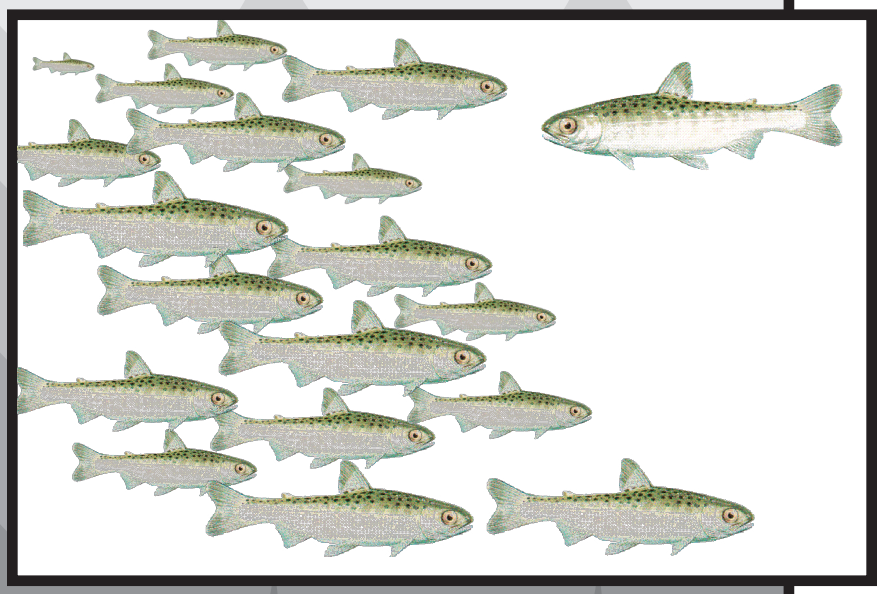
STATE OF WASHINGTON May 2006

2004 Skagit River Wild 0+ Chinook Production Evaluation Annual Report



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Washington Department of
FISH AND WILDLIFE
Fish Program
Science Division

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STATE OF WASHINGTON
DEPARTMENT OF FISH AND WILDLIFE

Annual Report

2004 Skagit River
Wild 0+ Chinook Production Evaluation

Funded by Seattle City Light

Greg Volkhardt
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Acknowledgements

Evaluation of the wild 0+ chinook production from the Skagit River in 2004 was made possible with funding from Seattle City Light. This eighth year of support, combined with funds from the Dingell-Johnson/Wallop-Breaux program and matched with Washington Department of Fish & Wildlife funds, enabled the *Wild Salmon Production Evaluation* unit to trap downstream migrants in the lower Skagit River from mid-January through July.

We appreciate the contributions of a number of individuals who provided logistical support: Sherman and Pat Courier, adjacent property owners, for providing drinking water and utility access at the site, and over-winter trap storage; Dike District 17 for allowing us to locate the mobile field office on their property; and Burlington Northern for continuing to allow us to anchor the trap barges to their railroad bridge.

The success of this project relies on the hard work of a number of dedicated permanent and temporary WDFW personnel. Scientific Technicians Mat Gillum, Jim Repoz, Dean Toba and Scott McGrath worked long hours operating and maintaining the traps, and enumerating and sampling catches. Unit biologists Mike Ackley and Pete Topping provided valuable logistical support during trap installation and removal, and Mark Hino developed the computer database which helped analyze much of the trap data contained in this report. We would also like to thank Pete Castle and the Region 4 staff for their diligent work on the adult spawner surveys and chinook escapement estimates.

Executive Summary

Skagit River chinook returns (spring and summer/fall combined) have declined over the last fifty years. In 1999, Puget Sound chinook salmon were listed as "Threatened" under the Endangered Species Act. To address this poor stock status, resource managers formed the multi-agency Skagit River Chinook work group in 1995. A major goal of this work group is to determine the factors that limit chinook production. In addition to assessing habitat and adult returns, monitoring juvenile production was initiated as it directly measures freshwater survival. Evaluating the biological attributes of outmigration timing and size contributes to our understanding of chinook freshwater life history. This information is useful for flow management, habitat protection and restoration, and designing hatchery programs to minimize adverse interactions.

