RECOMMENDATIONS FOR DEVELOPING FISHERY MANAGEMENT PLAN CONSERVATION OBJECTIVES FOR SACRAMENTO RIVER WINTER CHINOOK AND SACRAMENTO RIVER SPRING CHINOOK

Interagency Workgroup

Allen Grover, CDFG
Alice Low, CDFG
Paul Ward, CDFG
Jim Smith, USFWS
Michael Mohr, NMFS
Dan Viele, NMFS
Chuck Tracy, PFMC

Progress Report
February 19, 2004

CONTENTS

1 INTRODUCTION

1.1 Present Management of Winter and Spring Chinook

Winter Chinook Sacramento River winter chinook salmon were listed under the federal Endangered Species Act (ESA) as a threatened species in 1989 and reclassified as endangered in 1994. Since 1990, measures to limit the incidental take of winter chinook in the West Coast ocean salmon fishery have been developed through section 7 consultations conducted by the National Marine Fisheries Service (NMFS) under the ESA. The consultations and associated biological opinions were conducted in 1990, 1996, 1997 and 2002.

Spring Chinook Sacramento River spring chinook[1] were listed as threatened in 1999. NMFS concluded in a 2000 biological opinion that ESA requirements for winter chinook provided sufficient protection for spring chinook and additional constraints on ocean fisheries managed under the Pacific Coast Salmon Plan (FMP) were not necessary. Amendment 14 to the FMP included Sacramento River winter and spring chinook in the list of stocks and stock complexes of significance to ocean salmon fisheries and specified the conservation objective as NMFS' section 7 consultation (jeopardy) standard.

1.2 The Development of Management Goals through FMP Amendment

In November, 2001, NMFS proposed that the Pacific Fishery Management Council (Council) amend the FMP to specify recovery and long term conservation objectives for Sacramento River winter chinook and Sacramento River spring chinook. While management objectives for the two stocks could continue to be determined through section 7 consultations, NMFS believes it preferable that the Council develop conservation objectives, with full public involvement in the evaluation of alternatives. The Council, at its March 2002 meeting, directed NMFS and the California Department of Fish and Game (CDFG) to form a workgroup to develop alternatives and, if possible, a preferred alternative, for FMP conservation objectives.

A seven-member workgroup was formed consisting of representatives from the Council, NMFS, CDFG and the US Fish and Wildlife Service (USFWS). The workgroup has been compiling and evaluating the available information on fishery impacts and status of the two stocks. This progress report provides the workgroup's initial assessment of the potential of the existing data sets to predict fishery impacts on winter and spring chinook, and describes a framework for conservation objectives that the workgroup is considering for recommendation to the Council.

2 SACRAMENTO RIVER WINTER CHINOOK

2.1 Stock Description

The Sacramento River winter chinook stock consists of a single spawning group that enters the

[1] Central Valley spring chinook (the population listed under the ESA by NMFS) and Sacramento River spring chinook (the population referred to in the FMP and listed under the California Endangered Species Act) are the same population.

Sacramento River from November to June and spawns from late April to mid August, with a peak from May to June. NMFS determined that Sacramento River winter chinook represent a distinct population segment, for purposes of the ESA, in 1987 (52 FR 6041), prior to development of the NMFS species policy, and subsequently determined that the population meets the criteria to be considered an evolutionarily significant unit (Myers et al. 1998).

2.2 Population Indicators and Status

Sacramento River winter chinook historically spawned during the summer at high elevations in cold, spring-fed headwater streams, such as the upper reaches of the Little Sacramento, McCloud, and lower Pit Rivers. Shasta Dam, completed in 1943, completely blocked the migration of winter chinook to those areas, forcing adults to hold in deep pools downstream, before initiating spawning activities in the mainstem Sacramento River between Red Bluff and Keswick Dam. The population persists as a result of cool water released from Shasta Reservoir during the summer periods of spawning, incubation and rearing. Between 1970 and 1990, the spawning population declined from over 50,000 fish to less than a thousand.

2.2.1 Red Bluff Diversion Dam Counts

The completion in 1966 of a flashboard dam, Red Bluff Diversion Dam (RBDD), allowed quantitative estimates of all salmon runs to the upper Sacramento River, based on counts at fish ladders. The dam may have been operated with flashboards during some earlier phases of operation, but it is now, and has been since about 1970, an underflow dam with 11 mechanically operated gates. Beginning in 1989, the dam gates were removed for increasing periods to improve upstream passage of adult winter chinook, resulting in a smaller and smaller fraction of the adult run actually being observed. By 1993, observation of the run through the fish ladders was limited to the time between May 15 and September 15. The current expansion of the observed number of fish passing the dam to the total run size is based on the

Table 1 Spawning population estimates for Sacramento River winter chinook

	Estimate Based on Passage at RBDD[a]			Carcass Survey Jolly-Seber Estimate[b]	
CY	Total Population	Adults	3-Year Replacement Rate Adults[c]	Total Population	Total Females
1970	40,409	32,085			
1971	53,089	32,225			
1972	37,133	28,592			
1973	24,079	19,456			
1986	2,596	2,101			
1987	2,186	1,909			
1988	2,886	1,878			
1989	696	571	0.3		
1990	430	387	0.2		
1991	211	192	0.1		
1992	1,240	1,160	2.0		
1993	387	250	0.6		
1994	186	62	0.3		
1995	1,297	1,267	1.1		
1996	1,337	708	2.8		
1997	880	528	8.5		
1998	3,002	2,079	1.6		
1999	3,288	822	1.2		
2000	1,352	563	1.1	4,343	3,551
2001	5,523	1,696	0.8	7,171	4,686
2002	9,169	7,614	9.3	7,337	5,745
2003	9,757	6,172	11.0	8,133	5,179

Methodologies for estimating the spawning population from the carcass survey are under review and estimates are preliminary.
a/ Estimate expanded for spawning below RBDD.
b/ Estimate expanded for spawning below survey area.
c/ The 3-year replacement rate is calculated as the return of fish in year *n* divide by the return of fish in year *n*-3

fraction of the winter chinook spawning migration that passed the dam between May 15 and September 15 for years 1982-1986. Although the mean observed fraction was 15%, annual observations ranged between 3% and 48% (Snider et al. 2000). Similar variation in run timing presumably continues to occur, and as a result, the accuracy of the estimates of the total run size probably varies greatly.

2.2.2 Carcass Surveys

Since 1996, CDFG and USFWS have conducted mark-recapture carcass surveys in a 14 mile reach of the Sacramento River downstream from Keswick Dam, which is the primary spawning area for winter chinook. Since the improvement of passage at Anderson Cottonwood Irrigation District diversion dam, most of the spawning activity now occurs upstream from the dam, in an area in which it is more difficult to observe carcasses. CDFG has used several methodologies for estimating the spawning population from the observed carcasses, including the Jolly-Seber model (Table 1).

2.2.3 Population Status

Maturation rates estimated from cohort reconstructions of hatchery fish (Table 2) indicate that the large majority of winter chinook return to spawn as age 3 fish. Therefore, the 3-year replacement rate of adults or females can be used as an index of the cohort replacement rate. The 3-year replacement rate for adults (RBDD estimate) has exceeded 1.0 for 8 of the 9 years since 1995 (Table 1). The time series of spawning population abundance suggests a fairly consistent increase in the size of succeeding cohorts since 1995.

2.3 Fishery Interactions

2.3.1 Marked Wild Fish - Brood Years 1969-1971

In 1969, CDFG initiated a study to estimate the contribution of Sacramento River winter chinook to ocean fisheries and spawning escapement (Hallock and Reisenbichler 1980, Hallock and Fisher 1985). The study utilized 720,000 wild winter chinook juveniles which were captured immediately upstream from Red Bluff Diversion Dam during September and October of 1969, 1970, and 1971, marked with a fin clip and then released back to the river. Marked fish were recovered in ocean fisheries and at RBDD. The objectives of the study were to determine the return rate (contribution) of winter chinook to the ocean fisheries and spawning escapement. Difficulties associated with the study include: 1) the marked fish were an unknown mixture of the winter and late fall chinook; 2) the same mark was used for both 1970 and 1971 brood years and assigning recovered marked fish to the correct brood was accomplished by aging adults from their scales; 3) 1968 brood Trinity River chinook and 1972 brood Willamette chinook, marked with the same fin clip, may have confounded recoveries of marked winter chinook north of Ft. Bragg; 4) marked fish were not sampled in the river sport fishery. A cohort reconstruction of the pooled recoveries of the 1969 and 1970 brood years formed the basis of the Winter Chinook Ocean Harvest Model (CDFG 1989).

2.3.2 Coded Wire Tagged Hatchery Population

Beginning in 1955 the USFWS made several attempts, with varying levels of success, to propagate winter chinook at Coleman National Fish Hatchery. In 1998, the program was shifted to Livingston Stone National Fish Hatchery, located just below Shasta Dam and constructed specifically to produce winter chinook. All winter chinook produced at Livingston Stone are marked with adipose clips and coded wire tags, as was the case at Coleman (USFWS 2001). Even with the increased production at Livingston Stone, the numbers of coded wire tagged fish recovered are less than those from the 1969 or 1970 brood years; however the CWT data are free of many of the confounding factors associated with the earlier marking experiments and should provide an improved basis for evaluation of fishery impacts.

2.3.3 Harvest Distribution

Figure 1 displays the distribution of ocean recoveries of coded wire tagged winter chinook from 1993 to 2003, expanded for sample size. Over 95% of all recoveries occurred south of Point Arena, California, and 74% of all recoveries occurred in the recreational fishery south of Point Arena.

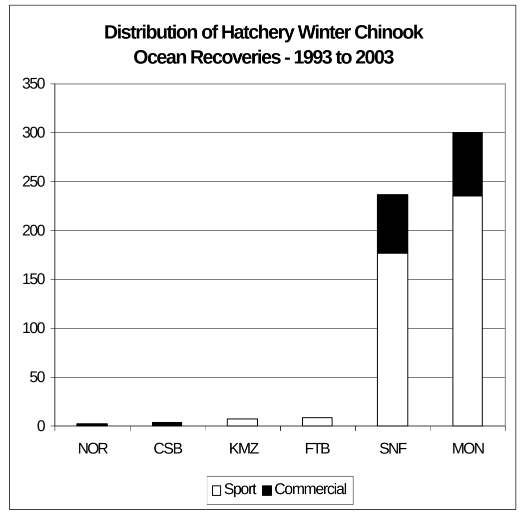


Figure 1. Landing distribution of Coleman and Livingston Stone hatchery produced winter chinook recovered from 1993 to 2003

2.3.4 Cohort Analysis

Cohort reconstruction estimates the number of fish of a single cohort that are alive at monthly intervals from the time at which fish first become vulnerable to fisheries through the spawning run of the oldest maturing fish. The aging convention for winter chinook and variables associated with the cohort reconstructions are explained in Appendix I, and the reconstructions of the 1998, 1999, and 2000 cohorts produced at Livingston Stone Hatchery are presented in Appendix II. The cohort analysis yields age-specific maturity rates, fishery contact rates and impact rates.

<u>Maturation Rates</u> Age-specific maturation rates are estimated in the cohort reconstruction as the fraction of the cohort at the beginning of March that leaves the ocean to spawn. The maturation rate for age 3 fish is estimated at over 90% for the 1998, 1999, and 2000 brood years (Table 2). The relatively high age 3 maturation rate of winter chinook leaves correspondingly few age 4 fish available for harvest.

Table 2. Life history and fishery interaction statistics for winter chinook .

Brood year		1998	1999	2000
Maturation rates	age 2	0.01	0.17	0.06
	age 3	0.96	0.96	0.97
	age 4	1.00	1.00	1.00
Age 3 impact rate:		0.23	0.20	0.21[1]
Age 4 impact rate:		0.57	0.74	NA
Spawner reduction rate:		0.26	0.23	0.24[1]

1 Preliminary estimate; brood escapement not complete.
NA: No estimate; brood escapement not complete.

<u>Contacts</u> Age-, month- and area-specific fishery contacts are estimated by dividing the landings for a given month and area by the proportion of the cohort that is above the minimum size limit. The contacts associated with the 1998 brood year are displayed in Table 3 and are similar in distribution to those of 1999 and 2000 brood years

(Appendix II). Seventy-four percent of all winter chinook contacts occurring between 2000 and 2003 (brood years 1998 through 2000) consisted of age 3 fish in the sport fishery south of Point Arena.

Table 3. Winter chinook contacts, 1998 hatchery cohort.

	Sport				Commercial			
	South of Point Arena		North of Point Arena		South of Point Arena		North of Point Arena	
Age	3	4	3	4	3	4	3	4
Mar	0	0	0	0	0	0	0	0
Apr	9	0	0	0	0	0	0	0
May	0	0	0	0	0	5	0	0
Jun	40	0	0	0	23	0	0	0
Jul	50	0	0	0	0	0	7	0
Aug	6	0	8	0	0	0	0	0
Sep	4	0	0	0	0	0	0	3
Oct	9	0	0	0	0	0	0	0
Nov	0	0	0	0	0	0	0	0
Total	118	0	8	0	23	5	7	3

Contact Rates Age-, month-, and fishery sector-specific contact rates are estimated by dividing contacts by the cohort abundance for that age at the beginning of that month. Each cohort reconstruction yields a single estimate of contact rate for a given month, age and fishery sector. Contact rates are provided in the cohort reconstructions in Appendix II.

Impact Rates Impact rates and spawner reduction rates for the 1998, 1999, and 2000 cohorts are summarized in Table 2. Age-specific ocean impact rates are estimated by dividing the fishery impacts (landings, hook-and-release mortality, and dropoff mortality) associated with an age class by the cohort abundance at the beginning of that age. The spawner reduction rate is the fraction of the cohort's potential spawners killed by the fishery, that is, the observed fishery mortality in terms of adult-equivalents divided by the predicted number of spawners that would survive natural mortality in the absence of fishery mortality. Spawner reduction rates were estimated with a cohort projection using the maturation and contact rates of the respective cohort reconstruction.

The high maturation rate of age 3 fish and the vulnerability of age 3 fish to recreational harvest result in the majority of ocean fishery impacts being age 3 fish. As an annual management objective, the age 3 impact rate is a better index of the cohort spawner reduction rate than the age 4 impact rate.

2.4 Conservation Objective for Winter Chinook

2.4.1 Predictive Models

The workgroup is considering a methodology for predicting winter chinook impact rates similar to that used in the Klamath Ocean Harvest Model (KOHM), in which "contact rate-effort" and "effort-days open" submodels are coupled to predict the contact rates and the resulting impact rates associated with proposed fishing seasons.

Contact Rate - Effort Relationship When a sufficient number of contact rate estimates become available, a ratio estimator is fit to the contact rates and respective observed effort. The slope of the ratio estimator provides a basis for predicting contact rates associated with varying levels of effort. Figures 2 and 3 show ratio estimators fit to the three available sets of monthly estimates of age 3 contact rates and the respective observed effort for recreational and commercial fisheries south of Point Arena. Sets of contact rate - effort estimators can also be characterized for age 4 fish for both recreational and commercial fisheries.

