Fall Chinook Salmon in the Coquille River:
Spawner Escapement, Run Reconstruction and Survey Calibration
2001 - 2002

Cumulative Progress Report

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EXECUTIVE SUMMARY

Using mark-recapture techniques, we estimated 12,500 adult fall chinook spawned in the Coquille basin in 2001 (95% relative precision of 25.8%) and 13,675 adult fall chinook spawned in 2002 (95% relative precision of 13.8%). Scale analyses from 2001 show that the adult population (>600 mm fork length) is predominately age 4 fish. Males returning to the river are about evenly split between age 3 and age 4 individuals, with a few of age 5. Females of age 4 make up about 75 – 80% of the population. Calibration of spawning survey indices is very preliminary at this point as we have only 2 years of data and no clear patterns are emerging yet.

INTRODUCTION

The Oregon Department of Fish and Wildlife (ODFW) is conducting a multi-year study designed to develop methods that provide reliable estimates of fall chinook salmon (*Oncorhynchus tshawytscha*) spawner escapements for the Coquille River. This study is part of a larger effort to develop similar high-quality escapement estimates for fall chinook in Oregon coastal basins in order to meet Oregon's Pacific Salmon Treaty monitoring responsibilities. Funding for this study was provided by the U.S. Section of the Chinook Technical Committee (CTC) of the Pacific Salmon Commission pursuant to the 1999 Letter of Agreement (LOA). Three stock aggregates have been identified to originate from Oregon coastal basins. These aggregates are thought to represent distinct genetic and behavioral characteristics and are managed separately. The North Oregon Coast (NOC) and Mid Oregon Coast (MOC) are the two stock aggregates that are north migrating, and are subjected to the CTC's abundance-based management program (PSC 1997). The Coquille River is one component of the MOC aggregate.

Current monitoring programs for Oregon coastal fall chinook do not supply the CTC with adequate information required for the management and rebuilding of Oregon's coastal chinook stocks. ODFW has conducted standard surveys for more than 50 years to monitor the status of chinook stocks along coastal Oregon (Jacobs and Cooney 1997). A total of 56 standard index spawner surveys (45.8 miles) are monitored throughout 1,500 stream miles on an annual basis to estimate peak escapement levels and track trends of north-migrating stocks. Although counts in these standard surveys may be sufficient to index long-term trends of spawner abundance, they are considered inadequate for deriving dependable annual estimates of spawner escapement for several reasons. These surveys were not selected randomly and cannot be considered representative of coast-wide spawning habitat. Also, fall chinook are known to spawn extensively in mainstem reaches and large tributaries, which are not conducive to the foot surveys. To provide estimates of escapements, index counts must be calibrated to known population levels. Obtaining accurate estimates of fall chinook spawner density in mainstem reaches are extremely difficult. Typically, these areas exhibit wide variations in stream flow and turbidity that create difficult and sometimes dangerous survey conditions resulting in unreliable visual counts. Alternative methods will be employed and more reliable estimates may be possible by way of calibrated carcass counts.

The goal of this project is to develop precise estimates of adult spawner escapement in the Coquille River and to identify survey methods that can be used to reliably index spawner abundance for the Coquille River and MOC stock aggregate. ODFW conducted mark-recapture experiments to estimate fall chinook spawning escapement in the Coquille River in 2001 and 2002. We conducted foot and float surveys to obtain counts of live fish, carcasses, and redds. These indices are assessed against the mark-recapture estimates to determine whether any of them track fall chinook spawner abundance with sufficient precision to form the basis for long-term monitoring and the incorporation of resulting escapement estimates into PSC harvest modeling efforts.

OBJECTIVES

1. Estimate the total escapement of adult chinook salmon spawners in the Coquille River such that the estimates are within ± 25% of the true value 95% of the time.

2. Estimate the age and sex composition of chinook salmon spawning in the Coquille River such that all estimated fractions are within ±15% of their true values 95% of the time.

3. Calibrate fall chinook spawning ground surveys against adult spawner escapement estimates to identify one or more survey indices that will robustly track spawner abundance.

STUDY AREA

Natural coastal chinook stocks from six rivers along the mid-coast are grouped in the MOC stock aggregate for rebuilding assessment and CTC modeling. One of the major populations within this aggregate of stocks is from the Coquille River that is composed of four major tributaries, the South, North, East, and Middle Forks (Figure 1). The mainstem Coquille River is entirely tidal and is formed by the convergence of the North Fork and South Fork Coquille River at river mile 36.3. The head of tide is located on the South Fork Coquille River near the confluence with the Middle Fork at river mile 41. The Coquille is the largest of all Oregon's rivers originating only in the coastal range and drains an area of approximately 1,058 square miles. Median monthly discharges at the mouth of the Coquille River range from less than 100 cfs during the summer months to 7,600 cfs in January.

The Coquille estuary is located in southern Coos County and within the Mid Oregon coast stock aggregate (MOC). Three towns are located on the shores of the estuary. Bandon is at the mouth and the towns of Coquille and Myrtle Point are located at the upper end of tidewater at river miles 25 and 37 respectively. The depth of the main channel varies considerably with an average depth of 10-20 feet. Two holes with depths exceeding 30 feet have been recorded at river mile 10.5 and river mile 15. The streambeds of the North Fork and Middle Fork are primarily sandstone. The substrate of the South Fork Coquille River is substantially different from the other major forks, consisting predominately of cobble and boulder.

Nicholas and Hankin (1988) classify Coquille River chinook salmon as mid-maturing, or Age-4 dominant. The majority of Coquille chinook are considered to be fall run fish, however a small spring run exists. The spawning escapement is cursorily monitored by ODFW at standard survey sites. Peak counts from these standard sites gathered since 1957 suggests that chinook abundance has increased. From initial analysis of the 2001 feasibility study results, we estimated a freshwater escapement of 12,500 fall chinook salmon. Historically, between 1,000 – 19,000 chinook were commercially harvested in the Coquille estuary (Nicholas and Hankin 1988). Releases of hatchery chinook in the Coquille River have been relatively modest compared to other coastal basins. In the last few years, volunteers funded by ODFW's Salmon Trout Enhancement Program have released moderate numbers (approximately 100,000) of smolts, using eyed eggs from Bandon Hatchery, in the lower mainstem.

