NEHALEM RIVER

FALL CHINOOK SALMON

ESCAPEMENT INDICATOR PROJECT
1998 – 2002

CUMULATIVE PROGRESS REPORT

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INTRODUCTION

The Oregon Department of Fish and Wildlife (ODFW) is conducting a multi-year, multi-basin study designed to develop methods that provide reliable estimates of fall chinook salmon (*Oncorhynchus tshawytscha*) spawner escapements for Oregon coastal streams. Chinook salmon originating in Oregon coastal rivers north of Elk River are north-migrating and vulnerable to fisheries off of southeast Alaska and British Columbia. The U.S. – Canada Pacific Salmon Treaty established the Pacific Salmon Commission (PSC) to provide a framework to manage salmon fisheries. The 1999 modification to the Treaty defines an aggregate abundance based management (AABM) regime whereby harvests will vary with abundance. A broader goal of this treaty is to restore and rebuild production of naturally spawning chinook (PSC 1997).

In order to accomplish these goals and monitor the rebuilding of specific chinook stocks, the PSC's Chinook Technical Committee (CTC) assesses three elements for each stock: 1) spawner escapement level, 2) fishery harvest and exploitation rate, and 3) subsequent production from spawners. Data on different chinook stocks provided by PSC participants (Canada and U.S. state, federal, and tribal agencies) are used in the PSC's Chinook Model that generates information on yearly pre- and post-season cohort abundance estimates. These estimates are used by the PSC to monitor the relative health of chinook stocks under PST jurisdiction and to set ocean harvest levels.

Currently, Oregon coastal chinook stock assessment information comes from a standard spawner survey program, a voluntary angler-returned catch card system, and two exploitation rate indicator stocks. These traditional monitoring programs 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 dependable annual estimates of spawner escapement. There are many weaknesses associated with using standard surveys as a means to estimate fall chinook escapement. These surveys were not selected randomly and can not 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 visual surveys. To provide estimates of escapements, index counts must be calibrated to known population levels. Obtaining accurate estimates of fall chinook spawner density in these mainstem reaches is extremely difficult. Typically, these areas exhibit wide variations in stream flow and turbidity that create difficult and sometimes dangerous survey conditions and that can result in unreliable visual counts. Alternative methods will be employed and a more reliable estimate may be possible by way of calibrated carcass counts.

The goal of this project is to develop precise estimates of spawner escapement in the North Fork and mainstem Nehalem River basins, and to identify survey indices that can be used to estimate spawner abundance for the NOC and MOC stock aggregates. The North Fork Nehalem River and the South Fork Coos River were originally selected by the CTC for feasibility studies of escapement and calibration efforts. The North Fork Nehalem was studied from 1998 through 2001, with disappointing results. Primary effort shifted to the mainstem Nehalem in 2000. In each case, a mark-recapture experiment was being conducted to obtain an estimate of fall chinook populations in each river. Various survey indices are being used to estimate spawner abundance in tributary and mainstem spawning habitat including foot and boat surveys to obtain live fish counts and carcass counts. All or a combination of these methods will be assessed to provide a chinook salmon spawner escapement to coastal Oregon rivers. Radio-telemetry was used to identify the distribution of chinook spawners in the Nehalem basin in 2000 and 2001 between mainstem and tributary spawning strata which may contribute to the tuning of indices of abundance. A statistical creel survey is being conducted in the Nehalem Basin as a means of calibrating Oregon's angler-returned catch card estimates of recreational salmon take in rivers. Work in the mainstem Nehalem will continue through the 2003 field season.

OBJECTIVES

1. Estimate the total escapement of adult chinook from ocean fisheries into the Nehalem River within ± 25% of the true value 95% of the time and to estimate the age specific proportions of the escapement within ± 5% of the true value 95% of the time. Specific tasks that must be completed to achieve the overall objective are:
   a) Estimate the spawning escapement of chinook salmon in North Fork Nehalem River (1998 – 2001) and the mainstem Nehalem River (2000 – 2002) such that the estimate is within ± 25% of the true value 95% of the time, and estimate age/sex specific proportions of that spawning escapement such that the estimate is within ± 5% of the true value 95% of the time.
   b) Estimate the sport harvest of chinook salmon in Nehalem River and Bay such that the estimate is within ± 25% of the true value 95% of the time, and estimate age/sex specific proportions of that harvest such that the estimates are within ± 5% of the true value 95% of the time.
2) Determine the appropriate spawner survey methodology that can be implemented at the aggregate level to estimate chinook spawner abundance in the other five Chinook production river systems in the NOC, by measuring several indexes of spawner abundance using ODFW's standard spawning survey methods.
3) Estimate adult chinook salmon spawner distribution among mainstem and tributary spawning areas by radio telemetry (2000 and 2001 only).

STUDY AREA

The Nehalem River is one of the eight chinook production river systems in the North Coast aggregate with a mainstem length of over 120 miles (Figure 1). The river is located entirely in the Oregon coastal mountain range with a maximum watershed elevation of 3,510 ft. Average annual river discharge is 2,672 cubic feet per second (cfs) and historically has ranged from 34 – 70,300 cfs. Peak discharges typically occur during the winter rainy season from November until February. Upland areas of the watershed are dominated by commercial timberlands and floodplains are predominately pastureland.

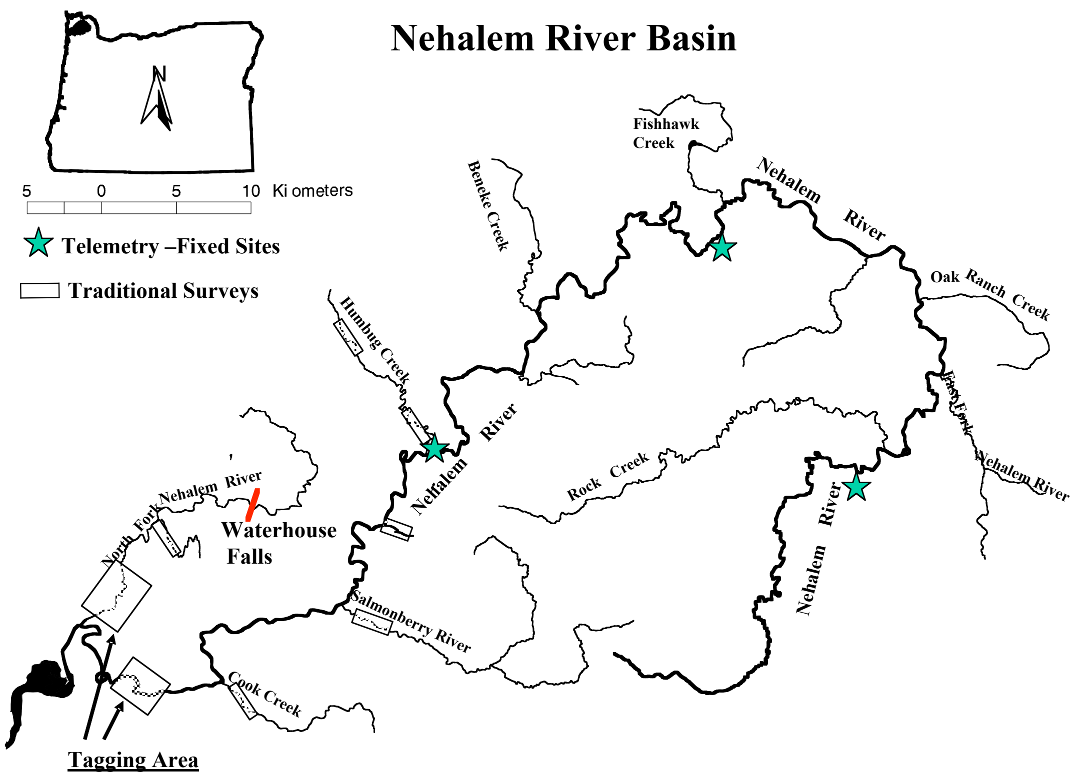

Figure 1. Map of the Nehalem River watershed showing capture and tagging locations on the North Fork and mainstem.

The Nehalem chinook stock has been labeled as a fall run (Nicholas and Hankin 1988). Most observed fall chinook spawning peaks in November. Oregon coastal fall chinook are considered ocean-type chinook and are a late-maturing stock with females maturing principally at age 5 and males principally at age 4 (Nicholas and Hankin 1988). However, the fact that chinook start entering Nehalem Bay in May and are found spawning as early as September in the mainstem as well as headwater tributaries suggests that a smaller component of spring/summer run fish is also present (Germond and Boechler 1988).

Historically (1950-1999) the only assessment of run-size was by means of visual surveys taken on foot at nonrandom "standard" spawning sites. Counts of live and dead chinook are used to generate a spawner density index (peak fish/mile). We do not know the relationship of this index to the actual escapement. Depending on the year, from 1.0 to 5.2 miles have been surveyed. Hodges and Jacobs (1997) and Riggers (1999, per. comm.) have estimated a total of 121 miles of spawning habitat. Zhou and Williams (1999) used this historic data and several untested assumptions about the relationship of the peak counts and the spawner abundance to analyze the stock- recruitment relationship from 1967-1996. The resultant production curve allowed the authors to estimate an interim biologically based escapement goal required by the new agreement. The MSY goal was estimated as 6,989 spawners (90% CI: 5,789-9,405). Figure 2 illustrates these historic escapement estimates.

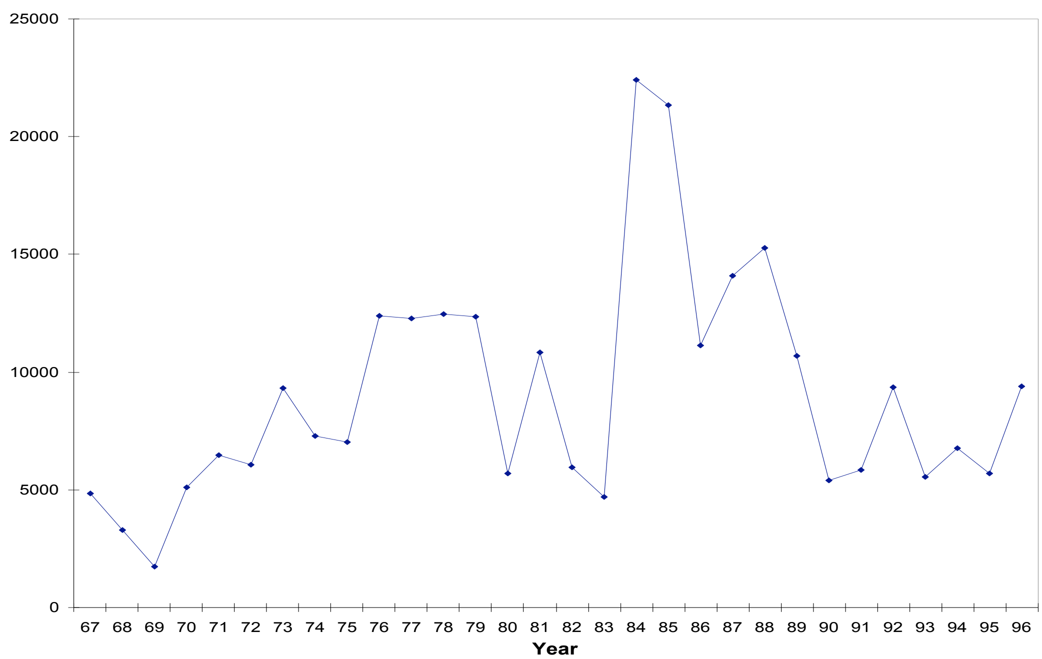

Figure 2. Estimated escapements of fall chinook in Nehalem River from 1967-1996 from Zhou and Williams (1999).

Nicholas and Hankin (1988) summarized commercial harvest data from fish-packing plants from 1896 until commercial harvest was eliminated in the early 1950's. Commercial harvests ranged from 8,000 – 18,000 fish. Reliable freshwater recreational harvest data before 1964 is limited.

Compared to other coastal rivers, the Nehalem River chinook stock has had minimal hatchery influence (Wallis 1961, Nicholas and Hankin 1988). Seventy-six hatchery releases (36 were spring run stocks) over ninety years have ranged from 15,600 to 1,460,000 chinook juveniles. All but three releases occurred before 1952. All fish were off-site hatchery releases and most were fingerlings or of unknown age. Three smolt releases of Trask River stock occurred in the early 1970's.

DATA COLLECTION METHODS

Mark-Recapture

Chinook spawner escapement was estimated using a two-event mark-recapture experiment.

