts in summer. More than 95% of the smolts enter the ocean as subyearlings during July through September at lengths of about 4-5 inches, while a small proportion of juveniles spend the winter in freshwater and enter the ocean during their second year of life (ODFW 2000). The life history characteristic of subyearling smolts differs markedly from most CHS populations farther to the north, which tend to migrate to the ocean as yearling smolts during their second year of life (Healey 1991).

Duration of ocean residence is highly variable (ODFW 2000). Some CHS rear in the ocean for less than one year, returning to freshwater as age 2 fish in their second year of life. The most common life history strategy is three years of ocean residence, with attainment of maturity as age 4 fish in their fourth year of life. A small percentage of the CHS rear in the ocean for five years, and return to freshwater as age 6 fish.

General Aspects of the Fisheries

Spring Chinook salmon contribute to commercial and recreational fisheries in the ocean, and to recreational fisheries in the Rogue River. Coastal landings of hatchery fish marked with coded-wire tags (CWT) suggest that CHS, produced in the Rogue SMU, rear in the ocean primarily off the coasts of Oregon and northern California (Lewis 2005). Recoveries of CWTs indicate that age 3 fish dominate the ocean harvest among CHS of Rogue River origin. Ocean fisheries also harvest some age 4 fish, but very few age 2 or age 5 fish.

Catches in freshwater are also dominated by specific age classes (ODFW 2000). Older age classes contribute to the river fisheries at higher rates than younger age classes. Two factors account for the differential harvest rates within the river fisheries. First, older fish enter the river earlier, and migrate through fisheries near Gold Beach and Grants Pass at a time when water conditions are conducive for catching CHS (ODFW 2000). Second, older CHS migrate past Gold Ray Dam on earlier dates, and thus are exposed to the fishery in the upper river for a longer period of time as compared to younger counterparts that pass Gold Ray Dam later (ODFW 2000).

Origin of the fish also affects susceptibility to capture. Hatchery fish are caught at lower rates in the river fisheries as compared to naturally produced fish. Two factors account for the differences in the contribution rates to the fisheries. First, hatchery CHS tend to mature at younger ages as compared to NP CHS and younger CHS migrate through the fisheries at later dates (ODFW 2000). Second, hatchery CHS leave the river by entering Cole M. Rivers Hatchery, while NP CHS remain resident in the river during the course of the fishery upstream of Gold Ray Dam (ODFW 2000).

SPECIES MANAGEMENT UNIT AND CONSTITUENT POPULATIONS

As previously described, the geographical boundaries of the SMU were provisionally identified as being limited only to that portion of the Rogue River basin located upstream of Gold Ray Dam (ODFW 2006). Consideration was given to the possibility that the geographical boundaries should be expanded to include other coastal river basins located between the California border and Euchre Creek, inclusive. Chinook salmon present in these basins are included in the geographical boundaries for the Southern Oregon and Northern California Evolutionarily Significant Unit, as identified by Biological Review Teams (NOAA Fisheries 1999). ODFW has chosen to identify separate SMUs for CHS and CHF due to differences in life history strategies.

A few adult CHS have been observed in the Applegate River, in the Pistol River, in the Illinois River, and in the Chetco River during surveys conducted for other purposes (ODFW unpublished observations). No other source of information could be identified that would suggest that other populations of CHS may be, or have been, present within the area in question, including historical records (see **Historical Context**, page 6). Consequently, within the context of this conservation plan, the geographical boundaries of the Rogue SMU for CHS are limited solely to the area upstream of Gold Ray Dam (Figure 1), where all of the spawning and early rearing of juveniles occurs for NP CHS. However, portions of this plan address issues pertaining to the Rogue River downstream of Gold Ray Dam, as this area is used as a migration corridor by juvenile and adult CHS.

Only one population of CHS appears to be present in the Rogue SMU, under the definition that a fish population is “a group of fish originating and reproducing in a particular time which do not interbreed to any substantial degree with any other group reproducing in a different area, or in the same area at a different time” (OAR 635-007-0501(45)). However, changes in the life history characteristics of NP CHS raised the possibility that multiple populations may be present in the area upstream of Gold Ray Dam. This possibility was partially evaluated by assessments of genetic material obtained from adult Chinook salmon trapped at Gold Ray Dam.

In 2004, tissue samples were collected from adult Chinook salmon to test two hypotheses: (1) naturally produced fish classified as CHS differ from counterparts classified as CHF, and (2) NP CHS differ from hatchery CHS. The assessment method chosen was a comparison of gene frequencies using microsatellite DNA markers. These highly variable nuclear DNA markers make possible genealogical analyses or genetic discrimination among closely related fish populations. For example, such methods identified different populations of CHS in two tributaries of the upper portion of the Sacramento River (Banks et al. 2000). The genetic assessment of Chinook salmon trapped at Gold Ray Dam was conducted by Renee Bellinger, with the Marine Fisheries Genetic Laboratory at Oregon State University.

Preliminary findings of the project, which have yet to be published, are:
1. There was no detectable difference between naturally produced Chinook salmon trapped during late May and early June as compared to counterparts trapped during late July and early August. Chinook salmon that pass Gold Ray Dam during these periods are currently classified by ODFW as CHS.
2. Naturally produced Chinook salmon trapped during late September and early October differed significantly from counterparts trapped during earlier periods. These later migrating fish are currently classified by ODFW as CHF.
3. There was no detectable difference between hatchery CHS trapped during the period of late May and early June and NP CHS trapped in either (1) late May and early June or (2) in late July and early August.

DESIRED BIOLOGICAL STATUS

As outlined in the Native Fish Conservation Policy, each conservation plan should describe a desired status for the SMU that reflects the ecological, economic and cultural benefits to be sought from the naturally produced fish. A description of the desired biological status must be based on measurable criteria that are directly relevant to biological attributes of population(s) within the relevant SMU. Prior to the development of specific numerical criteria for NP CHS, a series of generalized options were developed in consultation with the advisory committee (Table 2). Options three and four were each preferred by three members of the public advisory committee. No members of the public advisory committee supported any of the other four options. A majority of the members of the technical advisory committee preferred option three.

Options three and four differ only in relation to the way that the hatchery program would be managed for CHS. The preferences expressed indicated that there was interest in maintaining historical life history characteristics among hatchery CHS and to maximize the contribution rates of hatchery CHS to the consumptive fisheries. In contrast, there was no, or minimal, support for options one, two, five, or six. Options one and two would have compromised, to some degree, the ability to manage effectively for other fishery resources in the Rogue River Basin. Options five and six would have resulted in the SMU being managed for the increased production of NP CHF in areas that historically were dominated by NP CHS.
Using the preferred generalized options as a guideline, attention subsequently focused on the development of measurable criteria that are relative to biological attributes of population(s) within the relevant SMU. With the considerable amount of data available for CHS in the Rogue SMU, there was a myriad of possible elements that could compose a desired status statement. Generic elements that were initially considered included (1) abundance, migration timing, age

Table 2. Six options that characterize generalized attributes of potential management scenarios for Chinook salmon in the Rogue Spring Chinook Salmon Species Management Unit.

Option 1

Restore, to the greatest degree possible, the historical abundance and life history characteristics of NP CHS. When possible, provide harvest opportunities for naturally produced fish. Manage hatchery fish so as to maximize contribution rates to recreational and commercial fisheries.

Option 2

Restore, to the greatest degree possible, the historical abundance and life history characteristics of NP CHS while providing harvest opportunities for naturally produced and hatchery fish. Manage hatchery fish so as to minimize potential impacts on naturally produced fish.

Option 3

Maintain, at sustainable levels of abundance, the historical life history characteristics of NP CHS while providing harvest opportunities for naturally produced and hatchery fish. Manage hatchery fish so as to mitigate for fishery losses associated with the blockage of spawning habitat and the change in the life history patterns of NP CHS.

Option 4

Maintain, at sustainable levels of abundance, the historical life history characteristics of NP CHS while providing harvest opportunities for naturally produced and hatchery fish. Manage hatchery fish so as to maximize contribution rates to recreational and commercial fisheries.

Option 5

Maximize the production of naturally produced Chinook salmon in freshwater habitat that historically produced CHS while providing harvest opportunities for naturally produced and hatchery fish. Manage hatchery fish so as to maximize contribution rates to recreational and commercial fisheries.

Option 6

Maximize the production of naturally produced Chinook salmon in freshwater habitat that historically produced CHS, while providing harvest opportunities for naturally produced and hatchery fish. Manage hatchery fish so as to minimize potential impacts on naturally produced fish.

composition, spawning time, and spawning distribution of NP CHS, (2) relative abundance of hatchery fish among migrating and spawning CHS, and (3) relative abundance of CHF among all naturally produced adult Chinook salmon in the SMU. In addition, consideration was given to the length of time that provided an effective period by which to judge the status of attributes. A period of 10 years was chosen, which basically represents an interval that basically covers two complete generations. More information related to the initial consideration of the form of desired status elements can be found in (**APPENDIX E**).

Development of a specific statement of desired status followed a decision tree approach based on assessments of biological productivity and life history. Potential elements were set aside if (1) the critical parameter of a potential element was judged to be too difficult to estimate, (2) potential elements failed to complement each other, or (3) potential elements, in a practical sense, covered the same overall objective. There was a considerable amount of interest in development of a criterion related to juvenile abundance, but no means could be devised by which to visually differentiate juvenile CHS and CHF during any potential monitoring activities. The progressive development of a desired status statement is described in **APPENDIX E**. The statement of desired status, outlined in Table 3, represents a final product that was preferred by four public advisory committee members, six technical advisory committee members, and by ODFW. Two of the public advisory committee members also expressed support for the statement, with the exception that they felt that hatchery fish should compose less than 10% of the natural spawners. In addition, two public advisory committee members chose not to express a preference on whether the persistence element should be added, but otherwise supported the desired status statement.

Table 3. Criteria indicative of desired status for the Rogue Spring Chinook Salmon Species Management Unit. All criteria apply, except criterion six, as annual estimates averaged over a running period of ten years. Progressive steps in the development of the statement are outlined in **APPENDIX E**.

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1. **Abundance:** At least 15,000 naturally produced spring Chinook salmon should pass Gold Ray Dam.

2. **Migration Timing:** At least 60% of the naturally produced adult[a] spring Chinook salmon should pass Gold Ray Dam by 15 June.

3. **Age Structure:** Jacks[b] should compose no more than 10% of the naturally produced spring Chinook salmon that pass Gold Ray Dam.

4. **Spawner Distribution:** Among naturally produced spring Chinook salmon that spawn during September, at least 40% should spawn upstream of the Highway 62 bridge in Shady Cove.

5. **Spawner Composition:** Hatchery fish should compose no more than 15% of spring Chinook salmon that spawn naturally.

6. **Persistence:** There is at least a 99% chance that the population of naturally produced spring Chinook salmon will persist over a period of 100 years.

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[a] *Adults are defined as fish greater than, or equal to, 24 inches in length.*

[b] *Jacks are defined as fish less than 24 inches in length.*

The final selection of the measurable criteria included in the desired status statements represents an iteration process in that multiple revisions were made to the criteria when it became evident that more "liberal" interim desires for SMU status could not be achieved because of certain limiting factors that are very unlikely to change. For example, it is very unlikely that Lost Creek Dam will be removed, so criteria for elements of fish abundance and life history characters were adjusted accordingly.

Population Productivity

The Native Fish Conservation Policy of ODFW identifies that when possible, a measurable criterion for "standardized rate of population growth" for desired status should be identified in a conservation plan. This metric is often referred to as productivity. To specifically look at population growth rate, productivity should be measured as the ratio of returning spawners compared to their parents. The most appropriate way to measure a salmon population's productivity is to measure productivity with competitive factors removed, or the population's intrinsic productivity. It can be difficult to measure intrinsic productivity. Marine survival, and the ocean conditions that influence that survival, plays a key role as a competitive factor that influences the productivity of a salmon population. Another competitive factor is seen when populations in freshwater must compete for rearing space and food. This competition is believed to be lowest when a population's abundance is low. To measure a salmon population's intrinsic productivity, it is most appropriate to standardize the productivity for marine survival, and to measure it when abundances are low.

Non-standardized estimates of Rogue NP CHS productivity can currently be made and have ranged between 0.1 and 20 recruits per spawner for the 1975-2000 brood years, and averaged 4.3 fish per spawner (Figure 2 and Appendix Table F-3). The wide range in annual recruitment rates, coupled with sporadic spikes in recruitment rates, makes it difficult to make conclusions in relation to short-term trends in productivity. In addition, productivity estimates are not available on a timely basis for fishery managers. Six years must pass before all recruits can be accounted for, because some NP CHS in the Rogue SMU mature during their sixth year of life. This time lag, along with the inability to discern trends in non-standardized productivity, made it difficult for ODFW and the Advisory Committee to develop a criterion for productivity.

Productivity is most critical for a salmon population's viability when that population is at low abundances. Productivity must be high enough at these times to keep a population's abundance from dropping too low. When population abundance drops too low, it may become difficult for adults to find mates for spawning, or there may not be an adequate diversity of life history characteristics to ensure that the population can adapt to environmental change or catastrophes. If a population's productivity, or population growth, is adequate during low abundances, the population will not drop to a critical abundance level. For this reason, a productivity criterion is usually defined for periods of low abundance and is related to defining a level that maintains the population's viability.

While intrinsic productivity is valuable in describing the viability of a salmon population, it can be difficult to determine the appropriate level to define a population's desired status. Defining a

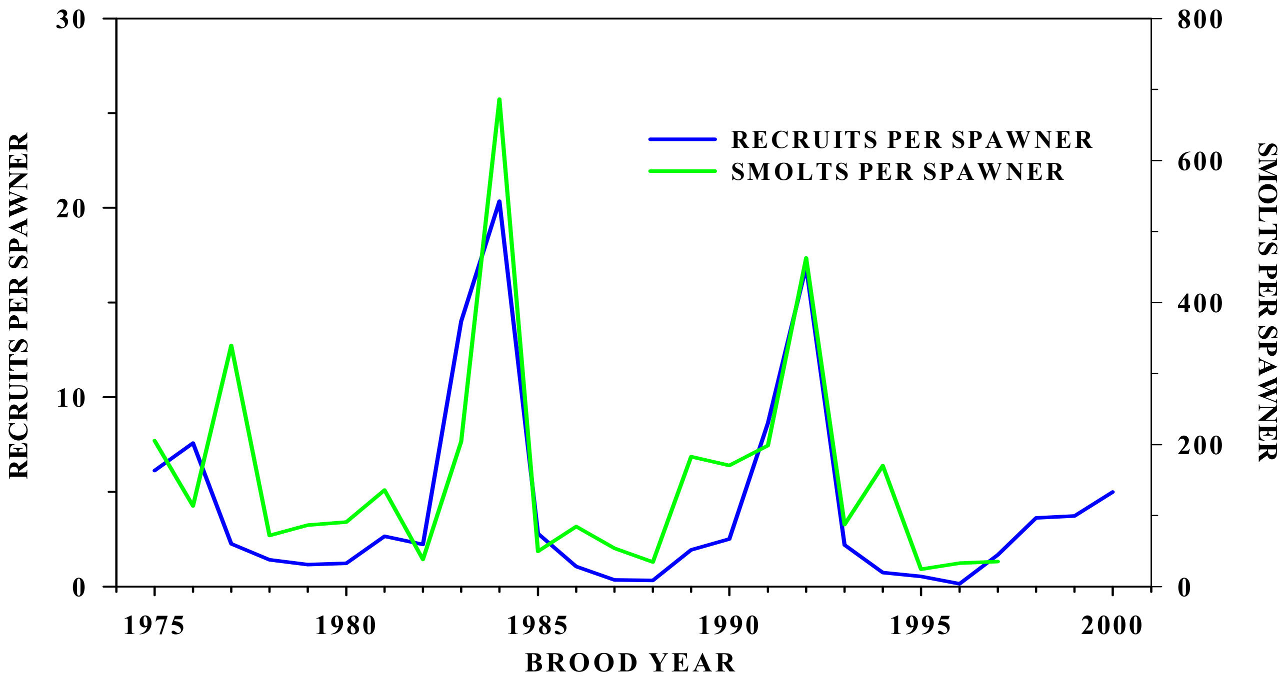

Figure 2. Productivity estimates for naturally produced spring Chinook salmon, 1975-2000 brood years. Smolt estimates are an index, as wild smolts were assumed to have survived at the same rate as hatchery smolts.

productivity level that ensures desired status is maintained has not been adequately researched. While the information available for Rogue NP CHS productivity suggests a population with productivity adequate to avoid critical abundance levels (maintain viability), it is not currently possible for ODFW to define and evaluate whether the population's productivity level is adequate to maintain desired status. Analyses into this subject are needed not only for Rogue NP CHS, but for other SMUs as well. ODFW will encourage and support such analyses. As the understanding of productivity related to desired status increases, ODFW will attempt to develop a productivity criterion for Rogue NP CHS. A process will be initiated to modify the conservation plan when a productivity criterion is developed.

CURRENT STATUS

The primary purpose of this section of the plan is to present metrics of current status that are directly relevant to metrics included in the desired status statement. A thorough review of the status of the population was not conducted, primarily because of the limited sources of data. Analytical methods followed procedures outlined by Zar (1984). Data judged to exhibit a normal distribution were analyzed with parametric statistics. Data with distributions judged to be other than normal were assessed with nonparametric statistics.

Sources of Available Data

Characterization of the current status of the SMU relies primarily on two sources of information: (1) estimates of fish passage at the counting station at Gold Ray Dam and (2) surveys of spawned carcasses of fish known to be spring Chinook salmon. Descriptions of each sampling method follow.

Passage of Chinook salmon at Gold Ray Dam has been estimated since 1942. All passing fish were counted during 1942-47. During 1948-92, fish were counted eight hours daily, five days weekly. Partial counts were designed to estimate biweekly passage with an average error of less than 10% (Li 1948). Since 1993, passage has been estimated with video recordings, a procedure which is assumed to have minimal uncertainty.

In 1942-68, fish were counted as they passed above a white board. Since 1969, fish have been counted as they passed an underwater viewing window. Counters also recorded fin clips and classified fish by size. During 1942-77, counters classified Chinook salmon as jacks if the fish were smaller than 20 inches (50 cm). After 1977, the size criteria for jacks changed to fish less than 24 inches (60 cm) in length.

Procedures to estimate the proportion of hatchery fish within the returns also varied through time, as described by ODFW (2000). Prior to the construction of the underwater counting station, the proportion of hatchery fish in the return was assumed to be equal to the proportion of marked fish among spring Chinook salmon processed at canneries near Gold Beach. Few unmarked hatchery fish were released prior to 1976, except as unfed fry, so it was assumed that all unmarked adult fish produced from previous brood years were of wild origin. Beginning in 1978, the proportion of hatchery fish in the run was estimated by the analyses of scales collected from unmarked fish trapped at Gold Ray Dam. Scale sampling ended in 1994 when field work for the Lost Creek Dam Fisheries Evaluation Project terminated. From 1995 through the present time, the proportion of hatchery fish within annual returns is estimated based on the difference between the proportion of marked fish among spring Chinook salmon that pass Gold Ray Dam and those that enter Cole M. Rivers Hatchery. For example, if 50% of the CHS that entered the hatchery were marked and 20% of the CHS that passed Gold Ray Dam were marked, then 40% of the CHS that passed Gold Ray Dam were estimated to be of hatchery origin. Minor adjustments were also made for those years when some unmarked CHS with CWTs were present within the returns.

Metrics for spawner composition and distribution were estimated from surveys for spawned carcasses of known spring Chinook salmon. As fall Chinook salmon begin spawning in areas upstream of Gold Ray Dam during October (ODFW 2000), newly designed surveys were designed to sample only spring Chinook salmon that spawned in September. All primary spawning areas are surveyed weekly upstream of Gold Ray Dam, including the lower mile of Big Butte Creek. The carcass surveys actually extend into the second week of October because of post-spawning longevity and lags in survey periodicity (ODFW 2000). This specific sampling began in 2004, but data gathered in 1974-81 during the Lost Creek Dam Fisheries Evaluation Project was directly comparable.

Abundance

The abundance of NP CHS in the Rogue SMU decreased during the last 30 years, and reached the lowest levels ever recorded during the 1990s (Figure 3). Passage estimates at Gold Ray Dam averaged about 27,875 (95% CI = ±4,342) fish in the 1940s through the 1960s, 28,052 (95% CI = ±7,166) fish in the 1970s, 24,207 (95% CI = ±10,587) fish in the 1980s, 7,684 (95% CI = ±3,853) fish in the 1990s, and 8,979 (95% CI = ±5,161) fish during 2000-06. During the last ten years, the annual passage of NP CHS at Gold Ray Dam averaged about 8,209 (95% CI = ±3,525) fish and ranged between 3,443 and 19,270 fish (Appendix Table F-1).

In contrast to naturally produced fish, the abundance of CHS of hatchery origin increased during the last 30 years, and reached the highest level ever recorded in the 1990s (Figure 3). Passage estimates of hatchery fish at Gold Ray Dam averaged 2,325 fish (95% CI = ±2,151) in the 1970s, 22,232 (95% CI = ±13,552) fish in the 1980s, 20,395 (95% CI = ±11,852) fish in the 1990s, and 22,765 (95% CI = ±10,080) fish during 2000-06 (Appendix Table F-1). While numbers of NP CHS decreased, numbers of NP CHF increased and reached the highest level ever recorded during 2000-2006 (Figure 3). Passage estimates of NP CHF at Gold Ray Dam averaged 3,248 (95% CI = ±893) fish in the 1970s, 5,791 (95% CI = ±1,995) fish in the 1980s, 6,803 (95% CI = ±2,797) fish in the 1990s, and 13,659 (95% CI = ±5,730) fish during 2000-06 (Appendix Table F-1). Few CHF of hatchery origin pass Gold Ray Dam (Figure 3).

Run Composition

Among CHS in the Rogue SMU, the relative abundance of hatchery fish increased sharply during the last 30 years. At Gold Ray Dam, the relative abundance of hatchery fish averaged 7% (95% CI = ±5%) in the 1970s, 42% (95% CI = ±11%) in the 1980s, 72% (95% CI = ±3%) in the 1990s, and 70% (95% CI = ±12%) during 2000-06. During the last 10 years, hatchery fish accounted for an average of 72% (95% CI = ±8%) of the annual returns of CHS, with annual estimates that ranged between 54% and 85% (Appendix Table F-1).

Race Composition

The relative abundance of CHF has increased sharply during the last 30 years. Among naturally produced Chinook salmon that passed Gold Ray Dam, the relative abundance of CHF averaged 11% (95% CI = ±4%) in the 1970s, 21% (95% CI = ±5%) in the 1980s, 48% (95% CI = ±12%) in the 1990s, and 62% (95% CI = ±8%) during 2000-06. During the last 10 years, CHF accounted

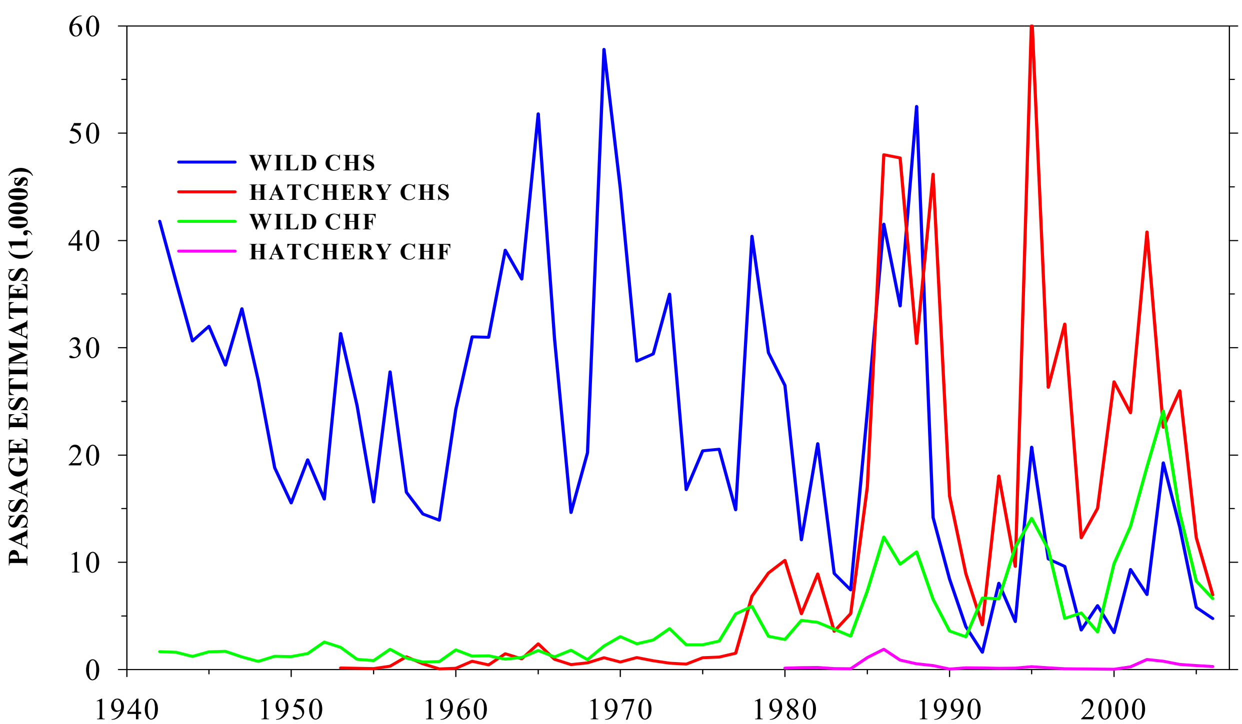

Figure 3. Estimated passage of Chinook salmon at Gold Ray Dam, 1942-2006.

for an average of 56% (95% CI = ±9%) of the naturally produced Chinook salmon that passed Gold Ray Dam, with annual estimates ranging between 33% and 74% (Appendix Table F-1).

Migration Timing

Naturally produced spring Chinook salmon migrated later during recent years as compared to historical patterns of migration timing (Figure 4). During 1942-79, an average of 63% (95% CI = ±5%) of the "adult" NP CHS passed Gold Ray Dam by 15 June. In comparison, during 2003-2006, an average of 45% (95% CI = ±13%) of the "adult" NP CHS passed Gold Ray Dam by 15 June. A t-test of arcsin transformed data indicated that the averages differed significantly at the 95% confidence level (*P* = 0.035). Jacks also now pass Gold Ray Dam later as compared to historical periods (Figure 4). The percentage of NP CHS jacks that passed the counting station by 15 June averaged 46% (95% CI = ±6%) in 1942-79 and averaged 23% (95% CI = ±15%) during 2003-06. A t-test of arcsin transformed data indicated that the averages differed significantly at the 95% confidence level (*P* = 0.020).

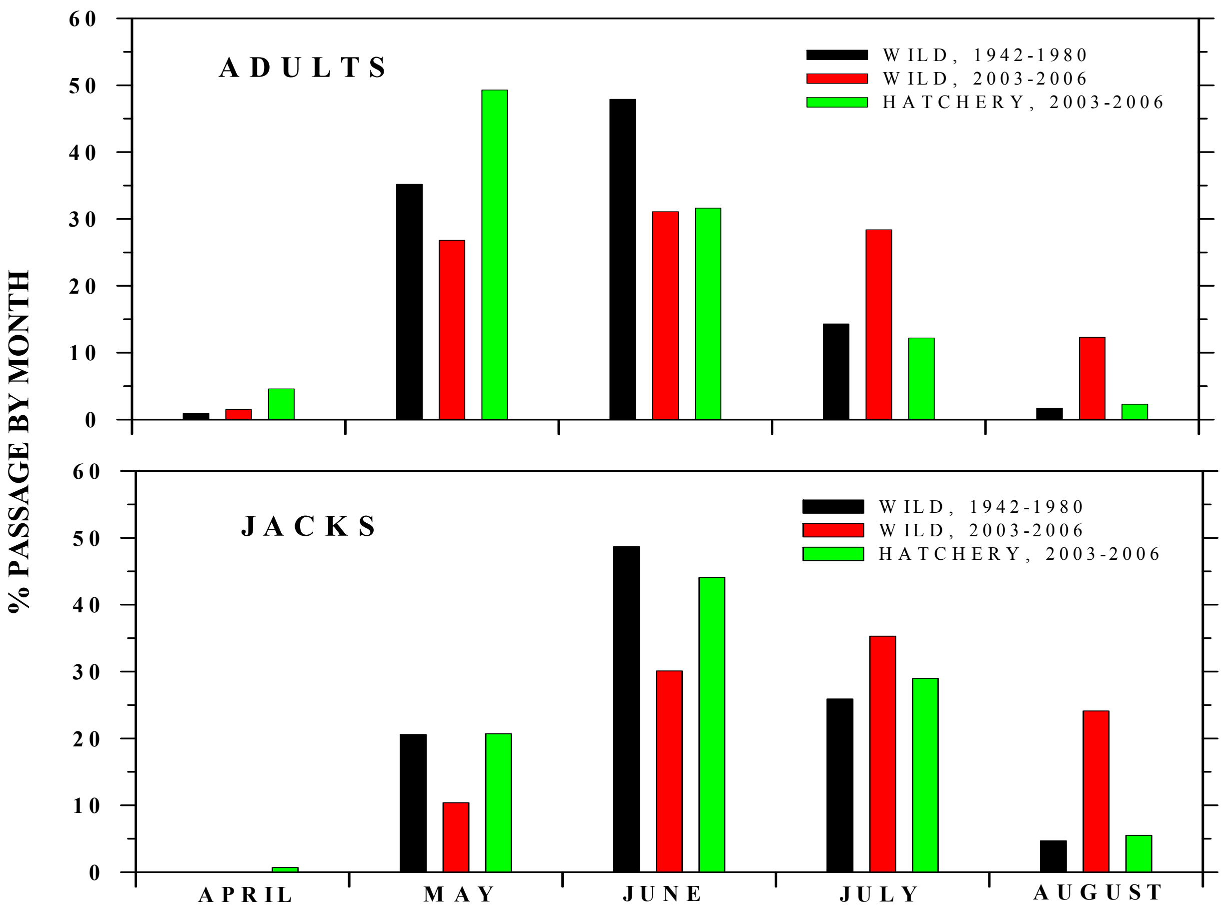

Figure 4. Average migration timing of spring Chinook salmon at Gold Ray Dam. Fish that passed the dam in 1942-80 were almost produced as juveniles before the operation of Lost Creek Dam. Differential migration timing estimates for naturally produced fish and hatchery fish could not be derived for 1981-2002 (see text for explanation).

Estimates of migration timing could not be developed for NP CHS that returned during 1980-2002 for three reasons: (1) marked hatchery fish usually composed less than 5% of the returns, (2) the proportion of hatchery fish that were marked varied among affected brood years and was usually less than 10%, and (3) naturally produced fish and hatchery fish migrated at different times (ODFW 2000). However, ODFW (2000) identified NP CHS from scale samples collected at Gold Ray Dam and determined that NP CHS produced after the operation of Lost Creek Dam migrated later than counterparts produced in previous years. Thus, the results of the comparisons of NP CHS migration timing in 1942-79 and in 2003-06 are commensurate with the results reported by ODFW (2000).

Currently, hatchery CHS tend to migrate past Gold Ray Dam at times that are more closely comparable to the migration timing patterns of NP CHS observed during 1942-80 (Figure 4). During 2003-06, an average of 74% (95% CI = ±13%) of the "adult" hatchery CHS, and an average of 49% (95% CI = ±24%) of the jack hatchery CHS passed the counting station by 15 June. Neither of these averages differed significantly from the respective average times of migration for NP CHS during 1942-80 ($P = 0.201$ for the "adult" comparison and $P = 0.487$ for the jack comparison; both comparisons made with arcsin transformed data).

Age Composition

Estimates of age composition for NP CHS are available only for the 1974-1994 return years, and are reported by ODFW (2000). However, jack counts at Gold Ray Dam provide one index of age composition. Jack counts include all of the returning age 2 fish and about one-half of the returning age 3 fish (ODFW 2000). Returning age 4, age 5, and age 6 fish are all larger than 24 inches, and are classified as "adults". In 2003 through 2006, jacks composed an average of 9% (range = 5-13%) of the NP CHS that passed Gold Ray Dam. Jack returns from earlier years are not presented because the size classification for jacks that passed Gold Ray Dam changed from 20 inches to 24 inches in 1978 and so direct comparisons are not appropriate.

Spawner Distribution

Spatial and temporal overlaps in spawning by CHS and CHS make it difficult to directly estimate the spawning distribution of the spring race. However, only CHS spawn during September, while CHF do not begin spawning until October (ODFW 2000). Currently, NP CHS spawn farther downstream as compared to earlier years (ODFW 2000). For those NP CHS that spawned in September, an average of 79% (95% CI = ±5%) spawned above Shady Cove in 1974-81 while an average of 48% (95% CI = ±30%) spawned above Shady Cove in 2004-06.

The most recent estimates of spawning distribution for all NP CHS date from 1986-87, when known CHS were individually tagged at Gold Ray Dam. These estimates indicated that more than 90% of the early-run and mid-run NP CHS spawned upstream of Dodge Bridge (Table 4).

Spawner Composition

Naturally produced fish compose a smaller proportion of CHS spawners as compared to historical patterns of spawner composition. During 1974 through 1981, hatchery fish accounted for only 1-2% of the natural spawners (Cramer et al. 1985). During 2004-2006, hatchery fish annually composed an average of 11% (range = 9-12%) of the natural spawners. In the four mile

Table 4. Spawning distribution of naturally produced spring Chinook salmon tagged at Gold Ray Dam during various months in 1986-87.

		Month(s) of tagging					
River miles	Survey area	May	June	July	August	May-June[a]	(95% CI)
156-152	Hatchery-Rogue Elk	48%	38%	14%	18%	42%	31%-53%
152-145	Rogue Elk-Shady Cove	26%	21%	16%	16%	23%	14%-33%
145-138	Shady Cove-Dodge	16%	23%	29%	24%	20%	12%-30%
138-131	Dodge-Touvelle	3%	6%	22%	21%	5%	1%-12%
131-127	Touvelle-Gold Ray pool	0%	4%	13%	18%	2%	<1%-8%
0-1	Big Butte Creek	6%	9%	5%	3%	8%	3%-16%
number of tagged spawners recovered		31	53	85	38	84	

[a] *portion of population that exhibited greatest decline in status. As defined in this plan, early-run fish pass Gold Ray Dam in May, mid-run fish pass Gold Ray Dam in June, and late-run fish pass Gold Ray Dam in July-mid August.*

reach downstream from Cole M. Rivers Hatchery, hatchery fish composed an average of 27% (range = 23-33%) of the natural spawners during 2004-2006.

Persistence of the Species Management Unit

As outlined in the Native Fish Conservation Policy, this plan should forecast the likelihood of SMU persistence in the near and long terms. The relationship between recruits and spawners was used to assess persistence potential (viability) of NP CHS in the Rogue SMU.

A population viability modeling exercise was undertaken to help assess the conservation status of NP CHS and to examine the possible consequences of different fishery management scenarios. The tool used to perform these analyses was the Conservation Assessment and Planning Model (CAPM), a population viability model developed by ODFW. An abbreviated description of this model follows, with a more detailed description presented in **APPENDIX G**. Data used in the assessment is presented in Appendix Table F-2.

CAPM was developed to assist salmonid conservation and recovery planning in Oregon. With the ability to define a wide range of possible future conditions the model lends itself to assessing both the likelihood of population extinction should conditions remain unchanged and also the likelihood of population extinction should these conditions change in response to implementation of successful conservation strategies. As is characteristic of all viability models, CAPM attempts to mimic the stochastic nature of population recruitment for a future period of time (e.g., the next 100 years). Simulations of this natural process are the basis for estimating probabilities of extinction, or in this case abundance less than the critical reproductive threshold (CRT).

Although mechanically similar to other population viability models, several features of CAPM are unique. First, rather than using only one recruitment model to simulate population recruitment, CAPM uses three. It was assumed that in doing so, the adverse consequences of case-by-case inaccuracies of data fits to a particular recruitment function could be reduced.

Secondly, in addition to the spawner abundance variable, all recruitment equations incorporate an independent index of environmental conditions. This second variable, SNEG, was based on a 7-year moving average of high elevation maximum snow depth. Inclusion of this variable not only improved recruitment model accuracy, but also had the effect of substantially reducing temporal autocorrelation of recruitment model residuals.

The estimated survival rate of hatchery spring Chinook smolts released from Cole M. Rivers Hatchery was also considered as a possible independent index of environmental conditions related to the period of ocean residence. This index made the recruitment models a bit more accurate, but was not incorporated into the models because the variable that was used to generate the spawner and recruit data set (harvest rate) was also a significant variable used to generate the smolt survival estimate. It was felt that the snow depth index was a better index of environmental conditions because of its complete independence from the other data used in the models.

Another unique feature of the model was that a probability of extinction was calculated for each set of recruitment function parameters estimated via the bootstrap process. This bootstrapping procedure was used to repeatedly sample the population data set (generally 200 times). A regression analysis was then performed on each data set sample using a nonlinear regression routine. This meant that for every bootstrap sample an estimate of recruitment equation parameters and associated standard deviations were generated for all three recruitment curves.

Probabilities of the population becoming less than CRT levels were then estimated for each sample of parameters. The CRT level for the NP CHS population was set at 300 spawners. CRT is considered the abundance level at which the population may tip into an extinction vortex from which it can not recover.

The primary purpose of the extended bootstrap procedure was to better understand the range and magnitude of possible errors in estimating recruitment equation parameters. However, as a result of this process, the output from CAPM is not a single probability of CRT estimate, but rather distributions of CRT probabilities that can be visualized as frequency histograms. The median and percentile values from these distributions are used to characterize these distributions and thereby population viability.

Viability Model Results and Discussion: The spawner-recruit data used in this analysis (Table 5) were describable as a recruitment curve function with only a modest degree of confidence.

The best fits were obtained with the ski recruitment function described by the equation:

$$\text{Ln(Recruits)} = \text{Ln(b)}+\text{Ln}(1-\exp(-(a * \text{Spawners})/b))+(c*\text{SNEG}_{76})$$

where the parameters a, b, and c were estimated as 18.6, 33246, and 0.022, respectively. Because of the less than ideal fit of the data, there was considerable uncertainty in the parameter values estimated. The parameter estimates represent the median values obtained from the bootstrap samples drawn from the population data set. However, range of these values is large. For example, the 18.6 median value for the productivity parameter, a, comes from a pool of bootstrap samples having a 5th percentile value of 8.3 recruits per spawner and a 95th percentile value of 34.7 recruits per spawner (Table 6). This wide range of values was also found to be the case for the other parameter estimates.

Table 5. Data set of spawners, recruits, and snow index (SNEG) for naturally produced spring Chinook salmon used to estimate population recruitment function for use in a population viability model.

Brood year	(x1) $SNEG_{76}$	(x2) Spawners	(y) Ln(Recruits)	Recruits
1977	-9	7784	10.003	22092
1978	7	21747	10.780	48059
1979	-45	16108	10.161	25864
1980	-44	14333	10.137	25251
1981	-35	4143	9.794	17929
1982	0	8683	10.492	36016
1983	9	5238	11.560	104813
1984	14	4099	11.782	130889
1985	5	10945	10.828	50399
1986	13	11749	10.544	37953
1987	-2	15817	9.178	9683
1988	-33	27247	9.455	12776
1989	-42	8789	9.932	20577
1990	-67	4096	9.442	12609
1991	-65	2510	10.201	26929
1992	-68	906	9.886	19660
1993	-56	4762	9.544	13962
1994	-75	2633	7.685	2176
1995	-52	16216	9.164	9550
1996	-50	8477	7.157	1283
1997	-1	9166	9.663	15732
1998	4	3039	9.496	13301
1999	-9	5799	10.010	22255
2000	3	2779	9.843	18835

Table 6. Description of parameter estimates for ski recruitment function fit to spawner-recruit data for naturally produced spring Chinook salmon.

	a	a ProbT	b	b ProbT	c	c ProbT	SDrsid	R^2	CurvProbT	AutoCorr
5%tile	8.3	0.027	26262	0.000	0.0116	0.000	0.56	0.14	0.000	0.48
Median	18.6	0.331	33246	0.000	0.0217	0.001	0.78	0.39	0.002	0.53
95%tile	34.7	0.726	43981	0.007	0.0324	0.061	0.94	0.62	0.078	0.62

It was evident there was considerable autocorrelation in the model residuals (Table 6) even though the environmental variable, SNEG, was included in the model, which effectively reduces this problem when used to fit recruitment data from other salmon and steelhead populations.

Autocorrelation of residuals is one symptom that a recruitment model does not describe population dynamics effectively. However, if present it needs to be accounted for when the recruitment relationship is used to estimate population extinction risk. Therefore, in light of this result, program code to simulate this autocorrelation behavior in the population recruitment was added to CAPM.

The extinction risks forecast for NP CHS using the CAPM model were low (Table 7), consistent with the relative robust productivity estimated for this population (18.3 recruits per spawner) and the large capacity of the habitat (33,246 potential recruits - parameter b in Table 6). These simulations also suggested that not until fishery impact rates were increased to 0.30 and above were there likely impacts on the viability of the population (Figure 5).

It should be noted that in other recovery planning venues the plus or minus 50% confidence intervals are used to define the "most likely" range for the probability of extinction estimates. Therefore, the blue heavy dashed line in Figure 5 represents the recovery planning benchmark. A population is classified as 'non-viable' if the probability of extinction is greater than 0.05, as read from this dashed line. Full recovery, has been previously defined in ODFW planning documents as the condition where the probability of extinction is 0.01 or less; again referenced to the benchmark dashed line in Figure 5.

Applying these standards to the results for NP CHS, we obtain a 'full recovery' classification for fishery impact rates less than 20% and a 'viable' classification for fishery impact rates less than 35% (Table 7). It is important to stress that as the fishery impact rate increases, even if the population remains in the viable zone, the total number of spawners will decline. Data illustrating this fact was obtained from CAPM modeling of extinction risk as shown in Figure 6.

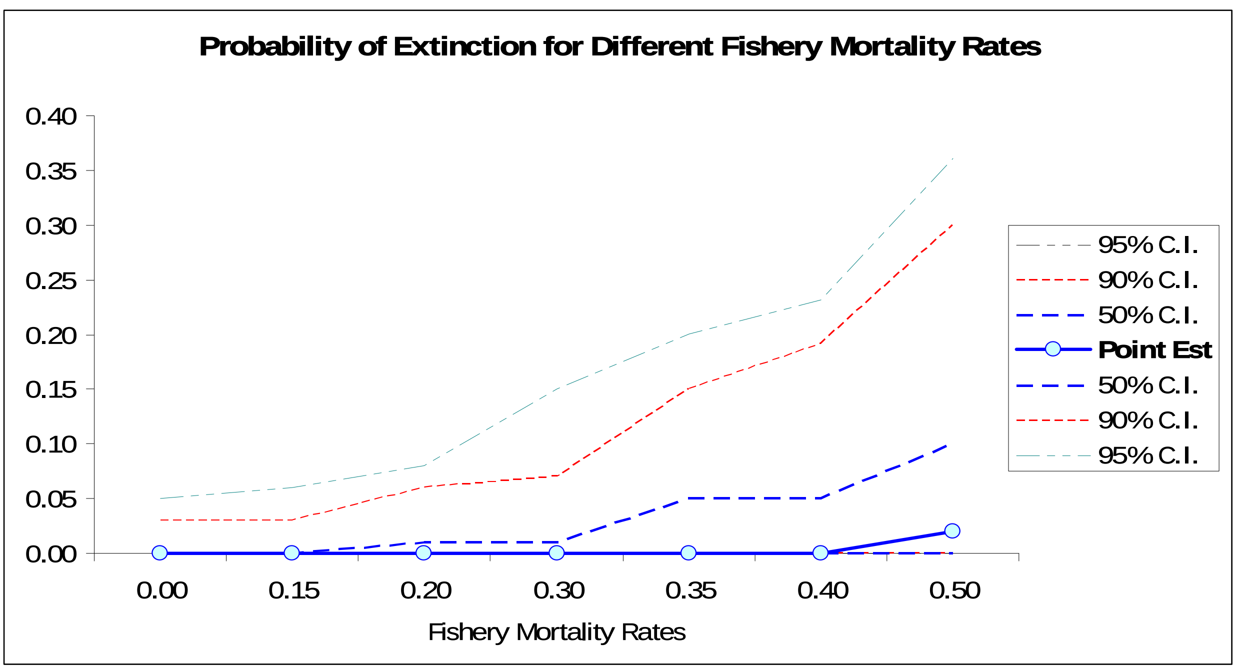

Figure 5. Illustration of point and approximate confidence intervals for extinction probabilities for Rogue River spring Chinook salmon forecast under different assumed fishery impact rates using the CAPM viability model.

Table 7. Point and approximate confidence intervals for extinction probabilities for naturally produced spring Chinook salmon forecast under different assumed fishery impact rates using the CAPM viability model.

	Fishery Impact Mortality Rates						
	0.00	0.15	0.20	0.30	0.35	0.40	0.50
95% C.I.	0.000	0.000	0.000	0.000	0.000	0.000	0.000
90% C.I.	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50% C.I.	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Point Est	0.000	0.000	0.000	0.000	0.000	0.000	0.020
50% C.I.	0.000	0.000	**0.010**	0.010	**0.050**	0.050	0.100
90% C.I.	0.030	0.030	0.060	0.070	0.150	0.191	0.300
95% C.I.	0.050	0.061	0.080	0.151	0.200	0.231	0.361

It is also important to stress that these results do not mean that the population would be incapable of sustaining fishery impact rates in individual years that exceed these levels. These results reflect a hypothetical scenario where fishery impact rates are fixed at the same test level for a 100 year simulation period. Additional modeling is necessary to understand how many times these rates can be exceeded in individual years before the population is placed at risk (assuming the average impact rate remains in the 20% to 35% range). In addition, fishery management strategies to adjust impact rates (harvest and/or pre-spawning mortality) based on parental

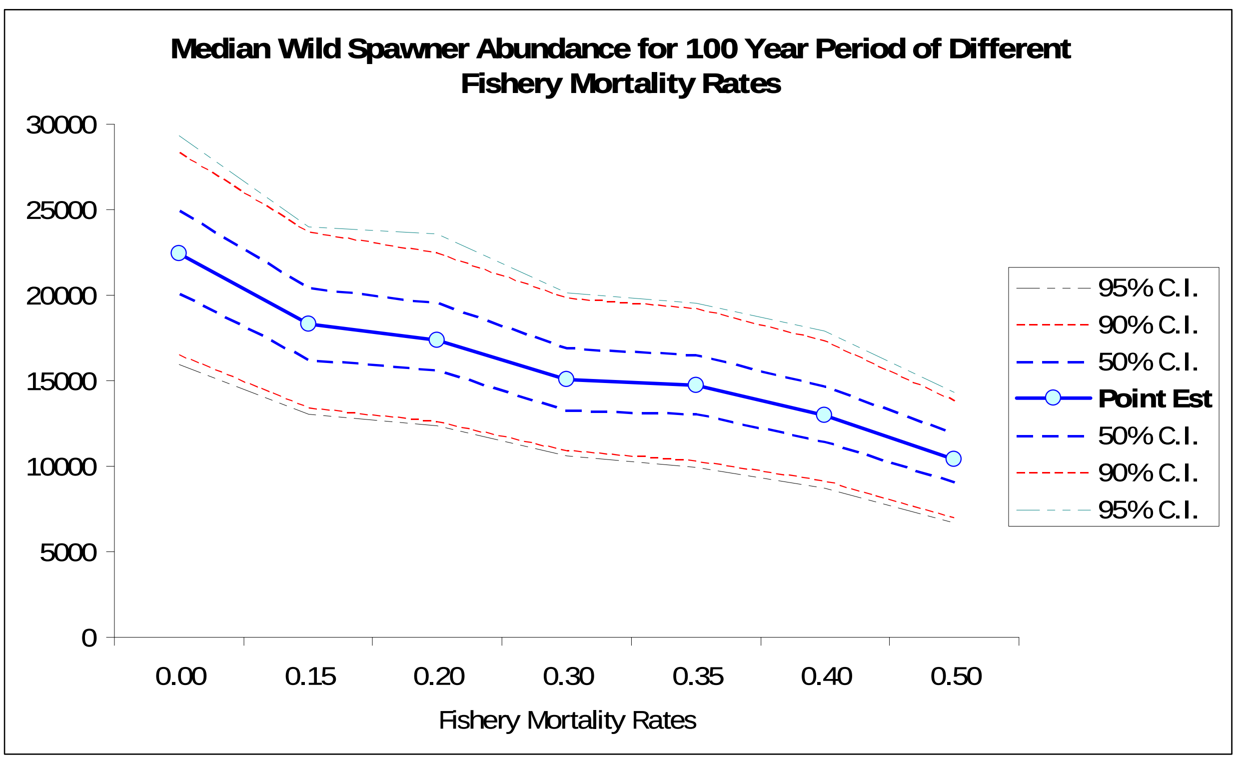

Figure 6. Median abundance of wild spawners forecast at different fishery impact rates as determined for Rogue River spring Chinook salmon from simulations using the CAPM population viability model.

abundance, run size forecasts, or expected marine survival rates also require more complicated and intensive modeling than reflected by the results presented here. ODFW currently believes that when intensive modeling is performed to account for reduced impact rates at low abundances, the risk of extinction from a 35 or 40 percent harvest rate during higher abundances will be in the range of one percent or less; the level identified as an element of desired status of the SMU (*see* **DESIRED BIOLOGICAL STATUS**, page 12).

Viability of the Species Management Unit

CAPM based population viability modeling was performed to evaluate a critical abundance level. Managers were interested in knowing if there was a minimum spawner abundance level at which the viability of NP CHS would become unacceptably high. To address this question, a series of supplemental CAPM model runs was performed that differed only in the number of spawners that were assumed to be present at the beginning of the 100 year simulation period. This "probing" of the critical spawner escapement thresholds was done under two assumed fishery impact rates, 15% and 40%.

As illustrated in Figures 7 and 8, the results from this analysis suggested that this population was relatively insensitive to short-term reductions in spawner abundance level. Even at the higher assumed fishery rate (40%) the probability of extinction did not begin increasing until the spawner abundance was less than 1,000 fish. However, it should be noted that at these higher fishery impact levels the uncertainty surrounding this determination was substantial, as reflected by the upper bounds of the confidence intervals (dashed lines) in Figure 7.

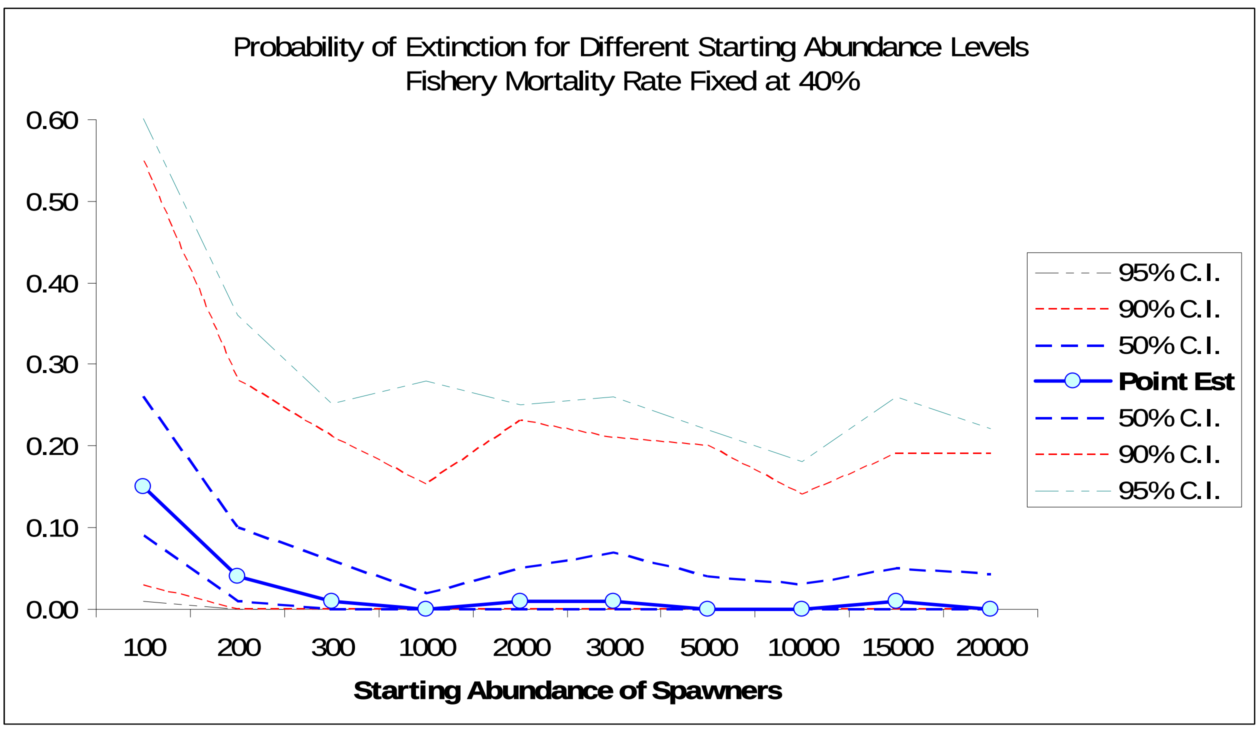

Figure 7. Relationship between starting spawner abundance and probability of extinction over a future 100 year time period for Rogue spring Chinook salmon based upon CAPM simulation with assumed fishery impact rate of 0.40.