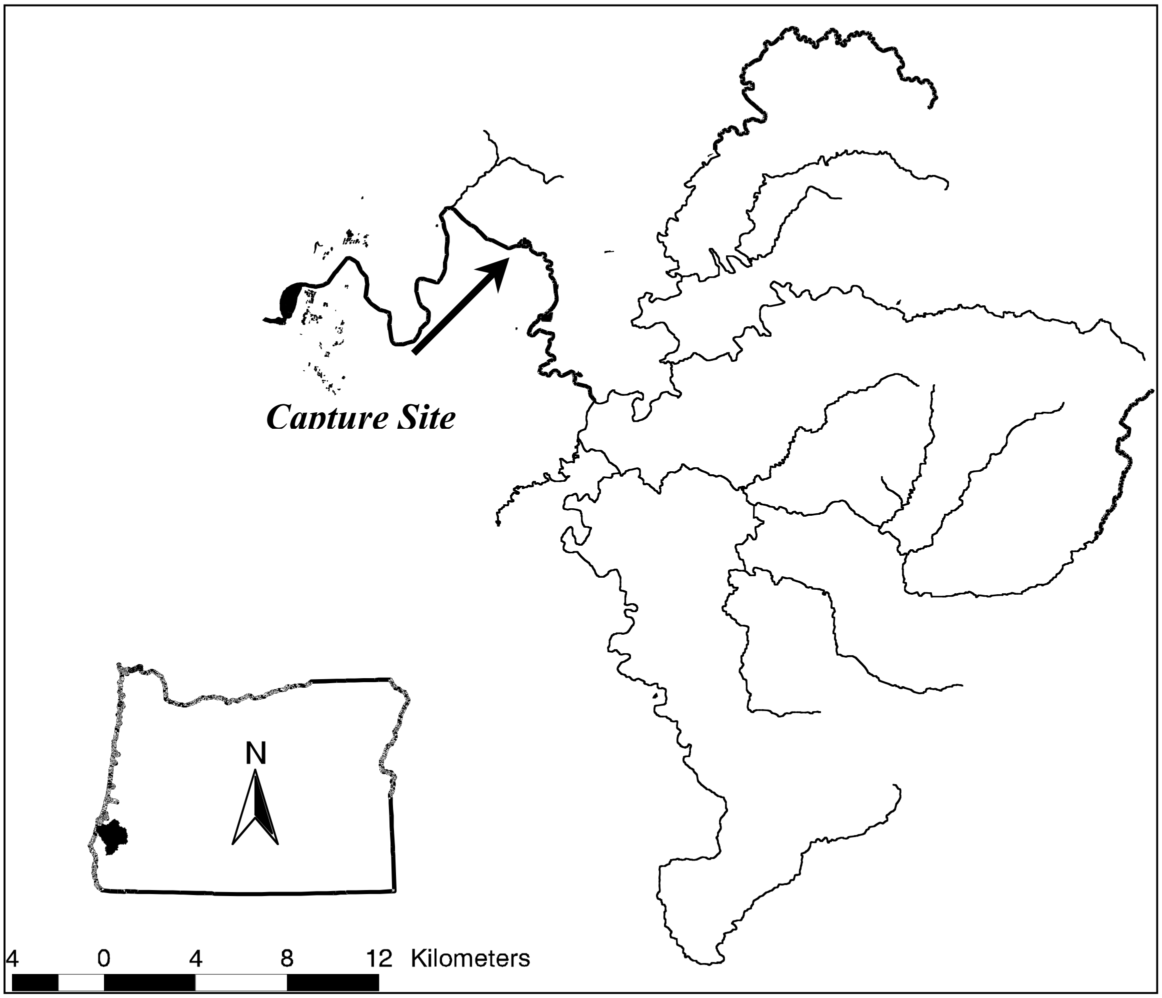

Figure 1. Coquille River basin in southern Oregon with location of marking site indicated by the arrow.

DATA COLLECTION METHODS

Mark-Recapture

The fall **c**hinook population in Coquille River was estimated using a two-event stratified Peterson mark-recapture experiment. In the Coquille Basin, fall chinook salmon were captured using tangle nets approximately one mile upstream of the town of Arago (Fig. 1). Chinook captured, tagged, and released at this site comprise the first capture event that took place from mid-September through mid-November in 2001 and 2002 (Fig 2); this period is thought to encompass the movement of the entire spawning population. Netting and tagging took place at night; crews worked four to five nights per week during the period that chinook were moving upstream. Daily logs were kept to record each net set, water temperature, tidal flow if pertinent, number of fish captured, and mortalities. Capture crew maintained visual or tactile contact with the net at all times to ensure that fish would be observed and removed quickly. Netted salmon were removed from the net promptly, and placed into a live well in the river to recover. At the end of netting operations, captured fish were placed into a hooded cradle for tagging and inspection. In 2001, we used a Dennison Mark II tagging gun to place an anchor tag on the left side of the dorsal. Tags displayed a unique number and were of a neutral color, as not to bias recovery of tagged fish. Fish were double marked to negate the impacts of tag loss.

In 2001, each anchor-tagged fish was also given a left operculum mark with a paper punch. Regeneration of opercular tissue is unlikely to occur in the relatively short time between marking and recovery on spawning grounds in this study, consequently this is a mark that ‘cannot’ be lost. Surveyors were trained to look for opercular punches. Fork length, sex, tag number, and presence of fin clips were recorded before release. All marked chinook had scales sampled. Recovered tags enabled us to develop a regression between fork and mid-eye posterior scale (MEPS) lengths taken on spawning ground surveys.

In 2002, we determined that uniquely identifying individual fish did not significantly contribute to project objectives, so we used only a single operculum punch to mark fish. The side and location of the mark was changed weekly which enables project analysts to investigate possible relationships between time at marking and time at liberty or location of carcass recovery.

After marking, fish were released back into the river (before dawn) to continue upstream movement.

Carcass Recovery and Spawner Surveys

Carcass recovery overlapped with surveys of standard and randomly selected reaches, but was not confined to these reaches. For purposes of the mark-recapture experiment, we sought to find and sample as many carcasses as possible in order to generate the most precise estimate possible. Our efforts to calibrate spawning ground surveys involved recording numbers of live and dead chinook salmon, and redds within specified standard and randomly selected survey reaches. Standard survey reaches were surveyed in both 2001 and 2002. Randomly selected reaches were surveyed beginning in 2002. Seven standard reaches totaling 5.1 miles were surveyed. In addition, 45 randomly selected stream reach segments totaling 56.3 miles were surveyed in 2002 (Table 1).

Survey reaches were divided into two strata, mainstem and tributary. Surveyors collected basic biological and physical data including live counts and carcasses counts. Each carcass was sampled for scales, length, and sex. Sampled carcasses had the tails removed to prevent re-sampling, unless chosen to be part of a carcass mark-recapture experiment. All of these surveys were performed according to ODFW spawner survey protocol (ODFW 1998). Surveys were walked in an upstream direction and at a pace adapted to weather and viewing conditions. Surveys were not conducted if the bottom of riffles could not be seen. Surveyors worked in pairs and each wore polarized glasses to aid in location and identification of live fish. Surveyors searched all areas of the banks, pools, and other low energy areas where carcasses are likely to be deposited.

The tributary and mainstem strata were determined according to ODFW coho spawner distributions. For the purpose of this study, tributary strata were defined as those stream areas that with spawning habitat used by both coho (*Oncorhynchus kisutch*) and chinook as documented in the ODFW database of spawning distribution (Jacobs and Nickelson 1998). The random survey design in tributary reaches incorporated all coho surveys selected through the Environmental Monitoring Assessment Program (EMAP) selection process as part of the monitoring associated with the Oregon Plan for Salmonids and Watersheds (Firman 1999) that overlapped with chinook spawning habitat. Additional surveys were selected randomly to increase the sampling rate. Twenty-eight surveys were conducted in the tributary stratum above the netting site on the Coquille River, totaling 30 miles (Table 1).