In the North Fork Nehalem, trapping was conducted at a fish ladder that was designed to aid with fish passage around a bedrock falls. The trap is located approximately 14 miles upriver from the mouth, and about eight miles above head of tide. Chinook salmon were trapped, tagged and released from mid-September through mid-November at the North Fork Nehalem River trap. In 2000 and 2001, a weir was constructed at approximately river mile 8. In the mainstem Nehalem, chinook salmon were captured through tangle netting, and at a weir located in Mohler at approximately river mile 12. Through the course of this study, we adjusted our capture and marking efforts to begin in August in order to capture and mark the entire run of fall chinook. (Fig 3)

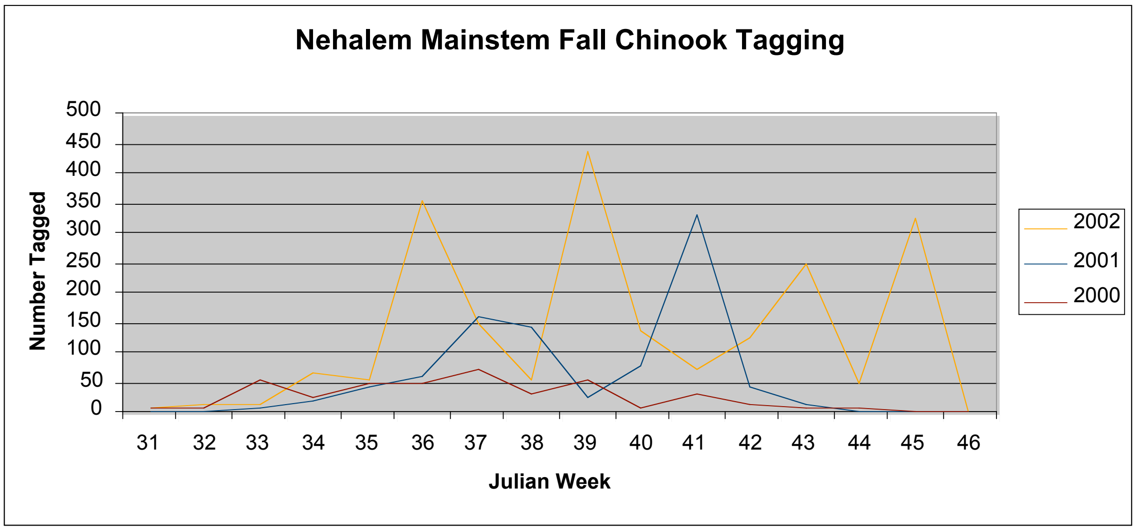

Figure 3A. Timing of fall chinook tagging in the mainstem Nehalem, 2000 – 2002

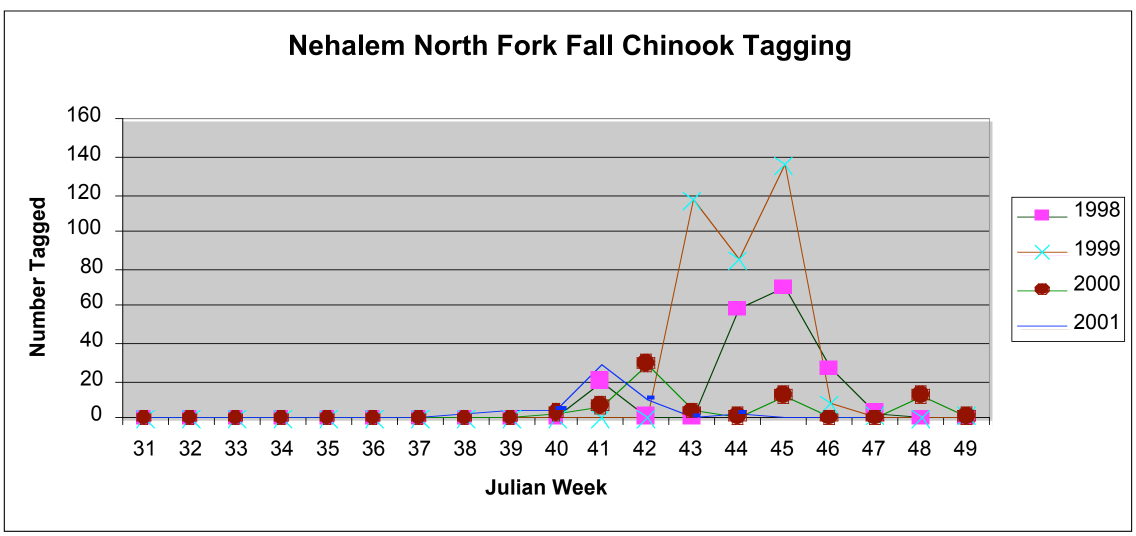

Figure 3B. Timing of fall chinook tagging in the North Fork Nehalem, 1998 – 2001.

Tagging occurred on a daily basis to minimize the the effect on 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. Each anchor-tagged fish was given a left opercle mark with a paper punch. This double identification was applied to negate tag loss. Fork length, sex, tag number, and presence of fin clips were recorded before release. A scale sample was taken from each chinook for later age analysis. Beginning in 2002, we discontinued the use of numbered anchor tags. Rather, fish were marked with operculum punches and clipping the right axillary appendage at upper river site only). Location and number (one or two) of punches served to identify the week of capture and marking. After tagging each fish was allowed to recover in the aerated live well and subsequently released to continue its upstream migration.

Spawner Surveys

The second event of the two event mark-recapture experiment involves actively locating chinook carcasses upstream of the marking sites. Spawning ground surveys were conducted to recover carcasses and record live counts. Carcasses were sampled for length, sex, scales, tag identification number, and operculum punch. Surveys designated as part of the random survey design were conducted on a weekly basis. 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 were marked to prevent re-sampling. 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.

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 supports habitat that is conducive to coho (*Oncorhynchus kisutch*) spawning as documented in the ODFW database of coho spawning distribution (Jacobs and Nickelson 1998). The random survey design in tributary reaches incorporated all coho surveys selected through the Environmental Monitoring and Assessment (EMAP) selection process as part of the monitoring associated with the Oregon Plan for Salmon and Watersheds (Firman 1999) that overlapped with chinook spawning habitat. Additional surveys were selected randomly to increase the sampling rate.

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 safe navigation. Surveyors floated these mainstem surveys in inflatable kayaks during periods of higher flows. Mainstem surveys were conducted on a regular basis as flow and visibility allowed. Four mainstem surveys totaling 4.9 miles and equating to 100% of the available habitat were conducted above the trap on the North Fork Nehalem River in 1998 through 2000. (Table 1). Kayaks were used in order 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. Six surveys totaling 5.2 miles and equating to approximately 29% of the available tributary habitat were conducted above the trap on the North Fork Nehalem River (Table 1).

Table 1. List of standard and random fall chinook surveys conducted in the North Fork Nehalem and mainstem Nehalem River during this project. Start and endpoints designates reach breaks and are not necessarily surveys boundaries. Lengths are in miles.

Table 1A. Nehalem Basin Standard Surveys Conducted Annually

Sub-basin	Reach	Reach ID	Miles
Mainstem	Cook Crk	25907	1
	Cronin Crk	25959	1
	Humbug Crk	25967	1
	E. Humbug Crk	25980	1.2
Salmonberry	Salmonberry R	25931	0.5
North Fork	Soapstone Crk	25864	0.7

Table 1B. Randomly selected surveys conducted in the North Fork Nehalem River.

Location	Reach	Start	End	Segment	Length
Nehalem River					
Mainstem:	Nehalem R, N Fk	Sally Cr	Gods Valley Cr	1	1.40
	Nehalem R, N Fk	Gods Valley Cr	Lost Cr	1	0.97
	Nehalem R, N Fk	Lost Cr	Sweet Home Cr	1	0.63
	Nehalem R, N Fk	Lost Cr	Sweet Home Cr	2	0.65
	Nehalem R, N Fk	Sweet Home Cr	Fall Cr	1	1.20
Tributary:	Lost Cr.	Mouth	Head Waters	1	1.00
	Sweet Home Cr.	Mouth	Sweet Home Cr	1	0.90
	Nehalem R, N Fk	Fall Cr.	Nehalem R, N Fk	1	1.25
	Nehalem R, N Fk	Nehalem R N Fk	Nehalem R, N Fk	1	0.95
	Nehalem R, N Fk	Nehalem R N Fk	Nehalem R, Little	1	0.80
	Nehalem R, N Fk	Nehalem R, Little	Nehalem R, Little	2	0.26

Table 1C. Nehalem Random Fall Chinook Surveys 2000 - 2002

Random Surveys Conducted in 2000

Chinook Habitat Type	Reach ID	Reach	Start	End	Length (miles)
Mainstem	25916	Nehalem R	Cook Cr	Lost Cr	1.1
Mainstem	25922	Nehalem R	Helloff Cr	Bastard Cr	1.9
Mainstem	25926	Nehalem R	Snark Cr	Salmonberry R	3
Mainstem	25927	Salmonberry R	Mouth	Hatchery Cr	0.3
Mainstem	25931	Salmonberry R	Buick Canyon	Belfort Cr	0.5
Mainstem	25939	Salmonberry R	Tunnel Cr	Salmonberry R, S Fk	1.2
Mainstem	25943	Salmonberry R	Salmonberry R, S Fk	Bathtub Cr	0.4
Mainstem	25949	Salmonberry R	Belding Cr	Kinney Cr	0.96
Mainstem	25956	Nehalem R	Salmonberry R	Cronin Cr	1.9
Mainstem	25962	Nehalem R	Cronin Cr	Trib 4	1.9
Mainstem	25964	Nehalem R	Spruce Run Cr	George Cr	3.2
Mainstem	25966	Nehalem R	George Cr	Humbug Cr	1.5
Mainstem	25986	Nehalem R	Humbug Cr	Quartz Cr	1.8
Mainstem	25996	Nehalem R	Cow Cr	Klines Cr	0.5
Mainstem	25998	Nehalem R	Klines Cr	Moores Cr	0.6
Mainstem	26009	Fishhawk Cr	Mouth	Beneke Cr	0.7
Mainstem	26019	Fishhawk Cr	Beneke Cr	Little Fishhawk Cr	1.5
Mainstem	26026	Nehalem R	Fishhawk Cr	Slaughters Cr	1.4
Mainstem	26028	Nehalem R	Strum Cr	Squaw Cr	0.7
Mainstem	26056	Nehalem R	Calvin Cr	Ford Cr	1.5
Mainstem	26074	Nehalem R	Cedar Cr	Oak Ranch Cr	0.5
Mainstem	26082	Nehalem R	Crooked Cr	Cook Cr	0.4
Mainstem	26097	Rock Cr	Bear Cr	Ivy Cr	1.5
Mainstem	26097	Rock Cr	Bear Cr	Ivy Cr	1
Mainstem	26103	Rock Cr	Selder Cr	Fall Cr	1.6
Mainstem	26105	Rock Cr	Fall Cr	Ginger Cr	2.5
Mainstem	26130.5	Nehalem R	Rock Cr	Beaver Cr	2.1
Mainstem	26136	Nehalem R	Cedar Cr	Weed Cr	1.3
□					□
Tributary	25889	Foley Cr	E Foley Cr	Crystal Cr	1.2
Tributary	25901	Anderson Cr	Mouth	Headwaters	1.12
Tributary	25911	Cook Cr	Hanson Cr	Cook Cr, S Fk	0.86
Tributary	25980	E Humbug Cr	Mouth	Headwaters	1.18
Tributary	26012	Beneke Cr	Gilmore Cr	Walker Cr	1
Tributary	26020	Little Fishhawk Cr	Mouth	Headwaters	2.3
Tributary	26021	Fishhawk Cr	Little Fishhawk Cr	Alder Cr	0.9