When this analysis was done under a lower fishery impact rate (15%) an inflection point in the probability of extinction also seemed to exist at 1,000 spawners (Figure 8). However, the absolute probabilities of extinction were lower in this case than those estimated for the higher fishery impact rate scenario. Although this is a cursory analysis of this problem, these results suggest that, at spawner escapements greater than 1,000 fish, lower fishery impact rates would not increase the probability of long-term viability (continued persistence) of NP CHS.

Using this analysis as the basis to look at a critical abundance level, it appears that the inflection point of 1,000 spawners is the tipping point at which the risk of extinction, regardless of the impact rate, begins to increase sharply. Until better metrics of viability can be developed, ODFW will consider 1,000 spawners to be the critical abundance level for NP CHS in the Rogue. Viability would be at risk if this critical level was not exceeded for five consecutive years, or one generation of NP CHS.

Model results also indicate that the NP CHS population in the Rogue SMU is very productive. The high level of productivity, along with the knowledge that the population never dropped below the critical abundance level of 1,000 spawners in any single year, indicates that the NP CHS population is currently viable.

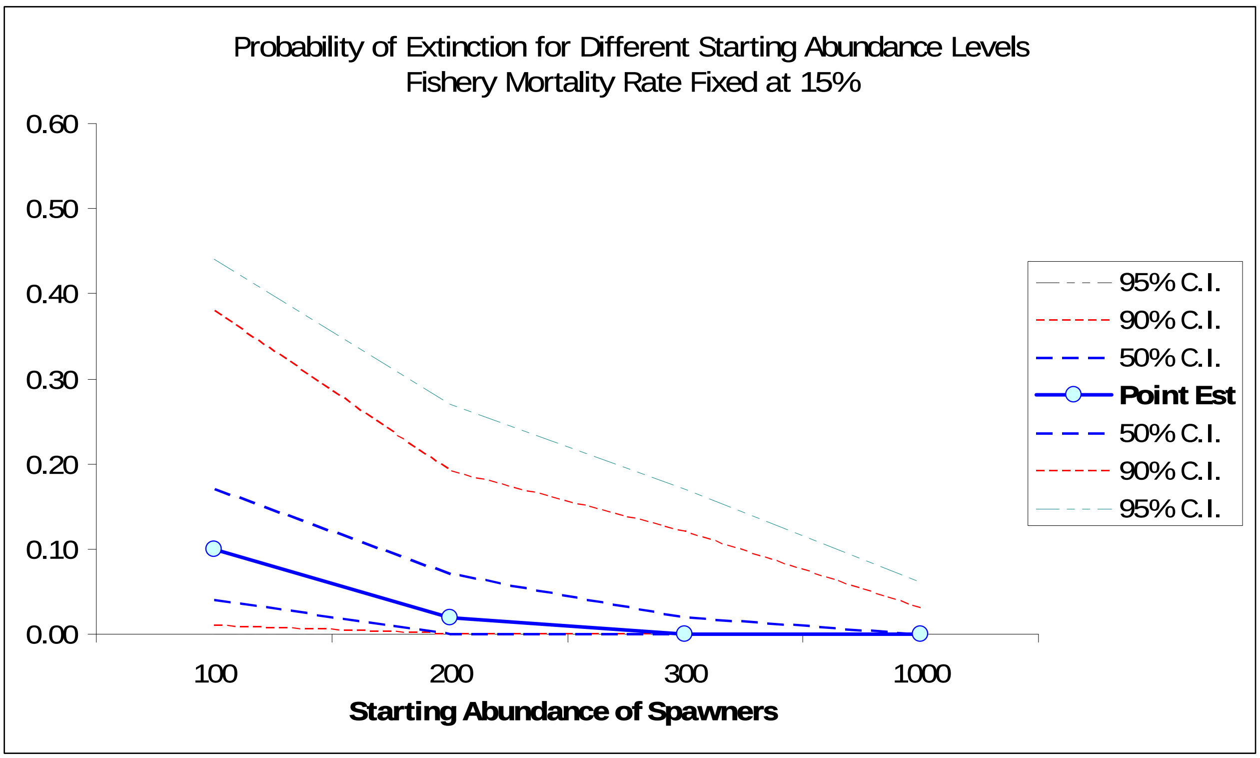

Figure 8. Relationship between starting spawner abundance and probability of extinction over a future 100 year time period for Rogue spring Chinook salmon based upon CAPM simulation with assumed fishery impact rate of 0.15.

As Figure 8 illustrates, there is considerable uncertainty in the model results. A more detailed examination of this question and consideration of other fishery management protocols to ensure population viability under naturally fluctuating conditions should be a topic of future investigation. Continued refinement of the methods to assess persistence and viability, along with the underlying data will be an emphasis of future research, monitoring and evaluation. These results reflect the importance of implementing specific measures under an adaptive management approach; should SMU status reach conservation criteria identified in this plan (*see* **CRITERIA INDICATING DETERIORATION IN STATUS**, page 79).

DISPARITY BETWEEN DESIRED AND CURRENT STATUS

Some differences, or gaps, exist between elements of desired status and elements of current status. The magnitude of the differences range widely, and in three cases are currently non-existent (Table 8).

Table 8. Comparisons of singular elements of current and desired status for naturally produced spring Chinook salmon in the Rogue Spring Chinook Salmon Species Management Unit. Numbers listed under current status represent the average of all data available for the last ten years.

Status Element	Desired Status	Current Status	"gap"
Abundance (at Gold Ray Dam)	≥15,000	8,200 (1997-2006)	6,800
Migration Timing[a] (% passage by 15 June)	≥60%	45% (2003-2006)	15%
Age Structure (% jacks)	≤10%	9% (2003-2006)	none
September Spawner Distribution (% above Shady Cove)	≥40%	48% (2004-2006)	none
Spawner Composition (% hatchery)	≤15%	11% (2004-2006)	none

[a] *For only those fish at least 24 inches in length ("adults").*

Persistence:
The NP CHS population may, or may not, currently meet the persistence criterion for desired status. Additional persistence modeling is needed to incorporate the proposed practice of decreasing impacts if the abundance of NP CHS returning to the Rogue is forecasted to be low (*see* **CRITERIA INDICATING DETERIORATION IN STATUS**, page 79). ODFW believes that once this modeling is performed the risk of extinction, with the current harvest rate of approximately 40 percent and impact reductions during low abundances, will likely be one percent or less. Because this modeling has yet to be completed, it is not possible to assess whether there is a gap between current and desired estimates of SMU persistence.

PRIMARY FACTORS RESPONSIBLE FOR DISPARITY

There are a number of factors that possibly contributed to the decline of, and the change in the life history of, NP CHS in the Rogue SMU. In addition, there were a number of factors that historically limited the population, and affected the life history strategies expressed within population attributes. Both types (current and historical) of possible limiting factors were considered as part of the following assessment. Possible limiting factors are organized under four categories (habitat volume, habitat quality, biological factors, and fisheries), and are classified as whether each factor can, or cannot be, managed through directed actions (Table 9). Factors that cannot be managed are excluded from the remaining discussion of potential limiting factors.

Habitat Volume

At the present time, there are about 30 miles of spawning habitat typically accessible to adult CHS in the Rogue River Basin. This estimate includes 29 miles in the mainstem of the Rogue River (head of the pool behind Gold Ray Dam, at river mile 127, upstream to the barrier dam at Cole M. Rivers Hatchery, at river mile 156) and also includes one mile of Big Butte Creek. A small natural waterfall in the lower portion of Big Butte Creek acts as a partial barrier to upstream migration. While spawning may occur in other areas, instances are sporadic and usually occur only during rare years when flows in tributaries increase significantly during the period of mid-September through mid-October (USFWS 1955c; ODFW unpublished observations).

The construction of Lost Creek Dam and the barrier dam at Cole M. Rivers Hatchery blocked about 20 miles of spawning habitat previously used by CHS, although about nine miles appeared to be used only sporadically. Prior to construction of these structures, CHS typically spawned in the Rogue River upstream to river mile 167, which is near the site of Laurelhurst Bridge (USFWS 1955c). Other records indicate that CHS periodically spawned in the Rogue River upstream as far as river mile 168 at Cascade Gorge (Rivers 1946), spawned in the South Fork of the Rogue River upstream to at least river mile five (ODFW unpublished data), and spawned in the Middle Fork upstream to at least river mile three (ODFW unpublished data).

Under current operating strategies employed for Lost Creek Lake, the reservoir typically fills by 1 May, and is about 16 feet below full pool elevation in the middle of March. At full pool, Lost Creek Lake inundates the Rogue River upstream to river mile 168 and also inundates about one-half mile of the South Fork of the Rogue River. Prior to reservoir construction, fry of CHS would have likely emerged from the gravel in March and April. Assuming that eggs and sac-fry would survive only in locations of flowing water, there appears to be about nine miles of potential habitat for CHS in the area upstream of Lost Creek Lake. In order for CHS to use this habitat, adult fish would have to be collected and transported for release in upstream areas. The efficacy of this potential management action is unknown. Uncertainty related to the survival rates of transported adults, and the survival rates of juveniles that would have to pass through Lost Creek Dam, should be thoroughly investigated prior to the implementation of any management action. In addition, other areas may have the potential to more productive for NP CHS.

Table 9. Parameters identified as factors potentially impact the abundance and life history of naturally produced spring Chinook salmon in the Rogue Spring Chinook Salmon Species Management Unit. Factors with stars are judged to be unmanageable.

Habitat Volume
Amount of ocean rearing habitat
Amount of spawning habitat
Amount of freshwater rearing habitat
Migration barriers

Habitat Quality
Current patterns in the ocean
Water temperature in the ocean
Water temperature in freshwater
Water quality
Stream flow
Changes in stream flow
Spawning gravel
Morphology of stream channels
Riparian areas
Water diversions

Biological Factors
Predators in the ocean
Competitors in the ocean
Predation in freshwater
Freshwater competitors
Disease
Spawner abundance
Genetics

Fishing
Direct mortality
Indirect mortality

Visual estimates of gravel resources provide some general indexes of the amount of potential spawning habitat for CHS. Two surveys, using differing methodologies, have been conducted in areas upstream of Gold Ray Dam. The first survey was conducted during July-September of 1944 and 1949. In the mainstem of the Rogue River, and in the South Fork of the Rogue River, surveyors estimated graveled areas only within those watered areas with a depth less than three feet and a water velocity of at least one foot/second (USFWS 1955c). In tributaries of the Rogue River, South Fork of the Rogue River excluded, surveyors estimated graveled areas within the active channel of the streams in areas judged to be accessible to anadromous salmonids (USFWS 1955c). In October of 2006, the USACE estimated potential spawning gravel for spring Chinook salmon in the Rogue River between the barrier dam at Cole M. Rivers Hatchery and Dodge Bridge (personal communication dated 11 June, 2006 from Gregory Taylor, USACE fishery biologist, Lowell, Trail, Oregon). USACE personnel identified potential spawning gravel by the presence of redds and, where redds were not present, used professional judgment to classify spawning habitat based on substrate size, water depth, and velocity. Each unique patch of gravel was measured (range finder or tape measure), mapped and summarized by reach. While survey methodologies differed between the surveys conducted in the 1940s and in 2006, three general inferences can be made.

First, gravel surveys in the 1940s suggested that the construction of Lost Creek Dam blocked about 25% of the spawning habitat typically used by CHS. Although about 25% of the primary spawning habitat was blocked, about 33% of the spawners typically used this area because spawner densities tended to be greatest near the upstream terminus of primary spawning (USFWS 1955c). Of the historical habitat that was blocked, only the South and Middle forks of the Rogue River are located upstream of the area inundated by Lost Creek Lake (Table 10). These areas appear to have been used only sporadically by spawning CHS (ODFW unpublished observations).

Second, gravel surveys in the 1940s may reflect the volume of spawning habitat that might be available if habitat can be expanded for CHS. As previously discussed, CHS rarely spawn in tributary streams because of low flows before and during spawning (lower mile of Big Butte Creek excepted). Of the major tributaries that enter the Rogue River upstream of Gold Ray Dam, Little Butte Creek appears to have the largest quantity of spawning habitat that could potentially be used by NP CHS (Table 10), although this area was not historically used by spawning NP CHS because of low stream flows. Thus, a large volume of water would be needed to sustain a natural population capable of using a large portion of the stream.

Cursory observations of Chinook salmon migration patterns in the Applegate River and in the lower end of Big Butte Creek suggest that flow in Little Butte Creek would need to be at least 100 cfs, during the middle of September through the middle of October, in order to establish a wide spawning population of spring salmon. Recent estimates of average flow range between only 20 and 40 cfs during this period of time (Figure 9). Historical flow records and current rate of water diversions indicate that natural flows were never sufficient to allow for a self-sustaining run of CHS in the Little Butte Creek Basin. The need for appropriate water temperature during adult migration is factored into projected minimum flow of 100 cfs for the establishment of a natural run because water temperature can exceed 60^{o}F through the end of September.
vary greatly among streams. Spring Chinook salmon spawn annually in Big Butte Creek, but rarely in the other streams.

In contrast to Little Butte Creek, there may be an opportunity to expand spawning habitat for NP CHS in Big Butte Creek. Flows average about 60 cfs in the middle of September and increase to an average of more than 100 cfs during the first half of October (Figure 9). A small natural waterfall at mile one is currently a partial barrier to the upstream migration of CHS. Additional flow during the latter half of September, or improvements to an existing fish ladder, could possibly result in an appreciable increase in the number of NP CHS that spawn farther upstream in Big Butte Creek. There is also a natural barrier that appears to be impassable for Chinook salmon located at river mile 1.5 on the South Fork of Big Butte Creek. Construction of a fish ladder could also possibly result in the establishment of a run of NP CHS in this creek. If natural production increases to a level that is sustainable, the life history characteristics of returning adults should be comparable to the historical life history patterns of NP CHS because the operation of Lost Creek Dam does not affect water temperature in Big Butte Creek.

Table 10. Visual estimates of potential spawning gravel in the Rogue River Basin upstream of Gold Ray Dam based on surveys conducted in the 1940s and in 2006. No estimates of statistical certainty could be generated from the survey data. Locations of most streams can be found in Figure 1.

	Estimated square yards of spawning gravel	
Stream, area	UFWS (1955c)	(USACE 2006)
Rogue River:		
Middle Fork	a,b	a,b
South Fork	9,700[b]	a,b
Lost Creek - Prospect	18,600[c]	a,c
McLeod - Lost Creek	31,200[c]	a,c
Elk Creek – McLeod	13,800[d]	9,925[d]
Lewis Creek – Elk Creek	19,700[d]	3,888[d]
Trail – Lewis Creek	26,900[d]	8,483[d]
Shady Cove - Trail	26,100[d]	27,956[d]
Dodge Bridge - Shady Cove	33,200[d]	99,833[d]
Bybee Bridge - Dodge Bridge	48,900[d]	a,d
Gold Ray Dam - Bybee Bridge	5,700[d]	a,d
Big Butte Creek	58,100[d,e]	a,e
Elk Creek	64,900[e]	a,e
Trail Creek	8,900[e]	a,e
Little Butte Creek	119,700[e]	a,e
Bear Creek	a,e	a,e

[a] *Not surveyed.*
[b] *Area is upstream of Lost Creek Lake.*
[c] *Area is now mostly inundated by Lost Creek Lake.*
[d] *Currently used by spawning CHS.*
[e] *Low flows during migration usually preclude use of these areas by spawning CHS, except in the lowest mile of Big Butte Creek.*

Third, comparison of survey estimates from the 1940s and 2006 appears to suggest that there has been a loss of spawning habitat in the area between Elk Creek and Trail (Table 10). Such a loss may have occurred because the downstream movement of gravel has ceased from locations upstream of Lost Creek Dam. With the cessation of gravel recruitment from the upper portion of the Rogue River, there is a good chance that the amount of spawning habitat for NP CHS in the Rogue River will decrease over time, as has been observed in areas downstream of many other dams (Williams and Wolman 1984).

In contrast to probable changes in spawning habitat, the volume of rearing habitat for juvenile NP CHS probably has not changed appreciably within areas downstream of Lost Creek Dam and thus is probably not a primary factor that currently limits production. The Rogue River appears

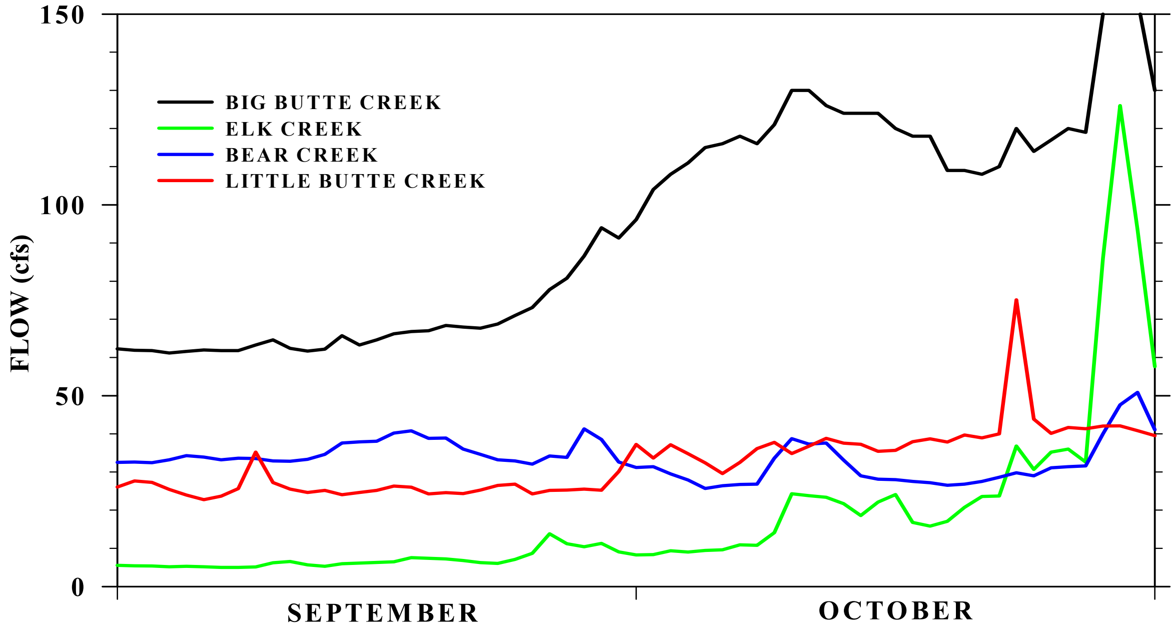

Figure 9. Average flow during September and October for the largest tributary streams that enter the Rogue River upstream of Gold Ray Dam. Estimates represent the period of record, which

to remain capable of producing large numbers of juvenile NP CHS, and that capability is likely reached only on a sporadic basis. ODFW (2000) documented wide variations (as great as 20-fold) in the abundance of naturally produced juveniles and also determined that fry abundance and smolt abundance were highly correlated (correlation coefficient (r) = 0.92, $P < 0.001$ at the 95% confidence level). These findings indicate that the amount of spawning habitat, rather than the volume of juvenile rearing habitat, is likely a primary factor that limits the production of NP CHS in the SMU. Consequently, in order to move the SMU towards desired status, consideration was given to possible actions that would result in an increase in the amount of spawning habitat that would produce increased numbers of juvenile NP CHS.

Habitat Quality

Aspects of habitat quality that have the potential to affect the abundance and life history of CHS are diverse. Habitat features that affect adult CHS include channel morphology, water quality, and flow. Habitat features that affect juvenile CHS include channel morphology, water quality, flow, changes in flow, sedimentation, gravel composition, riparian areas, and water diversions.

Adult CHS hold in areas upstream of Gold Ray Dam prior to spawning. Habitat features associated with specific holding sites used in the Rogue River are unknown, but such sites likely include such features as deep pools, undercut stream banks, and large structures for cover (bedrock outcrops, large boulders, downed trees or logs). These types of morphological features of a channel can be impacted by bank erosion, removal of riparian vegetation, and placement of rock (rip-rap) along channel margins.

Water quality elements that can affect adult CHS include temperature, dissolved oxygen, nutrients, and pollutants. Based on water quality index ratings reported by Mrazik (2004), none of these factors, except water temperature, are likely to affect the survival of adult CHS in the Rogue River. In contrast, water temperature is a primary factor that affected the survival rates of migrating adults. Pre-spawning mortality rates can exceed 50% (Table 11) during years of relatively high water temperatures (ODFW 2000). Almost all of the pre-spawning mortality occurs downstream of Grants Pass (river mile 103) during May-July, and the estimated rates of pre-spawning mortality are highly correlated with water temperature (correlation coefficient (r) = -0.89, $P < 0.001$ at the 95% confidence level).

Table 11. Estimated mortality rates (and number) of adult spring Chinook salmon that died in the Rogue River downstream of Gold Ray Dam, 1975-2005. Years when mortality rates were estimated to be less than 5% are not listed. Water temperatures, for years not listed, all averaged less than 64°F. No estimates of statistical certainty could be generated for the mortality estimates, as described by ODFW (2000).

Year	Mortality rate	Water temperature[a]	Number dead
1977	34%	66.4°F	8,539
1981	6%	65.1°F	1,071
1987	28%	66.0°F	31,579
1992	70%	70.2°F	13,684
1994	59%	67.8°F	20,134
2001	17%	65.3°F	8,286

[a] *Mean daily maximum (°F) during May-June at USGS gages located at either river mile 30 or river mile 48.*

A major factor that affects water temperature in areas downstream of Grants Pass during late spring and summer is river flow. Higher flows result in lower water temperature during that period of time (USACE 1991). During an average year, tributary flows contribute to a significant portion of the flow of the Rogue River during spring, but their contribution drops greatly by summer. Aerial thermal infrared remote sensing surveys in late July of 2004 detected that 10 of 17 tributary streams, in the area downstream of Grants Pass, contributed flow that was cooler than the Rogue River (Watershed Sciences 2004). Of these tributaries, only the Applegate River, which was warmer than the Rogue River, had sufficient flow to significantly impact the water temperature of the Rogue River (Watershed Sciences 2004). Smaller tributaries, such as Mule Creek and Stair Creek in the Wild and Scenic Section of the Rogue River, provide thermal refuges for adult CHS (Satterthwaite 2002) but adult CHS eventually have to migrate upstream through warmer water in order to reach spawning areas upstream of Gold Ray Dam.

In the area upstream of Grants Pass, river flow and releases from Lost Creek Lake are two of the major factors that affect water temperature of the Rogue River throughout the entire year (USACE 1991). During the late spring and early summer, tributary flows in this area usually contribute very little flow to the Rogue River. Aerial thermal infrared remote sensing surveys in late July of 2004 determined that all of the tributary flows, in the area upstream of Grants Pass, were warmer than the Rogue River (Watershed Sciences 2004). Results from the surveys also suggested that there may be minor sub-surface flows that may cool the river in the vicinity of

Gold Ray Dam. However, there was no evidence of cold sub-surface flows in areas farther upstream (Watershed Sciences 2004), primary holding areas for early-run and mid-run NP CHS.

Juvenile NP CHS are potentially affected by a broader array of features related to habitat quality. Similar to adults, juvenile NP CHS are probably not detrimentally impacted by water quality of the Rogue River, water temperature being a primary exception. Changes in water temperature, that resulted from reservoir operation, was identified as a primary factor that directly affected naturally produced juveniles through (1) increased developmental rates of eggs and sac-fry during gravel incubation, (2) earlier emergence of fry from the gravel, and (3) increased growth rate during freshwater residence (ODFW 2000).

Resultant changes in these three factors led to various changes in life history characteristics of NP CHS including (1) an earlier time of ocean entry by juveniles, (2) earlier maturation at younger ages, (3) later migration in freshwater, (4) later spawning time, and (5) a change in the race composition of naturally produced Chinook salmon produced upstream of Gold Ray Dam (*see* **Key Biological Attributes Affected By Reservoir Operation**, page 59). In addition, smolts migrating to the ocean are commonly exposed to water temperatures that exceed 75°F; possibly resulting in decreased survival rates (Baker et al. 1995).

Flows, and changes in flows, have also been documented as factors that affect juvenile NP CHS. Peak flows were negatively related to fry production, almost certainly as the result of scouring when eggs and sac-fry are present in the gravel (ODFW 2000). Fast decreases in flow can strand and kill NP CHS fry (Table 12), and also can cause fry to be trapped in side channels (ODFW 2000). Low flows also can result in dewatered redds (ODFW 2000), and can cause mortality among eggs and sac-fry resident in the gravel.

Table 12. Documented instances when naturally produced juvenile spring Chinook salmon were dewatered and killed as a result of reductions in outflow at Lost Creek Dam. Reasons for the reductions are unknown, except that none of the flow changes were carried out in response to potential flooding in downstream areas. In April, the largest decreases in natural flows generally do not exceed 800 cfs over 24 hours (ODFW 2000).

Year	Date of mortality	Decrease in outflow
1985	18 April	2,100 cfs in 7 hours
1986	2 April	500 cfs in 6 hours
1987	8 April	400 cfs in 4 hours
2002	19 April	900 cfs in 8 hours
2006	6 January	2,800 cfs in 24 hours

Flows, especially peak flows, also affect channel morphology, sedimentation rates, and gravel quality. Higher flows increase the width of unconstrained channels and the size of pools in low gradient streams; and these pools are the riverine habitat type preferred by juvenile Chinook salmon. In addition, wide, unconstrained, channels in low gradient streams tend to be characterized by larger areas of more diverse spawning habitat (Montgomery et al. 1999). Peak flows are also associated with storm events that increase the amount of sediment introduced into streams.

Sediment can arise from numerous sources, and sediment deposition on redds has been associated with decreased survival rates of eggs and sac-fry. Sediment deposition can also affect gravel quality in spawning areas. Fines can fill spaces within gravel, reducing space for incubating sac-fry and reducing water exchange around eggs and sac-fry (Chapman 1988). However, of possible greater concern, is the lack of recruitment of gravel from areas upstream of Lost Creek Dam. With the lack of gravel recruitment, the average size of gravel within spawning areas downstream of Lost Creek Dam will likely increase because small gravel is more likely to be displaced during scour events as compared to larger gravel or rocks (Williams and Wolman 1984).

The amount of sediment that enters streams is dependent on a variety of factors including mass failures, landslides, surface erosion, and stream bank erosion. Rates of bank erosion along streams are influenced by the integrity of the riparian zone. The riparian zone also produces large wood pieces that provide cover for fish, helps to stabilize stream channels, produces terrestrial sources of food for fish, and also helps shade streams. Shade produced by riparian zones is likely a significant factor that affects water temperature of the Rogue River.

Water temperature may also be affected by water withdrawals and return flows from irrigated lands and municipal discharges. Water withdrawals can also affect the survival of juvenile salmonids if the diversions are unscreened, or are poorly maintained. The volume of water diverted from the Rogue River will increase in the future as additional storage from Lost Creek Lake is purchased for irrigation use or municipal and industrial use.

Within Jackson County, the need for municipal and industrial water supplies is predicted to increase from 36,000 acre-feet in 2000 to 71,000 acre-feet in 2050 (Ryan and Dittmer 2001). Increased demands can also be assumed for other counties in the Rogue River Basin. About 45,000 acre-feet of water in Lost Creek Lake is allocated for irrigation and municipal and industrial use, of which about 34,000 acre-feet has yet to be contracted. This 34,000 acre-feet is currently used for fish enhancement purposes (including protection of NP CHS), and will become less available for fishery purposes in future years as more storage is purchased for consumptive uses.

The impact of the reduction in the volume of storage available for fishery purposes was assessed by comparing predictions of pre-spawning mortality rates of naturally produced Chinook salmon runs under two scenarios of (1) a year of low water yield and (2) a year of average water yield. Projections indicated that there is a good possibility that there will be sufficient reservoir storage to protect most CHS, provided that greater rates of pre-spawning mortality among CHF are acceptable (Table 13). These projections indicate that the protection and enhancement of Chinook salmon populations will become more difficult with decreases in the volume of reservoir storage available for fishery purposes in downstream areas.

To summarize this section, manageable aspects of habitat quality that have the largest impact on NP CHS abundance and life history appear to be (1) water temperature during egg and sac-fry incubation in the gravel, (2) water temperature during the period when adult CHS migrate within areas downstream of Gold Ray Dam, (3) the intensity of peak flows during egg and sac-fry incubation in the gravel, and (4) the rate of flow decreases after fry emerge from the gravel. All of these factors are affected, to some degree, by the operation of Lost Creek Dam and reservoir

Table 13. Projected impacts of a 30,000 acre-feet reduction in the availability of reservoir storage from Lost Creek Lake. Projections were generated for 2001 (a drought year) and 2002 (a year of average water yield). Projections assume (1) zero return flows from the 30,000 acre-feet removal of water from the Rogue River, (2) no reductions in reservoir releases for fishery purposes from Applegate Lake, and (3) average air temperatures during the period of potential disease outbreaks. Mortality rates of adult Chinook salmon were predicted using relationships between water temperature and fish mortality (ODFW 1992; ODFW 2000).

	2001		2002	
Fish variety	Predicted[a]	Predicted[b]	Predicted[a]	Predicted[b]
Spring Chinook salmon	21%	24%	3%	4%
Fall Chinook salmon	40%	61%	8%	17%

[a] *Pre-season prediction that assumed average air temperatures, May-September.*
[b] *Pre-season prediction that assumed average air temperatures, May-September, with 30,000 acre-feet of reservoir storage removed from fish allocation.*

management actions. Consequently, in order to move the SMU towards desired status, consideration was given to possible actions that would modify dam and reservoir operations so as to improve the quality of habitat for NP CHS in the Rogue River.

Biological Factors

Numerous biological factors have the potential to affect the abundance and life history of NP CHS in the Rogue SMU. The list of generalized factors includes competitors, predators, disease, spawner abundance, and hatchery fish. A discussion of specific aspects follows.

Competitors: The most likely competitors of juvenile NP CHS are juvenile NP CHF. The abundance of the fall race has increased greatly in the area upstream of Gold Ray Dam (*see* **Comparisons to Other Populations**, page 67). However, as adult NP CHF tend to spawn later than adult NP CHS (ODFW 2000), progeny of the fall race should be generally smaller in size as compared to progeny of the spring race and would be less competitive for food and rearing space. Competition, if occurring, likely results in slower growth rates for juvenile NP CHS.

Redside shiners (*Richardsonius balteatus*) also compete with juvenile NP CHS, as both species are found in similar types of habitat. Redside shiners were first documented in the Rogue River Basin during 1957, and by 1962 had become widely spread between Agness and Gold Ray Dam (Rivers 1964). This species dominated the number of fish caught with beach seines at some sites downstream of Grants Pass in the 1970s and 1980s, but were much less abundant at sites sampled upstream of Gold Ray Dam. Redside shiners prefer warmer water temperatures as compared with salmonids. Decreased water temperatures, resulting from reservoir releases during the summer months, have likely decreased the competitive ability of redside shiners in the primary rearing area of juvenile CHS (Reeves et al. 1987).

Juvenile Umpqua pikeminnow (*Ptychocheilus umpquaei*) may also compete with juvenile CHS, but to a lesser degree as compared to redside shiners. Umpqua pikeminnow were introduced in the Rogue River Basin during 1979. By the middle of the 1990s, the species was commonly found between Grants Pass and Gold Beach. Few have ever been found upstream of Gold Ray Dam, the primary rearing area for juvenile NP CHS. Similar to redside shiners, this species tends to prefer warmer water temperatures as compared with salmonids. Decreased water temperatures, resulting from reservoir releases during the summer months, have likely limited the upstream distribution of Umpqua pikeminnows in the Rogue River.

Competition with NP CHF is not restricted to the juvenile life history phase of life. A tagging project conducted in 1986-87 indicated that there was overlap in the spawning distribution of both races. While about 55% of tagged NP CHF were recovered as spawned carcasses in the nine miles immediately upstream of Gold Ray Dam, others were recovered as far upstream as Big Butte Creek (ODFW 2000). Given that there is also some overlap in spawning time (ODFW 2000), there may be some competition for redd sites among females of each race. Thus, it is also possible that female NP CHF excavated redds previously constructed by female NP CHS. The degree of competition for redd sites, and the degree of redd superimposition by NP CHF, is difficult to judge as the relative abundance of NP CHF increased to even a greater degree during the 1990s (*see* **Comparisons to Other Populations**, page 67).

Overlap in spawning time and spawning distribution also indicates that the spring and fall races of NP CHS may have hybridized to some unknown degree. Genetic assessments indicated that NP CHS that passed Gold Ray Dam in late July and early August differed from counterparts that passed in late September and early October (*see* **SPECIES MANAGEMENT UNIT AND CONSTITUENT POPULATIONS**, page 10). If hybridization has occurred to a significant level, naturally produced Chinook that pass Gold Ray Dam from the middle of August through the middle of September may exhibit mixed genetic characteristics of late run NP CHS and early run NP CHF. This question has been identified as a topic to be addressed by future research (see **Research Needs**, page 83)

To summarize this section, manageable aspects of competition that have the largest impact on NP CHS abundance may be the increased spawning of NP CHF in areas historically used by NP CHS. While the actual impacts on NP CHS remain unclear, consideration was given to possible actions that would decrease the number of NP CHF that pass Gold Ray Dam and would subsequently spawn in areas where NP CHS also spawn.

Predators: While competitors may be relatively few, there are a myriad of animals that prey upon NP CHS produced in the Rogue SMU. Known predators are listed in Table 14, along with the designation of each species as administered by the state of Oregon, and by the federal government. Among predators that inhabit freshwater, only three species are not protected under either state or federal law (Table 14).

The issue of predation on anadromous salmonids has received much attention in the Pacific Northwest, and numerous research projects have attempted to estimate salmonid losses as related to predation. However, predation is probably not a primary factor responsible for the differential decline of NP CHS in the Rogue SMU. CHF have increased in abundance, while the abundance of NP CHS has decreased (*see* **Comparisons to Other Populations**, page 67). Except for some juvenile hatchery fish that rear in the upper portion of the Rogue River after release from Cole M. Rivers Hatchery, individual types of predators are unlikely to have a greater effect on NP CHS as compared to NP CHF.

Table 14. A list of animals that prey, or likely prey, on juvenile or adult spring Chinook salmon of Rogue River origin. Largemouth bass and salmonids of hatchery origin are protected by the state of Oregon only under the provisions of harvest regulations for game fish.

	Protected species?	
Species or animal type	Federal	State
FISH		
Umpqua pikeminnow	no	no
Prickly sculpin	no	no
Reticulate sculpin	no	no
Largemouth bass	no	yes
Coho salmon (hatchery)	no	yes
Steelhead (hatchery)	no	yes
Coho salmon (wild)	yes	yes
Steelhead (wild)	no	yes
Cutthroat trout	no	yes
Marine species	some	some
BIRDS		
Cormorant (double-crested)	yes	yes
American merganser	yes	yes
Herons (multiple species)	yes	yes
Belted kingfisher	yes	yes
Gulls (multiple species)	yes	yes
Tern	yes	yes
Bald eagle	yes	yes
Osprey	yes	yes
Marine species	yes	yes
MAMMALS		
River otter	no	yes
Mink	no	yes
Harbor seal	yes	yes
California sea lion	yes	yes
Northern sea lion	yes	yes

Juvenile steelhead and coho salmon are released annually at Cole M. Rivers Hatchery. Release goals are presently 220,000 summer steelhead, 132,000 winter steelhead, and 200,000 coho salmon. Steelhead are generally released in late April and coho salmon are generally released in early May. These dates probably coincide with the period when peak numbers of NP CHS fry are present. Surveys conducted during 1979-81 indicated that both species preyed upon fry of NP CHS. Based on significant assumptions, the annual number of fry consumed by steelhead of hatchery origin may have ranged between 134,000 and 218,000, while the number of fry consumed by Coho salmon of hatchery origin may have ranged between 29,000 and 57,000 (Evenson et al. 1981). These estimates, if accurate, represent 3-7% of the CHS fry produced during those years. The rate of predation loss is highly dependent on the duration of time that hatchery fish reside in the river, and on the proportion of the release groups that fail to migrate downstream. Not much is known about residence time after release, except a greater proportion of juvenile steelhead fail to migrate as compared to juvenile coho salmon.

There are three species of freshwater fish that likely prey on juvenile CHS and are not currently protected by state or federal law. Two of these three species are sculpins that reside on the substrate of waterbodies. Sculpin predation on juvenile salmonids generally occurs when sac-fry are resident in the gravel, or are moving in and out of the gravel. Predation losses to Umpqua pikeminnows are probably negligible until juvenile CHS begin to actively migrate to the ocean as smolts. Juvenile CHS primarily rear in the area upstream of Gold Ray Dam (ODFW 2000), while Umpqua pikeminnow rear primarily downstream of Grants Pass. Among Umpqua pikeminnows collected during summer between Grants Pass and Galice, 4% (1993) and 7% (1994) contained salmonids (Satterthwaite 1995). Comparable sampling in the spring of 1994 determined that 30% of the pikeminnows contained salmonids. Within all sampling periods, most of the consumed salmonids were juvenile Chinook salmon. The best estimate of losses resulting from pikeminnow predation comes from the Columbia River, where it has been estimated that pikeminnows consume 8% of the juvenile salmonids that migrated as smolts (Beamesderfer et al. 1996; Zimmerman and Ward 1999).

To summarize this section, manageable aspects of predation that have the largest impact on NP CHS abundance appear to be the release of juvenile steelhead and coho salmon from Cole M. Rivers Hatchery. Consequently, in order to move the SMU towards desired status, consideration was given to possible actions that would decrease the number of NP CHS consumed by juvenile salmonids released from the hatchery.

Disease: In comparison to predation, disease is known to be a primary factor that affects the abundance of CHS. Downstream of Gold Ray Dam, extensive mortalities of adults were documented in 1977, 1987, 1992, and 1994. Estimates of mortality rates during those years ranged between 28% and 70% of the CHS that entered the Rogue River (ODFW 2000). In addition, extensive pre-spawning mortalities were documented in the area upstream of Gold Ray Dam during 1977 and 1981 (ODFW 2000).

A bacterial pathogen, *Flexibacter columnaris* (*Columnaris*), was the disease organism most often isolated from dead and dying CHF sampled in the Rogue River during the late 1970s and early 1980s (Amandi et al. 1982). Virulence of this bacterium varies among strains and epizootics may occur intermittently in salmonid populations (Becker and Fujihara 1978). Mortality rates of juvenile Chinook salmon infected with *Columnaris* increase as water temperature increases between 12^{o}C and 21^{o}C (Holt et al. 1975; Becker and Fujihara 1978). CHS in the Rogue River are annually exposed to water temperatures close to the upper end of this range.

Columnaris was detected in resident fish in Lost Creek Lake and in juvenile Chinook salmon held in the reservoir, but was not detected in reservoir water or reservoir outflow (Amandi et al. 1982). Among the various water bodies sampled, pathogen concentrations were greatest in the outflow from Cole M. Rivers Hatchery. CHS in the hatchery were also found to be infected with the disease. It could not be determined whether adult salmon carried the disease into the hatchery or contracted the disease after entry. *Columnaris* was also found in several species of fish sampled throughout the Rogue River Basin, including the Applegate River (Amandi et al. 1982). Other disease organisms detected in CHS include Infectious Hematopoeitic Necrosis (IHN), Bacterial Kidney Disease (BKD), *Furunculosis*, and *Ceratomyxa shasta*. At the present time, *Columnaris* is believed to pose the greatest risk to NP CHS in the Rogue SMU.

To minimize losses of adult CHS to disease, ODFW identified targets for maximum water temperature at the USGS gage near Agness (river mile 30) and since 1995, has requested releases of reservoir storage in order to meet water temperature targets in downstream areas. River flow must be augmented to meet water temperature targets because the effect of outflow temperature at Lost Creek Lake diminishes rapidly with distance downstream (USACE 1991). This approach has proved to be effective in decreasing losses related to disease. For example, the mortality rate of adult CHS in 2001 was estimated to be 17%, even though the yield of water in the Rogue River Basin was one of the lowest of record (Satterthwaite 2002).

Similar methods of flow augmentation were tried in 1992 and in 1994, but only after disease outbreaks were already underway. Increased flows cooled water temperatures in downstream areas, but failed to appreciably decrease mortality among adult CHS. Consequently, the strategy employed since 1995 is directed towards using reservoir storage to prevent, or to delay as long as possible, disease outbreaks. This approach means that, during an average year of water yield, the available amount of reservoir storage is insufficient to prevent some disease-related loss among late-run adult CHS. Reservoir storage is limited because ODFW also requests the release of storage to minimize the chance of disease outbreaks among NP CHF and also to increase the survival rates of juvenile salmonids that rear and migrate in the Rogue River during the middle of summer (ODFW 2000). As more reservoir storage is purchased for irrigation, and municipal and industrial supply, the amount of storage available for fishery purposes will decrease.

To summarize this section, manageable aspects of disease that have the largest impact on NP CHS abundance appear to be mortalities associated with *Columnaris*. The degree of loss to *Columnaris* is affected by water temperature in the area downstream of Gold Ray Dam. Consequently, in order to move the SMU towards desired status, consideration was given to possible actions that would decrease the water temperature of the Rogue River during the late spring and summer.

Spawner Abundance: A critical factor that obviously affects salmon populations is the number of adults that survive to spawn. Knowledge of the relationship between spawner abundance and the production of progeny is of primary importance in order to effectively manage salmon populations. The numerical relationship between spawners and progeny is often obscured by numerous factors (Ricker 1975), or by a lack of appropriate data. In contrast to a lack of data for many salmon populations, there are three possible ways to develop a relationship between spawner abundance and recruitment for NP CHS in the Rogue River. These relationships were developed to help guide advisory committee and ODFW discussions of potential numerical goals for the desired status and conservation status elements related to the number of NP CHS that pass Gold Ray Dam. There was no attempt made to investigate parent-progeny relationships for those broods produced prior to the construction and operation of Lost Creek Dam because of the negative impacts of the dam on NP CHS (ODFW 2000).

Estimation of the number of spawners is equivalent among methods, and is primarily based on the number of naturally produced fish that are estimated to have passed Gold Ray Dam. Numbers of naturally produced fish that survive to spawn are then estimated by subtracting estimates of angler harvest and pre-spawning mortality using the relationships reported by ODFW (2000). The number of hatchery CHS that spawn naturally are estimated by a 5% stray rate from Cole M. Rivers Hatchery (Cramer et al. 1985). Common to all three methods, fish less than 24 inches in length ("jacks") are removed from the estimated number of spawners because all jacks are males (ODFW 2000). Methods to estimate parent-progeny relationships in this conservation plan differ in the way that the abundance of progeny is indexed.

In method one, the number of naturally produced progeny (recruits) are estimated as the sum of ocean harvest and freshwater returns. Numbers of recruits are then compared to the estimated number of parents that spawned. This type of comparison is often used in assessments of salmon populations, and typically the parent-progeny relationship is characterized by fitting the data to a Ricker stock-recruitment model (Ricker 1975), or a Beverton-Holt stock-recruitment model (Beverton and Holt 1957), or some variation of these models. While stock-recruitment models applied to Pacific salmon differ, there is some commonality in that stock productivity (recruits per spawner) is relatively high at low levels of spawner abundance as compared to high levels of spawner abundance. This concept affected the choice of a model that was eventually chosen to characterize the stock-recruitment relationship for NP CHS produced in the Rogue River.

Numerous assumptions are required to generate recruitment estimates for NP CHS of Rogue River origin. First, the age of NP CHS that pass Gold Ray Dam must be estimated. Scale samples were collected for this purpose during 1974-94 as part of the Lost Creek Dam Fisheries Evaluation Project. As no directed sampling, to estimate the age of NP CHS, has been conducted since 1994, alternative estimation measures had to be employed. First, there was an assumption that the age composition of CWT marked hatchery fish reflected the age composition of returning wild fish. Second, harvest and natural mortality in the river downstream of Gold Ray Dam must be estimated. Estimates of harvest were generated from a combination of harvest estimates from salmon-steelhead cards and fishery selectivity factors reported by ODFW (2000); while rates of natural mortality were estimated based on the relationship of water temperature and mortality rate reported by ODFW (2000). Third, age-specific rates of harvest in the ocean fisheries must be estimated. Harvest rates in the ocean fisheries were derived from cohort reconstruction procedures described by ODFW (2000) for completed broods of CWT marked CHS released from Cole M. Rivers Hatchery. For incomplete broods, it was assumed that age-specific ocean harvest rates were the same as for fall Chinook salmon of Klamath River origin. As a result of the multiple assumptions, and lack of empirical data derived from directed sampling, it was not possible to develop estimates of certainty associated with the estimates of the number of NP CHS recruits produced annually.

With the available estimates, a comparison of the number of recruits and parents indicated that, during most years, spawning CHS produced less than 60,000 recruits (Figure 10). In addition, this level of production has not been reached since NP CHS broods were produced in the mid-1980s (Figure 10). As the primary purpose of characterizing the stock-recruitment relationship was to provide insight on possible numerical criteria for elements of desired status and conservation status, consideration was given to multiple numerical models that could be employed to evaluate data from the most recent years that tend to characterize the current status

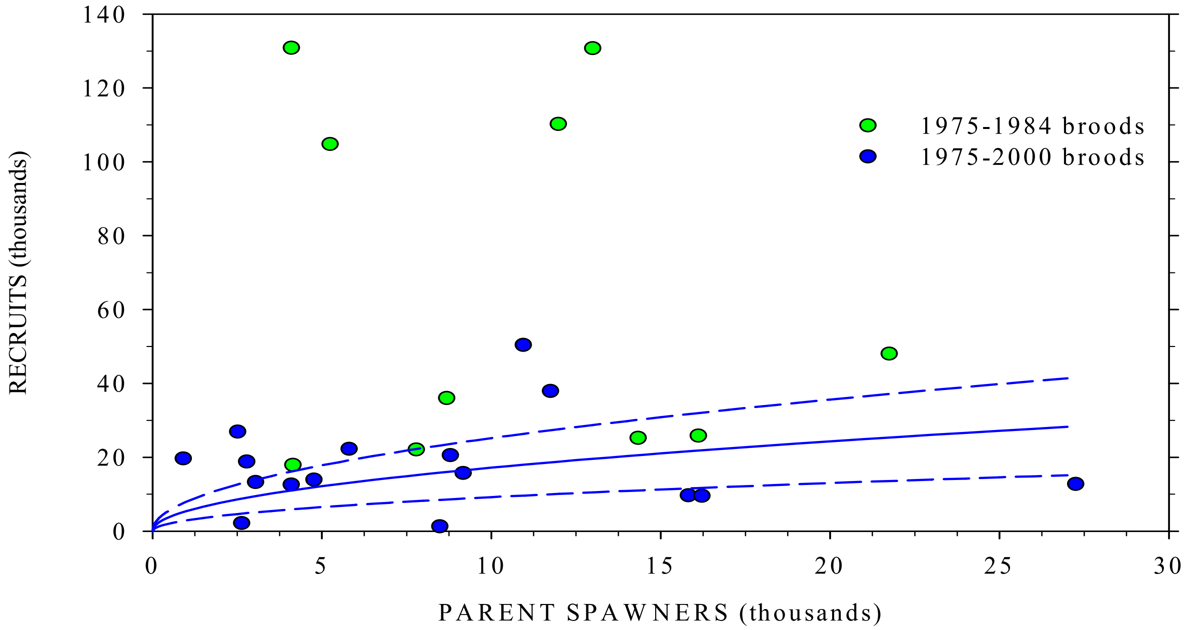

Figure 10. Relationship between the estimated numbers of naturally produced recruits and parents, brood years 1985-2000. Regression model #3 (see text) is the solid line with 95% confidence boundaries (dashed lines).

of the population. Consequently, only data from the 1985-2000 brood years are included in the following analyses.

Given the unknown degree of certainty associated with the estimation of the number of recruits, it was decided that a simple model would be used to quantitatively characterize the relationship between spawners and recruits. Based on the linear relationship between indexes of NP CHS fry abundance and migrant abundance reported by ODFW (2000) and the tendency for stock productivity to be high at relatively low levels of spawner abundance for Pacific salmon, it appeared most appropriate to examine potential transformations of the number of spawners rather than the number of recruits. Three forms of a model were examined with (1) no transformation of the number of spawners, (2) number of spawners transformed to natural logarithms, and (3) number of spawners transformed to square roots. The last form of the model is roughly similar in form to a Beverton-Holt model. The data was analyzed by regression analysis, with the regressions forced though the origin. Results of the regression analyses can be found in Table 15.

Table 15. Summary of the analyses for the estimated number of NP CHS recruits (y) regressed on the estimated number of CHS spawners (x), 1985-2000 brood years. Estimates included in the analyses are presented in Appendix Table F-2.

y transform	Equation	s_b^2	r^2	F	*P* (95% confidence)	Model #
none	y = 1.3080x	0.1561	0.422	10.96	< 0.001	(1)
ln	y = 2,052.2x	126,841	0.689	33.20	< 0.001	(2)
sqrt	y = 183.254x	1,466.1	0.604	22.91	< 0.001	(3)

Each of the potential models accounted for a significant percentage of the variation in the estimated number of NP CHS recruits produced by the 1985-2000 brood years. However, the performance of the models differed in their ability to reflect recruitment a various levels of spawner abundance. It appeared that Model #1 failed to reasonably reflect stock productivity because at all levels of spawner abundance, projections indicated that the population was barely able to reproduce an equal number of recruits (Table 16). Projections from Model #2 suggested

that wide variations in spawner numbers resulted in minimal variations in the number of recruits produced (Table 16), which did not appear to be a reasonable result. In contrast, projections from Model #3 reflected greater rates of recruitment at low levels of spawner abundance and relatively lower levels of recruitment rates at greater levels of spawner abundance (Table 16). Based on these findings, it was decided that Model #3, as portrayed in Figure 10, would be used as one indicator of guidance for the selection of numerical criteria for inclusion in the desired status and conservation status statements. However, as the spawner-recruit approach fails to directly account for variations in survival rates during the initial period of ocean residence, which can vary almost 10-fold among years for CHS (ODFW 2000), stock-recruitment relationships were also examined in relation to the available indexes of juvenile abundance.

Table 16. Predicted number of recruits based on the projected spawner abundance resulting from the passage of varied numbers of naturally produced spring Chinook salmon at Gold Ray Dam. Predictions were based on potential models portrayed in Table 15. Numbers of spawners were projected based on a fishing impact rate of 0.25 and a natural mortality rate of 0.02 in the area upstream of Gold Ray Dam, and a 0.05 rate of natural spawning by hatchery fish. Jacks were assumed to compose 10% of the fish passing Gold Ray Dam and are not included in the projected numbers of spawners.