Effort - Days Open Relationship Ratio estimators of the relationship between observed effort and days open are used in the KOHM "effort-management" submodel to predict the expected effort resulting from a given number of fishing days in monthly increments for specific areas and fishery sectors. This submodel could be modified to meet time and area requirements associated with winter chinook management.

Impact Rate Prediction The coupling of the two submodels would allow prediction of winter chinook contact rates associated with proposed recreational and commercial seasons south of Point Arena. Predicted contact rates, incorporated into a cohort projection, would allow prediction of the recreational age 3 impact rates and commercial age 3 and age 4 associated with proposed seasons and minimum size limits.

2.4.2 General Considerations

Measurable Effects The workgroup recommends that FMP conservation objectives for listed salmon stocks be expressed in terms of measurable effects that fisheries have on stock dynamics. An estimate of fishery impact rates is a critical element in evaluating the effects. Methodologies necessary to implement the objective, as well as assess whether the objective has been achieved, should be identified and made available.

Reliability of Predictive Models "Risk averse" management is appropriate in the case of listed species. In order to assess the degree of risk involved with fishery management decisions, the Council, NMFS and public should be provided with estimates of the uncertainty associated with the methodologies and monitoring programs used to measure and predict fishery effects. The workgroup recommends that management objectives for winter chinook include consideration of the uncertainty in estimating variables such as contact rates and effort, as well as with the use of the relatively small number of contact rate estimates which exist for winter chinook.

2.4.3 Management Framework Proposal

The workgroup is considering an FMP conservation objective for winter chinook in the form of a cap on the age 3 ocean fishery impact rate (i_{max}). Annual preseason impact rate targets would be determined by parent spawner status, marine survival, and the uncertainty associated with the impact rate forecast. Determination of whether the conservation objective has been met would be based on a post-season comparison of the realized (observed) impact rate, i_{post}, with i_{max}. Annual preseason impact rate targets, i_{pre}, would be set to provide a reasonable likelihood that i_{post} will not exceed i_{max}. The workgroup has discussed two alternatives for implementing the framework. Both approaches would allow annual preseason impact rate targets to vary with ocean productivity, parent spawner status, and changes in uncertainty in predicting impact rates. Changes in uncertainty are expected to result from the expansion of the data sets used to estimate contact rate - effort relationships.

Alternative A - Variable Maximum Impact Rates and Fixed Risk The conservation objective would consist of a matrix of impact rates, i_{max}, which would vary with parent spawner status and marine survival. A second matrix would provide the preseason impact rate targets, i_{pre} , such that i_{post} will not exceed i_{max} with some fixed level of probability. As additional estimates of contact rates accrue and uncertainty associated with impact rate prediction change, the preseason impact rate targets associated with a given category of marine survival and parent spawner status will also change.

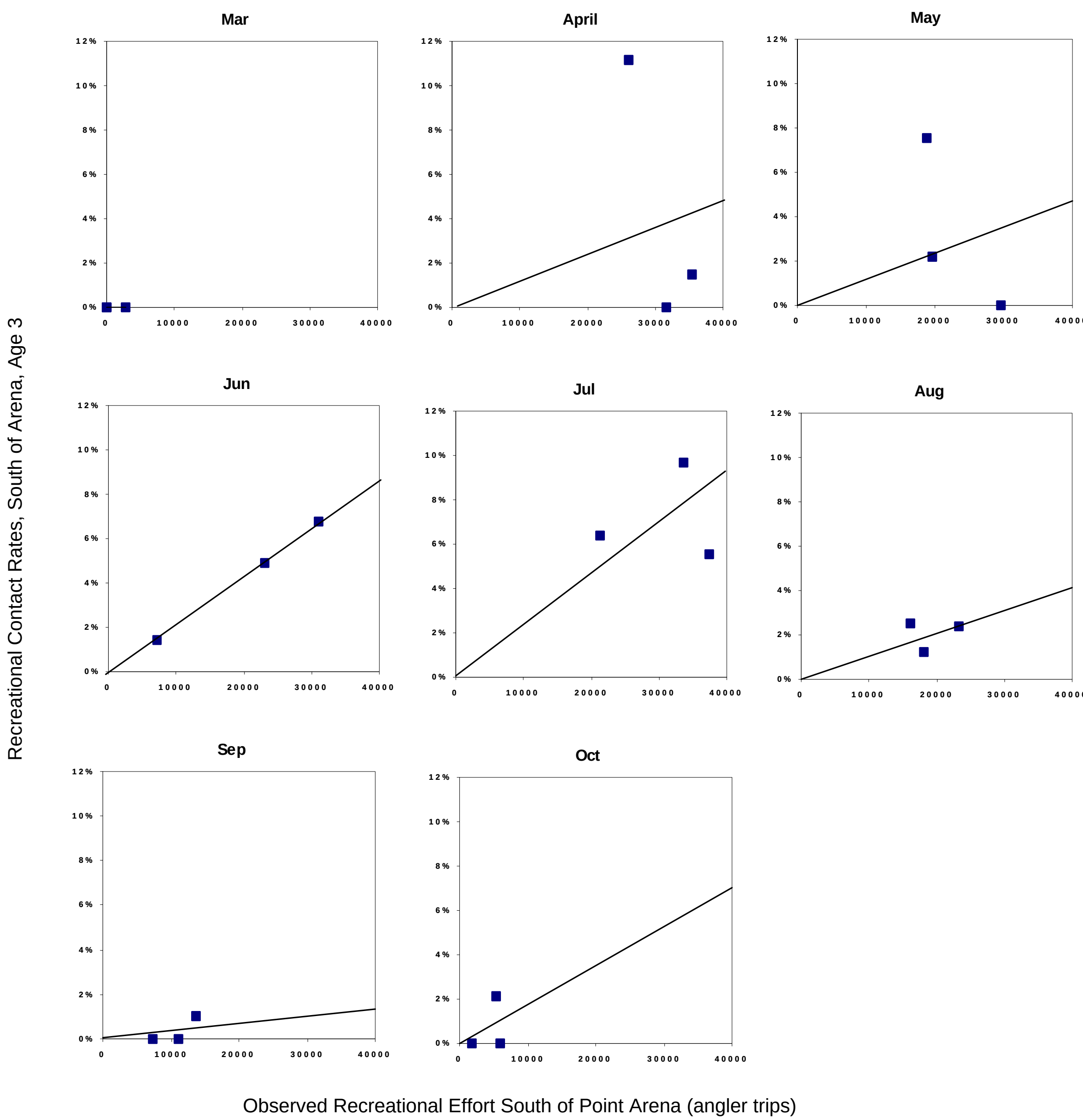


Figure 2   Contact rates of age 3 winter chinook plotted against effort for the recreational fishery south of Point Arena from cohort analyses of the 1998, 1999 and 2000 brood years. Contact rates are from Appendix II; effort estimates are from PFMC 2003.

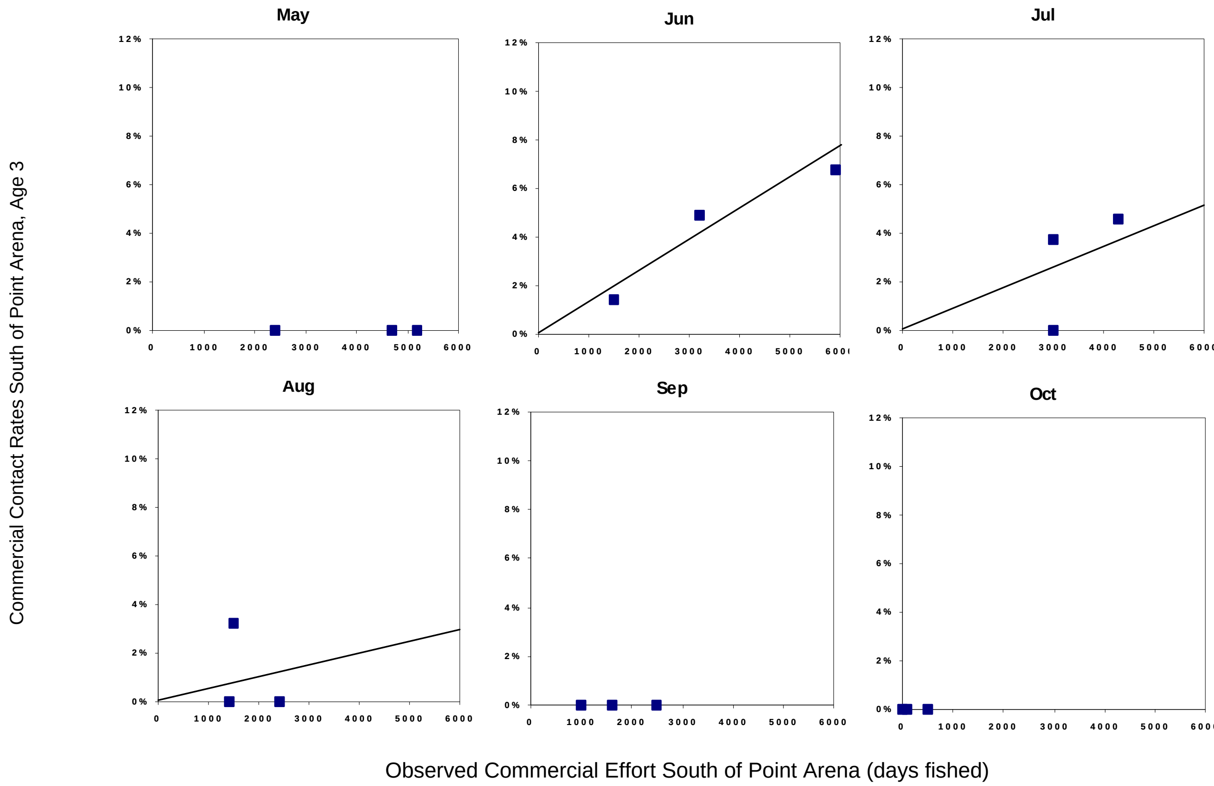


Figure 3 Contact rates of age 3 winter chinook plotted against effort for the commercial fishery south of Point Arena from cohort analyses of the 1998, 1999, and 2000 brood years. Contact rates are from Appendix II; effort estimates are from PFMC 2003.

Example *Values are for illustrative purposes only.* Table 4 is an example of a matrix of maximum impact rates associated with varying levels of marine survival and parent spawner status. Table 5 shows the associated preseason impact rate targets (i_{pre}) that would provide some fixed probability (.70 in this case) that the observed postseason impact rate (i_{post}) would not exceed the conservation objective (i_{max}). The values of i_{pre} would be expected to change as additional estimates of contact rates accrue.

Alternative B - Fixed Maximum Impact Rate and Variable Risk The conservation objective would consist of a single maximum impact rate (i_{max}) which would apply under all conditions of marine survival and parent spawner status. The annual preseason impact rate target (i_{pre}) would be determined through a matrix associating values of i_{pre} with the probability that the observed impact rates will not exceed the fixed maximum impact rate (i_{max}) given i_{pre}, i.e. $p(i_{post} \leq i_{max} \mid i_{pre})$.

Example *Values are for illustrative purposes only*. Assume i_{max} = 30%. Table 6 contains a matrix of probabilities that represent the risk that management believes appropriate for ensuring that i_{max} is not exceeded at various levels of parent spawner status and marine survival. Table 7 shows the preseason impact rate targets that would be associated with the different levels of risk set out in Table 6. As in Alternative A, the values of i_{pre} would be expected to change as additional estimates of contact rates accrue. Substitution of the preseason impact rate targets of Table 7 for the corresponding risk levels in Table 6 produces a matrix of preseason impact rate targets (Table 8) associated with various levels of parent spawner status and marine survival.

Table 6 . Matrix of acceptable risks (probabilities) that an observed impact rate will not exceed the conservation objective.

		Marine Survival Index		
		Low	Medium	High
Parent Spawner Status Females	High (delisted)	.60	.55	.50
	Medium	.70	.65	.60
	Low	.80	.75	.70
	Critically Low	.90	.90	.90

Table 4 Maximum impact rates (i_{max})

		Marine Survival Index		
		Low	Medium	High
Parent Spawner Status Females	High (delisted)	28%	32%	36%
	Medium	20%	24%	28%
	Low	16%	18%	20%
	Critically Low	8%	8%	8%

Table 7. Preseason impact rate targets (i_{pre}) and probability that the postseason impact rate (i_{post}) will not exceed the fixed conservation objective (i_{max}).

i_{pre}	5%	11%	13%	15%	18%	22%	26%	30%
$p(i_{post} \le i_{max} \mid i_{pre})$	.90	.80	.75	.70	.65	.60	.55	.50

Table 5. Preseason imact rate targets (i_{pre}) such that $p(i_{post} \le i_{max} \mid i_{pre}) \le .70$

		Marine Survival Index		
		Low	Medium	High
Parent Spawner Status Females	High (delisted)	22%	26%	30%
	Medium	15%	18%	22%
	Low	11%	13%	15%
	Critically Low	5%	5%	5%

Table 8. Resulting impact rates targerts (i_{pre})

		Marine Survival Index		
		Low	Medium	High
Parent Spawner Status Females	High (delisted)	22%	26%	30%
	Medium	15%	18%	22%
	Low	11%	13%	15%
	Critically Low	5%	5%	5%

2.4.4 Comments and Concerns for Implementation

The management framework described above is similar to that used by the Council for Oregon coastal natural coho, except that it: 1) explicitly considers the uncertainty associated with the predictive methodology, and 2) recognizes that uncertainty may change as data accumulates. Most components of the framework are "data-driven". However, two key elements, the maximum impact rate and the appropriate risk levels, would be specified by policy decisions. As a result, the difference between the two alternatives is primarily in the way in which uncertainty is integrated into the framework. Depending on the selected levels of risk and maximum impact rates, the same matrix of preseason impact rate targets, i_{pre}, could result from either alternative, as in the hypothetical examples presented here (Tables 5 and 8).

<u>Commercial and Recreational Impacts North of Point Arena not Predicted</u> In evaluating postseason impact and spawner reduction rates, the framework would incorporate all observed marine and freshwater recoveries. However, the preseason prediction of age 3 impact rates would only utilize effort and contact rate/unit effort estimates for fisheries south of Point Arena. As a result, marine impacts north of Point Arena will not be included in the age 3 impact rate prediction. About 5% of the available CWT recoveries occurred above Point Arena. A possible solution would

be the assumption, for purposes of modeling, that recoveries from north of Point Arena were caught south of Point Arena, similar to the approach taken in the KOHM for recoveries that occur outside the KOHM catch area partitions.

Inland Recreational Hook and Release Impacts not Included in Cohort Reconstruction The California Fish and Game Commission limits river recreational impacts on winter chinook by prohibiting retention of salmon in the Sacramento River recreational fishery during periods of time when winter chinook are present. As a result of recoveries of tagged winter chinook in late December 2000 and January 2001, the Fish and Game Commission advanced the no-retention date to January 1. No estimate is available for fishery impacts associated with releasing sport caught winter chinook. In 2003, CDFG suspended monitoring of Central Valley recreational fisheries for chinook due to budgetary constraints.