Mainstem strata for the two calibration sites were designated as those areas that were downstream of coho spawner distribution and included all river and tributary areas upstream of tidewater. Surveys were conducted on foot in mainstem strata when flows permitted. Surveyors floated these mainstem surveys in inflatable kayaks or pontoon boats during periods of higher flows. There were 17 surveys conducted above the initial capture site on the Coquille River, totaling 26.3 miles.

Table 1. Coquille Basin Fall Chinook Surveys in 2001 and 2002. Distances are in miles.

Coquille Standard Fall Chinook Survey Reaches: 2001 - 2002		
Reach ID	Reach	Length (mi)
22041.0	Coquille R, North Frk	1
21954.0	Coquille R, East Frk	1
21962.0	Coquille R, East Frk	0.3
21755.0	Rock Creek	0.5
21775.0	Coquille R, Middle Frk	0.5
21840.0	Coquille R, South Frk	1
21849.0	Salmon Crk	0.8

Coquille Basin Random Fall Chinook Surveys Beginning in 2002					
Chinook Habitat Type	Reach ID	Reach	Start	End	Length (miles)
Mainstem	21729.0	Coquille R, M Fk	Mouth	Indian Cr	1.50
Mainstem	21733.0	Coquille R, M Fk	Endicott Cr	Mcmullen Cr	2.20
Mainstem	21749.0	Coquille R, M Fk	Big Cr	Salmon Cr	0.40
Mainstem	21771.0	Coquille R, M Fk	Frenchie Cr	Sandy Cr	1.90
Mainstem	21773.0	Coquille R, M Fk	Sandy Cr	Slide Cr	0.20
Mainstem	21775.0	Coquille R, M Fk	Slide Cr	Rock Cr	2.50
Mainstem	21781.0	Coquille R, M Fk	Rock Cr	Slater Cr	3.00
Mainstem	21828.0	Coquille R, S Fk	Rhoda Cr	Dement Cr	0.80
Mainstem	21834.0	Coquille R, S Fk	Dement Cr	Yellow Cr	2.30
Mainstem	21836.0	Coquille R, S Fk	Yellow Cr	Beaver Cr	1.50
Mainstem	21848.0	Coquille R, S Fk	Woodward Cr	Salmon Cr	1.60
Mainstem	21864.0	Coquille R, S Fk	Salmon Cr	Mill Cr	0.60
Mainstem	21872.0	Coquille R, S Fk	Grant Cr	Banner Cr	0.50
Mainstem	21886.0	Coquille R, S Fk	Delta Cr	Dry Cr	0.40
Mainstem	21954.2	Coquille R, E Fk	Yankee Run	Hantz Cr	2.10
Mainstem	21954.3	Coquille R, E Fk	Yankee Run	Hantz Cr	3.10
Mainstem	21956.0	Coquille R, E Fk	Hantz Cr	Steel Cr	1.70
Tributary	21613.0	Bill Cr	Mouth	Headwaters	1.00
Tributary	21616.0	Bear Cr	Randleman Cr	Mack Cr	1.20
Tributary	21618.0	Bear Cr	Mack Cr	Monroe Cr	1.60
Tributary	21620.0	Bear Cr	Monroe Cr	Little Bear Cr	1.56
Tributary	21715.0	Catching Cr	Wolf Cr	Catching Cr, M Fk	0.67
Tributary	21740.0	Big Cr	Mouth	Fall Cr	0.90
Tributary	21742.2	Big Cr	Brownson Cr	Axe Cr	1.16
Tributary	21743.0	Axe Cr	Mouth	Headwaters	1.10
Tributary	21744.0	Big Cr	Axe Cr	Bear Cr	0.72
Tributary	21753.0	Rock Cr	Mouth	Rasler Cr	1.30
Tributary	21755.1	Rock Cr	Rasler Cr	Wooden Rock Cr	0.09
Tributary	21755.2	Rock Cr	Rasler Cr	Wooden Rock Cr	0.50
Tributary	21755.4	Rock Cr	Rasler Cr	Wooden Rock Cr	1.40
Tributary	21755.5	Rock Cr	Rasler Cr	Wooden Rock Cr	1.10
Tributary	21755.6	Rock Cr	Rasler Cr	Wooden Rock Cr	1.00
Tributary	21772.5	Sandy Cr	John Fetter Cr	Sandy Cr, Trib F	1.30
Tributary	21782.0	Slater Cr	Mouth	Headwaters	1.30
Tributary	21849.0	Salmon Cr	Mouth	Deer Cr	0.84
Tributary	21853.7	Salmon Cr	Waterpipe Cr	Pyburn Cr	0.68
Tributary	22006.1	Middle Cr	Cherry Cr	Coak Cr	1.13
Tributary	22006.3	Middle Cr	Cherry Cr	Coak Cr	1.20
Tributary	22008.0	Middle Cr	Coak Cr	Mast Cr	1.50
Tributary	22036.3	Hudson Cr	Mouth	Headwaters	1.15
Tributary	22036.4	Hudson Cr	Mouth	Headwaters	1.30
Tributary	22037.1	Coquille R, N Fk	Hudson Cr	Moon Cr	1.40
Tributary	22037.3	Coquille R, N Fk	Hudson Cr	Moon Cr	1.10
Tributary	22037.5	Moon Cr	Mouth	Moon Cr, Trib A	1.10
Tributary	22039.0	Coquille R, N Fk	Moon Cr	Whitley Cr	0.69

Age Composition Sampling

Scales were collected from all live chinook tagged and from all unmarked carcasses examined for tag recovery. Four to five scales were taken from each fish. Scale samples were placed into small paper envelopes until they could be mounted on gummed cards in the laboratory. An acetate impression of each scale was produced using a heat press. Experienced staff determined age by visual interpretation. Two separate readers independently aged each sample and disagreements were resolved by a third joint reading. Fish age was determined by counting winter annuli. Total age was computed as the count of all annuli plus one. All biological data recorded for each scale sample were transcribed to a database and cross-referenced to the recovery data.

Future Genetic Analyses

The population structure of fall chinook in the Coquille River basin is unknown. There may be more than one distinct breeding population of fall chinook, and we would suspect that these would be geographically based among the four forks of the Coquille system. To make this determination possible, ODFW field crews collected tissue samples (a rayed fin clip) from chinook collected by the brood program and from carcasses collected on spawning grounds. Brood fish are collected throughout the chinook run and should provide a representative sample of run timing. Collected tissue samples are stored in ethanol and are archived with Dr. Michael Banks of OSU's Hatfield Marine Science Center. Dr. Banks will be collaborating with other coastal labs in the establishment of a DNA baseline for fall chinook that will be a significant first step toward genetic stock identification.

DATA ANALYSIS METHODS

Spawner Escapement

The Chapman version of the Peterson mark/recapture formula was used to estimate fall chinook escapement above trap sites. Estimates were derived using the following formula:

$$\hat{N}_i = \frac{(M+1)(C+1)}{(R+1)}$$

where

$\hat{N}_i$ = the estimated population of fall chinook above the trap for calibration site i.
M = the number of fall chinook tagged at the trap site.
C = the number of fall chinook recovered on the spawning grounds.
R = the number of recovered tagged fall chinook.