NP CHS passing	CHS	Predicted number of recruits produced (±95% CI)		
Gold Ray Dam	spawners	Model #1	Model #2	Model #3
5,000	3,285	4,297 (±2,766)	16,617 (±6,145)	10,503 (±4,677)
10,000	6,750	8,594 (±5,531)	18,039 (±6,671)	14,854 (±6,614)
15,000	9,855	12,891 (±8,297)	18,871 (±6,979)	18,192 (±8,100)
20,000	13,140	17,188 (±11,062)	19,461 (±7,197)	21,006 (±9,353)
25,000	16,425	21,485 (±13,828)	19,919 (±7,367)	23,486 (±10,457)
30,000	19,710	25,781 (±16,593)	20,293 (±7,505)	25,727 (±11,455)

The second method that can be used to develop a stock-recruitment relationship for NP CHS in the Rogue SMU is similar to method one, except that there is an attempt to directly account for variations in survival rates during the initial period of ocean residence. The number of naturally produced smolts (juveniles that entered the ocean) is indexed by assuming that the initial ocean survival rates of naturally produced and hatchery fish are highly correlated. Estimation of initial ocean survival rates for CHS of hatchery origin basically follow the procedures outlined by Hankin (1990) and were described in detail by ODFW (2000). The number of wild smolts produced by each brood year was estimated as the estimated number of recruits divided by estimated survival rate of CWT marked spring Chinook salmon from released from Cole M. Rivers Hatchery during September and October.

Assuming that wild and hatchery CHS smolts survived at the same rates during the period of initial ocean residence, the number of wild NP CHS smolts produced by the 1975-1996 brood years ranged between about 300,000 and 4,400,000 smolts annually (Appendix Table F-2). Estimates for later brood years were not generated as data remains incomplete for all age classes of CWT marked CHS released from Cole M. Rivers Hatchery. A plot of the smolt and parent numbers suggested that smolt production increased as spawner abundance increased (Figure 11). Similar to the analysis of recruits, there was an indication that rates of smolt production per spawner decreased after the mid-1980s (Figure 11). Again, as the primary purpose of characterizing the stock-recruitment relationship was to provide insight on possible numerical criteria for elements of desired status and conservation status, consideration was given to multiple numerical models that could be employed to evaluate data from the most recent years (1985 brood year onward) that tend to characterize the current status of the population.

Similar to the recruit-parent regression analyses, three forms of relatively simple models were examined with: (1) no transformation of the number of spawners, (2) number of spawners transformed to natural logarithms, and (3) number of spawners transformed to square roots. This approach also allowed for a rough assessment as to which approach (recruit-parent or smolt-parent) better described the stock-recruitment relationship for NP CHS in the Rogue SMU.

Results of the regression analyses of smolt and parent data, with regressions forced through the origin, can be found in Table 17.

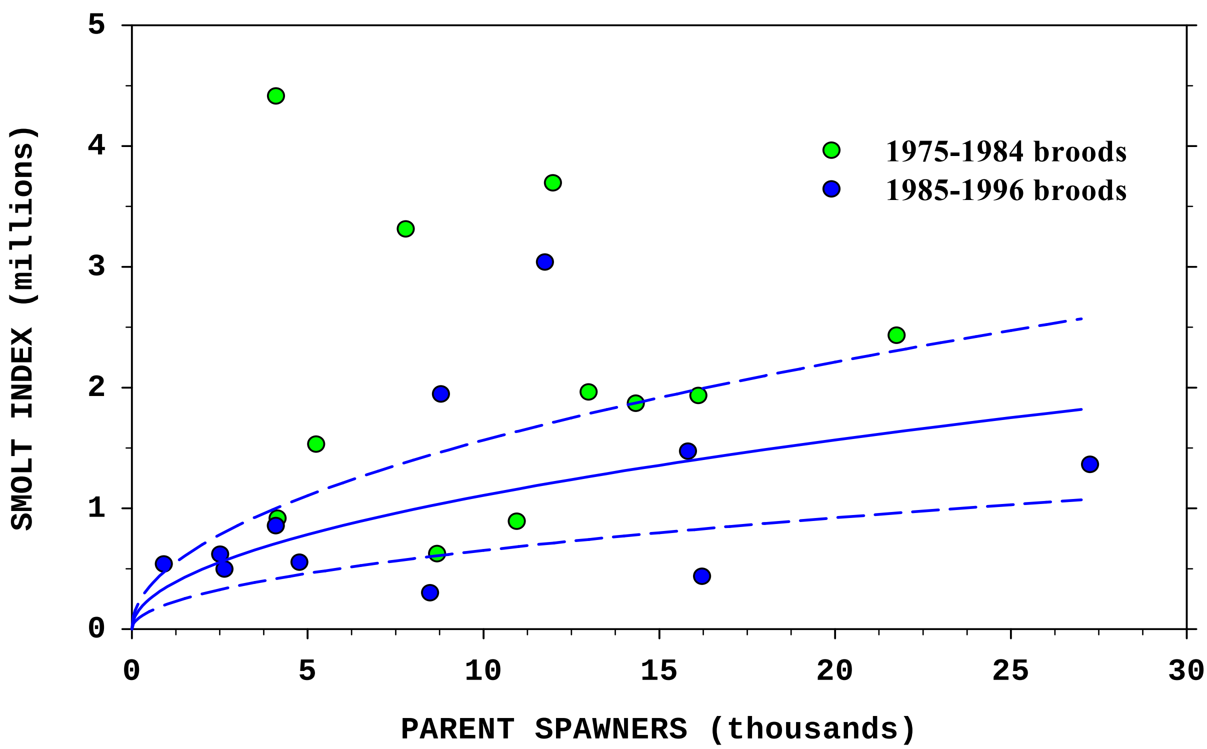

Figure 11. Relationship between the estimated numbers of naturally produced smolts and parents, brood years 1985-1996. Regression model #6 (see text) is the solid line with 95% confidence boundaries (dashed lines). Smolt numbers are an index, as wild smolts were assumed to have survived at the same rate as hatchery smolts.

Table 17. Summary of the analyses for the indexed number of NP CHS smolts (y) regressed on the estimated number of CHS spawners (x), 1985-1996 brood years. Estimates included in the analyses are presented in Appendix Table F-2.

y transform	Equation	s_b^2	r^2	F	*P* (95% confidence)	Model #
none	y = 82.78x	439.9	0.586	15.58	< 0.001	(4)
ln	y = 120,862x	610,255,944	0.685	23.94	< 0.001	(5)
sqrt	y = 11,070x	4,836,819	0.697	25.34	< 0.001	(6)

Each of the potential models accounted for a significant percentage of the variation in the indexed number of NP CHS smolts produced by the 1985-1996 brood years. However, the performance of the models differed in their ability to reflect recruitment a various levels of spawner abundance. Model #4 projected relatively high levels of recruitment rates at low levels of spawner abundance, but the uncertainty associated with projections of NP CHS smolt yields increased rapidly as the number of spawners increased (Table 18). Projections from Model #5 suggested that wide variations in spawner numbers resulted in minimal variations in the number of recruits produced (Table 18), which did not appear to be a reasonable result. In contrast, projections from Model #6 reflected higher levels of recruitment rates at low levels of spawner abundance and relatively low levels of recruitment rates at high levels of spawner abundance, and appeared to fit the data reasonably well (Figure 11). Based on these findings, it was decided that Model #6 would be used as another guidance indicator for the selection of numerical criteria for inclusion in the desired status and conservation status statements.

Table 18. Predicted number of smolts based on the projected spawner abundance resulting from the passage of varied numbers of naturally produced spring Chinook salmon at Gold Ray Dam. Predictions were based on potential models portrayed in Table 17. Numbers of spawners were projected based on a fishing impact rate of 0.25 and a natural mortality rate of 0.02 in the area upstream of Gold Ray Dam, and a 0.05 rate of natural spawning by hatchery fish. Jacks were assumed to compose 10% of the fish passing Gold Ray Dam and are not included in the projected numbers of spawners.

NP CHS passing	CHS	Predicted number (millions) of smolts produced (±95% CI)		
Gold Ray Dam	spawners	Model #4	Model #5	Model #6
5,000	3,285	0.414 (±0.217)	0.979 (±0.200)	0.634 (±0.126)
10,000	6,750	0.828 (±0.435)	1.062 (±0.217)	0.897 (±0.178)
15,000	9,855	1.242 (±0.652)	1.111 (±0.227)	1.098 (±0.218)
20,000	13,140	1.656 (±0.870)	1.146 (±0.234)	1.269 (±0.252)
25,000	16,425	2.069 (±1.087)	1.173 (±0.240)	1.419 (±0.282)
30,000	19,710	2.483 (±1.305)	1.195 (±0.244)	1.554 (±0.309)

Method three is distinctly different from the other two methods. The annual abundance of progeny are indexed as the number of newly emergent fry of CHS caught annually by sampling with beach seines (nets) at two sites upstream of Gold Ray Dam during 1976-94 (ODFW 2000). Thus, similar to the assessment of the smolt-parent relationship, highly variable survival rates during the initial period of ocean residence is not a factor that affects the relationship of progeny and parents. Use of the catch data as an abundance indicator was judged to be appropriate as beach seines has been shown to be an effective method of indexing the abundance of juvenile Chinook salmon (Parsley et al. 1989) and ODFW (2000) found that annual catch rates of newly emergent NP CHS fry were highly correlated (correlation coefficient (r)= 0.92, $P < 0.001$ at the 95% confidence level) with estimates of the number of naturally produced juvenile Chinook salmon that passed Savage Rapids Dam near Grants Pass.

ODFW (2000) hypothesized that four primary factors influenced NP CHS fry production: (1) numbers of female parents, (2) flow when parents spawned, (3) intensity of peak flow when eggs and alevins incubated in the gravel, and (4) water temperature when eggs and sac-fry incubated in the gravel and tested this hypothesis with a multiple regression analysis. Results indicated that annual catch rates of newly emergent CHS fry were positively related to an abundance index of female spawners, and were negatively related to the intensity of peak flows during incubation of embryos and water temperature during the incubation period of embryos (Table 19).

Table 19. Multiple regression analysis of annual catch rates of wild Chinook salmon fry seined at two sites in the Rogue River upstream of Gold Ray Dam, 1975-94 (ODFW 2000). Catch rates were transformed to natural logarithms before analysis.

Independent variable	Regression coefficient	Standard error	*P* (95% confidence)
Peak flow[a]	-10.422×10^{-5}	2.307×10^{-5}	<0.001
Female spawners[b]	6.514×10^{-4}	2.131×10^{-4}	0.009
Water temperature[c]	-0.4304	0.1654	0.021
Constant	9.653		

Analysis of variance

Source of variation	Sum of squares	df	Mean square	F	*P* (95% confidence)
Regression	9.825	3	3.275	13.87	<0.001
Residual	3.306	14	0.236		

	Partial r^2 in successive steps of analysis		
Variables tested	Step 1	Step 2	Step 3
Peak flow	0.53	--	--
Female spawners	0.16	0.20	--
Water temperature	0.10	0.12	0.29
Spawning flow	0.06	0.01	0.05

[a] *Peak mean daily flow (cfs) at Dodge Bridge in the preceding November-February.*

[b] *Number of spawned female parents counted between Cole M. Rivers Hatchery and Rogue Elk Park.*

[c] *Mean maximum water temperature (^oC) near McLeod in the preceding October-December.*

Of the three independent variables, peak flow was most highly correlated with fry catch rates (Table 19). Residual variation from that relationship was significantly related to annual counts of spawned female carcasses in standard areas surveyed in the previous year (Table 19). Finally, residual variation from the second step of the analysis was significantly related to water temperature during the period eggs and alevins incubated in the gravel (Table 19). The independent variables accounted for 69% (r^2) of the annual variation in fry catch rates.

To investigate the relationship between estimates of total spawner abundance and the fry abundance index, the environmental effects of peak flow and water temperature during the period that eggs and sac-fry incubated in the gravel accounted for by multiple regression analysis and the residual variation from that relationship was standardized by adding a constant. The standardized residuals were then plotted versus estimated spawner abundance. Results suggested that there was a positive relationship between the two variables (Figure 12). As with the recruit-parent and smolt-parent analyses, consideration was given to multiple numerical models that could be employed to evaluate the data.

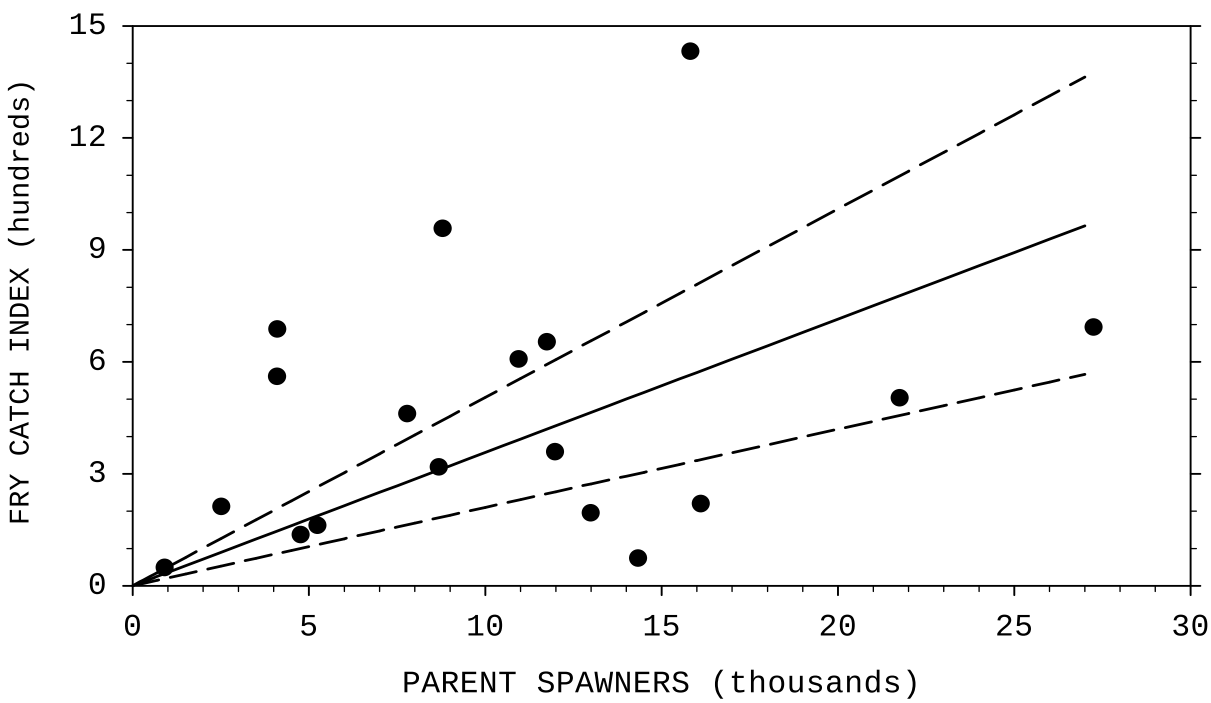

Figure 12. Relationship between catches of naturally produced fry and parents, brood years 1976-1993. Fry catches are adjusted for the effects of peak flow and water temperature during the period when eggs and sac-fry incubate in the gravel. Regression model #7 (see text) is the solid line with 95% confidence boundaries (dashed lines).

Three forms of relatively simple models were examined with: (1) no transformation of the number of spawners, (2) number of spawners transformed to natural logarithms, and (3) number of spawners transformed to square roots. Results of the regression analyses of smolt and parent data, with regressions forced through the origin, can be found in Table 20.

Table 20. Summary of the analyses for the catch rates of NP CHS fry (y) regressed on the estimated number of CHS spawners (x), 1975-1993 brood years. Estimates included in the analyses are presented in Appendix Table F-2.

y transform	Equation	s_b^2	r^2	F	*P* (95% confidence)	Model #
none	y = 0.0357x	0.00005	0.606	26.10	< 0.001	(7)
ln	y = 51.925x	77.607	0.671	34.74	< 0.001	(8)
sqrt	y = 4.607x	0.5825	0.682	36.44	< 0.001	(9)

Each of the potential models accounted for a significant percentage of the variation in the catches of NP CHS fry produced by the 1975-1993 brood years. However, the performance of the models differed in their ability to reflect recruitment at various levels of spawner abundance. Projections from Model #8 suggested that wide variations in spawner numbers resulted in minimal variations in the number of recruits produced (Table 21), which did not appear to be a reasonable result. To some degree, the same was true for Model #9 (Table 21). In contrast, projections from Model #7 seemed to better reflect the range of fry abundance that was observed during sampling (Table 21). Based on these findings, it was decided that Model #7 would be used as another guidance indicator for the selection of numerical criteria for inclusion in the desired status and conservation status statements; with the recognition that there was not much data from recent years.

Table 21. Predicted catch rates of newly emergent fry based on the projected spawner abundance resulting from the passage of varied numbers of naturally produced spring Chinook salmon at Gold Ray Dam. Predictions were based on potential models portrayed in Table 20. Numbers of spawners were projected based on a fishing impact rate of 0.25, and a natural mortality rate of 0.02, in the area upstream of Gold Ray Dam, and a 0.05 rate of natural spawning by hatchery fish. Jacks were assumed to compose 10% of the fish passing Gold Ray Dam and are not included in the projected numbers of spawners.

NP CHS passing	CHS	Predicted seine catch of fry produced (±95% CI)		
Gold Ray Dam	spawners	Model #7	Model #8	Model #9
5,000	3,285	179 (±74)	420 (±151)	264 (±92)
10,000	6,750	357 (±148)	456 (±163)	373 (±131)
15,000	9,855	536 (±221)	477 (±171)	457 (±160)
20,000	13,140	714 (±295)	492 (±176)	528 (±185)
25,000	16,425	893 (±369)	504 (±180)	590 (±206)
30,000	19,710	1,071 (±443)	513 (±184)	647 (±226)

It is important to note that none of the models presented in this section are proposed as the “best” way to characterize parent-progeny relationships for NP CHS in the Rogue SMU. Each of the three methods by which progeny were assessed (recruits, indexed smolts, and fry catch rates) has advantages and disadvantages. However, having multiple means, by which to compare parent-progeny relationships, should provide better guidance to decision makers; in comparison to sole reliance on one method. It also appears advantageous to have multiple methods of assessing parent-progeny relationships because there are major assumptions associated with the estimation of each index of parent and progeny abundance.

Parent-progeny relationships included in this section were considered by the advisory committee and by ODFW during development of the desired status and conservation status statements included in this conservation plan. Based upon the relationships described above, it can be shown that the productive potential of the NP CHS population is generally limited by the number of spawners. Thus, during most years, more recruits, or smolts, or fry would be be produced by and increase in the number of spawners. In addition, there was also general agreement that a spawner abundance of less than 5,000 represented a conservation problem because of implications for subsequent NP CHS production. This latter level of spawner abundance is somewhat reflective in the abundance element of the conservation status statement (*see* **CRITERIA INDICATING DETERIORATION IN STATUS**, page 79).

Hatchery Fish: During the last 20 years, there has been increased concern that hatchery fish may be partially responsible for documented declines in the abundance of some naturally produced salmon populations (ISAB 2002). Potential impacts can be classified as either genetic in basis, or as ecological interactions. Genetic impacts can develop when populations of naturally produced and hatchery fish have different genetic complements. Differences in genotypes can result from domestication of a hatchery population, or use of a non-local brood stock to establish a hatchery population, or inbreeding caused by small numbers of hatchery fish in the brood stock (ISAB 2002). Ecological impacts can result from (1) competition of naturally produced and hatchery fish, (2) direct predation on naturally produced fish by hatchery fish, (3) increased losses if hatchery fish attract additional predators, (4) disease transmission from hatchery fish to naturally produced fish, and (5) changes in water quality directly attributable to hatchery operations (HSRG 2005).

The risk of potential negative impacts to NP CHS, which result from the release of CHS from Cole M. Rivers Hatchery, is difficult to thoroughly evaluate. However, the following information can be used, to some degree, to assess the potential for risk to NP CHS:

1. The amount of domestication of the hatchery population is unknown. Cole M. Rivers Hatchery has been operational since 1973, when the first adult CHS were collected for brood stock. Assuming that age 4 spawners dominated the brood stock, approximately five generations of families have been raised at the facility.
2. The brood stock was developed from CHS (almost all naturally produced fish) that volitionally entered the hatchery, and during the intervening years, only those fish that volitionally entered the hatchery were included in the brood stock.
3. A minimum of 500 adults (usually more than 1,000) composed the annual brood stocks since the hatchery began operation.
4. With the exception of four years during the 1980s, juvenile CHS were released from Cole M. Rivers Hatchery no earlier than the middle of August. This date of release ensures that the preponderance of the juvenile hatchery fish do not rear in the Rogue River for an appreciable period of time (ODFW 2000), nor prey upon juvenile NP CHS.
5. Time of hatchery entry by adult CHS closely reflects the entry time of naturally produced fish during the first few years of hatchery operation.
6. The spawning time of hatchery brood stocks has not changed since the hatchery began operation (ODFW 2000).

7. Hatchery fish tend to mature at younger ages as compared to naturally produced fish. This difference is likely due to brood stock selection practices and accelerated growth rates of juveniles during hatchery residence.
8. With the exception of age at maturity, hatchery fish currently exhibit life history characteristics similar to those of NP CHS produced before the operation of Lost Creek Dam.
9. With the change in life history characteristics of NP CHS that resulted from reservoir construction and operation, NP CHS and hatchery CHS now differ in that hatchery fish migrate earlier in freshwater and also spawn earlier. These two life history characteristics are heritable traits and indicate that genetic differences are currently present between NP CHS and hatchery CHS.
10. Recent genetic assessments failed to detect differences between naturally produced and hatchery fish for the microsatellite DNA markers analyzed (*see* **SPECIES MANAGEMENT UNIT AND CONSTITUENT POPULATIONS**, page 10). Resolution of the testing does not preclude genetic differences.
11. There have been periodic disease outbreaks at Cole M. Rivers Hatchery, making it probable that concentrations of fish pathogens increased in the Rogue River as a result of hatchery operations.
12. Adult CHS of hatchery origin appear to be more susceptible to disease outbreaks as compared to naturally produced counterparts (ODFW 2000).
13. The homing rate of adult CHS of hatchery origin was estimated to be about 95% and about 5% of the hatchery fish spawn naturally (Cramer et al. 1985).
14. Hatchery fish are projected to account for about 13% of the natural spawners during years when hatchery fish compose about 75% of the CHS that pass Gold Ray Dam (ODFW 2000).
15. Spawner surveys conducted during 2004 and 2005 suggested that hatchery fish composed an average of 11% of all natural spawners and 23% of the fish that spawned between the hatchery and Rogue Elk Park. More than 70% of the stray hatchery fish spawned within 5 miles of Cole M. Rivers Hatchery.
16. It is possible that the large run of hatchery fish support levels of angling intensity that result in freshwater harvest rates that exceed optimal levels for NP CHS under the current angling regulations.

The production program for CHS at Cole M. Rivers Hatchery is comparable to an "integrated hatchery program" as defined by Hatchery Scientific Review Group (HSRG 2005). This term describes a management scenario where the hatchery brood stock is managed as a genetically integrated component of an existing population. Recommendations for brood stock composition for these types of programs are (1) naturally produced fish should compose at least 10% of the brood stock and (2) the proportion of naturally produced fish in the brood stock should be greater than the proportion of hatchery fish among natural spawners (HSRG 2005). These criteria were attained for the 2004-06 brood stocks at Cole M. Rivers Hatchery (Table 22). However, data from 2005 suggests that naturally produced fish may, at sometime in the future, need to be collected at a site other than Cole M. Rivers Hatchery. This issue should be addressed in a Hatchery Program Management Plan that will be developed by ODFW. Other recommendations related to principles of hatchery programs (HSRG 2005) are also mostly attained by the production program for CHS at Cole M. Rivers Hatchery.

Table 22. Estimated composition of adult spring Chinook salmon that spawned naturally, and were spawned at Cole M. Rivers Hatchery, 2004-06. The sample size for the number of natural spawners represents the number of carcasses recovered on the spawning grounds.

Year	% naturally produced fish among hatchery brood stock (n)	% hatchery fish among natural spawners (n)
2004	26% (1,105)	9% (1,749)
2005	15% (1,099)	12% (960)
2006	16% (1,213)	10% (855)

In conjunction with this conservation plan, ODFW will be developing a hatchery program management plan in order to comply with ODFW's Fish Hatchery Management Policy (ODFW 2003). This policy describes best management practices that are intended to help ensure the conservation of both naturally produced native fish and hatchery produced fish. Policy goals include:
1. Foster and sustain opportunities for sport, commercial and tribal fishers consistent with the conservation of naturally produced native fish.
2. Contribute toward the sustainability of naturally produced fish populations through the responsible use of hatcheries and hatchery-produced fish.
3. Maintain genetic resources of native fish populations spawned or reared in captivity.
4. Minimize adverse ecological impacts to watersheds caused by hatchery facilities and operations.

The Fish Hatchery Management Policy requires that ODFW hatchery programs be distinguished as harvest or conservation hatchery programs. Currently, ODFW manages the Rogue CHS program at Cole M. Rivers Hatchery as a mitigation type, harvest hatchery program. As described in the Fish Hatchery Management Policy, harvest hatchery programs operate to enhance or maintain fisheries without impairing naturally reproducing populations. The policy further states that a mitigation program is used pursuant to an agreement to provide fishing and harvest opportunities lost as a result of habitat deterioration, destruction or migration blockage.

However, there are some potential conservation benefits associated with the maintenance of the CHS hatchery program very similar to the present form. The brood stock was initially developed from NP CHS that volitionally entered Cole M. Rivers Hatchery, and efforts during the intervening years have focused on (1) the maintenance of genetic diversity and (2) the maintenance of some of the genetic based life history characteristics expressed by that portion of the NP CHS population that historically spawned upstream of Lost Creek Dam. While NP CHS and hatchery CHS currently differ in some life history characteristics, it may be important to maintain the current population of hatchery CHS in the event that further conservation efforts are needed for early-run and mid-run CHS.

To summarize this section, there appears to be some advantages associated with maintaining the current program for CHS at Cole M. Rivers Hatchery because the hatchery fish exhibit many characteristics that are similar to naturally produced fish that were historically produced in upstream areas. In addition, the history of brood stock collection practices and smolt release practices at Cole M. Rivers Hatchery have likely resulted in lesser impacts to naturally produced fish as compared with most other hatchery programs for salmon in the Pacific Northwest.

However, as there is also the potential for some negative impacts, there was general agreement among the advisory committee and ODFW that the proportion of hatchery fish among spawning CHS should be limited to some degree in order to decrease the potential risk to NP CHS. Consequently, consideration was given to possible actions that would decrease the proportion of hatchery fish among spawners, even though this factor does not appear to currently be a primary factor that limits possible attainment of desired status.

Fisheries

A primary impact exerted on salmon populations is mortality that results from fishing activities. Wading and boating may have some impact on production (Roberts and White 1992; Horton 1994), but the greatest impact almost certainly originates from the directed fishing on salmon by recreational and commercial fisheries. Mortality rates associated with fishing can vary widely for Pacific salmon, especially for Chinook salmon that mature at multiple ages.

Harvest rates within this conservation plan are defined as that percentage of a brood year which was taken by fishers, and were estimated by the equation:

$$(\text{ocean harvest} + \text{river harvest})/(\text{ocean harvest} + \text{freshwater returns})) * 100$$

Numerous assumptions are required to generate recruitment estimates for NP CHS of Rogue River origin. First, the age of NP CHS that pass Gold Ray Dam must be estimated. Scale samples were collected for this purpose during 1974-94 as part of the Lost Creek Dam Fisheries Evaluation Project. As no directed sampling, to estimate the age of NP CHS, has been conducted since 1994, alternative estimation measures had to be employed. First, there was an assumption that the age composition of CWT marked hatchery fish reflected the age composition of returning wild fish. Second, harvest and natural mortality in the river downstream of Gold Ray Dam must be estimated. Estimates of river harvest were generated from a combination of harvest estimates from salmon-steelhead cards and fishery selectivity factors reported by ODFW (2000); while rates of natural mortality were estimated based on the relationship of water temperature and mortality rate reported by ODFW (2000). Third, age-specific rates of harvest in the ocean fisheries must be estimated. Harvest rates in the ocean fisheries were derived from cohort reconstruction procedures described by ODFW (2000) for completed broods of CWT marked CHS released from Cole M. Rivers Hatchery. For incomplete broods, it was assumed that age-specific ocean harvest rates were the same as for fall Chinook salmon of Klamath River origin. As a result of the multiple assumptions, and lack of empirical data derived from directed sampling, it was not possible to develop estimates of certainty associated with the estimates of harvest rates for completed broods of NP CHS.

Estimates of harvest rates for NP CHS ranged between 30 and 76% for the 1972-2000 brood years (Appendix Table F-2). Harvest rates were greatest for fish produced in the 1970s, generally declined for fish produced during the mid 1980s through the mid 1990s, and slightly increased for fish produced in the late 1990s (Figure 13). The sharp decline in harvest rates for fish produced in 1980 and 1981 was probably linked to the extremely strong El Niño event of 1982-83 (ODFW 2000).

Figure 13. Estimated harvest rates of naturally produced spring Chinook salmon, 1972-2000 brood years. Harvest rates are estimated as ocean and freshwater harvest, divided by the sum of ocean harvest and return to freshwater.

Estimated rates of ocean harvest rates have decreased since the 1970s (Figure 14). Harvest rates in the ocean fisheries averaged 65% for broods that spawned in the 1970s, 40% for broods that spawned in the 1980s, and 11% for broods that spawned in the 1990s (Appendix Table F-2). The sharp decline in ocean harvest rates coincided with implementation of Amendment 9 of the Fishery Management Plan for CHF in the Klamath River Basin of northern California. Resultant harvest restrictions to the ocean fisheries caused NP CHS of Rogue River Basin origin to be harvested at lower rates because both groups of fish tend to be caught in the same general area of the ocean. For the purposes of this conservation plan, the harvest rates of NP CHS in the ocean fisheries can be assumed to average about 15% for the foreseeable future.

In contrast to ocean harvest rates, harvest rates in the river fishery increased since the 1970s (Figure 14). Harvest rates in the river fisheries averaged 9% for broods that spawned in the 1970s, 16% for broods that spawned in the 1980s, and 28% for broods that spawned in the 1990s (Appendix Table F-2). Factors responsible for the increase include increased numbers of anglers, better equipment, and increased season length in the area upstream of Gold Ray Dam (Table 23). In addition, during the entire time period, all areas of NP CHS habitat in the Rogue River remained open to the harvest of CHS; with the exception of some small areas near dams and falls, NP CHS may have been harvested at rates that exceeded optimum in most years during the 1970s and 1980s. Projections of harvest rates at maximum sustainable yield were about 50% for “early-maturing” populations of Chinook salmon and were about 40% for “mid-maturing” populations of Chinook salmon (Hankin and Healey 1986). Maturation rates estimated by ODFW (2000) indicated that NP CHS in the Rogue SMU can be characterized as being intermediate to “early-maturing” and “mid-maturing” populations as defined by Hankin and Healey (1986). Estimates of total harvest rates averaged 74% for recruits produced in the 1970s, 55% for recruits produced in the 1980s, and 39% for recruits produced in the 1990s (Appendix Table F-2). These estimates indicate that mortality related to fishing was a primary factor that affected population productivity during the 1970s and 1980s, but not necessarily so during the 1990s.

Table 23. Temporal changes in the fishing seasons for spring Chinook salmon in the area upstream of Gold Ray Dam. Regulations listed below apply to only to Chinook salmon at least 24 inches in length. Smaller Chinook salmon (jacks) could be harvested for later periods of time during some years.

Years	Period of legal harvest
-1964	1 January - 30 June
1965-71	1 January - 04 July
1972-77	1 January - 15 July
1978-06	1 January - 31 July

However, there is a chance that fishing was a primary factor that contributed to the current low numbers of early-run CHS. Freshwater fisheries in the Rogue River are highly selective for NP CHS fish that return as age 4-6 adults (ODFW 2000). A selective harvest of Chinook salmon in freshwater is not unique to the Rogue River. Anglers (primarily boaters) caught and released an estimated 73% of the early-run Chinook salmon in the Kenai River, Alaska (Bendock and Alexandersdottir 1993). Early-run winter steelhead were captured at higher rates by anglers as compared to late-run counterparts in a British Columbia River (Nelson et al. 2005). For the purposes of the following discussion of NP CHS, early-run fish are defined as those that pass

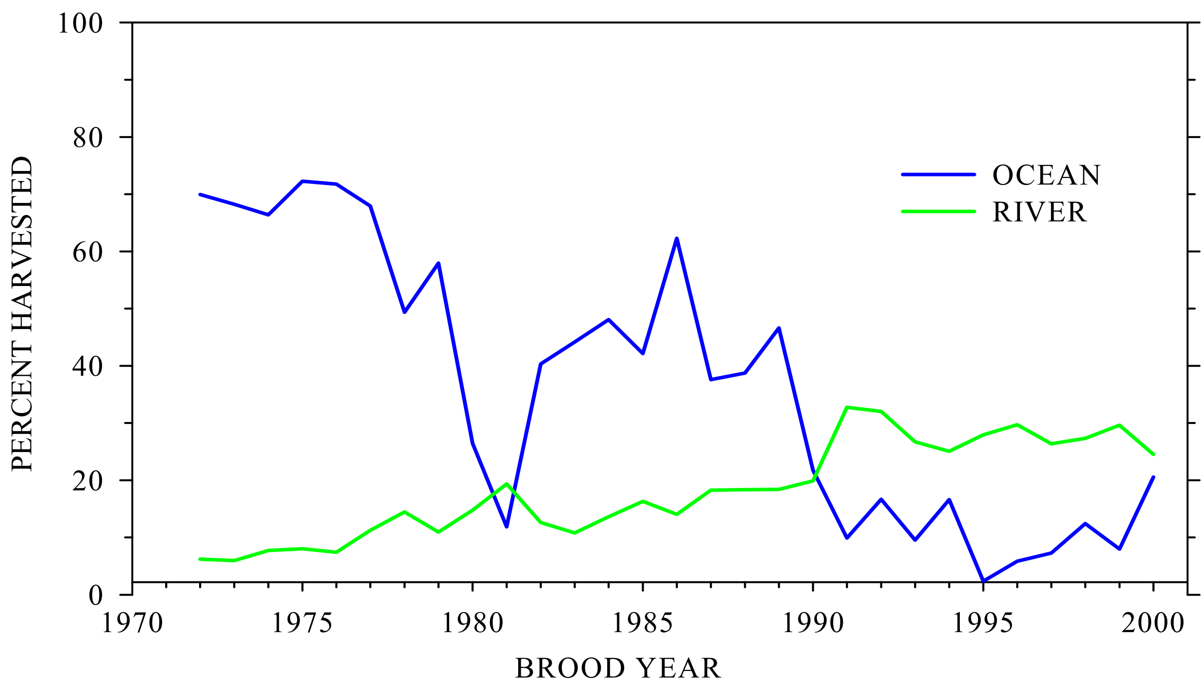

Figure 14. Estimated harvest rates of naturally produced spring Chinook salmon within the ocean fisheries and within the freshwater fisheries, 1972-2000 brood years. Harvest rates are estimated as the number of fish harvested per area, divided by the sum of ocean harvest and return to freshwater.

Gold Ray Dam before June, mid-run fish are defined as those that pass Gold Ray Dam during June, and late-run fish are those that pass Gold Ray Dam after June.

Direct estimation of the harvest rates of early-run NP CHS, as compared to later run NP CHS, was not possible with the available information. Some primary assumptions were needed in order to generate estimates of fishery metrics. These assumptions included (1) harvest estimates derived from salmon-steelhead cards ("punchcards") appropriately reflected total harvest within each area of the Rogue River and (2) the probability of harvest in each area was assumed to equal the harvest rate divided by the number of days that fish were exposed to fishing in each area. The residence time of fish in each area of the river was estimated from migration rate estimates reported by ODFW (2000). Results indicated that early-run NP CHS were likely harvested at greater rates as compared to later run counterparts (Table 24). In addition, there is an indication that early-run NP CHS, and possibly mid-run CHS, may be currently harvested at rates that exceed optimum and that mid-run and late-run NP CHS were likely harvested during the 1970s and 1980s at rates that exceeded optimum (Table 24).

Table 24. Total mortality rates of naturally produced spring Chinook salmon estimated under three scenarios of harvest rates in the ocean fisheries. These estimates show projected rates of total fishing-related mortality (ocean and freshwater) for early-run, mid-run, and late-run female fish. A total mortality rate estimate of 50% means that half the fish were killed as a result of fishing activity. Estimates were developed based on freshwater fishing regulations in effect during 1978-2003. Significant assumptions were associated with estimation procedures (*see* text). No estimates of statistical certainty could be generated for the mortality estimates.

Harvest rate	Total mortality rate for fish type		
in the ocean	early-run[a]	mid-run[b]	late-run[c]
15%	58%	40%	22%
30%	65%	51%	36%
50%	75%	65%	54%

a *Applicable to early-run fish that pass Gold Ray Dam on 15 May.*
b *Applicable to mid-run fish that pass Gold Ray Dam on 15 June.*
c *Applicable to late-run fish that pass Gold Ray Dam on 15 July.*

With the possibility that harvest rates on early-run NP CHS may have been excessive, projections of fishing mortality rates were developed under a variety of potential scenarios for the freshwater fisheries. In the absence of necessary information, some primary assumptions had to be made. Assumptions, in addition to those described in the previous paragraph, included: (1) the mortality rate of released CHS is 12% (Lindsay et al. 2004), (2) the probability that released fish are subsequently hooked again in fisheries downstream of Gold Ray Dam is equal to the probability of initial hooking, and (3) the probability that released fish are subsequently hooked again in fisheries upstream of Gold Ray Dam is equal to the probability of initial hooking during every subsequent period of twenty days. The propriety of the latter two assumptions is unknown, except that it seems certain that some released fish would be subsequently hooked again.

If the assumptions associated with the estimation procedures are reasonable, projections indicate that if generalized regional rules for the freshwater fisheries are to be maintained, significant changes should be made to one or more of the following components of angling regulations: (1) area open to harvest, (2) opening date of harvest, and (3) closing date of harvest. This conclusion is based on the projection that optimal rates of fishing mortality are likely no more than 40%. A variety of potential scenarios were identified and assessed (Table 25). All scenarios allow for the continued freshwater harvest of marked hatchery fish under standard (zone) regulations of a daily limit of two marked hatchery Chinook salmon.

Table 25. Total mortality rates estimated for varied scenarios of angling regulations for NP CHS in freshwater. These estimates show projected rates of total fishing mortality (ocean and freshwater) for early-run, mid-run, and late-run female fish. The rate of fishing mortality in the ocean is assumed to be 15%. A total mortality rate estimate of 50% means that half the fish were killed as a result of fishing activity. Estimates were developed based on the application of generalized statewide angling regulations for Chinook salmon in the Rogue River (similar to the 1978-2003 regulations). Under all but two scenarios, harvest opportunities for hatchery fish remain unchanged from those in place during 1978-2006 (July 31 closure upstream of Gold Ray Dam). For the two excepted scenarios, anglers could continue to harvest hatchery fish during August within the area between Dodge Bridge and Gold Ray Dam. Significant assumptions were associated with estimation procedures (*see* text). No estimates of statistical certainty could be generated for the mortality estimates.

Harvest season	Harvest season	Projected mortality rate for NP CHS		
Below Gold Ray Dam	Above Gold Ray Dam	early-run[a]	mid-run[b]	late-run[c]
opens 1 Jan.	Jan. - July	58%	40%	22%
opens 1 May	Jan. - July	53%	40%	22%
opens 1 June	Jan. - July	51%	37%	22%
opens 1 July	Jan. - July	50%	36%	22%
opens 1 Jan.	June - July	52%	40%	22%
opens 1 Jan.	Jan. - June	46%	27%	15%
opens 1 Jan.	closed	42%	26%	16%
opens 1 May	closed	34%	26%	16%
opens 1 May	July-Aug. (Dodge-GRD[d] only)	34%	33%	25%
opens 1 June	closed	32%	22%	16%
opens 1 June	July-Aug. (Dodge-GRD[d] only)	32%	30%	25%
opens 1 July	closed	31%	21%	16%

[a] *Applicable to NP CHS that pass Gold Ray Dam on 15 May.*
[b] *Applicable to NP CHS that pass Gold Ray Dam on 15 June.*
[c] *Applicable to NP CHS that pass Gold Ray Dam on 15 July.*
[d] *Dodge Bridge to Gold Ray Dam.*

A number of other regulatory options have the potential to decrease mortality rates of NP CHS that result from freshwater fishing. Included in these options would be changes in harvest limits, allowable types of fishing gear, allowable types of angling methods, and allowable methods of handling those fish that must be released. A variety of possible regulatory changes were considered during development of this plan, and many of those possibilities are listed in **APPENDIX H**.

Implications associated with potential regulation changes related to allowable types of fishing gear, allowable types of angling methods, and allowable methods of handling those fish that must be released, were difficult to evaluate. Interest in these options primarily originated out of concern that, under the current gear and methods employed by anglers, NP CHS are commonly hooked in body locations other than the mouth. Non-mouth hooking most commonly occurs at sites where CHS hold for extended periods and at chokepoints below dams and waterfalls. Implementation of gear and method regulations designed to reduce the probability of non-mouth hooking in the freshwater fisheries should reduce the rates of total fishing mortality, but the degree of reduction could not be estimated.

Implications associated with potential regulation changes related to allowable daily and seasonal limits of NP CHS were also difficult to evaluate. Information on daily and annual harvest could be retrieved from individual salmon-steelhead cards, but it is not possible to separate naturally produced fish from hatchery fish within those records because only a portion of the CHS of hatchery origin exhibited fin clips prior to the 2004 return year. As a result, estimates of angler success rates in the river fisheries could only be developed for three years in the early 1990s.

The estimated number of anglers that fished for CHS in the Rogue River averaged 5,100 people annually during 1991-93 (Olsen et al. 1994). Harvest estimates from salmon-steelhead cards, adjusted for jacks and the differential harvest of naturally produced and hatchery fish, indicated that anglers harvested an average of 2,600 NP CHS annually in the Rogue River during 1991-93. These estimates suggest that success rates averaged 0.50 NP CHS per angler during those years. While some anglers must have harvested multiple fish, there was no way of directly estimating the proportion of anglers that harvested more than one NP CHS. Consequently, some scenarios were developed to assess a potential annual limit of one NP CHS for each angler.

Implications of an annual limit of one NP CHS were assessed by projecting changes in total freshwater harvest under three hypothetical scenarios of fish abundance and four hypothetical scenarios of the distribution of angler success. Additional assumptions included in the assessment were (1) naturally produced fish accounted for one-third (33%) of the CHS that returned to freshwater, (2) freshwater harvest rates were selective for older fish and for naturally produced fish as estimated by (ODFW 2000), (3) the number of anglers that participated in the freshwater fisheries was 5,000 (Olsen et al. 1994) for a scenario of about 15,000 fish entering freshwater, and (4) the number of anglers increased by 25% for each additional 15,000 CHS entering freshwater.

Projections that resulted from the assessment varied markedly. However, some general implications of a possible annual limit of one NP CHS seemed to be relevant. First, reductions in freshwater harvest rates were greatest under the scenarios where a small proportion of anglers captured most of the fish (Table 26). Second, the reductions in harvest rates were progressive, in that reductions in harvest rates were greatest when large numbers of CHS returned to freshwater and were lowest when small numbers of CHS returned to freshwater (Table 26). These findings suggest that, even for an annual harvest limit of one NP CHS, additional conservation measures are likely warranted for years when relatively few naturally produced fish return to freshwater.

Table 26. Possible changes in freshwater harvest of naturally produced spring Chinook salmon under some hypothetical scenarios of angler success rates and run sizes. Estimates of freshwater harvest under historical (1978-2003) angling regulations are compared to harvest estimates under an annual harvest limit of one NP CHS per angler. Significant assumptions were associated with estimation procedures (*see* text). No estimates of statistical certainty could be generated for the mortality estimates.

	Number harvested			
Distribution of harvest[a]	expected[b]	projected[c]	difference	% change
15,000 CHS (5,000 WILD) AT RIVER ENTRY				
10% of anglers catch 50% of fish	2,295	1,658	-637	-28%
30% of anglers catch 50% of fish	2,295	2,295	0	0%
20% of anglers catch 80% of fish	2,295	1,481	-814	-35%
40% of anglers catch 80% of fish	2,295	2,295	0	0%
30,000 CHS (10,000 WILD) AT RIVER ENTRY				
10% of anglers catch 50% of fish	4,590	2,934	-1,656	-36%
30% of anglers catch 50% of fish	4,590	4,211	-379	-8%
20% of anglers catch 80% of fish	4,590	2,195	-2,395	-52%
40% of anglers catch 80% of fish	4,590	3,473	-1,118	-24%
45,000 CHS (15,000 WILD) AT RIVER ENTRY				
10% of anglers catch 50% of fish	6,885	4,241	-2,644	-38%
30% of anglers catch 50% of fish	6,885	5,837	-1,048	- 15%
20% of anglers catch 80% of fish	6,885	2,974	-3,911	-57%
40% of anglers catch 80% of fish	6,885	4,570	-2,315	-34%

[a] *Assumed scenarios within the freshwater fisheries.*
[b] *Harvest of NP CHS estimated for historical (1978-2003) angling regulations.*
[c] *Harvest of NP CHS estimated for an annual limit of one per angler.*

To summarize this section, it appears fairly certain that harvest rates in recent years did not exceed optimum for late-run NP CHS. However, there was concern among the advisory committee and ODFW that harvest rates have exceeded optimum for early-run NP CHS and have been close to exceeding optimum for mid-run NP CHS. Consequently, consideration was given to possible actions that would decrease the fishery impacts on early-run and mid run NP CHS, as this fishery impacts appear to be a primary factor that limits possible attainment of desired status.

Key Biological Attributes Affected By Reservoir Operation

The construction and operation of Lost Creek Dam has significantly affected the abundance and life history of NP CHS in the Rogue SMU. Some effects were documented within the first few years of reservoir operation, while other effects were not clearly delineated until the later portion of the 1990s. As the effects of reservoir operation are considered within the context of this conservation plan, an explanatory summary follows. More complete information can be found in

APPENDIX C, and detailed information can be found in a comprehensive report dedicated to this issue (ODFW 2000). Directed sampling associated with the Lost Creek Dam Fisheries Evaluation Project terminated in 1994, except that additional sampling was conducted in 2001 to estimate rates of pre-spawning mortality for Chinook salmon in the area downstream of Gold Ray Dam (Satterthwaite 2002).

One of the initial documented impacts was that CHS fry emerged from gravel nests (redds) earlier as a result of reservoir operation. Reservoir outflows in autumn and early winter were warmer than natural flows would have been (USACE 1991), which accelerated development rates of eggs and sac-fry. The change in emergence timing was most evident for the progeny of adult CHS that spawned early (Table 27). Changes in emergence timing were less evident for the progeny of adult fish that spawned later (Table 27). In addition, attempts to change reservoir outflow temperatures to restore the historical timing of fry emergence were only partially successful (Table 27). Premature emergence is associated with a decrease in the abundance of juvenile NP CHS (ODFW 2000).

Table 27. Comparisons of mean dates of gravel emergence estimated for fry produced by female Chinook salmon that spawned on three dates near McLeod (three miles downstream of Lost Creek Dam), 1972-2005. Potential differences were assessed by analysis of variance. Within rows, means with different superscripts differed at $P \leq 0.05$ based on a Newman-Keuls Multiple Range Test. Emergence dates were estimated from (1) mean daily water temperature at the USGS gage near McLeod and (2) 1,835 Fahrenheit temperature units to the "button-up" stage (personal communication dated 20 September, 1991 from Michael Evenson, ODFW, Cole M. Rivers Hatchery, Trail, Oregon).

Parent	Mean date of gravel emergence				*P* for difference
spawning date	1973-1978[a]	1979-1985[b]	1986-1995[c]	1996-2006[c]	(95% confidence)
15 September	20 March[d]	4 February[e]	17 February[e]	5 February[e]	<0.001
1 October	14 April[d]	8 March[e]	15 March[e]	6 March[e]	<0.001
15 October	29 April[d]	31 March[e]	1 April[e]	25 March[e]	<0.001

[a] *Before operation of Lost Creek Dam.*
[b] *After initial operation of Lost Creek Dam.*
[c] *After various changes were made to reservoir release strategies.*

When the surviving juvenile NP CHS returned as adults, a change in spawning time was also documented. Adult NP CHS produced as juveniles before reservoir operation spawned earlier as compared to counterparts produced as juveniles after reservoir operation (Table 28). This result was not surprising because spawning time is a highly heritable trait in Chinook salmon (Quinn et al. 2000). In other words, progeny spawn at the same time as their parents. The change in spawning time to a later date confirmed that the progeny of early spawning parents survived at lower rates than the progeny of late spawning parents, and that the change was linked to premature emergence of fry (ODFW 2000). While the seven day change in spawning time is seemingly minor, the implications for subsequent fry emergence timing are pronounced because water temperatures are relatively warm immediately after spawning, while water temperatures are relatively very cold just prior to the time of emergence (ODFW 2000).

Table 28. Comparisons of the mean date of spawning by naturally produced female spring Chinook salmon produced before and during operation of Lost Creek Dam (ODFW 2000). Potential differences were assessed with t-tests. Survey areas covered spring Chinook salmon spawning habitat in those areas of the Rogue River closest to Lost Creek Dam.

Survey area	Mean date of spawning		*P* for difference
	Pre-dam[a] (SE)	Post-dam[b] (SE)	(95% confidence)
Elk Creek - Hatchery[c]	Sept. 29 (1 day)	Oct. 6 (1 day)	< 0.001
Shady Cove - Elk Creek[d]	Sept. 29 (1 day)	Oct. 6 (1 day)	< 0.001

[a] *These fish were produced as juveniles before operation of Lost Creek Dam.*
[b] *These fish were produced as juveniles after operation of Lost Creek Dam.*
[c] *Sampled during 1974-94.*
[d] *Sampled during 1974-81 and 1986-90.*

Differential survival rates of fry also affected the migration timing of NP CHS in freshwater. Adults produced as juveniles before reservoir operation migrated earlier as compared to counterparts produced as juveniles after reservoir operation (Table 29). This result was anticipated because migration timing in Chinook salmon is also probably a highly heritable trait (Quinn et al. 1997). As an example, progeny of CHS enter freshwater at times similar to their parents, while the progeny of CHF enter freshwater at later dates. The change in migration timing was of concern to fishery managers because, for CHS in the Rogue River, early migrants contribute at greater rates to the river fisheries as compared to late migrants (*see* **Fisheries**, page 53).

Table 29. Comparisons of the mean date of capture, at Gold Ray Dam, for naturally produced age 3-5 spring Chinook salmon that were produced before and during operation of Lost Creek Dam, 1974-94 (ODFW 2000). Potential differences were assessed with t-tests. Data were excluded in those instances when less than 10 fish, in any single year class, were trapped within a year or when pre-spawning mortality in downstream areas exceeded 20%.

Fish age	Mean date of capture		*P* for difference
(years)	Pre-dam[a] (SE)	Post-dam[b] (SE)	(95% confidence)
3	3 June (3 days)	19 June (1 day)	< 0.001
4	28 May (4 days)	15 June (1 day)	< 0.001
5	26 May (4 days)	12 June (2 days)	< 0.001

[a] *These fish were produced as juveniles before operation of Lost Creek Dam.*
[b] *These fish were produced as juveniles after operation of Lost Creek Dam.*

Fishery managers were also concerned about a change in the age composition of NP CHS produced in the Rogue SMU, because older fish (early migrants) contribute at greater rates to the river fisheries as compared to younger fish (late migrants). Passage estimates at Gold Ray Dam in the 1980s indicated that the abundance of older fish decreased in relation to the number of younger fish. Initially, managers suspected that increased harvest rates in the ocean fisheries was responsible for a decrease in age at return. Subsequently, a detailed assessment indicated that the maturity rates of NP CHS had changed, and that the change was linked to reservoir operation. Fish produced before reservoir operation matured at older ages as compared to counterparts produced after reservoir operation (Table 30). In contrast, no changes in maturation rates were detected for naturally produced fall Chinook salmon (NP CHF) that inhabited the Rogue River Basin (ODFW 1992).

Table 30. Estimated age composition of naturally produced spring Chinook salmon at time of river entry, estimated under a scenario of no age-selective fishing mortality in the ocean, for the 1972-76 brood years as compared to the 1977-89 brood years (ODFW 2000). Estimates represent projected returns to freshwater without age selective mortality that resulted from fisheries or the El Niño event of 1982-83. Data were arcsin transformed prior to testing for potential differences with a one-way analysis of variance.

