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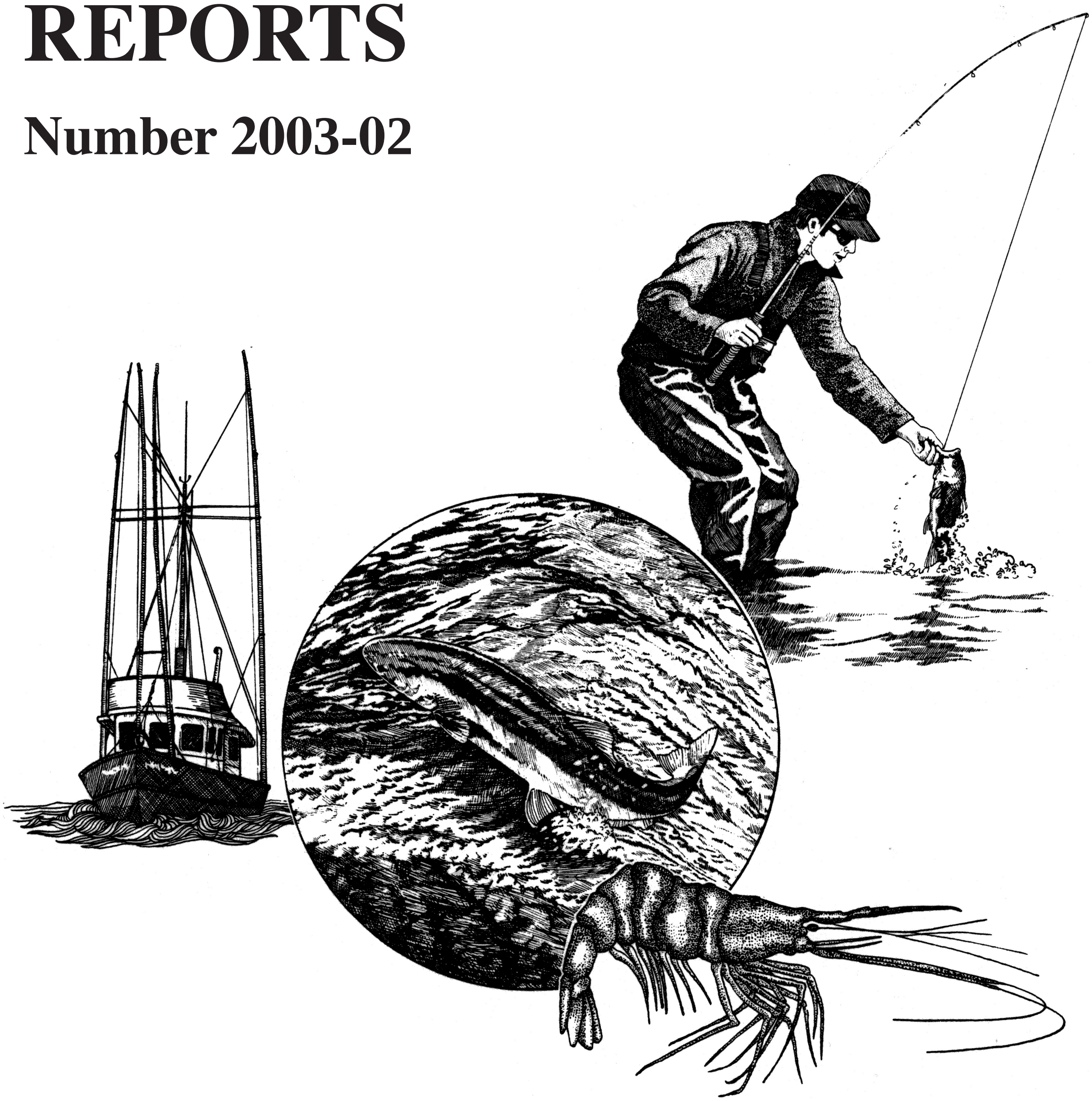

FISH DIVISION

Oregon Department of Fish and Wildlife

Fall Chinook Salmon in the South Fork Coos River: Spawner Escapement, Run Reconstruction and Survey Calibration, 1998 - 2000

Fall Chinook Salmon in the South Fork Coos River:
Spawner Escapement, Run Reconstruction and Survey Calibration
1998 - 2000

Final Report

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Brian Riggers
Jody White
Mike Hogansen
Steve Jacobs
Hal Weeks

Oregon Department of Fish and Wildlife
Coastal Chinook Research and Monitoring Project
Marine Resources Program
Newport, OR

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EXECUTIVE SUMMARY

We conducted a three year mark-recapture study to estimate fall chinook spawner abundance in the South Fork Coos River from 1998 through 2000. We estimated adult fall chinook spawner abundance as 2383 in 1998 (95% relative precision 45.6%), 3078 in 1999 (95% relative precision 17.7%) and 3172 in 2000 (95% relative precision 10.6%). Scale analyses from 1 99 and 2000 show that the adult population is predominately age 4 fish. About half of the males returning to the South Fork Coos River are age 3, with ages 4 and 5 individuals comprising about 30% and 20% of the population respectively. Females show an older age distribution with most individuals being age 4 or 5, depending on the year. We calculated expansion factors for each of several spawning survey indices; interannual coefficients of variation in these indices showed a wide range. However, with only two years of spawner abundance data available for this calibration (1998 was excluded due to poor precision of the abundance estimate), we are unable to draw firm conclusions. Radio telemetry shows that approximately 82% of the Coos River fall chinook spawn in mainstem habitat reaches, and about 18% spawn in tributary reaches.

INTRODUCTION

The Oregon Department of Fish and Wildlife (ODFW) has conducted a three year study designed to develop methods that provide reliable estimates of fall chinook salmon (*Oncorhynchus tshawytscha*) spawner escapements for the South Fork Coos 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 (PSC) pursuant to the 1999 Letter of Agreement (LOA). Three stock aggregates have been identified that 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 PSC's abundance-based management program (USCTC 1997). The South Fork Coos River is one component of the MOC aggregate.

Current monitoring programs for Oregon coastal fall chinook do not supply the CTC with adequate information that is 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 et al. 2000). 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 reliable 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 is 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.

The goal of this project is to develop precise estimates of adult spawner escapement in the South Fork Coos River and to identify survey methods that can be used to reliably index spawner abundance for the South Fork Coos River and MOC stock aggregate. ODFW conducted mark-recapture experiments to estimate fall chinook spawning escapement in the South Fork Coos River from 1998 through 2000. 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. We used radio-telemetry as an independent method to estimate the distribution of fall chinook spawners between mainstem and tributary strata.

OBJECTIVES

1. Estimate the total escapement of adult chinook salmon spawners in the South Fork Coos 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 South Fork Coos River such that all estimated fractions are within ±15% of their true values 95% of the time.

STUDY AREA

The South Fork of the Coos River was one of two systems selected as initial calibration sites to test the sampling plan and assess the degree of feasibility of surveys designed to obtain a reliable escapement estimate (Figure 1). The two sites were chosen because they provided trap sites located downstream of known spawning habitat. Trapping was used as the first capture event of a mark-recapture experiment to estimate chinook spawner populations.

Fall chinook salmon were collected in the Coos River at a permanent weir located at Dellwood. The Dellwood trap was built for hatchery broodstock collection and is located at the head of tide (approximately RM 11). Fish were also seined about one mile below the Dellwood trap.

The weir is constructed of large boulder and wire gabions encased in concrete and asphalt. The weir stands approximately four feet high and spans the width of the channel, terminating at a fishway. The fishway is constructed of two concrete slabs approximately five feet high and four feet apart. The fishway was fitted with a wooden holding pen that measures 12 by 8 feet.

There is about 64 miles of habitat upstream from the weir available for chinook spawning. Approximately 41 of these miles are considered to be within mainstem habitat. A small in-river fishery exists, but few chinook are harvested above the trap site (Mike Gray, ODFW, pers. comm.).