In 1990, WDFW initiated downstream migrant trapping in the Skagit River system at Burlington. Although this project was originally directed at assessing coho smolt production (April through June), we identified and enumerated all fish captured. In 1991, through a fisheries settlement agreement with state, federal and tribal agencies, Seattle City Light (operators of several dams on the Skagit River) created the Skagit Non-Flow Plan Coordinating Committee (NCC). Beginning in 1997, this program provided funding to expand our Skagit River downstream migrant trapping project to also estimate chinook production (January through July). This report documents our investigations in Spring 2004, the fifteenth year that we have measured downstream migrants from the Skagit River.

We used two traps, a floating inclined-plane screen trap (scoop trap) and a screw trap, to capture downstream migrants in 2004. The traps were operated from January 23 through July 28, and were fished every night and every third day unless flows and associated debris loads were excessive. Over the season we captured 13,009 and 6,694 wild 0+ chinook in the scoop and screw traps, respectively. Approximately 50% of the chinook outmigrants passing the mainstem traps by April 15. This is the third latest migration timing we have observed thus far, and the latest observed since 1998. Expanding catches for the intervals not fished estimates an additional 6,019 and 4,389 wild 0+ chinook would have been captured in the scoop and screw traps, respectively. Combining these projected catches with the actual catches estimates 30,111 wild 0+ chinook would have been caught in the two traps had we fished continuously from January 23 through July 28.

In addition to wild chinook, we caught a total of 19,474 ad-marked and coded-wire tagged (CWT) hatchery 0+ chinook in the mainstem traps. We estimate that, had the trap fished continuously, we would have caught an additional 7,980 hatchery fish. The projected total catch of 27,454 hatchery chinook includes 6,911 fall 0+ chinook (released at Baker River), 10,669 summer 0+ chinook (released at Countyline Ponds) and 8,445 spring 0+ chinook (released at Skagit Hatchery). Application of the catch rate for ad-marked/CWT fish (3.5%) to the projected season catch yields a combined estimate of 785,000 zero-age hatchery chinook. This estimate exceeds the reported number of hatchery chinook released because it includes unmarked/untagged fish from an unknown number of additional chinook released from Marblemount Hatchery that were too small or in too poor of condition to tag. This estimate indicates a very high (near 100%) survival rate for hatchery chinook released in 2004. Past years results indicates a 50% survival rate to the Burlington traps is more typical for hatchery releases.

To estimate trap efficiency early in the season (prior to May 26), we conducted four mark-recapture experiments using hatchery chinook. Recovery rates for these groups averaged 1.2%. Trap efficiency increased to 3.5% after this date as indicated by the recovery of ad-marked/CWT hatchery release groups. Production was estimated by stratifying the catch data and applying these two rates to projected catches occurring before and after May 26. This estimated system production at approximately 1.8-million zero-age wild chinook. Average survival-to-migration is estimated at 7.0%. This estimate is based on a potential deposition of 25.7 million eggs (4,668 females and an average fecundity of 5,500 eggs/female) for the 2003 brood.

Over the previous fourteen seasons, flow during egg incubation has explained most of the inter-annual variation in our estimates of egg-to-migrant survival rates. The survival rate measured in 2004 is nearly equal to the predicted value. Other factors may exert a greater influence on survival during lower, more benign, peak incubation flows. Continued monitoring of juvenile production including broods with high spawning populations and additional flow analyses will further define the constraints to chinook production from the Skagit River.

Introduction

Skagit River chinook returns (spring and summer/fall combined) have declined over the last fifty years (PSSSRG 1992, 1997). In 1994, the Joint Chinook Technical Committee of the Pacific Salmon Commission designated the status of these stocks as "Not Rebuilding." To address this poor stock status, resource managers formed the Skagit River Chinook work group in 1995. Composed of state, tribal, and federal fish biologists, this group recommends and coordinates restoration and monitoring programs. A major goal of this work group is to determine the limiting factors for chinook. Necessary data for this purpose include an indicator-stock tagging program, habitat inventory, annual adult escapement estimation, and wild juvenile chinook assessment. The juvenile production evaluation is a vital link in this process because it provides a direct measure of freshwater survival.