Nehalem Random Fall Chinook Surveys 2001

Chinook Habitat Type	Reach ID	Reach	Start	End	Length (miles)
Mainstem	25903	Cook Cr	Mouth	Dry Cr	1.1
Mainstem	25924	Nehalem R	Bastard Cr	Snark Cr	1
Mainstem	25927	Salmonberry R	Mouth	Hatchery Cr	0.3
Mainstem	25929	Salmonberry R	Hatchery Cr	Buick Canyon	1.2
Mainstem	25931	Salmonberry R	Buick Canyon	Belfort Cr	0.5
Mainstem	25933	Salmonberry R	Belfort Cr	Preston Cr	0.7
Mainstem	25935	Salmonberry R	Preston Cr	Tank Cr	1.2
Mainstem	25943	Salmonberry R	Salmonberry R, S Fk	Bathtub Cr	0.4
Mainstem	25947	Salmonberry R	Salmonberry R, N Fk	Belding Cr	1.1
Mainstem	25949	Salmonberry R	Belding Cr	Kinney Cr	0.96
Mainstem	25966	Nehalem R	George Cr	Humbug Cr	1.5
Mainstem	25986	Nehalem R	Humbug Cr	Quartz Cr	1.8
Mainstem	25992	Nehalem R	Osweg Cr	George Cr	0.5
Mainstem	26026	Nehalem R	Fishhawk Cr	Slaughters Cr	1.4
Mainstem	26026.3	Nehalem R	Slaughters Crk	Crawford Crk	1.5
Mainstem	26034	Nehalem R	Northrup Cr	Sager Cr	2.4
Mainstem	26036	Nehalem R	Sager Cr	Louisgnot Cr	1.5
Mainstem	26038	Nehalem R	Louisgnot Cr	Grub Cr	1
Mainstem	26038.7	Nehalem R	Grub Cr	Deep Cr	1.9
Mainstem	26044	Nehalem R	Deep Cr	Fishhawk Cr	2.6
Mainstem	26066	Nehalem R	Battle Cr	Deer Cr	0.7
Mainstem	26082	Nehalem R	Crooked Cr	Cook Cr	0.4
Mainstem	26094	Nehalem R	Nehalem R, E Fk	Knickerson Cr	1.7
Mainstem	26094	Nehalem R	Nehalem R, E Fk	Knickerson Cr	1.4
Mainstem	26094	Nehalem R	Nehalem R, E Fk	Knickerson Cr	0.75
Mainstem	26094.7	Nehalem R	Knickerson Cr	Coon Cr	1.7
Mainstem	26097, seg 3	Rock Cr	Bear Cr	Ivy Cr	1.2
Mainstem	26097, seg 4	Rock Cr	Bear Cr	Ivy Cr	2.4
Mainstem	26097, seg 7	Rock Cr	Bear Cr	Ivy Cr	0.91
Mainstem	26136	Nehalem R	Cedar Cr	Weed Cr	1.3
Mainstem	26136.7	Nehalem R	Weed Cr	Clear Cr	1
□					□
Tributary	25889	Foley Cr	E Foley Cr	Crystal Cr	1.2
Tributary	25901	Anderson Cr	Mouth	Headwaters	1.12
Tributary	25917	Lost Cr	Mouth	Headwaters	1.14
Tributary	25919	Fall Cr	Mouth	Headwaters	0.98
Tributary	26001	Buster Cr	Mouth	Little Rock Cr	1
Tributary	26012	Beneke Cr	Gilmore Cr	Walker Cr	1
□	□	□	□	□	□

Random Fall Chinook Surveys Conducted in 2002

Chinook Habitat Type	Reach ID	Reach	Start	End	Length (miles)
Mainstem	25902	Nehalem R	Anderson Cr	Cook Cr	1.3
Mainstem	25903	Cook Cr	Mouth	Dry Cr	1.1
Mainstem	25916	Nehalem R	Cook Cr	Lost Cr	1.1
Mainstem	25920	Nehalem R	Fall Cr	Helloff Cr	1.1
Mainstem	25924	Nehalem R	Bastard Cr	Snark Cr	1
Mainstem	25927	Salmonberry R	Mouth	Hatchery Cr	0.3
Mainstem	25929	Salmonberry R	Hatchery Cr	Buick Canyon	1.2
Mainstem	25933	Salmonberry R	Belfort Cr	Preston Cr	0.7
Mainstem	25935	Salmonberry R	Preston Cr	Tank Cr	1.2
Mainstem	25939	Salmonberry R	Tunnel Cr	Salmonberry R, S Fk	1.2
Mainstem	25956	Nehalem R	Salmonberry R	Cronin Cr	1.9
Mainstem	25962	Nehalem R	Cronin Cr	Trib 4	1.9
Mainstem	25964	Nehalem R	Spruce Run Cr	George Cr	3.2
Mainstem	25966	Nehalem R	George Cr	Humbug Cr	1.5
Mainstem	25986	Nehalem R	Humbug Cr	Quartz Cr	1.8
Mainstem	25990	Nehalem R	Quartz Cr	Osweg Cr	1
Mainstem	25994	Nehalem R	George Cr	Cow Cr	1
Mainstem	26000	Nehalem R	Moores Cr	Buster Cr	1.3
Mainstem	26008	Nehalem R	Buster Cr	Fishhawk Cr	1.5
Mainstem	26026	Nehalem R	Fishhawk Cr	Slaughters Cr	1.4
Mainstem	26032	Nehalem R	Squaw Cr	Northrup Cr	2.5
Mainstem	26036	Nehalem R	Sager Cr	Louisgnot Cr	1.5
Mainstem	26038	Nehalem R	Louisgnot Cr	Grub Cr	2.3
Mainstem	26044	Nehalem R	Deep Cr	Fishhawk Cr	2.6
Mainstem	26054.4	Nehalem R	Unnamed Trib, Nehalem R	Adams Cr	0.5
Mainstem	26054.8	Nehalem R	Adams Cr	Calvin Cr	1.3
Mainstem	26062	Nehalem R	Lundgren Cr	Battle Cr	1.9
Mainstem	26070	Nehalem R	Deer Cr	Gus Cr	0.8
Mainstem	26070	Nehalem R	Deer Cr	Gus Cr	1.9
Mainstem	26084	Nehalem R	Cook Cr	Nehalem R, E Fk	2.2
Mainstem	26094	Nehalem R	Nehalem R, E Fk	Knickerson Cr	1.7
Mainstem	26094	Nehalem R	Nehalem R, E Fk	Knickerson Cr	1.4
Mainstem	26094.7	Nehalem R	Knickerson Cr	Coon Cr	1.7
Mainstem	26097, seg 4	Rock Cr	Bear Cr	Ivy Cr	2.4
Mainstem	26097, seg 7	Rock Cr	Bear Cr	Ivy Cr	0.91
Tributary	25889	Foley Cr	E Foley Cr	Crystal Cr	1.2
Tributary	25893	Foley Cr	Dry Cr	Foley Cr, Trib Q	0.34

Tributary	25901	Anderson Cr	Mouth	Headwaters	1.12
Tributary	25907	Cook Cr	Harliss Cr	Piatt Canyon	1
Tributary	25915	Cook Cr	Cook Cr, E Fk	Hoevett Cr	0.66
Tributary	25917	Lost Cr	Mouth	Headwaters	1.14
Tributary	25931	Salmonberry R	Buick Canyon	Belfort Cr	0.5
Tributary	25958	Cronin Cr, N Fk	Mouth	Headwaters	0.54
Tributary	25959	Cronin Cr	Cronin Cr, N Fk	Cronin Cr, M Fk	1
Tributary	25967	Humbug Cr	Mouth	Cedar Cr	0.88
Tributary	25975	Humbug Cr	Big Cr	Alder Cr	1.18
Tributary	25980	E Humbug Cr	Mouth	Headwaters	1.18
Tributary	25985	W Humbug Cr	Beaver Cr	W Humbug Cr, Trib A	1
Tributary	26010	Beneke Cr	Mouth	Gilmore Cr	1.15
Tributary	26012	Beneke Cr	Gilmore Cr	Walker Cr	1
Tributary	26024	Hamilton Cr	Mouth	Headwaters	1.14
Tributary	26024	Hamilton Cr	Mouth	Headwaters	0.86
Tributary	26107	Rock Cr	Ginger Cr	Martin Cr	1.08
Tributary	26107	Rock Cr	Ginger Cr	Martin Cr	0.98
Tributary	26111	Rock Cr	Weed Cr	Olson Cr	0.39
Tributary	26111.9	Rock Cr	Olson Cr	Rock Cr, N Fk	1.08
Tributary	26141	Wolf Cr	Mouth	Wolf Cr, N Fk	1.3

Radio Telemetry

Adult fall chinook salmon in the mainstem Nehalem were radio tagged in 2000 and 2001 to understand spawner distribution between mainstem and tributary habitat strata. Radio-tagging was conducted in conjunction with the first capture event of the mark-recapture experiment. Transmitters were placed into the esophagus of each adult without the use of anesthetics and then released. Fish were selected by a systematic sample with a random start. Only healthy fish were tagged.

We used seven-volt, digitally encoded Lotek radio transmitters. Each transmitter weighs 13 g in water and is 16 X 83 mm in dimensions with a 30 cm whip antennae and a battery life of 265 days. Since some of the transmitters had already been used, the expected remaining battery life varied from 100-258 days depending on the transmitter's use history. Transmitters used six channels (MHz), 9 (149.480), 10 (149.500), 14 (149.580), 18 (149.660), 21 (149.720), and 22 (149.740). Each frequency consisted of multiple codes, so that each transmitter had a unique identifier.

Tracking methods was done using three fixed stations to record migration timing – one at the mouth of Humbug Creek, one at the mouth of Deep Creek, and the third at a private residence in Vernonia. At approximately two week intervals, one surveyor drove the river basin locating fish and documenting the extent of upstream movement with a GPS unit. One day of aerial tracking was accomplished in cooperation with the Oregon State Police.

Estimating Terminal Catch

Creel Survey Design

Roving-access and roving-roving survey designs were employed depending on geographic area and fishing method (Pollock et al. 1994). For the roving access point survey, anglers that completed fishing were interviewed as they leave a boat landing or marina and angling effort was determined from the total number of anglers that left the sampled access point during the day. Access point surveys are appropriate for areas with only one or two access points and effort is determined by using data generated from interviews during the sampling period as opposed to an instantaneous measure used in a "roving" survey. In roving surveys, a surveyor move or "rove" through a fishing area making angler or boat counts to determine effort (pressure counts) after which they conduct angler interviews. Roving-access surveys are used when most anglers are concentrated at numerous, known locations (e.g. marinas) and anglers are interviewed as they leave an area once fishing is completed. However, with roving-roving style surveys, anglers are not concentrated

Catch Areas for the 2001-2003 Nehalem Bay and River Creel Project.

Catch Area	Description
1 – Ocean	An "area" within 1 mile of the mouth of the bay that lies outside an imaginary line drawn perpendicular across the west ends of the jetties.
2 – Lower Nehalem Bay	The bay area from a line perpendicular across the west end of the jetties up to a line perpendicular across the bay at the State Park Boat Ramp.
3 - Upper Nehalem Bay	A line perpendicular across the bay at the State Park Boat Ramp up to and including the first visible portion of the North Fork Nehalem River.
4 – Tidewater	The mainstem Nehalem River from an imaginary line drawn across the river just upstream of the North Fork mouth upstream to the Roy Creek Bridge.
5 – Mainstem below Falls	Nehalem River from the Roy Creek Bridge upstream to the base of the Nehalem River Falls.
6 – Mainstem above Falls	All areas open to chinook fishing upstream of the Nehalem River Falls

at known locations (bank anglers) and a surveyor moves through the fishery interviewing anglers while they are still fishing.

The surveys were stratified by catch area, month, day (weekend, weekday), and angler type (bank or boat). Anglers were further divided into two groups, private and guided anglers, and post-stratified if catch rates were found to differ. Angler interviews included the number of hours fished, number of anglers in the boat or on shore, the number of salmonids caught or released (by species), and residency of the angler. All data was entered into hand-held electronic dataloggers. Fish checked were sampled for scales, length measured, sex identified, and the number and types of fin marks noted. If an adipose fin is missing a "detection wand" will be used to determine if a coded wire tag is present. If present, the snout will be removed for future tag decoding.

Nehalem Bay and Tidewater (Catch Areas 1-4)

A roving-access creel survey was used for all bay and tidewater locations. Access points were sampled proportionally to the monthly effort observed at each landing in 1998-1999. Surveyors traveled a predetermined schedule of wait and travel time, with access points randomly chosen, moving between the eight access points interviewing anglers. The sampling schedule will allow each access point to be sampled proportional to the amount of angling effort. Amount of effort per access point was calculated from interview data gathered in 1998-2000.

Two surveyors interviewed boat anglers as they return from fishing. To alleviate problems with differing effort due to time of day and tidal cycles, each day will be surveyed in its entirety. At each location, all boats returning to the marina were interviewed if possible. If large numbers of boats return to the dock and all cannot be interviewed, the surveyor interviewed a systematic random sample. Because the pressure counts recorded total number of boats in each catch area, all boats regardless of target species or activity were interviewed. If a contacted boat has fished for multiple fish types (e.g. salmon and crabbing or bottom fishing), two interviews are completed, one for the salmon angling and an additional one for non-salmon activities. Similarly, if a single boat fished multiple areas, multiple interviews are completed - one interview for each area fished.