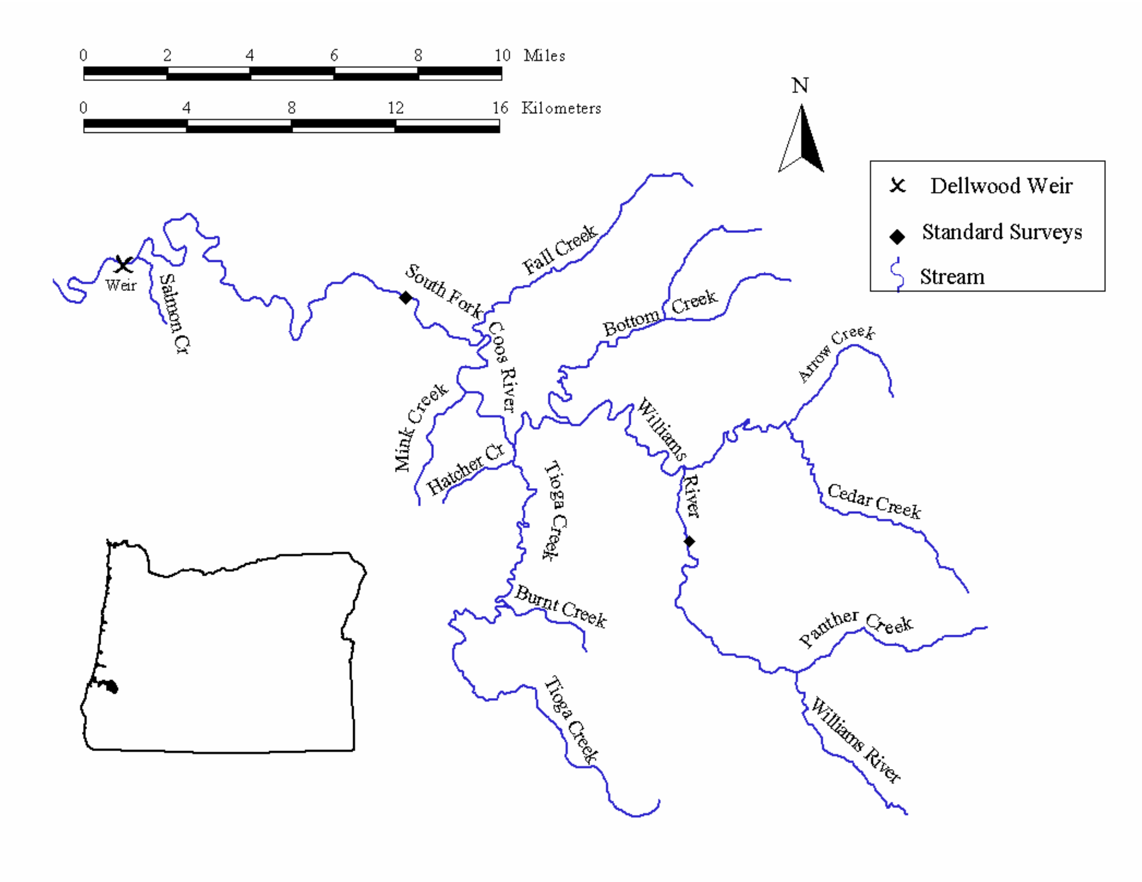

Figure 1. Coos River Basin in Southern Oregon with location of trapping site.

Data Collection Methods

Mark-Recapture

The fall chinook population in the South Fork Coos River was estimated using a two-event mark-recapture experiment. Chinook salmon were tagged and released from mid-September through mid-November in 1998 through 2000. Tagging occurred on a daily basis to limit the amount of time that upstream migration was delayed. Trapped salmon were placed into a hooded cradle for tagging and inspection. Using a Dennison Mark II tagging gun, an anchor tag was placed 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. Marking took place from mid-September through November, and is considered to cover the entire spawning population.

In 1998, each fish was tagged on both the left and right side of the dorsal to assess tag loss. In 1999 and 2000, 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, 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. A scale sample was collected from each fish for aging and subsequent reconstruction of age composition of the run.

Spawning ground surveys were conducted to recover carcasses and record counts of redds, and live and dead fish. Carcasses were sampled for length (mid-eye to posterior scale - MEPS), sex, scales, tag identification number, and operculum punch (1999 and 2000). Surveys designated as part of the random survey design were conducted on three-day intervals. Three-day intervals were chosen to maximize carcass recovery efficiency.

Radio Telemetry - 1999

The South Fork Coos River mark-recapture tagging crew placed radio-transmitters in adult chinook at the Dellwood trap in 1999. Radio-tags were placed in fish greater than 600 mm FL to minimize regurgitation of transmitters. Beginning with a random start each evening, every fourth fish captured, that was in good condition and not taken for brood stock, had a radio-transmitter placed into the esophagus with a small PVC pipe covered with glycerol. No anesthetics were used.

The telemetry technician located fish upstream of brackish water on the South Fork Coos River daily. If possible, all fish were located at a minimum every two days. The technician drove (or walked to areas inaccessible to vehicles) the mainstem and tributary areas. Once a fish or group of fish was located, the technician identified each fish's location as accurately as possible. The location was identified using a hand-held GPS unit and UTM coordinates were recorded. The location (pool, pool tail-out, riffle, rapid, glide, on bank, in brush, or unknown) and activity (holding, moving upstream, moving downstream, spawning, dead, or unknown) was noted. If a GPS reading was not available, the technician located the position of the fish on a USGS 7.5minute quadrangle and noted on the Telemetry Form.

Chinook that could be verified as spawners were used to determine the residence time (days) in spawning areas. The number of days that a spawning fish was found alive in a particular reach was summed from the tracking data. We assumed that males and females displayed different behaviors, with females remaining in the areas of spawning redds until death and males drifting downstream. This data was used to evaluate the use of a residence time estimator and frequency of spawner surveys in Area-Under-the-Curve (AUC) estimates currently in use by ODFW.

Carcass Recovery and Spawner Surveys

The survey design consisted of a random selection of survey reaches within 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 rifles could not be seen. Surveyors worked in pairs and each wore polarized glasses to aid in location and identification of live fish.

The tributary and mainstem strata were determined according to ODFW coho spawner distributions. For the purpose of this study, tributary reaches were defined as those stream areas that supports habitat that is conducive to both coho (*Oncorhynchus kisutch*) and chinook spawning 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 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 in tributary reaches were selected randomly to increase the sampling rate. Mainstem reaches were defined as those areas that were upstream of tidewater and downstream of coho spawner distribution. Surveys were conducted on foot in mainstem reaches when flows were such that they could be done safely. Surveyors floated these mainstem reaches in inflatable kayaks during periods of higher flows. The mainstem habitat category was further stratified for the 1998 field season into high and moderate classifications based on a habitat inventory performed in the summer of 1998 (Riggers et al. 2003). Mainstem strata classified as high were surveyed in their entirety and approximately 28% of the mainstem strata classified as moderate were randomly selected on the South Fork Coos as part of the survey design.

Mainstem surveys were conducted on a regular basis as flow and visibility allowed. There were 13 surveys conducted above the trap on the South Fork Coos River, combining for about 20 miles or 49% of the available mainstem chinook spawning habitat. Kayaks were used to access and search both riverbanks. Surveyors searched all areas of the banks, pools, and other low energy areas where carcasses are likely to be deposited. Eight surveys were conducted in the tributary stratum above the trap on the South Fork Coos River, totaling 7.1 miles or 31% of the available tributary chinook-spawning habitat (Table 1).

Table 1. List of fall chinook surveys conducted in the South Fork Coos River for the three years of this study. Start and endpoints designates reach breaks and are not necessarily surveys boundaries. Lengths are in miles.