Seattle City Light (operators of several dams on the Skagit River), through a 1991 fisheries settlement agreement with WDFW, the Skagit tribes (Skagit System Cooperative or SSC) and federal agencies – National Marine Fisheries Service (NMFS), US Fish & Wildlife Service (USFWS), US Forest Service (USFS) and National Park Service (NPS) – created the Skagit Non-Flow Plan Coordinating Committee (NCC). The NCC is responsible for funding several non-flow fisheries programs including the "Chinook Research Program." Beginning in 1997, this program provided funding to conduct chinook studies. This report documents our 2004 downstream migrant trapping project in the Skagit River which, with funding from the NCC, we expanded to continue estimating wild 0+ chinook production.

Understanding the major sources of inter-annual variation in run size is critical to improving harvest and habitat management. Quantifying anadromous salmonid populations as seaward migrants near saltwater entry is the most direct assessment of stock performance in freshwater because the variation resulting from marine survival and harvest are precluded. Relating smolt production to adult spawners over a number of broods empirically determines the watershed's natural production potential (provided escapement and environmental conditions are sufficient), its stock/recruit function if escapements are less than that required to achieve maximum production, and enables identification of the major density-independent source(s) of inter-annual variation in freshwater survival. To accomplish these and other fish management objectives, the WDFW implemented a long-term research program directed at measuring wild salmon production in terms of smolts and adults in selected watersheds, beginning in 1976 (Seiler *et al.*1981). In 1981, this program, which was directed primarily at coho salmon, was expanded to include additional large watersheds (Seiler *et al.*1984).

In 1990, we initiated downstream migrant trapping in the Skagit River system to quantify wild coho smolt production to, among other objectives, resolve a discrepancy in escapement estimates (Conrad *et al.* 1997). This program, which in 2004 was in its fifteenth year, involves trapping and marking wild coho smolts emigrating from a lower river tributary, Mannser Creek (R.M. 35), and sampling a portion of the entire population via floating traps in the lower mainstem (R.M. 17, Burlington Northern railroad bridge).

Although our trapping in the mainstem was originally directed at coho smolts, we identify and enumerate all fish captured. For the first seven years of this study (1990-1996), season total 0+ chinook catches in the one scoop trap varied six-fold, from 1,700 to 10,500 chinook. (As of 1993, we have simultaneously operated both a scoop and a screw trap.) In addition to abundance, these catch totals are influenced by fishing effort (the time fished on each date and for the season), migration

timing relative to the interval we trapped, and instantaneous trap efficiency. Many such variables as discharge, water velocity, turbidity, debris, channel configuration, trap placement, and fish size combine to affect both instantaneous and season average trap efficiency.

Preliminary expansion of these 0+ chinook catches, based on an average capture rate and several other assumptions held consistent between years, has yielded annual juvenile chinook production estimates that range from 0.5 to 6.5 million. The accuracy and precision of these estimates is presently incalculable because the assumptions remain unverified. We believe, however, that these estimates reflect the abundance of wild 0+ chinook production from these broods, at least in a relative sense. We base this contention upon the significant negative correlation between the freshwater survival estimates and the severity of flow during the period that the eggs were incubating in the gravel. The survival rates in this relationship are the ratio of total 0+ chinook emigrants estimated past the traps to the potential egg deposition. System total egg deposition is simply the product of the estimated total adult chinook escapement, an assumed sex ratio, and a fecundity of 5,500 eggs/female (Pete Castle pers. comm.). This relationship indicates that overall egg-to-migrant survival for Skagit River chinook has varied over ten-fold within just the first seven broods, almost entirely as a function of flow during egg incubation.

Measuring the biological attributes of outmigration timing and size contributes to our understanding of juvenile chinook freshwater life history. This information is useful for flow management (dams and other flow controls), habitat protection, and designing hatchery programs to minimize hatchery/wild interactions.

We estimate coho smolt production from the Skagit River with the mark and recapture strategy that we developed and have used successfully in a number of large watersheds throughout the state over many years. This method involves the following components:

1. Trapping all the wild coho smolts emigrating from a selected tributary;
2. Identifying each of these smolts with an external mark; and
3. Capturing a portion of the smolt population migrating through the lower mainstem and examining each fish for the mark.