Fishing effort in Catch Areas 1-4 is estimated by counting boats from several vantage points around the bay. Pressure counts typically take less than 30 minutes to complete and are considered instantaneous. Four or five pressure counts, depending on time of year, will be recorded throughout the day at assigned three hour time intervals. Boats in moorage and kayaks are not included in the count.

Mainstem Nehalem River (Catch Areas 5-6)

Both boat and bank anglers were interviewed on the mainstem Nehalem below Nehalem River Falls (Catch Area 5). Surveys began in early to mid-August, depending on water conditions and angling effort. One surveyor began sampling the mainstem Nehalem River in late-August. Historically, riverine angling effort is insignificant until water flows increase (usually in September) and large numbers of fish move into the river. Each surveyor worked four, ten-hour days a week, two weekend days and two-week days. A day was stratified into an AM shift and a PM shift. AM shifts began at 6:00 and ended at 4:00 and PM shifts were from 11:00 – 9:00. AM shifts were sampled at twice the rate as PM shifts.

For bank anglers, a roving-roving style survey was used. A surveyor moved through Catch Area 5 (including the shore areas just below the Roy Creek Bridge in Catch Area 4) randomly interviewing anglers. Angling effort or pressure counts took place at three intervals depending on day length by driving the mainstem and Andersen Creek roads and counting all people fishing. Pressure counts consisted of counting all cars located in the catch area that are parked in locations used by anglers. Pressure counts typically take less than 45 minutes and are considered instantaneous. Once the pressure count is complete, the surveyor interviewed anglers until the next scheduled pressure count. Interviews consisted of the same information gathered in the boat surveys. However, a sample consisted of interviewing a group of anglers that are attributed to each car. Non-anglers in the catch area were also interviewed to estimate the use by non-anglers and appropriately adjust the effort count.

The roving surveyor on the mainstem Nehalem also sampled boats that have completed fishing at Mohler Sand and Gravel. There are only three access points in Catch Area 5 that anglers can use to launch boats. The most upstream put-in is the Beaver Slide, several miles downstream is the Mohler Sand and Gravel access and the most downstream landing is Roy Creek. Effort was be determined by counting trailers at the Beaver Slide put-in during the bank angler pressure count.

Sampling was not been scheduled for the Nehalem River above the Nehalem River Falls (Catch Area 6). Periodic surveys in 1998-2001 determined that angler effort and catches in the area were too small to significantly affect the catch estimate for the basin and did not warrant the required survey effort.

Future Genetic Analyses

The population structure of fall chinook in the Nehalem River basin is unknown. There may be more than one distinct breeding population of fall chinook. We suspect that the upper basin fall chinook are distinct from other mainstem Nehalem groups based on migration timing and distance traveled. It could be that there are additional distinctions to be drawn among groups in the main Nehalem basin. 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. 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 Estimates

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,

fish do not lose their marks and all marks are recognizable.

Assumptions 1 and 2 are presumed not to hold true for trapping on the North Fork Nehalem River and mainstem Nehalem 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 will be estimated by data from the spawning grounds stratified by area and time. Chi-square analysis will be used to determine if there are significant differences between the strata. If differences are found, the Darroch (1961) maximum likelihood estimator will be used. If the resulting estimate is within 10% of the pooled Peterson estimator, the stratified estimate will not be used for simplicity sake.

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, trap induced 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 tags. All tags were assumed to be identified if present. Through the use of mutilation marks and anchor tags, trained field crews should observe each tagged fish. 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).

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 several capture histories to form an empirical probability distribution as follows:

1. marked and harvested in fishery ($=H_i$), this was assumed zero,
2. marked and were captured out of the experiment area ($=F_i$),
3. marked and recaptured on the spawning grounds ($=R_i$),
4. marked and never seen again ($=\hat{M}_i - R_i$),
5. unmarked and inspected on the spawning grounds, and ($=C_i - R_i$),
6. unmarked and never seen ($= \hat{N}_i - \hat{M}_i - C_i + R_i$),

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).

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

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 mainstem weir, which minimized any bias in selection of tagged fish (assumption 1). From the mark-recapture experiment, data on selectivity of fish either by size, sex or timing was available to assess any bias in the tagging procedure if it exists. However, since the fish that are available to the mark-recapture experiment and the telemetry study should 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 Nehalem River, 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 on the number of pre-spawn mortalities of radio tagged fish compared to the observed pre-spawn mortality of anchor tagged fish in the watershed.

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

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

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

n_i = number of fish with transmitters that spawned in either a trib. or mainstem statum,
n_h = fish with transmitters returned from anglers,
n_f = fish with transmitters that did not continue migrating up the Nehalem River,
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:

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

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):

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

Peak count is the largest sum of the live and carcass counts recorded on a single day for each survey. The peak counts are expressed as fish per unit length and averaged by each stratum. The high stratum of the mainstem was entirely surveyed; thus peak counts of each survey were summed. Expanding the average peak count for the other strata derived an escapement index for the total length of habitat in each stratum.

Average peak count per mile in each strata (S) was calculated as follows:

$$S = \left(\sum_{i=1}^{n} P_i\right) / \left(\sum_{i=1}^{n} M_i\right)$$

where

n = the number of surveys
P_i = peak count of the sum of carcasses and live chinook in survey i
M_i = length of survey i (miles)

Creel Data Analysis

The Nehalem River creel survey is stratified by month, catch area, and angler type (shore or boat). Depending on harvest rates, anglers could be further post-stratified into private trips and guided trips. Data analysis procedures for post-stratification of private and guided trips will follow Bernard et al. (1998) if harvest rates differ significantly between the trip types. Missing data points from surveyor illness or equipment failures will be treated as random events and removed from the sampling frame. Bernard et al. (1998) describes several other events which must be taken into account during analysis that can bias harvest estimates including 1) zero interviews, but angling effort was counted, 2) zero harvest rate, but effort was counted, and 3) very low (1-2) numbers of interviews but with harvest. If any of these situations are encountered and deemed to bias the data-set, the data will be treated as missing data points and the substituted values derived from methods described in Bernard et al. (1998) and Guthrie et al. (1991).

Roving-Access Survey: Harvest will be determined separately for kept fish and for released fish. Estimated harvest per sample day in a particular stratum is (Pollock et al. 1994, Bernard et al. 1998)

$$\hat{H}_i = \hat{E}_i \overline{cpue}_i$$

where,
i denotes sampling days,
$\hat{E}_i$ = estimated effort, and
$\overline{cpue}_i$ =average catch per unit.

Because the roving-access surveys only interview completed angler trips average catch per unit effort is estimated as the ratio of means (Hoenig et al. 1997):

$$\overline{cpue}_i = \frac{\sum_{k=1}^{m_i} h_{ik}}{\sum_{k=1}^{m_i} e_{ik}}, \text{ where}$$

k denotes individual anglers,
m denotes the number of anglers interviewed,
h is the number of fish caught during fishing trips that were interviewed, and
e is the length in hours of fishing trips of interviewed anglers.

Variance of cpue is estimated as (Bernard et al. 1998):

$$v(\overline{cpue}_i) = \frac{\sum_{k=1}^{m_i} \left(h_{ik} - e_{ik}\overline{cpue}_i\right)^2}{\bar{e}_i^2 m_i \left(m_i - 1\right)}.$$

Fish harvested per catch/month strata equals:

$$\hat{H} = D\frac{\sum_{i=1}^{d} \hat{H}_i}{d} \text{ where,}$$

d = number of sampled days in stratum, and
D = total available sampling days in stratum.

Daily effort is estimated as:

$$\hat{E}_i = T\frac{\sum_{t=1}^{r} x_{it}}{r} \text{ where,}$$

t denotes the individual roving count of anglers
r = number of pressure counts per day, and
T = the length of the sampling period (usually day length).

Since effort is determine systematically and not randomly the variance equation is (Wolter 1985):

$$v(\hat{E}_i) = T^2\frac{\sum_{t=2}^{r} \left(x_{it} - x_{i(t-1)}\right)^2}{r^2(r-1)}.$$

The variance of the daily harvest is (Goodman 1960 as cited by Bernard et al. 1998):

$$v(\hat{H}_i) = \hat{E}_i^2(\overline{cpue}_i) + \overline{cpue}_i^2 v(\hat{E}_i) - v(\overline{cpue}_i)v(\hat{E}_i)$$

and the variance for each catch/month stratum is:

$$v(\hat{H}) = D(D - d)\frac{s_1^2}{d} + \frac{D}{d}\sum_{i=1}^{d} v(\hat{H}_i), \qquad \textit{where}$$

$$s_1^2 = \frac{\sum (\hat{H}_i - \overline{\hat{H}})^2}{d - 1},$$

Total harvest is the sum of all catch in each strata and the total variance of the catch is the sum of all strata variances (Pollock et al. 1994).

Roving-Roving Surveys: The only difference in estimation between the roving – roving survey and the roving – access survey is the catch per unit effort (*cpue*) estimator. With roving surveys anglers are interviewed that have not completed fishing and the mean of ratios estimator should be used (Pollock et al. 1994).

$$\overline{cpue}_i = \frac{\sum_{k=1}^{m_i} \frac{h_{ik}}{e_{ik}}}{n}, \text{ where}$$

k denotes individual anglers,
m denotes the number of anglers interviewed,
h_{ik} is the number of fish caught for an interviewed angler,
e_{ik} is the length in hours fished for an interviewed angler, and
n is the number of interviews for each day *i*.

The variance is calculated as (Jones et al. 1995):

$$v(\overline{cpue}_i) = \frac{\sum_{k=1}^{m_i} e_{ik}\left(\frac{h_{ik}}{e_{ik}} - \overline{cpue}_i\right)^2}{m\sum_{i=1}^{m} e_{ik}}.$$

RESULTS

Spawner Escapement Estimates

We marked between 98 and 335 adult (> 600 mm fork length) fall chinook in the North Fork Nehalem basin from 1998 to 2001, and from 348 to 1,941 adult fall chinook in the maintem Nehalem from 2000 to 2002. Success in capture and marking migrating fall chinook varied depending on run size, timing of operations, and flow conditions. We experienced greater success as we learned from experience and covered a greater proportion of the run, and as we improved weir design.

Carcasses inspected in spawning ground surveys ranged from 49 in the Nehalem North Fork in 2001 to nearly 2,900 in the mainstem Nehalem in 2002. Numbers of marked chinook recaptured ranged from 0 to 281. Our percentage recapture ranged from 0 to 14.5%, also in the Nehalem mainstem in 2002.

Table 2 summarizes results for numbers of chinook marked, carcasses inspected and marked chinook recaptured.

We estimated spawner escapement numbers based on a pooled Peterson model. We also present estimates in Table 2 for stratified Peterson estimates based on sex, size and both sex and size for the mainstem Nehalem. In all cases but one, the stratified estimates were within 5% of the fully pooled Peterson estimate. The single exception was the estimate for the mainstem Nehalem in 2000 stratified by both sex and size. We feel that this estimate is driven strongly by the low numbers of female chinook recaptured that year, and that this estimate is not reliable.

We conducted chi-square tests for random assortment marked and unmarked chinook across sub-basins, and by Julian week in 2000 and 2001 (Appendix B). In most cases, we reject the null hypothesis of random assortment of these chinook. Accordingly, we performed stratified Darroch estimates of abundance. These are also presented in Table 2 and show close agreement with the fully pooled Peterson estimates. Therefore, we present the fully pooled Peterson estimates of spawner escapement as our best estimates based on the work performed in this study.

The 95% relative precision of our estimates were within the 25% objective for the Nehalem mainstem in 2001 and 2002 (Table 3). However, they were within 25% only in 1999 on the North Fork Nehalem. The failure to recover any marked carcasses in 2001 spawning ground surveys on the North Fork Nehalem was very disappointing, and prevents us from putting forward an escapement estimate for that year. Number of marked carcasses recovered is the primary element contributing to the level of precision of a spawner abundance estimate. We attribute the improved precision over time in the mainstem Nehalem to field crew experience in learning how to conduct surveys and where to look for marked carcasses.