No Cohort Analysis of Naturally Spawning Population Although scales are collected from naturally produced fish sampled in the spawning surveys, they have yet to be aged. Therefore, no age-structured analysis of the naturally spawning population exists and a cohort reconstruction of the naturally spawning population is not available. The age structure of the naturally spawning population, while containing no additional information on fishery impact rates, would improve the assessment of certain aspects of stock dynamics, in particular cohort replacement rates.

Index of Marine Survival An appropriate index of marine survival for Central Valley chinook stocks, e.g. return rate of jacks per hatchery smolt, would have to be developed, and an appropriate number of levels selected to trigger changes in impact rates.

Management Line at Pigeon Point If significantly different contact rates per unit effort are observed in the San Francisco and Monterey catch areas, consideration of a management line at Pigeon Point might offer more flexibility in controlling winter chinook impacts.

Parent Spawner Status An appropriate index of parent spawner status, such as spawning abundance of the cohort that produced the age 3 year class vulnerable in the fishing season under consideration, or an indicator of stock productivity, would need to be identified.

3 SACRAMENTO RIVER SPRING CHINOOK

3.1 Stock Description

Like winter chinook, spring chinook evolved to exploit spawning habitats at high elevations, generally above 1,500 feet; fish enter the river in the spring when higher elevation habitats are accessible, hold through the summer and spawn in the fall. The spring run of chinook salmon enters the Sacramento River from March to July and the fish spawn from late August through early October in the Sacramento River and its tributaries.

3.2 Population Indicators and Status

3.2.1 Spawning Surveys

Spring chinook salmon once occupied the headwaters of all major river systems in California's Central Valley. Commercial fish landings suggest the population of Central Valley spring chinook in the 1880s ranged from 127,000 to 604,000 fish (CDFG 1998). Self sustaining populations of spring chinook are now found in Mill, Deer, and Butte creeks, where they still have access to the spawning habitats historically utilized. Butte Creek spring chinook are genetically distinct from the Deer and Mill Creek populations and enter their natal stream earlier than the Deer and Mill Creek runs. Spring chinook appear sporadically in other tributaries to the Sacramento River, such as Beegum, Clear, Cottonwood, Antelope and Big Chico creeks. These remaining wild populations are small, isolated, and the range of suitable spawning habitat is restricted. Various methods have been used to evaluate the size of spring chinook spawning populations in the Sacramento River tributaries (Table 9). Most recent estimates have been based on snorkel surveys (Deer Creek), ground and aerial redd surveys (Mill Creek), and, in the case of Butte Creek, snorkel and carcass surveys.

Table 9 Recent spawning escapement estimates for Sacramento River spring chinook populations.

Return Year	Mill	Deer	Butte	Butte Carcass[a]	Antilope	Beegum	Big Chico
1995	320	1,295	7,500		7	8	200
1996	252	614	1,413		1	6	2
1997	200	466	635		0		2
1998	424	1,879	20,259		154	477	369
1999	560	1,591	3,529		40	102	27
2000	544	637	4,118		9	120	27
2001	1,104	1,622	9,605	18,312	8	245	39
2002	1,594	2,185	8,785[b]	16,328[c]	46	130	0
2003	1,426	2,751	4,398[d]	17,294[f]	46	73	81

a. Schaefer estimate
b. No prespawning mortalities added
c. Includes an estimated 3,431 prespawning mortalities
d. Snorkel survey estimate of Butte (no prespawn mortalities)
f. Includes estimated 11,231 prespawn mortalities

The largest self sustaining population of spring chinook occurs in Butte Creek. In 1995, CDFG initiated a study project to define life history characteristics of spring chinook in Butte and Big Chico Creeks (Ward et al. 2001, 2002, 2003). The project traps emigrating spring chinook fry at four locations along Butte Creek. At the uppermost site, directly downstream of the spring chinook spawning habitat, juveniles are marked with adipose clips and coded wire tags and released downstream from the trapping location. Table 10 shows the numbers of fish tagged and released since 1998.

In 2001, the project initiated a carcass survey of spring chinook spawning in Butte Creek, primarily for the purpose of recovering CWT marked fish. The survey was expanded to include estimates of the large numbers of pre-spawn mortalities during 2002 and 2003, and provides a spawning population estimate based on standard carcass survey methodologies (Table 5). The present range of spring chinook in Butte Creek is similar to the historic range. However Butte Creek does not conform to typical spring chinook habitat in that the accessible spawning areas are all below 1000 ft elevation and water temperatures frequently exceed lethal levels. As a result, high levels of prespawning mortality are not unexpected. Conducting a carcass survey on Butte Creek in future years will be important, both for assessing the status of the population as well as estimating harvest impacts.

Historically, spring chinook spawned in the upper reaches of the Feather River in substantial numbers. Early hydropower and agricultural diversions blocked access to much of the spring-run spawning habitat in the upper watershed. The construction of Oroville Dam blocked further upstream migration, but the release of cold reservoir water created conditions below the dam that support an early run of chinook salmon which are regarded as a spring-fall hybrid (CDFG 1998), a condition exacerbated by operations of the Feather River Hatchery. Like winter chinook, spring chinook may also have spawned in the mainstem Sacramento River below Keswick, but because of the lack of physical and temporal separation with the fall run, they have likely hybridized with fall chinook.

3.3 Status

Deer and Mill Creek Estimates of spawner abundance are available for Deer and Mill Creeks from as early as 1940 (CDFG 1998). These time series from the early 1940s through the mid 1970s indicate abundances that fluctuate around means of about 1,800 and 2,000 fish in Mill and Deer creeks respectively. Abundance declined during the late 1970s and early 1980s to levels generally fewer than 500 fish, and then increased beginning in the late 1990s. The average return over the past three years has been 1,375 and 2,186 to Mill and Deer Creeks respectively, suggesting these populations are recovering to levels approaching those of the 1940s and 1950s.

Butte Creek The carcass surveys of 2001, 2002, and 2003 estimated river escapements of approximately 18,000, 16,000 (3,000 pre-spawn mortality; 13,000 spawning), 17,000 (11,000 pre-spawn mortality; 6000 spawning). In 2002 and 2003, large numbers did not survive the holding period to spawn, due to an outbreak of two pathogens caused by elevated water temperatures and high densities of holding fish. In the record of spawner abundance estimates for Butte Creek spring chinook dating back to 1954 (CDFG 1998), abundance exceeded 6,100 fish only once. Like the estimates for Deer and Mill Creek, standardized survey methods were not consistently applied in Butte Creek and the series must be interpreted with some caution. However, the high prespawning mortality observed in the past two years, and the utilization of most of the available spawning habitat in Butte Creek, may indicate that the numbers of spring chinook that survive to spawn can not be expected to increase substantially over current levels.

3.4 Fishery Interactions

3.4.1 Harvest Distribution

Figure 4 displays the distribution of ocean recoveries of coded wire tagged Butte Creek spring chinook from 1998 to 2003, expanded for sample size, which includes recoveries from the relatively small numbers of fish marked from the 1995 and 1997 cohorts. Of the total recoveries, 58% were in the commercial fishery, 64% were in fisheries south of Point Arena, California, and 39% in the commercial fishery south of Point Arena.

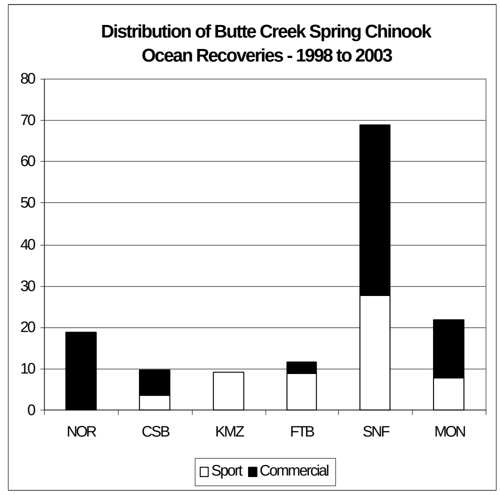


Figure 4. Landing distribution of marked Butte Creek spring chinook recovered from 1998 to 2003

The number of spring chinook CWT recoveries available for cohort reconstruction is less than a fifth of that for winter chinook. Compared with winter chinook, the recovery rate (sum of expanded ocean and river recoveries divided by release numbers) for each of the Butte Creek spring chinook broods has been about 15% of the recovery rate for winter chinook. The difference may be due to higher mortality rates experienced by spring chinook between the time they are tagged and the time they recruit to ocean fisheries; winter chinook are tagged as smolts, while Butte Creek spring chinook are tagged as fry. Table 10 compares the numbers of Butte Creek spring chinook and winter chinook tagged and recovered since 1998.

Table 10 Summary of releases and expanded recoveries of winter and spring chinook for brood years 1998 through 2000

	Livingston Stone Winter Chinook				Butte Creek Spring Chinook			
Brood Year	Tagged and Released	Expanded Ocean Recoveries	Expanded River Recoveries	Recovery Rate	Tagged and Released	Expanded Ocean Recoveries	Expanded River Recoveries	Recovery Rate
1998	141,482	147	381	0.37%	106,690	32	32	0.06%
1999	30,035	78	368	1.48%	58,854	54	68	0.21%
2000	162,198	90	315	0.25%	166,570	19	41	0.04%

The existence of the yearling life history component of spring chinook complicates the analysis of fishery impacts. A very small fraction (0.4%) of the marked 1998 brood year Butte Creek spring chinook were trapped and tagged as yearlings, however 3 of the 9 ocean recoveries were yearlings. It is not known whether that fraction is representative of either the fraction of the cohort out-migrating as yearlings, or the fraction of the cohort available as yearlings at age of recruitment to ocean fisheries.

3.4.2 Cohort Analysis

The cohort reconstructions of the 1998, 1999, and 2000 cohorts of tagged naturally produced Butte Creek spring chinook are presented in Appendix III; they are similar in construction to the winter chinook reconstructions. The notable differences are the aging convention (see Appendix I), and the addition of age 5 fish.

<u>Maturation Rates</u> Age-specific maturation rates are shown in Table 11. The relatively low age 3 maturation rate of spring chinook leaves significant numbers of age 4 fish and even a small number of age 5 fish available for harvest.[2]

Table 11. Butte Creek spring chinook life history and fishery interaction statistics

Brood year		1998	1999	2000
Maturation Rates	age 2	0.00	0.01	NA
	age 3	0.40	0.28	NA
	age 4	0.67	1.00[1]	NA
	age 5	1.00[2]		NA
Age 3 impact rate:		0.08	0.05	0.12[1]
Age 4 impact rate:		0.62	0.55	NA
Spawner reduction rate:		0.36	0.42[1]	NA

1. Preliminary estimate, brood escapement not complete
2. No age 5 recoveries have occurred in the river; one age 5 fish was recovered in the ocean.

NA No estimate, brood escapement not complete

<u>Impact Rates</u> The impact rates, summarized in Table 11, suggest that spring chinook are less available to ocean fisheries at age 3 than are winter chinook. The age 4 impact rates, similar to those of winter chinook, reflect the vulnerability of spring chinook to both recreational and commercial harvest. The combined maturity schedule and exposure to commercial harvest result in spawner reduction rates, 0.36 and 0.42, higher than those estimated for winter chinook. Seventy-four percent of the ocean recoveries of Butte Creek spring chinook have been age 4, and for purposes of an annual management objective, the age 4 impact rate would be the better index of the cohort spawner reduction rate.

The age-4 impact rates occurring in 2001 (0.62) and 2002 (0.55) are similar to one another, as are the CVI harvest rate indices for 2001 and 2002 (26% and 35%) (PFMC 2004, Table II-1). If Butte Creek spring chinook impact rates are well correlated with those for Central Valley fall chinook, Butte Creek spring chinook impact rates were likely substantially higher over the past 30 years than the 0.36 and 0.42 estimated here.

3.5 Recommendations

Cohort reconstructions of CWT marked naturally produced Butte Creek spring chinook provide the best available estimate of fishery impacts on listed stocks of Sacramento River spring chinook. However, the number of recoveries are not sufficient to allow fine scale assessments of ocean impacts, and given that the results are derived from just two cohorts, the impact rates should be interpreted with some caution. Confidence in future results would increase in proportion to the numbers of tagged fish that are released.

Without substantially more information on the magnitude and distribution of ocean fishery impacts on naturally spawning spring chinook populations, the development of FMP conservation objectives that specify measurable fishery effects on the stock will be difficult. In principle, a conservation objective for Butte Creek spring chinook, expressed as an age 4 ocean impact rate, is possible and should be considered. Implementation of such an objective would require a continuation and increase in the commitment of resources for the Butte Creek spring chinook life history

[2] The workgroup's concern regarding the small number of Butte Creek spring chinook CWT recoveries available for the cohort reconstruction is illustrated by the effect of a single recovery on estimated maturation rates: the ocean recovery of one age 5 fish of the 1998 cohort produces an age 4 maturation rate of .67. Had the recovery not occurred, the rate would have been 1.0, as estimated for the 1999 cohort.

investigation. The project is scheduled to terminate in 2004 due to lack of available funding. The numbers of CWTs recovered in ocean fisheries and spawning surveys from releases of less than 200 thousand tagged fry are currently small, probably too small to serve as a reliable basis for a cohort analysis.

The workgroup is generally skeptical of the use of Feather River Hatchery spring chinook as a surrogate for naturally spawning spring chinook populations. The “spring chinook” produced at Feather River Hatchery are genetically more similar to fall chinook than they are to Deer, Mill or Butte Creek spring chinook, at least in part due to the difficulty in distinguishing between the progeny of Feather River Hatchery fall- and spring-runs on the basis of run timing. Tagging studies at the hatchery show that significant numbers of fall chinook return early enough to be mistakenly spawned as spring chinook (CDFG 1998). The use of Feather River Hatchery spring chinook CWT data set, which is large, should be conditioned on a demonstration that the stock exhibits similarities with naturally spawning spring chinook populations with respect to ocean distribution and run timing.

Spawner reduction rates on Butte Creek spring chinook in the range of .36 to .42 constitute a significant source of mortality on the population. The Deer and Mill Creek populations most likely experience similar rates. These impact rates however, under the current fresh water and ocean conditions, have been low enough to allow spawning populations to increase, provided suitable holding and spawning habitat is available. The workgroup believes that lowering the impact rate through reductions in recreational and commercial fishing effort would be necessary should Sacramento River spring chinook populations experience a reversal in the recent trends in recovery. Reducing impact rates under the current conditions of ocean productivity would likely increase the growth rate of the Deer and Mill Creek populations and benefit efforts to establishing spring runs in newly accessible reaches of Battle and Clear Creeks. In contrast, a reduction of fishing impacts under current fresh water and ocean conditions may not increase the numbers of fish surviving to spawn in Butte Creek. In 2002 and 2003, 21% and 65% of the spring run entering the river died as a result of high temperatures and disease prior to spawning.

REFERENCES

California Department of Fish and Game. 1989. Description of winter chinook ocean harvest model. Ocean Salmon Project. 27pp.

California Department of Fish and Game. 1998. Report to the Fish and Game Commission: A status review of the spring-run chinook salmon (Oncorhynchus tshawytscha) in the Sacramento River drainage.