This design produces relatively precise and (we believe) unbiased production estimates, because a temporally- representative portion of the coho population is marked via 100% trapping at an upstream tributary. Therefore, trapping in the mainstem does not have to be continuous or even representative with respect to timing (Seber 1982). We explicitly developed this design to avoid the requirement of estimating gear efficiency.

Because of the early life history characteristics of chinook in freshwater, estimating their smolt production with the same statistical precision we achieve for coho smolts is not possible. Chinook originate in discrete portions of the mainstem, and subsequently rear for variable intervals in various reaches. Therefore, the methodology we use with coho, capturing and identifying a representative portion of the entire population, is not feasible for chinook. Each component likely has different survival patterns that result from the complex interactions of a number of factors: their parent's spawning timing and distribution; genetically-programmed juvenile rearing strategies; and the flow and habitat conditions each brood and sub-population within it encounters. In a system as wide as the lower Skagit River, the migration pathways selected may also vary between sub-populations, which

would affect capture rates. The susceptibility of migrants to capture also varies as a function of flow and environmental conditions in effect at the trap and upstream of it.

Sources of Variation Affecting Wild 0+ Chinook Estimates

Given the foregoing problems, estimating wild juvenile 0+ chinook production from the trapping data we have collected in the lower Skagit River involves a number of assumptions. Accuracy of the production estimates is a direct function of the veracity of these assumptions. Each assumption deals with the uncertainty resulting from the following five major sources of variation we have identified.

1. **Trap efficiency**. Expanding catches to estimate wild 0+ chinook production requires estimates of instantaneous gear efficiency, ideally as a function of some measurable variable such as flow.

2. **Day vs. night trap efficiency**. Trap efficiency may be influenced by light. For example, it may be lower during the daylight than at night.

   We have operated the traps primarily at night because catch rates, especially for coho and to a lesser extent chinook, are higher at night than during the daylight. Estimating instantaneous trap efficiency during the daylight hours, however, is probably not possible because it would require that a sufficient and known number of marked wild chinook pass the traps within a single daylight period. The traps fish only the top 4 ft of the water column, and the depth at our site is 20-30 ft, depending on discharge. If, as a function of increasing light intensity, juvenile chinook migrate at greater depth and/or their ability to avoid the trap increases, then trap efficiency during daylight hours would be lower. The behavior of juvenile chinook and the biases imposed by releasing marked fish immediately upstream of the traps precludes estimating instantaneous efficiency within such a limited time interval as a single daylight period. Catches during daylight hours appear to be positively affected by increasing turbidity. If true, this positive correlation between daytime catch and turbidity results from either increased migration rate and/or an increase in trap efficiency because avoidance is reduced.

3. **Day vs. night migration**. Efficiency-based estimates rely on trapping either continuously or randomly throughout the time strata that migration is estimated. We developed our experimental design for estimating coho production to avoid the requirement of continuous trapping in the mainstem. Therefore, trapping in the early years was conducted almost entirely at night.

4. **Migration interval**. Skagit River 0+ chinook emigrate over a longer season than coho smolts. Chinook begin their downstream migration in January or earlier, and continue through the summer. In the first four years, we operated the traps only over the coho smolt migration period, early-April through mid-June. Beginning in 1994, and continuing through 1996, we extended trapping as late as mid-July. In 1997, we began trapping in mid-February and continued into September. To better define the early portion of the migration period, in 1998, we began trapping in mid-January and extended trapping into September. In 1999 and 2000 we assessed late migration by operating the traps intermittently during October.

5. **Incidence of hatchery-produced fish**. Prior to 1994, releases of hatchery-produced 0+ chinook in the Skagit River were unmarked. Consequently, our estimates of wild chinook production for the first four years rely on an assumption for the number of hatchery-produced

fingerlings we caught. Estimating wild and hatchery components of the migration relies on assumptions of how many hatchery fish survived to pass the trap during the interval trapped. Beginning with the 1993 brood, (released in 1994) all hatchery-produced zero-age chinook released into the Skagit River have been marked with an adipose fin-clip (ad-mark) and coded-wire tagged.

Study Plan for 2004

The study plan for the 2004 trapping season was directed at continuing to improve the estimates of Skagit River chinook production through achieving a better understanding of the sources of variation. In addition to continuing our analysis of the chinook and coho trapping data collected over the previous fourteen years, the 2004 work plan included the following six operational elements.