Table 2: Spawner population estimates with numbers of chinook marked, carcasses inspected and marked chinook recaptured during four years of work in the Nehalem River basin

Table 2A: Mainstem Nehalem spawner escapement estimates

Nehalem	Mainstem		Mark	Carcass	Recaptures	Tag Loss	Pooled Peterson Est	95% Rel Prec'n	Stratified Estimates Sex Strat	Size Strat	S&S Strat	Darroch Est time	space	R/M	R/C
2002															
	Both	Sum>600	1941	2897	281	n/a	19,956	10.10%	19,656	19,355	19,136	19640	19640	14.48%	9.70%
		<600 mm	94	98	6		1,343		98.49%	96.99%	95.89%	98.42%	98.42%	6.38%	6.12%
		600-800	819	694	97		5,814							11.84%	13.98%
		800-1000	937	1596	129		11,522							13.77%	8.08%
		1000+	185	607	55		2,018							29.73%	9.06%
	Males	Sum>600	1194	1433	163		10,448							13.65%	11.37%
		<600 mm	89	91	6		1,182							6.74%	6.59%
		600-800	636	488	76		4,044							11.95%	15.57%
		800-1000	428	549	47		4,915							10.98%	8.56%
		1000+	130	396	40		1,267							30.77%	10.10%
	Females	Sum>600	747	1464	118		9,208							15.80%	8.06%
		<600 mm	5	7	0		47							0.00%	0.00%
		600-800	183	206	21		1,730							11.48%	10.19%
		800-1000	509	1047	82		6,439							16.11%	7.83%
		1000+	55	211	15		741							27.27%	7.11%
2001															
	Both	Sum>600	807	1153	74	10.6%	12,431	24.90%	13,172	12,067	12,150	12105	12148	9.17%	6.42%
		<600 mm	44	20	0		944		105.96%	97.07%	97.74%	97.37%	97.72%	0.00%	0.00%
		600-800	214	194	13		2,994							6.07%	6.70%
		800-1000	557	896	58		8,482							10.41%	6.47%
		1000+	36	63	3		591							8.33%	4.76%
	Males	Sum>600	414	685	51		5,474							12.32%	7.45%
		<600 mm	39	20	0		839							0.00%	0.00%
		600-800	120	171	11		1,733							9.17%	6.43%
		800-1000	262	451	37		3,127							14.12%	8.20%
		1000+	32	63	3		527							9.38%	4.76%
	Females	Sum>600	393	468	23		7,698							5.85%	4.91%
		<600 mm	5	0	0		5							0.00%	0.00%
		600-800	94	23	2		759							2.13%	8.70%
		800-1000	295	445	21		6,000							7.12%	4.72%
		1000+	4	0	0		4							0.00%	
2000												NA	NA		
	Both	Sum>600	348	458	14	6.7%	10,678	51.30%	10,758	8,802	8,010			4.02%	3.06%
		<600 mm	15	22	2		122		100.75%	82.43%	75.01%			13.33%	9.09%
		600-800	136	112	4		3,095							2.94%	3.57%
		800-1000	201	254	9		5,150							4.48%	3.54%
		1000+	11	92	1		557							9.09%	1.09%
	Males	Sum>600	129	259	4		6,759							3.10%	1.54%
		<600 mm	10	22	1		126							10.00%	4.55%
		600-800	61	81	2		1,694							3.28%	2.47%
		800-1000	58	118	2		2,339							3.45%	1.69%
		1000+	10	60	0		670							0.00%	0.00%
	Females	Sum>600	219	199	10		3,999							4.57%	5.03%
		<600 mm	5	0	1		2							20.00%	
		600-800	75	31	2		810							2.67%	6.45%
		800-1000	143	136	7		2,465							4.90%	5.15%
		1000+	1	32	1		32							100.00%	3.13%

Table 2A: Mainstem Nehalem spawner escapement estimates with numbers of marked Chinook, carcasses inspected, and marked Chinook recaptured.

North Fork Nehalem

1998	Both	Sum>600	165	105	17		977	48.20%	979 100.25%	10.30%	16.19
	Males	Sum>600	76	50	6		560	□		7.89%	12.00
								□			
	Females	Sum>600	89	55	11		419	□		12.36%	20.00
□	□	□	□	□	□	□	□	□	□ □ □ □ □ □ □		
1999	Both	Sum>600	335	91	62		490	13.30%	482 98.49%	18.51%	68.13
	Males	Sum>600	142	50	28		250			19.72%	56.00
	Females	Sum>600	193	41	34		232			17.62%	82.93
2000	Both	Sum>600	98	80	8		890	40.60%	1475 165.77%	8.16%	10.00
	Males	Sum>600	72	38	8		315			11.11%	21.05
	Females	Sum>600	26	42	0		1160			0.00%	0.00
2001	Both	Sum>600	53	49	0		n/a	n/a		0.00%	0.00
	Males	Sum>600	30	26	0		n/a			0.00%	0.00
	Females	Sum>600	21	23	0		n/a			0.00%	0.00

Table 3: Fall chinook spawner escapement estimates with associated 95% confidence intervals, relative precision and bias estimate for the Nehalem River (2000 - 2002) and the Nehalem North Fork (1998 - 2001).

			□			Bootstrap Simulation						
			95% CI	□		Standard	□	95% Rel Precision		Bias	% Bias	Rel Bias
Escapement Estimate		Year	**25**	**975**	Mean	Standard Deviation	CV	(s.d.*1.96)/Mean	□	(Pld Ptrsn - Btstrp Mn)	□	(Bias/sd)
977	Nehalem North Fork	1998	686	1553	1008	240.20	23.83%	**48.188%**		-31	-3.17%	-0.129
490	Nehalem North Fork	1999	430	559	489	33.20	6.79%	13.280%		1	0.20%	0.030
890	Nehalem North Fork	2000	560	2007	1000	406.60	40.66%	89.543%		-110	-12.36%	-0.271
n/a	Nehalem North Fork	2001	n/a	n/a	n/a	n/a	n/a	n/a		n/a	n/a	n/a
			□	□			□					
10678	Nehalem River	2000	6863	18036	10783	2795.29	25.92%	51.309%		-105	-0.98%	-0.038
12431	Nehalem River	2002	11050	17215	13407	1578.31	11.77%	24.885%		-976	-7.85%	-0.618
19956	Nehalem River	2002	18213	22235	20058	1027.10	5.12%	10.088%		-102	-0.51%	-0.099

Spawning ground survey calibrations

We conducted spawning ground surveys on five 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 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 (Tables 4A, 4B). 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. Interannual coefficients of variation for standard surveys range from a low of 22.7% (average peak dead chinook per mile) to a high of 70.5% (live chinook AUC per mile). 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.

Table 4A. Preliminary expansion factors for mainstem Nehalem River fall chinook spawning ground surveys.

						1. Average Peak Count(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 Factor
Nehalem River	2000	Pooled Random	63.1	163	48	11.1	30.7	***962.0***	8	18	***1334.8***	15.7	50.5	***680.1***	4	6.2	***2669.5***
		Mainstem Random	46.9	115	31	7.9	16.5	***1351.6***	3.9	6.6	***2737.9***	10.9	26.1	***979.6***	4.7	4.4	***2271.9***
		Tributary Random	16.2	48	17	14.7	41.6	***726.4***	9.9	20.5	***1078.6***	21.1	68.9	***506.1***	3.6	7	***2966.1***
		Standard Surveys	4.7	4.7	5	42.2		***253.0***	36.6		***291.7***	69.8		***153.0***	17.6		***606.7***
Nehalem River	2001	Pooled Random	61.7	163	46	38.25	43.5	***325.0***	35.35	49.7	***351.7***	32.58	36.4	***381.6***	9.69	9.02	***1282.9***
		Mainstem Random	40.8	115	28	43.11	46.5	***288.4***	41.7	53.3	***298.1***	36.45	38.1	***341.0***	10.45	9.66	***1189.6***
		Tributary Random	20.9	48	18	15.86	9.72	***783.8***	8.37	10.2	***1485.2***	10.32	7.75	***1204.6***	6.18	4.11	***2011.5***
		Standard Surveys	4.7	4.7	5	82.36	89.1	***150.9***	61.5	46.7	***202.1***	69.87	59.3	***177.9***	37.49	34.7	***331.6***
Nehalem River	2002	Pooled Random	73	163	57	25.42	23.7	***785.1***	22.81	46.2	***874.9***	23.25	34.2	***858.3***	15	21	***1330.4***
		Mainstem Random	52.3	115	35	31.32	47.7	***637.2***	27.12	53.4	***735.8***	29.13	34.7	***685.1***	13.82	16.3	***1444.0***
		Tributary Random	20.7	48	22	14.67	33.9	***1360.3***	14.19	12.8	***1406.3***	12.79	31.5	***1560.3***	17.16	30.3	***1162.9***
		Standard Surveys	4.7	4.7	5	123.91	145	***161.1***	99.86	117	***199.8***	84.54	92.4	***236.1***	71.95	108	***277.4***
Pooled Random Calibration(mean)						□		690.7	□		853.8	□		640.0	□		1760.9
Pooled Random Calibration(cv)						□		47.61%	□		57.61%	□		37.64%	□		44.70%
Mainstem Random Calibration(mean)						□		759.1	□		1257.3	□		668.6	□		1635.2
Mainstem Random Calibration(cv)						□		71.41%	□		103.46%	□		47.80%	□		34.61%
Tributary Random Calibration (mean)						□		956.8	□		1323.4	□		1090.3	□		2046.8
Tributary Random Calibration (cv)						□		36.64%	□		16.29%	□		49.19%	□		44.07%
						□			□			□			□		
StandardSurvey Expansion (mean)						□		188.3	□		231.2	□		189.0	□		405.2
Standard Survey Expansion (cv)						□		29.87%	□		22.67%	□		22.56%	□		43.58%

Table 4A (cont'd). Preliminary expansion factors for Nehalem 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.
5.8	18.1	***1841.0***	187		***57.1***	2.96		***3603.1***	2.7	4.5	***3954.8***	1.5	3.8	***7118.7***	10678
2.8	4.7	***3813.6***	140		***76.3***	2.99		***3577.1***	3	4.9	***3559.3***	1.7	4.3	***6281.2***	10678
11.2	29.9	***953.4***	47		***227.2***	2.90		***3680.5***	1.9	2.8	***5620.0***	1.3	2.7	***8213.8***	10678
35.9		***297.4***	222		***48.1***	47.23		***226.1***	13.2		***808.9***	12.8		***834.2***	10678
8.16	8.09	***1523.4***	33.39	63.28	***372.3***	29.38	47.03	***423.1***	12.22	18.91	***1017.3***	15.84	23	***784.8***	12431
8.85	8.5	***1404.6***	40	68.21	***310.8***	35.18	50.12	***353.4***	14.6	20.13	***851.4***	19.52	24.4	***636.8***	12431
4.2	3.67	***2959.8***	3	5.66	***4143.7***	2.68	4.95	***4638.4***	1.28	1.94	***9711.7***	1.1	2.2	***11300.9***	12431
29.85	21.79	***416.4***	55.33	74.37	***224.7***	64.35	83.45	***193.2***	35.03	57.7	***354.9***	32.43	59.1	***383.3***	12431
13.08	18.35	***1525.7***	21.96	45.31	***908.7***	17.07	34.06	***1169.1***	8.9	17.81	***2242.2***	7.29	18.3	***2737.4***	19956
12.23	14.1	***1631.7***	27.65	52.11	***721.7***	20.54	38.56	***971.6***	10.46	20.04	***1907.8***	7.59	20.4	***2629.2***	19956
14.58	24.58	***1368.7***	11.59	27.63	***1721.8***	10.75	23.57	***1856.4***	6.06	12.87	***3293.1***	6.75	14.6	***2956.4***	19956
58.79	69.02	***339.4***	88.5	114.4	***225.5***	101.92	133.24	***195.8***	55.23	73.85	***361.3***	62.2	80.3	***320.8***	19956
															□
□		1630.0	□		446.0	□		1731.8	□		2404.8	□		3547.0	□
□		11.21%	□		96.53%	□		96.03%	□		61.36%	□		91.45%	□
□		2283.3	□		369.6	□		1634.0	□		2106.2	□		3182.4	□
□		58.25%	□		88.40%	□		104.71%	□		64.80%	□		89.95%	□
□		1760.6	□		2030.9	□		3391.8	□		6208.3	□		7490.4	□
□		60.15%	□		97.32%	□		41.67%	□		52.34%	□		56.33%	□
□			□			□			□			□			□
□		351.1	□		166.1	□		205.0	□		508.4	□		512.8	□
□		17.19%	□		61.52%	□		8.92%	□		51.20%	□		54.63%	□

Table 4B. Preliminary expansion factors for North Fork Nehalem River fall chinook spawning ground surveys.