Random Fall Chinook Surveys – 1998

Location	Reach	Start	End	Segment	Length
		South Fork Coos River			
Main stem:					
	COOS R, S FK	SALMON CR	WEST CR	-	2
	COOS R, S FK	MINK CR	TIOGA CR	-	2.5
	WILLIAMS R	BOTTOM CR	SKIP CR	-	2.6
	COOS R, S FK	COX CR	ELK CR	-	2.2
	WILLIAMS R	SKIP CR	TRIB A	-	1.5
	WILLIAMS R	CABIN CR	FALL CR	-	1.5
Tributary:					
	TIOGA CR	HATCHER CR	SHOTGUN CR	1	1.1
	TIOGA CR	SHOTGUN CR	SUSAN CR	1	1.4
	TIOGA CR	HOG RANCH CR	BURNT CR	1	0.5
	TIOGA CR	BURNT CR	BUCK CR	1	0.9
	TIOGA CR	MOUTH	HATCHER CR	1	0.5
	TIOGA CR	SHOTGUN CR	SUSAN CR	2	1
	TIOGA CR	SUSAN CR	HOG RANCH CR	1	0.7
	LAKE CR	MOUTH	HEADWATERS	1	1.3

Random Fall Chinook Surveys – 1999

Location	Reach	Start	End	Segment	Length
Coos River					
Mainstem:	Coos R, S Fk	Elk Cr	Farrin	1	1.35
	Coos R, S Fk	Cox Cr	Burma Cr	1	2.3

	Coos R, S Fk	Mink Cr	Tioga Cr	1	2.5
	Coos R, S Fk	Farrin Cr	Coal Cr	1	1.2
	Coos R, S Fk	West Cr	Big Cr	1	0.71
	Coos R, S Fk	Trib X	Cox Cr	1	0.71
	Williams R	Cabin Cr	Fall Cr	1	1.5
	Williams R	Trib A	Cedar Cr	1	1.7
	Williams R	Bear Cr	Panther Cr	1	1.1
	Williams R	Trib 1	Skip Cr	1	2.1
	Williams R	Trib 2	Trib D	1	1.24
	Williams R	Trib D	Cabin Cr	1	2.1
	Williams	Gooseberry Cr	Bear Cr	1	1.24
Tributary:	Tioga Cr	Mouth	Hatcher Cr	1	0.5
	Tioga Cr	Shotgun Cr	Susan Cr	1	0.96
	Tioga Cr	Buck Cr	Eight R Cr	1	1.1
	Tioga Cr	Buck Cr	Eight R Cr	2	0.3
	Tioga Cr	Eight R Cr	Tioga Cr, Trib A	1	1.28
	Bottom Cr	Mouth	Bottom Cr, N Fk	1	1
	Cedar Cr	Mouth	Cedar Cr, Trib	2	0.58
	Cedar Cr	Cedar Cr, Trib	Gods Thumb Cr.	1	1.35

Random Fall Chinook Surveys – 2000

Location	Reach	Start	End	Segment	Length
Coos River	Coos R, S Fk	Big Cr		3	0.7
Mainstem:			Cox Cr		
	Coos R, S Fk	Cox Cr	Burma Cr	1	2.3
	Coos R, S Fk	Burma Cr	Elk Cr	1	2.2
	Coos R, S Fk	Fall Cr	Mink Cr	1	2.9
	Coos R, S Fk	Mink Cr	Tioga Cr	1	2.5
	Williams R	Bottom Cr	Trib 1	1	0.6
	Williams R	Trib 1	Skip Cr	1	2.1
	Williams R	Trib A	Cedar D	1	1.24
	Williams R	Cedar Cr	Trib D	1	0.7
	Williams R	Cedar Cr	Trib D	2	1
	Williams	Cabin Cr	Fall Cr	1	1.5

	Williams	Fall Cr	Goosberry Cr	1	0.4
	Williams	Goosberry Cr	Bear Cr	1	1.2
Tributary:					
	Tioga Cr	Hog Ranch Cr	Burnt Cr	1	1
	Tioga Cr	Buck Cr	Eight R Cr	1	1.1
	Tioga Cr	Buck Cr	Eight R Cr	2	0.3
	Tioga Cr	Eight R Cr	Tioga Cr, Trib A	1	1.28
	Cedar Cr	Mouth	Cedar Cr, Trib A	2	0.58
	Cedar Cr	Cedar Cr, Trib A	Gods Thumb Cr.	1	1.3

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 to be violated for our work on the South Fork Coos River. The proportion of chinook marked at the trap sites varies due to flow conditions and trap inefficiencies. The same holds true on the spawning grounds for carcass collection. However, information about size and age selectivity during the two capture events can be estimated 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 simplest analytic approach, a stratified estimate was not used when 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. Therefore, trap induced behavior will not occur.

Tag loss (assumption 6) was assumed to be zero because of the use of multiple tags. All tags were assumed to be identified if present. Through the use of mutilation marks and anchor tags, trained field crews should recognize every marked fish encountered. The uses of multiple marks (including tags and an operculum punch) have 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, we assume no tag loss to the operculum punch.

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 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).

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

Radio telemetry

Radio telemetry information was used to partition the basin-wide make-recapture estimate into tributary and mainstem strata. Several assumptions must be taken into consideration in order to effectively use telemetry data:

1. fish tagged are typical of the population of interest, and
2. behavior is not altered by handling or the presence of a tag, and
3. survival is not altered by handling or presence of a tag.

Fish were selected by a systematic random sample over the entire run at the Dellwood trap, which minimized any bias in selection of tagged fish (assumption 1). Since the fish that are available to the mark-recapture experiment and the telemetry study would be biased similarly, biased selection should not be a problem for the telemetry study. The population of interest is the distribution of tagged fish in the Coos River watershed, since that is the only information the mark-recapture estimate will be using. Changes in survival between tagged and non-tagged fish (assumption 3) were assessed by anecdotal information gathered at the trap and on the spawning grounds. There were no pre-spawn mortalities associated with radio tagged fish, and of the four chinook carcasses identified as pre-spawners, none had been previously tagged.

The fraction of chinook located in each stratum *i* (tributary or mainstem) was estimated by (Cochran 1977):

$\hat{p}_i = \frac{n_i}{\hat{n}}$, where

$\hat{n} = n_h + n_f + n_m + n_l$, and

n_i = number of fish with transmitters that spawned in either a tributary or mainstem statum,
n_h = fish with transmitters returned from anglers,
n_f = fish with transmitters that did not continue migrating up the South Fork Coos,
n_m = fish with transmitters that died before spawning, and
n_l = transmitters that were regurgitated, batteries failed, or not recorded again.

The estimated variance of p$_i$ is:

$$\mathrm{var}(\hat{p}_i) = \frac{\hat{p}_i(1 - \hat{p}_i)}{\hat{n} - 1}$$

Therefore the estimated number of chinook ($\hat{N}_i$) in each stratum *i* is:

$\hat{N}_i = \hat{p}_i \hat{N}$, where

$\hat{N}$ = the chinook salmon escapement estimate from the mark-recapture experiment.

The variance of the estimated chinook population in stratum *i* is (Goodman 1960):

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

RESULTS

Escapement Estimates

<u>1998</u>

We tagged and released a total of 522 fall chinook above the Dellwood trap on the South Fork Coos River from 19 September through 20 November 1998 (Figure 2). Of these, 486 were adults equal to or greater than 600 mm fork length: 254 adult males and 232 females. Ninety-two (92) carcasses were inspected on spawning ground surveys. Of these, eighteen were recaptures of marked fish. The low number of recaptured individuals precluded us from creating an adequate conversion of FL to MEPS length; thus we used the relationship developed in 1999.

We did not test for size selectivity and bias in marking and recapture events due to the small number of recaptured individuals. However, we did estimate spawning population abundance based on size and sex-stratified bases as well as a fully pooled Peterson estimate (Table 2). With the exception of the population estimate stratified by both sex and size, all estimates were within 10% of the fully pooled population estimate. Additionally, we tested whether marked and unmarked fish, and males and females, mixed randomly on the spawning grounds in time and space through chi-square analysis.

In each case, the null hypothesis of random mixing could not be rejected (Appendix A). Darroch population estimates based on the distribution of marked fish in time and space in during the study were within five percent of the fully pooled population estimate (Table 3).

We estimate the spawner abundance in the Coos River in 1998 to have been 2,383 adult fall chinook. The relative precision of this estimate is 45.6% and an estimated bias of -91 (Table 3).