The assumptions for use of the Peterson estimator are:

1. all fish have an equal probability of being marked at the trap site; or,
2. all fish have an equal probability of being inspected for marks; or,
3. marked fish mix completely with unmarked fish in the population between events; and,
4. there is no recruitment to the population between capture events; and,
5. there is not trap induced behavior; and,
6. fish do not lose their marks and all marks are recognizable

Assumptions 1 and 2 are assumed not to hold true for trapping on the Coquille River. The proportion of chinook marked at the netting site will vary due to flow conditions, netting (in)efficiencies and the fact that fish are netted for marking only at night. The same holds true on the spawning grounds for carcass collection. However, size selectivity during the two capture events can be investigated through a battery of tests (Appendix A) to determine if further stratification of the data set is appropriate to meet the assumptions. Assumption 3 was estimated by data from the spawning grounds stratified by area and time. Chi-square analysis was used to determine if there were significant differences between the strata. When differences were found, the Darroch (1961) maximum likelihood estimator was used to determine whether the Peterson estimate was significantly biased. To maintain the most straightforward analytic approach, a stratified estimate was not used if it was within 10% of the pooled Peterson estimator.

Assumptions 4 and 5 do not apply to this situation. Only adult chinook salmon migrating upstream of the trap sites were used in the mark-recapture study and recruitment to the population is not possible. The second capture event is an active sampling technique to collect carcasses within the spawning areas upstream of the trap sites and trap induced behavior will not occur. However, for the first event, behavior can occur and age/sex selectivity is estimated as discussed for size bias.

Tag loss (assumption 6) was assumed to be zero because of the use of multiple marks in 2001. Through the use of mutilation marks and anchor tags, trained field crews should observe each tagged fish. The use of multiple marks (including tags and an operculum punch) has been shown to assure the identification of marked fish on the spawning grounds (Pahlke et al. 1999). Based on the criteria for a carcass recapture, specifically an intact skeleton with head and both opercula, we assume no tag loss to the operculum punch. The relatively short period of time between marking and carcass inspection on spawning grounds means that regeneration of the operculum is not a concern as it might be with spring chinook.

A bootstrap technique was used to estimate variance, bias and confidence intervals of the population estimate (Buckland and Garthwaite 1991, Mooney and Duval 1993). The fate of chinook that pass by each trapping facility were divided into four capture histories to form an empirical probability distribution as follows:

1. marked and never seen again (= M_i - C_i),
2. marked and recaptured on the spawning grounds (= R_i),
3. unmarked and inspected on the spawning grounds, and (= $C_i - R_i$),
4. unmarked and never seen (= N_i - M_i - C_i + R_i),

where M_i = the number of fish tagged at a trap site (event 1), C_i = the number of carcasses inspected on spawning grounds (event 2), R_i = the number of marked fish recovered on spawning grounds (event 3), and N_i is the population estimate.

A random sample of size N_i was drawn with replacement from the empirical probability distribution. Values for the statistics M_i^* , C_i^* , R_i^* were calculated and a new population size N_i^* estimated. We repeated this process 1,000 times to obtain samples for estimates of variance, bias and bounds of 95% confidence intervals.

Variance was estimated by:

$$v(\hat{N}_i^*) = \frac{\sum_{b=1}^{B} \left(\hat{N}_{i(b)}^* - \overline{\hat{N}_i^*}\right)^2}{B - 1}$$

where B equals 1,000 (the number of bootstrap samples).

The 95% confidence intervals of the estimate are taken as +/- 1.96* $\sigma(\hat{N}_i^*)$ from the bootstrap simulation. The 95% relative precision of the estimate is thus 1.96* $\sigma(\hat{N}_i^*)/\hat{N}_i$.

To estimate the statistical bias, the average or expected bootstrap population estimate was subtracted from the point estimate (Mooney and Duvall 1993:31).

$$Bias(\hat{N}_i) = \hat{N}_i - \overline{\hat{N}_i^*}, \text{ where } \overline{\hat{N}_i^*} = \frac{\sum_{b=1}^{B} \hat{N}_{i(b)}^*}{B}$$

Age and Sex Composition Analysis

If a population estimate was not stratified by size or sex, the proportion of chinook at age from the scale analysis is used to estimate the number of chinook at age for the population. The variance was a simple variance of a product:

$$\text{var}(N_i) = \sum_i \left[\text{var}(\hat{p}_i)\hat{N}^2 + \text{var}(\hat{N})\hat{p}_i^2 - \text{var}(\hat{N}_i)\text{var}(\hat{p}_i)\right]$$

If a mark-recapture experiment was stratified by size or sex, then to estimate the age composition of the whole population the following equations are used:

$p_{ij}=n_{ij}/n_i$

where
n_i = the number sampled from stratum I in the mark-recapture experiment
n_{ij} = the number sampled from stratum I that belong to age group j
p_{ij} = the estimated fraction of the fish in age group j in stratum I

$v[p_{ij}]= p_{ij}(1-p_{ij})/(n_i-1)$

The estimated abundance of age group j in the population (N_j) is:

$N_j = \sum(p_{ij}N_i)$

Where N_i = the abundance in stratum I of the mark-recapture experiment.

$v[N_j] = \sum(v[p_{ij}]N_i^2+v[N_i]p_{ij}^2-v[N_{ij}]v[p_{ij}])$

The estimate fraction of the population that belongs to age group j (p_j) is :
$p_j = N_j/N$ where $N=\sum N_i$.

$v[p_j] = \sum v[p_{ij}]\{N_j/N\}^2 + \sum(v[n_i] (p_{ij}-p_j)^2/N^2$

RESULTS

Spawner Abundance Estimates

2001

The 2001 field season was funded as a feasibility study of mark-recapture methodology in the Coquille River basin. We captured, marked and released 772 fall chinook from September 27 through November 12. Of these, 117 were jacks and excluded from the analysis. Of the 655 adult fish marked and released, 428 were males and 227 were females. We inspected 1,167 chinook carcasses on the spawning grounds, of these 1,029 were adult fish (> 600 mm fork length) with intact left opercula that could be included in the analysis: 466 males and 563 females. Fifty three carcasses were recaptured marked fish: 35 males and 18 females. Unique identification of anchor tagged carcasses enabled us to determine the relationship between MEPS length and fork length. For males, FL = (MEPS length x 1.2258) + 29.035 mm (r2 = 0.91). For females, FL = (MEPS length x 0.7697) + 339.86 mm. These relationships were used to determine whether a carcass sampled on the spawning grounds met the criteria for inclusion in the analysis as an adult fish (applied to males) and to determine what size category a fish should be placed in for purposes of calculating a size-stratified estimate.