Fish age	Mean	Mean proportion of production		*P* for difference
(years)	length	Pre-dam[a] (SE)	Post-dam[b] (SE)	(95% confidence)
Age 2	16 inches	0.029 (0.011)	0.076 (0.013)	0.034
Age 3	24 inches	0.062 (0.032)	0.124 (0.027)	0.166
Age 4	30 inches	0.362 (0.162)	0.494 (0.036)	0.049
Age 5	34 inches	0.467 (0.209)	0.273 (0.038)	0.013
Age 6	37 inches	0.080 (0.036)	0.014 (0.006)	0.006

[a] *These fish were produced as juveniles before operation of Lost Creek Dam.*
[b] *These fish were produced as juveniles after operation of Lost Creek Dam.*

A change in the growth rate of juvenile NP CHS in freshwater appeared to be a primary factor that accounted for the change in maturity rates. Juvenile growth rates increased, and the increase was linked to reservoir construction and operation (ODFW 2000). With the increase in growth rate, juveniles more quickly attained a size that may have triggered an active downstream migration as smolts. As a consequence of faster growth, juvenile NP CHS produced after reservoir operation entered the ocean earlier as compared to counterparts produced before reservoir operation (Table 31). In contrast, there was minimal change in CHS smolt size at the time of ocean entry (ODFW 2000).

Table 31. Comparisons of the mean date of ocean entry for naturally produced spring Chinook salmon produced before and during operation of Lost Creek Dam (ODFW 2000). Potential differences were assessed with t-tests. Data only includes fish that migrated to the ocean during the first year of life, the predominate life history of naturally produced spring Chinook salmon in the Rogue River. Dates of ocean entry could not be estimated for the 1981 and later brood years (ODFW 2000).

Fish age	Mean date of ocean entry		*P* for difference
(years)	Pre-dam broods[a] (SE)	Post-dam broods[b] (SE)	(95% confidence)
All ages	October 12 (6 days)	August 26 (7 days)	0.002
Age 4	September 11 (9 days)	August 20 (4 days)	0.054

[a] *These fish were produced as juveniles before operation of Lost Creek Dam, 1973-76 broods.*
[b] *These fish were produced as juveniles after operation of Lost Creek Dam, 1977-80 broods.*

Earlier dates of ocean entry were linked to the change in maturity rates among NP CHS in the Rogue SMU (ODFW 2000). This finding is commensurate with those of Hankin (1990) who found that Chinook salmon matured at younger ages when released as smolts earlier at hatcheries in northern California and Oregon. In addition, during ocean residence, probability of maturation for Chinook salmon is known to be affected by three factors: parental age (Hankin et al. 1993), sex of fish, and fish length (ODFW 2000). Among NP CHS in the Rogue SMU, only a small proportion of females mature at age 3 and none mature at age 2. Fish length appears to affect maturation probability through some type of physiological trigger mechanism. Because growth rates are greater in the ocean, as compared to freshwater, an earlier time of ocean entry will cause fish to be larger on any given date during ocean residence. The size of NP CHS in the ocean in late winter and early spring affects maturation probability. During the period, attainment of a larger size leads to a greater chance of maturity at a younger age (ODFW 2000). These findings for NP CHS fish were confirmed by analysis of coded-wire tagged CHS released at Cole M. Rivers Hatchery. Hatchery CHS released in June matured at the youngest ages, followed successively by counterparts released in August, September, October, and December (ODFW 2000). Hatchery CHS released in March as yearlings matured at the oldest ages.

Attempts have been made to try and restore key life history attributes for NP CHS in the Rogue SMU. Restoration measures have centered on adjustments to the temperature of water released from the reservoir because water temperature affected all of the key biological attributes previously described in this section. In the mid 1980s, the USACE concluded that the design of the turbidity conduit at the bottom of Lost Creek Lake allowed for sustained use of the conduit. Continual use of the turbidity conduit resulted in the release of the coldest water possible during the period that eggs and sac-fry of NP CHS incubated in the gravel. In addition, an ODFW research project was extended to determine whether decreased outflow temperatures, during late spring and early summer residence, would restore the historical age structure of NP CHS. Project findings indicated that fishery goals, related to restoration of life history attributes of NP CHS, could not be attained because of limited amounts of cold water that could be stored and retained in Lost Creek Lake (ODFW 2000). Because restoration goals of historical timing of fry emergence and historical age structure among adults collectively require more cold water than is available in the reservoir, a comprehensive model of water temperature is needed to identify management strategies that optimize the use of the limited supply of cold water stored in Lost Creek Lake (ODFW 2000).

To summarize this section, reservoir operations at Lost Creek Lake have a significant detrimental impact on the abundance and life history characteristics of NP CHS, and reservoir operations are clearly a primary factor that limits attainment of desired status. Of particular concern are the effects of the increase in water temperature during autumn and early winter when eggs and sac-fry of NP CHS incubate in the gravel. Consequently, in order to move the SMU towards desired status, consideration was given to possible actions that might return water temperatures during this period to levels more similar to those observed prior to the construction of Lost Creek Dam.

Simulation Model Used for Fishery Assessments: ODFW (2000) presented and discussed a simulation model for developed for Chinook salmon produced in the Rogue River Basin upstream of Gold Ray Dam. The model was designed for three primary purposes: (1) simulations should result in more effective recommendations for reservoir management through a synthesis of the multitude of project findings, (2) simulations should identify the primary factors that affect the production and harvest of Chinook salmon in the Rogue River, and (3) simulations should identify areas where additional work may improve understanding of population dynamics of Chinook salmon produced in the Rogue River.

The model structure reflects the basic life history of NP CHS, NP CHF produced upstream of Gold Ray Dam, and hatchery CHS origin during periods of freshwater and ocean residence (Figure 15). The model simulates population and harvest parameters for one brood year based on selected values of input variables, because it was not possible to quantitatively simulate the primary factors that could account for the wide variations in ocean survival rates. Regression equations composed the primary components of the model. It was assumed that the regressions were independent of each other for the purposes of simulation analyses. In actuality, regressions were not independent of each other because many were developed with the same sets of independent variables that included the same sources of measurement errors.

A simulation run with mean values for input variables indicated that the model has a relatively high degree of precision. Coefficients of variation associated with most of the key output parameters were less than 20% (Table 32). Variability among output responses were highest for predictions of pre-spawning mortality. Variability among output responses were least for predictions of ocean harvest, freshwater abundance, freshwater harvest, and spawner abundance. The predicted outputs from model run with mean input values exhibited a high degree of precision because the simulations were run under the assumption of constant rates of survival in the ocean. Consequently, the precision of the outputs are primarily affected by environmental conditions in freshwater. As the primary purpose of the project was to develop optimal strategies for reservoir releases, the precision appeared to be sufficient for that particular purpose.

Sensitivity analyses suggested that the production and harvest of Chinook salmon produced in the upper portion of the Rogue River was most sensitive to variations in (1) the survival rate, and number, of smolts released from Cole M. Rivers Hatchery, (2) the intensity of peak flow during the period that eggs and sac-fry incubated in the gravel, (3) the number of females that spawned naturally, and (4) the harvest rate of immature age 3 fish in the ocean (ODFW 2000). Predictions of harvest and production were less affected by variations in other input variables.

Additional sensitivity analyses also suggested that spawner abundance appeared to be most sensitive to changes in (1) the survival rate of smolts released from Cole M. Rivers Hatchery, (2) the intensity of peak flow, and water temperature, during the period that eggs and alevins incubated in the gravel, (3) the number of females that spawned naturally, and (4) water temperature during late summer when adult fall Chinook salmon are susceptible to pre-spawning mortality (ODFW 2000). In addition, the analyses also suggested that the number of Chinook salmon that died prior to spawning was most sensitive to variations in water temperature during the late spring and summer when adult fish were present in the river (ODFW 2000).

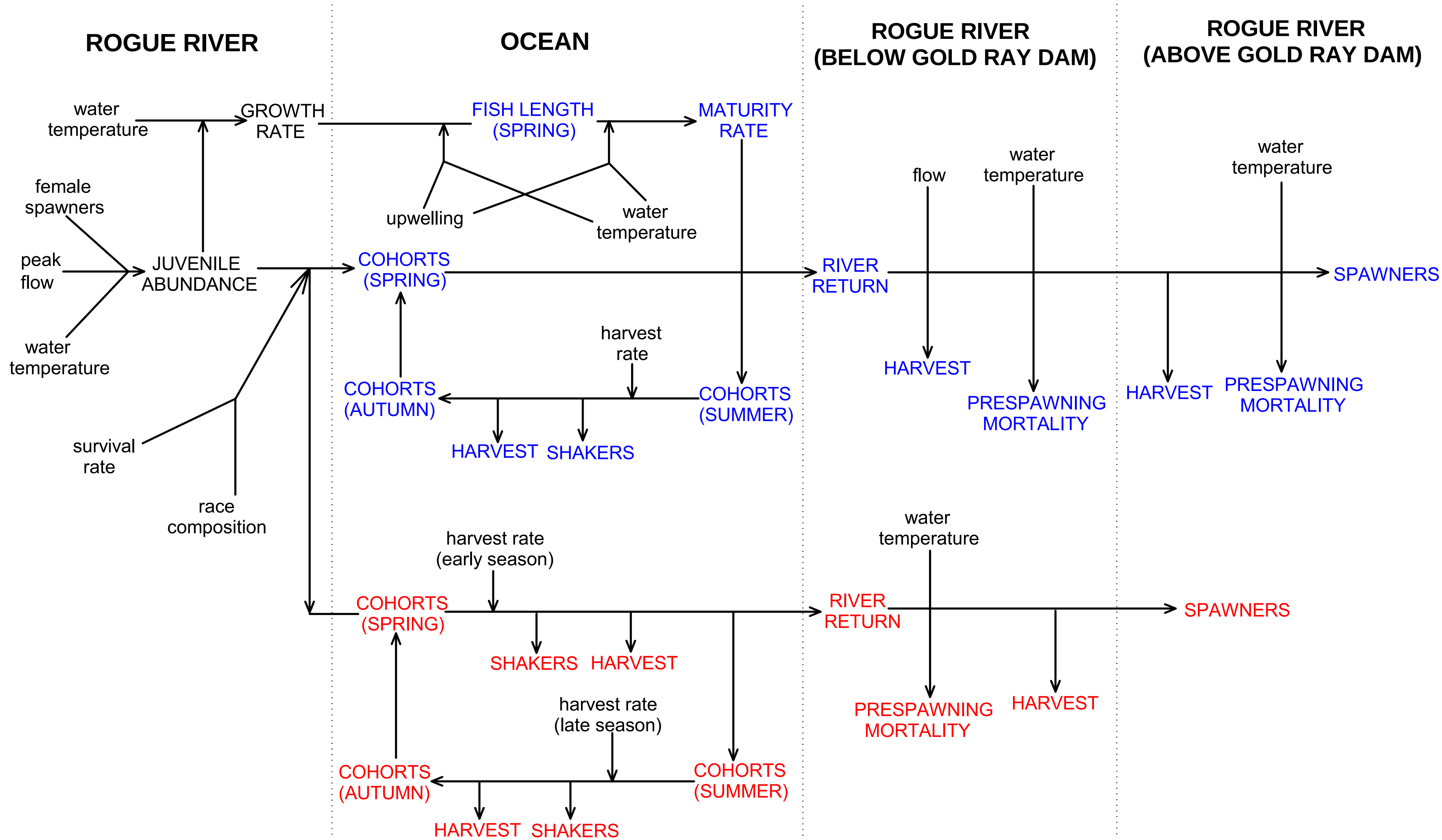

Figure 15. Schematic of the simulation model for naturally produced Chinook salmon produced in the Rogue River upstream of Gold Ray Dam (ODFW 2000). The upper half of the page portrays spring Chinook salmon (blue text), while the lower half of the page portrays fall Chinook salmon (red text). Input variables are in small case type and output variables are in large case type.

Table 32. Variability estimates of model outputs for a simulation with average values for input parameters.

Output parameter	Mean prediction	Coefficient of variation	95% confidence boundary Lower	Upper
NATURALLY PRODUCED SPRING CHINOOK SALMON				
Ocean harvest (n)	10,405	10%	8,414	12,536
Freshwater return (n)	16,143	10%	13,204	19,429
Freshwater harvest (n)	4,165	11%	3,224	5,064
Freshwater harvest rate (p)	0.26	7%	0.22	0.30
Pre-spawning mortality (n)	681	22%	419	992
Pre-spawning mortality rate (p)	0.04	12%	0.03	0.05
Spawner abundance (n)	11,297	10%	9,241	13,694
Female spawners (n)	3,966	11%	3,093	4,788
SPRING CHINOOK SALMON OF HATCHERY ORIGIN				
Ocean harvest (n)	18,196	6%	16,219	19,983
Freshwater return (n)	34,789	5%	32,100	38,257
Freshwater harvest (n)	6,351	6%	5,660	17,160
Freshwater harvest rate (p)	0.18	6%	0.16	0.20
Pre-spawning mortality (n)	2,621	20%	1,827	3,825
Pre-spawning mortality rate (p)	0.08	18%	0.05	0.11
Hatchery return (n)	24,527	6%	22,157	27,632
Proportion among spawners (p)[a]	0.07	10%	0.06	0.09
ALL CHINOOK SALMON (WILD AND HATCHERY)				
Ocean harvest (n)	32,360	5%	29,273	35,556
Freshwater return (n)	57,343	5%	52,438	62,496
Freshwater harvest (n)	11,056	7%	9,693	12,573
Freshwater harvest rate (p)	0.19	6%	0.17	0.22
Pre-spawning mortality (n)	4,312	17%	3,092	5,718
Pre-spawning mortality rate (p)	0.08	14%	0.06	0.10
Spawner abundance (n)	17,448	8%	14,868	20,112
Female spawners (n)	6,362	8%	5,320	7,308
Race composition of spawners (p)[b]	0.30	10%	0.26	0.34

[a] *Among spring Chinook salmon spawning naturally.*
[b] *Proportion of wild fish estimated to be fall Chinook salmon.*

Results from the sensitivity analyses indicated that the simulation model for Chinook salmon can be used to evaluate alternative strategies for reservoir management, and can also be used to determine how to optimize the release of cold water stored in the hypolimnion of the reservoir. While the sensitivity analyses indicated that reservoir release strategies, that reduce water temperature of the river, are beneficial for almost the entire year. However, there is only a limited supply of hypolimnetic storage available for that purpose.

Water temperature of the Rogue River is affected by the volume of flow, location on the river, air temperature, and water temperature at release from the reservoir (USACE 1991). Flow can vary greatly among years depending on the water yield from the basin. Hamlin-Tillman and Haake (1990) simulated water temperature in the Rogue River for a low flow year (1981), an average flow year (1986), and a high flow year (1984). Similar simulations are needed for a variety of reservoir management strategies in order to determine how to most effectively use the limited amount of hypolimnetic storage in Lost Creek Lake. At a minimum, three management strategies should be simulated: (1) use of hypolimnetic storage during late spring and summer to minimize pre-spawning mortality among adult Chinook salmon, (2) conservation of hypolimnetic storage for release in autumn to minimize the accelerated development of Chinook salmon embryos, and (3) release of hypolimnetic storage partially during summer and partially during autumn. These simulations must be completed before the fishery model can be used to quantitatively identify optimal reservoir management strategies to protect and enhance fishery resources in downstream areas.

Comparisons to Other Populations

The abundance of NP CHS in the Rogue SMU has greatly decreased during the last 20 years. One possible cause might be a regional decrease in the survival rates of juvenile Chinook salmon during the period of initial ocean residence. Cyclical patterns in survival rates of regional groups of Pacific salmon are related to changes in current patterns that typify various regions of the ocean (Beamish et al. 2004). Abundance trends among geographically proximal populations should roughly track each other, unless limiting factors differentially affect one or more of the populations (Pyper et al. 2005). Comparisons of abundance trends indicated that NP CHS in the Rogue SMU declined in abundance as compared to (1) the population of NP CHS in the North Umpqua River, (2) the population of NP CHF in the middle and lower portion of the Applegate River (Rogue River Basin), and (3) the population of NP CHF in the Rogue River upstream of Gold Ray Dam.

The Umpqua River Basin is located immediately north of the Rogue River Basin, and the Umpua and Rogue rivers are the only two rivers in Oregon that arise in the Cascade Mountain Range and flow west to the Pacific Ocean through the Coast Range of Oregon. Spring Chinook salmon are endemic in both the North Umpqua River and the South Umpqua River. These populations and the CHS population in the Rogue River Basin are grouped in different Evolutionarily Significant Units based on genetic assessments (Myers et al. 1998). However, there is likely some commonality among factors that affect the natural production of spring Chinook salmon in both basins because of (1) similar patterns of the volume and timing of water yield, (2) similar patterns for age at smolting and age at maturity (Nicholas and Hankin 1988), and (3) there is significant spatial overlap in the contribution of immature fish to the ocean fisheries (Nicholas and Hankin 1988; Lewis 2005).

Covariation in returns of NP CHS to the North Umpqua and Rogue rivers was first identified by ODFW (2000). During 1946-80, the Rogue River component, of the combined annual returns to the fish counting stations on both rivers, averaged 83% (95% CI = ± 2%). These years were grouped because returns to Rogue River were composed of fish produced as juveniles prior to the operation of Lost Creek Dam (ODFW 2000). During 1981-2006, the Rogue River component averaged 67% (95% CI = ± 5%) of the combined returns to both rivers. The change in the Rogue River component (83% in 1946-80 as compared to 67% in 1981-2006) of the average returns was significant ($P < 0.001$) based on a t-test of arc-sin transformed data. This result indicated that NP CHS returns in the Rogue River differentially decreased as compared to NP CHS returns to the North Umpqua River, during the time periods in question; and that the timing of the change was associated with the construction and operation of Lost Creek Dam.

The change was also evident from a visual examination of the data. During the 1940s through the early 1980s, passage estimates of NP CHS at the fish counting station at Gold Ray Dam consistently exceeded the passage estimates of counterparts at the fish counting station at Winchester Dam on the North Umpqua River (Figure 16). In contrast, after 1990, there were four years when similar numbers of NP CHS passed the counting stations in both rivers (Figure 16). Again, this change indicates that the abundance of NP CHS in the Rogue River decreased as compared to the abundance of NP CHS in the North Umpqua River.

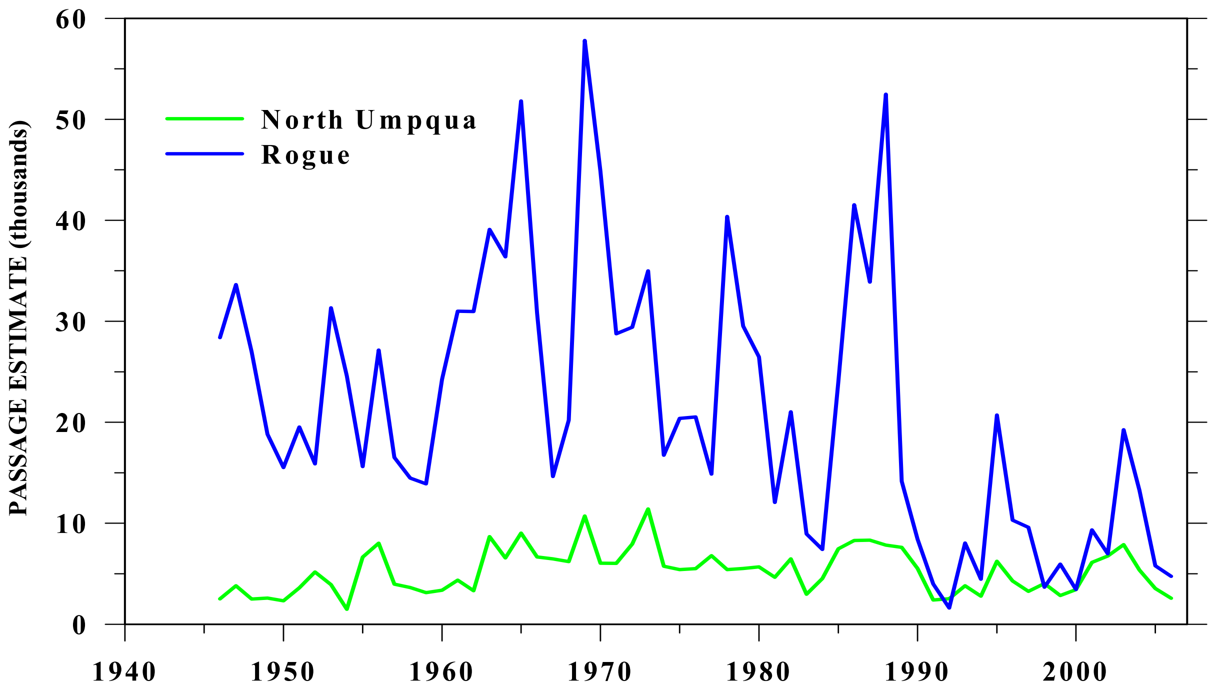

Figure 16. Estimated number of naturally produced spring Chinook salmon that passed fish counting stations on the North Umpqua and Rogue rivers, 1946-2005.

Temporal trends in fish abundance can also be assessed by comparing the returns of NP CHS at Gold Ray Dam to other populations of naturally produced Chinook salmon in nearby areas of the same ecoregion. From 1977 through 2005, ODFW counted the numbers of spawned carcasses of CHF that spawned in areas of the Rogue and Applegate rivers near Grants Pass. No CHF of hatchery origin were released in any nearby areas and scale analyses confirmed that few CHF were of hatchery origin. During 1977 through 1989, the median difference between returns of NP CHS to Gold Ray Dam and the number of CHF carcasses recovered was 16,034 fish (more NP CHS returned to Gold Ray Dam. In contrast, during 1990-2005, the median difference between the two metrics was only 2,356 fish. A Mann-Whitney Rank Sum Test indicated that the difference was statistically significant ($P < 0.001$).

This change indicates that the abundance of NP CHS in the Rogue River decreased as compared to the abundance of NP CHF that spawned in nearby areas of the Rogue and Applegate rivers. The change was also evident from a visual examination of the data. The number of CHF carcasses recovered during the surveys was consistently lower than the passage estimates of NP CHS during the 1970s through the mid-1980s (Figure 17). However, from the late 1990s onward, carcass counts of NP CHF were about equal to, or exceeded, numbers of NP CHS that passed Gold Ray Dam during most years (Figure 17). No statistical inferences could be made about the effects of Lost Creek Dam because there were only four years of data (1977-80) when pre-dam broods dominated returns of NP CHS to Gold Ray Dam. However, there was a considerable amount of data by which to make comparisons of returns of NP CHS and NP CHF at Gold Ray Dam.

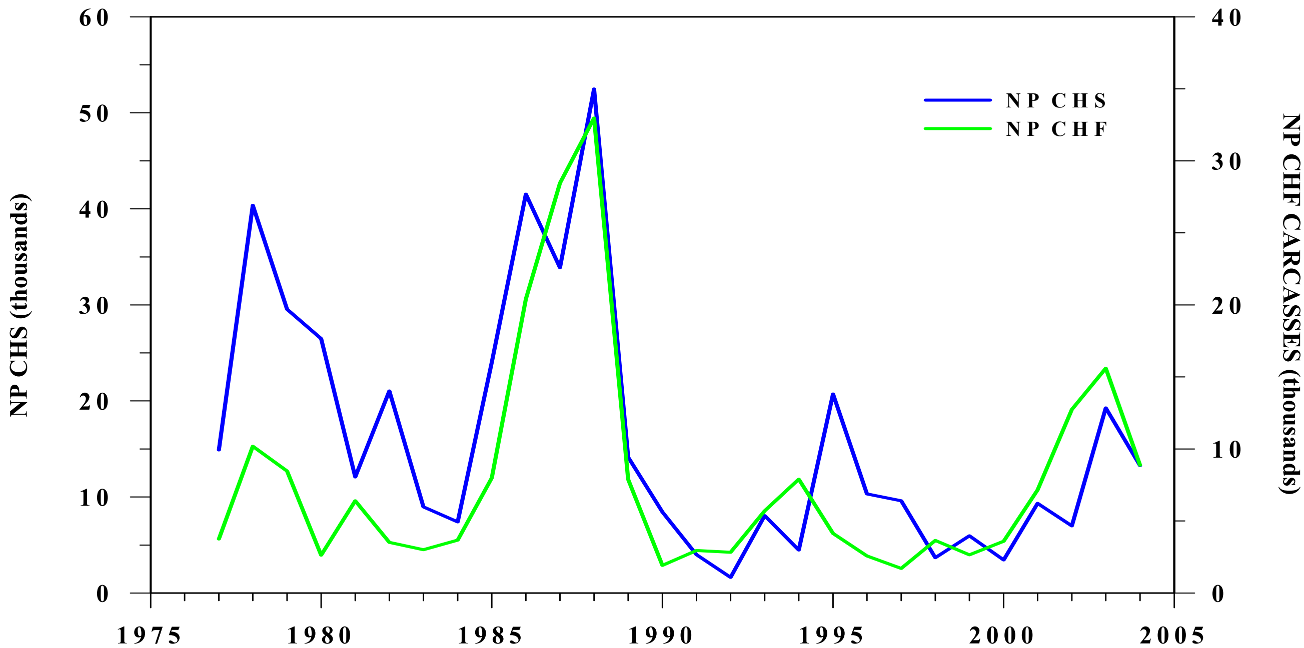

Figure 17. Estimated number of naturally produced spring Chinook salmon (NP CHS) that passed Gold Ray Dam as compared to the number of naturally produced fall Chinook salmon (NP CHF) recovered as spawned carcasses in standard survey areas farther downstream in the Rogue River Basin.

The number of NP CHS that passed Gold Ray Dam consistently exceeded the number of NP CHF during 1940s through the 1980s (Figure 18). However, during years after 1990, the annual returns for each race of naturally produced fish has been approximately equal (Figure 18). The relative abundance of CHF, among naturally produced Chinook salmon that passed Gold Ray Dam, averaged 4% (95% CI = ±1%) in the 1940s, 7% (95% CI = ±2%) in the 1950s, 5% (95% CI = ±2%) in the 1960s, 11% (95% CI = ±4%) in the 1970s, 21% (95% CI = ±5%) in the 1980s, 48% (95% CI = ±12%) in the 1990s, and 62% (95% CI = ±8%) during 2000-06. These changes suggest that the production of NP CHF increased, while the production of NP CHS decreased, in areas upstream of Gold Ray Dam.

The increase in the relative abundance of NP CHF in the area upstream of Gold Ray Dam was greatest after Lost Creek Dam became operational. During the period when NP CHS returns were dominated by broods produced before reservoir construction and operation (1942-80 returns) NP CHF composed an average of 7% (95% CI = ±2%) of the naturally produced Chinook salmon that passed Gold Ray Dam. During the period when NP CHS returns were dominated by broods produced after reservoir construction and operation (1981-2006 returns) NP CHF composed an average of 43% (95% CI = ±8%) of the naturally produced Chinook salmon that passed Gold Ray Dam. This change was associated with changes in reservoir operations that negatively impacted the production of NP CHS (ODFW 2000), but positively impacted the production of NP CHF (ODFW 1992).

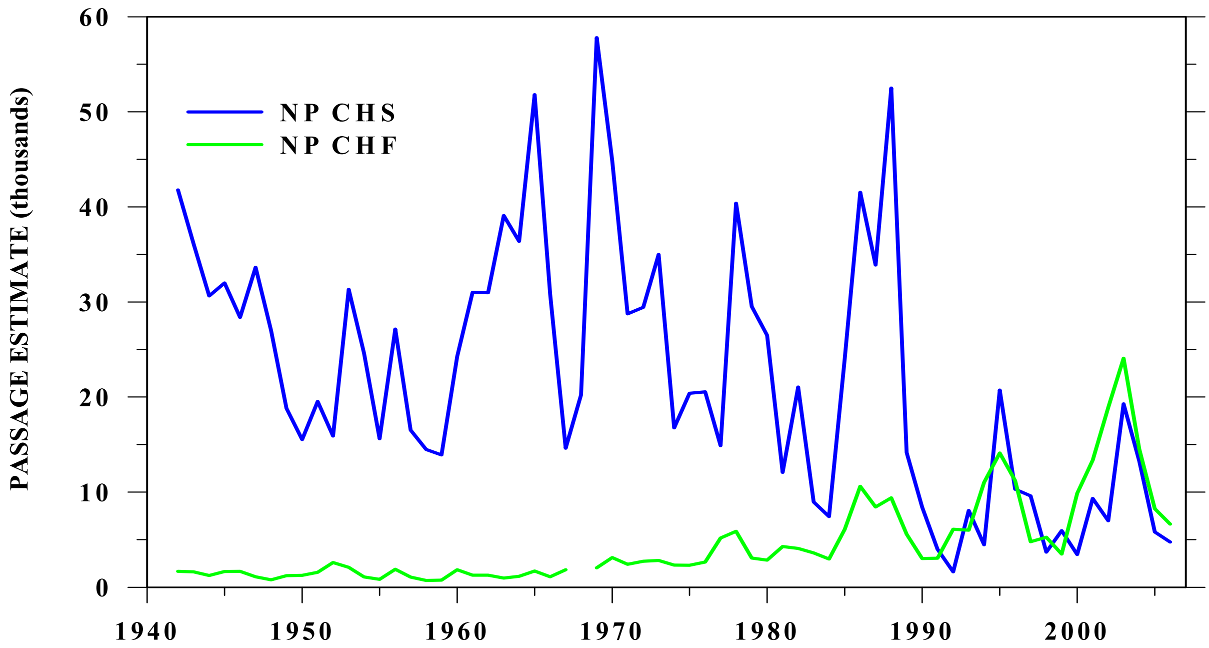

Figure 18. Estimated passage of naturally produced spring (NP CHS) and fall (NP CHF) Chinook salmon at Gold Ray Dam, 1942-2006.

To summarize this section, the differential decline in the abundance of NP CHS in the Rogue SMU, as compared to other nearby populations of naturally produced Chinook salmon, clearly indicates that one or more limiting factors differentially affected the abundance of NP CHS in the Rogue SMU. Decreased abundance of NP CHS, coupled with increases of nearby populations of NP CHS and NP CHF, should lead to serious consideration of those potential limiting factors that have differential effects on both races of naturally produced Chinook salmon produced upstream of Gold Ray Dam. Limiting factors that clearly have differential affects on NP CHS, as compared to other populations of naturally produced Chinook salmon, include (1) blockage of habitat that resulted from construction of Lost Creek Dam (*see* **Habitat Volume**, page 29), (2) changes in river flow and water temperature that resulted from reservoir operation (*see* **Key Biological Attributes Affected By Reservoir Operation**, page 59 and **Simulation Model Used for Fishery Assessments,** page 63), and (3) harvest rates in the freshwater fisheries (*see* **Fisheries**, page 53).

ALTERNATIVE MANAGEMENT STRATEGIES

The Native Fish Conservation Policy requires that conservation plans shall illustrate a range of options for recovery strategies, fisheries and the responsible use of hatchery produced fish. Accordingly, a primary goal of the planning process was to develop alternatives that (1) if implemented, would have a reasonable chance for attainment of desired status for NP CHS in the Rogue SMU (*see* **DESIRED BIOLOGICAL STATUS**, page 12) and (2) would encompass a broad range of potential management strategies. A formidable number of potential management actions were considered during the planning process. Each potential management action was categorically linked to those factors that limit, or could limit, attainment for each element of desired status (**APPENDIX H** and **APPENDIX I**). Potential limiting factors and potential management actions were also assigned alphanumeric codes in order to aid in cross-referencing singular management strategies embedded within the various alternatives.
As outlined in the previous section, the primary factors that appear to limit, or may in the future

limit, attainment of desired status are (1) a limited amount of spawning habitat, (2) changes in river flow and water temperature that result from reservoir operation, and (3) fishery impact rates on early-run and mid-run NP CHS. Each of these factors can be managed to some degree by natural resource agencies. Initial attempts to develop management alternatives focused on options related to addressing the three primary limiting factors.

This approach resulted in the development of nine alternative suites of management strategies (Table 33). Probability of attainment of desired status varies considerably among the various alternatives, yet no objective means of ranking suite efficacy could be developed. As a result, the alternatives are presented in sequential order, without any implications in relation to a ranking of expected outcome. All nine alternatives were considered by each of the advisory committee teams. The two alternatives which received some support from members of the public advisory committee, Alternative 8 and Alternative 9, are discussed below in greater detail.

Both Alternative 8 and Alternative 9 describe singular management strategies that are specifically directed at the three primary limiting factors that must be addressed in order to have a reasonable chance of attaining desired status. In addition, both alternatives describe singular management strategies that are specifically designed to address two secondary (non-primary) limiting factors: predation and naturally spawning CHS of hatchery origin. The category of "secondary limiting factor" includes those factors for which impacts remain unclear. Both Alternative 8 and Alternative 9 are comprised of five management strategies that have some degree of commonality.

Alternative 8

While this suite of management strategies was not preferred by the Oregon Fish and Wildlife Commission, it was preferred by five advisory committee members who represented the public. The alternative incorporates various elements of input received from the entire advisory committee and from ODFW during the course of plan development. Primary features of the alternative include (1) design reservoir management strategies with an emphasis on the protection and enhancement of NP CHS, (2) expand natural spawning habitat for NP CHS, (3) increase the production of NP CHS by the transportation of adult CHS into areas currently not accessible to natural spawners, (4) establish predator control measures, (5) establish harvest regulations designed to limit the annual harvest to no more than three NP CHS for each angler, (6) establish a no-harvest zone for NP CHS, and (7) minimize the risk of genetic changes among naturally produced fish.

There is a reasonable chance that adoption of this alternative will result in the attainment of desired status, although efficacy is difficult to assess because expected harvest rates in the freshwater fisheries cannot be projected. Increased production of juvenile NP CHS in non-historical habitat is likely to increase returns of naturally produced adult fish, provided that transported adults survive at high rates. Assuming a sufficient number of transported adults survive through spawning, the increase in the production of NP CHS should compensate for continued selective harvest of early-run and mid-run NP CHS in the freshwater fisheries (*see* **Fisheries**, page 53).

A complete description of proposed management strategies and allied specific actions can be found in **APPENDIX J**.

Table 33. Summary of the primary features that compose the nine alternative suites of management strategies developed during the planning process. Early-run spring Chinook salmon pass Gold Ray Dam before June, mid-run spring Chinook salmon pass Gold Ray Dam during June, and late-run spring Chinook salmon pass Gold Ray Dam after June. Singular management actions associated with each alternative can be found in **APPENDIX J**.

Alternative 1

a. Limit NP CHS to current habitat
b. Reservoir management recommendations designed solely for NP CHS
c. Terminate freshwater harvest of NP CHS

Alternative 2

a. Limit NP CHS to current habitat
b. Reservoir management strategies designed for emphasis on NP CHS
c. Terminate freshwater harvest of NP CHS

Alternative 3

a. Expand natural spawning habitat for NP CHS
b. Reservoir management strategies designed for emphasis on NP CHS
c. Freshwater harvest opportunity for late-run NP CHS

Alternative 4

a. Establish juvenile production in areas not accessible to adult CHS
b. Reservoir management strategies designed for emphasis on NP CHS
c. Freshwater harvest opportunity for mid-run and late-run NP CHS

Alternative 5

a. Expand natural spawning habitat for NP CHS
b. Establish juvenile production in areas not accessible to adult CHS
c. Reservoir management strategies designed for emphasis on NP CHS
d. Freshwater harvest opportunity for mid-run and late-run NP CHS

Alternative 6

a. Expand natural spawning habitat for NP CHS
b. Reservoir management strategies designed for emphasis on NP CHS
c. Establish freshwater sanctuary area (no fishing) for early-run NP CHS

Alternative 7

a. Expand natural spawning habitat for NP CHS
b. Reservoir management strategies designed for emphasis on NP CHS
c. Specialized regulations for freshwater CHS fisheries

Alternative 8

a. Expand natural spawning habitat for NP CHS
b. Establish juvenile production in areas not accessible to adult CHS
c. Reservoir management strategies designed for emphasis on NP CHS
d. Specialized regulations for freshwater CHS fisheries
e. Increased control of predators

Alternative 9

a. Expand natural spawning habitat for NP CHS
b. Reservoir management strategies designed for emphasis on NP CHS
c. Regional regulations for freshwater CHS fisheries
d. Adjust production goals at Cole M. Rivers Hatchery

Alternative 9

This alternative was preferred by three members of the public advisory committee, five members of the technical advisory committee, ODFW, and by the Oregon Fish and Wildlife Commission. The alternative incorporates various elements of input received from the entire advisory committee during the course of plan development. Primary features of the alternative include (1) design reservoir management strategies with an emphasis on the protection and enhancement of NP CHS, (2) expand natural spawning habitat for NP CHS, (3) limit harvest of early-run and mid-run NP CHS while providing freshwater harvest opportunities for NP late-run CHS, (4) establish a no-harvest zone for NP CHS, (5) minimize complexity of angling regulations, and (6) increase production goals at Cole M. Rivers Hatchery to meet the intent of mitigation goals and to offset reduced harvest opportunities for early-run and mid-run NP CHS. Unless otherwise stated, all actions outlined in the following section are directed to ODFW.

There is a reasonable chance that adoption of this alternative will result in the attainment of desired status. Reductions in freshwater harvest rates of early-run and mid-run NP CHS are likely to lead to total (ocean + freshwater) harvest rates that should rarely exceed 40% for completed broods (*see* **Fisheries**, page 53). In addition, strategies designed for the freshwater fisheries are likely to decrease the selective harvest of early-run fish as compared to late-run fish (*see* **Fisheries**, page 53).

Specific actions are listed within each management strategy. Some brief explanatory information is provided where it may be not clear how the action item directly links with the management strategy. Further information on proposed actions can be found in **APPENDIX I**.

<u>**Management Strategy 9.1.**</u> **Implement actions designed to ensure that Lost Creek Lake is managed to maintain a viable population of naturally produced spring Chinook salmon that exhibits, as much as possible, historical life history characteristics. Continue actions designed to protect habitat in the Rogue River downstream of Lost Creek Lake. The intent of this strategy is to maintain and enhance quantity and quality of habitat available to naturally produced spring Chinook salmon that spawn in the Rogue River Basin.**

This management strategy addresses the effects of operation of Lost Creek Dam on NP CHS. Dam operation and allied reservoir management is a primary factor which currently limits attainment of desired status (*see* **Habitat Quality**, page 29, **Key Biological Attributes Affected by Reservoir Operation**, page 59, **Simulation Model Used for Fishery Assessments**, page 63**,** and **Comparisons to Other Populations**, page 67). Actions described

in this management strategy were crafted based on the conclusion by the advisory committee, and by ODFW, that Lost Creek Lake would continue to be managed by the USACE with a primary objective of annual filling of the reservoir and a usual release of 180,000 acre-feet of conservation storage annually. Other options for reservoir management were also considered by the advisory committee and ODFW, and are described in **APPENDIX K**.

Assumptions and Rationale

1. As outlined by the Congress of the United States of America, enhancement of fishery resources in downstream areas is a primary authorized purpose by which Lost Creek Lake should be managed.

2. As outlined by the Congress of the United States of America, fishery enhancement, irrigation supply, and municipal and industrial supply are primary authorized purposes of equal priority, and are of subservient priority only during those operations designed to prevent flooding in downstream areas.
3. Findings that resulted from a long-term fishery research project (ODFW 2000); funded by the USACE, provide reliable estimates of the impacts of reservoir operations on NP CHS produced in areas downstream of Lost Creek Lake.
4. Implementation of recommendations for reservoir management strategies at Lost Creek Lake, presented by ODFW (2000), are advisable methods to protect and enhance NP CHS produced in downstream areas.
5. Reservoir management strategies will continue to be refined as additional information becomes available.
6. The water control manual for Lost Creek Lake can be revised to incorporate measures designed to ensure that operational decisions recognize downstream needs of fishery resources as a primary authorized project purpose.
7. The USACE has the authority to manage Lost Creek Lake at elevations below the maximum elevations outlined by the United States Congress.
8. Quality of riparian zones along the Rogue River will continue to decline as human population numbers increase in the general area.
9. Gravel quality and quantity will decrease in areas downstream of Lost Creek Lake as a result of gravel being trapped at the upstream end of the reservoir.

Actions

Action 1.1. Request that Lost Creek Lake be managed to reduce the intensity of peak flows during the period eggs and sac-fry incubate in the gravel. The purpose of this action is to increase egg-fry survival rates and to minimize rates of spawning gravel loss below Lost Creek Lake.

Action 1.2. Request that Lost Creek Lake be managed to release the coldest water possible during egg and sac-fry incubation. The purpose of this action is to minimize the early emergence of fry from the gravel in order to increase fry survival rates. Progeny of early-run and mid-run NP CHS will benefit most from this action.

Action 1.3. Request development of USACE simulation models for water temperature in order to determine release strategies that result in optimal strategies for reservoir management under a variety of water years. The purpose of this action is to determine optimal use of the limited supply of cold hypolimnetic storage during years of varied water yield.

Action 1.4. Request implementation of procedures designed to minimize the potential dewatering of juveniles in areas downstream of Lost Creek Lake. The purpose of this action is to increase the survival rates of NP CHS fry.

Action 1.5. Request that Lost Creek Lake be managed to ensure minimal flow augmentation during the spawning period. The purpose of this action is to (1) minimize the number of CHS redds dewatered during the succeeding season of reservoir filling, (2) decrease passage of CHF upstream of Gold Ray Dam, and (3) conserve cold hypolimnetic storage for later release after all eggs of NP CHS spawners have been deposited.

Action 1.6. Request that Lost Creek Lake be managed to minimize passage of CHF upstream of Gold Ray Dam. The purpose of this action is to minimize potential (1) interbreeding with NP CHS, (2) competition with NP CHS for spawning sites, and (3) excavation of NP CHS redds. This action is commensurate with Action 1.6.

Action 1.7. Request that Lost Creek Lake be managed to minimize potential for disease outbreaks in areas downstream of Lost Creek Lake. The purpose of this action is to increase survival rates of migrating adult NP CHS.
Action 1.8. Request USACE restoration and maintenance of NP CHS spawning habitat in the area between Lost Creek Lake and Shady Cove. The purpose of this action is to mitigate for the loss of spawning gravel trapped within Lost Creek Lake.
Action 1.9. Develop recommendations for reservoir release strategies on a seasonal and annual basis, and submit those recommendations to the USACE through the Oregon Department of Water Resources. The purpose of this action is to ensure that fishery management objectives interface with releases from Lost Creek Lake.
Action 1.10. Request an update of the water control manual for Lost Creek Lake, and support USACE efforts to incorporate those revisions designed to protect and enhance fishery resources in downstream areas. The purpose of this action is to provide better guidance to reservoir regulators, especially ones newly assigned to the position(s).
Action 1.11. Request that USACE employees, who work on reservoir management issues for Lost Creek Lake, be oriented on relevant fishery issues and the relationships between reservoir management actions and fishery management objectives.
Action 1.12. Provide technical assistance, as requested by the USACE, on reservoir management issues for Lost Creek Lake. The purpose of this action is to ensure that fishery management objectives are considered during development of reservoir management plans.
Action 1.13. Continue to support improvements of fish passage facilities. The purpose of this action is to increase the survival rates of migrants juvenile and adult NP CHS.
Action 1.14. Continue to comment on permit applications that have the potential to affect habitat quality and quantity. The purpose of this action is to minimize deleterious effects of development on aquatic habitat and riparian zones.
Action 1.15. Develop a program designed to inform landowners about measures that help protect aquatic habitat and riparian zones.

Management Strategy 9.2. Enhance the production of naturally produced spring Chinook salmon in Big Butte Creek. The intent of this strategy is to increase the amount of habitat available for the production of naturally produced spring Chinook salmon.

This management strategy addresses the limited amount of spawning habitat that currently produces NP CHS. The relatively small amount of spawning habitat is a primary factor which currently limits attainment of desired status (*see* **Habitat Volume**, page 29 and **Comparisons to Other Populations**, page 67).

Assumptions and Rationale

1. Improved upstream passage in Big Butte Creek will significantly increase the production of NP CHS.
2. Life history characteristics of fish produced within expanded habitat in Big Butte Creek will be similar to those exhibited by fish produced in nearby areas of the Rogue River before construction of Lost Creek Dam.

Actions

Action 2.1. Improve upstream passage for adult CHS at a partial natural barrier located in the lower mile of Big Butte Creek. The purpose of this action is to increase the amount of spawning habitat for NP CHS.

<u>Action 2.2.</u> Obtain additional water allocations that would be dedicated to the increase of flow in Big Butte Creek during 15 September through 15 October. The purpose of this action is to increase the amount of spawning habitat for NP CHS. Additional water allocations would have to come from transfer, purchase, or leasing of current water rights as Big Butte Creek is fully appropriated for water withdrawals.
<u>Action 2.3.</u> Identify the potential to improve CHS spawning habitat in Big Butte Creek.
<u>Action 2.4.</u> If warranted, based on findings from Action 2.5, improve spawning habitat in Big Butte Creek.

<u>Management Strategy 9.3.</u> Decrease rates of predation on naturally produced spring Chinook salmon. The intent of this strategy is to increase the survival rate of naturally produced spring Chinook salmon.

This management strategy addresses predation losses of NP CHS. Predation loss appears to be a secondary factor which currently contributes to the non-attainment of desired status (*see* **Predators**, page 38).

Assumptions and Rationale
1. Any reductions in introduced (non-native) predatory fishes are advantageous for native fishes.

Actions
<u>Action 3.1.</u> Develop a program designed to encourage fishing related mortality for non-native Umpqua pikeminnows.

<u>Management Strategy 9.4.</u> Manage fisheries to sustain productivity for all segments of the population of naturally produced spring Chinook salmon, with a secondary objective of increasing harvest opportunities for hatchery fish produced to mitigate for blocked habitat. The intent of this strategy is to ensure sustainability of the historical life history characteristics of naturally produced spring Chinook salmon while maximizing freshwater harvest opportunities for spring Chinook salmon of hatchery origin.

This management strategy addresses fishery impact rates on early-run and mid-run NP CHS. Fishery impacts on these two portions on the NP CHS populations is a primary factor which appears to currently limit attainment of desired status (*see* **Fisheries**, page 53).

Assumptions and Rationale
1. NP CHS mature at rates comparable to those estimated by ODFW (2000).
2. Ocean and river fisheries harvest CHS in an age-selective manner, and ODFW (2000) estimates of age-selective harvest rates are of reasonable accuracy.
3. River fisheries selectively intercept early-run CHS as compared to late-run counterparts (ODFW 2000), and that estimates of freshwater fishing mortality reported in this plan are of reasonable accuracy.
4. Spawner abundance goals and harvest rate goals established for CHF in the Klamath River Basin will remain unchanged over the lifetime of this plan.
5. Ocean distribution patterns of CHS and CHF of Klamath River Basin origin will not differentially change over the lifetime of this plan.
6. Future rates of ocean harvest will be about 15-20% for completed broods of NP CHS.
7. Methods developed to estimate the proportion of hatchery fish among spawners are of reasonable accuracy.

8. Harvest opportunities in the freshwater fisheries should be expanded when quantitative predictions indicate that (1) more than 15,000 NP CHS can be expected to pass Gold Ray Dam and (2) disease losses will be less than 10%.
9. In terms of pre-season expectations, expansion of harvest seasons is preferable as compared to reductions of harvest seasons.
10. It is in the public interest to minimize the complexity of regulations for freshwater fisheries.
11. Survival rates of NP CHS released by anglers can be significantly increased through a combination of increased enforcement and increased angler knowledge of appropriate handling procedures.
12. CHS of hatchery origin originated from naturally produced fish that volitionally swam into Cole M. Rivers Hatchery during the 1970s and exhibit, to some degree, life history characteristics that reflect that portion of the run that was blocked by construction of Lost Creek Dam (ODFW 2000).
13. The loss of harvest opportunities for NP CHS that resulted from construction of Lost Creek Dam, was to be mitigated by comparable harvest opportunities for hatchery fish.
14. Mitigation goals, as assessed by commercial and recreational harvest, have not been attained because of constraints to ocean fisheries and the tendency of hatchery fish to leave the Rogue River and enter Cole M. Rivers Hatchery rather than remain in the river during ongoing fisheries (ODFW 2000).
15. Among hatchery fish, CHS are harvested at greater rates than coho salmon (ODFW 1991; ODFW 2000).
16. Hatchery production will be consistent with the Fish Hatchery Management Policy of ODFW.
17. Reductions in the proportion of hatchery fish among natural spawners decrease the risk of genetic impacts on NP CHS.
18. About 90% of the early-run and mid-run NP CHS spawn upstream of Dodge Bridge.

Actions

Action 4.1. Employ regional (zone) regulations that allow for the harvest of naturally produced Chinook salmon to begin on 1 June downstream of Gold Ray Dam, and that allow for the harvest of naturally produced Chinook salmon during July and August in the area between Gold Ray Dam and Dodge Bridge. The area upstream of Dodge Bridge would be closed to the harvest of NP CHS. The purpose of this action is to ensure harvest rates on early-run, mid-run, and late-run NP CHS do not exceed 40% until attainment of desired status.

Action 4.2. Expand harvest opportunities for NP CHS in freshwater when returns to Gold Ray Dam are predicted to exceed 15,000 NP CHS and disease losses are predicted to be less than 10%. The purpose of this action is to increase harvest opportunities when the population exceeds the relevant desired status element.

Action 4.3. Support only those special regulations for freshwater fisheries that are critical to conservation needs for CHS. The purpose of this action is to increase the complexity of angling regulations only if warranted.

Action 4.4. Request increased enforcement of regulations established for freshwater fisheries that target CHS. The purpose of this action is to ensure appropriate protection for NP CHS.

Action 4.5. Promote ethical angling and proper techniques for catch and release of NP CHS. The purpose of this action is to increase the survival rate of NP CHS released by anglers.

Action 4.6. Revise spawning practices at Cole M. Rivers Hatchery to increase harvest rates on CHS of hatchery origin. The purpose of this action is to produce fish that will mature at older ages, which results in greater rates of harvest.

Action 4.7. Beginning with the 2009 brood year, replace the production of coho salmon at Cole M. Rivers Hatchery with an increase in the production of CHS smolts, except for the 50,000 coho salmon smolts needed for monitoring and evaluation purposes. This action will be initiated only if (1) hatchery fish compose less than 20% of the CHS that spawn naturally between Cole M. Rivers Hatchery and Rogue Elk Park, (2) the action is consistent with measures identified in a recovery plan to be completed for coho salmon in the Northern California - Southern Oregon Evolutionarily Significant Unit, and (3) the action is consistent with mitigation goals for the USACE Rogue Basin Project.

Management Strategy 9.5. Manage spring Chinook salmon of hatchery origin so as to minimize the risk of genetic changes among naturally produced fish and to maintain the genetic integrity, and life history characteristics, of that portion of the natural population that historically spawned in upstream areas prior to the construction of Lost Creek Dam. The intent of this strategy is to maintain the genetic integrity of naturally produced spring Chinook salmon.

This management strategy addresses the potential risk of hatchery fish to NP CHS. Natural spawning by hatchery fish is a secondary factor which might contribute to the non-attainment of desired status. The current level of impact is very difficult to assess for NP CHS in the Rogue SMU (*see* **Hatchery Fish**, page 50), but may become more apparent as additional research is completed on other populations of salmonids.

Assumptions and Rationale

1. Reductions in the proportion of hatchery fish among natural spawners decrease the risk of genetic impacts on NP CHS.
2. Methods developed to estimate the proportion of hatchery fish among CHS spawners are of reasonable accuracy.
3. Projections under revised regulations for freshwater fisheries indicate that the spawner composition will average about 10% hatchery fish annually.
4. Brood stock selection of CHS at Cole M. Rivers Hatchery should continue to reflect the life history characteristics of that portion of the NP CHS population that spawned in upstream areas prior to the construction of Lost Creek Dam.
5. Changes in brood stock composition at Cole M. Rivers Hatchery are warranted to compensate for the selective harvest of older CHS.
6. The five mile area between Cole M. Rivers Hatchery and Rogue Elk Park remains a primary spawning area for early-run NP CHS.

Actions

Action 5.1. Block adult CHS at the primary outflow from Cole M. Rivers Hatchery, to increase the proportion of hatchery CHS that enter the collection facility at the hatchery. The purpose of this action is to reduce the proportion of hatchery fish among natural spawners.

Action 5.2. Revise spawning practices at Cole M. Rivers Hatchery so that maturity rates of hatchery CHS are similar to that portion of the natural population that historically spawned upstream of Lost Creek Dam. The purpose of this action is to (1) more closely mimic the age structure of older NP CHS that spawned historically upstream of the Lost Creek Dam site and (2) reduce the proportion of hatchery fish among natural spawners by increasing the harvest rates of hatchery CHS.