Fish were double tagged in 1998, and tag loss can be addressed in two ways. First, loss of one or both tags to be independent, tag loss can be calculated from the number of carcasses recovered with one tag (n=8) relative to those with two tags (n=6). This converts to a tag loss rate of 28.5%. Using this probability, and assuming the loss of a second tag is independent from the loss of the first, then the probability that a fish loses both tags is $(.285)^2$ or 8.1%. Carrying this through to estimates of spawner abundance, we can estimate that 8.1% or 39 of our marked fish lost both tags. Reducing our number of marked fish by this number and recalculating the pooled Peterson estimate would result in a spawner abundance estimate of 2,777 adult fall chinook. An alternative treatment of tag loss is to estimate loss by incorporating carcasses that had lost both tags, but that bore clear indications of tag holes. In this instance, we then have 18 recaptures of marked fish, four that had lost both tags, eight having lost one tag, and six retaining both. Again assuming loss of either tag is an independent event, this results in a calculated tag loss of 44.4%. The probability of losing both tags as an independent event would then be

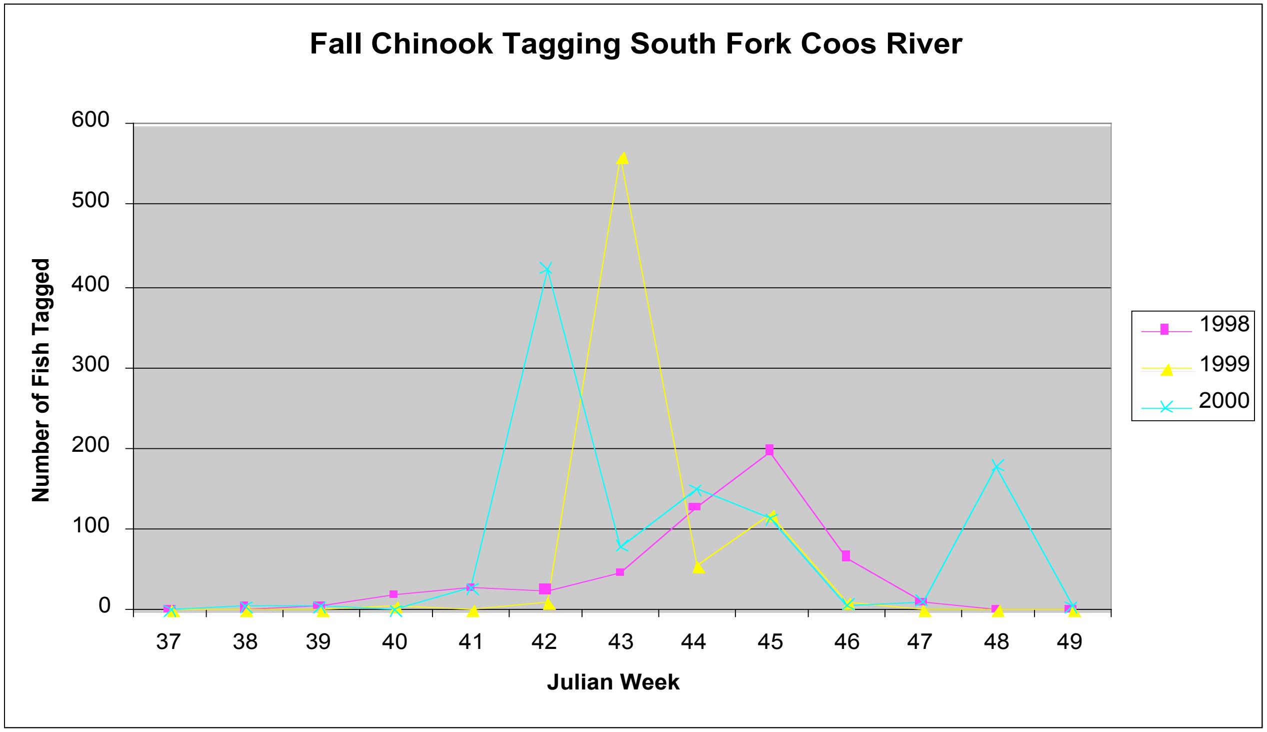

Figure 2: Numbers of fall Chinook tagged by statistical week in the South Fork Coos River: 1998-2000

Table 2. Peterson (pooled and stratified) and Darroch estimates of spawner escapement number. Fully pooled Peterson estimates were used as nearly all stratified estimates were within 5% of the fully pooled estimate.

Basin	Year	Sex	Size	Marked	Carcasses Recovered on Spawning Grounds	Marked Fish Recaptured	Completely Pooled Peterson Estimate	95% Relative Precision	Sex Stratified (drops unknown sex)	Size Stratified	Size and Sex Stratified	DARROCH ESTIMATE TIME	SPACE	R/M	R
Coos	**2000**	Both	All (>600)	880	694	192	**3172**	10.6%	3212	3131	3129	3096	3136	0.22	0.
			600 - 800	241	131	36	862		101.26%	98.7%	98.7%	97.6%	98.88%	0.15	0.
			800 - 1000	585	521	145	2094							0.25	0.
			1000+	48	42	11	175							0.23	0.
		males	all	374	276	67	1527							0.18	0.
			600-800	201	86	23	731							0.11	0.
			800 - 1000	143	162	39	586							0.27	0.
			1000+	30	28	5	149							0.17	0.
		females	all	506	418	125	1685							0.25	0.
			600 - 800	40	45	13	134							0.33	0.
			800 - 1000	442	359	106	1489							0.24	0.
			1000+	18	14	6	40							0.33	0.
			no length	6											
Coos	**1999**	Both	All > 600	627	455	92	**3078**	17.7%	3062	2920	2877	3054	3068	0.15	0.
			600 - 800	138	47	16	391		99.47%	94.8%	93.5%	99.2%	99.67%	0.12	0.
			800 - 1000	469	392	73	2495							0.16	0.
			1000+	7	16	3	33							0.43	0.
		males	all	276	205	43	1296							0.16	0.
			600-800	80	32	11	222							0.14	0.
			800 - 1000	190	159	29	1018							0.15	0.
			1000+	6	14	3	25							0.50	0.
		females	all	351	250	49	1766							0.14	0.
			600 - 800	58	15	5	156							0.09	0.
			800 - 1000	279	233	44	1455							0.16	0.
			1000+	1	0	0	1								
			unkn lngth	13	2										
Coos	**1998**	Both	all >600	486	92	18	**2383**	45.6%	2294	2218	2003	2484	2484	0.04	0.

	600 - 800	188	17	4	679	96.27%	93.1%	84.1%	104.2%	104.25%	0.02	0.
	800 - 1000	276	58	10	1485						0.04	0.
	1000+	22	11	4	54						0.18	0.
males	all	254	47	9	1223						0.04	0.
	600-800	148	10	3	409						0.02	0.
	800 - 1000	97	21	3	538						0.03	0.
	1000+	9	10	3	27						0.33	0.
	unkn lngth		6									
females	all	232	45	9	1071						0.04	0.
	600 - 800	40	7	1	163						0.03	0.
	800 - 1000	179	37	7	854						0.04	0.
	1000+	13	1	1	13						0.08	1.

Table 3: South Fork Coos River escapement estimates with associated 95% confidence intervals, relative precision and bias estimate for each basin and year studied.

Escapement Estimate		Year	95% CI 25	975	Bootstrap Simulation Mean	Standard Deviation	CV	95% Rel Precision (s.d.*1.96)/Mean	Bias (Pld Ptrsn - Btstrp Mn)	% Bias	Rel Bias (Bias/sd)
3172	PP	2000	2864	3509	3175	172.10	5.42%	10.634%	-3	-0.09%	-0.017
3078	PP	1999	2606	3703	3103	277.56	8.94%	17.674%	-25	-0.81%	-0.090
2383	PP	1998	1709	3764	2474	554.49	22.41%	45.606%	-91	-3.82%	-0.164

19.7%. Recalculating the number of marked fish for this estimated loss of both tags (n=96), and re-estimating spawner abundance yields an estimate of 2,423 adult fall chinook spawners (1.2% higher than the estimate used).

Our estimate of spawner abundance (2,383) makes use of the four carcasses that had evidence of tag holes, but that had lost both tags. An assumption in this approach is that tag holes, if present, would be recognized and noted by surveyors.

1999

A total of 732-fall chinook were tagged and released above the counting stations on the South Fork Coos River from 16 September through 19 November 1999 (Table 2). Of those chinook, 627 were adult fall chinook 600 mm fork length or greater. The tagging composition was made up of 334 females and 397 males (125 age 2 males) and 1 of unknown gender. The tagging time frame was considered to have covered the entire spawning population. We recovered 473 chinook carcasses on the spawning grounds (Table 3). These carcasses consisted of 243 females, 222 males (18 age 2 males) and 8 of unknown gender. Of the 473 recoveries there were a total of 97 tags recovered consisting of 47 females, 47 males, and three jacks.