Using all adult chinook salmon allowed us to calculate a fully pooled Peterson estimate of spawner abundance of 12,512 adult chinook salmon. Inspection of the rate of

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recapture of marked fish showed apparent differences across size classes (600 to 800 mm, 800 to 1000 mm, and over 1000 mm). Consequently, we also estimated spawner abundance based on sex-stratification, size-stratification, and size and sex stratification. All estimates were within 10% of the fully pooled Peterson estimate. Chi-square analysis also led us to reject the null hypothesis of random mixing of marked and unmarked fish on the spawning grounds in both space (by sub-basin) and in time (by Julian week). A Darroch estimate of spawner abundance was performed based on both time and location of carcass recovery. These estimates were well within 10% of the fully pooled Peterson estimate (Table 2).

Bootstrap analysis of this estimate indicated that the 95% confidence intervals surrounding this estimate were 25.8% of the estimate which is just outside of our goal of 25% relative precision (Tables 2 and 3).

2002

The 2002 field season built upon the experiences of the 2001 season. We captured, marked and released 871 fall chinook from September 19 through November 12 (Figure 2). Of these, 121 were jacks and excluded from the analysis. Of the 750 adult fish marked and released, 542 were males and 208 were females. We inspected 2,955 adult chinook carcasses on the spawning grounds, of these 2,858 were adult fish with intact opercula that could be included in the analysis: 1489 males and 1369 females. 156 adult carcasses were recaptured marked fish: 112 males and 44 females. The MEPS-FL regressions developed in 2001 were used to determine whether a carcass sampled on the spawning grounds met the criteria for inclusion in the analysis as an adult fish (applied to males) and to determine what size category a fish should be placed in for purposes of calculating a size-stratified estimate.

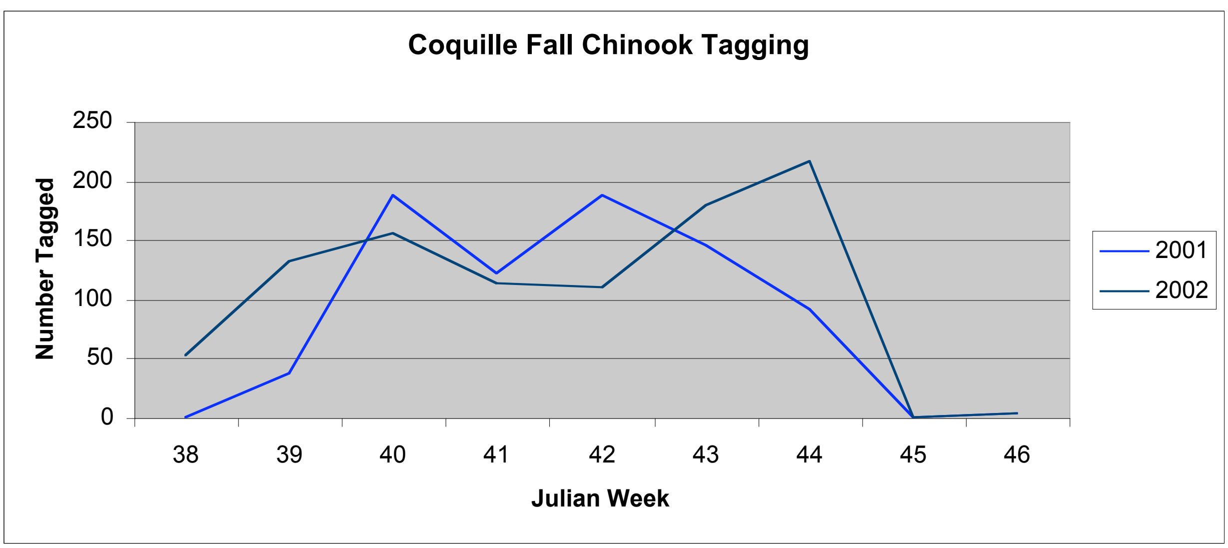

Figure 2. Capture and marking of Coquille River fall chinook by Julian week in 2001 and 2002.

Using all adult chinook salmon allowed us to calculate a fully pooled Peterson estimate of spawner abundance of 13,675 adult chinook salmon. Inspection of the rate of recapture of marked fish showed apparent differences across size classes (600 to 800 mm, 800 to 1000 mm, and over 1000 mm). Consequently, we also estimated spawner abundance based on sex-stratification, size-stratification, and size and sex stratification.

Table 2: Spawner escapement estimates for the Coquille basin from mark-recapture experiments in 2001 and 2002.

Year	Sex	Size	Marked	Carcasses	Recaptures	Pooled Peterson	Sex Stratified	Size Stratified	Size & Sex Stratified	% Marked Chinook Recaptured	% Marked Chinook among Carcasses	Darroch Estimates	
										R/M	R/C	Time	Space
2002	Both	All >600	750	2858	156	13675	13521	12185	12361	21.00%	5.00%	13798	13808
		<600	121	97	7	1494	98.87%	89.11%	90.39%	6.00%	7.00%	100.90%	100.97%
		600 - 800	296	328	36	2640				12.00%	11.00%		
		800 - 1000	372	2033	93	8070				25.00%	5.00%		
		1000+	82	497	27	1475		95% relative precision		33.00%	5.00%		
								13.8%					
	Males	All >600	542	1489	112	7159				21.00%	8.00%		
		<600	121	82	7	1265				6.00%	9.00%		
		600 - 800	262	311	32	2486				12.00%	10.00%		
		800 - 1000	206	728	53	2794				26.00%	7.00%		
		1000+	74	450	27	1207				36.00%	6.00%		
	Females	All >600	208	1369	44	6362				21.00%	3.00%		
		<600	0	15	0	15					0.00%		
		600 - 800	34	17	4	125				12.00%	24.00%		
		800 - 1000	166	1305	40	5319				24.00%	3.00%		
		1000+	8	47	0	431				0.00%	0.00%		
2001													
	Both	All>600 mm	655	1029	53	12512	12331.1	11329.6	11320.5	8.09%	5.15%	12964	12964
		600 - 800	155	66	6	1492.1	98.6%	90.6%	90.5%	3.87%	9.09%	103.62%	103.62%
		800-1000	437	882	43	8788.9				9.84%	4.88%		
		1000+	63	81	4	1048.6				6.35%	4.94%		
	Males	All > 600	428	466	35	5564.1		95% relative precision		8.18%	7.51%		
		600 - 800	132	46	5	1040.8		25.8%		3.79%	10.87%		
		800-1000	237	342	26	3022.5				10.97%	7.60%		
		1000+	59	78	4	947.0				6.78%	5.13%		
	Females	All>600	227	563	18	6767.0				7.93%	3.20%		
		600-800	23	20	1	251.0				4.35%	5.00%		
		800 - 1000	200	540	17	6040.2				8.50%	3.15%		
		1000+	4	3	0	19.0							

Table 3: Fall chinook spawner escapement estimates with associated 95% confidence intervals, relative precision and bias estimate for the Coquille River in2001 and 2002.