Goldwasser, L., M. S. Mohr, A. M. Grover, M. L. Palmer-Zwahlen, S. Barrow, and C. Melcher. 2000. The supporting databases and analyses for the revision of the Klamath ocean harvest model: a progress report. Klamath Fishery Management Council, Yreka, California.

Hallock, R.J. and R.R. Reisenbichler. 1980. Freshwater and ocean returns of marked winter-run and late fall-run chinook salmon, Oncorhynchus tshawytscha, from the Sacramento River. Calif. Dept. Of Fish and Game, Anad. Fish. Br., Office Rept. September 15, 1980. 9 p.

Hallock, R.J. and F.W. Fisher. 1985. Status of winter-run chinook salmon (Oncorhynchus tshawytscha) in the Sacramento River. Calif. Dept. Of Fish and Game, Anad. Fish. Br., Office Rept., January 25, 1985. 28 p.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status review of chinook salmon from Washington, Idaho, Oregon, and California. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-35, 443 p.

Pacific Fishery Management Council. 2003. Review of 2002 ocean salmon fisheries.

Pacific Fishery Management Council. 2004. Preseason I report stock abundance analysis for 2004 ocean salmon fisheries.

Snider, B., B. Reavis and S. Hill. 2000. 1999 upper Sacramento River winter-run chinook salmon escapement survey May-August 1999. Habitat Conservation Division. CDFG. Stream Evaluation Program Technical Report No. 00-1

US Fish and Wildlife Service. 2001. Biological assessment of artificial propagation at Coleman National Fish Hatchery and Livingston Stone National Fish Hatchery: program description and incidental take of chinook salmon and steelhead trout. Prepared by Red Bluff Fish and Wildlife Office, Red Bluff, CA 96080.

Ward, P.W. and T.R. McReynolds. 2001. Butte and Big Chico Creeks spring-run chinook salmon, Oncoryhnchus tshawytscha life history investigation 1998-2000. California Department of Fish and Game Inland Fisheries.

Ward, P.W., T.R. McReynolds, and C.E. Garman. 2002. Butte and Big Chico Creeks spring-run chinook salmon, Oncoryhnchus tshawytscha life history investigation 2000-2001. California Department of Fish and Game Inland Fisheries.

Ward, P.W., T.R. McReynolds, and C.E. Garman. 2003. Butte and Big Chico Creeks spring-run chinook salmon, Oncoryhnchus tshawytscha life history investigation 2001-2002. California Department of Fish and Game Inland Fisheries.

Yoshiyama, R.M., E.R. Gerstung, F.W. Fisher, and P.B. Moyle. 1996. Historical and present distribution of chinook salmon in the Central Valley drainage of California Sierra Nevada ecosystem project, final report to Congress, vol. III, Assessments, Commissioned Reports, and Background Information, University of California, Davis, Centers for Water and Wildland Resources, 1996.

Appendix I Description of Cohort Reconstructions

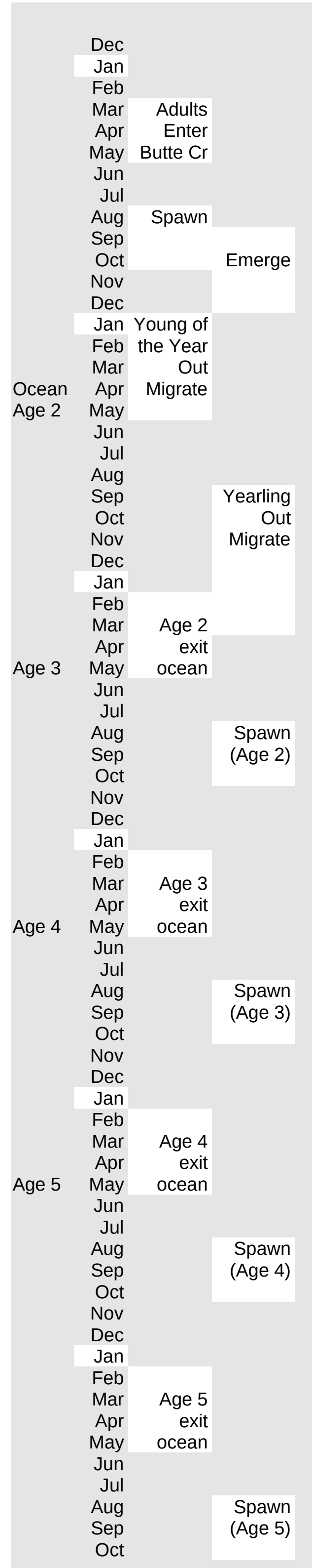
1 Aging Conventions

<u>Sacramento River Winter Chinook</u> Based on the appearance of adults at Red Bluff Diversion Dam, winter chinook are believed to enter the San Francisco Bay between November and May. Spawning occurs between April and July. Fry emerge in the fall and emigrate to the ocean during the winter and spring. Winter chinook become vulnerable to ocean fisheries towards the end of their second calendar year of life as age 3 fish (Figure 1). Age increments on March 1, unless fish enter the river; the date is intended to represent the time when the majority of fish destined to mature in a given year have left the ocean. Under this convention, fish are designated as age 2 soon after they emigrate to the ocean, although they are still in their first calendar year of life.

<u>Butte Creek Spring Chinook</u> Spring chinook enter Butte Creek about six weeks earlier than do the populations of Deer and Mill Creeks. Fry emerge in the fall and the emigration of juveniles occurs primarily in January and February for young of the year and from September to May for yearlings. The aging convention is similar to that used for winter chinook, except the age of fish increments on May 1, unless they enter the river to spawn. They first appear in ocean fisheries during June and July of their second calendar year of life as age 3 fish (Figure 2). Age 5 CWT recoveries have occurred in ocean fisheries but not in carcass surveys.

Figure 1. Aging convention for Sacramento River winter chinook.

Figure 2. Aging convention for Butte Creek spring chinook



2 Cohort Reconstruction Variables and Parameters

Each cohort (brood year) is treated separately. The cohort reconstructions start with the oldest observed recoveries in a cohort, e.g. ocean recoveries of age 5 spring chinook, or the spawning population of age 4 winter chinook, and proceed backward in monthly intervals, with the population increased by estimated natural mortality, fishery impacts, and spawning escapement. The reconstructions end at the point of the youngest tag recoveries for the cohort (usually age 2 spawning population).

Variables associated with reconstruction include: the number of fish that contact fishing gear and either drop off before landing (includes sea lion predation), or are landed and then either retained (legal size) or released (sublegal size); the number of fishery impacts (landed mortality, hook and release mortality, and drop-off mortality) during the month; the number of fish alive in all areas of the ocean at the beginning of each month; the number of fish that mature and leave the ocean as age 2, age 3, and age 4 fish; the number of fish that are removed by river recreational fisheries; the number of fish that are available to spawn.

Landings are estimated by expanding the observed numbers of CWTs to account for sample size and losses of CWTs during processing and decoding (Goldwasser et al. 2000). Contacts are estimated by dividing landings (legal sized fish) by the proportion of the cohort that is legal size (P_{legal}). P_{legal} is estimated as 1 - normative cumulative density evaluated at the minimum size limit in effect for the specified mean and standard deviation of the winter chinook length at monthly intervals. The means are interpolated from measurements of the 1969 and 1970 brood winter chinook spawners; standard deviations are based on Sacramento River fall chinook (CDFG, 1989). The size at age relation for winter chinook is also used in the spring chinook reconstructions, pending development of independent estimates.

Hook and release mortality is estimated by multiplying sub-legal contacts by the hook and release mortality rates. The hook and release mortality rate is fishery-, time- and area-specific, as adopted by the Council’s Salmon Technical Team. Sub-legal contacts are estimated by subtracting landings from contacts.

Drop-off mortality is estimated by multiplying contacts by .05. Drop-off mortality is intended to account for the mortality associated with pinniped and shark depredation, the release mortality of hooked but non-landed fish, and unreported landings.

Fishery impacts are the sum of landings, hook and release mortality, and drop-off mortality.

Ocean escapement estimates of tagged fish include river recreational harvest (if observed), recoveries in spawning and pre-spawning mortality carcass surveys and, in the case of winter chinook, fish taken for hatchery brood stock. Butte Creek spring chinook escapement is increased by 1% to account for poaching. Bear predation is very apparent in Butte Creek, but the removals are believed to be primarily dead carcasses.

Appendix II Winter Chinook Cohort Reconstructions

Winter Chinook 1998 Cohort

LANDINGS: Coded wire tag recoveries expanded for sampling

	Sport				Commercial			
	South		North		South		North	
Month	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4
Mar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
May	0.0	0.0	0.0	0.0	0.0	4.7	0.0	0.0
Jun	39.0	0.0	0.0	0.0	10.5	0.0	0.0	0.0
Jul	49.7	0.0	0.0	0.0	0.0	0.0	3.8	0.0
Aug	5.6	0.0	7.6	0.0	0.0	0.0	0.0	0.0
Sep	4.3	0.0	0.0	0.0	0.0	0.0	0.0	2.5
Oct	9.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	110.3	0.0	7.6	0.0	10.5	4.7	3.8	2.5

CONTACTS: Landings divided by proportion legal

	Sport				Commercial			
	South		North		South		North	
Month	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4
Mar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr	9.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
May	0.0	0.0	0.0	0.0	0.0	4.8	0.0	0.0
Jun	39.7	0.0	0.0	0.0	22.6	0.0	0.0	0.0
Jul	50.3	0.0	0.0	0.0	0.0	0.0	6.9	0.0
Aug	5.7	0.0	7.7	0.0	0.0	0.0	0.0	0.0
Sep	4.3	0.0	0.0	0.0	0.0	0.0	0.0	2.6
Oct	9.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	118.3	0.0	7.7	0.0	22.6	4.8	6.9	2.6

IMPACTS: landings + shaker deaths + drop off deaths

	Sport				Commercial			
	South		North		South		North	
Month	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4
Mar	0	0	0	0	0	0	0	0
Apr	5	0	0	0	0	0	0	0
May	0	0	0	0	0	5	0	0
Jun	41	0	0	0	15	0	0	0
Jul	52	0	0	0	0	0	5	0
Aug	6	0	8	0	0	0	0	0
Sep	5	0	0	0	0	0	0	3
Oct	9	0	0	0	0	0	0	0
Nov	0	0	0	0	0	0	0	0
Dec	0	0	0	0	0	0	0	0
Jan	0	0	0	0	0	0	0	0
Feb	0	0	0	0	0	0	0	0
Total	119	0	8	0	15	5	5	3

BY 1998 WINTER CHINOOK COHORT ANALYSIS: mortality applied in monthly increments (50% annual age 2 and 20% annual age 3 and 4). Alive is population at beginning of month. Impacts precede escapement, escapement precedes natural mortality

	Age 4		Age 3		Age 2	
Month	Impacts	Alive	Impacts	Alive	Impacts	Alive
Mar	0	13	0	626	0	0
Apr	0	13	5	614	0	0
May	5	13	0	598	0	0
Jun	0	8	56	587	0	0
Jul	0	8	57	521	0	0
Aug	0	8	14	456	0	0
Sep	3	7	5	433	0	0
Oct	0	5	9	421	0	0
Nov	0	5	0	404	0	0
Dec	0	5	0	397	0	0
Jan	0	4	0	389	0	0
Feb	0	4	0	382	0	671
Total	8		146		0	
Escapement		4		368		8

Maturation Rates

Age 2 0.01

Age 3 0.96

Age 3 impact rate: 0.23

Age 4 impact rate: 0.57

BY 1998 CONTACT RATES: number of contacts (age area month) divided by the total ocean pop (age month)

	Sport				Commercial			
	South		North		South		North	
Month	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4
Mar								
Apr	1.5%							
May						37.3%		
Jun	6.8%				3.9%			
Jul	9.7%						1.3%	
Aug	1.2%		1.7%					
Sep	1.0%							34.7%
Oct	2.1%							
Nov								

Winter Chinook 1999 Cohort

LANDINGS: Coded wire tag recoveries expanded for sampling

	Sport				Commercial			
	South		North		South		North	
Month	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4
Mar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr	14.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
May	4.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jun	4.0	0.0	0.0	0.0	0.0	5.2	0.0	0.0
Jul	23.8	3.6	8.4	0.0	5.6	0.0	0.0	0.0
Aug	8.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sep	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	55.0	3.6	8.4	0.0	5.6	5.2	0.0	0.0

CONTACTS: Landings divided by proportion legal

	Sport				Commercial			
	South		North		South		North	
Month	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4
Mar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr	48.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
May	8.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jun	5.5	0.0	0.0	0.0	0.0	5.3	0.0	0.0
Jul	24.1	3.6	8.5	0.0	14.0	0.0	0.0	0.0
Aug	8.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sep	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	95.2	3.6	8.5	0.0	14.0	5.3	0.0	0.0

IMPACTS: landings + shaker deaths + drop off deaths

	Sport				Commercial			
	South		North		South		North	
Month	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4
Mar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr	26.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
May	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jun	4.6	0.0	0.0	0.0	0.0	5.5	0.0	0.0
Jul	25.1	3.8	8.8	0.0	8.5	0.0	0.0	0.0
Aug	8.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sep	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dec	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Feb	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	70.7	3.8	8.8	0.0	8.5	5.5	0.0	0.0

BY 1999 WINTER CHINOOK COHORT ANALYSIS: mortality applied in monthly increments (50% annual age 2 and 20% annual age 3 and 4). Alive is population at beginning of month. Impacts precede escapement, escapement precedes natural mortality

	Age 4		Age 3		Age 2	
Month	Impacts	Alive	Impacts	Alive	Impacts	Alive
Mar	0	12	0	442		
Apr	0	12	26	434		
May	0	12	6	400		
Jun	5	12	5	387		
Jul	4	6	42	375		
Aug	0	2	9	327		
Sep	0	2	0	312		
Oct	0	2	0	307		
Nov	0	2	0	301		
Dec	0	2	0	295		
Jan	0	2	0	290		
Feb	0	2	0	285	0	563
Total	9		88		0	
Escapement		2		272		94

Maturation Rates		Age 3 impact rate:	0.20
Age 2	0.17	Age 4 impact rate:	0.74
Age 3	0.96		

BY 1999 CONTACT RATES: number of contacts (age area month) divided by the total ocean pop (age month)

	Sport				Commercial			
	South		North		South		North	
Month	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4
Mar								
Apr	11.2%							
May	2.2%							
Jun	1.4%					44.8%		
Jul	6.4%	58.6%	2.3%		3.7%			
Aug	2.5%							
Sep								
Oct								
Nov								

Winter Chinook 2000 Cohort

LANDINGS: Coded wire tag recoveries expanded for sampling

	Sport				Commercial			
	South		North		South		North	
Month	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4
Mar	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
May	17.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jun	15.1	0.0	0.0	0.0	5.2	2.9	0.0	0.0
Jul	21.2	0.0	0.0	0.0	9.5	0.0	0.0	0.0
Aug	8.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0
Sep	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	62.2	4.0	0.0	0.0	21.3	2.9	0.0	0.0