We tested for size selectivity between live chinook salmon marked at the trap site and recovered tagged and non-tagged carcasses upstream of the marking using chi-square and the Kolmogrov-Smirnov (K-S) two-sample test to determine whether there was size selectivity. While the results of the K-S indicated that there was size selectivity in carcass recovery on the spawning grounds, chi-square tests of expected and observed recaptured fish in size strata of 600 – 800 mm FL, 800 – 1000 mm FL and over 1000 mm FL did not lead us to reject the null hypothesis of equal recapture probability. Similarly, chi-square tests of the expected encounter of marked and unmarked carcasses by sex also did not lead to rejection of the null hypothesis. Only fish sampled in the second capture event were used to determine the age composition of spawners.

We estimated spawner escapement abundance based on Peterson estimates stratified by size and sex, by a fully pooled Peterson estimate, and by Darroch estimates stratified by time and space (Table 2). In all cases, the stratified estimates were within 10% of the fully pooled Peterson estimate. Therefore, we present an estimate of 1999 spawner abundance in the South Fork Coos river of 3,078 individuals. This estimate has a relative precision of 17.7% and an estimated bias of -25 (Table 3).

The primary factor attributing to the improved precision of our estimates was the high recovery rate of tagged carcasses in both basins. This could be a result of survey design being changed from a mandatory 10-day rotation to a 3-day rotation. This 3-day rotation was attainable due to favorable weather and flow conditions in both basins. The previous summer, a spawning habitat inventory was taken at both calibration sites (Riggers et al. 2003). The habitat sites were rigorously surveyed in three-day intervals if they fell within our random survey sites. The recognition of spawning habitat along with the decreased time intervals may have also attributed to the high rate of carcass recoveries.

As noted previously, analysis of the temporal and spatial distribution was performed to test the hypothesis of random mixing on spawning grounds. We did not reject the null hypothesis of equal mixing by sex on a spatial basis, nor did we reject the null hypothesis for temporal mixing of marked and unmarked fish. However, the null hypothesis was rejected for temporal mixing by sex and spatial mixing by marked and unmarked fish. We made stratified estimates by space and time using the Darroch (1961) maximum likelihood estimator. Stratifying the estimate to account for these biases did not result in a significant change in the population estimate (Table 2); thus a pooled Peterson, not stratified by sex, time period or area, was used for Coos River population estimates.

<u>2000</u>

A total of 998 fall chinook were marked and released at the Dellwood trap between 20 September and 7 December 2000. Of these, 880 were adult fish equal or greater than 600 mm FL (374 males, 506 females). Spawning ground surveyors found and inspected 694 adult carcasses (MEPS converted to FL), and 192 were marked. This results in a fully pooled Peterson estimate of 3,172 adult fall chinook with a relative precision of 10.6% (Tables 2 and 3).

We again tested the null hypotheses addressing random mixing on spawning grounds and size selectivity. K-S two sample tests indicated that there was size selectivity on the spawning grounds, and chi-square tests on size stratified recoveries required us to reject the null hypothesis of equal probability of capturing or recapturing fish on the spawning grounds (Table 2).

Chi-square tests of random assortment of marked vs unmarked fish on spawning grounds in time and space, and random assortment of males and females lead us to accept the null hypothesis of random mixing for each comparison except mixing of marked and unmarked fish in space (Appendix A).

We performed fully pooled and size– and sex-stratified Peterson estimates, and Darroch estimates stratified by time and space (Table 2). In each case, the stratified estimate was within 2.5% of the fully pooled Peterson estimate. We therefore present a fully pooled Peterson estimate of 3,172 adult spawners in the South Fork Coos River in 2000. This estimate has a 95% relative precision of 10.6% and a bias of -3 (Table 3).

Age and Sex Composition

Ages were determined from scales collected from carcasses on the South Fork. Coos River in 1999 and 2000. We used only scales collected during spawning ground carcass recovery to estimate age composition as chi-square and K-S test analyses indicated a size related bias (Bernard 1991). In 1999, the age composition of both males and females was dominated by age 4 individuals (Table 4); males and females showed approximately similar age structure in 1999. In 2000, the age structure was slightly different. Nearly 90% of the females were age 4 and 5 individuals, while approximately 75% of the males were age 3 and 4 individuals (Table 4). In general, the 95% relative precision of the age composition estimates were well above the desired 15% level. This is primarily due to the numbers of individuals of any given age sampled on the spawning grounds, as the precision of estimates were correspondingly higher for those ages with larger numbers of individuals sampled.

Table 4a. Age and sex composition of fall chinook salmon in the South Fork Coos River in 1999.

Table 4a-01. Summary of scale readers analysis of fall chinook salmon inspected on spawning grounds in South Fork Coos River, 1999.

Count of Age	Age						
Gender	2	3	4	5	6	7	Total
F	0	8	173	47	1	0	229
M	0	26	152	17	1	0	196
U	0						0
Total	0	34	325	64	2	0	425

Std Error of the proportion by age for each sex

Gender	Age 2	3	4	5	6	7
Female	0.0%	0.7%	2.4%	1.5%	0.2%	0.0%
Male	0.0%	1.2%	2.3%	1.0%	0.2%	0.0%
Combined	0.0%	1.3%	2.1%	1.7%	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%	0.6%	36.0%	8.1%	-0.2%	0.0%
Female Upper Ci	0.0%	3.2%	45.4%	14.0%	0.7%	0.0%
Male Lower CI	0.0%	3.8%	31.2%	2.1%	-0.2%	0.0%
Male Upper CI	0.0%	8.4%	40.3%	5.9%	0.7%	0.0%
Combined Lower CI	0.0%	5.4%	72.4%	11.7%	-0.2%	0.0%
Combined Upper CI	0.0%	10.6%	80.5%	18.5%	1.1%	0.0%

Table 4a-02. Summary of the proportion within age by gender of fall chinook sampled in the year 1999 South Fork Coos River spawning ground surveys.

	Age					
Gender	2	3	4	5	6	7
Female	0	23.5%	53.2%	73.4%	50.0%	0
Male	0	76.5%	46.8%	26.6%	50.0%	0

Estimated number of chinook spawners = 3,078

Table 4a-03. Summary of the proportion of fall chinook sampled in the year 1999 South Fork Coos River spawning ground surveys as a percent of total sample by gender and by age.

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	1.9%	40.7%	11.1%	0.2%	0.0%
Male	0.0%	6.1%	35.8%	4.0%	0.2%	0.0%
Combined	0.0%	8.0%	76.5%	15.1%	0.5%	0.0%

Table 4a-04. Summary of the estimated number of fall chinook escaping into the South Fork Coos River in the year 1999 based on the age distribution of spawned out carcasses.

	Age						Total
Gender	2	3	4	5	6	7	1709
Female	0	60	1291	351	7	0	1462
Male	0	194	1134	127	7	0	3173
All Chinook	0	254	2426	478	15	0	

Table 4a-05. Confidence intervals (95%) for the age classes of the estimated fall chinook spawning escapement in the South Fork Coos River, 1999.

Age-	2	3	4	5	6	7
Lower CI	0	172	2298	370	-6	0
Upper CI	0	336	2554	586	36	0
SE of All Chinook	0.0	41.8	65.3	55.1	10.7	0.0
1/2 95% CI	0	82	128	108	21	0

Table 4b. Age and sex composition of fall chinook salmon in the South Fork Coos River in 2000 based on initial tagging.

Table 4b-01. Summary of scale readers analysis of tagged fall chinook salmon in South Fork Coos River in 2000.

Count of Age	Age						
Gender	2	3	4	5	6	7	Total
F	0	29	133	230	5	0	397
M	5	163	97	59	0	0	324
U	0						0
Total	5	192	230	289	5	0	721

Std Error of the proportion by age for each sex

Gender	Age 2	3	4	5	6	7
Female	0.0%	0.7%	1.4%	1.7%	0.3%	0.0%
Male	0.3%	1.6%	1.3%	1.0%	0.0%	0.0%
Combined	0.3%	1.6%	1.7%	1.8%	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%	2.6%	15.6%	28.5%	0.1%	0.0%
Female Upper Ci	0.0%	5.5%	21.3%	35.3%	1.3%	0.0%
Male Lower CI	0.1%	19.6%	11.0%	6.2%	0.0%	0.0%
Male Upper CI	1.3%	25.7%	15.9%	10.2%	0.0%	0.0%
Combined Lower CI	0.1%	23.4%	28.5%	36.5%	0.1%	0.0%
Combined Upper CI	1.3%	29.9%	35.3%	43.7%	1.3%	0.0%

Table 4b-02. Summary of the proportion within age by gender of fall chinook tagged in the year 2000 South Fork Coos mark-recapture experiment.