Basin	Year	Strata	Miles Sampled	Miles Total	Reaches Sampled	Peak Count/mile (Reach)	st.dev	Expansion Factor	Avg Peak Count (Period)		Expansion Factor	Live (AUC)/mile		Expansion Factor
N. Fk. Nehalem *(above waterhouse Falls)*	1998	Pooled	6.5	20.3	6	18.2	19.8	**53.68**	16.5	5.3	**59.21**	23	21	**42.48**
		Mainstem	2.2	4.9	2	25.4	6.5	**38.46**	27.5	9.2	**35.53**	40	3.9	**24.43**
		Tributary	4.3	15.4	4	14.6	24.2	**66.92**	11	2.3	**88.82**	15	21	**65.13**
(Soapstone Survey)		Standard Surveys	0.69	0.69	1	119		**8.21**	119		**8.21**	170		**5.75**
N. Fk. Nehalem *(above waterhouse Falls)*	1999	Pooled	10.1	20.3	10	16.3	22.7	**30.06**	9.5	12.2	**51.58**	19	29	**25.79**
		Mainstem	4.9	4.9	4	35	22	**14.00**	19.6	11.5	**25.00**	43	29	**11.40**
		Tributary	5.2	15.4	6	1	1.9	**490.00**	1.2	2.4	**408.33**	0		**n/a**
(Soapstone Survey)		Standard Surveys	0.69	0.69	1	66.7		**7.35**	66.7		**7.35**	101.5		**4.83**
N. Fk. Nehalem	2000	Pooled	10.6	36	12	6	8.4	**148.33**	7.4	15.9	**120.27**	9.9	16	**89.90**
		Mainstem	4.8	13.8	6	7.3	7.6	**121.92**	8.4	10.5	**105.95**	11.3	15	**78.76**
		Tributary	5.8	22.2	6	4.8	9.1	**185.42**	7	17.6	**127.14**	8.5	18	**104.71**
(Soapstone Survey)		Standard Surveys	0.69	0.69	1	23		**38.70**	23		**38.70**	35		**25.43**
N. Fk. Nehalem	2001	Pooled	7.3	36	8	20.4	21.7	**n/a**	18.8	25.1	**n/a**	7.8	9.7	**n/a**
		Mainstem	3.4	13.8	4	20.8	16.1	**n/a**	35.8	43.6	**n/a**	7.8	6.7	**n/a**
		Tributary	3.9	22.2	4	31.4	25.4	**n/a**	9.4	17.1	**n/a**	7.8	13	**n/a**
(Soapstone Survey)		Standard Surveys	0.69	0.69	1	72		**n/a**	72		**n/a**	61.4		**n/a**
Mainstem Random Calibration(interannual mean)								**58.13**			**55.49**			**38.19**
Mainstem Random Calibration(interannual cv)								**97.34%**			**79.32%**			**93.55%**
Tributary Random Calibration (interannual mean)								**247.44**			**208.10**			**84.92**
Tributary Random Calibration (interannual cv)								**88.20%**			**83.84%**			**32.95%**
Pooled Random Calibration(interannual mean)								**77.36**			**77.02**			**52.72**
Pooled Random Calibration(interannual cv)								**80.91%**			**48.88%**			**63.08%**
StandardSurvey Calibration (interannual mean)								**18.08**			**18.08**			**12.00**
StandardSurvey Calibration (interannual cv)								**98.74%**			**98.74%**			**96.97%**

Table 4B (cont'd). Preliminary expansion factors for North Fork Nehalem River fall chinook spawning ground

Avg Peak Redd/Mile		Expansion Factor	Redd/mile (AUC)		Expansion Factor	Sum of Dead	Expansion Factor	Dead/Mile	Expansion Factor	Avg Peak Dead		Expansion Factor	Peak Dead (Period)		Expansion Factor	Pooled Petersen Escapment Est.
4.6	2.7	**212.39**	4	2.9	**244.25**	29	**33.69**	4.46	**218.98**	3.5		**279.14**	2.9		**336.90**	977
7.3	0.9	**133.84**	6.3	0	**155.08**	20	**48.85**	9.09	**107.47**	8.2		**119.15**	6.5		**150.31**	977
3.2	2	**305.31**	2.8	3.5	**348.93**	9	**108.56**	2.09	**466.79**	1.1		**888.18**	1		**977.00**	977
11.6		**84.22**	10.6		**92.17**	33	**29.61**	47.83	**20.43**	30.4		**32.14**	30.4		**32.14**	977
10.2	11.6	**48.04**	5.2	5.4	**94.23**	72	**6.81**	7.13	**68.74**	3.6	4.9	**136.11**	2.7	4	**181.48**	490
19	12	**25.79**	8.3	5.6	**59.04**	71	**6.90**	14.49	**33.82**	7.7	4.5	**63.64**	5.6	3.9	**87.50**	490
2.5	4.2	**196.00**	2.7	4.3	**181.48**	1	**490.00**	0.19	**2548.00**	0.21	0.51	**2333.33**	0.21	0.51	**2333.33**	490
43.5		**11.26**	44.3		**11.06**	16	**30.63**	23.19	**21.13**	15.9		**30.82**	15.9		**30.82**	490
10.2	11.6	**87.25**	4.8	4.8	**185.42**	63	**14.13**	5.94	**149.75**	4.6	13.3	**193.48**	7.4	15.9	**120.27**	890
19	11.9	**46.84**	3.2	5.4	**278.13**	18	**49.44**	3.75	**237.33**	4	4.8	**222.50**	8.4	10.5	**105.95**	890
2.5	4.2	**356.00**	6.7	3.7	**132.84**	45	**19.78**	7.76	**114.71**	4.8	16	**185.42**	7	17.6	**127.14**	890
15.7		**56.69**	12.7		**70.08**	11	**80.91**	15.94	**55.83**	2.9		**306.90**	2.9		**306.90**	890
12.2	18.3	**n/a**	7.4	11	**n/a**	85	**n/a**	11.64	**n/a**	10.7	18.5	**n/a**	11.4	23.5	**n/a**	NA
14.80	26.60	**n/a**	8.8	15	**n/a**	80	**n/a**	23.53	**n/a**	20.9	22.7	**n/a**	19	29.8	**n/a**	NA
9.6	7.6	**n/a**	6	4.5	**n/a**	5	**n/a**	1.28	**n/a**	0.42	0.83	**n/a**	0.83	1.2	**n/a**	NA
50		**n/a**	33.8		**n/a**	29	**n/a**	42.03	**n/a**	18.6		**n/a**	18.6		**n/a**	NA
		68.82			**164.08**		**35.07**		**126.21**			**135.09**			**114.59**	
		83.23%			**66.93%**		**69.56%**		**81.65%**			**59.68%**			**28.17%**	
		285.77			**221.08**		**206.11**		**1043.17**			**1135.64**			**1145.83**	
		28.61%			**51.27%**		**121.21%**		**126.06%**			**96.43%**			**97.11%**	
		115.90			**174.63**		**18.21**		**145.82**			**202.91**			**212.88**	
		74.06%			**43.28%**		**76.34%**		**51.57%**			**35.47%**			**52.46%**	
		50.73			**57.77**		**47.05**		**32.46**			**123.28**			**123.28**	
		72.63%			**72.58%**		**62.34%**		**62.34%**			**128.98%**			**128.98%**	

Table 5A. Summary of Nehalem mainstem basin fall chinook standard survey expansion coefficients of variation.

Nehalem River (Mainstem) Survey Index:	1	2	3	4	5
Pooled Random Calibration(interannual cv)	47.61%	57.61%	37.64%	44.70%	11.21%
Mainstem Random Calibration(interannual cv)	71.41%	103.46%	47.80%	34.61%	58.25%
Tributary Random Calibration (interannual cv)	36.64%	16.29%	49.19%	44.07%	60.15%
Standard Survey Expansion (interannual cv)	29.87%	22.67%	22.56%	43.58%	17.19%

	6	7	8	9
Pooled Random Calibration(interannual cv)	96.53%	96.03%	61.36%	91.45%
Mainstem Random Calibration(interannual cv)	88.40%	104.71%	64.80%	89.95%
Tributary Random Calibration (interannual cv)	97.32%	41.67%	52.34%	56.33%
Standard Survey Expansion (interannual cv)	61.52%	8.92%	51.20%	54.63%

Table 6.1. Analysis of fall chinook salmon age composition from the North Fork Nehalem mark-recapture study, 1998. Spawning ground recoveries.

Table 6.1-01. Summary of scale readers analysis of fall chinook salmon carcasses recovered on spawning grounds in the North Fork Nehalem River mark-recapture feasibility study, 1998.

Count of Age	Age						
Gender	2	3	4	5	6	7	Total
F	0	0	17	20	4	0	41
M	2	4	26	7	2	0	41
U	0						0
Total	2	4	43	27	6	0	82

Std Error of the proportion by age for each sex

Gender	Age 2	3	4	5	6	7
Female	0.0%	0.0%	4.5%	4.8%	2.4%	0.0%
Male	1.7%	2.4%	5.2%	3.1%	1.7%	0.0%
Combined	1.7%	2.4%	5.5%	5.2%	2.9%	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%	0.0%	11.9%	15.0%	0.2%	0.0%
Female Upper Ci	0.0%	0.0%	29.6%	33.7%	9.6%	0.0%
Male Lower CI	-0.9%	0.2%	21.6%	2.5%	-0.9%	0.0%
Male Upper CI	5.8%	9.6%	41.8%	14.6%	5.8%	0.0%
Combined Lower CI	-0.9%	0.2%	41.6%	22.7%	1.6%	0.0%
Combined Upper CI	5.8%	9.6%	63.3%	43.2%	13.0%	0.0%

Table 6.1-02. Summary of the proportion within age by gender of fall chinook salmon carcasses recovered on spawning grounds in the year 1998 North Fork Nehalem River mark-recapture feasibility study.

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	0.0%	39.5%	74.1%	66.7%	0.0%
Male	100%	100.0%	60.5%	25.9%	33.3%	0%

Table 6.1-03. Summary of the proportion of fall chinook carcases in the year 1998 North Fork Nehalem River as percent of total sample by gender and by age.

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	0.0%	20.7%	24.4%	4.9%	0.0%
Male	2.4%	4.9%	31.7%	8.5%	2.4%	0.0%
Combined	2.4%	4.9%	52.4%	32.9%	7.3%	0.0%

977 = Estimated number of adult chinook spawners

Table 6.1-04. Summary of the estimated number of fall chinook by age escaping into the North Fork Nehalem River in the year 1998 based on spawning ground recoveries.

	Age						
Gender	2	3	4	5	6	7	Total
Female	0	0	203	238	48	0	489
Male	24	48	310	83	24	0	489
All Chinook	24	48	512	322	71	0	977

Table 6.1-05. Confidence intervals (95%) for the age classes of the estimated fall chinook escapement in the North Fork Nehalem River 1998.

	Age					
	2	3	4	5	6	7
Lower CI	-9	2	406	222	16	0
Upper CI	57	93	619	422	127	0
SE of All Chinook	16.8	23.5	54.1	51.0	28.1	0.0
1/2 95% CI	33	46	107	100	56	0

Table 6.2 Analysis of fall chinook salmon age composition from the North Fork Nehalem River mark-recapture study, 1999. Spawning ground recoveries.

Table 6.2-01. Summary of scale readers analysis of fall chinook salmon carcasses recovered on spawning grounds in the North Fork Nehalem River mark-recapture study, 1999.

Count of Age	Age						
Gender	2	3	4	5	6	7	Total
F	0	0	11	39	2	0	52
M	0	2	18	22	0	0	42
U	0						0
Total	0	2	29	61	2	0	94

Std Error of the proportion by age for each sex

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	0.0%	3.3%	5.1%	1.5%	0.0%
Male	0.0%	1.5%	4.1%	4.4%	0.0%	0.0%
Combined	0.0%	1.5%	4.8%	4.9%	1.5%	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%	0.0%	5.2%	31.5%	-0.8%	0.0%
Female Upper Ci	0.0%	0.0%	18.2%	51.5%	5.1%	0.0%
Male Lower CI	0.0%	-0.8%	11.2%	14.8%	0.0%	0.0%
Male Upper CI	0.0%	5.1%	27.1%	32.0%	0.0%	0.0%
Combined Lower CI	0.0%	-0.8%	21.5%	55.2%	-0.8%	0.0%
Combined Upper CI	0.0%	5.1%	40.2%	74.6%	5.1%	0.0%

Table 6.2-02. Summary of the proportion within age by gender of fall chinook salmon carcasses recovered on spawning grounds in the year 1999 North Fork Nehalem mark-recapture study.