CONTACTS: Landings divided by proportion legal

	Sport				Commercial			
	South		North		South		North	
Month	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4
Mar	0.0	4.1	0.0	0.0	0.0	0.0	0.0	0.0
Apr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
May	18.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jun	15.4	0.0	0.0	0.0	11.2	2.9	0.0	0.0
Jul	21.4	0.0	0.0	0.0	17.5	0.0	0.0	0.0
Aug	8.1	0.0	0.0	0.0	10.9	0.0	0.0	0.0
Sep	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	63.8	4.1	0.0	0.0	39.6	2.9	0.0	0.0

IMPACTS: landings + shaker deaths + drop off deaths

	Sport				Commercial			
	South		North		South		North	
Month	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4
Mar	0.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0
Apr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
May	19.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jun	15.9	0.0	0.0	0.0	7.3	3.0	0.0	0.0
Jul	22.3	0.0	0.0	0.0	12.4	0.0	0.0	0.0
Aug	8.4	0.0	0.0	0.0	8.3	0.0	0.0	0.0
Sep	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dec	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Feb	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	65.7	4.2	0.0	0.0	28.0	3.0	0.0	0.0

BY 2000 WINTER CHINOOK COHORT ANALYSIS: mortality applied in monthly increments (50% annual age 2 and 20% annual age 3 and 4). Alive is population at beginning of month. Impacts precede escapement, escapement precedes natural mortality

	Age 4		Age 3		Age 2	
Month	Impacts	Alive	Impacts	Alive	Impacts	Alive
Mar	4	7	0	455		
Apr	0	3	0	447		
May	0	3	19	439		
Jun	3	3	23	412		
Jul	0	0	35	381		
Aug	0	0	17	340		
Sep	0	0	0	318		
Oct	0	0	0	312		
Nov	0	0	0	306		
Dec	0	0	0	300		
Jan	0	0	0	295		
Feb	0	0	0	289	0	515
Total	7		94		0	
Escapement		NA		282		33

Maturation Rates

Age 2 0.06

Age 3 0.97

Age 3 impact rate: 0.21

Age 4 impact rate: NA

NA: No estimate, brood year not yet complete

BY 2000 CONTACT RATES: number of contacts (age area month) divided by the total ocean pop (age month)

	Sport				Commercial			
	South		North		South		North	
Month	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4
Mar		55.4%						
Apr								
May	4.3%							
Jun	3.7%				2.7%	96.5%		
Jul	5.6%				4.6%			
Aug	2.4%				3.2%			
Sep								
Oct								
Nov								

Appendix III Butte Creek Spring Chinook Cohort Reconstructions.

Butte Creek Spring Chinook brood year 1998

LANDINGS: Coded wire tag recoveries expanded for sampling

	Sport				Commercial			
	South		North		South		North	
Month	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4
May	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jun	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jul	0.0	0.0	0.0	13.9	0.0	2.8	0.0	0.0
Aug	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8
Sep	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5
Oct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dec-Feb	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0
Total	3.3	0.0	0.0	13.9	0.0	2.8	3.6	5.3

CONTACTS: Landings divided by proportion legal

	Sport				Commercial			
	South		North		South		North	
Month	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4
May	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jun	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jul	0.0	0.0	0.0	13.9	0.0	2.9	0.0	0.0
Aug	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8
Sep	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6
Oct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dec-Feb	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0
Total	3.3	0.0	0.0	13.9	0.0	2.9	3.8	5.3

IMPACTS: landings + shaker deaths + drop off deaths

	Sport				Commercial			
	South		North		South		North	
Month	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4
May	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jun	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jul	0.0	0.0	0.0	14.6	0.0	3.0	0.0	0.0
Aug	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9
Sep	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7
Oct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dec-Feb	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0
Total	3.5	0.0	0.0	14.6	0.0	3.0	3.8	5.6

BY 1998 BUTTE CREEK SPING CHINNOOK COHORT ANALYSIS mortality applied in monthly increments (50% annual age 2 and 20% annual age 3 and 4) Alive: alive at beginning of month. Impacts precede escapement, escapement precedes natural mortality

	Age 5		Age 4		Age 3		Age 2	
Month	Impcts	Alive	Impcts	Alive	Impcts	Alive	Impcts	Alive
May	0	3	0	37	0	86		
Jun	0	3	0	37	3	85		
Jul	3	3	18	36	0	80		
Aug	0	0	3	18	0	78		
Sep	0	0	3	15	0	77		
Oct	0	0	0	12	0	75		
Nov	0	0	0	12	0	74		
Dec	0	0	0	12	0	73		
Jan	0	0	0	11	0	71		
Feb	0	0	0	11	0	70		
Mar	0	0	0	11	0	69		
Apr	0	0	0	11	4	67	0	91
Total	3		23		7		0	
Escapement		0		7		25		0

Maturation Rates		Age 3 impact rate:	0.08
Age 2	0.00	Age 4 impact rate:	0.62
Age 3	0.40		
Age 4	0.67		

BY 1998 CONTACT RATES: number of contacts (age area month) divided by the total ocean pop (age month)

	Sport				Commercial			
	South		North		South		North	
Month	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4
May								
Jun	3.9%							
Jul				38.5%		8.0%		
Aug								15.3%
Sep								17.1%
Oct								
Nov								
Dec-Feb								
Mar								
Apr							5.6%	

Note: the workgroup has not yet finalized the procedure for expanding CWTs recovered in the Butte Creek carcass surveys. Escapement numbers reported in the Butte Creek spring chinook cohort reconstructions are provisional.

Butte Creek Spring Chinook brood year 1999

LANDINGS: Coded wire tag recoveries expanded for sampling

	Sport				Commercial			
	South		North		South		North	
Month	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4
May	0.0	0.0	0.0	0.0	0.0	10.9	0.0	0.0
Jun	0.0	7.2	0.0	0.0	0.0	12.3	0.0	0.0
Jul	0.0	0.0	0.0	1.7	0.0	9.9	0.0	2.7
Aug	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sep	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6
Oct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dec-Feb	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar	4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0
Total	4.4	7.2	0.0	1.7	0.0	33.1	3.2	4.3

CONTACTS: Landings divided by proportion legal

	Sport				Commercial			
	South		North		South		North	
Month	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4
May	0.0	0.0	0.0	0.0	0.0	11.3	0.0	0.0
Jun	0.0	7.2	0.0	0.0	0.0	12.5	0.0	0.0
Jul	0.0	0.0	0.0	1.7	0.0	10.1	0.0	2.8
Aug	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sep	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6
Oct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dec-Feb	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr	0.0	0.0	0.0	0.0	0.0	0.0	3.4	0.0
Total	4.5	7.2	0.0	1.7	0.0	33.9	3.4	4.4

IMPACTS: landings + shaker deaths + drop off deaths

	Sport				Commercial			
	South		North		South		North	
Month	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4
May	0.0	0.0	0.0	0.0	0.0	11.6	0.0	0.0
Jun	0.0	7.6	0.0	0.0	0.0	13.0	0.0	0.0
Jul	0.0	0.0	0.0	1.8	0.0	10.5	0.0	2.9
Aug	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sep	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7
Oct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dec-Feb	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr	0.0	0.0	0.0	0.0	0.0	0.0	3.5	0.0
Total	4.6	7.6	0.0	1.8	0.0	35.0	3.5	4.6

BY 1999 BUTTE CREEK SPING CHINNOOK COHORT ANALYSIS mortality applied in monthly increments (50% annual age 2 and 20% annual age 3 and 4) Alive: alive at beginning of month. Impacts precede escapement, escapement precedes natural mortality

	Age 5		Age 4		Age 3		Age 2	
Month	Impacts	Alive	Impacts	Alive	Impacts	Alive	Impacts	Alive
May	0	0	12	88	0	164		
Jun	0	0	21	75	0	161		
Jul	0	0	15	54	0	158		
Aug	0	0	0	38	0	155		
Sep	0	0	2	37	0	152		
Oct	0	0	0	35	0	149		
Nov	0	0	0	34	0	147		
Dec	0	0	0	34	0	144		
Jan	0	0	0	33	0	141		
Feb	0	0	0	32	0	139		
Mar	0	0	0	32	5	136		
Apr	0	0	0	31	3	129	0	176
Total	0		49		8		0	
Escapement		NA		31		36		2

Maturation Rates		Age 3 impact rate:	0.05
Age 2	0.01	Age 4 impact rate:	0.55
Age 3	0.28		
Age 4	NA		

NA: brood year not yet complete

BY 1999 CONTACT RATES: number of contacts (age area month) divided by the total ocean pop (age month)

	Sport				Commercial			
	South		North		South		North	
Month	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4
May						12.7%		
Jun		9.5%				16.6%		
Jul				3.2%		18.7%		5.2%
Aug								
Sep								4.3%
Oct								
Nov								
Dec-Feb								
Mar	3.3%							
Apr							2.7%	

Butte Creek Spring Chinook brood year 2000

LANDINGS: Coded wire tag recoveries expanded for sampling

	Sport				Commercial			
	South		North		South		North	
Month	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4
May	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jun	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0
Jul	8.6	0.0	0.0	4.3	0.0	3.6	0.0	0.0
Aug	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sep	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dec-Feb	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	8.6	0.0	0.0	4.3	0.0	6.5	0.0	0.0

CONTACTS: Landings divided by proportion legal

	Sport				Commercial			
	South		North		South		North	
Month	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4
May	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jun	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0
Jul	8.7	0.0	0.0	4.3	0.0	3.7	0.0	0.0
Aug	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sep	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dec-Feb	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	8.7	0.0	0.0	4.3	0.0	6.6	0.0	0.0

IMPACTS: landings + shaker deaths + drop off deaths

	Sport				Commercial			
	South		North		South		North	
Month	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4
May	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jun	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0
Jul	9.1	0.0	0.0	4.5	0.0	3.8	0.0	0.0
Aug	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sep	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dec-Feb	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	9.1	0.0	0.0	4.5	0.0	6.8	0.0	0.0

BY 2000 BUTTE CREEK SPING CHINNOOK COHORT ANALYSIS
mortality applied in monthly increments (50% annual age 2 and 20% annual age 3 and 4) Alive: alive at beginning of month. Impacts precede escapement, escapement precedes natural mortality

	Age 5		Age 4		Age 3		Age 2	
Month	Impacts	Alive	Impacts	Alive	Impacts	Alive	Impacts	Alive
May	0	0	0	12	0	75		
Jun	0	0	3	11	0	74		
Jul	0	0	8	8	9	72		
Aug	0	0	0	0	0	62		
Sep	0	0	0	0	0	61		
Oct	0	0	0	0	0	60		
Nov	0	0	0	0	0	59		
Dec	0	0	0	0	0	58		
Jan	0	0	0	0	0	57		
Feb	0	0	0	0	0	55		
Mar	0	0	0	0	0	54		
Apr	0	0	0	0	0	53	0	79
Total	0		11		9		0	
Escapement		NA		NA		42		0

Maturation Rates

Age 2	0.00	Age 3 impact rate:	0.12
Age 3	NA	Age 4 impact rate:	NA
Age 4	NA		

NA: brood year not yet complete

BY 2000 CONTACT RATES: number of contacts (age area month) divided by the total ocean pop (age month)

	Sport				Commercial			
	South		North		South		North	
Month	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4	Age 3	Age 4
May								
Jun						25.5%		
Jul	12.1%			51.3%		44.4%		
Aug								
Sep								
Oct								
Nov								
Dec-Feb								
Mar								
Apr								

Appendix IV CWT Recoveries Winter Chinook (Livingston Stone National Fish Hatchery)