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	15.1%	57.8%	79.6%	100.0%	0
Male	100%	84.9%	42.2%	20.4%	0.0%	0

Estimated number of chinook spawners = 3,172

Table 4b-03. Summary of the proportion of fall chinook tagged in the year 2000 South Fork Coos River mark-recpature experiment as a percent of total sample by gender and by age.

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	4.0%	18.4%	31.9%	0.7%	0.0%
Male	0.7%	22.6%	13.5%	8.2%	0.0%	0.0%
Combined	0.7%	26.6%	31.9%	40.1%	0.7%	0.0%

Table 4b-04. Summary of the estimated number of fall chinook escaping into the South Fork Coos River in 2000 based on age composition at tagging

	Age						
Gender	2	3	4	5	6	7	Total
Female	0	128	585	1012	22	0	1747
Male	22	717	427	260	0	0	1426
All Chinook	22	845	1012	1271	22	0	3172

Table 4b-05. Confidence intervals (95%) for the age classes of the estimated escaping fall chinook in the South Fork Coos River mark-recapture experiment in 2000.

Age-	2	3	4	5	6	7
Lower CI	3	742	904	1158	3	0
Upper CI	41	947	1120	1385	41	0
SE of All Chinook	9.7	52.6	55.1	57.7	9.7	0.0
1/2 95% CI	19	103	108	114	19	0

Table 4c. Age and sex composition of fall chinook salmon in the South Fork Coos River in 2000 based on spawning ground recoveries..

Table 4c-01. Summary of scale readers analysis of spawning ground recoveries of fall chinook salmon in South Fork Coos River in 2000

Count of Age	Age						
Gender	2	3	4	5	6	7	Total
F	0	13	69	89	4	0	175
M	2	56	49	34	0	0	141
U	0						0
Total	2	69	118	123	4	0	316

Std Error of the proportion by age for each sex

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	1.1%	2.3%	2.5%	0.6%	0.0%
Male	0.4%	2.2%	2.0%	1.7%	0.0%	0.0%
Combined	0.4%	2.3%	2.7%	2.7%	0.6%	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%	1.9%	17.3%	23.2%	0.0%	0.0%
Female Upper Ci	0.0%	6.3%	26.4%	33.1%	2.5%	0.0%
Male Lower CI	-0.2%	13.5%	11.5%	7.3%	0.0%	0.0%
Male Upper CI	1.5%	21.9%	19.5%	14.2%	0.0%	0.0%
Combined Lower CI	-0.2%	17.3%	32.0%	33.5%	0.0%	0.0%
Combined Upper CI	1.5%	26.4%	42.7%	44.3%	2.5%	0.0%

Table 4c-02. Summary of the proportion within age by gender of fall chinook sampled on spawning grounds in the year 2000, South Fork Coos River.

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	18.8%	58.5%	72.4%	100.0%	#DIV/0!
Male	100%	81.2%	41.5%	27.6%	0.0%	#DIV/0!

Table 4c-03. Summary of the proportion of fall chinook sampled in 2000 on spawning grounds of the South Fork Coos River by gender and by age.

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	4.1%	21.8%	28.2%	1.3%	0.0%
Male	0.6%	17.7%	15.5%	10.8%	0.0%	0.0%
Combined	0.6%	21.8%	37.3%	38.9%	1.3%	0.0%

Estimated number of fall chinook spawners = 3,172

Table 4c-04. Summary of the estimated number of fall chinook escaping in the South Fork Coos River, 2000 based on estimated ages of carcasses recovered on spawning grounds.

	Age						
Gender	2	3	4	5	6	7	Total
Female	0	130	693	893	40	0	1756
Male	20	562	492	341	0	0	1415
All Chinook	20	693	1184	1235	40	0	3172

Table 4c-05. Confidence intervals (95%) for the age classes of the estimated harvested chinook in the South Fork Coos River, 2000.

Age-	2	3	4	5	6	7
Lower CI	-8	548	1015	1064	1	0
Upper CI	48	837	1354	1405	79	0
SE of All Chinook	14.3	74.0	86.2	87.2	19.9	0.0
1/2 95% CI	28	145	170	171	39	0

Spawner sex composition was 42.3% male and 57.7% female in 1999 and 47.5% male and 52.5% female in 2000. The 95% relative precision of these estimates was well within the desired 15% (Table 4).

Radio Telemetry

We tagged 108 fall chinook with radio transmitters in 1999 (Table 5). Of these, 58 were males and 50 were females. Four transmitters from females were found either at the trap or below the trap and considered regurgitated. One female was located outside the study area eight miles below the weir.

Chinook distribution was determined using 102 chinook, including 83 in mainstem strata, 18 in tributary strata and 1 outside the study area (Table 6).

Table 5. Fate of chinook salmon tagged with radio transmitters at the Dellwood Trap on the South Fork Coos River 1999. Mortality status includes regurgitated tags.

		Mainstem Strata		**Tributary Strata**		
Transmitter Status		Mainstem Coos	Williams River	Tioga Creek	Tributaries	Sum
Valid	Male	25	17	10	5	57
	Female	36	5	3	0	44
One Hit	Male	1	0	0	0	1
	Female	1	0	0	0	1
Regurgitated Tags	Male	0	0	0	0	0
	Female	4	0	0	0	4
Total		68	22	13	5	108
Out of Basin	Male	0	0	0	0	0
	Female	1	0	0	0	1

Table 6. Estimated distribution of radio transmitter tagged chinook in the Coos River Basin (n = sample size; SE = standard error).

Strata	**n**	**Percent**	**SE**
Mainstem	83	82	0.005
Tributary	18	18	0.022

Residence time was estimated from the radio-tagging data. Residence time is defined as the number of days a live adult salmon spends on the spawning grounds. A total of 32 radio tagged chinook (20 males and 12 females) were selected to represent residence time behavior of the population based on repeated encounters on spawning grounds. Females appeared to stay on or near their redds until death. Males were often observed moving after spending a period of time in the spawning area; this resulted in a slightly shorter estimated residence time than females. Residence times for males (14.3 days) and females (17.5 days) were not significantly different (t test, $p>0.20$) (Table 7).

Table 7. Chinook salmon estimated residence time (days), standard error (SE), and sample size (n) in surveyed spawning areas from radio telemetry data on the South Fork Coos River, 1999.

	Residence Time (days)	SD	N
Pooled Average	15.5	6.0	32
Males	14.3	4.7	20
Females	17.5	8.1	12

Spawner Survey Calibration

We conducted spawning ground surveys on 5 standard survey totaling 4.7 miles in the Nehalem mainstem and North Fork. In addition, we conducted surveys on randomly selected mainstem and tributary reaches tributary reaches as summarized in Table 1. In each survey, numbers of live fall chinook, dead fall chinook and redds were counted. From this data, we develop 9 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.

Estimates of adult fall chinook spawner abundance from 1999 and 2000 were used to explore whether ODFW spawning ground surveys (standard survey reaches and randomly selected survey reaches; Table 1) tracked spawner escapement estimates. We excluded 1998 from this calibration effort because the relative precision of the spawner escapement estimate was unacceptably low. We divide each of several survey indices into the spawner escapement estimate to derive an expansion factor for that index. These indices and expansion factors are presented in Table 8. The most desirable survey index is one that has a low inter-annual coefficient of variation. As can be readily seen, there is quite a bit of variability in the realized coefficients of variation. These expansion factors and resulting coefficients of variation are based on two years of data, which does not provide a desired level of confidence for management application. It must be noted that these interannual c.v.s do not incorporate uncertainty resulting from either the survey indices or the spawner abundance estimate; thus the uncertainty in these relationships is probably understated. As an example, we present two figures illustrating the population estimates and confidence intervals generated by the ‘average peak dead’ survey index in standard reaches (c.v. = 0.76%), and the same index generated from pooled randomly selected survey reaches (c.v. 77%) (Figure 3).