Action 5.3. In the event that hatchery fish compose more than 25% of the CHS that spawn between Cole M. Rivers Hatchery and Rogue Elk Park, employ additional measures to reduce the proportion of hatchery fish among natural spawners. The purpose of this action is to decrease the risk of potential negative impacts of hatchery fish on early-run NP CHS in their most important spawning area.

Action 5.4. Develop a hatchery program management plan for Cole M. Rivers Hatchery. The purpose of this action is to establish hatchery practices that will decrease the chance that the production and release of CHS will have negative impacts on NP CHS.

CRITERIA INDICATING DETERIORATION IN STATUS

As outlined in the Native Fish Conservation Policy, measurable criteria are needed as indicators of a significant deterioration in SMU status. Reaching conservation criteria would trigger a modification to management strategies that are adopted in this conservation plan (*see* **ALTERNATIVE MANAGEMENT STRATEGIES**, page 70). Revised strategies would be crafted to begin or to expand conservation actions, and could take a variety of forms depending upon (1) which criteria were reached and (2) the degree of deterioration in status.

A number of potential criteria were considered as potential indicators of status deterioration of NP CHS in the Rogue SMU. Of primary importance was the identification of conservation criteria that would ensure maintenance of genetic diversity, population productivity, and historical life history characteristics. Development of criteria related to elements included in the desired status statement (*see* **DESIRED BIOLOGICAL STATUS**, page 12) was advantageous because these attributes were already identified as primary indicators of SMU status. In addition, consideration was given to the length of time that provided an effective period by which to judge whether significant deterioration may have occurred. The statement of conservation status, outlined in Table 34, represents a final product that was preferred by all members (four) of the public advisory committee who expressed their preference on the matter, four of the five members of the technical advisory committee, and by ODFW.

Identification of the conservation criterion for fish abundance is considered to be of primary importance. The criterion outlined in Table 34 was chosen after review of the relationships between the abundance of parents and the abundance of progeny, for those years of relatively low spawner abundance. As previously described, three methods were developed to assess the relationship between parents and progeny (*see* **Spawner Abundance**, page 41). These relationships are shown in Figures 10-12.

The conservation criteria identified herein are intended to trigger modifications to spring Chinook management before the population has reached a level where SMU viability may be in jeopardy. These criteria were also developed with the knowledge that there is a level of uncertainty with some of the analyses that were used to develop the management strategies proposed. Currently, the sole metric of viability is the critical abundance threshold of 1,000 spawners (*see* **Viability of the Species Management Unit**, page 26). The abundance conservation criterion was chosen primarily based on the relationships between parents and progeny, and is well above the critical abundance threshold for SMU viability. This cushion between the threshold and the conservation criterion ensures that uncertainties related to the viability or management of NP CHS will not lead to irreversible impacts to the viability of the SMU.

Table 34. Conservation criteria indicative of a significant deterioration in the status of naturally produced spring Chinook salmon in the Rogue SMU.

1. **Abundance:** Passage of naturally produced spring Chinook salmon at Gold Ray Dam is less than 3,500 fish in any single year or averages less than 5,000 fish during any three year period.

2. **Migration Timing:** Less than 30% of the naturally produced adult[a] spring Chinook salmon pass Gold Ray Dam by 15 June. This criterion represents a running average over a period of three years.

3. **Age Structure:** Jacks[b] smaller than 24 inches compose more than 25% of the naturally produced spring Chinook salmon that pass Gold Ray Dam. This criterion represents a running average over a period of three years.

4. **Spawner Distribution:** Among naturally produced spring Chinook salmon that spawn during September, less than 30% spawn upstream of the Highway 62 bridge in Shady Cove. This criterion represents a running average over a period of three years.

5. **Spawner Composition:** Hatchery fish compose more than 25% of naturally spawning spring Chinook salmon. This criterion represents a running average over a period of two years.

[a] *Adults are defined as fish greater than, or equal to, 24 inches in length.*
[b] *Jacks are defined as fish less than 24 inches in length.*

As described in the Native Fish Conservation Policy, realization of any criteria outlined in Table 34 could trigger a temporary modification of management strategies, or actions, implemented as part of this conservation plan for CHS in the Rogue SMU. Any temporary modification of strategies, or actions, should be dependent on which conservation criteria were realized, the current status of the SMU, and the projected status of the SMU during subsequent years. In addition, temporary modifications to management strategies may be employed when preseason or in-season forecasts indicate there is a good chance that conservation criteria will likely be realized. Adaptive management will be employed by ODFW as a means to identify and implement temporary revisions to management strategies (*see* **Adaptive Management**, page 84).

Revised strategies may be crafted to improve performance, or some strategies may be terminated and be replaced by management strategies that are determined to be more effective. Some strategies or actions that were previously identified, but not adopted as part of this plan, may be employed under a scenario of significant deterioration of SMU status. Examples include, but are not limited to, (1) increased emphasis on CHS during ODFW planning of reservoir release strategies (as was done in 2001), (2) use of hatchery fish to temporarily supplement the production of NP CHS, (3) additional harvest reductions in freshwater (as was done in 2006 and 2007) and (4) additional harvest reductions in the area of the ocean that falls under the jurisdiction of the state of Oregon. Upon improvement in SMU status to the point where ODFW projects that conservation criteria are unlikely to be met, management strategies adopted as part of this conservation plan will then be re-employed.

MONITORING, EVALUATION, AND RESEARCH NEEDS

Efficacy of resource management plans can only be determined if objective measures are developed by which to track and evaluate progress towards attainment of plan goals. Tracking of progress can be accomplished through the development of methods to monitor those SMU attributes relevant to critical components of the plan. As new information becomes available, updated evaluations can better identify (or quantify) the relationships between limiting factors and management strategies employed by the plan. For those management strategies that are critical to plan execution, and that have substantial uncertainty, research projects will be needed to test the assumptions associated with adoption and implementation of specific management strategies. To complete the all of efforts outlined in the remainder of this section, ODFW will need additional staff, or will need to restructure the priorities of current staff, or will need to arrange for help from other entities. Prioritization of evaluation and research needs will be completed by ODFW after adoption of the final version of this conservation plan, as priorities are dependent upon the adopted suite of management strategies. As the adaptive management process begins with this plan, it is likely that additional monitoring, evaluation and research needs will be identified in future years. The needs listed below are based on knowledge at the time this plan was developed.

Monitoring Needs

Currently, there is a broad array of monitoring for physical and chemical parameters of the Rogue River. Generalized monitoring needs associated with streams throughout the state of Oregon were described by the Oregon Watershed Enhancement Board (2003). The following section outlines those monitoring efforts that are needed to track SMU status, and to assess the status, and changes within, those physical factors of the Rogue River that appear to directly affect the production and life history of NP CHS.

Annual Monitoring: Specific monitoring of CHS must be conducted annually by ODFW in order to determine SMU status in relation to the desired status statement and the conservation status statement embedded in this plan. Estimates relevant to these annual monitoring needs include:

1. Number of NP CHS that pass Gold Ray Dam.
2. Migration timing of NP CHS that pass Gold Ray Dam.
3. Percent jacks among NP CHS that pass Gold Ray Dam.
4. Percentage of NP CHS that spawn upstream of Shady Cove during September.
5. Percent hatchery fish among CHS that spawn naturally.
6. Percent hatchery fish among CHS that spawn naturally between Cole M. Rivers Hatchery and Rogue Elk Park.

Weekly Monitoring: Monitoring of river physical parameters and reservoir volume should be conducted weekly by ODFW in order to ensure that releases from Lost Creek Lake interface with fishery management objectives in downstream areas. Specific monitoring that should be conducted on a weekly basis includes:

1. Rate of reduction (ramping rates) in reservoir outflow.
2. Reservoir outflow.

3. Reservoir volume and rate of change in reservoir volume.
4. Reservoir inflow and rate of change in reservoir inflow.
5. Flow and water temperature of the Rogue River at the USGS gages near McLeod, Dodge Bridge, and Agness.

In addition, during years of expected low returns of NP CHS, ODFW should monitor the passage of NP CHS at the fish counting station at Gold Ray Dam on a weekly basis. This effort is needed in order to predict whether conservation criteria will likely be reached (as was done in 2006 and 2007).

Intermittent Monitoring: Intermittent monitoring is defined as surveys that should be conducted to monitor resources that may change over a span of a number of years or generations of NP CHS. Specific intermittent monitoring that should be conducted includes:

1. Genetic assessments that should be conducted every twelve years (two complete brood cycles) in order to ensure that the genetic integrity of NP CHS has not been compromised by increased numbers of NP CHF spawning within the SMU.
2. Assessments of the amount, distribution, and composition of gravel in spawning areas located between Cole M. Rivers Hatchery and Shady Cove. This effort should be the responsibility of the USACE, and should be conducted approximately every ten years. Resultant data should be in such a form that it is possible to estimate the habitat capacity for spawning Chinook salmon in this area. Habitat capacity for spawners can be estimated with methods similar to those employed by Beechie et al. (2006).
3. Assessments of the amount of shade provided by the riparian zone along the Rogue River should be conducted approximately every ten years. Possible approaches to this type of monitoring are outlined by the Oregon Watershed Enhancement Board (2004); and a state of Oregon agency, or a watershed council, should be identified as the entity to be responsible for this effort.

Evaluation Needs

In contrast to monitoring needs, evaluation needs vary greatly in relation to immediacy of need, frequency of need, and duration of need. However, as with the proposed monitoring, the following evaluations must be conducted in order to assess the efficacy of the management strategies adopted as part of this conservation plan. Evaluation needs are outlined below, and are ranked in an approximate order of priority:

1. Evaluate the efficacy of ODFW recommendations for the release of reservoir storage from Lost Creek Lake during years of low water yield. Surveys need to be conducted during years of low flow to identify optimal use of the limited volume of reservoir storage allocated for fishery purposes. Availability of reservoir storage utilized for fishery purposes in downstream areas will decrease through time, as additional reservoir storage is purchased for consumptive uses.
2. Evaluate efficacy of management strategies adopted within this conservation plan. Recruitment estimates provide one measure by which to index population status. As recruitment estimates from any singular brood year are difficult to interpret, and as estimation of harvest in the ocean and freshwater fisheries takes significant effort, this type of evaluation should be conducted about every five years. Results from this periodic evaluation should also be used to update the estimate of SMU persistence. Updated persistence assessments should incorporate, if possible, functions to better simulate reduced harvest rates that result from conservation

measures to be employed during periods of low returns (*see* **CRITERIA INDICATING DETERIORATION IN STATUS**, page 79).
3. Evaluate the efficacy of ODFW recommendations for ramping rates (rates of flow decreases) at Lost Creek Lake. Surveys, during periods when river flow decreases quickly, need to be conducted in order to identify optimal recommendations that will minimize stranding rates of juvenile NP CHS.
4. Evaluate the handling mortality of any NP CHS collected for brood stock at any site other than Cole M. Rivers Hatchery, or are transported in order to increase the number of NP CHS that spawn naturally.
5. Evaluate the feasibility of adjusting catch area designations on salmon-steelhead cards. Depending on the strategies employed for the management of freshwater fisheries, some adjustments appear warranted in order to improve estimates of the spatial and temporal harvest of NP CHS and CHS of hatchery origin.

Research Needs

Research needs were identified as discrete projects designed to produce products needed to evaluate the efficacy of the management strategies adopted as part of this conservation plan. As the most important management strategies will be investigated, it is imperative that estimates of uncertainty (or certainty) be developed as part of each proposed project. Estimation of uncertainty will significantly increase the amount of effort needed to complete each of the proposed research projects. As a result, research projects will only be conducted if the appropriate amount of funding can be obtained. A unified project has been designed to address three of the research needs described below as bullet numbers 3, 4, 5. Proposed needs are not listed in order of priority, as each need is of critical importance:

1. Develop methods to quantitatively predict the number of NP CHS expected to return to freshwater. Pre-season predictions of run size will afford fishery managers the means to (1) expand harvest opportunities when more than 15,000 NP CHS are predicted to pass Gold Ray Dam (*see* **DESIRED BIOLOGICAL STATUS**, page 12) or (2) constrain harvest opportunities when predictions indicate that conservation criteria are likely to be reached (*see* **CRITERIA INDICATING DETERIORATION IN STATUS**, page 79).
2. Determine the distribution and relative abundance of juvenile NP CHS upstream and downstream of the partial barrier proposed for modification in the lower portion of Big Butte Creek. This project should be conducted to ensure that modification of the partial barrier at river mile one results in an increased production of NP CHS.
3. Develop a method to monitor (index) spawner abundance and spawner composition. No method is currently employed because of the spawning overlap of spring and fall Chinook salmon. A method to index spawner abundance is also needed because there is a good chance that Gold Ray Dam will eventually be removed, resulting in the loss of the fish counting station.
4. Determine the relationships between (1) time of freshwater entry, (2) passage timing at Gold Ray Dam, (3) spawning time, and (4) spawning distribution for early-run, mid-run, late-run NP CHS, and early-run NP CHF that pass Gold Ray Dam. This information is needed in order to effectively manage distinct components of the naturally produced population, better define fixed migration dates for differentiation of CHS and CHF, and to determine efficacy of management strategies for freshwater fisheries.
5. Determine freshwater fishing mortality rates in order to effectively manage distinct components of the population and to determine efficacy of management strategies for freshwater fisheries. Use of radio tags or acoustic tags should allow for this effort to be coupled with

research need 4. In addition, the use of such tags may also result in the identification of specific sites at which NP CHS hold after passing Gold Ray Dam.
6. Determine, with genetic assessments, whether the fixed calendar date of 15 August remains the most appropriate measure by which to differentiate CHS and CHF that pass the fish counting station at Gold Ray Dam.
7. Develop methods to monitor spawning habitat for NP CHS in the Rogue River. The volume and quality of spawning areas probably has decreased through time as a result of gravel being trapped in Lost Creek Lake.
8. Determine the efficacy of attempting to restore the production of NP CHS in the area upstream of Lost Creek Lake.

PROCESS TO MODIFY CORRECTIVE STRATEGIES

Findings that result from monitoring, evaluation, and research efforts described in the previous section will provide insight as to the efficacy of management strategies and actions outlined in this conservation plan for NP CHS in the Rogue SMU. Management strategies adopted as components of this plan are mostly general in nature, while management actions are fairly specific. Specificity can be advantageous, yet can also be disadvantageous unless there is flexibility to revise management actions as new information becomes available. In addition, changes in local, state, or federal laws may require modifications to management strategies or actions outlined in this plan.

Adaptive Management

Given the inherent uncertainty associated with quantitative estimates of cause-and-effect relationships, adaptive management will be employed as a means to identify and implement revisions to management actions adopted as plan components. Regular reviews of fish status, and monitoring and evaluation data, will occur upon implementation of this plan (*see* **Reporting**, section below). This information will be used to assess the current management strategies being employed and allow for adjustments, if needed. For example, harvest opportunities on NP CHS could be increased if a pre-season forecast indicates that more than 15,000 NP CHS are expected to pass Gold Ray Dam. ODFW fishery managers will need to consider current SMU status, predicted run size, and the predicted rate of disease loss prior to deciding whether or not to increase harvest opportunities for naturally produced fish in freshwater.

Other actions may be revised to improve performance, or actions may be terminated and be replaced by other actions that are determined to be more effective. Rationale associated with any changes in management actions will be detailed in annual status reports developed by ODFW (*see* **Reporting**, section below), and where applicable, will be linked to findings from monitoring, evaluation, and research efforts.

In the event that pre-season forecasts indicate that conservation criteria will likely be realized (*see* **CRITERIA INDICATING DETERIORATION IN STATUS**, page 79), ODFW will craft management options to address the need to temporarily modify the plan. These options will be presented in the annual report, and ODFW will solicit public input. ODFW will evaluate input received from the public prior to making the decision on how to adjust management actions to address any deterioration in SMU status.

Findings from research projects not directly applicable to NP CHS in the Rogue SMU should be evaluated thoroughly prior to revision of any management actions outlined in this plan. Should specific research projects proposed for Rogue CHS not be completed, it is probable that at least two generations (10 years) of NP CHS will need to return to freshwater before the efficacy of employed strategies and actions can be evaluated.

Reporting

Status reports will be produced on an annual basis for NP CHS in the Rogue SMU. At a minimum, annual reports will present the SMU status in relation to desired status and conservation status statements embedded in this plan, and should also present summaries of annual efforts to monitor SMU attributes.

Other primary components of annual reports will include (1) presentation of the implications of research or evaluation projects completed during the reporting year, (2) presentation of any updated assessments of population attributes completed during the reporting year, and (3) presentation of the rationale associated with any changes in management actions made during the reporting year. Annual status reports should be completed within the succeeding year of the reporting period to be covered. These reports will be available to the public from the district offices in the Rogue Watershed District, and should address all SMUs within the Rogue Watershed District that have completed conservation plans.

In addition, status reviews will be completed by ODFW every five years, beginning in 2010. These reviews should be designed to brief the public and the ODFW commission on the progress made towards attainment of desired status for all SMUs within the Rogue Watershed District. Status reviews will form the basis for the periodic assessment of the efficacy of management strategies and actions employed under this conservation plan. Attainment of desired status, progress towards attainment of desired status, or the lack of progress towards attainment of desired status will be used to judge the success of the management strategies and actions. Findings from monitoring, evaluation, and research efforts will also be presented and discussed in detail.

Finally, a comprehensive assessment of the efficacy of this conservation plan will be undertaken during intervals not to exceed every 15 years, which is approximately three generations of spring Chinook salmon. The purpose of these comprehensive assessments is to determine whether the adopted management strategies are making progress towards the attainment of desired status. The results of the comprehensive assessment will be presented in a summary report, and two public meetings will be held in order to obtain input. These meetings will be held at locations near the ODFW district offices in the Rogue Watershed District. Should the assessment indicate that there is a need to modify management strategies or other key elements of the plan, ODFW will craft options for those changes, will include them in the assessment report, and will seek input on the options at the public meetings. ODFW will evaluate input received during the public meetings prior to making revisions to the conservation plan. If revisions to the strategies or desired status are needed, the revised plan, including public comments, will be submitted to the ODFW commission for approval.

POTENTIAL IMPACTS TO OTHER NATIVE SPECIES

Some impacts to other species of native fish will likely result from implementation of management strategies outlined in this conservation plan. Degree of impact is dependent upon which suite of management strategies is adopted, but some of the most probable impacts are discussed below.

Changes in ODFW recommendations for reservoir management strategies are likely to have minimal effect on native fishes, with the possible exception of coho salmon and fall Chinook salmon. Under the management strategy of attempting to reduce passage of CHF at Gold Ray Dam by less flow augmentation in September, coho salmon and fall Chinook salmon may become more vulnerable to disease outbreaks (ODFW 1991; ODFW 1992). Impacts to other species of native fish are likely to be benign, or possibly advantageous. Findings from water temperature modeling will most likely lead to water temperatures in the area upstream of Gold Ray Dam that more closely resemble conditions prior to the operation of Lost Creek Dam.

Modification of the partial barrier in the lower portion of Big Butte Creek will likely lead to increased upstream passage of adult NP CHS, and an associated increase in the production of juvenile NP CHS. That portion of Big Butte Creek, located above the barrier is a primary producer of coho salmon and steelhead. Some cutthroat trout also reside in the area. Increased numbers of CHS are not expected to have significant impacts because (1) CHS spawn earlier than the other species, (2) juvenile NP CHS mostly spend less than one year in freshwater (ODFW 2000), and (3) juvenile coho salmon appear to dominate (out-compete) juvenile Chinook salmon (Taylor 1991). Similar conclusions can be drawn for potential impacts associated with the transportation strategy for adult CHS, except that transported adults could be placed in areas of streams not accessible to anadromous salmonids. These areas would most likely contain resident rainbow trout or cutthroat trout.

ECONOMIC IMPACTS

Economic impacts of plan implementation will vary to some degree based on which suite of management strategies is adopted as part of this conservation plan for NP CHS in the Rogue SMU. The first portion of this section will outline projected impacts associated with those management actions that are common to each of the primary alternatives proposed for consideration. The second portion of the section will outline projected impacts based on those management actions that are unique to the primary alternatives under consideration. Regardless of the adopted alternative, no reporting requirements are proposed for any business or the public in general. Consequently, there are no compliance costs associated with the implementation of this plan, except for some minor reporting costs accrued by ODFW.

Implementation of any of the primary alternatives presented in this plan are expected to have the following economic impacts:

1. Tourboat operations on the Rogue River will be impacted during a ten day period in September. With minimal flow augmentation from Lost Creek Lake during 10-20 September, the company based in Grants Pass will be likely either (1) need to dredge channels in order to continue operations or (2) operations will cease. Companies based in Gold Beach may also be impacted, but to a lesser degree as compared to the company based in Grants Pass.

2. Fishing guides, tackle shops, lodging providers, restaurants, and other support services will be negatively impacted if angler effort decreases in response to decreased opportunities to harvest NP CHS.
3. Fishing guides, tackle shops, lodging providers, restaurants, and other support services will be positively impacted if angler effort increases in response to increased opportunities to harvest NP CHS that result from the attainment of desired status.
4. The state of Oregon (ODFW) will accrue additional expense as a result of the proposed monitoring, evaluation, and research that is needed to ensure the efficacy of management actions implemented as part of this plan. In addition, ODFW will accrue additional expenses in order to improve fish passage at the partial barrier in Big Butte Creek.
5. The federal government (USACE) will be requested to revise reservoir management policies and practices, and will also be requested to complete some additional assessments of reservoir management strategies. These requests will result in additional expenses for the USACE.

Economic impacts of the primary alternatives differ in relation to the immediate effects on businesses that benefit from harvest opportunities for NP CHS. In a broad sense, adoption of Alternative 8 would likely have the least immediate impact as there would be minimal change in the opportunity to harvest NP CHS (*see* **Alternative 8**, page 71). Adoption of Alternative 9 may have the greatest immediate impact, but would be offset to some degree, by a possible increase in the production of hatchery fish and an added month (August) of angling opportunity for Chinook salmon in the area upstream of Gold Ray Dam (*see* **Alternative 9**, page 73). The long-term economic impacts of the primary alternatives presented in this plan is dependent on how quickly, and to what degree, the population of NP CHS responds to the differing management actions.

Adoption of Alternative 8 (*see* **Alternative 8**, page 71) is expected to have the following additional significant economic impacts:
1. The state of Oregon (ODFW) will accrue additional expense as a result of the need to (1) transport and release adult CHS at sites other than Cole M. Rivers Hatchery, (2) transport and release juvenile steelhead and coho salmon at a site other than Cole M. Rivers Hatchery.

ATTAINMENT OF DESIRED STATUS

The purpose of this Conservation Plan is to ensure the continued viability of the Rogue Spring Chinook Salmon Species Management Unit (SMU), and to achieve a desired status that will provide significant ecological, economic and cultural benefits for all Oregonians.

Upon attainment of desired status, fishery management actions will be modified to allow for increased harvest opportunities for naturally produced spring Chinook salmon. After full implementation of management strategies and management actions, ODFW projects that there is a reasonable chance that desired status can be attained within two or three generations (12 or 18 years) of spring Chinook salmon. It should be noted that this conservation plan remains in effect regardless of SMU status, because ocean survival rates of spring Chinook salmon are cyclical. Thus, the SMU could exceed desired status for a period of time, and subsequently once again drop below desired status for a period of time.

Until attainment of desired status, harvest opportunities for naturally produced spring Chinook salmon could increase if pre-season forecasts predict large returns to freshwater. ODFW fishery managers will consider current SMU status, and predicted run size, prior to deciding whether or not to increase harvest opportunities for naturally produced fish in freshwater.

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APPENDIX A

Definitions

“95% CI” means the range in which a true population mean (average) will fall for 95% of all samples possibly drawn from the population.

"Anadromous" means fish which migrate from saltwater to freshwater for spawning.

“Aquatic habitat" means the waters which support fish or other organisms which live in water and which includes the adjacent land area and vegetation (riparian habitat) that provides shade, food, and/or protection for those organisms.

"Brood" means a group of fish that are produced by parents during a single year of spawning.

"Brood stock" means a group of fish that are held and eventually artificially spawned to provide a source of fertilized eggs for hatchery programs.

"Brood year" means the year in which the adults spawn.

"CH" means Chinook salmon (spring and fall races).

"CHF" means fall Chinook salmon.

"CHS" means spring Chinook salmon.

"Conservation" means managing for sustainability of native fish so that present and future generations may enjoy their ecological, economic, recreational, and aesthetic benefits.

"Disease" means problems caused by infectious agents, such as parasites or pests, and by other conditions that impair the performance of the body or one of its parts.

"Early-run" means spring Chinook salmon that pass Gold Ray Dam before 1 June.

"Enhancement" means management activities including rehabilitation and supplementation that increase fish production beyond the existing levels.

"Fish Hatchery" means a facility at which adult broodstock are held, or where eggs are collected and incubated, or where eggs are hatched, or where fish are reared.

"Fry" means fish which have recently hatched.

"Genotype" means the kinds of and the combination of genes possessed by an individual.

"Harvest rate" means that portion of a brood year which was harvested by fishers.

"Hatchery fish" means a fish incubated or reared under artificial conditions for at least a portion of its life.

"Hatchery Program" means a program in which a specified hatchery population is planted in a specified geographical location.

"Hypolimnion" means the cold water present at the bottom of a lake or reservoir.

"Late-run" means spring Chinook salmon that pass Gold Ray Dam after 30 June.

"Lost Creek Dam" means the same as William Jess Dam.

"Marine species" means those fish found in the ocean or the saline or brackish water of estuaries or bays along the coast, but not generally found in freshwater streams.

"Mean" means average.

"Median" means the mid-value (50% higher and 50% lower) of the observations.

"Mid-run" means spring Chinook salmon that pass Gold Ray Dam during June.

"Mitigation" means to lessen the impact of activities or events that cause fish or habitat loss.

"Native fish" means indigenous to Oregon, not introduced. This includes both naturally produced and hatchery produced fish.

"Naturally produced" means fish that reproduce and complete their full life cycle in natural habitats.

"Natural spawners" means fish, regardless of parental origin, that spawn in the natural environment.

"NP" means naturally produced.

"NP CHS" means naturally produced spring Chinook salmon.

"NP CHF" means naturally produced fall Chinook salmon.

"ODFW" means the Oregon Department of Fish and Wildlife.

"Optimum" means the level of fish abundance that results in the greatest ecological, economic, recreational, and aesthetic benefits.

"*P*" means the probability that values in the analysis were not statistically different.

"Policy" means mandatory direction or constraints that provide the framework for programs of governmental agencies.

"Population" means a group of fish originating and reproducing in a particular area at a particular time which do not interbreed to any substantial degree with any other group reproducing in a different area or in the same area at a different time.

"Production" means the number or pounds of fish raised in a hatchery or resulting from natural spawning and rearing in freshwater, estuarine, or ocean habitats.

"Recruits" means fish produced by a single generation of parents.

"Recruitment" means the addition of recruits to a population of fish.

"Risk" means the extent to which, a management practice may reduce population productivity or cause an undesirable change in genetic characteristics of a population.

"SE" means standard error.

"Selective mortality" means fish mortality that generally affects the genotypic and phenotypic traits of fish populations.

"Serious depletion" means a significant likelihood that the species management unit will become threatened or endangered under either the state or federal Endangered Species Act.

"Smolt" means a juvenile salmon or trout that is capable of initiating a seaward migration and is capable of living in the sea.

"Species" means any group or population that interbreeds and is substantially reproductively isolated.

"Species management unit" or "SMU" means a collection of populations from a common geographic region that share similar genetic and ecological characteristics.

"Stray" means a hatchery fish that spawns naturally in a location different from the location intended when the fish was stocked.

"Sustainable" means persistence over time, that is to say the ability of a population or a species management unit to maintain temporal, spatial, genetic, and ecological coherence while withstanding demographic, environmental, and genetic variation and catastrophic events from natural and human induced causes.

"USACE" means the United States Army Corps of Engineers.

"USGS" means the United States Geological Survey.

"Wild" means fish that reproduce and complete their full life cycle in natural habitats (same definition as "naturally produced").

APPENDIX B

Regulatory Responsibilities of Governmental Agencies

Local Government

Cities and counties are responsible for the administration of land-use planning. Under Oregon's statewide land-use planning program, administered by the Department of Land Conservation and Development (DLCD), all cities and counties are required to adopt comprehensive plans that meet mandatory state land-use standards. The standards are 19 statewide planning goals that deal with land use, development, housing, transportation, and the conservation of natural resources. Comprehensive plans approved by the Land Conservation and Development Commission (LCDC) become the controlling document for land use in the area covered by that plan.

Several statewide planning goals require the protection of natural resources by cities and counties through adoption of land-use planning ordinances. Most notable is Goal #5, which covers open spaces, scenic and historic areas, and natural resources. Other applicable statewide planning goals include Goal #6, which covers air, water and land resources quality, Goal #8, which covers recreational needs, Goal #16, which covers estuarine resources, and Goal #19, which covers ocean resources.

Natural resource related land-use activities that may be regulated by cities and counties, through land-use planning, include riparian and wetland protection, stormwater management, floodway/floodplain development, and removal-fill activities in waters of the State.

State Government

ODFW goals and policies for commercial and sport fishing regulations, fish management, and the Native Fish Conservation Policy and Fish Hatchery Management Policy are adopted as Oregon Administrative Rules (OAR). These policies along with the Oregon Plan for Salmon and Watersheds provide guidance on the development of fisheries management options for water bodies throughout the state.

Fish management authority and associated activities conducted by ODFW are provided and directed by statute, rule, and policy. ODFW is authorized by Oregon Revised Statute (ORS) to manage the fish and wildlife resources of the state (ORS chapter 496). Within the Oregon Administrative Rules (OAR's), Division 007 rules provide directives associated with fish management and hatchery operations. Specific Division 007 policies include the Native Fish Conservation Policy (OAR 635-007-0502), General Fish Management Goals (OAR 635-007-0510), Hatchery Program Management Plans (OAR 635-007-0545), and Control of Fish Disease (OAR 635-007-0550). Additional guiding policies are found within OAR Division 415 and 412 rules for Fish and Wildlife Habitat Mitigation and Fish Passage and within Division 500 rules for fish management plans.

Regulatory responsibilities for the preponderance of activities that may affect aquatic ecosystems are executed by a variety of state agencies under the umbrella of the Oregon Plan for Salmon and Watersheds.

The Oregon Department of Environmental Quality (DEQ) is responsible for protecting and enhancing Oregon's water and air quality, for cleaning up spills and releases of hazardous materials, and for managing the proper disposal of hazardous and solid wastes. In addition to local programs, the Environmental Protection Agency (EPA) delegates authority to DEQ to operate federal environmental programs within the state such as the Federal Clean Air, Clean Water, and Resource Conservation and Recovery Acts.

The Oregon Water Resources Department (OWRD) is charged with administration of the laws governing surface and ground water resources. The Department's core functions are to protect existing water rights, facilitate voluntary flow restoration in streams, increase the understanding of the demands on the state's water resources, provide accurate and accessible water resource data, and facilitate water supply solutions.

The Department of State Lands (DSL) is responsible for administering the removal-fill law, which protects Oregon´s waterways and wetlands from uncontrolled alteration. DSL is the lead state agency for the protection and maintenance of wetlands resources; and management of coastal resources seaward of the mean high tide line.

The Oregon Department of Forestry (ODF) responsibilities include implementation of the Oregon Forest Practices Act, which provides for timber harvest using techniques that are consistent with conservation and environmental protection. ODF also manages state-owned forest land in Oregon.

The Oregon Department of Geology and Mineral Industries (DOGAMI) is lead regulator for geologic resources (oil; gas; geothermal energy; metallic and industrial minerals; and sand, gravel, and crushed stone). The Mineral Land Regulation and Reclamation Program is the lead coordinating agency for state mining regulation.

The Oregon Parks and Recreation Department (OPRD) administers the Oregon Scenic Waterways Program. Approval must be obtained from OPRD for activities such as cutting of trees, mining, construction of roads, railroads, utilities, buildings, or other structures within a one-quarter mile of the bank of a designated scenic waterway. Portions of both the Rogue and Illinois Rivers are designated as scenic waterways. The OPRD, through its ocean shore rules, administers a permit program for ocean shore alterations.

The Oregon Department of Agriculture (ODA) Natural Resources Division works to conserve, protect, and develop natural resources on public and private lands so agriculture will continue to be productive and economically viable in Oregon. Primary program areas include: water quality, confined animal feeding operations, smoke management, land use, soil & water conservation districts, and plant conservation biology. The ODA Plant Division oversees statewide noxious weed control efforts.

The Oregon State Marine Board (OSMB) is Oregon's recreational boating agency. The OSMB registers outfitters and guides and licenses ocean charter boats. The OSMB establishes statewide boating regulations and contracts with county sheriffs and the Oregon State Police to enforce marine laws. The OSMB also provides grants and engineering services to local governments (cities, counties, park districts, port districts) to develop and maintain accessible boating facilities and protect water quality.

Oregon State Police (OSP) Fish and Wildlife Enforcement Services Division ensures compliance with the laws and regulations that protect and enhance the long term health and equitable utilization of Oregon's fish and wildlife resources and the habitats upon which they depend.

The Oregon Watershed Enhancement Board (OWEB) promotes and funds voluntary actions that strive to enhance Oregon's watersheds. OWEB programs support efforts to restore salmon runs, improve water quality, and strengthen ecosystems that are critical to healthy watersheds and sustainable communities. OWEB administers a grant program funded from the Oregon Lottery. The grant program supports voluntary efforts by Oregonians seeking to create and maintain healthy watersheds.

Regulatory Responsibilities – Federal Government

The Bureau of Land Management (BLM) administers public lands within a framework of numerous laws. The most comprehensive of these is the Federal Land Policy and Management Act of 1976. Other applicable laws include the National Environmental Policy Act of 1969, Multiple-Use Sustained-Yield Act of 1960, Mining Law of 1872, Taylor Grazing Act of 1934, and the Oregon and California Act of 1937.

The United States Forest Service (USFS) manages national forest lands for a number of multiple uses within the framework of the National Forest Management Act of 1976. Other applicable laws include the Multiple-Use Sustained-Yield Act of 1960, National Environmental Policy Act of 1969, and Mining Law of 1872.

Substantial portions of the Rogue River Basin are managed by the BLM and the USFS. Land management activities such as logging and road construction are designed to meet forest practices rules and water quality standards outlined by the Oregon Forest Practices Act. A portion of the Rogue River was designated a national Wild and Scenic River in 1968. The BLM and USFS regulate commercial and recreational boat traffic within the Wild and Scenic section of the Rogue River.

The Environmental Protection Agency (EPA) administers the Clean Water Act. The Clean Water Act gives EPA the authority to implement pollution control programs such as setting wastewater standards for industry. The Clean Water Act also continued requirements to set water quality standards for all contaminants in surface waters. The Act makes it unlawful for any person to discharge any pollutant from a point source into navigable waters, unless a permit was obtained under provisions of the Act.

National Marine Fisheries Service (NOAA Fisheries) is responsible for the management, conservation and protection of living marine resources within the Exclusive Economic Zone (waters three to 200 miles offshore) as provided by the Magnuson-Stevens Act. Under the Marine Mammal Protection Act and the Endangered Species Act, NOAA Fisheries is responsible for the recovery of protected marine species, which includes species of anadromous fish species.

The Pacific Fishery Management Council (PMFC) is one of eight regional fishery management councils established by the Magnuson Fishery Conservation and Management Act of 1976. Fishery Management Councils advise NOAA Fisheries on issues that relate to the management of ocean fisheries within the Exclusive Economic Zone. PFMC is responsible for fisheries off the coasts of California, Oregon, and Washington.

The United States Fish and Wildlife Service (USFWS) administers protection programs for native endangered and threatened species under the Endangered Species Act. The USFWS also administers permits for activities such as depredation control under the Migratory Bird Act.

The Natural Resources Conservation Service (NRCS) provides technical and financial assistance to help agricultural producers, and other entities, conserve land and water resources. NRCS works through conservation districts, and other entities, to help landowners, as well as Federal, State, tribal, and local governments and community groups, conserve natural resources on private lands.

The U.S. Army Corps of Engineers (USACE) regulatory authority extends to structures in navigable waterways under the Rivers and Harbors Act of 1899 and the discharge of dredge and fill material under Section 404 of the Federal Water Pollution Control Act Amendments of 1972. In addition, the USACE regulates stream flows under the Flood Control Acts of 1936 and 1958. Included in these legislative acts were directives to survey for flood control potential in the Rogue River Basin. Subsequent legislation authorized the construction of three dams in the basin (United States Congress 1962), two of which have been built and are operational.

APPENDIX C

Synopsis of the Lost Creek Dam Fisheries Evaluation Project

PROJECT GOALS AND OBJECTIVES

1974-1977 Goals

1. Determine baseline conditions for major salmonid populations.
2. Develop data to assess impact of USACE dams on native salmonid populations.

1974-77 Objectives

1. Determine the life history of juvenile Chinook salmon; including growth, distribution, migration behavior, and time of ocean entry.
2. Determine the variation in juvenile life history and the relative contribution of each variant life history to the adult population.
3. Determine the spawning time and spawning distribution of adult Chinook salmon.

1978-1985 Goals

1. Determine the effects of Lost Creek Dam on anadromous salmonids.
2. Develop operating strategies that optimize the production and harvest of fishery resources in downstream areas.

1978-85 Objectives

1. Determine changes in water temperature, flow, and turbidity which result from reservoir operation.
2. Determine the effects of Lost Creek Dam and develop criteria for its operation as related to the river sport fishery for adult salmonids.
3. Determine the effects of Lost Creek Dam and develop criteria for its operation as related to the abundance, migration, spawning, and size and age composition of adult salmonids.
4. Determine the effects of Lost Creek Dam and develop criteria for its operation as related to the rearing and migration of juvenile salmonids.

1986-1996 Goal

Determine release strategies at Lost Creek that result in optimum production and harvest of wild spring Chinook salmon.

1986-96 Objectives

1. Determine the effect of the modified release strategy on water temperature.
2. Determine the effect of water temperature on the production of wild juvenile spring Chinook salmon.
3. Determine the effect of water temperature on the maturity rate, race composition, and spawning time of adult Chinook salmon.
4. Develop recommendations for reservoir release strategies during years of varied water yield in the Rogue River Basin.

PROJECT FINDINGS

(reproduced from ODFW 2000)

Physical Factors

1. Reservoir operation increased flow in summer, decreased flow in winter and spring, and decreased the intensity of peak flows during winter in all downstream areas.

2. Reservoir operation decreased water temperature in summer and increased water temperature during autumn and winter in all downstream areas.

3. Water temperature three kilometers downstream of the dam decreased by an average of 2^{o}C in early summer, and again in early summer, after a change in release strategies during the mid-1980s.

4. Simulation modeling is the best available method to estimate the effects of reservoir operation on water temperature.

Adult Spring Chinook Salmon

1. Passage estimates of wild and hatchery fish at Gold Ray Dam during 1942-94 averaged 31,000 spring Chinook salmon and 3,300 fall Chinook salmon. Annual estimates of spring Chinook salmon varied between 6,000 and 90,000. Annual estimates of fall Chinook salmon varied between 700 and 14,000.

2. Comparisons made with returns of wild spring Chinook salmon to the North Umpqua River indicated that the operation of Lost Creek Dam was associated with (1) an increase in the production of wild fall Chinook salmon, (2) a decrease in the production of wild spring Chinook salmon, and (3) a decrease in production of all wild Chinook salmon.

3. In terms of numbers of adult fish that passed Gold Ray Dam, returns of hatchery fish mitigated for spawning habitat blocked by Lost Creek Dam.

4. The percentage of hatchery fish among spring Chinook salmon averaged 7% in the 1970's, 43% in the 1980's, and 70% in the early 1990's.

5. Fall Chinook salmon accounted for 13% of the wild fish produced before reservoir operation and 24% of the wild fish produced after reservoir operation.

8. The number of wild age 2 spring Chinook salmon resident in the ocean averaged about 240,000 fish for broods produced before reservoir operation and about 96,000 fish for broods produced after reservoir operation.

11. Ocean fisheries annually harvested an average of 44,000 Chinook salmon in 1974-93. Annual landings of spring Chinook salmon averaged about 29,000 wild fish and about 14,000 hatchery fish. Annual landings of wild fall Chinook salmon averaged about 1,600 fish.

12. Annual estimates of ocean harvest rates in 1977-93 ranged between 0.03 and 0.54 for age 3 fish and ranged between 0.04 and 0.80 for age 4 fish.

13. Production estimates averaged about 11 recruits per spawner and ranged between 1 and 37 recruits per spawner for wild spring Chinook salmon from the 1974-89 brood years.

14. Adults matured at ages 2-6. Spring Chinook salmon of hatchery origin, and wild fall Chinook salmon, matured at younger ages as compared to wild spring Chinook salmon.

15. Maturation rates of wild and hatchery fish affected contribution rates to recreational and commercial fisheries in the ocean. Older fish contributed to the ocean and freshwater fisheries at greater rates than younger fish.

16. Wild spring Chinook salmon produced after reservoir operation matured at younger ages than counterparts produced before reservoir operation. Maturity rates of fish produced in the initial years of reservoir operation (1978-85) did not differ from those for fish produced in the later years of reservoir operation (1986-90).

17. Maturity rates of wild fish were primarily related to growth rates in the ocean and to growth rates of juveniles in freshwater.

18. Maturation rates of hatchery fish were primarily related to growth rates in the ocean, date of release from the hatchery, and to fish size when released from the hatchery.

19. Among fish of the same age, hatchery fish migrated upstream earlier than wild fish. Older fish migrated upstream earlier than younger fish among wild and hatchery fish.

20. Wild fish produced after reservoir operation migrated upstream later than wild fish produced before reservoir operation. Migration timing of wild fish was more highly related to water temperature when the fish were embryos than to water temperature or flow when the fish were adults.

21. Large numbers of adults died prior to spawning before and after operation of Lost Creek Dam. Annual mortality rates downstream of Gold Ray Dam ranged between 0% and 70%. Annual mortality rates upstream of Gold Ray Dam ranged between 1% and 63%.

23. Fish that migrated earliest spawned farthest upstream and also spawned earliest.

24. Wild fish produced after reservoir operation spawned farther downstream and spawned later than counterparts produced before reservoir operation. In contrast, time of spawning did not change among hatchery fish.

25. A decrease in the relative abundance of early migrating adults was responsible for the downstream shift in the spawning distribution of spring Chinook salmon.

26. The change to later spawning was most pronounced for early migrating spring Chinook salmon. Late migrating adults were less affected.

27. Later spawning probably resulted from a decrease in the survival rate for progeny of early spawning adults.

29. Fall Chinook salmon excavated few redds of spring Chinook salmon, but probably interbred with the spring race. In the area where spawning of fall and spring races overlapped, spawning time differed little between races.

30. About 5% of the spring Chinook salmon of hatchery origin spawned naturally rather than entering Cole M. Rivers Hatchery.

Juvenile Spring Chinook Salmon

1. Reservoir operation caused eggs and alevins to develop at accelerated rates, resulting in an early emergence of fry from gravel nests. Accelerated emergence timing is most evident for the progeny of females that spawned early.

6. Eggs and alevins that incubate in gravel redds can become dewatered during the period of reservoir filling when reservoir releases increase river flow while parents spawn.

7. Large changes in river flow caused fry to be dewatered and killed.

8. Juvenile growth rates increased during the initial years of reservoir operation (1978-85) and then decreased during the later years of reservoir operation (1986-90).

9. Annual growth rates were primarily related to the abundance of juvenile Chinook salmon and water temperature.

10. Fish that matured at younger ages grew faster when juveniles in the Rogue River as compared to cohorts that matured at older ages.

11. Most juveniles entered the ocean in their first year of life and the relative abundance of older migrants decreased after reservoir operation.

12. Subyearling migrants entered the ocean earlier during the initial years of reservoir operation (1978-81) as compared to counterparts produced before reservoir operation. Data were insufficient to estimate the date of ocean entry for later years of reservoir operation.

13. Juveniles destined to mature at age 2 entered the ocean earlier as compared to cohorts that matured at older ages.

14. Date of ocean entry was primarily related to growth rate and water temperature. Broods that grew at faster rates entered the ocean earlier.

15. Juveniles were larger at ocean entry during the initial years of reservoir operation (1978-85) as compared to later years of reservoir operation (1986-90) and as compared to years before reservoir operation.

Freshwater Fisheries

1. Estimates of freshwater harvest averaged 6,900 spring Chinook salmon in 1956-94. These estimates only included those fish large enough to require entry on salmon-steelhead cards.

2. Annual harvest rates averaged 23% of spring Chinook salmon that returned in 1961-94. Annual harvest rates averaged 13% in the lower river and 16% in the upper river (1971-94). These estimates only included those fish large enough to require entry on salmon-steelhead cards.

3. Fisheries for spring Chinook salmon were age-selective. Older fish were harvested at greater rates than younger fish in the lower river and in the upper river.

4. Among fish of the same age, wild fish and hatchery fish were harvested at similar rates in the lower river fishery. In the upper river fishery, hatchery fish were harvested at only one-half of the rate for wild fish of the same age, probably because they entered Cole M. Rivers Hatchery while wild fish stayed in the river.

5. Harvest in the lower river fishery was primarily related to age at return, fish abundance, and flow during the fishery. Harvest in the upper river fishery was primarily related to age at return and the abundance of wild and hatchery fish.

6. Angler catch rates in the lower river and in the upper river were primarily related to fish abundance, flow, and water temperature.

7. Angler effort in the lower river was primarily related to fish abundance, flow, and water temperature. In contrast, angler effort in the upper river was primarily related to fish abundance.

Simulation Model

1. We developed a simulation model that reflected major life history events in fresh water and in the ocean. However, we were not able to simulate changes in rates of natural mortality in the ocean or the rate of natural mortality between the time of downstream migration and the initial six months of ocean residence.

2. Simulations indicated that the production, harvest, and mortality of wild Chinook salmon was more greatly affected by changes in water temperature as compared to changes in river flow.

3. Simulations indicated that hatchery fish account for about 13% of the spring Chinook salmon that spawn naturally when hatchery fish account for 75% of the run at Gold Ray Dam.

RECOMMENDATIONS

Reservoir Management and Operation of Lost Creek Dam

The following recommendations are directed primarily to the United States Army Corps of Engineers, the agency responsible for managing the reservoir and releases from Lost Creek Dam. Cooperation of other state and federal agencies are needed to implement these recommendations.

1. Plans for reservoir releases should be developed seasonally and should incorporate estimates of the projected water yield from the Rogue River Basin and objectives identified by state and federal agencies responsible for management of fishery resources.

2. The simulation model described in this report can be used to help evaluate the responses of wild Chinook salmon to alternative strategies of reservoir management.

3. The USACE should develop additional simulations for water temperature of the Rogue River under varied strategies of reservoir management. These simulations are needed to better allocate reservoir storage for the maintenance and possible enhancement of salmonids in areas downstream of Lost Creek Dam. At a minimum, water temperature should be simulated for years of low, average, and high water yield; and should also be simulated under alternative management strategies of (1) use of hypolimnetic storage in summer, (2) use of hypolimnetic storage in autumn, and (3) equal use of hypolimnetic storage in summer and autumn.

4. The reservoir should be managed so that daily maximum water temperature does not exceed 18^{o}C (65^{o}F) at Agness in May-June. This recommendation is designed to minimize prespawning mortality among adult spring Chinook salmon.

Additional simulations of water temperature are needed to determine the flow that is required to attain the recommended water temperature. In the interim, the USACE should continue to coordinate annual efforts to identify the minimum flow at Agness needed to protect spring Chinook salmon. Current information indicates that a flow of 4,000 cfs is sufficient. This interim target flow may change as more information becomes available.

5. The reservoir should be managed to minimize intensity of peak flows in downstream areas during November-March. This recommendation is designed to increase the survival rates of eggs and alevins that incubate in the gravel. Present strategies for reservoir operation decrease peak flows during operational seasons of flood control and conservation storage. We believe that the intensity of peak flows can be further decreased in years of high water yield.

Authorizing documents for the Rogue River Basin project designate flood control as the first priority for reservoir management. Storage in excess of the rule curve decreases reservoir capability for flood control. However, maintenance of the reservoir level below the rule curve can provide for additional reductions in peak flows.

The USACE should develop criteria for reservoir level in operational seasons for flood control and conservation storage. We believe reservoir level can be scaled to estimates of water yield in the area upstream of the reservoir. Reservoir level should be reduced when water content of the snowpack is great. Implementation of this recommendation would increase reservoir capacity for flood control and decrease intensity of peak flows in downstream areas.

6. Release of water stored in the reservoir during freshets should be managed so flow in downstream areas does not exceed the peak flow that previously occurred during the season. This recommendation is designed to increase survival rates of eggs and alevins that incubate in the gravel.

We recognize that this recommendation may conflict, at times, with flood control operations. For example, managers may seek to return the reservoir level to the authorized rule curve for short periods between large storms. However, when potential for further flooding is minimal, reservoir level should be returned to minimum pool for flood control (or lower) so as not to produce a new peak flow in downstream areas.

7. Release of water stored in the reservoir during flood control operations should be managed so that the rate of decrease in reservoir outflow does not exceed the rate of decrease in reservoir inflow following the freshet. This recommendation is designed to reduce the number of juvenile salmonids, including spring Chinook salmon, that are stranded and killed as a result of flood control operations.

8. Release of water stored in the reservoir during operations other than flood control should be managed so that the rate of decrease in reservoir outflow do not exceed maximum incremental rates of 150 cfs every three hours and 750 cfs daily. This recommendation is designed to reduce the stranding mortality of juvenile fish. Transect surveys to determine the relationship between discharge and gravel coverage may produce more effective recommendations for the reduction of stranding mortality.

9. The reservoir should be managed so that there is minimal flow augmentation between 21 September and 15 November. This recommendation is designed to (1) minimize the probability that eggs and alevins of spring Chinook salmon will be dewatered and killed during the subsequent filling of the reservoir, (2) reduce the proportion of fall Chinook salmon that migrate to spawning areas upstream of Gold Ray Dam (ODFW 1992), and (3) conserve cold hypolimnetic storage to reduce early emergence of spring Chinook salmon fry.

10. Reservoir storage that is not released to minimize prespawning mortality among fall Chinook salmon (ODFW 1992) and spring Chinook salmon should be released so as to decrease the water temperature to the greatest degree possible in the area downstream of Grants Pass during July-August. This recommendation is designed to provide more optimal water temperatures for juvenile salmonids resident in the area (ODFW 1992; ODFW 1994) and to decrease the number of juvenile salmonids, including spring Chinook salmon, that are consumed by Umpqua squawfish.

11. Recommendations for water temperatures to be released from Lost Creek Dam in March-October should be considered as interim recommendations that need to be evaluated upon the completion of additional simulations of water temperature by the USACE. These recommendations are designed to (1) minimize prespawning mortality among spring Chinook salmon in the area upstream of Gold Ray Dam, (2) minimize the risk of disease outbreaks among fish rearing at Cole M. Rivers Hatchery, and (3) conserve cold hypolimnetic storage for release in autumn, as described in the succeeding recommendation.

12. The temperature of water released from Lost Creek Dam should be as cold as possible during November-February. This recommendation is designed to minimize early emergence by fry of spring Chinook salmon and should be evaluated upon the completion of additional simulations of water temperature by the USACE.

13. The USACE should monitor the quality and quantity of salmon and steelhead spawning habitat downstream of Lost Creek Dam. Reservoir construction terminated the recruitment of gravel from areas upstream of the dam and the recruitment of gravel, from an unknown distance downstream of the dam, may not be sufficient to prevent the additional loss of spawning habitat.

Management and Evaluation of Fishery Resources

The following recommendations are directed primarily to the Oregon Department of Fish and Wildlife, the lead agency for management of fishery resources in the Rogue River Basin. Cooperation of other state and federal agencies are needed to implement these recommendations.

1. Management objectives, in order of priority, should be developed annually by agencies responsible for the management of anadromous salmonids in the Rogue River Basin.

2. The simulation model described in this report can be used to help evaluate the responses of wild and hatchery Chinook salmon to differing strategies of fisheries management.

3. Management plans and activities should recognize that wild and hatchery spring Chinook salmon differ in life history and also differ in contribution rates to recreational and commercial fisheries.