			□ **95% CI**	□	**Bootstrap Simulation**	Standard	□	**95% Rel Precision**		**Bias** (Pld Ptrsn - Btstrp Mn)	**% Bias**	**Rel Bias**
Escapement Estimate		Year	**25**	**975**	Mean	Standard Deviation	CV	(s.d.*1.96)/Mean	□		□	(Bias/sd)
12512	Coquille	2001	9939	16427	12687	1646.00	12.97%	25.785%		-175	-1.40%	-0.106
13675	Coquille	2002	11959	15666	13719	964.50	7.03%	13.824%		-44	-0.32%	-0.046
			□	□			□					

All estimates were within 11% of the fully pooled Peterson estimate. Chi-square analysis also led us to reject the null hypothesis of random mixing of males and females, and of marked and unmarked fish on the spawning grounds in both space (by sub-basin) and in time (by Julian week). A Darroch stratified estimate of spawner abundance was performed based on both time and location of carcass recovery. These estimates were also well within 5% of the fully pooled Peterson estimate. Therefore, we present our estimate of 13,675 adult spawners in 2002. (Table 2).

Bootstrap analysis of this estimate indicated that the 95% confidence intervals surrounding this estimate were 13.8% of the estimate which meets the project goal of 25% relative precision (Tables 2 and 3).

Spawning ground survey calibrations

We conducted spawning ground surveys on six standard survey reaches in 2001 and 2002, and 36 randomly selected survey reaches in 2002. In each survey, numbers of live fall chinook, dead fall chinook and redds were counted. From this data, we develop nine indices of abundance:

1. Peak Count per Mile by Reach – Peak count of live and dead fall chinook within each reach. Average over all reaches surveyed.

2. Peak Count Per Mile by Period – Find the week with the largest count per mile; average over all reaches surveyed that week.

3. Live Chinook AUC per mile – Area under the curve estimate of live chinook per mile, averaged over all reaches.

4. Average Peak Redd per Mile – Peak count of redds for each reach, averaged over all reaches surveyd.

5. Redd AUC per Mile – Area under the curve estimate of the number of chinook redds per mile, averaged over all reaches surveyed.

6. Sum of Dead – Sum of dead fall chinook observed in a reach, averaged over all reaches surveyed.

7. Dead per Mile – Dead per mile in each reach, averaged over all reaches surveyed.

8. Average peak Dead – Peak dead per mile for each reach, averaged over all reaches.

9. Peak dead per Mile by Period – Determine the week with the highest count of dead fish, average over all reaches surveyed that week.

Survey crews made every effort to visit reaches weekly. In some cases, low flow conditions meant that sequential zeroes were recorded, this was particularly true for 2002 with the late onset of fall rains. In other cases, rain events could prevent a reach from being surveyed if visibility criteria were not met.

For each survey index developed, we also calculated an expansion factor by dividing the index value into the spawner escapement estimate for that year (Table 4). For standard surveys, we now have two years of data and can look at the coefficient of variation in the expansion factor across years. The ideal survey index would have an interannual coefficient of variation of 0 if it moved in lock-step with changes in spawner abundance. Preliminary standard survey coefficients of variation range from a low of 13.4% (average live chinook AUC per mile) to a high of 91.5% (peak number of dead chinook by period). Two years of data is inadequate for calibration purposes, and we expect this section of the report to be more worthy of discussion in the 2004 edition.

Variability in the interannual coefficient of variation in expansion factors is likely underestimated as this descriptive statistic does not incorporate the precision of the population estimate used, nor does it incorporate the variability within the survey index.

Age Structure

Coquille basin fall chinook were dominated by age 4 individuals in 2001. At the first capture event, about 45% of males were age 3 and approximately 51% were age 4, and only about 2% were age 5. Approximately 80% of females were age 4, and another 15% were age 3. These analyses exclude jacks (Table 6). In spawning ground recoveries, the age structure of females is largely the same, but that of males is shifted more heavily toward age 3 fish. This is likely due to the lower recovery rate of smaller males that has been observed consistently in ODFW mark-recapture studies (Table 2).

Scales from 2002 field work have not yet been completely read, and we are unable to report on them here.

DISCUSSION

The Coquille escapement stock indicator project demonstrates that mark-recapture escapement estimates can be conducted with a high level of precision in large coastal river systems in Oregon. The project also shows a clear progression as field crews adapt methods based on experience. Our efforts show a clear progression of increasing numbers of chinook marked, carcasses inspected and marked chinook recaptured, all of which contribute to an increasingly precise estimate of spawner escapement.

Calibration of spawning ground survey indices is an on-going process; the three years of calibration data collected thus far is not yet adequate for us to ascertain whether any of the indices being used will provide a sufficiently precise monitoring mechanism for Oregon fall chinook. There is substantial opportunity for future analysis in this area; the indices we present are simple means of survey values, by reach. It is reasonable to hypothesize and investigate whether indices developed based on a subset of the selected reaches may pose a more reliable tracking mechanism of spawning escapement than the fairly course approach presented here.

Table 4. Preliminary expansion factors for Coquille River fall chinook spawning ground surveys.

Basin	Year	Strata	Miles Sampled	Miles Total	Reaches Sampled	1. Peak Count/mile (Reach)	St Dev	Expansion Factor	2. Avg Peak Count (Period)	St Dev	Expansion Factor	3. Live (AUC)/mile	St Dev	Expansion Factor	4. Avg Peak Redd/Mile	St Dev	Expansion
Coquille	2001	Pooled Random			45	n/a		n/a	n/a		n/a	n/a		n/a	n/a		n/a
		Mainstem Random			17	n/a		n/a	n/a		n/a	n/a		n/a	n/a		n/a
		Tributary Random			28	n/a		n/a	n/a		n/a	n/a		n/a	n/a		n/a
		Standard Surveys			7	107.94	72.27	***115.9***	99.09	56.49	***126.3***	83.59	58.47	***149.7***	72.7	27.62	***172.1***
	2002	Pooled Random				65.3	107.57	***209.4***	53.74	102.54	***254.5***	52.23	81.86	***261.8***	37.75	52.01	***362.3***
		Mainstem Random				77.33	117.39	***176.8***	83.97	143.12	***162.9***	86.78	111.05	***157.6***	31.17	39.53	***438.7***
		Tributary Random				58.01	102.69	***235.7***	41.43	80.87	***330.1***	34.95	57.52	***391.3***	41.75	58.64	***327.5***
		Standard Surveys				197.2	226.21	***69.3***	156.12	228.19	***87.6***	110.23	78.63	***124.1***	106.2	71.39	***128.8***

	1. Expansion Factor	2. Expansion Factor	3. Expansion Factor	4. Expansion
Pooled Random Calibration(mean)	n/a	n/a	n/a	n/a
Pooled Random Calibration(cv)	n/a	n/a	n/a	n/a
Mainstem Random Calibration(mean)	n/a	n/a	n/a	n/a
Mainstem Random Calibration(cv)	n/a	n/a	n/a	n/a
Tributary Random Calibration (mean)	n/a	n/a	n/a	n/a
Tributary Random Calibration (cv)	n/a	n/a	n/a	n/a
StandardSurvey Expansion (mean)	92.631	106.931	136.871	150.43
Standard Survey Expansion (cv)	35.55%	25.58%	13.24%	20.37%

Table 4 (cont'd). Preliminary expansion factors for Coquille River fall chinook spawning ground surveys.