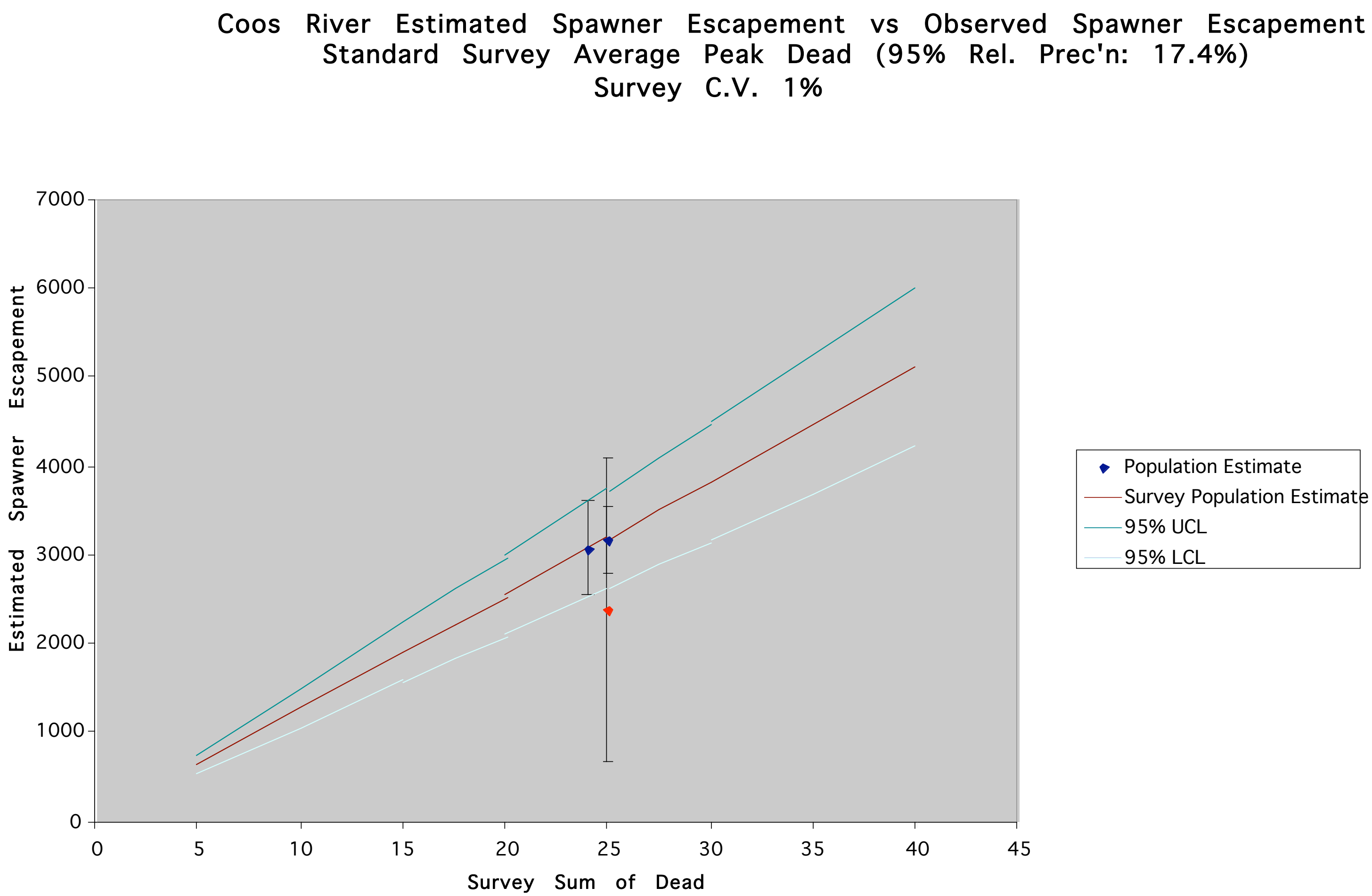

Figure 3a. Predicted population size with 95% confidence intervals generated by standard survey reach indices of the average peak number of dead Chinook observed.

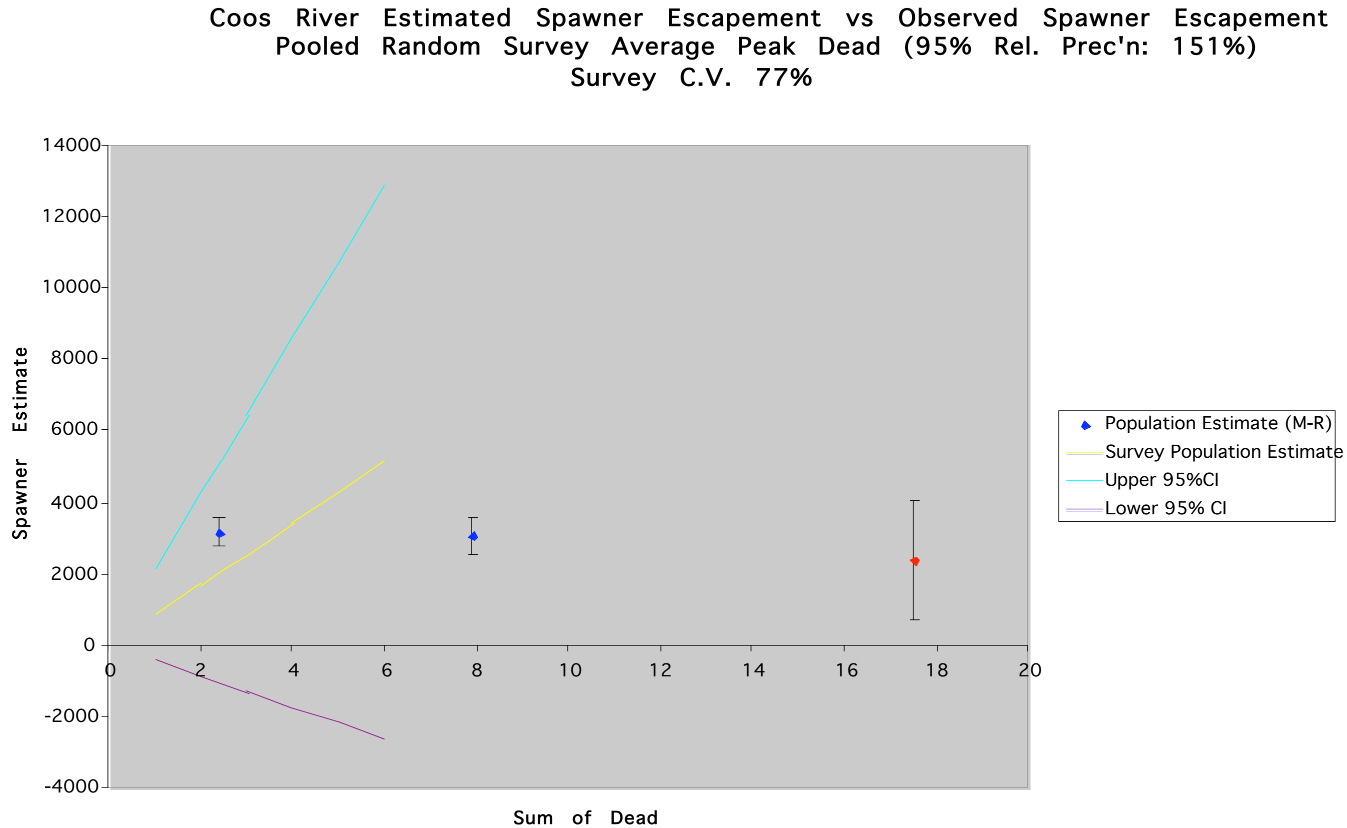

Figure 3b. Predicted population size with 95% confidence intervals generated by pooled randomly selected survey reaches indices of the average peak number of dead chinook observed.

Table 8. Spawning survey index calibration values for standard and randomly selected survey reaches, associated expansion factors and interannual coefficients of variation for the South Fork Coos River.