4. Management plans and activities should recognize that modification of the current hatchery program to reflect life history parameters of the present population of wild spring Chinook salmon will decrease the contribution rates of hatchery fish to recreational and commercial fisheries.

5. Management plans and activities should recognize that it is unlikely that the life history parameters of wild spring Chinook salmon will be completely restored to preimpoundment conditions, unless Lost Creek Dam is removed.

6. Management plans and activities should recognize three populations of Chinook salmon in the Rogue River upstream of Gold Ray Dam: (1) wild spring Chinook salmon that pass Gold Ray Dam before 16 August, (2) early-run fall Chinook salmon that pass Gold Ray Dam after 15 August, and (3) spring Chinook salmon of hatchery origin.

7. All spring Chinook salmon of hatchery origin should be marked with fin clips so that adult fish can be identified at Gold Ray Dam and so that known wild fish can be collected for hatchery broodstock.

8. Representative samples of each group exposed to differing hatchery practices should be marked with adipose fin clips and coded-wire tags in order to monitor and evaluate survival rates, maturation rates, and contribution rates to the ocean fisheries.

9. Maturation rates of the production group raised at Cole M. Rivers Hatchery should not exceed: 0.01 for age 2 fish, 0.10 for age 3 fish, 0.70 for age 4 fish, and 0.95 for age 5 fish in order to optimize contribution rates to the fisheries. Changes in broodstock selection practices may be needed to meet these targets.

10. Fall Chinook salmon of hatchery origin should not be released in the area upstream of Gold Ray Dam.

11. Management of spring Chinook salmon should be brought into compliance, or exempted from, the Wild Fish Management Policy that was adopted by the Oregon Fish and Wildlife Commission in 1992. Current management strategies are not in compliance with the policy

because (1) hatchery fish now appear to compose more than 10% of the natural spawners, (2) wild fish compose less than 30% of the hatchery broodstock, and (3) wild-type phenotypes of the present population of wild fish are not maintained in hatchery fish.

Fishery managers have five options by which to bring management strategies for spring Chinook salmon into compliance with the Wild Fish Policy: (1) release no hatchery fish, (2) limit the number of hatchery fish to less than 50% of the naturally spawning population and establish hatchery practices to include at least 30% wild fish in the broodstock and establish wild-type phenotypes among hatchery fish, (3) limit the number of hatchery fish to less than 10% of the naturally spawning population, (4) classify the production of hatchery fish as a special rehabilitation program, and (5) exemption from the policy. Implications associated with each of these options are discussed in the report.

12. We recommend no adjustments to the management of the ocean fisheries for Chinook salmon, except as outlined in the succeeding recommendation. Current programs designed to manage fall Chinook salmon produced in the Klamath River Basin of northern California should provide sufficient protection to spring Chinook salmon of Rogue River origin because both populations exhibit similar patterns of distribution in the ocean and contribute to the ocean fisheries at similar rates.

13. Management plans should identify a minimum spawning escapement for age 4-6 spring Chinook salmon and should regulate harvest as needed to meet the goal. The management option selected under the Wild Fish Policy will probably affect any goal chosen for minimum spawning escapement. Our findings are insufficient for identification of specific spawning goals because we found a linear, rather than a curvilinear, relationship between spawning escapement and resultant juvenile production.

14. Habitat projects designed to maintain or increase the production of spring Chinook salmon should be directed at gravel quality and quantity in the Rogue River and in Big Butte Creek.

15. Management plans for public and private lands in the Rogue River Basin should identify and minimize activities that may increase the intensity of peak flows in autumn-winter and may increase water temperature in summer.

16. Continual removal of Umpqua squawfish from the Rogue River should be supported to the greatest possible extent to reduce predation losses of juvenile Chinook salmon.

17. Information related to the impact of Umpqua squawfish on anadromous salmonids in the Rogue River should be publicized in order to decrease the chance that the species is unintentionally introduced into other coastal basins in southwest Oregon and northern California.

APPENDIX D

Brief History of Hatchery Programs for Spring Chinook Salmon in the Rogue River

1877 - R.D. Hume begins raising spring Chinook salmon near Gold Beach.
1899 - Brood stock collection site moved to upper river.
1918 - Brood stock collection site moved to Big Butte Creek. United States Bureau of Fisheries takes over program.
1921 - Rearing of fry to the fingerling stage begins. Fish are raised at Butte Falls Hatchery.
1938 - Oregon State Game Commission takes over program.
1949 - Evaluation of hatchery program begins.
1962 - Evaluation of hatchery program ends. Findings included (1) releases in the middle river and in the upper river survived at greater rates as compared to releases in the lower river and in the canyon, (2) releases in December survived at greater rates as compared to releases during other months (July through March). Hatchery fish composed an average of 2% of the spring Chinook salmon run.
1973 - Cole M. Rivers Hatchery begins operation. Brood stock is developed from fish that volitionally entered the hatchery. Brood stock practices attempt to randomly mate fish in order to mimic wild fish genetics and life history.
1976 - Size and time of release experiments (Phase I) begin.
1977 - Experimental release in estuary. Returns indicate almost no survival.
1978 - First outbreak of bacterial kidney disease.
1980 - Erythromycin feeding and incubation experiments begin.
1981 - Experimental release of spring Chinook salmon in the Applegate River. Returns indicated a low survival rate.
1981 - Effect of release time on age-at-maturity first noted.
1981 - Recycling of excess hatchery adults begins in the upper river.
1982 - Off-station and on-station release experiments begin. Results indicated there were no differences between groups in adult homing rates to the hatchery, or time of hatchery entry.
1984 - Recycling of excess adults found to be cost-effective.
1985 - Time of release experiments (Phase II) begin.
1987 - Time of release experiments (Phase I) completed. Results indicated that fish released in October survived at greater rates as compared to fish released in December or March.
1988 - Broodstock collection guidelines modified to include older fish.
1990 - Incubation of eggs and sac-fry changed to single pass water system.
1993 - Experimental release of acclimated fish held in net pens for about one month at a site 27 miles downstream of the hatchery. Results indicated there were no differences between groups in homing rates to the hatchery, or in the time of hatchery entry.
1999 – First release of 100% marked smolts (mostly adipose fin clips).
2000 - Loss of 1.4 million fry results in shortfall of about 1.2 million smolts. ODFW decides to increase releases in 2001-2004 by 0.3 million smolts annually, and to increase the number of recycled adults.

APPENDIX E

Development of the Desired Status Statement

During initial discussions about the composition of a potential statement of desired status, the advisory committee and ODFW considered a number of potential quantitative metrics that could be included in a desired status statement. The form of the metrics (averages or medians) was also considered, along with the period of time for which metrics could apply. After review of the variation associated with potential short-term (2-3 years) and potential long-term (10-20 years), and the uncertainty associated with making management decisions based on a few years of data, there was a general consensus that elements of desired status should encompass a period of about two successive brood years. As almost all NP CHS mature by age 5, the advisory committee and ODFW concluded that desired status elements should encompass ten years. In addition, there was general agreement that desired status elements should be characterized as running averages in order to capture almost the entire period of two successive brood years. Generic elements that were initially considered included (1) abundance, migration timing, age composition, spawning time, and spawning distribution of NP CHS, (2) relative abundance of hatchery fish among migrating and spawning CHS, and (3) relative abundance of CHF among all naturally produced adult Chinook salmon in the SMU. Final choices focused on those attributes which were considered most directly related to the abundance and life history of NP CHS, and could be effectively monitored through time.

Identification of specific numerical estimates began with consideration of whether it was possible to restore the abundance and life characteristics of NP CHS to levels comparable to those observed before the construction of Lost Creek Dam. However, the advisory committee concluded that complete restoration would be impossible without the removal of Lost Creek Dam.

The first draft desired status statement was crafted by the advisory committee during June of 2005. The committee focused on a status statement that accounted for blockage of habitat that resulted from construction of Lost Creek Dam. Subsequent statements reflect change in status elements as various issues were evaluated and discussed. Primary issues examined during the process included:

1. Implications of Lost Creek Dam being operated solely for flood control (no storage)
2. Implications of Lost Creek Dam being operated with increased storage allocations for fishery enhancement purposes.
3. Implications of variations in release strategies at Lost Creek Dam.
4. Implications of variations in operating strategies at Cole M. Rivers Hatchery.
5. Implications associated with the interaction of NP CHS and CHS of hatchery origin.
6. Implications associated with the selective harvest of NP CHS in the ocean and freshwater fisheries.
7. Implications associated with variations in harvest rates and spawning escapement.
8. Implications associated with changes in the life history characteristics of NP CHS.
9. Implications associated with various measures that could be employed to either improve, or expand, habitat for NP CHS.

As these evaluations and discussions proceeded, draft desired status statements were modified multiple times, as outlined on the following pages.

ADVISORY COMMITTEE WORKING STATEMENT OF DESIRED STATUS (as of 22 June 2005[a])

1. On average, at least 23,000 wild spring Chinook salmon should annually pass Gold Ray Dam. This goal represents a running average over a period of 10 years.

2. On average, at least 50% of the wild "adult" spring Chinook salmon should annually pass Gold Ray Dam by 15 June. Adults are defined as fish greater than 24 inches in length as compared to smaller fish (jacks). This goal represents a running average over a period of 10 years.

3. On average, jacks smaller than 24 inches should compose no more than 10% of the wild spring Chinook salmon that annually pass Gold Ray Dam. This goal represents a running average over a period of 10 years.

4. On average, among wild spring Chinook salmon that spawn during September, at least 60% should spawn upstream of the Highway 62 bridge in Shady Cove. This goal represents a running average over a period of 10 years.

5. On average, at least 50% of the spring Chinook salmon that pass Gold Ray Dam should spawn during September. This goal represents a running average over a period of 10 years.

6. On average, hatchery fish should compose no more than 10% of the spring Chinook salmon that spawn naturally during September. This goal represents a running average over a period of 10 years.

[a] *Element was subsequently dropped by the advisory committee because monitoring of the element required that spring Chinook salmon be tagged annually at Gold Ray Dam.*

ADVISORY COMMITTEE WORKING STATEMENT OF DESIRED STATUS (committee changes of 7 January 2006 in bold text)

1. On average, at least **15,000**[a] wild spring Chinook salmon should annually pass Gold Ray Dam. This goal represents a running average over a period of 10 years.

2. On average, at least 50% of the wild "adult" spring Chinook salmon should annually pass Gold Ray Dam by 15 June. Adults are defined as fish greater than 24 inches in length as compared to smaller fish (jacks). This goal represents a running average over a period of 10 years.

3. On average, jacks smaller than 24 inches should compose no more than 10% of the wild spring Chinook salmon that annually pass Gold Ray Dam. This goal represents a running average over a period of 10 years.

4. On average, among wild spring Chinook salmon that spawn during September, at least 60% should spawn upstream of the Highway 62 bridge in Shady Cove. This goal represents a running average over a period of 10 years.

5. On average, hatchery fish should compose no more than 10% of the spring Chinook salmon that spawn naturally during September. This goal represents a running average over a period of 10 years.

[a] *Goal was modified by the advisory committee because assessments indicated that this level of production was unlikely without major changes in water level during the winter at Lost Creek Lake.*

ADVISORY COMMITTEE WORKING STATEMENT OF DESIRED STATUS (committee changes of 18 February 2006 in bold text)

1. On average, at least 15,000 wild spring Chinook salmon should annually pass Gold Ray Dam. This goal represents a running average over a period of 10 years.

2. On average, at least 50% of the wild "adult" spring Chinook salmon should annually pass Gold Ray Dam by 15 June. Adults are defined as fish greater than 24 inches in length as compared to smaller fish (jacks). This goal represents a running average over a period of 10 years.

3. On average, jacks smaller than 24 inches should compose no more than 10% of the wild spring Chinook salmon that annually pass Gold Ray Dam. This goal represents a running average over a period of 10 years.

4. On average, among wild spring Chinook salmon that spawn during September, at least 60% should spawn upstream of the Highway 62 bridge in Shady Cove. This goal represents a running average over a period of 10 years.

5. On average, hatchery fish should compose no more than 10% **of naturally spawning spring Chinook salmon**[a]. This goal represents a running average over a period of 10 years.

[a] *Goal was modified by the advisory committee in order to establish a goal that covered the entire population, rather than a segment of the population.*

ODFW WORKING STATEMENT OF DESIRED STATUS[a] (17 April 2006)

1. On average, at least 15,000 wild spring Chinook salmon should annually pass Gold Ray Dam. This goal represents a running average over a period of 10 years.

2. On average, at least 60% of the wild "adult" spring Chinook salmon should annually pass Gold Ray Dam by 15 June. Adults are defined as fish greater than 24 inches in length as compared to smaller fish (jacks). This goal represents a running average over a period of 10 years.

3. On average, jacks smaller than 24 inches should compose no more than 10% of the wild spring Chinook salmon that annually pass Gold Ray Dam. This goal represents a running average over a period of 10 years.

4. On average, among wild spring Chinook salmon that spawn during September, at least 40% should spawn upstream of the Highway 62 bridge in Shady Cove. This goal represents a running average over a period of 10 years.

5. On average, hatchery fish should compose no more than 20% of naturally spawning spring Chinook salmon. This goal represents a running average over a period of 10 years.

[a] *Goals were developed based on input received from the advisory committee and on fishery management objectives established by the agency.*

COORDINATED (ODFW + ADVISORY COMMITTEE) WORKING STATEMENT OF DESIRED STATUS (19 April 2006)

1. On average, at least 15,000 wild spring Chinook salmon should annually pass Gold Ray Dam. This goal represents a running average over a period of 10 years.

2. On average, at least 60% of the wild “adult” spring Chinook salmon should annually pass Gold Ray Dam by 15 June. Adults are defined as fish greater than 24 inches in length as compared to smaller fish (jacks). This goal represents a running average over a period of 10 years.

3. On average, jacks smaller than 24 inches should compose no more than 10% of the wild spring Chinook salmon that annually pass Gold Ray Dam. This goal represents a running average over a period of 10 years.

4. On average, among wild spring Chinook salmon that spawn during September, at least 40% should spawn upstream of the Highway 62 bridge in Shady Cove. This goal represents a running average over a period of 10 years.

5. On average, hatchery fish should compose no more than 15% of naturally spawning spring Chinook salmon. This goal represents a running average over a period of 10 years.

FINAL COORDINATED (ODFW + ADVISORY COMMITTEE) STATEMENT OF DESIRED STATUS (changes of 20 November 2006 in bold text)

1. On average, at least 15,000 wild spring Chinook salmon should annually pass Gold Ray Dam. This goal represents a running average over a period of 10 years.

2. On average, at least 60% of the wild “adult” spring Chinook salmon should annually pass Gold Ray Dam by 15 June. Adults are defined as fish greater than 24 inches in length as compared to smaller fish (jacks). This goal represents a running average over a period of 10 years.

3. On average, jacks smaller than 24 inches should compose no more than 10% of the wild spring Chinook salmon that annually pass Gold Ray Dam. This goal represents a running average over a period of 10 years.

4. On average, among wild spring Chinook salmon that spawn during September, at least 40% should spawn upstream of the Highway 62 bridge in Shady Cove. This goal represents a running average over a period of 10 years.

5. On average, hatchery fish should compose no more than 15% of naturally spawning spring Chinook salmon. This goal represents a running average over a period of 10 years.

6. There is at least a 99% chance that the population of naturally produced spring Chinook salmon will persist over a period of 100 years.

OTHER POSSIBLE ELEMENTS CONSIDERED FOR INCLUSION IN A DESIRED STATUS STATEMENT

1. On average, at least 50% of the spring Chinook salmon that pass Gold Ray Dam should spawn during September. This goal represents a running average over a period of 10 years. This possible element was dropped by the advisory committee in January 2006 because measurement of attribute would require that naturally produced spring Chinook salmon be tagged annually at Gold Ray Dam.

2. Measurable goals related to (1) the percentage of fall Chinook salmon among all wild Chinook salmon that pass Gold Ray Dam, (2) the percentage of hatchery fish among all Chinook salmon that spawn upstream of Gold Ray Dam, and (3) the percentage of hatchery fish among spring Chinook salmon that pass Gold Ray Dam. These possible elements were set aside by the advisory committee in May and July of 2005 because the committee felt that elements of desired status should be directed solely at spring Chinook salmon and because the committee felt that it was more biologically important to set a goal for the percentage of hatchery fish among spawners as compared to the percentage of hatchery fish in the run.

3. A measurable goal related to the specific age composition of wild spring Chinook salmon that pass Gold Ray Dam (relative abundance of age 2, age 3, age 4, age 5, and age 6 fish). This possible element was dropped in May of 2005 in favor of an element that related to the percentage of jacks in the run.

APPENDIX F

Data and Estimates Used During Plan Development

Appendix Table F-1. Estimates of the number of Chinook salmon that passed the fish counting station at Gold Ray Dam, 1942-2006. Estimates for 1942-1994 were reported by ODFW (2000) and differ somewhat from other estimates distributed by ODFW. Estimates for 1942-47 and 1993-2006 are complete counts, while estimates from 1948-92 are accurate within ± 10% (Li 1948). The underwater viewing chamber was first used to count marked fish in 1969. In earlier years, the proportion of marked fish among the returns was estimated from CHS processed at canneries in Gold Beach.

	Spring Chinook			Fall Chinook		
Year	Wild	Hatchery	Total	Wild	Hatchery	Total
1942	41,779	a	41,779	1,579	a	1,579
1943	36,136	a	36,136	1,926	a	1,926
1944	30,632	a	30,632	1,307	a	1,307
1945	31,998	a	31,998	1,722	a	1,722
1946	28,374	a	28,374	1,681	a	1,681
1947	33,637	a	33,637	1,103	a	1,103
1948	26,979	a	26,979	763	a	763
1949	18,810	a	18,810	1,218	a	1,218
1950	15,530	a	15,530	1,240	a	1,240
1951	19,543	a	19,543	1,568	a	1,568
1952	15,888	a	15,888	2,600	a	2,600
1953	31,327	138	31,465	2,083	0	2,083
1954	24,585	119	24,704	1,081	0	1,081
1955	15,613	101	15,714	836	0	836
1956	27,751	317	28,068	1,884	0	1,884
1957	16,517	1,193	17,710	1,060	0	1,060
1958	14,486	530	15,016	700	0	700
1959	13,918	54	13,972	735	0	735
1960	24,264	110	24,374	1,843	0	1,843
1961	31,006	769	31,775	1,260	0	1,260
1962	30,965	430	31,395	1,256	0	1,256
1963	39,094	1,473	40,567	960	0	960
1964	36,384	1,006	37,390	1,140	0	1,140
1965	51,807	2,406	49,401	1,701	0	1,701
1966	30,825	953	31,778	1,095	0	1,095
1967	14,627	452	15,079	1,838	0	1,838
1968	20,220	625	20,845	a	a	a
1969	57,797	1,107	58,904	2,039	0	2,039
1970	44,857	692	45,549	3,106	0	3,106
1971	28,761	1,124	29,885	2,400	0	2,400

	Spring Chinook			Fall Chinook		
Year	Wild	Hatchery	Total	Wild	Hatchery	Total
1972	29,424	818	30,242	2,739	0	2,739
1973	34,987	583	35,570	2,819	0	2,819
1974b	16,756	508	17,264	2,322	0	2,322
1975b	20,391	1,018	21,409	2,310	0	2,310
1976b	20,542	1,153	21,695	2,648	0	2,648
1977b	14,884	1,511	16,395	5,181	0	5,181
1978b	40,381	6,843	47,224	5,888	0	5,888
1979b	29,536	8,996	38,532	3,097	5	3,111
1980b	26,484	10,167	36,651	2,853	137	2,990
1981b	12,079	5,206	17,285	4,289	480	4,869
1982b	21,043	8,900	29,943	4,078	524	4,602
1983b	8,957	3,554	12,511	3,607	232	3,839
1984b	7,417	5,224	12,641	2,971	215	3,186
1985b	24,020	17,020	41,040	6,085	2,367	8,452
1986b	41,530	47,992	89,522	10,616	3,623	14,239
1987b	33,886	47,696	81,582	8,445	2,255	10,700
1988b	52,488	30,397	82,885	9,397	2,106	11,503
1989b	14,161	46,169	60,330	5,567	1,336	6,903
1990b	8,428	16,162	24,590	3,007	646	3,653
1991b	3,991	8,922	12,913	3,042	163	3,205
1992b	1,618	4,183	5,801	6,100	697	6,797
1993b	8,060	18,043	26,103	6,001	710	6,711
1994b	4,470	9,606	14,076	11,014	516	11,530
1995c	20,726	61,225	81,951	14,105	261	14,366
1996c	10,307	26,314	36,621	11,220	165	11,385
1997c	9,599	32,195	41,794	4,780	77	4,857
1998c	3,684	12,273	15,957	5,264	68	5,332
1999c	5,952	15,029	20,981	3,499	41	3,540
2000c	3,443	26,822	30,265	9,861	31	9,892
2001c	9,340	23,933	33,273	13,351	255	13,606
2002c	6,989	40,792	47,781	18,900	923	19,823
2003c	19,270	22,571	41,841	24,088	769	24,857
2004c	13,254	25,989	39,243	14,541	466	15,007
2005c	5,804	12,286	18,090	8,244	371	8,615
2006cd	4,755	6,963	11,718	6,624	281	6,905

[a] *Estimates could not be developed for these years.*

[b] *Estimates of unmarked hatchery fish were developed from scale analyses of Chinook salmon trapped at Gold Ray Dam (ODFW 2000).*

[c] *Estimates of unmarked hatchery fish were developed based the difference in the proportions of marked spring Chinook salmon at Gold Ray Dam as compared to Cole M. Rivers Hatchery.*

[d] *Preliminary estimates.*

Appendix Table F-2. Estimates of the basic fishery metrics for wild spring Chinook salmon in the Rogue Species Management Unit, 1972-2000 brood years. Estimates assume that among spring Chinook salmon of the same age, that wild and coded-wire tagged hatchery fish were harvested at the same rate (ODFW 2000). Statistical measures of certainty could not be developed for the estimates.

Brood Year	# age 2 in ocean[a]	Ocean harvest[b]	River harvest Total[c]	River harvest Below[d]	River harvest Above[e]	River return[f]	Harvest rate[g]	Recruits[h]	Smolts[i]	Fry[j]	Spawners All	Spawners No jacks
1972	220,394	61,373	5,436	3,372	2,064	26,362	0.76	87,735	--	--	--	--
1973	184,923	50,969	4,439	2,177	2,261	23,722	0.74	74,691	--	--	--	--
1974	283,162	75,730	8,816	3,152	5,664	38,351	0.74	114,081	--	--	--	--
1975	276,218	79,686	8,857	3,026	5,832	30,559	0.80	110,244	3,694,119	359	17,974	11,974
1976	309,885	93,829	9,691	2,520	7,172	36,939	0.79	130,768	1,962,349	195	17,259	12,991
1977	54,159	15,003	2,484	671	1,813	7,089	0.79	22,092	3,311,710	461	9,750	7,784
1978	108,581	23,715	6,944	2,057	4,887	24,343	0.64	48,059	2,431,655	503	33,862	21,747
1979	102,998	14,983	2,825	1,004	1,821	10,881	0.69	25,864	1,932,632	220	22,297	16,108
1980	162,107	6,683	3,726	876	2,850	18,568	0.41	25,251	1,868,784	74	20,583	14,333
1981	47,586	2,127	3,471	904	2,567	15,801	0.31	17,929	916,887	--	6,753	4,143
1982	84,630	14,529	4,541	1,104	3,437	21,487	0.53	36,016	623,152	318	16,217	8,683
1983	240,005	46,278	11,314	2,145	9,169	58,534	0.55	104,813	1,530,471	162	7,482	5,238
1984	308,914	62,939	17,827	3,999	13,827	67,950	0.62	130,889	4,413,059	688	6,430	4,099
1985	114,985	21,232	8,224	1,879	6,344	29,167	0.58	50,399	892,566	607	17,995	10,945
1986	87,713	23,643	5,327	1,504	3,823	14,310	0.76	37,953	3,037,000	653	35,932	11,749
1987	24,712	3,639	1,771	720	1,051	6,043	0.56	9,683	1,471,215	1,432	27,202	15,817
1988	34,450	4,949	2,341	1,230	1,111	7,827	0.57	12,776	1,362,577	693	39,470	27,247
1989	55,048	9,592	3,788	1,902	1,886	10,985	0.65	20,577	1,945,146	957	10,631	8,789
1990	30,640	2,743	2,507	1,144	1,363	9,866	0.42	12,609	854,673	561	5,015	4,096
1991	70,118	2,667	8,813	4,021	4,792	24,262	0.43	26,929	619,392	212	3,118	2,510
1992	49,587	3,275	6,294	3,845	2,449	16,385	0.49	19,660	538,319	49	1,163	906
1993	36,409	1,333	3,727	2,045	1,682	12,629	0.36	13,962	553,457	137	6,340	4,762
1994	5,594	362	545	330	215	1,814	0.42	2,176	496,106	--	2,912	2,633
1995	24,920	223	2,670	1,492	1,178	9,327	0.30	9,550	436,741	--	17,826	16,216
1996	3,449	75	381	158	223	1,208	0.36	1,283	292,964	--	8,867	8,477
1997	39,667	1,145	4,146	1,501	2,645	14,587	0.34	15,732	332,058	--	9,402	9,166
1998	36,031	1,655	3,636	1,344	2,291	11,647	0.40	13,301	--	--	3,672	3,039
1999	57,460	1,774	6,593	2,544	4,049	20,481	0.38	22,255	--	--	5,966	5,799
2000	46,867	3,869	4,620	1,776	2,844	14,966	0.45	18,835	--	--	3,774	2,779

[a] *Estimated number of fish alive in the ocean before any maturation at age 2.*
[b] *Estimated harvest in the ocean fisheries.*
[c] *Estimated number harvested in freshwater.*
[d] *Estimated number harvested in freshwater downstream of Gold Ray Dam.*
[e] *Estimated number harvested in freshwater upstream of Gold Ray Dam.*
[f] *Estimated number that entered freshwater.*
[g] *Estimated as total harvest divided by the number of recruits.*
[h] *Estimated number harvested in the ocean + the number that returned to freshwater.*
[i] *Estimated number of wild fish (estimated from survival rates of hatchery fish).*
[j] *Catch per seine haul, adjusted for the effects of peak flow and water temperature.*
[k] *Estimated number of wild and hatchery fish that spawned naturally.*

Appendix Table F-3. Productivity estimates for spring Chinook salmon in the Rogue Species Management Unit, 1972-2000 brood years. Estimates were derived from numbers reported in Appendix Table F-2.

Brood	Recruits/Spawner		Smolts/Spawner	
Year	All spawners	w/o jacks	All spawners	w/o jacks
1972	--	--	--	--
1973	--	--	--	--
1974	--	--	--	--
1975	6	9.2	206	308
1976	8	10.1	114	151
1977	2	2.8	340	426
1978	1	2.2	72	112
1979	1	1.6	87	120
1980	1	1.8	91	130
1981	3	4.3	136	221
1982	2	4.1	38	72
1983	14	20	204	292
1984	20	31.9	686	1,077
1985	3	4.6	50	82
1986	1	3.2	84	259
1987	0	1	54	93
1988	0	0.5	34	50
1989	2	2.3	183	221
1990	3	3.1	170	209
1991	9	10.7	199	247
1992	17	21.7	463	594
1993	2	3	87	116
1994	1	1	170	188
1995	1	1	24	27
1996	0	0.2	33	35
1997	2	1.7	35	36
1998	4	4.4	--	--
1999	4	4	--	--
2000	5	6.8	--	--

APPENDIX G

Conservation Assessment and Planning Model

Background

The following describes CAPM (Conservation Assessment and Planning Model) a population viability model that was developed to assist salmonid conservation and recovery planning in Oregon. The model's primary outputs are forecast probabilities of population extinction. Each forecast is performed under a specific set of assumptions concerning key variables such as reproductive rate, habitat capacity, environmental variability, critical population abundance, proportion of hatchery fish, and fishery related mortality rates. Values for these variables (and others contained within the model structure) can be set to represent current conditions for the population or they can be set to reflect alternate conditions that are expected to occur in response to the implementation of specific recovery strategies. Therefore, modeling results can provide insight into the likelihood of population extinction should conditions remain unchanged in the future and also the likelihood of population extinction should these conditions change in response to implementation of successful recovery strategies.

A wide variety of viability models have been used by conservation biologists to estimate the vulnerability of populations to extinction (Shaffer 1981, 1990; Murphy et al. 1990; Nickelson and Lawson 1998). CAPM represents yet another approach to estimating population viability. It was generally based on methodology described by Burgman et al. (1993) and Morris and Doak (2002). However, CAPM also draws on original methodologies described here for the first time here.

In general, CAPM forecasts the probability of population extinction by simulating wild spawner abundance over a future time period of 100 years. Depending on the average life age of the species, this requires the simulation of 20 to 33 cycles of spawners and subsequent recruits (100 years). CAPM relies on spawner-recruit functions to accomplish this. These functions predict recruits (offspring) from two variables: 1) the number of parents (spawners), and 2) an independent environmental index of cyclic variations in freshwater and marine survival. SNEG, an index of high elevation maximum snow depths, was used as the environmental survival variable. Although, several other survival related indices were considered for this purpose (e.g. PDO, OPI, and PNI), SNEG, when evaluated across all species, appeared to have the greatest power to explain observed variations in population recruitment.

As is characteristic of all population viability models, CAPM attempts to mimic the stochastic behavior of population recruitment as it occurs in nature. Without this stochastic component added to the model, recruitment functions will always yield the same value for recruits produced for each input value for spawner abundance. So for example, from a spawner escapement 500 fish, a specific recruitment function might predict 800 recruits would be produced. More importantly, each time a spawner abundance of 500 was seeded into the recruitment function, the forecast number of subsequent recruits would always be exactly 800. However, real fish populations don't behave this way. For example, the repetition of a 500 fish spawner escapement for say 10 years in a row, would most likely result in 10 different values for the number of recruits produced. These recruit abundance values may average 800 fish, but random and unknown variations in annual survival could easily produce a range in the annual recruit number from 400 to 1200. Therefore, the inclusion of a stochastic component to CAPM, ensured that recruitment functions would produce a range of values from each spawner abundance level rather than the same answer over and over. It was assumed that inclusion of this stochastic element would produce a more accurate model of real populations and their vulnerability to extinction.

Although the stochastic component is not unique among population viability assessment (PVA) models, there are several features of CAPM that are perhaps atypical. The first is the use of an independent environmental variable (SNEG) within the recruitment function. This was done to obtain a more accurate mathematical description of the biological recruitment process observed for each population. Secondly, rather than using only one recruitment model to simulate population recruitment, CAPM uses three. It was assumed that in doing so the adverse consequences of case by case inaccuracies of data fits to a particular recruitment function could be reduced. Thirdly, a probability of extinction was calculated for each set of recruitment function parameters estimated via the bootstrap process (description to follow). Therefore, CAPM results for each run of the model consist of many estimates of probability extinction for each population. The range, median and distribution of these extinction probabilities is used to help gauge model results in terms of uncertainty with respect to how well the shape of the recruitment curves fit observed population data.

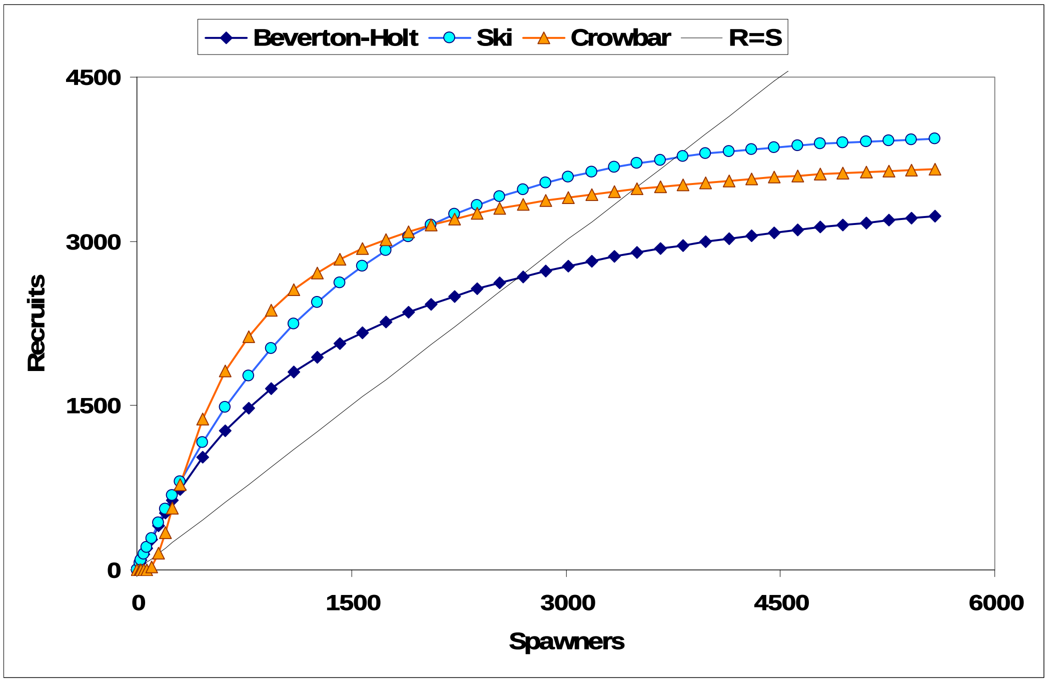
Key topics discussed in this summary of CAPM are: 1) the population recruitment function, 2) fitting population recruitment curves, 3) addition of stochastic effects, 4) assumptions about future conditions, 5) program mechanics, and 6) model output.

Population Recruitment Function

As stated earlier three equations were used to simulate population recruitment. The first of these was based on the Beverton-Holt recruitment model (Beverton-Holt 1957). The second function was the Ski recruitment model. This is a previously undescribed recruitment curve that is similar to the Beverton-Holt (BH) model. However the Ski (SK) curve builds to maximum recruit capacity more rapidly than the BH model for each increment in spawner abundance, from mid-range spawner levels upward (Appendix Figure G1). The Crowbar model, also a previously undescribed recruitment curve, was the third function used by CAPM. The Crowbar (CB) function is similar to the SK function however it has a unique feature in that reproductive rates at very low spawner abundance levels decline rather than increase (Appendix Figure G2). As a consequence maximum recruits per spawner typically occur at higher spawner abundance levels than for either the BH or SK curves. Essentially the CB curve has built-in depensation, while the BH and SK curves do not. Mathematically these three recruitment functions are described by the following equations:

Beverton-Holt:	$R_t = (a * S_t) / (1 + (a / b * S_t))$	(1)
Ski:	$R_t = b * (1 - \exp(- (a / b * S_t)))$	(2)
Crowbar:	$R_t = b * \exp((- b * \exp(- 1)) / (a * S_t))$	(3)

Where R_t = the total number of adults produced from the spawners of a particular year (t), S_t = number of spawners in year t, a = maximum recruits per spawner, b = and capacity of habitat expressed as maximum possible recruits.

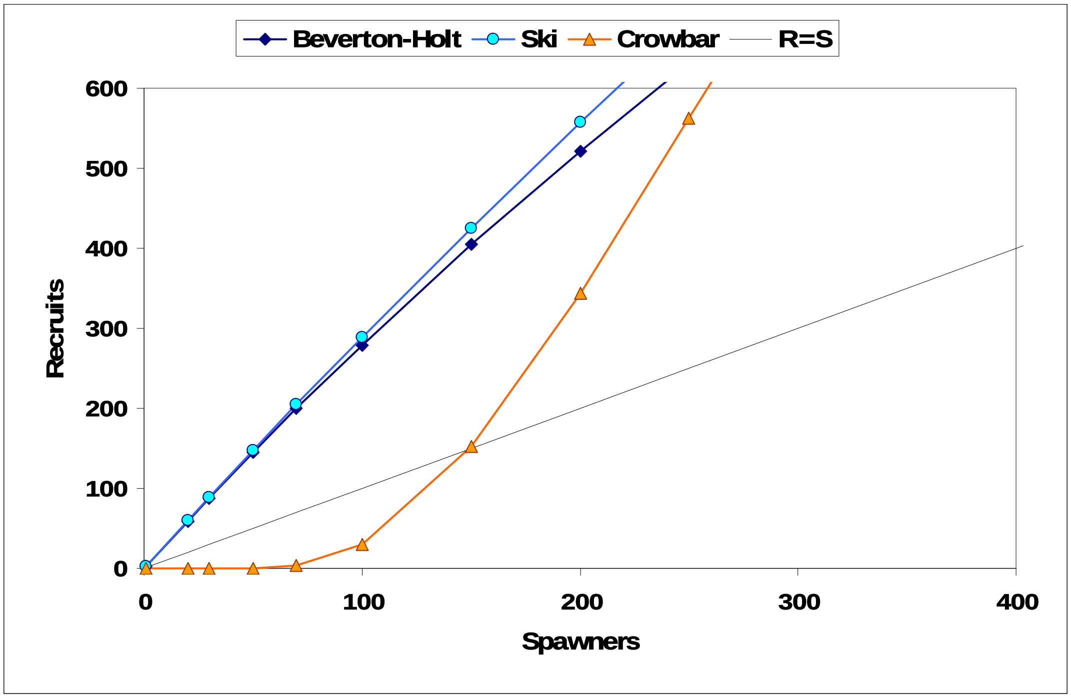


Appendix Figure G1. Recruitment curves for three spawner-recruit functions used within CAPM for an example where maximum recruits per spawner (a) equals 3.0 and maximum habitat capacity (b) equals 4,000.

As noted earlier, the CAPM recruitment functions included an environmental variable, SNEG. The inclusion of this variable changed the recruitment relationship from the 2-dimenisional curve of Appendix Figure G1, to a 3-

dimensional recruitment surface as illustrated in Appendix Figure G3. Mathematically the inclusion of this second variable modifies the recruitment Equations 1, 2, and 3 to the following:

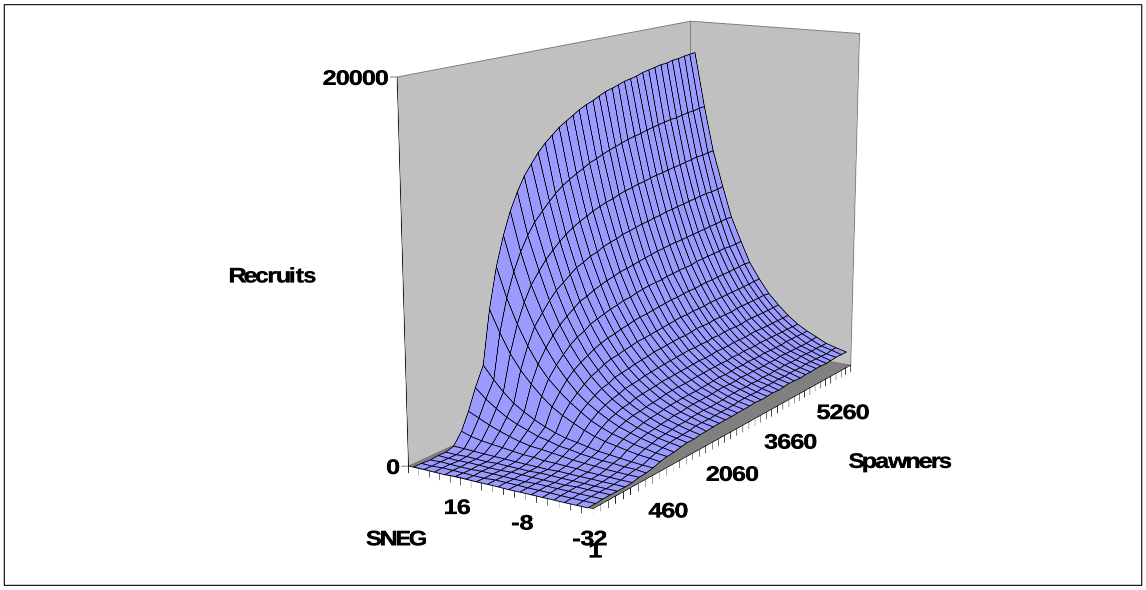
BH:	$R_t = (a * S_t) / (1 + (a / b * S_t)) * (\exp(c * SNEG_{t+m}))$	(4)
SK:	$R_t = b * (1 - \exp(- (a / b * S_t))) * (\exp(c * SNEG_{t+m}))$	(5)
CB:	$R_t = b * \exp((- b * \exp(- 1)) / (a * S_t)) * (\exp(c * SNEG_{t+m}))$	(6)



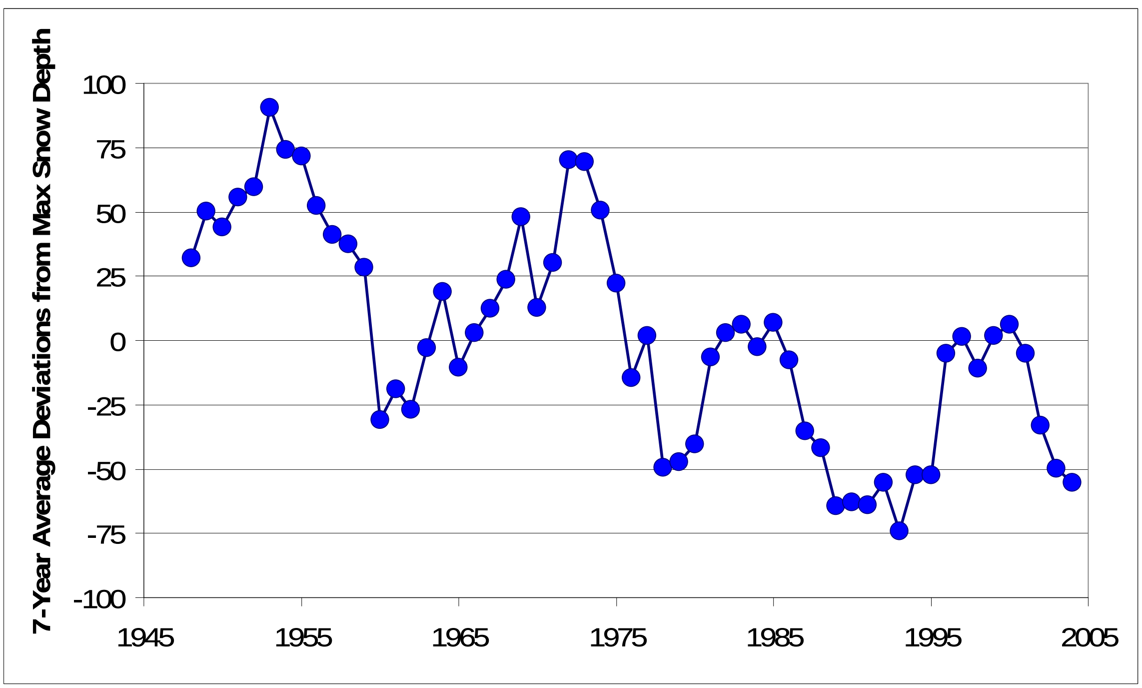
Appendix Figure G2. Recruitment curves for three spawner-recruit functions used within CAPM for an example where maximum recruits per spawner (a) equals 3.0 and maximum habitat capacity (b) equals 4,000, (same as Appendix Figure G1, but expanded to better compare functions at low spawner abundance levels).

Where R_t, S_t, a, b are as defined in previously (Equations 1, 2, and 3) and c = the parameter for the snow index $SNEG_{t+m}$ for the year t+m, where t = spawner brood year, and m = a modification number that best aligns the index to the recruitment performance of the species and region. The value for m ranges from +2 to -2.

The snow index (SNEG) was derived from the maximum annual snow depths observed at Mt. Rainier and Crater Lake National Park sample sites from 1945 to present. These annual average snow depths were then converted so they were expressed as a deviation from the 1945 to 2007 average. A negative value in the resulting data set meant the maximum depth was less than the 1945-2007 average; a positive value meant the snow depth measurement was greater than the 1945 to 2007 average. The SNEG index was calculated as the 7-year moving average of these data. Therefore the 1948 SNEG year was the average of annual snow deviations from 1945 to 1951, the 1949 SNEG year the average of annual data from 1946 to 1952, and so forth until the last index point for the 2004 SNEG year which was the average of the years 2001 to 2007. As illustrated in Appendix Figure G4 these 7-year averages show both a cyclic pattern and a downward slope since the 1950s.



Appendix Figure G3. Illustration of Crowbar recruitment function with SNEG variable added (a = 3.0, b = 4,000, and c =0.05)



Appendix Figure G4. SNEG 7-year moving average index of annual maximum snow depths, expressed as deviations (cm) from 1945 to 2007 mean maximum snow depth; snow data are from annual measurements averaged for two high elevation monitoring stations, Mt. Rainier and Crater Lake.

Fitting Population Recruitment Curves

Fitting the recruitment curves to the observed data was a two step process. First a baseline data set of spawners, recruits, and SNEG index values was constructed. Because the SNEG index was not population specific, it was easily obtained following methods previously described. However, spawner and recruit data sets were more difficult to develop. For many populations, there are either no data or too few years of data to perform a recruitment analysis.

Where sufficient data exist there were often data gaps of unknown hatchery fish fractions that must resolved in order to build a useable data set. Although the steps involved were specific to each population, there are several common and important elements that should be highlighted.

One of these important elements is that "spawners" are defined as the total of both wild and naturally spawning hatchery fish. When hatchery fish occur in the data base they are not given a reproductive success "discount" to correct for their likely reproductive inefficiency compared to wild fish. The discounting step was not taken for several reasons. First, it is not clear how much of a discount to apply. Second, such discounts may not appropriately account for the full impact of naturally spawning hatchery fish on subsequent population productivity. For example, in those studies showing large reproductive differences in reproductive success between naturally spawning hatchery fish and wild fish, a sizable portion of the naturally produced smolts were offspring of hatchery spawners. However, the marine survival of those natural smolts having hatchery parentage is typically less than those from wild parents. Therefore, there is likely a density dependent effect of hatchery spawners on smolt production, that can not be accounted for by applying a simple discount to hatchery spawners proportional full life history reproductive differences between hatchery and wild spawners.

Another important feature of the recruitment curve fitting was the estimation of brood year specific recruits from spawner escapement data. The number of recruits produced by each brood year of spawners was estimated by reconstructing each production group using the following relationship:

$$R_t = \sum [(A_j * S_{t+j})/(1 - F_{t+j})] \qquad (3)$$

where R_t represents the number of naturally produced (wild) recruits by fish that spawned in year t, A_j is the proportion of fish having age j at spawning (j = 2, 3, 4, 5, 6, 7), S_{t+j} is the number of wild spawners in year t + j, and F_{t+j} is the cumulative fishing mortality rate for the return of fish that spawned in year t + j.

The second step of fitting the recruitment curves was estimating the parameters for each equation and capturing the uncertainty associated with these estimates. Recruitment equation parameters were estimated via multivariate non-linear regression using the DataFit software developed by Oakdale Engineering (Oakdale, Pennsylvania). The DataFit software parameter estimation algorithm is based on the Levenberg-Marquardt method described by Marquardt (1963). Because the errors were assumed to be log-normally distributed, the form of the recruitment equations upon which the regression analyses were performed were modified to the lognormal form as follows, where ϵ_t represents the lognormal error term.

BH: $Ln(R_t) = Ln(a) + Ln(S_t) - Ln(1 + (a / b * S_t)) + (c * SNEG_{t+m}) + \epsilon_t$ (7)
SK: $Ln(R_t) = Ln(b) + Ln(1 - exp(- (a / b * S_t))) + (c * SNEG_{t+m}) + \epsilon_t$ (8)
CB: $Ln(R_t) = Ln(b) + ((- b * exp(- 1)) / (a * S_t)) + (c * SNEG_{t+m}) + \epsilon_t$ (9)

The regression input data as used for CAPM consisted of a table with the first two columns containing the annual values for the predictor variables S (spawner abundance) and SNEG (snow index) and the third column the corresponding values for the response variable Ln(R) (natural log of recruits). Each row of the data table represented the observations associated with one brood year.

The procedure for estimating equation parameters and the associated standard deviation of the residuals entailed more than performing a single DataFit-based regression analysis of a population's data set. Instead, a Monte Carlo bootstrapping procedure was used to repeatedly sample the population data set. A regression analysis was then performed on each data set sample using the same DataFit-based nonlinear regression routine. This meant that for every bootstrap sample an estimate of recruitment equation parameters and associated standard deviations were generated for all three recruitment curves (BH, SK, and CB). Therefore, if 500 bootstrap samples were drawn, 500 parameter and standard deviation estimates for each of the three recruitment equations would be generated. The primary purpose of this extended bootstrap procedure was to better understand the range and magnitude of possible errors in estimating recruitment equation parameters.

Simulating Population Recruitment - Addition of Stochastic Effects

An important element of simulating population recruitment within CAPM was the inclusion of random variation in the recruitment process. This element was intended to represent the effect of natural variations in annual recruitment and be consistent with the assumption that for real populations, the recruitment process is not a simple, unwavering deterministic process. To accomplish this, the error term (ϵ_t) in equations 7, 8, and 9 was replaced with a number (dev_t) randomly drawn from a normal distribution having a mean of zero and standard deviation equal to the regression standard deviation. Each time one of these equations was used within CAPM to simulate population recruitment; a new random number was drawn and used to calculate a new value for dev_t. This randomly fluctuating component of the recruitment equation was the primary source of stochasticity for CAPM population abundance simulations and ultimately estimates of extinction risk.

Simulating Population Recruitment – Snow Data

Each estimate of population recruitment within CAPM requires a value for SNEG. Therefore, for the population simulation portion of this model it was necessary to generate 100-year sequences of the SNEG index in manner that was consistent with observed SNEG values of the past Appendix Figure G4. The method implemented within CAPM to do this begins by randomly selecting 120 snow depth values from a normal distribution having a mean equal to the 1945-2007 maximum snow depth value (442 cm) and a standard deviation from the same period (101 cm). For most model runs each pool of random numbers was adjusted downward to make the starting snow conditions equal to the average snow depth conditions of the last 30 years (1977 to 2007). This adjustment entailed subtracting the difference between 1977-2007 snow average and the 1945-2007 snow average (37cm) from each random number. In addition, CAPM was also capable of performing model runs that assumed a downward long-term trend in maximum snow depth. To implement this capability within a model run, each randomly picked snow depth value was adjusted downward by subtracting: (the slope of the downward trend expressed as change in snow depth per year) x (year number in model run sequence -1). For example, in year 2 of the simulation, if the change rate was expected to be -0.5cm per year and then the snow depth value would be adjusted downward by -0.5cm. In year 3, the adjustment would be – 1.0 cm, for year 4, -1.5cm, and so forth.

Once the string of randomly selected snow depths had been selected and adjusted, they were converted to be deviations by subtracting from each, the 1945 to 2007 mean snow depth (37cm). Model run values for SNEG were then calculated as the moving 7-year averages of this string of annual snow depth deviations. The same string of SNEG values were used for each bootstrap sample and associated parameter estimates.

Assumptions about Future Conditions

Like all viability models, CAPM is build around assumptions concerning the future conditions a population will likely experience. Since model runs are meant to simulate a future time period lasting 100 years, these future condition assumptions are usually critical to extinction probabilities forecast by the model. As reported here, CAPM results were generally based on the assumption that future conditions would approximate those experienced by populations from 1977 to 2007. The primary way for doing this was as previously described, constructing the simulation values for the SNEG index such that they would be representative of the 1977 to 2007 observations.

However, with respect to harvest and naturally spawning hatchery fish, the simulated future conditions were not always intended to represent those observed from 1977 to 2007. For fishery harvest the reason for this was that fishery impacts prior to the 1990s were higher than those of the most years and those anticipated in the future. For example, lower Columbia coho experienced cumulative harvest rates of 75% to 90% prior to 1990. Since 1990, these rates have been reduced and it is unlikely that for wild fish they will exceed 25% in the future.

The second departure from past conditions is the way hatchery fish were treated. In many populations the presence of hatchery fish on the spawning grounds has been a significant, yet highly variable feature. Most evidence suggests that naturally spawning hatchery fish tend to lower the overall natural reproductive rate for mixed populations of hatchery and wild fish compared to populations comprised only of wild fish.
However, in terms of natural offspring produced, hatchery fish may also make a substantial contribution, especially when they represent more than 50% of the natural spawning population.