5. Redd/mile (AUC)	St Dev	Expansion Factor	6. Sum of Dead	St Dev	Expansion Factor	7. Dead/Mile	St Dev	Expansion Factor	8. Avg Peak Dead	St Dev	Expansion Factor	9. Peak Dead (Period): Mean	St Dev	Expansion Factor	Pooled Peterson Escapment Est.
n/a		n/a	n/a		n/a	n/a		n/a	n/a		n/a	n/a		n/a	12512
n/a		n/a	n/a		n/a	n/a		n/a	n/a		n/a	n/a		n/a	12512
n/a		n/a	n/a		n/a	n/a		n/a	n/a		n/a	n/a		n/a	12512
54.1	22.16	***231.3***	33.38	41.15	***374.8***	40.29	46.38	***310.5***	17.83	14.93	***701.7***	17.75	11.13	***704.9***	12512
34.7	38.39	***394.1***	52.16	79.73	***262.2***	56.64	99.08	***241.4***	32.11	57.97	***425.9***	29.72	50.7	***460.1***	13675
34.12	35.09	***400.8***	55.24	60.91	***247.6***	51.05	76.13	***267.9***	31.72	48.01	***431.1***	27.54	41.25	***496.6***	13675
34.99	40.56	***390.8***	50.29	90.28	***271.9***	60.03	111.84	***227.8***	32.36	64.1	***422.6***	31.49	58.75	***434.3***	13675
93.96	53.25	***145.5***	128.63	126.06	***106.3***	157.62	147.43	***86.8***	74.82	72.79	***182.8***	89.54	75.33	***152.7***	13675
		n/a			n/a			n/a			n/a			n/a	
		n/a			n/a			n/a			n/a			n/a	
		n/a			n/a			n/a			n/a			n/a	
		n/a			n/a			n/a			n/a			n/a	
		n/a			n/a			n/a			n/a			n/a	
		n/a			n/a			n/a			n/a			n/a	
		188.408			240.574			198.654			442.255			428.813	
		32.18%			78.93%			79.66%			82.98%			91.05%	

Table 5. Summary of Coquille basin fall chinook standard survey expansion coefficients of variation.

Survey Index:	1	2	3	4	5
Pooled Random Calibration(cv)	n/a	n/a	n/a	n/a	n/a
Mainstem Random Calibration(cv)	n/a	n/a	n/a	n/a	n/a
Tributary Random Calibration (cv)	n/a	n/a	n/a	n/a	n/a
Standard Survey Expansion (cv)	35.55%	25.58%	13.24%	20.37%	32.18%

Survey Index:	6	7	8	9
Pooled Random Calibration(cv)	n/a	n/a	n/a	n/a
Mainstem Random Calibration(cv)	n/a	n/a	n/a	n/a
Tributary Random Calibration (cv)	n/a	n/a	n/a	n/a
Standard Survey Expansion (cv)	78.93%	79.66%	82.98%	91.05%

Table 6. Analysis of fall chinook salmon age composition from the Coquille River mark-recapture feasibility study, 2001.

Table 6-01. Summary of scale readers analysis of fall chinook salmon tagged in the Coquille River mark-recapture feasibility study in 2001.

Count of Age	Age						
Gender	2	3	4	5	6	7	Total
F	0	32	171	8	3	0	214
M	7	187	212	8	1	0	415
U	0	0	0	0	0	0	0
Total	7	219	383	16	4	0	629

Std Error of the proportion by age for each sex

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	0.9%	1.8%	0.4%	0.3%	0.0%
Male	0.4%	1.8%	1.9%	0.4%	0.2%	0.0%
Combined	0.4%	1.9%	1.9%	0.6%	0.3%	0.0%

1.96 = t value at P=5%

95% Confidence Interval of Proportions by age for each sex

	2	3	4	5	6	7
Female Lower CI	0.0%	3.4%	23.7%	0.4%	-0.1%	0.0%
Female Upper Ci	0.0%	6.8%	30.7%	2.1%	1.0%	0.0%
Male Lower CI	0.3%	26.2%	30.0%	0.4%	-0.2%	0.0%
Male Upper CI	1.9%	33.3%	37.4%	2.1%	0.5%	0.0%
Combined Lower CI	0.3%	31.1%	57.1%	1.3%	0.0%	0.0%
Combined Upper CI	1.9%	38.5%	64.7%	3.8%	1.3%	0.0%

Table 6-02. Summary of the proportion within age by gender of fall chinook tagged in the year 2001 Coquille River mark-recapture feasibility study.

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	14.6%	44.6%	50.0%	75.0%	0.0%
Male	100%	85.4%	55.4%	50.0%	25.0%	0%

Table 6-03. Summary of the proportion of fall chinook tagged in the year 2001 Coquille River mark-recapture feasibility study as a percent of the total sample by gender and by age.

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	5.1%	27.2%	1.3%	0.5%	0.0%
Male	1.1%	29.7%	33.7%	1.3%	0.2%	0.0%
Combined	1.1%	34.8%	60.9%	2.5%	0.6%	0.0%

Estimated number of Chinook spawners = 12,512

Table 6-04. Summary of the estimated number of fall chinook salmon escaping into the Coquille River in the year 2001.

	Age						
Gender	2	3	4	5	6	7	Total
Female	0	637	3402	159	60	0	4258
Male	139	3720	4217	159	20	0	8255
All Chinook	139	4356	7619	318	80	0	12512

Table 6-05. Confidence intervals (95%) for the age classes of the estimated fall chinook escapement in the Coquille River in 2001.

	Age					
	2	3	4	5	6	7
Lower CI	37	3890	7141	164	2	0
Upper CI	242	4823	8096	472	157	0
SE of All Chinook	52.0	237.8	243.9	78.6	39.8	0.0
1/2 95% CI	103	467	478	154	78	0

Table 6 (cont'd). Analysis of fall chinook salmon age composition from the Coquille River mark-recapture feasibility study, 2001.

Table 6-06. Summary of scale readers analysis of fall chinook salmon sampled on spawning grounds in Coquille River 2001.

Count of Age	Age						
Gender	2	3	4	5	6	7	Total
F	0	70	412	56	4	0	542
M	0	123	292	20	2	0	437
U	0	0	0	0	0	0	0
Total	0	193	704	76	6	0	979

Std Error of the proportion by age for each sex

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	0.8%	1.6%	0.7%	0.2%	0.0%
Male	0.0%	1.1%	1.5%	0.5%	0.1%	0.0%
Combined	0.0%	1.3%	1.4%	0.9%	0.2%	0.0%

1.96 = t value at P=5%

95% Confidence Interval of Proportions by age for each sex

Gender	2	3	4	5	6	7
Female Lower CI	0.0%	5.5%	39.0%	4.3%	0.0%	0.0%
Female Upper Ci	0.0%	8.8%	45.2%	7.2%	0.8%	0.0%
Male Lower CI	0.0%	10.5%	27.0%	1.2%	-0.1%	0.0%
Male Upper CI	0.0%	14.6%	32.7%	2.9%	0.5%	0.0%
Combined Lower CI	0.0%	17.2%	69.1%	6.1%	0.1%	0.0%
Combined Upper CI	0.0%	22.2%	74.7%	9.4%	1.1%	0.0%

Table 6-07. Summary of the proportion within age by gender of fall chinook salmon sampled in the year 2001 Coquille spawning ground recoveries.