Ocean Recoveries

Brood Year	Sector	Recov Date	Age	Recovery Location	Est No	Tag Code	ID
1991	Sport	5/27/93	3	PIGEON PT.-POINT SUR	7.08	0501010406	50426
1991	Sport	7/23/93	3	FORT ROSS-PIGEON PT	5.46	0501010405	51610
1991	Troll	5/6/94	4	FORT ROSS-PIGEON PT	3.41	0501010406	55024
1992	Sport	6/19/94	3	FORT ROSS-PIGEON PT	3.60	0501010713	53145
1992	Sport	3/26/94	3	PIGEON PT.-POINT SUR	6.50	0501010702	55500
1992	Sport	3/20/94	3	FORT ROSS-PIGEON PT	4.92	0501010610	55619
1992	Sport	5/21/94	3	FORT ROSS-PIGEON PT	4.49	0501010609	55374
1992	Sport	7/11/94	3	FORT ROSS-PIGEON PT	3.62	0501010611	15608
1992	Sport	4/14/94	3	FORT ROSS-PIGEON PT	5.49	0501010711	55313
1992	Sport	4/4/94	3	PIGEON PT.-POINT SUR	4.42	0501010711	55212
1992	Sport	4/14/94	3	FORT ROSS-PIGEON PT	5.49	0501010609	55311
1992	Sport	7/31/94	3	PIGEON PT.-POINT SUR	4.33	0501010609	49678
1992	Sport	6/18/94	3	PIGEON PT.-POINT SUR	4.29	0501010608	49638
1992	Sport	4/20/94	3	PIGEON PT.-POINT SUR	4.45	0501010614	55221
1992	Troll	7/11/94	3	PIGEON PT.-POINT SUR	9.84	0501010614	49652
1992	Troll	7/12/94	3	POINT SUR-CA/MEX.BOR	9.84	0501010705	55825
1992	Troll	9/14/94	3	FORT ROSS-PIGEON PT	11.20	0501010611	53586
1992	Troll	7/16/94	3	FORT ROSS-PIGEON PT	7.22	0501010614	15620
1992	Troll	7/15/94	3	FORT ROSS-PIGEON PT	5.80	0501010703	7920
1992	Troll	7/19/94	3	POINT SUR-CA/MEX.BOR	9.84	0501010609	55827
1993	Sport	4/28/95	3	FORT ROSS-PIGEON PT	3.23	0501010902	4409
1993	Sport	7/30/95	3	FORT ROSS-PIGEON PT	5.14	0501010907	11536
1993	Sport	5/28/95	3	POINT SUR-CA/MEX.BOR	9.21	0501010905	12429
1993	Sport	7/29/95	3	PIGEON PT.-POINT SUR	4.81	0501010810	10939
1993	Sport	4/26/96	4	PIGEON PT.-POINT SUR	5.00	0501010907	5342
1994	Sport	3/30/96	3	POINT SUR-CA/MEX.BOR	4.52	0501011015	5024
1994	Sport	3/15/96	3	FORT ROSS-PIGEON PT	3.87	0501011113	1058
1994	Sport	5/30/97	4	FORT ROSS-PIGEON PT	4.54	0501011102	878
1994	Sport	3/16/97	4	POINT SUR-CA/MEX.BOR	4.11	0501011105	9011
1994	Troll	4/22/97	4	POINT SUR-CA/MEX.BOR	1.51	0501011115	8758
1994	Troll	7/3/97	4	PIGEON PT.-POINT SUR	3.80	0501011011	14017
1994	Troll	4/15/97	4	POINT SUR-CA/MEX.BOR	1.57	0501011101	9513
1994	Troll	4/22/97	4	POINT SUR-CA/MEX.BOR	1.51	0501011012	8862
1994	Troll	6/25/97	4	PIGEON PT.-POINT SUR	4.18	0501011106	13682
1994	Troll	4/20/97	4	POINT SUR-CA/MEX.BOR	1.51	0501011112	9685
1994	Troll	9/30/97	4	FORT ROSS-PIGEON PT	3.40	0501011201	19439
1995	Sport	8/24/97	3	FORT ROSS-PIGEON PT	4.78	0501011409	15958
1995	Sport	8/11/97	3	FORT ROSS-PIGEON PT	4.82	0501011413	15494
1995	Sport	7/12/97	3	PIGEON PT.-POINT SUR	4.37	0501011412	16556
1995	Sport	7/23/97	3	PIGEON PT.-POINT SUR	6.64	0501011301	45545
1998	Sport	8/11/99	2	FORT ROSS-PIGEON PT	4.02	0501020913	39803
1998	Sport	8/13/99	2	FORT ROSS-PIGEON PT	4.02	0501020813	39358
1998	Sport	8/11/00	3	BIG LAG.-CENTERV.BEA	4.42	0501020903	42738
1998	Sport	8/21/00	3	PIGEON PT.-POINT SUR	2.87	0501020812	41788
1998	Sport	8/16/00	3	BROOKINGS SPORT 6	3.21	0501020913	J5319
1998	Sport	7/15/00	3	PIGEON PT.-POINT SUR	3.94	0501020913	41341
1998	Sport	7/14/00	3	PIGEON PT.-POINT SUR	3.94	0501020913	35299
1998	Sport	7/2/00	3	PIGEON PT.-POINT SUR	3.94	0501020913	35234
1998	Sport	7/16/00	3	PIGEON PT.-POINT SUR	3.72	0501020909	41740
1998	Sport	7/2/00	3	PIGEON PT.-POINT SUR	3.94	0501020811	41315
1998	Sport	6/24/00	3	PIGEON PT.-POINT SUR	3.98	0501020814	43402
1998	Sport	6/17/00	3	PIGEON PT.-POINT SUR	3.98	0501020813	43836
1998	Sport	7/7/00	3	PIGEON PT.-POINT SUR	3.94	0501020815	41328
1998	Sport	6/17/00	3	PIGEON PT.-POINT SUR	3.98	0501020903	43833
1998	Sport	6/25/00	3	PIGEON PT.-POINT SUR	3.98	0501020814	43413
1998	Sport	7/9/00	3	PIGEON PT.-POINT SUR	3.94	0501020903	41732
1998	Sport	6/10/00	3	PIGEON PT.-POINT SUR	4.35	0501020906	43338
1998	Sport	9/19/00	3	PIGEON PT.-POINT SUR	4.30	0501020814	34453
1998	Sport	7/8/00	3	PIGEON PT.-POINT SUR	3.94	0501020814	41330
1998	Sport	6/23/00	3	PIGEON PT.-POINT SUR	3.98	0501020905	43392
1998	Sport	7/25/00	3	PIGEON PT.-POINT SUR	3.72	0501020904	34423
1998	Sport	6/29/00	3	PIGEON PT.-POINT SUR	3.98	0501020815	43469
1998	Sport	7/25/00	3	PIGEON PT.-POINT SUR	3.72	0501020909	41360
1998	Sport	6/6/00	3	FORT ROSS-PIGEON PT	3.27	0501020911	43328
1998	Sport	10/9/00	3	FORT ROSS-PIGEON PT	4.43	0501020913	35334
1998	Sport	7/22/00	3	FORT ROSS-PIGEON PT	3.28	0501020903	34148
1998	Sport	6/19/00	3	FORT ROSS-PIGEON PT	3.51	0501020902	40529
1998	Sport	7/21/00	3	PIGEON PT.-POINT SUR	3.72	0501020914	34406
1998	Sport	7/3/00	3	PIGEON PT.-POINT SUR	3.94	0501020813	41725
1998	Sport	8/2/00	3	FORT ROSS-PIGEON PT	2.77	0501020815	34163
1998	Sport	10/20/0	3	FORT ROSS-PIGEON PT	4.52	0501020814	34627
1998	Sport	4/27/00	3	FORT ROSS-PIGEON PT	2.72	0501020910	22627
1998	Sport	6/23/00	3	PIGEON PT.-POINT SUR	3.98	0501020914	43390
1998	Troll	6/17/00	3	PIGEON PT-CA/MEX.BOR	2.51	0501020915	28763
1998	Troll	6/7/00	3	POINT SUR-CA/MEX.BOR	2.97	0501020902	28710
1998	Troll	6/27/00	3	PIGEON PT-CA/MEX.BOR	2.51	0501020901	28789
1998	Troll	6/23/00	3	PIGEON PT-CA/MEX.BOR	2.51	0501020914	19972
1998	Troll	7/19/00	3	COOS BAY TROLL 5	3.76	0501020912	J4538
1998	Troll	5/16/01	4	POINT SUR-CA/MEX.BOR	4.66	0501020908	34857
1998	Troll	9/19/01	4	NEWPORT TROLL 4	2.54	0501020815	G2886
1999	Sport	7/17/01	3	C.VIZCAINO-NAVARR.HD	3.69	0501021306	47400
1999	Sport	7/21/01	3	PT.SN.PEDRO-PIGN.PT.	3.63	0501021208	29885
1999	Sport	7/25/01	3	PT.REYES-PIGEON PT.	3.63	0501021306	50756
1999	Sport	7/2/01	3	C.VIZCAINO-NAVARR.HD	4.66	0501021306	44912
1999	Sport	6/18/01	3	PT.ARENA-PT.REYES	4.03	0501021214	47150
1999	Sport	7/20/01	3	PT.REYES-PIGEON PT.	3.63	0501021213	48489
1999	Sport	8/4/01	3	PT.REYES-PIGEON PT.	4.12	0501021213	35656
1999	Sport	8/11/01	3	PT.REYES-PIGEON PT.	4.12	0501021303	27149
1999	Sport	4/13/01	3	PIGEON PT.-POINT SUR	4.82	0501021304	28617
1999	Sport	7/1/01	3	PIGEON PT.-POINT SUR	4.30	0501021307	48178
1999	Sport	4/9/01	3	POINT SUR-CA/MEX.BOR	4.82	0501021302	34804
1999	Sport	5/17/01	3	PIGEON PT.-POINT SUR	4.72	0501021303	46695
1999	Sport	7/13/01	3	PIGEON PT.-POINT SUR	4.30	0501021301	48206
1999	Sport	7/14/01	3	PIGEON PT.-POINT SUR	4.30	0501021208	48212
1999	Sport	3/31/01	3	POINT SUR-CA/MEX.BOR	4.53	0501021302	34801
1999	Sport	7/18/02	4	PT.ARENA-PT.REYES	3.63	0501021305	51661
1999	Troll	7/13/01	3	PT.REYES-PIGEON PT.	2.80	0501021302	49151
1999	Troll	7/10/01	3	PT.ARENA-PT.REYES	2.80	0501021303	50080
1999	Troll	6/14/02	4	PT.REYES-PIGEON PT.	2.59	0501021214	56970
1999	Troll	6/14/02	4	PT.ARENA-PT.REYES	2.59	0501021214	54109
2000	Sport	8/22/02	3	PT.SN.PEDRO-PIGN.PT.	3.81	0501030204	58199
2000	Sport	6/22/02	3	PT.REYES-PIGEON PT.	3.60	0501030305	57601
2000	Sport	5/4/02	3	PT.REYES-PIGEON PT.	2.88	0501030107	46963
2000	Sport	7/11/02	3	PT.REYES-PIGEON PT.	4.31	0501030403	58750
2000	Sport	6/9/02	3	POINT SUR-CA/MEX.BOR	3.84	0501030309	51936
2000	Sport	6/17/02	3	PIGEON PT.-POINT SUR	3.83	0501030302	55611
2000	Sport	6/19/02	3	POINT SUR-CA/MEX.BOR	3.83	0501030403	55303
2000	Sport	5/25/02	3	PT.SN.PEDRO-PIGN.PT.	4.40	0501030306	51765
2000	Sport	7/21/02	3	PT.REYES-PIGEON PT.	3.63	0501030301	59425
2000	Sport	8/18/02	3	PIGEON PT.-POINT SUR	4.20	0501030305	57339
2000	Sport	7/22/02	3	PIGEON PT.-POINT SUR	4.46	0501030303	60068
2000	Sport	7/10/02	3	PT.REYES-PIGEON PT.	4.31	0501030307	58743
2000	Sport	5/24/02	3	PIGEON PT.-POINT SUR	3.54	0501030108	46895
2000	Sport	5/24/02	3	PIGEON PT.-POINT SUR	3.54	0501030407	46893
2000	Sport	7/26/02	3	PIGEON PT.-POINT SUR	4.46	0501030206	57325
2000	Sport	5/25/02	3	PIGEON PT.-POINT SUR	3.54	0501030207	53846
2000	Sport	3/29/03	4	PIGEON PT.-POINT SUR	4.00	0501030107	60005
2000	Troll	6/14/02	3	PT.REYES-PIGEON PT.	2.59	0501030402	54098
2000	Troll	7/11/02	3	PT.REYES-PIGEON PT.	3.26	0501030402	57153
2000	Troll	7/19/02	3	PIGEON PT.-POINT SUR	3.41	0501030107	60066
2000	Troll	6/14/02	3	PT.ARENA-PT.REYES	2.59	0501030309	53268
2000	Troll	7/10/02	3	PIGEON PT.-POINT SUR	2.80	0501030202	54939
2000	Troll	8/1/02	3	PT.ARENA-PT.REYES	6.65	0501030301	58241
2000	Troll	6/12/03	4	PT.REYES-PIGEON PT.	2.87	0501030201	66928
2001	Sport	5/21/03	3	PT.REYES-PIGEON PT.	3.08	0501030903	61557
2001	Sport	7/11/03	3	PIGEON PT.-POINT SUR	5.01	0501030802	61957
2001	Sport	7/26/03	3	PT.REYES-PIGEON PT.	4.02	0501030903	68657
2001	Sport	7/18/03	3	PIGEON PT.-POINT SUR	4.03	0501030806	62580
2001	Sport	6/27/03	3	PT.REYES-PIGEON PT.	3.57	0501030705	66526
2001	Sport	6/27/03	3	PT.REYES-PIGEON PT.	3.57	0501030904	66524
2001	Sport	6/27/03	3	PT.REYES-PIGEON PT.	3.57	0501030904	65760
2001	Sport	5/22/03	3	PT.REYES-PIGEON PT.	3.08	0501030705	62027
2001	Sport	5/21/03	3	PT.REYES-PIGEON PT.	3.08	0501030705	62256
2001	Sport	5/9/03	3	PT.REYES-PIGEON PT.	2.95	0501030707	61542
2001	Sport	6/14/03	3	PT.REYES-PIGEON PT.	4.51	0501030802	65725

Total Recoveries: 135

Carcass Survey CWT Recoveries

Brood Year	Method	Recovery Date	Age	Est #	CWT Code
1998	Carcass	7/14/01	3	2.94	0501020914
1998	Carcass	6/8/01	3	2.94	0501020911
1998	Carcass	7/20/01	3	2.94	0501020911
1998	Carcass	7/23/01	3	2.94	0501020910
1998	Carcass	6/13/01	3	2.94	0501020913
1998	Carcass	6/13/01	3	2.94	0501020913
1998	Carcass	7/9/01	3	2.94	0501020913
1998	Carcass	7/9/01	3	2.94	0501020913
1998	Carcass	6/28/01	3	2.94	0501020912
1998	Carcass	8/2/01	3	2.94	0501020905
1998	Carcass	7/8/01	3	2.94	0501020914
1998	Carcass	8/4/01	3	2.94	0501020911
1998	Carcass	6/29/01	3	2.94	0501020905
1998	Carcass	6/28/01	3	2.94	0501020905
1998	Carcass	7/8/01	3	2.94	0501020905
1998	Carcass	6/17/01	3	2.94	0501020905
1998	Carcass	6/14/01	3	2.94	0501020905
1998	Carcass	7/21/01	3	2.94	0501020905
1998	Carcass	7/29/01	3	2.94	0501020905
1998	Carcass	7/30/01	3	2.94	0501020905
1998	Carcass	8/1/01	3	2.94	0501020905
1998	Carcass	7/5/01	3	2.94	0501020914
1998	Carcass	8/13/01	3	2.94	0501020813
1998	Carcass	6/16/01	3	2.94	0501020811
1998	Carcass	7/8/01	3	2.94	0501020811
1998	Carcass	7/14/01	3	2.94	0501020811
1998	Carcass	6/22/01	3	2.94	0501020811
1998	Carcass	7/11/01	3	2.94	0501020811
1998	Carcass	7/5/01	3	2.94	0501020811
1998	Carcass	6/23/01	3	2.94	0501020811
1998	Carcass	7/20/01	3	2.94	0501020811
1998	Carcass	6/22/01	3	2.94	0501020811
1998	Carcass	6/19/01	3	2.94	0501020911
1998	Carcass	7/20/01	3	2.94	0501020813
1998	Carcass	7/8/01	3	2.94	0501020911
1998	Carcass	7/2/01	3	2.94	0501020813
1998	Carcass	7/17/01	3	2.94	0501020903
1998	Carcass	7/29/01	3	2.94	0501020903
1998	Carcass	5/11/01	3	2.94	0501020902
1998	Carcass	7/11/01	3	2.94	0501020902
1998	Carcass	7/5/01	3	2.94	0501020906
1998	Carcass	7/23/01	3	2.94	0501020911
1998	Carcass	7/29/01	3	2.94	0501020911
1998	Carcass	7/1/01	3	2.94	0501020912
1998	Carcass	7/12/01	3	2.94	0501020813
1998	Carcass	5/11/01	3	2.94	0501020908
1998	Carcass	6/26/01	3	2.94	0501020814
1998	Carcass	6/14/01	3	2.94	0501020814
1998	Carcass	7/9/01	3	2.94	0501020814
1998	Carcass	7/17/01	3	2.94	0501020815
1998	Carcass	7/24/01	3	2.94	0501020815
1998	Carcass	7/30/01	3	2.94	0501020812
1998	Carcass	7/12/01	3	2.94	0501020812
1998	Carcass	8/7/01	3	2.94	0501020812
1998	Carcass	7/9/01	3	2.94	0501020908
1998	Carcass	7/6/01	3	2.94	0501020908
1998	Carcass	6/22/01	3	2.94	0501020906
1998	Carcass	6/16/01	3	2.94	0501020908
1998	Carcass	7/27/01	3	2.94	0501020812
1998	Carcass	7/17/01	3	2.94	0501020814
1998	Carcass	6/19/01	3	2.94	0501020909
1998	Carcass	7/15/01	3	2.94	0501020912
1998	Carcass	7/8/01	3	2.94	0501020909
1998	Carcass	7/29/01	3	2.94	0501020909
1998	Carcass	6/28/01	3	2.94	0501020909
1998	Carcass	6/16/01	3	2.94	0501020901
1998	Carcass	7/24/01	3	2.94	0501020901