The net effect of increased spawners and decreased reproductive rate as a result of naturally spawning hatchery fish is difficult to evaluate. However, for the purposes of understanding extinction risk and recovery potential, the key question is whether the wild fish would able to sustain themselves without ‘reproductive support’, should this ‘support’ indeed be a net positive benefit. As self-sustainability is the key question, we have chosen to make two conservative assumptions about future conditions as it relates to hatchery fish. First, that the recruitment parameters estimated during the period when hatchery fish were present in the past, are assumed to be representative of the wild fish in the population. Second, only wild fish are assumed to be present in the future and as a consequence their persistence dependent only on their ability to be self-sustaining. In this way the results obtained from the modeling exercise reflect our best estimate of the potential of the wild fish to maintain themselves in the future.

In reality, it is expected that substantial improvements in the natural reproductive rate will occur in many populations because the proportion of naturally spawning hatchery fish has been greatly reduced in recent years. For example, winter steelhead populations in the upper Willamette ESU. Also, it is possible that in places where naturally spawning hatchery will continue to occur (e.g. coho in the Youngs Bay streams), a portion of the naturally produced fish will be dependent on the reproductive contribution of stray hatchery fish.

However, the key question to be addressed by the viability modeling effort was: “if we assume the productive capacity of the population observed over the past 30 years is representative of wild fish, would such a population be self-sustaining in the future with no hatchery fish present.” This is a conservative way to ask the question because it assumes any possible negative impact of past interactions with hatchery fish will continue and yet the future contribution of stray hatchery fish to the production of naturally produced offspring would be eliminated.

Program Mechanics

The CAPM is a program written in Visual Basic linked to nonlinear regression fitting algorithms provided by DataFit software. An Excel spreadsheet provides the user interface for data input, model run set up and display of the results. Starting with a population data set, CAPM proceeds through a series of calculations to produce multiple estimates of extinction probability. As stated earlier, the result is a distribution of extinction probabilities rather than a single estimate. The key steps in this series of calculations and the order in which they occur for the populations examined in this report are outlined in the following description.

After the raw population data and model conditions are entered, the program generates multiple estimates of the parameters for each of the three recruitment equations via the bootstrap process. For viability estimates 300 bootstrap samples were drawn as described earlier. Each of these bootstrap samples was fit to the three recruitment equations using the DataFit software. The net result was 900 parameter sets (i.e., 300 samples x 3 recruitment equations). For each parameter set, CAPM simulated a future 100 year sequence of population abundance. The starting abundance for each of these 100 year simulations was set to equal the value for recruitment equation parameter for capacity, b, as described in Equations 7, 8, and 9. These 100-year simulations were repeated 500 times for each parameter set. The number of 100-year simulations that were found to incur an ‘extinction event’, was then divided by 500 to obtain a probability of extinction for the parameter sample. This process was repeated until probabilities of extinction probabilities were obtained for all parameter sets. This modeling protocol was computer intensive and time consuming as it essentially required the simulation of 45 million years of population growth and abundance (i.e., 500 repetitions of a 100 year simulation period, for each of 900 parameter sets).

The definition of an ‘extinction event’ was the occurrence of an average spawner abundance that was less than a population specific Critical Risk Threshold (CRT). Conceptually the CRT, was defined the level, below which the recruitment processes and the likelihood of population rebound was judged to be uncertain and potentially unlikely.
The period of years used for calculating the average abundance to test against the CRT was equal to the average age of spawners in the population. So for example, for coho a 3-year average was used and for summer steelhead a 5-year average was used. In summary, the detection of an ‘extinction event’ occurred if within the 100-year simulation of spawner abundance numbers, there was a sequence of years equal to the average age of the species (e.g. 3 years for coho) with an average abundance less than the CRT value.

The process of simulation recruitment under the CAPM also involved an assumption that at extremely low spawner abundance levels recruitment would totally fail. In other words, no recruits would be produced. This reproductive fail point was set at 20% of a population's CRT. So for example, if a population's CRT level was 300 spawners, then the reproductive fail point would be 60, (20% of 300).

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APPENDIX H

Potential Strategies for Management of Freshwater Fisheries Considered during Plan Development

Limiting Factor A16 – fishing mortality in freshwater

The following options for specific regulations apply only to wild Chinook salmon (CH), unless otherwise stated. For all options, the harvest of wild Chinook salmon is closed during August through December in the area upstream of Gold Ray Dam, unless otherwise stated. Also, for all options, gear and method restrictions apply only to the period of January through July, unless otherwise stated.

Alternative A16(a)

Management options are organized under the scenario that wild spring Chinook salmon would be managed without differential protection to various segments of the run. Regional (zone) harvest limits would be employed during fisheries for spring Chinook salmon.

Option A16(a1). Harvest of wild CH and hatchery CH opens 1 July below Gold Ray Dam and is closed above Gold Ray Dam.
Option A16(a2). Harvest of wild CH opens 1 July below Gold Ray Dam and is closed above Gold Ray Dam.
Option A16(a3). Harvest of wild CH opens 1 January below Gold Ray Dam and is closed above Gold Ray Dam.
Option A16(a4). Harvest of wild CH opens 1 July below Gold Ray Dam and is open January-July above Gold Ray Dam.
Option A16(a5). Harvest of wild CH opens 1 July below Gold Ray Dam and is open January-June above Gold Ray Dam.
Option A16(a6). Harvest of wild CH opens 1 June below Gold Ray Dam and is open January-June above Gold Ray Dam.
Option A16(a7). Harvest of wild CH opens 1 May below Gold Ray Dam and is open January-June above Gold Ray Dam.
Option A16(a8). Extend angling deadlines at migration bottlenecks (Rainie Falls, Savage Rapids Dam, Hayes Falls, and Gold Ray Dam).

Alternative A16(b)

Management options are organized under the scenario that wild spring Chinook salmon would be managed without differential protection to various segments of the run. Specialized (non-zone) harvest limits would be employed during fisheries for spring Chinook salmon.

Option A16(b1). Daily and seasonal limit of one wild CH, January-July.
Option A16(b2). Daily and seasonal limit of one wild CH, January-July below Gold Ray Dam. Harvest of wild CH closed above Gold Ray Dam.
Option A16(b3). Daily and seasonal limit of one wild CH, January-July above Gold Ray Dam.

Harvest of wild CH closed below Gold Ray Dam.
Option A16(b4). Daily limit of one wild CH, season limit of three wild CH, January-July
Option A16(b5). Daily limit of one wild CH, season limit of three wild CH, January-July. Harvest of wild CH closed above Gold Ray Dam.
Option A16(b6). Daily limit of one wild CH, season limit of three wild CH, January-July. Harvest of wild CH closed below Gold Ray Dam.
Option A16(b7). Daily limit of one wild CH, January-July.
Option A16(b8). Daily limit of one wild CH, harvest of wild CH closed above Gold Ray Dam.
Option A16(b9). Daily limit of one wild CH, harvest of wild CH closed below Gold Ray Dam.
Option A16(b10). Daily limit of one CH (wild or hatchery) and harvest of wild CH closes June 30 above Gold Ray Dam.
Option A16(b11). Daily limit of one CH (wild or hatchery) and harvest of wild CH closes July 31 above Gold Ray Dam).
Option A16(b12). Extend angling deadlines at migration bottlenecks (Rainie Falls,

Savage Rapids Dam, Hayes Falls, and Gold Ray Dam).

Alternative A16(c)

Management options are organized under the scenario that wild spring Chinook salmon would be managed without differential protection to various segments of the run. Specialized (non-zone) harvest limits would be employed during fisheries for spring Chinook salmon.

Option A16(c1). Daily and seasonal limit of one wild CH, January-July.
Option A16(c2). Daily limit of one wild CH, season limit of three wild CH, January-July.
Option A16(c3). Daily limit of one wild CH, January-July.
Option A16(c4). Daily limit of one CH (wild or hatchery), January-July.

Package 1 - Gear and Method Options

Gear restrictions include: (1) two hooks maximum per line, (2) barbless hooks only, maximum hook size of #1 on non-floating lures, (4) maximum hook size of 2/0 for single hooks, (5) maximum leader length of five feet between attached weight and farthest hook.

Method restrictions include: (1) CH to be released must be kept in water, (2) soft nets must be used when handling CH in areas downstream of Hog Creek, (3) no fishing from moored device, Touvelle Park – Cole M. Rivers Hatchery, May – October, (4) ODFW recommends, to Oregon State Marine Board, no motor use between Touvelle Park and Cole M. Rivers Hatchery, May – October.

Package 2 - Gear and Method Options

Gear restrictions include: (1) maximum leader length of five feet between attached weight and farthest hook, (2) no treble hooks allowed, except on floating lures.

Method restrictions include: (1) CH to be released must be kept in water, (2) soft nets must be used when handling CH in areas downstream of Hog Creek.

Alternative A16(d)

Management options are organized under the scenario that wild spring Chinook salmon would be managed with differential protection to various segments of the run. Regional (zone) harvest limits would be employed during fisheries for spring Chinook salmon.

Option A16(d1). Harvest of wild CH is closed upstream of Dodge Bridge.
Option A16(d2). Harvest of wild CH is closed upstream of Shady Cove.
Option A16(d3). No fishing allowed, May – October, Elk Creek – Shady Cove.
Option A16(d4). No fishing allowed, May – October, Shady Cove – Dodge Bridge.
Option A16(d5). Harvest of wild CH opens 1 May below Gold Ray Dam and is closed above Gold Ray Dam.
Option A16(d6). Harvest of wild CH opens 1 June below Gold Ray Dam and is closed above Gold Ray Dam.
Option A16(d7). Harvest of wild CH opens 1 July below Gold Ray Dam and is closed above Gold Ray Dam.
Option A16(d8). Harvest of wild CH opens May 1 below Gold Ray Dam and is open July + August, Dodge Bridge to Gold Ray Dam.
Option A16(d9). Harvest of wild CH opens June 1 below Gold Ray Dam and is open July + August, Dodge Bridge to Gold Ray Dam.
Option A16(d10). Harvest of wild CH opens 1 June below Dodge Bridge and closes 31 August above Gold Ray Dam.
Option A16(d11). Harvest of wild CH opens 1 July below Dodge Bridge and closes 31 August above Gold Ray Dam.
Option A16(d12). Harvest of wild CH opens June 1 below Gold Ray Dam and is open July + August, Shady Cove to Gold Ray Dam.
Option A16(d13). Harvest of wild CH opens June 1 below Gold Ray Dam, closes June 30 above Dodge Bridge, and closes August 31 above Gold Ray Dam.
Option A16(d14). Harvest of wild CH opens June 1 below Gold Ray, closes June 30 above Shady Cove, and closes August 31 above Gold Ray Dam.
Option A16(d15). Extend deadlines at migration bottlenecks (Rainie Falls, Savage Rapids Dam, Hayes Falls, and Gold Ray Dam).

Alternative A16(e)

Management options are organized under the scenario that wild spring Chinook salmon should be managed with differential protection to various segments of the run. Specialized (non-zone) harvest limits would be employed during fisheries for spring Chinook salmon.

Option A16(e1). Harvest of wild CH is closed upstream of Dodge Bridge.
Option A16(e2). Harvest of wild CH is closed upstream of Shady Cove.
Option A16(e3). Harvest of wild CH is closed in the area between Rogue Elk Park and the Highway 62 bridge at McGregor Park. Area is open only to flyfishing or fishing with floating lures.
Option A16(e4). Daily and seasonal limit of one wild CH for (inclusive):
Mouth to Hog Creek, January - May (zone limits after May),
Hog Creek to Gold Ray Dam, January - June (zone limits after June),
Gold Ray Dam to McGregor Park, January - July,
McGregor Park to Cole M. Rivers Hatchery, January - 15 September.

Option A16(e5). Daily limit of one wild CH, season limit of three wild CH, for (inclusive):
Mouth to Hog Creek, January - June (zone limits after June),
Hog Creek to Cole M. Rivers Hatchery, January - July.
Option A16(e6). Daily limit of one wild CH, season limit of three wild CH, for (inclusive):
Mouth to Hog Creek, January - June (zone limits after June)
Hog Creek to Shady Cove, January - July.

Package 1 - Gear and Method Options

Gear restrictions include: (1) two hooks maximum per line, (2) barbless hooks only, maximum hook size of #1 on non-floating lures, (4) maximum hook size of 2/0 for single hooks, (5) maximum leader length of five feet between attached weight and closest hook.

Method restrictions include: (1) CH to be released must be kept in water, (2) soft nets must be used when handling CH in areas downstream of Hog Creek, (3) no fishing from moored device, Touvelle Park – Cole M. Rivers Hatchery, May – October, (4) ODFW recommends, to Oregon State Marine Board, no motor use between Touvelle Park and Cole M. Rivers Hatchery, May – October.

Package 2 - Gear and Method Options

Gear restrictions include: (1) maximum leader length of five feet between attached weight and farthest hook, (2) no treble hooks allowed, except on floating lures.

Method restrictions include: (1) CH to be released must be kept in water, (2) soft nets must be used when handling CH in areas downstream of Hog Creek.

APPENDIX I

Potential Management Actions Considered during Plan Development

List includes only those factors that limit, or have the potential to limit, attainment of desired biological status

DESIRED STATUS ELEMENT: FISH ABUNDANCE (≥15,000 NP CHS)

Limiting Factor A1 - peak flow during egg and sac-fry incubation

Potential management options:

A1(a). ODFW requests that the USACE reduce peak flows during the period of November through March as much as possible under current reservoir management strategies adopted for Lost Creek Lake. **Primary Implications:** This action has been taken (ODFW 2000), but has yet to be incorporated in an ODFW fisheries management plan.

A1(b). ODFW requests that the USACE increase the reduction of peak flows during the period of November through March. **Primary Implications:** This action would usually require that the USACE manage Lost Creek Lake at levels significantly below the rule curve and also would require the release of more than 180,000 acre-feet of reservoir storage annually, which exceeds the amount authorized for a "normal" year (United States Congress 1962).

A1(c). ODFW recommends a specific maximum target for flow in the upper portion of the Rogue River. One plausible target might be 7,000 cfs at Dodge Bridge. **Primary Implications:** This action would decrease flexibility of USACE reservoir regulators if the reservoir level reaches the rule curve and cause the reservoir to be evacuated at greater rates, leading to a potential increase in fry dewatering. In addition, this action may lead to the perception that no regulatory actions should be taken when flows are not expected to reach 7,000 cfs.

A1(d). Take no action. Reductions of peak flows may negatively affect long term productivity of aquatic ecosystems.

Limiting Factor A2 - water temperature during egg and sac-fry incubation

Potential management options:

A2(a). ODFW requests that the USACE release the coldest water possible during November through February. **Primary Implications:** This action has been taken by ODFW (ODFW 2000), but has yet to be incorporated in an ODFW fisheries management plan.

A2(b). Same as option A2(a) except ODFW also requests that the USACE determine if the reservoir operations can be modified to further decrease the temperature of water released during the period of November through February. Development of water temperature models will be needed to accomplish this assessment. **Primary Implications:** This action has been taken by ODFW (ODFW 2000), but has yet to be incorporated in an ODFW fisheries management plan.

A2(c). ODFW requests that the USACE investigate the possibility of bypassing reservoir inflow around, or through, Lost Creek Lake during the period of November through February. **Primary**

Implications: This action may require that the USACE obtain funds to conduct such an assessment.

A2(d). Take no action.

Limiting Factor A3 - flow during egg and sac-fry incubation

Potential management options:

A3(a). ODFW requests that the USACE manage reservoir releases for minimal flow augmentation during the spawning period for CHS in order to minimize the number of redds that would be dewatered during the season of reservoir filling. **Primary Implications:** This action has been taken (ODFW 2000), but has yet to be incorporated in an ODFW fisheries management plan.

A3(b). Take no action.

Limiting Factor A4 - flow decreases during juvenile rearing

Potential management options:

A4(a). ODFW requests that the USACE manage reservoir releases to meet current criteria designed to minimize the potential for dewatering of juvenile NP CHS. **Primary Implications:** This action has been taken (ODFW 2000), but has yet to be incorporated in an ODFW fisheries management plan.

A4(b). ODFW requests that the USACE undertake measures to improve criteria designed to minimize the potential for dewatering of juvenile NP CHS. **Primary Implications:** This action has been taken (ODFW 2000), but has yet to be incorporated in an ODFW fisheries management plan.

A4(c). Take no action.

Limiting Factor A5 - predation by juvenile hatchery fish

Potential management options:

A5(a). ODFW reduces the number of steelhead and/or coho salmon of hatchery origin. **Primary Implications:** Reductions in fishery contributions.

A5(b). ODFW reduces the number of steelhead and/or coho salmon of hatchery origin and, to compensate for the fishery losses, increases the number of juvenile CHS released. **Primary Implications:** This action would increase the relative abundance of hatchery fish among spawning CHS (conflicts with desired status element of no more than 15% hatchery fish among spawners).

A5(c). ODFW reduces residualism among juvenile steelhead and coho salmon by moving to some strict volitional migration criteria at Cole M. Rivers Hatchery. **Primary Implications:** This action would likely result in non-migrants being moved to fisheries for resident salmonids (i.e. lakes) and would result in some level of harvest reduction in the coho salmon and steelhead fisheries. Also, the hatchery would need to be modified so that cleaning effluent can be pumped directly into the abatement pond without using the release channel.

A5(d). Angling regulations would be modified so as to allow for the harvest of juvenile steelhead and coho salmon of hatchery origin during the entire year. **Primary Implications:** This action would increase the non-harvest related mortality on wild juvenile steelhead (juvenile coho salmon not likely to be impacted).

A5(e). Transport, and release, juvenile steelhead and coho salmon downstream of Gold Ray Dam. **Primary Implications:** This action would probably slightly increase the proportions of hatchery fish among naturally spawning steelhead and/or coho salmon.

A5(f). Take no action.

Limiting Factor A6 - water temperature during smolt migration

Potential management options:

A6(a). ODFW requests that the USACE manage reservoir releases to increase survival of migrating smolts by releasing storage that is not needed to decrease disease-related losses of adult CHS and adult CHF. **Primary Implications:** This action has been taken (ODFW 2000), but has yet to be incorporated in an ODFW fisheries management plan.

A6(b). Analogous to option A6(a), except ODFW requests that the USACE manage reservoir releases to maximize smolt survival rates. **Primary Implications:** This alternative will result in increased mortality among adult CHS and adult CHF (ODFW 2000), or more reservoir storage, in excess of the current fisheries allocation, will be needed to protect both races of Chinook salmon.

A6(c). Analogous to A6(a), except ODFW requests that the USACE manage reservoir releases to meet specific water temperature goals at Agness during the smolt migration period in summer. **Primary Implications:** This action would sometimes result in increased mortality among adult NP CHF, unless more reservoir storage (in excess of the current fisheries allocation) is authorized by the United States Congress.

A6(d). Take no action.

Limiting Factor A7 - predation on smolts (and adults)

Potential management options:

A7(a). The same as described in option A6(a). Umpqua pikeminnow consumption of Chinook salmon smolts would decrease because decreased water temperatures in downstream areas would decrease pikeminnow metabolic rates and growth rates. **Primary Implications:** The same as described in option A6(a).

A7(b). ODFW encourages fishing-related mortality for Umpqua pikeminnows. **Primary Implications:** This action has been taken (ODFW 2000), but has yet to be incorporated in an ODFW fisheries management plan.

A7(c). ODFW delays the release of juvenile CHS from Cole M. Rivers Hatchery until October to ensure that juvenile NP CHS have completely migrated from the river. This action is based on the hypothesis that hatchery fish attract near-shore and off-shore predators that likely feed on wild fish as well as hatchery fish. **Primary Implications:** Efficacy of action is unknown.

Fishery yields of hatchery fish would decrease, because fish released in August or September contribute to fisheries at greater rates.

A7(d). ODFW initiates a program to decrease cormorant predation on smolts passing through the estuary. **Primary Implications:** These animals are currently protected under the Federal Migratory Bird Treaty Act. However, the United States Fish and Wildlife Service has authorized some states to take steps designed to limit cormorant populations.

A7(e). ODFW requests that NOAA Fisheries evaluate the effects of marine mammals on salmon and steelhead of Rogue River origin. **Primary Implications:** This action would provide background information in the event that NOAA Fisheries authorizes states to take steps designed to limit populations of marine mammals. Marine mammals are currently protected under federal law.

A7(f). Take no action.

Limiting Factor A8 - juvenile mortality at water diversions

Potential management options:

A8(a). ODFW continues to support improvements at diversion sites in order to increase the survival rates of juvenile salmonids. **Primary Implications:** This action has been taken by ODFW, and would include support for the reconstruction or removal of structures that inadequately protect downstream migrants.

A8(b). Take no action.

Limiting Factor A9 - water temperature during adult migration

Potential management options:

A9(a). ODFW requests that the USACE manage reservoir releases to increase survival by decreasing disease-related losses of adult CHS. **Primary Implications:** This action has been taken (ODFW 2000), but has yet to be incorporated in an ODFW fisheries management plan.

A9(b). The same as described in option A9(a), except ODFW requests that the USACE manage reservoir releases to maximize survival by decreasing disease-related losses of adult CHS. **Primary Implications:** This action would often result in increased mortality among adult CHF (ODFW 1992), unless more reservoir storage (in excess of the current fisheries allocation) is authorized by the United States Congress.

A9(c). The same as described in option 9A(a), except ODFW requests that the USACE manage reservoir releases to cap expected disease-related losses of adult CHS at a maximum of 5%. **Primary Implications:** This action would often result in increased mortality among adult NP CHF (ODFW 1992), unless more reservoir storage (in excess of the current fisheries allocation) is authorized by the United States Congress.

A9(d). Take no action.

Limiting Factor A10 - redd competition and excavation by fall Chinook salmon

Potential management options:

A10(a). ODFW requests that the USACE manage reservoir releases to minimize flow augmentation after September 20, in part to discourage adult CHF from migrating upstream of Gold Ray Dam. **Primary Implications:** This action has been taken by (ODFW 2000), but has yet to be incorporated in an ODFW fisheries management plan.

A10(b). The same as described in option 10A(a), except change the date to September 10. **Primary Implications:** same as alternative A10(a), except there is an increased risk of disease related losses increases among adult CHF and adult coho salmon (ESA protected fish).

A10(c). ODFW requests that the USACE manage reservoir releases to minimize flow augmentation during the period of July 20 through August 20. The intent of this action would be to increase disease related losses among NP CHF destined to migrate upstream of Gold Ray Dam (ODFW 1992). **Primary Implications:** This action would decrease flows during the period when NP CHS smolts migrate to the ocean (conflicts with potential management actions A6 and A7).

A10(d). ODFW requests that the USACE determine if the reservoir operations can be modified to further decrease the temperature of water released during the period of November through February (same as option A2(b). Colder water during the period of egg and sac-fry incubation is more suitable for the production of NP CHS and less suitable for the production of NP CHF. **Primary Implications:** This action has been taken (ODFW 2000), but has yet to be incorporated in an ODFW fisheries management plan.

A10(e). ODFW attempts to selectively exclude adult CHF from passing upstream of Gold Ray Dam. **Primary Implications:** Summer steelhead and coho salmon (ESA protected fish) passage must continue at site.

A10(f). Angling regulations would be modified so as to allow for an increase in the harvest of CHF destined to pass Gold Ray Dam. **Primary Implications:** Depending on the area, this action may impact other populations of NP CHF, and would require a deviation from regional angling regulations currently in effect for the fisheries for CHF.

A10(g). Take no action.

Limiting Factor A11 - amount of spawning habitat

Potential management options:

A11(a). ODFW pursues the means to improve the passage of adults at a small falls in the lower mile of Big Butte Creek. **Primary Implications:** This action would require installation of a fish ladder or modification of a natural barrier.

A11(b). ODFW collects and transfers adult CHS into potential spawning habitat that is not accessible to naturally migrating adults. **Primary Implications:** Hatchery fish excess to broodstock needs would compose most of the transported fish. However, adult NP CHS may have to trapped, transported to, and held at, Cole M. Rivers Hatchery before release in streams to ensure that hatchery fish would account for less than 15% of the natural spawners. Survival rates of trapped and transported adult NP CHS may be low as a result of handling and stress.

A11(c). ODFW pursues the means to obtain high quality water that would be used to allow for adult migration and spawning in Little Butte Creek during the period of September 15 through October 15. **Primary Implications:** This action would likely require at least 10,000 acre-feet of water that is currently not available. It is likely that such a volume can only become available if it originates from storage in a reservoir that has yet to be planned.

A11(d). ODFW pursues the means to obtain high quality water that would be used to allow for adult migration and spawning in Bear Creek during the period of September 15 through October 15. **Primary Implications:** This action would likely require at least 10,000 acre-feet of water that is currently not available. It is likely that such a volume can only become available if it originates from storage in a reservoir that has yet to be planned.

A11(e). ODFW pursues the means to obtain high quality water that would be used to allow for adult migration and spawning in Big Butte Creek during the period of September 15 through October 15. **Primary Implications:** This action might require about 5,000 acre-feet of water that is currently not available. It is possible that such a volume can only become available if it originates from storage in a reservoir that has yet to be planned.

A11(f). Take no action.

Limiting Factor A12 - amount of rearing habitat

Potential management options:

A12(a). ODFW annually transfers juvenile CHS of hatchery origin upstream of Lost Creek Lake to supplement production in the lower 5 miles of the Middle Fork and the lower 10 miles of the South Fork. These areas were accessible to anadromous salmoids prior to the construction of Lost Creek Dam. **Primary Implications:** Survival rates of smolts passing through the water intake tower in Lost Creek Lake are unknown. Juveniles would need to be marked as hatchery fish so that any survivors could be identified upon return to Cole M. Rivers Hatchery or upon recovery as spawned carcasses. If returning adults spawn naturally, rather than entering Cole M. Rivers Hatchery, this action is in conflict with the desired status element that calls for no more than 15% hatchery fish among natural spawners.

A12(b). ODFW annually transfers juvenile CHS of hatchery origin to rear in areas of tributary streams that are not accessible to natural spawners. **Primary Implications:** Returning adults would not be able to return and spawn in natal areas, but would spawn in areas currently used by NP CHS. This action is in conflict with the desired status element that calls for no more than 15% hatchery fish among natural spawners.

A12(c). Take no action.

Limiting Factor A13 - quality of spawning habitat

Potential management options:

A13(a). ODFW requests that the USACE monitor spawning habitat in areas downstream from Lost Creek Lake. **Primary Implications:** This action has been taken by (ODFW 2000), but has yet to be incorporated in an ODFW fisheries management plan.

A13(b). ODFW uses spawning survey data to determine when it would be desirable to begin efforts to improve spawning habitat. **Primary Implications:** Decisions would be resource dependent as determined from some objective criteria (i.e. when carcass densities upstream of Elk Creek drop below 75% of the average calculated from areas farther downstream).

A13(c). ODFW requests that the USACE act to restore and maintain, at historic levels, gravel quality and quantity in spawning areas between Lost Creek Lake and Shady Cove. **Primary Implications:** None.

A13(d). ODFW investigates the potential to improve spawning habitat in Big Butte Creek, and if warranted, takes steps to improve spawning habitat. **Primary Implications:** This action would be taken if the upstream passage of adults is improved at a partial barrier near the mouth of the stream.

A13(e). Take no action.

Limiting Factor A14 - quality of rearing habitat

Potential management options:

A14(a). ODFW develops an education program designed to encourage landowners to maintain riparian habitat. **Primary Implications:** The primary benefits of this action are maintenance of channel shading and streambank stability.

A14(b). Take no action.

Limiting Factor A15 – fishing mortality in the ocean

Potential management options:

A15(a). ODFW recommends additional harvest restrictions for fisheries operating in the Klamath Zone Management Area. Fisheries operating (3-200 miles offshore) in this area are managed by NOAA Fisheries, with input from the Pacific Fisheries Management Council. **Primary Implications:** Allowable harvest in this area is currently primarily based on projected impacts to CHF produced in the Klamath River Basin.

A15(b). ODFW adopts additional harvest restrictions inside the three mile coastal zone, where the state of Oregon establishes fishery regulations. **Primary Implications:** Commercial and recreation fishery regulations inside the three mile limit usually match those fishery regulations set for those areas outside the three mile limit.

A15(c). Combine fishing-related mortality in the ocean and in freshwater. Identify an allowable harvest rate, and then allocate a portion of the harvest to each fishery.

A15(d). Take no action.

Limiting Factor A16 – fishing mortality in freshwater

Potential management options (specific options are in APPENDIX H):

A16(*). Establish daily or annual limits for harvest.

A16(*). Establish specific seasons for harvest.

A16(*). Establish specific areas for harvest.

A16(*). Establish gear restrictions to maximize survival of released fish.

A16(*). Establish area(s) closed to angling.

A16(f). Combine fishing related mortality in the ocean and in freshwater. Identify an allowable harvest rate, and then allocate a portion of the harvest to each fishery.

A16(g). Promote ethical angling and proper techniques for catch and release.

A16(h). Increase effectiveness of enforcement of fishery regulations.

A16(i). Take no action.

Limiting Factor A17 - spawning escapement

Potential management options are the same as those described under **Limiting Factors A1-A16**.

DESIRED STATUS ELEMENT: MIGRATION TIMING (≥60% PASSAGE BY 15 JUNE)

Limiting Factors include peak flow during egg and sac-fry incubation (**Limiting Factor A1**), water temperature during egg and sac-fry incubation (**Limiting Factor A2**), flow during egg and sac-fry incubation (**Limiting Factor A3**), flow decreases during juvenile rearing (**Limiting Factor A4**), predation by juvenile hatchery fish (**Limiting Factor A5**), water temperature during adult migration (**Limiting Factor A9**), redd competition and excavation by CHF (**Limiting Factor A10**), amount of spawning habitat (**Limiting Factor A11**), amount of rearing habitat (**Limiting Factor A12**), quality of spawning habitat (**Limiting Factor A13**), and spawning escapement (**Limiting Factor A17**). All of these factors differentially affect the abundance of early-run CHS as compared to late-run CHS. Other limiting factors include:

Limiting Factor B1 - water temperature during adult migration

Potential management options:

B1(a). ODFW requests that the USACE manage reservoir releases so as to increase water temperatures during the late spring and early summer, with the objective of earlier passage of adult NP CHS at Gold Ray Dam. This direct environmental effect has a non-genetic basis, and thus differs from option B1(b). **Primary Implications:** This action would increase risk of disease related losses of adult CHS in low flow years (ODFW 2000). In addition, this action would slightly increase growth rates of juvenile NP CHS (ODFW 2000). Faster growth leads to a younger age at maturity (ODFW 2000), which conflicts directly with the desired status element that calls for no more than 10% jacks among NP CHS that pass Gold Ray Dam.

B1(b). ODFW follows management actions, as described under **Limiting Factors A1-A5** and **Limiting Factors A9-A13**, that are designed to increase the production of NP CHS genetically programmed to migrate as early-run or mid-run adults.

B1(c). Take no action.

Limiting Factor B2 - age-selective fishing mortality in the ocean

Potential management options:

Spring Chinook salmon destined to mature at older ages are selectively harvested by the ocean fisheries (ODFW 2000), and older CHS pass Gold Ray Dam earlier as compared to younger cohorts (ODFW 2000). Management actions directed at the ocean fisheries thus affect passage timing at Gold Ray Dam. Options for potential management actions associated with ocean fisheries were previously described (*see* **Limiting Factor A15**).

Limiting Factor B3 - time-selective fishing mortality in freshwater

Potential management options:

Early-run CHS are selectively harvested by recreational fisheries in the Rogue River (ODFW 2000). Management actions directed at the freshwater fisheries thus affect passage timing at Gold Ray Dam. Options for relevant potential management actions were previously described (*see* **Limiting Factor A16**).

DESIRED STATUS ELEMENT: AGE COMPOSITION (≤10% JACKS)

Limiting Factor C1 - water temperature during juvenile rearing

Potential management options:

C1(a). ODFW requests that the USACE manage reservoir releases to decrease water temperatures during spring and early summer when juveniles rear in freshwater. Decreased growth rates cause juveniles to migrate later to the ocean, which in turn causes NP CHS to mature at older ages (ODFW 2000). **Primary Implications:** This action would more quickly deplete cold water stored in Lost Creek Lake, and would result in warmer water temperatures during the period eggs incubate in the gravel (*see* **Limiting Factor A2**). Water temperature modeling is needed to assess magnitude of the impact.

C2(b). Take no action.

Limiting Factor C2 - juvenile abundance

Potential management options:

Juvenile NP CHS that grow at slower rates in freshwater mature at older ages (ODFW 2000), and growth rates are dependent on water temperature and juvenile density (ODFW 2000). Actions taken to increase fry production and fry survival rates will thus also act to increase the age of maturity for NP CHS. ODFW follows management actions, as described under **Limiting Factors A1-17**, that are designed to increase the production of juvenile NP CHS.

Limiting Factor C3 - age-selective fishing mortality in the ocean

Potential management options:

Spring Chinook salmon destined to mature at older ages are selectively harvested by the ocean fisheries (ODFW 2000). Management actions directed at the ocean fisheries thus affect the age composition of adults that pass Gold Ray Dam. Options for potential management actions associated with ocean fisheries were previously described (*see* **Limiting Factor A15**).

Limiting Factor C4 - age-selective fishing mortality in freshwater

Potential management options:

Spring Chinook salmon destined to mature at older ages are selectively harvested by recreational fisheries in the Rogue River (ODFW 2000). Management actions directed at the freshwater

fisheries thus affect the age composition of adults that pass Gold Ray Dam. Options for relevant potential management actions were previously described (*see* **Limiting Factor A16**).

DESIRED STATUS ELEMENT: DISTRIBUTION OF SEPTEMBER SPAWNERS (≥40% ABOVE SHADY COVE)

Limiting Factors include peak flow during egg and sac-fry incubation (**Limiting Factor A1**), water temperature during egg and sac-fry incubation (**Limiting Factor A2**), flow during egg and sac-fry incubation (**Limiting Factor A3**), flow decreases during juvenile rearing (**Limiting Factor A4**), predation by juvenile hatchery fish (**Limiting Factor A5**), water temperature during adult migration (**Limiting Factor A9**), and quality of spawning habitat (**Limiting Factor A13**). All of these factors differentially affect the abundance of NP CHS that spawn close to Lost Creek Dam as compared to cohorts that spawn farther downstream. Other limiting factors include:

Limiting Factor D1 – selective fishing mortality in freshwater

Potential management options:

Adult NP CHS that are destined to spawn farthest upstream are selectively harvested in the fisheries that operate in the Rogue River (ODFW 2000). Fishery management actions thus affect the proportion of NP CHS that spawn upstream of Shady Cove. Options for relevant potential management actions were previously described (*see* **Limiting Factor A16**).

DESIRED STATUS ELEMENT: SPAWNER COMPOSITION (≤15% HATCHERY)

Limiting Factors include peak flow during egg and sac-fry incubation (**Limiting Factor A1**), water temperature during egg and sac-fry incubation (**Limiting Factor A2**), flow during egg and sac-fry incubation (**Limiting Factor A3**), flow decreases during juvenile rearing (**Limiting Factor A4**), predation by juvenile hatchery fish (**Limiting Factor A5**), water temperature during adult migration (**Limiting Factor A9**), redd competition and excavation by adult CHF (**Limiting Factor A10**), amount of spawning habitat (**Limiting Factor A11**), amount of rearing habitat (**Limiting Factor A12**), quality of spawning habitat (**Limiting Factor A13**), and spawning escapement (**Limiting Factor A17**). All of these factors differentially affect the abundance of NP CHS as compared to CHS of hatchery origin. Other limiting factors include:

Limiting Factor E1 – abundance of naturally spawning hatchery fish

Potential management options:

E1(a). ODFW attempts to increase homing rates to Cole M. Rivers Hatchery. **Primary Implications:** This action would require the engineering, installation, and operation of an adult fish trap at the primary outflow for the hatchery; or would require blocking adult fish that attempt to enter the primary outflow from the hatchery.

E1(b). ODFW decreases the number of juvenile CHS released from Cole M. Rivers Hatchery. Current releases average 1.6 million smolts annually. **Primary Implications:** This action would result in decreased fishery yields.

E1(c). ODFW develops a sliding scale of smolt release goals dependent on the percentage of naturally produced fish within the parental broodstock. **Primary Implications:** Smolt releases from Cole M. Rivers Hatchery would vary among years.

E1(d). ODFW revises broodstock collection practices at Cole M. Rivers Hatchery to increase age at maturity of progeny by developing length-specific goals for adult fish to be included in the broodstock. Older adults would be selectively bred at the hatchery to compensate for age-selective harvest in the ocean and freshwater fisheries. **Primary Implications:** This action would likely (1) increase harvest in the ocean fisheries, (2) to a lesser degree, decrease harvest in the freshwater fishery, and (3) decrease the number of hatchery fish that spawn naturally. This action also runs counter to the prevailing concept of random mating of hatchery brood stocks. Currently, jacks excepted, size (age) is not considered when collecting fish for broodstock at the hatchery.

E1(e). ODFW terminates the recycling of excess hatchery fish through the recreational fishery upstream of Gold Ray Dam. **Primary Implications:** This action will result in decreased fishery yields and it's likely that few recycled fish spawn naturally.

E1(f). Take no action.

Limiting Factor E2 - age-selective fishing mortality in the ocean

Potential management options:

Naturally produced CHS are selectively harvested by the ocean fisheries as compared to CHS of hatchery origin, because hatchery fish tend to mature at younger ages than wild fish (ODFW 2000). Thus, management actions directed at the ocean fisheries affect the relative abundance of hatchery fish among adult CHS that return to freshwater. Options for potential management actions associated with ocean fisheries were previously described (*see* **Limiting Factor A15**).

Limiting Factor E3 - selective fishing mortality in freshwater

Potential management options:

Naturally produced CHS are selectively harvested in the recreational fishery upstream of Gold Ray Dam because most hatchery CHS tend to enter Cole M. Rivers Hatchery while NP CHS remain in the river (ODFW 2000). Fishery management actions can differentially affect the number of wild and hatchery fish that survive to spawn. Options for relevant potential management actions were previously described (*see* **Limiting Factor A16**).

Limiting Factor E4 – water temperature during juvenile rearing

Potential management options:

E4(a). ODFW requests that the USACE manage reservoir releases to increase water temperatures during spring and early summer when juveniles rear in freshwater. Increased growth rates cause juveniles migrate earlier to the ocean, which in turn causes Chinook salmon to mature at younger ages (ODFW 2000). A younger age at maturity increases spawning escapement of NP CHS because the ocean and freshwater fisheries operate in an age-selective manner (ODFW 2000). **Primary Implications:** This action would likely conserve cold water stored in Lost Creek Lake, and would result in warmer water temperatures during the period eggs incubate in the gravel (*see* **Limiting Factor A2**). However, this action would also increase the relative abundance of younger fish in the run (conflicts with desired status element of no more than 10% jacks among NP CHS that pass Gold Ray Dam). Water temperature modeling is needed to assess magnitude of these impacts.

E4(b). Take no action.

APPENDIX J

Description of Alternative Suites of Management Actions
(abbreviations described in **APPENDIX A**)

ALTERNATIVE SUITES OF MANAGEMENT ACTIONS

Alternative 1

a. Limit NP CHS to current habitat
b. Reservoir management recommendations designed solely for NP CHS
c. Terminate freshwater harvest of NP CHS

Alternative 2

a. Limit NP CHS to current habitat
b. Reservoir management strategies designed for emphasis on NP CHS
c. Terminate freshwater harvest of NP CHS

Alternative 3

a. Expand natural spawning habitat for NP CHS
b. Reservoir management strategies designed for emphasis on NP CHS
c. Freshwater harvest opportunity for late-run NP CHS

Alternative 4

a. Establish juvenile production in areas not accessible to adult CHS
b. Reservoir management strategies designed for emphasis on NP CHS
c. Freshwater harvest opportunity for mid- and late-run NP CHS

Alternative 5

a. Expand natural spawning habitat for NP CHS
b. Establish juvenile production in areas not accessible to adult CHS
c. Reservoir management strategies designed for emphasis on NP CHS
d. Freshwater harvest opportunity for mid- and late-run NP CHS

Alternative 6

a. Expand natural spawning habitat for NP CHS
b. Reservoir management strategies designed for emphasis on NP CHS
c. Establish freshwater sanctuary area (no fishing) for early-run NP CHS

Alternative 7

a. Expand natural spawning habitat for NP CHS
b. Reservoir management strategies designed for emphasis on NP CHS
c. Specialized regulations for freshwater CHS fisheries

Alternative 8

a. Expand natural spawning habitat for NP CHS
b. Establish juvenile production in areas not accessible to adult CHS
c. Reservoir management strategies designed for emphasis on NP CHS
d. Specialized regulations for freshwater CHS fisheries
e. Increased control of predators

Alternative 9

a. Expand natural spawning habitat for NP CHS
b. Reservoir management strategies designed for emphasis on NP CHS
c. Regional regulations for freshwater CHS fisheries
d. Adjust production goals at Cole M. Rivers Hatchery

PROPOSED MANAGEMENT ACTIONS COMMON TO ALL ALTERNATIVES

Coded management actions are described in **APPENDIX I**

Management Actions Related to the Operation of Lost Creek Lake

A1(a) Request reduced peak flows during egg and sac-fry incubation
A2(a) Request release of coldest water possible during egg and sac-fry incubation
A2(b) Request water temperature modeling from USACE
A3(a) Request minimal flow augmentation during spawning
A4(a) Request USACE employ current criteria to minimize fry dewatering
A4(b) Request USACE development of improved methods to minimize fry dewatering
A6(a) Request reservoir releases to increase smolt survival
A9(a) Request reservoir releases to increase adult survival
A10(b) Request decreased flow augmentation during CHF migration
A10(d) Request water temperature modeling from USACE
A13(c) Request restoration and maintenance of spawning habitat by USACE

Management Actions Related to Other Habitat Issues

A8(a) Support improvements of fish passage facilities
A13(d) If warranted, improve spawning habitat in Big Butte Creek*****
A14(a) Develop landowner education program

Management Actions Related to Other Species of Animals

A7(b) Encourage fishing related mortality on non-native Umpqua pikeminnows
A7(e) ODFW requests that NOAA Fisheries evaluate effects on marine mammals*****

Management Actions Related to Hatchery Fish

(none)

Management Actions Related to Fisheries

A16(g) Promote ethical angling and proper techniques for catch and release.
A16(h) Increase effectiveness of enforcement of fishery regulations.

*** Exception, not included in Alternative 9.**

ALTERNATIVE 1

a. Limit NP CHS to current habitat
b. Reservoir management recommendations designed solely for NP CHS
c. Terminate freshwater harvest of NP CHS

MANAGEMENT SUITE

Coded management Actions are described in **APPENDIX H** and **APPENDIX I**

Management Actions Related to the Operation of Lost Creek Lake

(employs actions common to other alternatives)

A6(b) Request increased reservoir releases in summer
A7(a) Request increased reservoir releases in summer
A9(b) Request increased reservoir releases in late spring and early summer

Management Actions Related to Other Habitat Issues

(employs strategies common to other alternatives)

Management Actions Related to Other Species of Animals

(employs strategies common to other alternatives)

Management Actions Related to Hatchery Fish

(none)

Management Actions Related to Fisheries

(employs strategies common to other alternatives)

A16(d7): Regional (zone) angling regulations employed for the Rogue River. Harvest of NP Chinook salmon opens 1 July below Gold Ray Dam and remains closed above Gold Ray Dam.

PRIMARY IMPLICATIONS OF THE ALTERNATIVE

In-river mortality rates of CHF and coho salmon will increase over time, compared with other alternatives, as additional reservoir storage is purchased for consumptive uses.
Freshwater harvest of NP CHS is limited to a few late-run fish.

ALTERNATIVE 2

a. Limit NP CHS to current habitat
b. Reservoir management strategies designed for emphasis on NP CHS
c. Terminate freshwater harvest of NP CHS

MANAGEMENT SUITE

Coded management strategies are described in **APPENDIX H** and **APPENDIX I**

Management Actions Related to the Operation of Lost Creek Lake

(employs strategies common to other alternatives, except Alternative 1)

Management Actions Related to Other Habitat Issues

(employs strategies common to other alternatives)

Management Actions Related to Other Species of Animals

(employs strategies common to other alternatives)

Management Actions Related to Hatchery Fish

(none)

Management Actions Related to Fisheries

(employs strategies common to other alternatives)

A16(d7): Regional (zone) angling regulations employed for the Rogue River. Harvest of NP Chinook salmon opens 1 July below Gold Ray Dam and remains closed above Gold Ray Dam.

PRIMARY IMPLICATIONS OF THE ALTERNATIVE

Freshwater harvest of NP CHS is limited to a few late-run fish.
In-river mortality rates of CHF and coho salmon may increase.

ALTERNATIVE 3

a. Expand natural spawning habitat for NP CHS
b. Reservoir management strategies designed for emphasis on NP CHS
c. Freshwater harvest opportunity for late-run NP CHS

MANAGEMENT SUITE

Coded management strategies are described in **APPENDIX H** and **APPENDIX I**

Management Actions Related to the Operation of Lost Creek Lake

(employs strategies common to other alternatives, except Alternative 1)

Management Actions Related to Other Habitat Issues

(employs actions common to other alternatives)

A11(a,e) Improve passage for adult CHS at a natural barrier in lower Big Butte Creek.
A12(c) Secure, if opportunity arises, September-October flows needed for adult CHS migration and spawning in Little Butte Creek.

Management Actions Related to Other Species of Animals

(employs actions common to other alternatives)

Management Actions Related to Hatchery Fish

(none)

Management Actions Related to Fisheries

(employs actions common to other alternatives)

A16(d9): Regional (zone) angling regulations employed for the Rogue River. Harvest of NP Chinook salmon opens 1 June below Gold Ray Dam, and is open July-August between Gold Ray Dam and Dodge Bridge.

PRIMARY IMPLICATIONS OF THE ALTERNATIVE

Harvest of NP CHS will include some mid-run fish in addition to late-run fish.
Flow in Little Butte Creek will likely need to exceed 120 cfs during 15 September through 15 October in order to establish a naturally spawning population. This volume of water will be difficult to obtain.
In-river mortality rates of CHF and coho salmon may increase.

ALTERNATIVE 4

a. Establish juvenile production in areas not accessible to adult CHS
b. Reservoir management actions designed for emphasis on NP CHS
c. Freshwater harvest opportunity for mid- and late-run NP CHS

MANAGEMENT SUITE

Coded management actions are described in **APPENDIX H** and **APPENDIX I**

Management Actions Related to the Operation of Lost Creek Lake

(employs actions common to other alternatives, except Alternative 1)

Management Actions Related to Other Habitat Issues

(employs actions common to other alternatives)

A11(b) Excess broodstock at Cole M. Rivers Hatchery is transported to habitat not accessible to naturally spawning CHS.

Management Actions Related to Other Species of Animals

(employs actions common to other alternatives)

Management Actions Related to Hatchery Fish

A11(b) Excess broodstock at Cole M. Rivers Hatchery is transported to habitat not accessible to naturally spawning CHS.
E1(a) Adult hatchery fish are trapped from the outflow of Cole M. Rivers Hatchery.

Management Actions Related to Fisheries

(employs actions common to other alternatives)

A16(d8): Regional (zone) angling regulations employed for the Rogue River. Harvest of NP Chinook salmon opens 1 May below Gold Ray Dam, and is open July-August between Gold Ray Dam and Dodge Bridge.

PRIMARY IMPLICATIONS OF THE ALTERNATIVE

Harvest of NP CHS will include some early-run fish in addition to mid-run and late-run fish.
Significant numbers of adult CHS will need to be transported from Cole M. Rivers Hatchery for release in non-historic habitat. The survival rate of transported adults may be low, and progeny that survive to maturity would not be able to return to natal areas.
Trapping of adult CHS at the outflow of Cole M. Rivers Hatchery will require a significant amount of engineering and construction.
In-river mortality rates of CHF and coho salmon may increase.

ALTERNATIVE 5

a. Expand natural spawning habitat for NP CHS
b. Establish juvenile production in areas not accessible to adult CHS
c. Reservoir management actions designed for emphasis on NP CHS
d. Freshwater harvest opportunity for mid- and late-run NP CHS

MANAGEMENT SUITE

Coded management actions are described in **APPENDIX H** and **APPENDIX I**

Management Actions Related to the Operation of Lost Creek Lake

(employs actions common to other alternatives, except Alternative 1)

Management Actions Related to Other Habitat Issues

(employs actions common to other alternatives)

A11(a,e) Improve passage for adult CHS at a natural barrier in lower Big Butte Creek.
A11(b) Excess broodstock at Cole M. Rivers Hatchery is transported to habitat not accessible to naturally spawning CHS.
A12(c) Secure, if opportunity arises, September-October flows needed for adult CHS migration and spawning in Little Butte Creek.

Management Actions Related to Other Species of Animals

(employs actions common to other alternatives)

Management Actions Related to Hatchery Fish

A11(b) Excess broodstock at Cole M. Rivers Hatchery is transported to habitat not accessible to naturally spawning CHS.
E1(a) Adult CHS are trapped at the outflow of Cole M. Rivers Hatchery.

Management Actions Related to Fisheries

(employs actions common to other alternatives)

A16(d8): Regional (zone) angling regulations employed for the Rogue River. Harvest of NP Chinook salmon opens 1 May below Gold Ray Dam, and is open July-August between Gold Ray Dam and Dodge Bridge.

PRIMARY IMPLICATIONS OF THE ALTERNATIVE

Harvest of NP CHS will include some early-run fish in addition to mid-run and late-run fish.
Significant numbers of adult CHS will need to be transported from Cole M. Rivers Hatchery for release in non-historic habitat. The survival rate of transported adults may be low, and progeny that survive to maturity would not be able to return to natal areas.
Transportation of juvenile steelhead and coho salmon may slightly increase the proportion of hatchery fish among natural spawners.
Trapping of adult CHS at the outflow of Cole M. Rivers Hatchery will require a significant amount of engineering and construction.
In-river mortality rates of CHF and coho salmon may increase.

ALTERNATIVE 6

a. Expand natural spawning habitat for NP CHS
b. Reservoir management actions designed for emphasis on NP CHS
c. Establish freshwater sanctuary area (no fishing) for early-run NP CHS

MANAGEMENT SUITE

Coded management actions are described in **APPENDIX H** and **APPENDIX I**

Management Actions Related to the Operation of Lost Creek Lake

(employs actions common to other alternatives, except Alternative 1)

Management Actions Related to Other Habitat Issues

(employs actions common to other alternatives)

A11(a,e) Improve passage for adult CHS at a natural barrier in lower Big Butte Creek.
A12(c) Secure, if opportunity arises, September-October flows needed for adult CHS migration and spawning in Little Butte Creek.

Management Actions Related to Other Species of Animals

(employs actions common to other alternatives)

Management Actions Related to Hatchery Fish

(none)

Management Actions Related to Fisheries

(employs actions common to other alternatives)

Fishery option A16(d3): Regional (zone) angling regulations employed for the Rogue River. Rogue River is closed to fishing in the area between Elk Creek and the Highway 62 bridge at Shady Cove, May-October .

PRIMARY IMPLICATIONS OF THE ALTERNATIVE

Harvest of NP CHS will include some mid-run fish in addition to late-run fish.
Flow in Little Butte Creek will likely need to exceed 120 cfs during 15 September through 15 October in order to establish a naturally spawning population. This volume of water will be difficult to obtain.
Anglers will not be able to fish for six months in the six miles immediately upstream of the Highway 62 bridge at Shady Cove.
In-river mortality rates of CHF and coho salmon may increase.

ALTERNATIVE 7

a. Expand natural spawning habitat for NP CHS
b. Reservoir management actions designed for emphasis on NP CHS
c. Specialized regulations for freshwater CHS fisheries

MANAGEMENT SUITE

Coded management actions are described in **APPENDIX H** and **APPENDIX I**

Management Actions Related to the Operation of Lost Creek Lake

(employs actions common to other alternatives, except Alternative 1)

Management Actions Related to Other Habitat Issues

(employs actions common to other alternatives)

A11(a,e) Improve passage for adult CHS at a natural barrier in lower Big Butte Creek.
A12(c) Secure, if opportunity arises, September-October flows needed for adult CHS migration and spawning in Little Butte Creek.