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	36.3%	58.5%	73.7%	66.7%	0.0%
Male	0.0%	63.7%	41.5%	26.3%	33.3%	0%

Table 6-08. Summary of the proportion of fall chinook sampled on spawning grounds in the year 2001 Coquille River as percent of total sample by gender and by age.

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	7.2%	42.1%	5.7%	0.4%	0.0%
Male	0.0%	12.6%	29.8%	2.0%	0.2%	0.0%
Combined	0.0%	19.7%	71.9%	7.8%	0.6%	0.0%

Estimated number of Chinook spawners = 12,512

Table 6-09. Summary of the estimated number of fall chinook escaping into the Coquille River in the year 2001 based on carcass recoveries.

	Age						
Gender	2	3	4	5	6	7	Total
Female	0	895	5266	716	51	0	6928
Male	0	1572	3732	256	26	0	5586
All Chinook	0	2467	8997	971	77	0	12512

Table 6-10. Confidence intervals (95%) for the age classes of the estimated fall chinook escapement in the Coquille River, 2001.

	Age					
	2	3	4	5	6	7
Lower CI	0	2155	8645	761	15	0
Upper CI	0	2779	9350	1181	138	0
SE of All Chinook	0.0	159.2	179.6	107.1	31.6	0.0
1/2 95% CI	0	312	353	210	62	0

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APPENDIX A

Detection of size-selectivity in sampling and its effects on estimation of size composition *[Taken directly from Pahlke et al. 1999, developed by Dave Bernard, Alaska Dept. of Fish and Game, Anchorage, AK].*

Results of Hypothesis Tests (K-S and χ^2) on lengths of fish MARKED during the First Event and RECAPTURED during the Second Event	Results of Hypothesis Tests (K-S and χ^2) on lengths of fish CAPTURED during the First Event and CAPTURED during the Second Event
Case I:	
"Accept" H_o	"Accept" H_o
There is no size-selectivity during either sampling event.	
Case II:	
"Accept" H_o	Reject H_o
There is no size-selectivity during the second sampling event but there is during the first.	
Case III:	
Reject H_o	"Accept" H_o
There is size-selectivity during both sampling events.	
Case IV:	
Reject H_o	Reject H_o
There is size-selectivity during the second sampling event; the status of size-selectivity during the first event is unknown.	

Case I: Calculate one unstratified abundance estimate, and pool lengths, sexes, and ages from both sampling events to improve precision of proportions in estimates of composition.

Case II: Calculate one unstratified abundance estimate, and only use lengths, sexes, and ages from the second sampling event to estimate proportions in compositions.

Case III: Completely stratify both sampling events, and estimate abundance for each stratum. Add abundance estimates across strata to get a single estimate for the population. Pool lengths, ages, and sexes from both sampling events to improve precision of proportions in estimates of composition, and apply formulae to correct for size bias to the pooled data.

Case IV: Completely stratify both sampling events and estimate abundance for each stratum. Add abundance estimates across strata to get a single estimate for the population. Use lengths, ages, and sexes from only the second sampling event to estimate proportions in compositions, and apply formulae to correct for size bias to the data from the second event.

Whenever the results of the hypothesis tests indicate that there has been size-selective sampling (Case III or IV), there is still a chance that the bias in estimates of abundance from this phenomenon is negligible. Produce a second estimate of abundance by not stratifying the data as recommended above. If the two estimates (stratified and unbiased vs. biased and unstratified) are dissimilar, the bias is meaningful, the stratified estimate should be used, and data on compositions should be analyzed as described above for Cases III or IV. However, if the two estimates of abundance are similar, the bias is negligible in the UNSTRATIFIED estimate, and analysis can proceed as if there were no size-selective sampling during the second event (Cases I or II).

APPENDIX B

Appendix B: Chi square analyses of random assortment in Coquille basin fall chinook spawning ground surveys, 2001.

1. marked and unmarked chinook by sub-basin

	observed			expected			
subbasin	marked	unmarked	sum	marked	unmarked	chitest	df
2	13	167	180	9	171	0.099	3
3	4	99	103	5	98		
4	7	66	73	4	69		
5	29	664	693	35	658		
sum	53	996	1049				

2. male and female chinook by sub-basin

	observed			expected			
subbasin	male	female	sum	male	female	chitest	df.
2	99	81	180	80	100	0.003	3
3	35	68	103	46	57		
4	35	38	73	32	41		
5	298	395	693	309	384		
sum	467	582	1049				

3. marked and unmarked chinook by Julian week

	observed			expected		chitest	d.f.
week(s)	mark	unmarked	sum	marked	unmarked	0.014	4
45-46	9	84	93	5	88		
47	13	136	149	8	141		
48	5	108	113	6	107		
49	13	242	255	13	242		
50-52	13	426	439	22.180172	416.81983		
sum	53	996	1049				

4. male and female chinook by Julian week

	observed			expected			
week(s)	males	females	sum	male	female	chitest	d.f.
45-46	39	54	93	41	52	0.0179148	6
47	84	65	149	66	83		
48	55	58	113	50	63		
49	110	145	255	114	141		
50	82	97	179	80	99		
51	8	13	21	9	12		
52	89	150	239	106	133		
sum	467	582	1049				

Appendix B (cont'd). Chi square analyses of random assortmentin Coquille basin fall chinook spawning ground surveys, 2002.

□	Observed	□	□	Expected	□	□	□	□
Sub-basin	Mark	Unmark	sum	mark	unmark	□	chitest	d.f.
2	13	184	197	11	186		0.492	3
3	26	508	534	29	505			□
4	31	437	468	25	443			□
5	86	1585	1671	91	1580			□
□	156	2714	2870	□	□	□	□	□

□	Observed	□	□	Expected	□	□	□	□
Sub-basin	male	female	□	male	female	□	chitest	d.f.
2	104	93	197	102	95		0.147	3
3	289	245	534	277	257			□
4	221	247	468	243	225			□
5	875	796	1671	867	804			□
□	1489	1381	2870	□	□	□	□	□

□	Observed	□	□	Expected	□	□	□	□
Week(s)	mark	unmark	sum	mark	unmark	□	chitest	d.f.
45-47	62	522	584	32	552		0.000	3
48	51	854	905	49	856			□
49	37	934	971	53	918			□
50 - 2	6	406	412	22	390			□
sum	156	2716	2872	156	2716	□	□	□

□	Observed	□	□	Expected	□	□	□	□
Week(s)	male	female	sum	male	female	□	chitest	d.f.
45-46	22	20	42	22	20		0.000	5
47	323	219	542	281	261			□
48	492	413	905	469	436			□
49	459	512	971	503	468			□
50	157	174	331	172	159			□
51 - 2	36	45	81	42	39			□
sum	1489	1383	2872	□	□	□	□	□