Brood Year	Method	Recovery Date	Age	Est #	CWT Code
1998	Carcass	7/5/01	3	2.94	0501020908
1998	Carcass	7/12/01	3	2.94	0501020908
1998	Carcass	7/30/01	3	2.94	0501020907
1998	Carcass	7/5/01	3	2.94	0501020904
1998	Carcass	6/25/01	3	2.94	0501020904
1998	Carcass	7/5/01	3	2.94	0501020815
1998	Carcass	5/14/01	3	2.94	0501020904
1998	Carcass	6/19/01	3	2.94	0501020815
1998	Carcass	7/26/01	3	2.94	0501020907
1998	Carcass	7/15/01	3	2.94	0501020812
1998	Carcass	8/8/01	3	2.94	0501020905
1998	Carcass	7/1/01	3	2.94	0501020906
1998	Carcass	5/8/01	3	2.94	0501020905
1998	Carcass	6/7/01	3	2.94	0501020906
1998	Carcass	7/8/01	3	2.94	0501020904
1998	Carcass	7/14/01	3	2.94	0501020815
1998	Carcass	8/19/01	3	2.94	0501020907
1998	Carcass	5/4/02	4	2.15	0501020905
1998	Carcass	6/25/02	4	2.15	0501020812
1998	Keswick	7/2/01	3	1.00	0501020909
1998	Keswick	6/13/01	3	1.00	0501020813
1998	Keswick	6/6/01	3	1.00	0501020905
1998	Keswick	6/13/01	3	1.00	0501020905
1998	Keswick	6/6/01	3	1.00	0501020906
1998	Keswick	6/13/01	3	1.00	0501020811
1998	Keswick	6/6/01	3	1.00	0501020905
1998	Keswick	7/2/01	3	1.00	0501020914
1998	Keswick	5/30/01	3	1.00	0501020815
1998	Keswick	6/13/01	3	1.00	0501020910
1998	Keswick	6/13/01	3	1.00	0501020812
1998	Keswick	6/13/01	3	1.00	0501020914
1999	Carcass	7/8/01	2	2.94	0501021307
1999	Carcass	5/30/01	2	2.94	0501021214
1999	Carcass	5/24/01	2	2.94	0501021214
1999	Carcass	6/26/01	2	2.94	0501021212
1999	Carcass	7/23/01	2	2.94	0501021213
1999	Carcass	7/12/01	2	2.94	0501021213
1999	Carcass	6/28/01	2	2.94	0501021215
1999	Carcass	7/11/01	2	2.94	0501021215
1999	Carcass	7/6/01	2	2.94	0501021214
1999	Carcass	6/20/01	2	2.94	0501021302
1999	Carcass	7/8/01	2	2.94	0501021305
1999	Carcass	7/2/01	2	2.94	0501021304
1999	Carcass	6/22/01	2	2.94	0501021301
1999	Carcass	7/14/01	2	2.94	0501021305
1999	Carcass	7/5/01	2	2.94	0501021305
1999	Carcass	7/1/01	2	2.94	0501021306
1999	Carcass	6/19/01	2	2.94	0501021210
1999	Carcass	7/17/01	2	2.94	0501021301
1999	Carcass	7/8/01	2	2.94	0501021303
1999	Carcass	7/20/01	2	2.94	0501021208
1999	Carcass	6/17/01	2	2.94	0501021306
1999	Carcass	6/23/01	2	2.94	0501021306
1999	Carcass	6/23/01	2	2.94	0501021302
1999	Carcass	6/28/01	2	2.94	0501021215
1999	Carcass	7/6/01	2	2.94	0501021213
1999	Carcass	7/5/01	2	2.94	0501021210
1999	Carcass	7/26/01	2	2.94	0501021307
1999	Carcass	6/29/01	2	2.94	0501021215
1999	Carcass	7/5/01	2	2.94	0501021302
1999	Carcass	6/16/01	2	2.94	0501021213
1999	Carcass	6/26/01	2	2.94	0501021302
1999	Carcass	7/24/01	2	2.94	0501021215
1999	Carcass	7/24/02	3	2.15	0501021305
1999	Carcass	6/30/02	3	2.15	0501021210
1999	Carcass	6/30/02	3	2.15	0501021306

Brood Year	Method	Recovery Date	Age	Est #	CWT Code
1999	Carcass	7/3/02	3	2.15	0501021306
1999	Carcass	6/9/02	3	2.15	0501021306
1999	Carcass	6/15/02	3	2.15	0501021306
1999	Carcass	5/22/02	3	2.15	0501021306
1999	Carcass	7/18/02	3	2.15	0501021207
1999	Carcass	5/28/02	3	2.15	0501021306
1999	Carcass	6/25/02	3	2.15	0501021306
1999	Carcass	7/15/02	3	2.15	0501021306
1999	Carcass	7/3/02	3	2.15	0501021306
1999	Carcass	6/25/02	3	2.15	0501021306
1999	Carcass	6/25/02	3	2.15	0501021305
1999	Carcass	6/30/02	3	2.15	0501021210
1999	Carcass	5/16/02	3	2.15	0501021210
1999	Carcass	5/25/02	3	2.15	0501021210
1999	Carcass	6/12/02	3	2.15	0501021212
1999	Carcass	7/18/02	3	2.15	0501021212
1999	Carcass	7/15/02	3	2.15	0501021212
1999	Carcass	7/15/02	3	2.15	0501021212
1999	Carcass	7/15/02	3	2.15	0501021205
1999	Carcass	5/31/02	3	2.15	0501021205
1999	Carcass	6/3/02	3	2.15	0501021305
1999	Carcass	5/28/02	3	2.15	0501021305
1999	Carcass	6/30/02	3	2.15	0501021306
1999	Carcass	6/25/02	3	2.15	0501021303
1999	Carcass	6/21/02	3	2.15	0501021209
1999	Carcass	5/25/02	3	2.15	0501021209
1999	Carcass	6/25/02	3	2.15	0501021209
1999	Carcass	6/4/02	3	2.15	0501021209
1999	Carcass	5/22/02	3	2.15	0501021209
1999	Carcass	7/3/02	3	2.15	0501021307
1999	Carcass	7/4/02	3	2.15	0501021207
1999	Carcass	7/9/02	3	2.15	0501021207
1999	Carcass	7/21/02	3	2.15	0501021207
1999	Carcass	7/6/02	3	2.15	0501021207
1999	Carcass	7/18/02	3	2.15	0501021208
1999	Carcass	6/21/02	3	2.15	0501021208
1999	Carcass	6/9/02	3	2.15	0501021209
1999	Carcass	6/25/02	3	2.15	0501021303
1999	Carcass	7/9/02	3	2.15	0501021209
1999	Carcass	6/15/02	3	2.15	0501021303
1999	Carcass	5/22/02	3	2.15	0501021303
1999	Carcass	6/25/02	3	2.15	0501021303
1999	Carcass	7/12/02	3	2.15	0501021215
1999	Carcass	6/6/02	3	2.15	0501021215
1999	Carcass	7/12/02	3	2.15	0501021215
1999	Carcass	6/12/02	3	2.15	0501021215
1999	Carcass	6/25/02	3	2.15	0501021215
1999	Carcass	6/25/02	3	2.15	0501021215
1999	Carcass	6/15/02	3	2.15	0501021215
1999	Carcass	7/6/02	3	2.15	0501021215
1999	Carcass	6/18/02	3	2.15	0501021215
1999	Carcass	6/21/02	3	2.15	0501021208
1999	Carcass	5/19/02	3	2.15	0501021301
1999	Carcass	7/9/02	3	2.15	0501021305
1999	Carcass	7/27/02	3	2.15	0501021305
1999	Carcass	7/27/02	3	2.15	0501021305
1999	Carcass	6/21/02	3	2.15	0501021305
1999	Carcass	7/15/02	3	2.15	0501021305
1999	Carcass	6/21/02	3	2.15	0501021305
1999	Carcass	6/30/02	3	2.15	0501021305
1999	Carcass	6/15/02	3	2.15	0501021305
1999	Carcass	7/15/02	3	2.15	0501021213
1999	Carcass	6/9/02	3	2.15	0501021213
1999	Carcass	7/6/02	3	2.15	0501021213
1999	Carcass	7/6/02	3	2.15	0501021213
1999	Carcass	6/3/02	3	2.15	0501021209
1999	Carcass	6/21/02	3	2.15	0501021301

Brood Year	Method	Recovery Date	Age	Est #	CWT Code
1999	Carcass	5/13/02	3	2.15	0501021301
1999	Carcass	6/22/02	3	2.15	0501021301
1999	Carcass	7/9/02	3	2.15	0501021301
1999	Carcass	7/12/02	3	2.15	0501021206
1999	Carcass	7/12/02	3	2.15	0501021206
1999	Carcass	6/27/02	3	2.15	0501021206
1999	Carcass	5/16/02	3	2.15	0501021214
1999	Carcass	5/16/02	3	2.15	0501021214
1999	Carcass	5/29/02	3	2.15	0501021214
1999	Carcass	6/1/02	3	2.15	0501021214
1999	Carcass	5/10/02	3	2.15	0501021214
1999	Carcass	7/3/02	3	2.15	0501021214
1999	Carcass	7/6/02	3	2.15	0501021213
1999	Carcass	6/25/02	3	2.15	0501021304
1999	Carcass	6/21/02	3	2.15	0501021304
1999	Carcass	5/22/02	3	2.15	0501021304
1999	Carcass	7/3/02	3	2.15	0501021304
1999	Carcass	5/22/02	3	2.15	0501021304
1999	Carcass	7/6/02	3	2.15	0501021304
1999	Carcass	6/21/02	3	2.15	0501021304
1999	Carcass	7/6/02	3	2.15	0501021304
1999	Carcass	6/21/02	3	2.15	0501021304
1999	Carcass	5/10/02	3	2.15	0501021302
1999	Carcass	6/6/02	3	2.15	0501021304
1999	Carcass	5/22/02	3	2.15	0501021211
1999	Carcass	6/15/02	3	2.15	0501021304
1999	Carcass	5/22/02	3	2.15	0501021304
1999	Carcass	6/21/02	3	2.15	0501021304
1999	Carcass	5/29/02	3	2.15	0501021211
1999	Carcass	6/12/02	3	2.15	0501021211
1999	Carcass	7/15/02	3	2.15	0501021211
1999	Carcass	5/13/02	3	2.15	0501021307
1999	Carcass	6/25/02	3	2.15	0501021307
1999	Carcass	6/18/02	3	2.15	0501021304
1999	Carcass	8/5/02	3	2.15	0501021307
1999	Carcass	5/16/02	3	2.15	0501021302
1999	Carcass	7/18/02	3	2.15	0501021307
1999	Carcass	7/9/02	3	2.15	0501021307
1999	Carcass	6/30/02	3	2.15	0501021307
1999	Carcass	6/21/02	3	2.15	0501021307
1999	Carcass	5/31/02	3	2.15	0501021307
1999	Carcass	7/24/02	3	2.15	0501021307
1999	Carcass	6/12/02	3	2.15	0501021302
1999	Carcass	6/15/02	3	2.15	0501021302
1999	Carcass	6/6/02	3	2.15	0501021302
1999	Carcass	6/30/02	3	2.15	0501021302
1999	Carcass	5/4/02	3	2.15	0501021302
1999	Carcass	6/3/02	3	2.15	0501021302
1999	Carcass	6/21/02	3	2.15	0501021307
1999	Carcass	6/9/02	3	2.15	0501021302
1999	Carcass	6/21/02	3	2.15	0501021302
1999	Carcass	5/28/02	3	2.15	0501021302
1999	Carcass	7/17/03	4	2.44	0501021305
1999	Keswick	5/1/02	3	1.00	0501021211
1999	Keswick	4/17/02	3	1.00	0501021306
1999	Keswick	4/17/02	3	1.00	0501021213
1999	Keswick	4/17/02	3	1.00	0501021307
1999	Keswick	4/24/02	3	1.00	0501021211
2000	Carcass	7/9/02	2	2.15	0501030201
2000	Carcass	7/15/02	2	2.15	0501030302
2000	Carcass	7/18/02	2	2.15	0501030206
2000	Carcass	7/15/02	2	2.15	0501030307
2000	Carcass	6/25/02	2	2.15	0501030306
2000	Carcass	7/7/02	2	2.15	0501030408
2000	Carcass	7/15/02	2	2.15	0501030401
2000	Carcass	7/15/02	2	2.15	0501030207
2000	Carcass	7/4/02	2	2.15	0501030306
2000	Carcass	7/10/02	2	2.15	0501030308
2000	Carcass	7/16/02	2	2.15	0501030308
2000	Carcass	7/3/02	2	2.15	0501030205

Brood Year	Method	Recovery Date	Age	Est #	CWT Code
2000	Carcass	7/16/02	2	2.15	0501030308
2000	Carcass	7/2/03	3	2.44	0501030203
2000	Carcass	5/27/03	3	2.44	0501030403
2000	Carcass	7/9/03	3	2.44	0501030403
2000	Carcass	7/8/03	3	2.44	0501030402
2000	Carcass	7/20/03	3	2.44	0501030202
2000	Carcass	7/23/03	3	2.44	0501030401
2000	Carcass	6/29/03	3	2.44	0501030401
2000	Carcass	6/2/03	3	2.44	0501030403
2000	Carcass	7/9/03	3	2.44	0501030401
2000	Carcass	7/8/03	3	2.44	0501030401
2000	Carcass	7/11/03	3	2.44	0501030401
2000	Carcass	7/20/03	3	2.44	0501030203
2000	Carcass	7/8/03	3	2.44	0501030203
2000	Carcass	7/21/03	3	2.44	0501030204
2000	Carcass	7/11/03	3	2.44	0501030205
2000	Carcass	7/11/03	3	2.44	0501030203
2000	Carcass	7/8/03	3	2.44	0501030203
2000	Carcass	7/14/03	3	2.44	0501030203
2000	Carcass	5/21/03	3	2.44	0501030205
2000	Carcass	7/8/03	3	2.44	0501030204
2000	Carcass	7/11/03	3	2.44	0501030204
2000	Carcass	7/17/03	3	2.44	0501030204
2000	Carcass	7/14/03	3	2.44	0501030204
2000	Carcass	7/5/03	3	2.44	0501030203
2000	Carcass	8/7/03	3	2.44	0501030308
2000	Carcass	7/11/03	3	2.44	0501030202
2000	Carcass	7/29/03	3	2.44	0501030201
2000	Carcass	7/2/03	3	2.44	0501030404
2000	Carcass	7/11/03	3	2.44	0501030202
2000	Carcass	8/1/03	3	2.44	0501030406
2000	Carcass	7/18/03	3	2.44	0501030307
2000	Carcass	7/20/03	3	2.44	0501030202
2000	Carcass	6/29/03	3	2.44	0501030307
2000	Carcass	7/23/03	3	2.44	0501030308
2000	Carcass	7/8/03	3	2.44	0501030308
2000	Carcass	5/15/03	3	2.44	0501030107
2000	Carcass	5/15/03	3	2.44	0501030107
2000	Carcass	6/8/03	3	2.44	0501030107
2000	Carcass	7/23/03	3	2.44	0501030107
2000	Carcass	7/14/03	3	2.44	0501030202
2000	Carcass	6/23/03	3	2.44	0501030306
2000	Carcass	7/2/03	3	2.44	0501030402
2000	Carcass	7/2/03	3	2.44	0501030402
2000	Carcass	7/2/03	3	2.44	0501030309
2000	Carcass	7/2/03	3	2.44	0501030305
2000	Carcass	7/9/03	3	2.44	0501030306
2000	Carcass	7/26/03	3	2.44	0501030109
2000	Carcass	7/29/03	3	2.44	0501030306
2000	Carcass	7/12/03	3	2.44	0501030402
2000	Carcass	6/23/03	3	2.44	0501030108
2000	Carcass	7/5/03	3	2.44	0501030108
2000	Carcass	7/5/03	3	2.44	0501030108
2000	Carcass	7/29/03	3	2.44	0501030307
2000	Carcass	6/29/03	3	2.44	0501030307
2000	Carcass	8/4/03	3	2.44	0501030307
2000	Carcass	6/29/03	3	2.44	0501030306
2000	Carcass	9/1/03	3	2.44	0501030302
2000	Carcass	8/4/03	3	2.44	0501030209
2000	Carcass	7/30/03	3	2.44	0501030209
2000	Carcass	7/2/03	3	2.44	0501030209
2000	Carcass	7/11/03	3	2.44	0501030301
2000	Carcass	6/24/03	3	2.44	0501030301
2000	Carcass	6/29/03	3	2.44	0501030404
2000	Carcass	7/8/03	3	2.44	0501030408
2000	Carcass	7/8/03	3	2.44	0501030206
2000	Carcass	8/4/03	3	2.44	0501030408
2000	Carcass	7/26/03	3	2.44	0501030408
2000	Carcass	7/6/03	3	2.44	0501030408
2000	Carcass	7/14/03	3	2.44	0501030408
2000	Carcass	7/23/03	3	2.44	0501030209