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	0.0%	37.9%	63.9%	100.0%	0.0%
Male	0%	100.0%	62.1%	36.1%	0.0%	0%

Table 6.2-03. Summary of the proportion of fall chinook carcases in the year 1999 North Fork Nehalem River as percent of total sample by gender and by age.

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	0.0%	11.7%	41.5%	2.1%	0.0%
Male	0.0%	2.1%	19.1%	23.4%	0.0%	0.0%
Combined	0.0%	2.1%	30.9%	64.9%	2.1%	0.0%

490 = Estimated number of adult chinook spawners

Table 6.2-04. Summary of the estimated number of fall chinook by age escaping into the North Fork Nehalem River in the year 1999 based on spawning ground recoveries.

	Age						
Gender	2	3	4	5	6	7	Total
Female	0	0	57	203	10	0	270
Male	0	10	94	115	0	0	219
All Chinook	0	10	151	318	10	0	489

Table 6.2-05. Confidence intervals (95%) for the age classes of the estimated fall chinook escapement in the Siuslaw River (excluding North Fork Siuslaw), 2001.

Age-	2	3	4	5	6	7
Lower CI	0	-4	105	270	-4	0
Upper CI	0	25	197	366	25	0
SE of All Chinook	0.0	7.1	23.5	24.5	7.1	0.0
1/2 95% CI	0	15	46	48	15	0

Table 6.3. Analysis of fall chinook salmon age composition from the North Fork Nehalem River mark-recapture study, 2000. Scales taken at tagging.

Table 6.3-01. Summary of scale readers analysis of fall chinook salmon tagged in the North Fork Nehalem River mark-recapture study, 2000.

Count of Age	Age						
Gender	2	3	4	5	6	7	Total
F	0	9	5	0	0	0	14
M	0	3	7	4	1	0	15
U	0						0
Total	0	12	12	4	1	0	29

Std Error of the proportion by age for each sex

	Age						
Gender	2	3	4	5	6	7	
Female	0.0%	8.7%	7.1%	0.0%	0.0%	0.0%	
Male	0.0%	5.8%	8.1%	6.5%	3.4%	0.0%	
Combined	0.0%	6.8%	6.8%	4.2%	2.1%	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%	13.9%	3.2%	0.0%	0.0%	0.0%
Female Upper Ci	0.0%	48.2%	31.2%	0.0%	0.0%	0.0%
Male Lower CI	0.0%	-0.9%	8.3%	1.0%	-3.3%	0.0%
Male Upper CI	0.0%	21.6%	40.0%	26.6%	10.2%	0.0%
Combined Lower CI	0.0%	2.0%	2.0%	-3.0%	-2.9%	0.0%
Combined Upper CI	0.0%	28.7%	28.7%	13.3%	5.4%	0.0%

Table 6.3-02. Summary of the proportion within age by gender of fall chinook salmon tagged in the year 2000 North Fork Nehalem River mark-recapture study.

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	75.0%	41.7%	0.0%	0.0%	0.0%
Male	0%	25.0%	58.3%	100.0%	100.0%	0%

Table 6.3-03. Summary of the proportion of fall chinook tagged in the year 2000 North Fork Nehalem River as percent of total sample by gender and by age.

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	31.0%	17.2%	0.0%	0.0%	0.0%
Male	0.0%	10.3%	24.1%	13.8%	3.4%	0.0%
Combined	0.0%	15.4%	15.4%	5.1%	1.3%	0.0%

890 = Estimated number of adult chinook spawners

Table 6.3-04. Summary of the estimated number of fall chinook by age escaping into the North Fork Nehalem River in the year 2000 based on tagging.

	Age						
Gender	2	3	4	5	6	7	Total
Female	0	276	153	0	0	0	429
Male	0	92	215	123	31	0	461
All Chinook	0	137	137	46	11	0	331

Table 6.3-05. Confidence intervals (95%) for the age classes of the estimated fall chinook escapement in the North Fork Nehalem River in 2000.

Age-	2	3	4	5	6	7
Lower CI	0	18	18	-27	-26	0
Upper CI	0	256	256	118	48	0
SE of All Chinook	0.0	60.7	60.7	37.2	18.9	0.0
1/2 95% CI	0	119	119	73	37	0

Table 6.3. Analysis of fall chinook salmon age composition from the North Fork Nehalem River mark-recapture study, 2000. Spawning ground recoveries.

Table 6.3-06. Summary of scale readers analysis of fall chinook salmon carcasses recovered on spawning grounds in the North Fork Nehalem River mark-recapture study, 2000.

Count of Age	Age						
Gender	2	3	4	5	6	7	Total
F	0	6	3	26	4	0	39
M	0	13	16	9	1	0	39
U	0						0
Total	0	19	19	35	5	0	78

Std Error of the proportion by age for each sex

Gender	Age 2	3	4	5	6	7
Female	0.0%	3.0%	2.2%	5.4%	2.5%	0.0%
Male	0.0%	4.2%	4.6%	3.6%	1.3%	0.0%
Combined	0.0%	4.9%	4.9%	5.7%	2.8%	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%	1.7%	-0.4%	22.8%	0.2%	0.0%
Female Upper Ci	0.0%	13.6%	8.1%	43.9%	10.1%	0.0%
Male Lower CI	0.0%	8.3%	11.5%	4.4%	-1.2%	0.0%
Male Upper CI	0.0%	25.0%	29.5%	18.7%	3.8%	0.0%
Combined Lower CI	0.0%	14.8%	14.8%	33.8%	0.9%	0.0%
Combined Upper CI	0.0%	33.9%	33.9%	56.0%	11.9%	0.0%

Table 6.3-07. Summary of the proportion within age by gender of fall chinook salmon carcasses recovered on spawning grounds in the year 2000 North Fork Nehalem mark-recapture study.

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	31.6%	15.8%	74.3%	80.0%	0.0%
Male	0%	68.4%	84.2%	25.7%	20.0%	0%

Table 6.3-08. Summary of the proportion of fall chinook carcases in the year 2000 North Fork Nehalem River as percent of total sample by gender and by age.

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	7.7%	3.8%	33.3%	5.1%	0.0%
Male	0.0%	16.7%	20.5%	11.5%	1.3%	0.0%
Combined	0.0%	24.4%	24.4%	44.9%	6.4%	0.0%

890 = Estimated number of Chinook spawners.

Table 6.3-09. Summary of the estimated number of fall chinook by age escaping into the North Fork Nehalem River in the year 2000 based on spawning ground recoveries.

	Age						
Gender	2	3	4	5	6	7	Total
Female	0	68	34	297	46	0	445
Male	0	148	183	103	11	0	445
All Chinook	0	217	217	399	57	0	890

Table 6.3-10. Confidence intervals (95%) for the age classes of the estimated fall chinook escapement in the North Fork Nehalem River, 2000.

	Age					
	2	3	4	5	6	7
Lower CI	0	131	131	300	8	0
Upper CI	0	302	302	498	106	0
SE of All Chinook	0.0	43.9	43.9	50.5	25.0	0.0
1/2 95% CI	0	86	86	99	49	0

Table 6.4. Analysis of fall chinook salmon age composition from the mainstem Nehalem River mark-recapture study, 2000. Scales taken at tagging.

Table 6.4-01. Summary of scale readers analysis of fall chinook salmon tagged in the mainstem Nehalem River mark-recapture feasibility study, 2000.

Count of Age	Age						
Gender	2	3	4	5	6	7	Total
F	0	48	48	67	3	0	166
M	0	49	31	13	0	0	93
U	0						0
Total	0	97	79	80	3	0	259

Std Error of the proportion by age for each sex

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	2.4%	2.4%	2.7%	0.7%	0.0%
Male	0.0%	2.4%	2.0%	1.4%	0.0%	0.0%
Combined	0.0%	3.0%	2.9%	2.9%	0.7%	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%	13.8%	13.8%	20.5%	-0.1%	0.0%
Female Upper Ci	0.0%	23.3%	23.3%	31.2%	2.5%	0.0%
Male Lower CI	0.0%	14.1%	8.0%	2.4%	0.0%	0.0%
Male Upper CI	0.0%	23.7%	15.9%	7.7%	0.0%	0.0%
Combined Lower CI	0.0%	31.5%	24.9%	25.3%	-0.1%	0.0%
Combined Upper CI	0.0%	43.4%	36.1%	36.5%	2.5%	0.0%

Table 6.4-02. Summary of the proportion within age by gender of fall chinook salmon tagged in the year 2000 mainstem Nehalem mark-recapture feasibility study.

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	49.5%	60.8%	83.8%	100.0%	0.0%
Male	0%	50.5%	39.2%	16.3%	0.0%	0%

Table 6.4-03. Summary of the proportion of fall chinook tagged in the year 2001 Siuslaw River as percent of total sample by gender and by age.

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	18.5%	18.5%	25.9%	1.2%	0.0%
Male	0.0%	18.9%	12.0%	5.0%	0.0%	0.0%
Combined	0.0%	37.5%	30.5%	30.9%	1.2%	0.0%

10,678 = Estimated number of fall chinook spawners

Table 6.4-04. Summary of the estimated number of fall chinook by age escaping into the mainstem Nehalem River in the year 2000 based on scales taken at tagging.

	Age						
Gender	2	3	4	5	6	7	Total
Female	0	1979	1979	2762	124	0	6844
Male	0	2020	1278	536	0	0	3834
All Chinook	0	3999	3257	3298	124	0	10678

Table 6.4-05. Confidence intervals (95%) for the age classes of the estimated fall chinook escapement in the mainstem Nehalem River, 2000.

	Ages					
	2	3	4	5	6	7
Lower CI	0	3368	2657	2696	-16	0
Upper CI	0	4630	3857	3900	263	0
SE of All Chinook	0.0	321.9	306.1	307.1	71.4	0.0
1/2 95% CI	0	631	600	602	140	0

Table 6.4. Analysis of fall chinook salmon age composition from the mainstem Nehalem River mark-recapture study, 2000. Spawning ground recoveries.

Table 6.4-06. Summary of scale readers analysis of fall chinook salmon carcasses recovered on spawning grounds in the mainstem Nehalem River mark-recapture feasibility study, 2000.

Count of Age	Age						
Gender	2	3	4	5	6	7	Total
F	0	10	73	78	5	0	166
M	0	51	84	67	1	0	203
U	0						0
Total	0	61	157	145	6	0	369

Std Error of the proportion by age for each sex

Gender	Age 2	3	4	5	6	7
Female	0.0%	1.0%	2.5%	2.5%	0.7%	0.0%
Male	0.0%	2.1%	2.6%	2.4%	0.3%	0.0%
Combined	0.0%	2.3%	3.1%	3.0%	0.8%	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%	0.7%	14.9%	16.2%	-0.1%	0.0%
Female Upper Ci	0.0%	4.7%	24.6%	26.1%	2.8%	0.0%
Male Lower CI	0.0%	9.6%	17.6%	13.5%	-0.4%	0.0%
Male Upper CI	0.0%	18.0%	27.9%	22.9%	0.9%	0.0%
Combined Lower CI	0.0%	12.0%	36.5%	33.3%	0.1%	0.0%
Combined Upper CI	0.0%	21.1%	48.6%	45.3%	3.2%	0.0%

Table 6.4-07. Summary of the proportion within age by gender of fall chinook salmon carcasses recovered on spawning grounds in the year 2000 mainstem Nehalem mark-recapture feasibility study.

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	16.4%	46.5%	53.8%	83.3%	0.0%
Male	0%	83.6%	53.5%	46.2%	16.7%	0%

Table 6.4-08. Summary of the proportion of fall chinook carcases in the year 2000 mainstem Nehalem River as percent of total sample by gender and by age.

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	2.7%	19.8%	21.1%	1.4%	0.0%
Male	0.0%	13.8%	22.8%	18.2%	0.3%	0.0%
Combined	0.0%	16.5%	42.5%	39.3%	1.6%	0.0%

10,678 = Estimated number of fall chinook spawners

Table 6.4-09. Summary of the estimated number of fall chinook by age escaping into the mainstem Nehalem River in the year 2000 based on spawning ground recoveries.

	Age						
Gender	2	3	4	5	6	7	Total
Female	0	289	2112	2257	145	0	4803
Male	0	1476	2431	1939	29	0	5875
All Chinook	0	1765	4543	4196	174	0	10678

Table 6.4-10. Confidence intervals (95%) for the age classes of the estimated fall chinook escapement in the mainstem Nehalem River, 2000.