Management Actions Related to Other Species of Animals

(employs actions common to other alternatives)

Management Actions Related to Hatchery Fish

(none)

Management Actions Related to Fisheries

(employs actions common to other alternatives)

A16(e4): Specialized angling regulations employed for the Rogue River.
- Harvest Regulations:
  - Mouth to Hog Creek:
    - 1 January to 31 May:
      - Seasonal bag limit of one NP Chinook salmon.
      - Nets, if used to land Chinook salmon, must be made of soft cotton.
    - 1 June onward: Regional (zone) harvest regulations for Chinook salmon.
  - Hog Creek to Gold Ray Dam:
    - 1 January to 30 June:
      - Seasonal bag limit of one NP Chinook salmon.
    - 1 July onward: Regional (zone) angling harvest regulations for Chinook salmon.
  - Gold Ray Dam to Highway 62 Bridge at McGregor Park:
    - 1 January to 31 July:
      - Seasonal bag limit of one NP Chinook salmon.
  - Highway 62 Bridge at McGregor Park to Cole M. Rivers Hatchery:
    - 1 January to 15 September:
      - Seasonal bag limit of one NP Chinook salmon.
- Gear Regulations (entire year):
  - Maximum leader length of five feet between attached weight and closest hook
  - No treble hooks, except on floating lures.
- Method Regulations:
  - Chinook salmon to be released must be left in water.

PRIMARY IMPLICATIONS OF THE ALTERNATIVE

Harvest will include early-run, mid-run, and late-run NP CHS.
In-river mortality rates of CHF and coho salmon may increase.

ALTERNATIVE 8

a. Expand natural spawning habitat for NP CHS
b. Establish juvenile production in areas not accessible to adult CHS
c. Reservoir management actions designed for greater emphasis on NP CHS
d. Specialized regulations for freshwater CHS fisheries
e. Increased control of predators

MANAGEMENT SUITE

Coded management actions are described in **APPENDIX H** and **APPENDIX I**

Management Actions Related to the Operation of Lost Creek Lake

(employs actions common to other alternatives, except Alternative 1)
A1(b) Request increased reduction of peak flows during egg and sac-fry incubation.
A2(c) Request that USACE investigate potential to bypass reservoir inflow.

Management Actions Related to Other Habitat Issues

(employs actions common to other alternatives)
A11(a,e) Improve passage for adult CHS at a natural barrier in lower Big Butte Creek.
A11(b) Excess broodstock at Cole M. Rivers Hatchery is transported to habitat not accessible to naturally spawning CHS.
A12(c) Secure, if opportunity arises, September-October flows needed for adult CHS migration and spawning in Little Butte Creek.

Management Actions Related to Other Species of Animals

(employs actions common to other alternatives)
A7(d) Initiate program to decrease numbers of cormorants

Management Actions Related to Hatchery Fish

A5(e) Transport and release juvenile steelhead and coho salmon of hatchery origin downstream of Gold Ray Dam.
A11(b) Excess broodstock at Cole M. Rivers Hatchery is transported to habitat not accessible to naturally spawning CHS.
E1(a) Block hatchery outflow to decrease the number of hatchery fish that spawn naturally.
E1(d) Revise spawning practices to increase harvest rates for CHS of hatchery origin.

Management Actions Related to Fisheries

(employs actions common to other alternatives)
A16(d2,e6): Specialized angling regulations employed for the Rogue River.
- Harvest Regulations:
  - Mouth to Hog Creek:
    - 1 January to 30 June: Limits for NP Chinook salmon: one daily, three during season.
    - 1 July onward: Regional (zone) harvest regulations for Chinook salmon.
  - Hog Creek to Highway 62 bridge at Shady Cove:
    - 1 January to 31 July: Limits for NP Chinook salmon: one daily, three during season
  - Highway 62 Bridge at Shady Cove to Cole M. Rivers Hatchery:
    - 1 January to 31 July: Closed to harvest of NP Chinook salmon.
- Gear Regulations (entire year): In addition to the general (statewide) hook and weight regulations, any attached weight may be no more than 5 feet above the lowermost hook.
- Method Regulation: Chinook salmon to be released must be left in water.

PRIMARY IMPLICATIONS OF ALTERNATIVE 8

Harvest will include early-run, mid-run, and late-run NP CHS.
Establishes an upstream "deadline" for the harvest of NP CHS.
Progeny produced from transported adults will not be able to return to natal areas.
Federal authorization is needed to take actions designed to reduce cormorant populations.
In-river mortality rates of CHF and coho salmon may increase.
Increased reductions in peak flows will require that annual releases from Lost Creek Lake exceed the release volume authorized by Congress during "normal" years.

STRATEGIES AND ACTIONS

<u>Management Strategy 8.1.</u> Implement actions designed to ensure that Lost Creek Lake is managed to maintain a viable population of naturally produced spring Chinook salmon that exhibits, as much as possible, historical life history characteristics. Continue actions designed to protect habitat in the Rogue River downstream of Lost Creek Lake. The intent of this strategy is to maintain and enhance quantity and quality of habitat available to naturally produced spring Chinook salmon that spawn in the Rogue River Basin.

This management strategy addresses the effects of operation of Lost Creek Dam on NP CHS. Dam operation and allied reservoir management is a primary factor which currently limits attainment of desired status (*see* **Habitat Quality**, page 33, **Key Biological Attributes Affected by Reservoir Operation**, page 59, **Simulation Model Used for Fishery Assessments,** page 63, and **Comparisons to Other Populations**, page 67). Actions described in this management strategy were crafted based on the conclusion by the advisory committee, and by ODFW, that Lost Creek Lake would continue to be managed by the USACE with a primary objective of annual filling of the reservoir and a usual release of 180,000 acre-feet of conservation storage annually. Other options for reservoir management were also considered by the advisory committee and ODFW, and are described in **APPENDIX K**.

Assumptions and Rationale

1. As outlined by the Congress of the United States of America, enhancement of fishery resources in downstream areas is a primary authorized purpose by which Lost Creek Lake should be managed.
2. As outlined by the Congress of the United States of America, fishery enhancement, irrigation supply, and municipal and industrial supply are primary authorized purposes of equal priority, and are of subservient priority only during those operations designed to prevent flooding in downstream areas.
3. Findings that resulted from a long-term fishery research project (ODFW 2000); funded by the USACE, provide reliable estimates of the impacts of reservoir operations on NP CHS produced in areas downstream of Lost Creek Lake.
4. Implementation of recommendations for reservoir management strategies at Lost Creek Lake, presented by ODFW (2000), are advisable methods to protect and enhance NP CHS produced in downstream areas.
5. Reservoir management strategies will continue to be refined as additional information becomes available.
6. The water control manual for Lost Creek Lake can be revised to incorporate measures designed to ensure that operational decisions recognize downstream needs of fishery resources as a primary authorized project purpose.
7. The USACE has the authority to manage Lost Creek Lake at elevations below the maximum elevations outlined by the United States Congress.
8. Quality of riparian zones along the Rogue River will continue to decline as human population numbers increase in the general area.
9. Gravel quality and quantity will decrease in areas downstream of Lost Creek Lake as a result of gravel being trapped at the upstream end of the reservoir.

Actions

Action 1.1. Request that Lost Creek Lake be managed to further reduce the intensity of peak flows during the period eggs and sac-fry incubate in the gravel. The purpose of this action is to increase egg-fry survival rates and to minimize rates of spawning gravel loss below Lost Creek Lake.

Action 1.2. Request that Lost Creek Lake be managed to release the coldest water possible during egg and sac-fry incubation. The purpose of this action is to minimize the early emergence of fry from the gravel in order to increase fry survival rates. Progeny of early-run and mid-run NP CHS will benefit most from this action.

Action 1.3. Request development of USACE simulation models for water temperature in order to determine release strategies that result in optimal strategies for reservoir management under a variety of water years. The purpose of this action is to determine optimal use of the limited supply of cold hypolimnetic storage during years of varied water yield.

Action 1.4. Request that the USACE investigate the means to bypass reservoir inflow around or through Lost Creek Lake. The purpose of this action is to determine whether it is feasible to bypass colder water to restore the historical time of fry emergence from the gravel.

Action 1.5. Request implementation of procedures designed to minimize the potential dewatering of juveniles in areas downstream of Lost Creek Lake. The purpose of this action is to increase the survival rates of NP CHS fry.

Action 1.6. Request that Lost Creek Lake be managed to ensure minimal flow augmentation during the spawning period. The purpose of this action is to (1) minimize the number of CHS redds dewatered during the succeeding season of reservoir filling, (2) decrease passage of CHF upstream of Gold Ray Dam, and (3) conserve cold hypolimnetic storage for later release after all eggs of NP CHS spawners have been deposited.

Action 1.7. Request that Lost Creek Lake be managed to minimize passage of CHF upstream of Gold Ray Dam. The purpose of this action is to minimize potential (1) interbreeding with NP CHS, (2) competition with NP CHS for spawning sites, and (3) excavation of NP CHS redds. This action is commensurate with Action 1.6.

Action 1.8. Request that Lost Creek Lake be managed to minimize potential for disease outbreaks in areas downstream of Lost Creek Lake. The purpose of this action is to increase survival rates of migrating adult NP CHS.

Action 1.9. Request USACE restoration and maintenance of NP CHS spawning habitat in the area between Lost Creek Lake and Shady Cove. The purpose of this action is to mitigate for the loss of spawning gravel trapped within Lost Creek Lake.

Action 1.10. Develop recommendations for reservoir release strategies on a seasonal and annual basis, and submit those recommendations to the USACE through the Oregon Department of Water Resources. The purpose of this action is to ensure that fishery management objectives interface with releases from Lost Creek Lake.

Action 1.11. Request an update of the water control manual for Lost Creek Lake, and support USACE efforts to incorporate those revisions designed to protect and enhance fishery resources in downstream areas. The purpose of this action is to provide better guidance to reservoir regulators, especially ones newly assigned to the position(s).

Action 1.12. Request that USACE employees, who work on reservoir management issues for Lost Creek Lake, be oriented on relevant fishery issues and the relationships between reservoir management actions and fishery management objectives.

Action 1.13. Provide technical assistance, as requested by the USACE, on reservoir management issues for Lost Creek Lake. The purpose of this action is to ensure that fishery management objectives are considered during development of reservoir management plans.

Action 1.14. Continue to support improvements of fish passage facilities. The purpose of this action is to increase the survival rates of migrants juvenile and adult NP CHS.
Action 1.15. Continue to comment on permit applications that have the potential to affect habitat quality and quantity. The purpose of this action is to minimize deleterious effects of development on aquatic habitat and riparian zones.
Action 1.16. Develop a program designed to inform landowners about measures that help protect aquatic habitat and riparian zones.

Management Strategy 8.2. Establish the production of naturally produced spring Chinook salmon in tributaries of the Rogue River. Obtain water rights to ensure the development of at least one self-sustaining run of naturally produced spring Chinook salmon. Until water rights can be obtained, supplement the production of naturally produced fish by the release of adult spring Chinook salmon in non-historical habitat that is not currently accessible to spawners. The intent of this strategy is to significantly increase the amount of habitat available for the production of naturally produced spring Chinook salmon.

This management strategy addresses the limited amount of spawning habitat that currently produces NP CHS. The relatively small amount of spawning habitat is a primary factor which currently limits attainment of desired status (*see* **Habitat Volume**, page 29 and **Comparisons to Other Populations**, page 67). This strategy was developed by the advisory committee to provide additional natural production to offset the continued harvest of early-run and mid-run NP CHS that is called for in Strategy 8.4.

Assumptions and Rationale
1. Advantages associated with the establishment of adult CHS in non-historical habitat outweigh the disadvantages of possible detrimental impacts on native species of fish.
2. Life history characteristics of fish produced within expanded habitat in tributary streams will be similar to those exhibited by fish produced in nearby areas of the Rogue River before construction of Lost Creek Dam.
3. Improved upstream passage in Big Butte Creek will significantly increase the production of NP CHS.
4. Dedicated water allocations can be obtained for either stored water or natural flows in the Big Butte Creek and Little Butte Creek basins as a result of a coordinated effort among the affected entities.
5. The production of juvenile NP CHS can be significantly increased by transporting adults to spawning areas currently not available to CHS.

Actions
Action 2.1. Obtain additional water allocations that would be dedicated to the increase of flow in Big Butte Creek during 15 September through 15 October. The purpose of this action is to increase the amount of spawning habitat for NP CHS. Additional water allocations would have to come from transfer, purchase, or leasing of current water rights as Big Butte Creek is fully appropriated for water withdrawals.
Action 2.2. Support efforts to identify additional water allocations that would be dedicated to the increase of flow in Little Butte Creek during 15 September through 15 October. The purpose of this action is to increase the amount of spawning habitat for NP CHS. Additional water allocations would have to originate from outside the Little Butte Creek basin as natural flows are insufficient to allow for establishment of a NP CHS run.

Action 2.3. Support efforts to develop water projects that would provide for the storage of a volume of water sufficient to establish runs of NP CHS in Big Butte Creek and Little Butte Creek. The purpose of this action is to increase the amount of spawning habitat for NP CHS.
Action 2.4. Improve upstream passage for adult CHS at partial natural barriers and irrigation diversions to maximize NP CHS spawning distribution in Big Butte Creek. The purpose of this action is to increase the amount of spawning habitat for NP CHS.
Action 2.5. Identify the potential to improve CHS spawning habitat in Big Butte Creek.
Action 2.6. If warranted, based on findings from Action 2.5, improve spawning habitat in Big Butte Creek.
Action 2.7. Identify optimal areas for the transportation and release of adult CHS in tributary streams of the Rogue River. The purpose of this action is to increase the amount of habitat that produces NP CHS.
Action 2.8. Develop procedures for the transportation and release of adult CHS in tributary streams of the Rogue River. The purpose of this action is to ensure high survival rates among transported fish that will produce NP CHS as progeny.
Action 2.9. Transport and release adult CHS to spawn in areas of tributary streams not accessible to naturally migrating adults. The purpose of this action is to increase the amount of habitat that produces NP CHS.

Management Strategy 8.3. Decrease rates of predation on naturally produced spring Chinook salmon. The intent of this strategy is to increase the survival rate of naturally produced spring Chinook salmon.

This management strategy addresses predation losses of NP CHS. Predation loss appears to be a secondary factor which currently contributes to the non-attainment of desired status (*see* **Predators**, page 38).

Assumptions and Rationale
1. Any reductions in introduced (non-native) predatory fishes are advantageous for native fishes.
2. The state of Oregon is able to obtain, from the federal government, the authority to limit cormorant numbers.

Actions
Action 3.1. Develop a program designed to encourage fishing related mortality for non-native Umpqua pikeminnows.
Action 3.2. Initiate a program designed to decrease numbers of cormorants residing along the Rogue River.
Action 3.3. Request that NOAA Fisheries evaluate the effects of marine mammals on NP CHS in the Rogue River. The purpose of this action is to improve estimates of marine mammal predation on NP CHS.
Action 3.4. Transport and release juvenile steelhead and coho salmon of hatchery origin downstream of Gold Ray Dam. The purpose of this action is to release predacious hatchery fish at a site downstream of areas inhabited by NP CHS fry.

Management Strategy 8.4. Manage fisheries to sustain productivity for all segments of the population of naturally produced spring Chinook salmon, with a secondary objective of affording anglers the opportunity to annually harvest three naturally produced spring Chinook salmon. The intent of this strategy is to ensure sustainability of the historical life

history characteristics of naturally produced spring Chinook salmon, while maintaining harvest opportunities for all types of naturally produced spring Chinook salmon.

This management strategy addresses fishery impact rates on early-run and mid-run NP CHS. Fishery impacts on these two portions on the NP CHS population is a primary factor which appears to currently limit attainment of desired status (*see* **Fisheries**, page 53). This strategy relies on additional natural production of CHS occurring in new areas, as called for in Strategy 8.2, to offset the continued harvest of early-run and mid-run NP CHS.

Assumptions and Rationale

1. NP CHS mature at rates comparable to those estimated by ODFW (2000).
2. Ocean and river fisheries harvest CHS in an age-selective manner, and ODFW (2000) estimates of age-selective harvest rates are of reasonable accuracy.
3. River fisheries selectively intercept early-run CHS as compared to late-run counterparts (ODFW 2000), and that estimates of freshwater fishing mortality reported in this plan are of reasonable accuracy.
4. Spawner abundance goals and harvest rate goals established for CHF in the Klamath River Basin will remain unchanged over the lifetime of this plan.
5. Ocean distribution patterns of CHS and CHF of Klamath River Basin origin will not differentially change over the lifetime of this plan.
6. Future rates of ocean harvest will be about 15-20% for completed broods of NP CHS.
7. Harvest opportunities in the freshwater fisheries should be expanded when quantitative predictions indicate that (1) more than 15,000 NP CHS can be expected to pass Gold Ray Dam and (2) disease losses will be less than 10%.
8. In terms of pre-season expectations, expansion of harvest seasons is preferable as compared to reductions of harvest seasons.
9. Implementation of an annual harvest limit of three NP CHS, coupled with specific gear and method regulations, will keep freshwater harvest rates within appropriate levels for all segments of the population.
10. Survival rates of NP CHS released by anglers can be significantly increased through a combination of gear regulations, method regulations, increased enforcement, and increased angler knowledge of appropriate handling procedures.
11. Hatchery production will be consistent with the Fish Hatchery Management Policy of ODFW.
12. Reductions in the proportion of hatchery fish among natural spawners decrease the risk of genetic impacts on NP CHS.

Actions

<u>Action 4.1</u>. Establish regulations that allow individual anglers to annually harvest a maximum of three NP CHS in the area downstream of the Highway 62 bridge in Shady Cove (*see* **Alternative 8** in **APPENDIX J** for specific regulations). The area upstream of the Highway 62 bridge in Shady Cove would be closed to the harvest of NP CHS. The purpose of this action is to reduce harvest rates on NP CHS, with an emphasis on those early-run and mid-run fish holding in the uppermost portion of the Rogue River prior to spawning.

<u>Action 4.2.</u> Expand harvest opportunities for NP CHS in freshwater when returns to Gold Ray Dam are predicted to exceed 15,000 NP CHS and disease losses are predicted to be less than 10%. The purpose of this action is to increase harvest opportunities when the population exceeds the relevant desired status element.

Action 4.3. Request increased enforcement of regulations established for freshwater fisheries that target CHS. The purpose of this action is to ensure appropriate protection for NP CHS.
Action 4.4. Promote ethical angling and proper techniques for catch and release of NP CHS. The purpose of this action is to increase the survival rate of NP CHS released by anglers.
Action 4.5. Revise spawning practices at Cole M. Rivers Hatchery to increase harvest rates on CHS of hatchery origin. The purpose of this action is to produce fish that will mature at older ages, which results in greater rates of harvest.

Management Strategy 8.5. Manage spring Chinook salmon of hatchery origin so as to minimize the risk of genetic changes among naturally produced fish and to maintain the genetic integrity, and life history characteristics, of that portion of the natural population that historically spawned in upstream areas prior to the construction of Lost Creek Dam. The intent of this strategy is to maintain the genetic integrity of naturally produced spring Chinook salmon.

This management strategy addresses the potential risk of hatchery fish to NP CHS. Natural spawning by hatchery fish is a secondary factor which might contribute to the non-attainment of desired status. The current level of impact is very difficult to assess for NP CHS in the Rogue SMU (*see* **Hatchery Fish**, page 50), but may become more apparent as additional research is completed on other populations of salmonids.

Assumptions and Rationale

1. Reductions in the proportion of hatchery fish among natural spawners decrease the risk of genetic impacts on NP CHS.
2. Methods developed to estimate the proportion of hatchery fish among CHS spawners are of reasonable accuracy.
3. Projections under revised regulations for freshwater fisheries indicate that the spawner composition will average about 10% hatchery fish annually.
4. Brood stock selection of CHS at Cole M. Rivers Hatchery should continue to reflect the life history characteristics of that portion of the NP CHS population that spawned in upstream areas prior to the construction of Lost Creek Dam.
5. Changes in brood stock composition at Cole M. Rivers Hatchery are warranted to compensate for the selective harvest of older CHS.

Actions

Action 5.1. Block adult CHS at the primary outflow from Cole M. Rivers Hatchery to increase the proportion of hatchery CHS that enter the collection facility at the hatchery. The purpose of this action is to reduce the proportion of hatchery fish among natural spawners.
Action 5.2. Revise spawning practices at Cole M. Rivers Hatchery so that maturity rates of hatchery CHS are similar to that portion of the natural population that historically spawned upstream of Lost Creek Dam. The purpose of this action is to (1) more closely mimic the age structure of older NP CHS that spawned historically upstream of the Lost Creek Dam site and (2) reduce the proportion of hatchery fish among natural spawners by increasing the harvest rates of hatchery CHS.
Action 5.3. Develop a hatchery program management plan for Cole M. Rivers Hatchery. The purpose of this action is to establish hatchery practices that will decrease the chance that the production and release of CHS will have negative impacts on NP CHS.

ALTERNATIVE 9

a. Expand natural spawning habitat for NP CHS
b. Reservoir management actions designed for emphasis on NP CHS
c. Regional regulations for freshwater CHS fisheries
d. Adjust production goals at Cole M. Rivers Hatchery

MANAGEMENT SUITE

Coded management actions are described in **APPENDIX H** and **APPENDIX I**

Management Actions Related to the Operation of Lost Creek Lake

(employs actions common to other alternatives, except Alternative 1)

Management Actions Related to Other Habitat Issues

(employs actions common to other alternatives)
A11 (a,e) Improve passage for adult CHS at a natural barrier in lower Big Butte Creek.

Management Actions Related to Other Species of Animals

(employs actions common to other alternatives)

Management Actions Related to Hatchery Fish

A5(b) Reduce releases of coho salmon to decrease predation on NP CHS fry.
E1(a) Block hatchery outflow to decrease the number of hatchery fish that spawn naturally.

Management Actions Related to Fisheries

(employs actions common to other alternatives)
A16(d9): Regional (zone) angling regulations employed for the Rogue River. Harvest of NP Chinook salmon opens 1 June below Gold Ray Dam, and is open during July-August between Gold Ray Dam and Dodge Bridge.

PRIMARY IMPLICATIONS OF THE ALTERNATIVE

Harvest of NP CHS will include some mid-run fish in addition to late-run fish.
Reduction of coho salmon production at Cole M. Rivers Hatchery should be offset with increased production of CHS in order to (1) compensate for fishery losses and (2) meet intent of mitigation goals.

In-river mortality rates of CHF and coho salmon may increase.

APPENDIX K

Options for Reservoir Operation

During development of the conservation plan, ODFW and the advisory committee considered the impacts of the operation of Lost Creek Dam and the management of Lost Creek Lake in relation to the impacts outlined in the previous section of this document. In general terms, the following options were considered in relation to the retention and operation of Lost Creek Dam and Lost Creek Lake:

Option 1. Dam removal (no dam option)
Option 2. Operation only for flood control (no pool option)
Option 3. Operation only for conservation storage (conservation storage option)
Option 4. Operation as authorized by Congress (full pool option)

In addition, ODFW and the advisory committee considered the following options relative to the full pool option:

Option 4a. Operation with increased release of storage for fishery purposes (increased release option).
Option 4b. Operation with current storage for fishery purposes dedicated solely to spring Chinook salmon (spring chinook only option).
Option 4c. Operation with current storage for fishery purposes dedicated primarily to spring Chinook salmon with current life history characteristics (current life history, multi-species option).
Option 4d. Operation with current storage for fishery purposes dedicated primarily to spring Chinook salmon with historical life history characteristics (endemic life history, multi-species option).

A brief evaluation of each of the options follows:

Option 1. (no dam option).

Scenario: Lost Creek Dam would be removed, or would be breached to allow for the unobstructed upstream passage of NP CHS.

Evaluation: This option is most likely to completely restore the historical abundance and life history parameters of NP CHS in the Rogue River.

Required Action: The Congress of the United States would have to pass legislation authorizing removal of Lost Creek Dam. This legislation, which could be part of a package including other legislation, would have to also receive approval of the President of the United States of America.

Prognosis: The advisory committee and ODFW concluded that such action is unlikely given the current preferences of the general public and elected officials.

Option 2. (no pool option).

Scenario: Lost Creek Dam would be operated solely for flood control purposes. No storage would be retained except during flood control operations. Returning adult salmonids, and other native fish, would be trapped and transported to areas upstream of the dam, or Lost Creek Dam would need to be retrofitted with fish passage facilities.

Evaluation: There is a reasonable chance that this option would completely restore the historical abundance and life history parameters of NP CHS in the Rogue River.

Required Action: The Congress of the United States would have to pass legislation changing the authorized purposes of Lost Creek Dam. This legislation, which could be part of a package including other legislation, would have to also receive approval of the President of the United States of America.

Prognosis: The advisory committee and ODFW concluded that such action is unlikely given the current preferences of the general public and elected officials.

Option 3. (conservation storage option).

Scenario: Lost Creek Dam would be operated in a manner similar to current operations, except that all reservoir storage would be released before NP CHS begin to spawn in the Rogue River. Returning adult salmonids, and other native fish, would be trapped and transported to areas upstream of the dam, or Lost Creek Dam would need to be retrofitted with fish passage facilities.

Evaluation: There is a reasonable chance that this option would completely restore the historical abundance and life history parameters of NP CHS in the Rogue River.

Required Action: The Congress of the United States would have to pass legislation changing the authorized purposes of Lost Creek Dam. This legislation, which could be part of a package including other legislation, would have to also receive approval of the President of the United States of America.

Prognosis: The advisory committee and ODFW concluded that such action is unlikely given the current preferences of the general public and elected officials.

Option 4a. (increased release option).

Scenario: Lost Creek Dam would be operated in a manner similar to current operations, except that the reservoir would be drawn down to minimum conservation pool before NP CHS begin to spawn in the Rogue River.

Evaluation: It is very unlikely that this option would completely restore the historical abundance and life history parameters of NP CHS in the Rogue River because (1) spawning habitat would remain blocked and mostly inundated by Lost Creek Lake and (2) the residual pool volume would still cause NP CHS fry to emerge somewhat early from the gravel. However, there is a reasonable chance that this option would result in attainment of desired status.

Required Action: The Congress of the United States would have to pass legislation changing the authorized purposes of Lost Creek Dam. This legislation, which could be part of a package including other legislation, would have to also receive approval of the President of the United States of America.

Prognosis: The advisory committee and ODFW concluded that such action is unlikely given the current preferences of the general public and elected officials. In addition, there is the possibility that based on a broad spectrum of public input, Congress could act instead to reduce or eliminate the volume of reservoir storage currently authorized for fishery purposes in downstream areas. This option was considered at length by both the advisory committee and ODFW.

Option 4b. (spring chinook only option).

Scenario: Lost Creek Dam would be operated in a manner so that reservoir storage, available for fishery purposes, would be dedicated solely to the protection and enhancement of NP CHS. No storage would be allocated to the protection and enhancement of NP CHF, or to other varieties of anadromous fish.

Evaluation: It is very unlikely that this option would completely restore the historical abundance and life history parameters of NP CHS in the Rogue River because (1) spawning habitat would remain blocked and mostly inundated by Lost Creek Lake and (2) the residual pool volume would still cause NP CHS fry to emerge early from the gravel. However, there is a very good chance that this option would result in attainment of desired status, if coupled with other conservation measures.

Required Action: Fish and Wildlife Commission adopts this conservation plan, with Alternative 1 (see **ALTERNATIVE MANAGEMENT STRATEGIES** section in the conservation plan) as the suite of management strategies to be implemented.

Priority: Low. The advisory committee and ODFW concluded that projected impacts on other species of anadromous fish, including NP CHF, would not be in the best interest of either the public or the entirety of native fish resources resident in the Rogue River.

Option 4c. (current life history, multi-species option)

Scenario: Lost Creek Dam would be operated similar to current operations, with improved operating practices, to protect and enhance that portion of the run that exhibits life history characteristics similar to the current population of NP CHS (later migrating and spawning as compared to historical endemic population).

Evaluation: It is almost certain that this option would not completely restore the historical abundance and life history parameters of NP CHS in the Rogue River because (1) spawning habitat would remain blocked and mostly inundated by Lost Creek Lake and (2) the residual pool volume would still cause fry of NP CHS fry to emerge early from the gravel. In addition, it is almost certain that this option would not result in attainment of desired status, even if coupled with other conservation measures.

Required Action: This conservation plan would need to be greatly revised before the Fish and Wildlife Commission could consider adoption.

Priority: Low. Both the advisory committee and ODFW concluded that it was desirable to manage NP CHS in the Rogue River so as to restore the historical life history characteristics of the population to the greatest degree possible.

Option 4d. (endemic life history, multi-species option)

Scenario: Lost Creek Dam would be operated similar to current operations, with improved modifications to protect and enhance that portion of the run that exhibits life history characteristics similar to the historical population of NP CHS. This scenario is described in detail within Alternative 8 and Alternative 9 of this conservation plan (see **ALTERNATIVE MANAGEMENT STRATEGIES** section in the conservation plan).

Evaluation: It is very unlikely that this option will completely restore the historical abundance and life history parameters of NP CHS in the Rogue River. However, this option represents the best scenario given the current preferences of the general public and elected officials, and there is a good chance that this option will result in attainment of desired status.

Required Action: Fish and Wildlife Commission adopts the conservation plan. ODFW formally requests changes in reservoir management actions at Lost Creek Lake.

Priority: High. Both the advisory committee and ODFW concluded that it was desirable to manage spring Chinook salmon in the Rogue River so as to restore the historical life history characteristics of the population, to the greatest degree possible.

There was general agreement between the advisory committee and ODFW that reservoir management option 4d (endemic life history, multi-species option) was preferable as compared to the other options for two primary reasons (1) it was judged that changes in the authorized purposes of Lost Creek Dam are unlikely and (2) the option was commensurate with the two options (three and four) of a generalized statement of desired status preferred by members of the advisory committee. Based on this decision, alternative management strategies described in the following section were crafted based on the assumption that Lost Creek Lake would continue to be managed by the USACE with a primary objective of annual filling of the reservoir and a usual release of 180,000 acre-feet of conservation storage annually.

APPENDIX L

Commitments by State Agencies

Oregon Water Resources Department (OWRD)

The Oregon Water Resources Department is the primary agency responsible for determining the availability of water for beneficial uses, monitoring, distributing and regulating water use, and promoting responsible water management. The Department's mission is to serve the public by practicing and promoting responsible water management through two key goals: To directly address Oregon's water supply needs, and to restore and protect streamflows and watersheds in order to ensure the long-term sustainability of Oregon's ecosystems, economy, and quality of life.

Existing Legal Framework
Oregon water law determines which water rights are legally entitled to water based on the doctrine of prior appropriation. This doctrine operates by the "first in time, first in right" principle meaning that, in water-short times, the appropriator with the oldest, or most "senior" water right, can demand the water specified under the right regardless of the needs of other users. If there is water in excess of the needs of this senior right holder, the person with the next oldest priority date can take as much as necessary to satisfy needs under that right, and so on down the line until all needs are met, or until no water is available. Junior water right holders are protected by laws that prohibit senior users from making changes in use through water right transfers that injure junior users.

Water management in Oregon has historically emphasized consumptive water uses. The growing concern for and recognition of the need to protect instream values such as fish and wildlife and their associated aquatic habitat has required new approaches that consider the public interest and instream needs and values. New statutory authorities were created to reflect these changing values. These include authority for state agencies (Environmental Quality, Parks and Recreation, and Fish and Wildlife) to apply for instream water rights, the ability to move existing consumptive rights instream via leases, transfers and allocations of conserved water, and public interest evaluations of new water use applications.

Conservation Plan Framework
Potential factors identified in the Rogue River Spring Chinook Conservation Plan that limit Spring Chinook populations include low flows and changes in stream flow. In particular, enhancing tributary streamflows through restorative measures and coordinating reservoir releases to assure mainstem temperature targets are reached were identified as important to population conservation.

Alternatives 8 and 9 identified in the Conservation Plan include reservoir management strategies designed to emphasize Naturally Produced Spring Chinook. OWRD acts in a coordinating capacity on behalf of State natural resource agencies to provide input to managers of Federal projects within the Rogue River basin. For example, the timing and magnitude of releases from the Lost Lake project may benefit Spring Chinook populations by helping assure optimal temperatures are maintained in the Rogue River mainstem. Each spring, the State of Oregon and other stakeholders provide input to project managers regarding annual flow management priorities. OWRD coordinates with other natural resource agencies to define and communicate priorities. These Oregon priorities include consideration of flow priorities developed by ODFW to benefit Spring Chinook populations. Ongoing coordination helps assure project management objectives are met. OWRD has been engaged in these coordination activities for over 25 years and commits to continued action in this area.

Alternatives 8 and 9 also include actions intended to expand natural spawning habitat for Naturally Produced Spring Chinook. With respect to this conservation goal, OWRD will continue to focus its limited staff capability in areas that have the greatest opportunities to benefit fish. Staff actively coordinate their conservation efforts with those of other natural resource agencies. For example, OWRD and ODFW jointly identified priority areas for streamflow restoration throughout the state. These priority areas represent watersheds in which there is a combination of need and opportunity for flow restoration. Within the Rogue River Spring Chinook SMU, 48 high priority flow restoration watersheds have been identified, including Big and Little Butte Creek watersheds.

Agency Actions

OWRD has a number of ongoing actions targeted in priority flow restoration watersheds and streams that incrementally aid in improving salmonid habitat. Within the existing legal framework, the actions are intended to support conservation by encouraging voluntary efforts by water users to preserve and enhance streamflows and by ensuring that the use of water is consistent with state water law and the terms and conditions of water rights. Programs, specific actions and new statewide concepts that may contribute to Rogue River Spring Chinook conservation are described below.

Water Distribution and Regulation

Water distribution and regulation includes OWRD regulatory authority to prevent illegal use and to distribute water according to the water rights of record. The relationship between this regulatory authority and instream benefits are described in the following actions.

<u>Perform distribution to provide water rights, including Instream Water Rights, with the water to which they are entitled</u>

One of OWRD's primary functions is the distribution and regulation of water use based on the system of prior appropriation and rights of record. Watermasters are responsible for the protection of senior water rights, including instream water rights. Watermasters and their assistants work with water users to protect existing instream water rights from junior and illegal uses in streams of the Rogue River Spring Chinook SMU. The authority to regulate water use is set forth in Oregon statute (ORS 540.045) and rules (OAR Chapter 690, Division 250) and is the primary mechanism for providing certainty of implementation and effectiveness of streamflow protection and restoration efforts. The 2007-2009 budget includes 5 FTE for Assistant Watermasters. These additional staff will counter declining funding for Assistant Watermasters at the county level.

When streamflow measurements indicate the quantity of water in a stream is less than the instream water rights, the Department requires junior water right holders to stop or curtail their use. Depending on the priority date of the instream water right, flows may be stabilized or may improve. In many instances, the instream water right is junior relative to other rights on the stream. Under Oregon law, an instream water right cannot affect a use of water with a senior priority date. Therefore, instream water rights do not guarantee minimum streamflows in stream reaches. Protection of existing instream water rights and increasing flow through voluntary flow restoration will be key to addressing flow as a potential limiting factor.

OWRD has established performance measures and targets related to regulating water use on behalf of instream water rights. One performance measure is the ratio of streams regulated to protect instream water rights to all streams regulated. The Department's goal is for 35% of all streams regulated to be regulated on behalf of instream water rights. The Department does not currently track this performance measure at the SMU scale. However, within the three Watermaster districts that include the Rogue River Spring Chinook SMU, 13% of streams regulated in 2005 were regulated on behalf of instream water rights. This ratio is significantly influenced by factors such as weather, high or low streamflow years, and relative priority date of the instream water right. Of 261 regulatory actions taken, 21% were on behalf of instream water rights in the Rogue Basin.

Maintaining Streamflows through Compliance and Enforcement

It is a priority for OWRD to reduce or eliminate illegal water use. Illegal water use may be any one of the following:

a) Use of water without a water right or other legal water use authorization;
b) Use of water is in excess of or contrary to the terms and conditions of a water right;
c) Continued use of water after use has been denied by OWRD.

Reducing and eliminating illegal water use increases streamflows and allows other users, including instream users, to benefit from the flows. Since many instream water rights are junior in priority to older out-of-stream uses, elimination of illegal water use increases the likelihood that an instream water right will be met.

OWRD has a strong regulatory role in the Rogue River basin. The primary responsibility for enforcing water law resides with OWRD Watermasters and their county assistants. Enforcement or compliance monitoring of water rights is initiated either by Watermaster investigation or by investigation of a complaint. The Rogue River Spring Chinook SMU falls within three Watermaster districts. Of regulation that occurred, voluntary compliance within the three Watermaster districts of the Rogue River Spring Chinook SMU exceeded 99% in 2005.

Water Use Measurement

As part of their regulatory function, Watermasters monitor streamflow and instream water right usage. These efforts create the base information necessary to determine the flows that are present, and to shepherd water past junior users to the senior users, both instream and out-of-stream.

Watermasters and their assistants regularly monitor streams within their districts, particularly those with instream water rights or minimum streamflows. Under the Oregon Plan, Watermasters have also trained volunteers to perform streamflow measurements. These flow measurements made by volunteers aid Watermasters in distributing water as necessary to protect instream water rights. Funding for the 2007-2009 biennium will provide additional statewide flow monitoring and restoration equipment. OWRD is also interested in further partnerships with OWEB to secure funding for watershed groups to provide volunteer streamflow monitoring within priority watersheds for which flow is a limiting factor.

In addition to point measurements, continuous streamflow data are collected by OWRD and the USGS using a network of about 40 gaging stations. Approximately 30 of the gages are equipped to provide real-time data for water management. Operation and maintenance of the gages depend on funding, and therefore the number of active sites changes with time. In addition to OWRD and USGS streamflow gages, data may also be available from gages operated by other agencies such as the USBR and USACE. OWRD considers data from these cooperatively operated gaging stations provisional until data quality is assured. The Department continues to seek alternate funding sources for monitoring instream flows and to install and maintain continuous monitoring gages. Data may be accessed at:
http://www.wrd.state.or.us/OWRD/SW/index.shtml#Surface_Water_Data

ORS 537.099 requires that government entities holding water rights report water use on an annual basis. This requirement applies to OWRD as the holder in trust of instream water rights. OWRD monitors and reports "water use" by instream water rights to the Water Resources Commission on an approximately annual basis. However, the water use measurement and reporting position which was responsible for analyzing and synthesizing instream measurements collected by Watermasters was eliminated in the 2005-2007 legislatively adopted budget. Restoration of this position for the 2007-2009 biennium will improve statewide instream water rights "water use" reporting. In turn, this will help inform Rogue River Spring Chinook SMU research, monitoring and evaluation.

Inventory of Significant Diversions

As part of the Water Resources Commission strategy for increasing water measurement statewide, OWRD has been completing an inventory and field inspection of significant diversions in high priority flow restoration watersheds. Significant diversions are defined as all diversions of permitted and certificated water rights with conditions requiring measurement and reporting and diversions greater than 5 cfs or greater than 10% of the lowest monthly 50% exceedance flow on a stream. Within high priority watersheds of the Rogue River Spring Chinook SMU, 608 significant diversions have been identified at this time. Field staff are currently in the process of inspecting the significant diversions identified. During this phase, assessments of headgates and measuring devices are conducted to assure compliance with permit conditions, including conditions requiring screening and fish passage. More information on the measurement strategy may be found at:
http://www.wrd.state.or.us/OWRD/mgmt_measure.shtml

Fish and Fish Habitat Protection

Actions associated with fish and fish habitat protection are designed to maintain and restore streamflow and improve fish passage and habitat.

Instream Water Rights

Instream water rights (ISWRs) were established by Oregon statute in 1987. The Instream Water Right law allows ODFW, DEQ, and OPRD to apply for ISWRs for the purpose of fish protection, minimizing the effects of pollution, or maintaining recreational uses (ORS 537.332). The law gives ISWRs the same status as other water rights. Once issued, ISWRs are held by OWRD as trustee for the people of the State of Oregon.

Within the Rogue River Spring Chinook SMU, approximately 670 miles of stream are protected by an ISWR. ISWRs establish flow levels to stay in a stream on a monthly or half-month basis and are usually set for a certain stream reach. ISWRs can be issued for up to the estimated average natural flow of the stream even if this flow is not currently present – or at even higher flows if there is a documented reason such as addressing a fish passage barrier. Since ISWRs are based on natural streamflow rather than existing or actual flows, they may appropriate all of the remaining water in a stream and result in limited opportunity for additional out-of-stream uses of water. Depending on the priority date of the instream water right, flows are either stabilized or may improve where ISWRs are in place. In many instances, the ISWR is junior relative to other rights on the stream. Under Oregon law, an ISWR cannot affect a use of water with a senior priority date. Therefore, ISWRs do not guarantee minimum streamflows in stream reaches.

In addition to instream water rights, ODFW holds water rights for stored water in Lost Creek Lake and Applegate Reservoir for fishery enhancement purposes. Since these rights are treated like other water rights, they are protected from injury. Water right holders must obtain approval from OWRD to change the type of water use, place of use, or point of diversion on a stream. Water rights statutes do not allow a water right change, or "transfer," if the proposed change results in injury to another existing water right, including ISWRs.

Evaluation and Issuance of New Water Rights

New appropriations of surface water or hydraulically connected ground water are evaluated using the Water Resources Commission's Water Allocation Policy under OAR Chapter 690, Division 410. The Water Allocation Policy sets standards for evaluating whether water is available for new appropriations from Oregon streams. Direct appropriations from streams are evaluated on an 80% exceedance basis. This means that before a new water right may be issued OWRD must conclude that water is available for appropriation 80% of the time. The amount of available water for each month is calculated by subtracting consumptive uses, scenic waterway flows, and ISWRs from natural flow. Use of the 80% exceedance standard helps ensure that new appropriations will not further diminish water available to satisfy instream water rights and scenic waterway flows. As part of its Oregon Plan efforts, the Department updated its water availability model in 1997 to ensure that instream water right flows were included in the model. The Rogue River Basin is closed to further appropriation of live surface water flows during the months of July through September. Big Butte Creek is closed year around to further appropriation.

Issuance of new surface water rights in the Rogue River Basin is further constrained by additional public interest standards to protect the habitat of sensitive, threatened, and endangered species (OAR Chapter 690, Division 033). These rules were adopted in 1996 and require that all new water right applications must undergo a review by an interagency team for adverse impacts to fish habitat. The purpose of this review is to only grant applications that can be conditioned to protect the habitat of sensitive, threatened, or endangered fish species. As a result, all new permits require barrier-free fish passage where there are fish present, to the specifications requested by ODFW. All new permits also require fish screening where fish are present, to the specifications requested by ODFW. More information on Water Rights in Oregon may be found on the OWRD website at http://www.wrd.state.or.us/OWRD/PUBS/aquabook.shtml.

Enclosed Livestock Water Delivery

Livestock owners with legal access to use of surface waters are exempt from the requirement to obtain a permit or certificate if the water is diverted to a trough or tank through an enclosed water delivery system and the delivery system is equipped with an automatic shutoff or flow mechanism or includes a means for returning water to the surface water source. Watermasters and their assistants provide technical support to livestock owners to facilitate implementation of enclosed livestock water delivery systems. When coupled with riparian fencing programs, this program is particularly effective in the restoration and protection of habitat.

Flow Restoration Programs

These agency actions promote flow restoration and conservation through a variety of voluntary programs.

In 1987, Oregon passed legislation (ORS 537.348) allowing any person to purchase, lease, or receive as a gift any existing water right or portion thereof for conversion to an instream water right. Water rights may be transferred to instream uses, either permanently by an instream transfer or an allocation of conserved water or temporarily by a lease agreement or temporary transfer. These transferred rights become ISWRs with the priority date of the original right. Instream transfers and leases provide a method for the State to incrementally increase streamflows. Transfers and leases also provide the opportunity to strategically address flow problems on specific stream reaches. Existing water rights can be acquired and converted to ISWRs on stream reaches that are in need of additional flows for salmon conservation. Watermasters and OWRD technical staff regularly provide assistance to those completing the application process for voluntary flow restoration programs.

OWRD works in partnership with interested landowners and other entities to facilitate protection and enhancement of instream flows by transferring and leasing senior, out-of-stream rights. One group working to restore flows is the Oregon Water Trust, a private nonprofit organization formed in 1993. The Trust takes a free-market approach to restoring and protecting critical stream habitat for fish and wildlife, and works with water right holders who are willing to sell, lease, or gift all or a portion of their water right for instream flows. OWRD Watermasters and staff provide significant technical assistance to these types of conservation groups and to landowners working on lease, transfer, and conserved water applications.

During 2006, 70 voluntary streamflow restoration projects were in effect in the Rogue River Spring Chinook SMU. As a result, approximately 26 cubic feet per second (cfs) of water was restored instream during this period. Additional research monitoring and evaluation will be necessary to determine specific improvements to Spring Chinook populations brought by incremental flow restoration. Regardless of this uncertainty, OWRD continues to work with landowners and other partners to seek these incremental flow improvements in areas where they are most needed for fish. Participation in voluntary flow restoration programs continues to increase statewide.

Voluntary Instream Leases

Oregon's Instream Leasing program provides a voluntary means to aid the restoration and protection of streamflows. This arrangement provides benefits to both water right holders and to instream values by providing water users with options that protect their water rights while leasing water for instream benefits. Water users who are at risk of forfeiture of their water rights due to non-use may find instream leases to be a good management option.

OWRD has streamlined the instream leasing process, so that most leases are processed in one month. The length of term of an instream use lease cannot exceed five years or, in the case of irrigation rights, five irrigation seasons. However, leases may be renewed an unlimited number of times. Additionally, the Oregon Watershed Enhancement Board has funded instream leases during drought years. These leases of older consumptive use rights for instream use provide greater certainty that water will be instream to meet fish needs.

Voluntary Water Right Transfers

Water rights are appurtenant to the land and generally are conveyed with the land when it is sold from one landowner to another. A water right may only be used for the purposes authorized under the right at the location identified in the right unless a change in the use is authorized by OWRD through a water right transfer. A transfer may approve changes in the place of use, point of diversion, or character of use of a water right. In reviewing applications to transfer water rights, OWRD is responsible for ensuring that other water right holders will not be injured by the change. There is growing interest in the state in the use of the water right transfer process as a tool to secure water to support streamflow restoration.

Allocations of Conserved Water

The Allocation of Conserved Water program is a voluntary activity that provides benefits to both water right holders and instream values. The law allows a water user who conserves water to use a portion of the conserved water on additional lands, lease or sell the water, or dedicate the water to instream use. The primary intent of the law is to promote the efficient use of water to satisfy current and future needs--both out-of-stream and instream. The law provides a certainty that after mitigating the effects on any other water rights, a minimum of 25% of the conserved water is allocated to the state for an instream water right. The applicant receives 75 % of the conserved water, unless the applicant proposes a higher allocation to the state or more than 25% of the project costs come from federal or state non-reimbursable sources. In many cases, 100 % of the conserved water is permanently protected instream. The conserved water has either the same priority date as the originating water right, or is one-minute junior to the originating right.

Conservation Reserve Enhancement Program

Water rights are generally subject to forfeiture after five years of non-use. However, by statute, water rights appurtenant to lands enrolled in the Conservation Reserve Enhancement Program (CREP) are not subject to forfeiture due to non-use during the time these lands are enrolled in the program. While water rights appurtenant to lands enrolled in CREP are not subject to forfeiture during the enrollment period, landowners are encouraged to lease or temporarily transfer their water rights for instream use during CREP enrollment. A water right that is leased or temporarily transferred instream is considered to be beneficially used during the term of the lease. OWRD will continue to work cooperatively with other agencies to promote this program.

Agricultural Water Management and Conservation Planning Program

This largely voluntary program helps irrigation districts and other agricultural water suppliers examine their supply, demand, future needs, and water conservation tools. Analysis and application of appropriate conservation tools may lead to an increase in available water supplies. Conservation options include promotion of energy audits, conversion to a metered pressurized system, piping or lining of canals, increased flexibility of deliveries and modification of distribution facilities. The goal of this program includes promoting effective and responsible water management and conservation within irrigation districts. OWRD is committed to reviewing each Water Management and Conservation Plan within 90 days of receipt.

With funding from the Bureau of Reclamation, OWRD is completing a guidebook to assist irrigation districts and other agricultural water suppliers to prepare Water Management and Conservation Plans that meet Oregon and Federal requirements. This guidebook will help agricultural water suppliers describe their water systems and needs, identify their sources of water, and identify ways to manage and conserve those supplies to meet present and future needs. Workshops will be conducted to introduce the guidebook and describe how it can aid them in meeting water supply and regulatory demands.

Municipal Water Management and Conservation Planning Program

The Municipal Water Management and Conservation Planning program provides a process for municipal water suppliers to develop plans to meet future water needs. Many municipal water suppliers are required to prepare plans under water right permit conditions. In addition, with the revision of the permit extension rules in fall 2002, communities seeking long-term permit extensions are required to prepare plans. These plans quantify the communities' needs for increased diversions of water under the permits as their demands grow. The plan also provides a description of the water system, identifies the sources of water used by the community, and explains how the water supplier will manage and conserve supplies to meet future needs. Preparation of a plan is intended to represent a pro-active evaluation of the management and conservation measures that suppliers can undertake. The planning program requires municipal water suppliers to consider water that can be saved through conservation practices as a source of supply to meet growing demands if the saved water is less expensive than developing new supplies. As such, a plan represents an integrated resource management approach to securing a community's long-term water supply.

OWRD recently partnered with the League of Oregon Cities and other groups to complete a guidebook to assist municipalities with the preparation of Municipal Water Management Plans. Release of the guidebook has resulted in improvements in the quality of submitted plans and a decrease in time required for their review and approval.

Additional information on OWRD Water Conservation and Flow Restoration Programs can be found at: http://www.wrd.state.or.us/OWRD/mgmt.shtml#Water_Conservation

Public Outreach and Education

Watermasters and field services staff provide ongoing public outreach and education to water users and conservation interests. In addition, Watermasters provide technical support and information to watershed councils and others involved in streamflow and habitat restoration. OWRD is committed to continuing this effort within the Rogue River Spring Chinook SMU.

OWRD is also committed to maintaining and providing accurate streamflow data to researchers and interested parties, and to make data supportive of watershed and fish restoration activities readily accessible via the OWRD website within its existing capabilities.

A significant amount of data is now available through the OWRD website. Annual reports of regulatory activity by stream reach and Watermaster are available following the close of each water year (October 1 through September 30). Key performance measures are also available, including high priority flow restoration transactions and ratio of streams regulated for instream uses compared to all streams regulated. Additional data includes the Water Availability Reporting System (WARS). This database provides water available for new out-of-stream consumptive uses from a given point. The Oregon Water Resources Web Mapping Program allows interactive mapping and querying of data associated with the OWRD water rights information system (WRIS), water availability basins (WABs), points of diversion and use, and ground water limited areas, for example.

With funding from the National Fish and Wildlife Foundation's Columbia Transactions Program, OWRD is currently migrating instream leasing, transfer and allocations of conserved water data to our on-line water right information system. Providing voluntary flow restoration data through the OWRD website will provide information critical to the evaluation of current conservation measures and adaptive management. This project is slated for completion during September 2007. OWRD's online mapping program may be found at: http://map.wrd.state.or.us/apps/wr/wr_mapping/

OWRD continues to investigate potential enhancements to our reporting capabilities and accessibility of data to assist in outreach, education, monitoring, and adaptive management efforts under the Conservation Plan. In particular, OWRD will assess opportunities to report regulation activities and other relevant data at scales that support ongoing needs of adaptive management.

Improvement of Resource Understanding

OWRD continues to work to improve our understanding of the State's surface and ground water resources. In addition to surface water measurements and analysis, ground water investigations are key to assessing stream-aquifer interactions, aquifer hydraulic properties and aquifer recharge and discharge relationships. General funding for these investigations was reduced over the last several biennia and eliminated in 2005-2007. However, partial funding has been provided for the 2007-2009 biennium and OWRD continues to look for ways and partnerships to complete these important investigations.

OWRD received funding for the 2007-2009 biennium supporting most elements of a new concept that will advance our understanding of our water resources and the demands on them. The Oregon Water Supply and Conservation Initiative, a comprehensive overview of future supply needs, will assess existing and future water needs, including instream water needs; inventory potential storage sites; and analyze potential conservation opportunities. Match funding for community-based and regional water supply planning is also supported.

Research Monitoring & Evaluation

The Water Resources Department will continue to incorporate adaptive management principles through the development of annual action plans for high priority watersheds.
To facilitate research, monitoring and evaluation of Rogue River Spring Chinook conservation efforts, OWRD will assess opportunities to report regulation activities and other relevant data at scales which support adaptive management under this and other Conservation Plans.