Brood Year	Method	Recovery Date	Age	Est #	CWT Code
2000	Carcass	6/2/03	3	2.44	0501030408
2000	Carcass	8/1/03	3	2.44	0501030302
2000	Carcass	7/2/03	3	2.44	0501030302
2000	Carcass	7/20/03	3	2.44	0501030302
2000	Carcass	7/23/03	3	2.44	0501030303
2000	Carcass	7/26/03	3	2.44	0501030303
2000	Carcass	8/7/03	3	2.44	0501030303
2000	Carcass	7/20/03	3	2.44	0501030304
2000	Carcass	7/11/03	3	2.44	0501030304
2000	Carcass	8/4/03	3	2.44	0501030304
2000	Carcass	7/8/03	3	2.44	0501030409
2000	Carcass	7/8/03	3	2.44	0501030409
2000	Carcass	8/7/03	3	2.44	0501030409
2000	Carcass	6/17/03	3	2.44	0501030408
2000	Carcass	7/23/03	3	2.44	0501030206
2000	Carcass	7/24/03	3	2.44	0501030404
2000	Carcass	7/29/03	3	2.44	0501030404
2000	Carcass	6/2/03	3	2.44	0501030404
2000	Carcass	5/19/03	3	2.44	0501030404
2000	Carcass	6/18/03	3	2.44	0501030405
2000	Carcass	6/29/03	3	2.44	0501030405
2000	Carcass	6/23/03	3	2.44	0501030405
2000	Carcass	7/29/03	3	2.44	0501030206
2000	Carcass	7/5/03	3	2.44	0501030208
2000	Carcass	7/11/03	3	2.44	0501030206
2000	Carcass	7/8/03	3	2.44	0501030206
2000	Carcass	7/20/03	3	2.44	0501030206
2000	Carcass	7/11/03	3	2.44	0501030206
2000	Carcass	6/27/03	3	2.44	0501030206
2000	Carcass	7/6/03	3	2.44	0501030207
2000	Carcass	7/8/03	3	2.44	0501030406
2000	Carcass	6/29/03	3	2.44	0501030208
2000	Carcass	6/17/03	3	2.44	0501030208
2000	Carcass	8/7/03	3	2.44	0501030406
2000	Carcass	6/5/03	3	2.44	0501030406
2000	Carcass	6/12/03	3	2.44	0501030406
2000	Carcass	8/1/03	3	2.44	0501030406
2000	Carcass	6/17/03	3	2.44	0501030207
2000	Carcass	7/17/03	3	2.44	0501030207
2000	Carcass	7/2/03	3	2.44	0501030206
2000	Carcass	7/17/03	3	2.44	0501030207
2000	Carcass	7/29/03	3	2.44	0501030207
2000	Keswick	6/12/02	2	1.00	0501030409
2000	Keswick	4/17/02	2	1.00	0501030108
2000	Keswick	6/12/02	2	1.00	0501030306
2000	Keswick	4/23/03	3	1.00	0501030301
2000	Keswick	4/23/03	3	1.00	0501030304
2000	Keswick	3/11/03	3	1.00	0501030302
2000	Keswick	6/4/03	3	1.00	0501030206
2000	Keswick	5/14/03	3	1.00	0501030202
2000	Keswick	6/4/03	3	1.00	0501030305
2001	Carcass	6/14/03	2	2.44	0501030803
2001	Carcass	7/20/03	2	2.44	0501030705
2001	Carcass	8/1/03	2	2.44	0501030705
2001	Carcass	6/29/03	2	2.44	0501030705
2001	Carcass	6/5/03	2	2.44	0501030705
2001	Carcass	7/3/03	2	2.44	0501030705
2001	Carcass	7/24/03	2	2.44	0501030705
2001	Carcass	7/24/03	2	2.44	0501030806
2001	Carcass	7/6/03	2	2.44	0501030903
2001	Carcass	6/29/03	2	2.44	0501030802
2001	Carcass	7/14/03	2	2.44	0501030802
2001	Keswick	6/18/03	2	1.00	0501030803

Total Recoveries: 409

River Recreational Recoveries

Brood Year	Recovery Location	Recovery Date	Age	Est #	CWT Code
1998	AMER.R. TO COLUSA	1/7/01	3	8.26	0501020905
1998	AMER.R. TO COLUSA	1/7/01	3	8.26	0501020908
1998	COLUSA TO RBDD	1/14/01	3	22.4	0501020908
1998	COLUSA TO RBDD	1/6/01	3	22.4	0501020906
1998	COLUSA TO RBDD	1/6/01	3	22.4	0501020906
1998	AMER.R. TO COLUSA	12/28/00	3	8.2	0501020907
1998	CARQUINEZ TO AMER. R	12/29/00	3	13.7	0501020811
1998	Submitted by angler	1/4/01	3	1	0501020904

Appendix V Coded Wire Tag Recoveries Butte Creek Spring Chinook

Ocean Recoveries

Brood Year	Sector	Recovery Date	Age	Recovery Location	Est No	Tag Code	ID
1995	Sport	4/29/98	3	FORT ROSS-PIGEON PT	2.64	B61202	36704
1995	Sport	4/17/98	3	FORT ROSS-PIGEON PT	2.64	B61202	36406
1995	Troll	5/8/98	4	POINT SUR-CA/MEX.BOR	2.86	B61201	23378
1997	Sport	6/10/00	4	FORT ROSS-PIGEON PT	3.27	0601120201	43589
1997	Troll	5/23/00	4	FORT ROSS-POINT SUR	4.75	0601120205	42801
1997	Troll	7/20/00	4	FORT ROSS-PIGEON PT	2.05	0601120112	34313
1997	Troll	9/25/01	5	PT.REYES-PIGEON PT.	3.16	0601120206	47136
1998	Sport	6/13/00	3	FORT ROSS-PIGEON PT	3.27	0601120211	29505
1998	Sport	7/1/01	4	SPAN.FLAT-C.VIZCAINO	4.66	0601120215	45767
1998	Sport	7/1/01	4	CA/OR BOR-FA.KLAM.RC	4.36	0601120214	48539
1998	Sport	7/30/01	4	BIG LAG.-CENTERV.BEA	4.88	0601120212	35565
1998	Sport	7/5/02	5	PIGEON PT.-POINT SUR	3.34	0601120307	54991
1998	Troll	4/23/01	3	NEWPORT TROLL 4	3.57	0601120215	J0304
1998	Troll	7/11/01	4	PT.ARENA-PT.REYES	2.80	0601120209	50227
1998	Troll	8/18/01	4	NEWPORT TROLL 4	2.75	0601120307	J8571
1998	Troll	9/18/01	4	NEWPORT TROLL 4	2.54	0601120307	J8939
1999	Sport	3/31/02	3	PIGEON PT.-POINT SUR	4.38	0601120311	52114
1999	Sport	6/29/02	4	PT.REYES-PIGEON PT.	3.60	0601120309	52271
1999	Sport	7/15/02	4	MARINE AREA 2	1.74	0601120308	
1999	Sport	6/25/02	4	PT.ARENA-PT.REYES	3.60	0601120310	56801
1999	Troll	4/23/02	3	COOS BAY TROLL 5	3.24	0601120311	J2015
1999	Troll	6/5/02	4	POINT SUR-CA/MEX.BOR	4.54	0601120310	54374
1999	Troll	9/25/02	4	GARIBALDI TROLL 3	1.59	0601120312	D2544
1999	Troll	7/12/02	4	PT.REYES-PIGEON PT.	3.26	0601120313	58078
1999	Troll	6/13/02	4	PT.REYES-PIGEON PT.	4.54	0601120311	54407
1999	Troll	6/28/02	4	PT.REYES-PIGEON PT.	3.22	0601120310	57913
1999	Troll	7/14/02	4	PT.REYES-PIGEON PT.	3.26	0601120313	56676
1999	Troll	7/25/02	4	PT.REYES-PIGEON PT.	3.41	0601120311	59550
1999	Troll	5/22/02	4	PT.REYES-PIGEON PT.	5.45	0601120310	46835
1999	Troll	7/24/02	4	SPAN.FLAT-PT.ARENA	1.37	0601120311	59211
1999	Troll	7/24/02	4	SPAN.FLAT-PT.ARENA	1.37	0601120311	44358
1999	Troll	5/28/02	4	PIGEON PT.-POINT SUR	5.45	0601120310	54325
2000	Sport	7/11/02	3	PT.REYES-PIGEON PT.	4.31	0601000201	58756
2000	Sport	7/3/02	3	PT.REYES-PIGEON PT.	4.31	0601120404	58415
2000	Sport	7/21/03	4	SPAN.FLAT-PT.ARENA	4.25	0601120408	63283
2000	Troll	7/1/03	4	PT.REYES-PIGEON PT.	3.62	0601120402	65133
2000	Troll	6/5/03	4	PT.REYES-PIGEON PT.	2.87	0601120406	64545

Total Recoveries: 37

River Recoveries

Brood Year	Comment	Recovery Date	Age	Est #	Tag Code
1995		10/13/99	4	1.00	B61201
1997		9/18/01	4	1.80	0601120113
1997		9/27/01	4	1.80	0601120113
1998		6/11/01	3	1.80	0601120212
1998		9/25/01	3	1.80	0601120215
1998		9/27/01	3	1.80	0601120213
1998		10/2/01	3	1.80	0601120210
1998		10/2/01	3	1.80	0601120212
1998		10/2/01	3	1.80	0601120214
1998		10/3/01	3	1.80	0601120211
1998		10/4/01	3	1.80	0601120212
1998		10/4/01	3	1.80	0601120303
1998		10/4/01	3	1.80	0601120210
1998		10/4/01	3	1.80	0601120212
1998		10/9/01	3	1.80	0601120213
1998		10/11/01	3	1.80	0601120212
1998		10/11/01	3	1.80	0601120212
1998		8/13/02	4	2.07	0601120210
1998		10/10/02	4	2.07	0601120213
1998	Stray	10/29/02	4	1.00	0601120307

River Recoveries Continued

Brood Year	Comment	Recovery Date	Age	Est #	Tag Code
1999		7/31/02	3	2.07	0601120310
1999		8/21/02	3	2.07	0601120311
1999		9/24/02	3	2.07	0601120310
1999		9/26/02	3	2.07	0601120309
1999		10/1/02	3	2.07	0601120309
1999		10/1/02	3	2.07	0601120310
1999		10/3/02	3	2.07	0601120311
1999		10/3/02	3	2.07	0601120309
1999		10/3/02	3	2.07	0601120311
1999		10/3/02	3	2.07	0601120310
1999		10/3/02	3	2.07	0601120311
1999		10/10/02	3	2.07	0601120312
1999		10/10/02	3	2.07	0601120310
1999		10/10/02	3	2.07	0601120310
1999		10/10/02	3	2.07	0601120312
1999		10/10/02	3	2.07	0601120311
1999		10/17/02	3	2.07	0601120313
1999		9/25/03	4	1.53	0601120309
1999		10/2/03	4	1.53	0601120312
1999		10/2/03	4	1.53	0601120310
1999		10/9/03	4	1.53	0601120310
1999		10/9/03	4	1.53	0601120313
1999		10/9/03	4	1.53	0601120313
1999		10/23/03	4	1.53	0601120311
1999	PreSpawnMort	7/31/03	4	2.03	0601120310
1999	PreSpawnMort	8/12/03	4	2.03	0601120309
1999	PreSpawnMort	8/12/03	4	2.03	0601120310
1999	PreSpawnMort	8/12/03	4	2.03	0601120313
1999	PreSpawnMort	8/13/03	4	2.03	0601120309
1999	PreSpawnMort	8/13/03	4	2.03	0601120309
1999	PreSpawnMort	8/18/03	4	2.03	0601120312
1999	PreSpawnMort	8/18/03	4	2.03	0601120312
1999	PreSpawnMort	8/28/03	4	2.03	0601120309
1999	PreSpawnMort	9/2/03	4	2.03	0601120310
2000		9/30/03	3	1.53	0601120406
2000		9/30/03	3	1.53	0601120405
2000		10/2/03	3	1.53	0601120407
2000		10/7/03	3	1.53	0601120402
2000		10/7/03	3	1.53	0601120405
2000		10/9/03	3	1.53	0601120405
2000		10/9/03	3	1.53	0601000205
2000	PreSpawnMort	5/23/03	3	2.03	0601120406
2000	PreSpawnMort	8/5/03	3	2.03	0601000202
2000	PreSpawnMort	8/7/03	3	2.03	0601120402
2000	PreSpawnMort	8/12/03	3	2.03	0601120407
2000	PreSpawnMort	8/12/03	3	2.03	0601120406
2000	PreSpawnMort	8/12/03	3	2.03	0601120405
2000	PreSpawnMort	8/13/03	3	2.03	0601120408
2000	PreSpawnMort	8/13/03	3	2.03	0601120406
2000	PreSpawnMort	8/13/03	3	2.03	0601120405
2000	PreSpawnMort	8/13/03	3	2.03	0601000202
2000	PreSpawnMort	8/18/03	3	2.03	0601120406
2000	PreSpawnMort	8/21/03	3	2.03	0601120404
2000	PreSpawnMort	8/26/03	3	2.03	0601120403
2000	PreSpawnMort	8/28/03	3	2.03	0601000201
2000	PreSpawnMort	8/28/03	3	2.03	0601120406

Total Recoveries: 77

Appendix VI Expansion of Coded Wire Tags Recoveries in Carcass Surveys Methodology

[To be completed]