	Age					
	2	3	4	5	6	7
Lower CI	0	1281	3899	3560	9	0
Upper CI	0	2249	5187	4832	338	0
SE of All Chinook	0.0	246.9	328.6	324.5	84.2	0.0
1/2 95% CI	0	484	644	636	165	0

Table 6.5. Analysis of fall chinook salmon age composition from the mainstem Nehalem River mark-recapture study, 2001.

Table 6.5-01. Summary of scale readers analysis of fall chinook salmon tagged in the mainstem Nehalem River mark-recapture study, 2001.

Count of Age	Age						
Gender	2	3	4	5	6	7	Total
F	0	60	145	23	1	0	229
M	0	60	112	4	0	0	176
U	0						0
Total	0	120	257	27	1	0	405

Std Error of the proportion by age for each sex

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	1.8%	2.4%	1.2%	0.2%	0.0%
Male	0.0%	1.8%	2.2%	0.5%	0.0%	0.0%
Combined	0.0%	2.3%	2.4%	1.2%	0.2%	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%	11.4%	31.1%	3.4%	-0.2%	0.0%
Female Upper Ci	0.0%	18.3%	40.5%	7.9%	0.7%	0.0%
Male Lower CI	0.0%	11.4%	23.3%	0.0%	0.0%	0.0%
Male Upper CI	0.0%	18.3%	32.0%	2.0%	0.0%	0.0%
Combined Lower CI	0.0%	25.2%	58.8%	4.2%	-0.2%	0.0%
Combined Upper CI	0.0%	34.1%	68.2%	9.1%	0.7%	0.0%

Table 6.5-02. Summary of the proportion within age by gender of fall chinook salmon tagaged in the year 2001 mainstem Nehalem mark-recapture study.

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	50.0%	56.4%	85.2%	100.0%	0.0%
Male	0%	50.0%	43.6%	14.8%	0.0%	0%

Table 6.5-03. Summary of the proportion of fall chinook tagged in the year 2001 mainstem Nehalem River as percent of total sample by gender and by age.

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	14.8%	35.8%	5.7%	0.2%	0.0%
Male	0.0%	14.8%	27.7%	1.0%	0.0%	0.0%
Combined	0.0%	29.6%	63.5%	6.7%	0.2%	0.0%

12,431 = Estimated number of fall chinook spawners

Table 6.5-04. Summary of the estimated number of fall chinook by age escaping into the mainstem Nehalem River in the year 2001 based on scales taken during tagging.

	Age						
Gender	2	3	4	5	6	7	Total
Female	0	1842	4451	706	31	0	7030
Male	0	1842	3438	123	0	0	5403
All Chinook	0	3683	7888	829	31	0	12431

Table 6.5-05. Confidence intervals (95%) for the age classes of the estimated fall chinook escapement in the mainstem Nehalem River, 2001.

	Ages					
	2	3	4	5	6	7
Lower CI	0	3130	7305	526	-29	0
Upper CI	0	4237	8472	1131	91	0
SE of All Chinook	0.0	282.1	297.4	154.6	30.6	0.0
1/2 95% CI	0	554	584	303	60	0

Table 6.5. Analysis of fall chinook salmon age composition from the mainstem Nehalem River mark-recapture study, 2001.

Table 6.5-06. Summary of scale readers analysis of fall chinook salmon carcasses recovered in the mainstem Nehalem River mark-recapture study, 2001.

Count of Age	Age						
Gender	2	3	4	5	6	7	Total
F	0	29	349	93	4	0	475
M	13	226	446	57	0	0	742
U	0						0
Total	13	255	795	150	4	0	1217

Std Error of the proportion by age for each sex

Gender	Age 2	3	4	5	6	7
Female	0.0%	0.4%	1.3%	0.8%	0.2%	0.0%
Male	0.3%	1.1%	1.4%	0.6%	0.0%	0.0%
Combined	0.3%	1.2%	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

	2	3	4	5	6	7
Female Lower CI	0.0%	1.5%	26.1%	6.1%	0.0%	0.0%
Female Upper Ci	0.0%	3.2%	31.2%	9.1%	0.7%	0.0%
Male Lower CI	0.5%	16.4%	33.9%	3.5%	0.0%	0.0%
Male Upper CI	1.6%	20.8%	39.4%	5.9%	0.0%	0.0%
Combined Lower CI	0.5%	18.7%	62.6%	10.5%	0.0%	0.0%
Combined Upper CI	1.6%	23.2%	68.0%	14.2%	0.7%	0.0%

Table 6.5-07. Summary of the proportion within age by gender of fall chinook salmon carcasses recovered in the year 2001 mainstem Nehalem mark-recapture study.

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	11.4%	43.9%	62.0%	100.0%	0.0%
Male	100%	88.6%	56.1%	38.0%	0.0%	0%

Table 6.5-08. Summary of the proportion of fall chinook carcasses recovered in the year 2001 mainstem Nehalem River as percent of total sample by gender and by age.

	Age					
Gender	2	3	4	5	6	7
Female	0.0%	2.4%	28.7%	7.6%	0.3%	0.0%
Male	1.1%	18.6%	36.6%	4.7%	0.0%	0.0%
Combined	1.1%	21.0%	65.3%	12.3%	0.3%	0.0%

12,431 = Estimated number of fall chinook spawners

Table 6.5-09. Summary of the estimated number of fall chinook by age escaping into the mainstem Nehalem River in the year 2001 based on spawning ground recoveries.

	Age						
Gender	2	3	4	5	6	7	Total
Female	0	296	3565	950	41	0	4852
Male	133	2308	4556	582	0	0	7579
All Chinook	133	2605	8120	1532	41	0	12431

Table 6.5-10. Confidence intervals (95%) for the age classes of the estimated fall chinook escapement in the mainstem Nehalem River, 2001.

	Age					
	2	3	4	5	6	7
Lower CI	61	2320	7788	1302	1	0
Upper CI	205	2889	8453	1762	81	0
SE of All Chinook	36.7	145.4	169.4	117.3	20.4	0.0
1/2 95% CI	72	285	333	230	40	0

Age Composition

Age composition based on scales taken at tagging and during spawning ground recoveries are presented in Tables 6.1 through 6.5. In general, males are returning at ages 3 and 4, with very few age 5 individuals represented in the samples. Females return predominately at ages 4 and 5, with a somewhat lower frequency of age 3 individuals. Age 6 individuals are uncommon in this population.

Radio Telemetry – Habitat Use and Spawning Ground Residence Time

We successfully tracked 34 radio tagged chinook in 2000 and 43 radio tagged chinook in 2001. In each year, approximately three quarters of the chinook spawned in mainstem habitat strata, and about one quarter in tributary habitat strata. These results are in accord with the results of radio tracking of fall chinook in other coastal basins (Table 7).

Table 7. Distribution of radio tagged fall chinook by strata from telemetry studies from four telemetry studies in three Oregon coastal basins.

Location	**Mainstem Strata**			**Tributary Strata**		
	n	Distribution	SE	n	Distribution	SE
Nehalem River-00	26	76%	0.017	8	24%	0.032
Nehalem River-01	31	72%	0.015	12	28%	0.039
Siuslaw River-02	28	76%	0.016	9	24%	0.050
South Fork Coos River-99	83	82%	0.005	18	18%	0.022

Terminal Harvest Estimates

Creel surveys began July 1 and extended through November. In 2000 and 2001, the bulk of the salmon entered the bay by mid October and bay angling was done by November 1. However, 2002 marked a dramatic change in that the bulk of the salmon did not enter the bay until after November 1. Consequently, the distribution of effort of surveyors among sampling areas necessarily varies from year to year.

2002 was an experimental year in an attempt to streamline the Nehalem data collection process. Changes that were made include: targeting fishing boats, targeting fishing dock locations, and targeting fishing boat pressure counts. The purpose of the changes was to eliminate the collection of data unrelated to salmon harvest. In particular, changes excluded crabbing and non-fishing data.

The goal of the creel project is to calibrate Oregon's angler harvest card database that is the state's standard method for estimating recreational salmonid harvest. There are now two years of overlapping data for comparison as there is generally a two year lag in the computation of these harvest estimates. The creel survey for 1999 shows close agreement with the harvest card estimate, while the 2000 project creel estimate is 50% higher than the corresponding harvest card estimates (Table 8).

Table 8. Estimated terminal harvest catch of fall chinook salmon in the Nehalem River 1987-2001.

Harvest estimates based on recreational angler punchcards: 1987 - 2000

Stream	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	20
						Run Year										
Nehalem R. & Bay below Elsie	1,925	1,997	1,243	1,343	1,776	2,239	3,508	2,527	2,990	3,390	2,509	2,314	1,901	1,979		
Nehalem R. & Bay above Elsie	--	--	--	--	--	104	0	37	48	100	36	10	44	41		
N. Fk. Nehalem River	169	252	271	279	316	377	456	350	565	540	482	273	149	157		
Nehalem Total	2,094	2,249	1,514	1,622	2,092	2,720	3,964	2,914	3,603	4,030	3,027	2,597	2,094	2,177	n/a	n/a
													Harvest estimates based on creel survey: 1999 - 200			
													2002	3357	2978	
Creel Estimate/Catch Card Estimate (%)													95.61%	154.20%		

Creel point estimates have been calculated for 2001 and 2002. However, challenges of data compilation into the appropriate format for calculating variances has not been completed.

DISCUSSION

The Nehalem stock indicator project demonstrates that mark-recapture escapement estimates can be conducted with a high level of precision in large coastal river systems. The project also shows improved precision and efficiency as methodologies have evolved based on experience.

The mainstem Nehalem (exclusive of the North Fork Nehalem) accounts for an estimated 90% of the fall chinook returning to this system. Our efforts there 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.

The North Fork Nehalem River efforts at mark-recapture were disappointing. The system and site for tagging were selected to take advantage of existing facilities and opportunities. However, the small size of the North Fork Nehalem fall chinook population has precluded the cost-effective development of precise spawner abundance estimates that are adequate for CTC purposes.

Results of radio telemetry work in the Nehalem contributes to our understanding of fall chinook in two ways. First, it confirms and refines our understanding of residence time of live fish on spawning grounds, a parameter that is is important in estimating 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 adequate to determine whether any of the indices being used can provide a 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 coarse approach presented here.

Creel surveys as a means to calibrate the Oregon catch-card monitoring of salmonid harvest are also too preliminary to evaluate effectively at this time. Our work is constrained by several factors including the time-lag in developing Oregon catch-card harvest estimates, and the lack of variance information associated with these estimates.

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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 (p. 17).

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 random assortment by Julian week and sub-basin for marked and unmarked chinook salmon.

Marked and Unmarked chinook by Nehalem sub-basin, 2002

□	Observed	□	□	□	Expected	□	□	□	□
□	marked	unmarked			marked	unmarked		chitest	d.f.
Cook	18	155	173		17	156		1.371E-10	6
Humbug	64	998	1062		105	957			□
Lost	28	285	313		31	282			□
Nehalem	136	806	942		93	849			□
Rock	30	146	176		17	159			□
Salmnbry	8	174	182		18	164			□
Rest	3	53	56		6	50			□
sum	287	2617	2904	□	□	□	□	□	□

Marked and Unmarked chinook by Julian week, 2002

□	Observe	□	□	□	Expected	□	□	□	□
weeks	marked	unmarked	sum		marked	unmarked		chitest	d.f.
39,40	11	48	59		6	53		4.057E-11	9
41	39	234	273		27	246			□
42	25	161	186		18	168			□
43	30	167	197		19	178			□
44	17	96	113		11	102			□
45	9	56	65		6	59			□
46	21	78	99		10	89			□
47	73	663	736		73	663			□
48	40	624	664		66	598			□
49 - 51	22	490	512		51	461			□
sum	287	2617	2904	□	□	□	□	□	□

Appendix B: Chi Square tests of random assortment by Julian week and sub-basin for marked and unmarked chinook salmon.

Marked and Unmarked chinook by Nehalem sub-basin, 2001

	Observed			Expected			
Sub-basin	marked	unmarked	sum	marked	unmarked	chitest	d.f.
Humbug	19	308	327	21	306	4.63692E-07	4
Nehalem	45	316	361	23	338		
Rock	9	299	308	20	288		
Salmonberry	2	127	129	8	121		
Other	0	28	28	2	26		
sum	75	1078	1153				

Marked and Unmarked chinook by Julian week, 2001

	Observed			Expected			
Week(s)	marked	unmarked	sum	marked	unmarked	chitest	d.f
39-42	10	262	272	18	254	0.001719941	3
43	24	242	266	17	249		
44	17	124	141	9	132		
45-48	24	450	474	31	443		
sum	75	1078	1153				