South Fork Coos River Habitat

☐	Survey Strata	Total Habitat Miles	1998 Miles Surveyed	1998 Reaches Surveyed	1999 Miles Surveyed	1999 Reaches Surveyed	2000 Miles Surveyed	2000 Reaches Surveyed
	Pooled Random	60.3	23.9	14	26.2	21	28.8	21
	Mainstem Random	41.5	17.3	7	19.2	13	20.4	13
	Tributary Random	18.8	6.6	7	7	8	8.4	8
	Standard Surveys		2	2	2	2	2	2

			Peak Count/mile (Reach)	CV	Avg Peak Count (Period)	CV	Live (AUC)/mile	CV	Avg Peak Redd/Mile	CV	Redd/mile (AUC)	CV	Sum of Dead	CV	Dead/Mile	CV	Avg Peak Dead	CV	Peak Dead (Period)	CV
Coos River	Average Pooled	☐	216.83	53.75%	261.03	84.70%	180.10	26.87%	142.87	11.68%	122.44	25.48%	12.01	32.27%	333.90	38.54%	855.64	77.02%	1569.89	96.70%
	SD Pooled		116.56		221.09		48.40		16.69		31.20		3.88		128.69		659.06		1518.07	
	Standard Survey Average		35.50	13.79%	35.66	13.07%	35.95	78.72%	49.27	66.48%	47.49	87.75%	18.85	32.24%	37.69	32.24%	127.57	0.76%	128.86	0.67%
	Standard Survey SD		4.89		4.66		28.30		32.75		41.67		6.08		12.15		0.97		0.86	
	Average Mainstem		218.17	42.16%	267.57	68.14%	162.80	3.60%	194.97	43.10%	183.09	58.37%	14.81	20.50%	294.62	24.68%	752.10	64.25%	1078.00	66.64%
	SD Mainstem		91.98		182.33		5.86		84.02		106.87		3.04		72.72		483.23		718.42	
	Average Tributary		228.75	65.00%	278.88	98.66%	255.75	69.91%	118.00	8.25%	87.23	5.08%	73.93	75.27%	596.84	84.06%	1236.29	100.48%	2337.71	114.44%
	SD Tributary		148.69		275.14		178.79		9.73		4.43		55.65		501.70		1242.22		2675.16	

DISCUSSION AND RECOMMENDATIONS

The South Fork Coos River spawner escapement project has demonstrated that mark-recapture population estimates can be successfully performed in Oregon coastal basins. Precision goals for spawner escapement estimates were met in 1999 and 2000, as were precision goals for sex composition of the run. Age composition estimates did not meet the project goal, largely due to relatively small numbers of fish of some ages sampled on spawning grounds.

Results of radio telemetry work in the South Fork Coos River contributes to our understanding of fall chinook in two ways. First, it contributes to our understanding of residence time of live fish on spawning grounds, a parameter that is is important in estimating area-under-the-curve(AUC) indices from spawning survey data. Additionally, the telemetry information contributes to an emerging and consistent pattern that approximately three quarters of fall chinook spawn in what ODFW categorizes as mainstem habitat areas. This suggests that future emphasis on spawning surveys for abundance monitoring might best concentrate on these areas.

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.

The Oregon Department of Fish and Wildlife is obligated under the Pacific Salmon Treaty to provide high quality abundance estimates of fall chinook salmon in its two coastal aggregates of river systems. To meet this goal within the pragmatic confines of funding, we need to identify a spawning survey index, or indices, that correlates to abundance estimates with a high level of precision. We find that two years of data represents an inadequate time-series to identify the appropriate index. The learning curve in conducting abundance estimates, combined with the interannual variability in survey conditions and changes in stream conditions creates a level of background variability that does not allow calibration with two years of data. Our recommendation is that calibrations of spawner survey methods with spawner escapement estimates, in any basin, be made for a minimum of six years, and preferably twelve years, in order to develop a high level of confidence in the methodology being applied.

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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].

Tests (K-S and χ^2) on lengths of fish First Event and RECAPTURED during the	Tests (K-S and χ^2) on lengths of fish ıe First Event and CAPTURED during the
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 tests of equal mixing in time and space of fall chinook in the South Fork Coos River, 2000.

Spatial Mixing			
Stratum	marked	unmarked	total
S. Frk Coos	160	360	520
Williams River	8	55	63
Tioga Crk	27	86	113
total	195	501	696
	expected		
S. Frk Coos	145.7	374.3	
Williams River	17.7	45.3	
Tioga Crk	31.7	81.3	
	p	df	
Chi Square =	0.006	1	

Mixing by Sex in Space			
substrata	M	F	total
S. Frk Coos	206	314	520
Williams R	23	40	63
Tioga Creek	51	62	113
	280	416	696
	expected		
	209.2	310.8	
	25.3	37.7	
	45.5	67.5	
	p	df	
Chi Square=	0.455	2	

Temporal Mixing			
Julian Week	Marked	Unmarked	total
43 - 45	9	35	44
46	50	133	183
47	16	50	66
48	34	77	111
49	18	31	49
50	13	43	56
51	27	44	71
52	20	34	54
1 -- 4	8	44	52
total	195	501	696
	expected		
43 - 45	12.3	31.7	
46	51.3	131.7	
47	18.5	47.5	
48	31.1	79.9	
49	13.7	35.3	
50	15.7	40.3	
51	19.9	51.1	
52	15.1	38.9	
1 -- 4	14.6	37.4	
total	195	501	
	p	df	
Chi Square =	0.071	8	

Mixing by Sex in Time			
Julian Week	M	F	total
43 - 45	17	27	44
46	76	107	183
47	23	43	66
48	53	58	111
49	24	25	49
50	19	37	56
51	30	41	71
52	22	32	54
1 -- 4	16	46	62
	280	416	696
	expected		
43 - 45	17.7	26.3	
46	73.6	109.4	
47	26.6	39.4	
48	44.7	66.3	
49	19.7	29.3	
50	22.5	33.5	
51	28.6	42.4	
52	21.7	32.3	
1 -- 4	24.9	37.1	
	p	df	
Chi Square =	0.172	8	

Appendix B: Chi-Square tests of equal mixing in time and space of fall chinook in the South Fork Coos River, 1999.

Spatial Mixing			
	marked	unmarked	total
S. Frk Coos	41	104	145
Willliams R	32	154	186
Tioga Crk	20	104	124
total	93	362	455
	expected		
	29.6	115.4	
	38.0	148.0	
	25.3	98.7	
	p	df	
Chi Square =	0.018	2.0	

Spatial Mixing by Sex			
	male	female	
S. Frk Coos	57	88	143
Willliams R	85	101	186
Tioga Crk	65	59	124
total	207	248	455
	expected		
	65.1	77.9	
	84.6	101.4	
	56.4	67.6	
	p	df	
Chi Square =	0.096	2.0	

Temporal Mixing			
	marked	unmarked	total
Julian Week			
45, 46	23	68	89
47	45	143	188
48,49	18	106	124
50 - 52, 1	7	45	52
	93	362	455
	expected		
45, 46	18.2	70.8	
47	38.4	149.6	
48,49	25.3	98.7	
50 - 52, 1	10.6	41.4	
	p	df	
Chi Square =	0.071	3.0	

Temporal Mixing by Sex			
Julian Week	male	female	total
45 - 46	50	41	91
47	84	104	188
48	47	48	95
49-52,1	26	55	81
	207	248	455
	expected		
	41.4	49.6	
	85.5	102.5	
	43.2	51.8	
	36.9	44.1	
	p	df	
Chi Square =	0.020	3.0	

Appendix B: Chi-Square tests of equal mixing in time and space of fall chinook in the South Fork Coos River, 1998.

Spatial Mixing			
Stratum			
	Mark	Unmark	Total
S. Frk Coos	14	36	50
Willliams R	2	8	10
Tioga Crk	2	30	32
total	18	74	92
	expect		
	9.78	40.22	
	1.96	8.04	
	6.26	25.74	
	p	df	
Chi Square =	0.053	2.00	

Spatial Mixing by Sex			
Stratum	M	F	
S. Frk Coos	28	22	50
Willliams R	5	5	10
Tioga Crk	14	18	32
total	47	45	92
	expect		
	25.5	24.5	
	5.1	4.9	
	16.3	15.7	
	p	df	
Chi Square =	0.555	2.0	

Temporal Mixing			
Julian Week	Marked	Unmarked	Total
46 to 49	5	29	34
50	9	29	38
51,52	4	16	20
sum	18	74	92
	expect		
	6.7	27.3	
	7.4	30.6	
	3.9	16.1	
	p	**df**	
Chi Square =	0.631	2.0	

Temporal Mixing by Sex			
Julian Week	M	F	Total
46-49	23	11	34
50	16	22	38
51-52	8	12	20
	47	45	92
	expect		
	17.4	16.6	
	19.4	18.6	
	10.2	9.8	
	p	df	
Chi Square =	0.051	2.0	

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Fish & Wildlife

3406 Cherry Ave. NE
Salem, Oregon 97303