1. **Trapping season**. Operate traps from mid-January through July.

2. **Nightly trap operation**. Fish the scoop and screw traps nightly throughout the season.

3. **Daytime trap operation**. Trap throughout every third day; enumerate catches shortly after dawn and around dusk to separate day and night catches.

4. **Wild coho marking**. Install 100% smolt trap at Mannser Creek (tributary to the lower river) in mid-April, and operate continuously through mid-June. Enumerate and mark (left-ventral fin clip) captured coho smolts. Sampling mainstem trap catches for these marks provides the basis for estimated coho smolt production from this system. In addition, the recovery rate of these marked fish yields the season average trap efficiency.

5. **Trap efficiency**. In addition to the wild coho marked and released from the Mannser Creek tributary trap and the groups of ad-marked/coded-wire tagged hatchery chinook fingerlings released from the three production facilities (Countyline Ponds, Baker River and Skagit Hatchery), we marked and released four groups of hatchery chinook above the trap to calibrate trap efficiency.

6. **Visibility/Turbidity**. Relate turbidity data taken at the water withdrawal plant at Mount Vernon to our day:night catch rate ratios.

Methods

Trapping Gear and Operation

We use two trap types: a floating inclined-plane screen trap (scoop trap) (Seiler *et al.* 1981) and a screw trap (Busack *et al.* 1991). Both traps are contained between steel pontoon barges, outfitted with two five-ton, bow-mounted anchor winches loaded with up to 600 ft of $^3/_8$-inch aircraft cable. Overall, the scoop trap barge measures 13-ft x 44-ft, while the screw trap barge is 15-ft x 30-ft. The inclined-screen of the scoop trap is 6-ft wide, and we fish it 3.5-ft deep to maintain an oblique angle to the flow. We have found that the angle formed by the 16 ft-long screen, set 3.5-ft deep at the entrance, precludes impinging even such small migrants as pink and chum fry, as there is sufficient sweep velocity across the surface relative to the flow through it. At this depth, the scoop trap screens a rectangular cross-sectional area of 21-ft^2. The 8-ft diameter screw trap screens a cross-sectional area of 25-ft^2, in the shape of a semi-circle.

The traps were placed in the lower Skagit River at R.M. 17 (Figure 1). With the permission of Burlington Northern, we attached the four anchor lines to the bridge support structures. The traps were positioned side by side in the zone of highest water velocity, which is just south of the southernmost pier, approximately 70-ft from the south bank. Velocity at this site varies as a function of discharge. At low flows it averages around 5 fps, and increases to around 9 fps at high flows.

The traps were fished every night and every third day. All captured fish were enumerated by species and age and examined for external marks. Samples of wild chinook, coho, steelhead, and char were measured (fork length) over the season. We used the nonparametric Kolmogorov-Smirnov (K-S) two-sample test (Sokal and Rohlf 1981) to check for differences in the size distributions between the scoop and screw trap catches, and marked releases versus those recaptured in the mainstem traps. We used SYSTAT 8.0 (SPSS Inc.1998) to conduct the K-S test and generate the maximum unsigned difference between the two distributions with a corresponding probability value >0.05.

Environmental Parameters

Flow is the dominant factor affecting downstream migrant trapping operations in any system. This is particularly true in the lower Skagit River due to the quantity of large woody debris this system transports during rising and high flows. We used daily mean flow data provided by the USGS gauge, located at Mount Vernon. We also measured water temperature daily and obtained turbidity data from the Anacortes water withdrawal facility in Mount Vernon, located just below the trap site at R.M.16.

Estimating Migration

Estimating migration for any period, whether over a short time interval or an entire season, requires a catch and an estimate of capture rate or trap efficiency. Catch is the product of abundance and capture rate (Equation 1). As our objective is to estimate abundance, and catch is simply a count within a time period, estimating capture rate is the primary challenge. We directed our analysis of the catch data at correlating day and night catch rates with flow and turbidity data. We evaluated the value of these correlations to project 24-hour catches of wild 0+ chinook and selected groups of marked fish to the standard of continuous trapping. Relating the projected numbers of marked fish recovered to the numbers released provides estimates of capture rates.

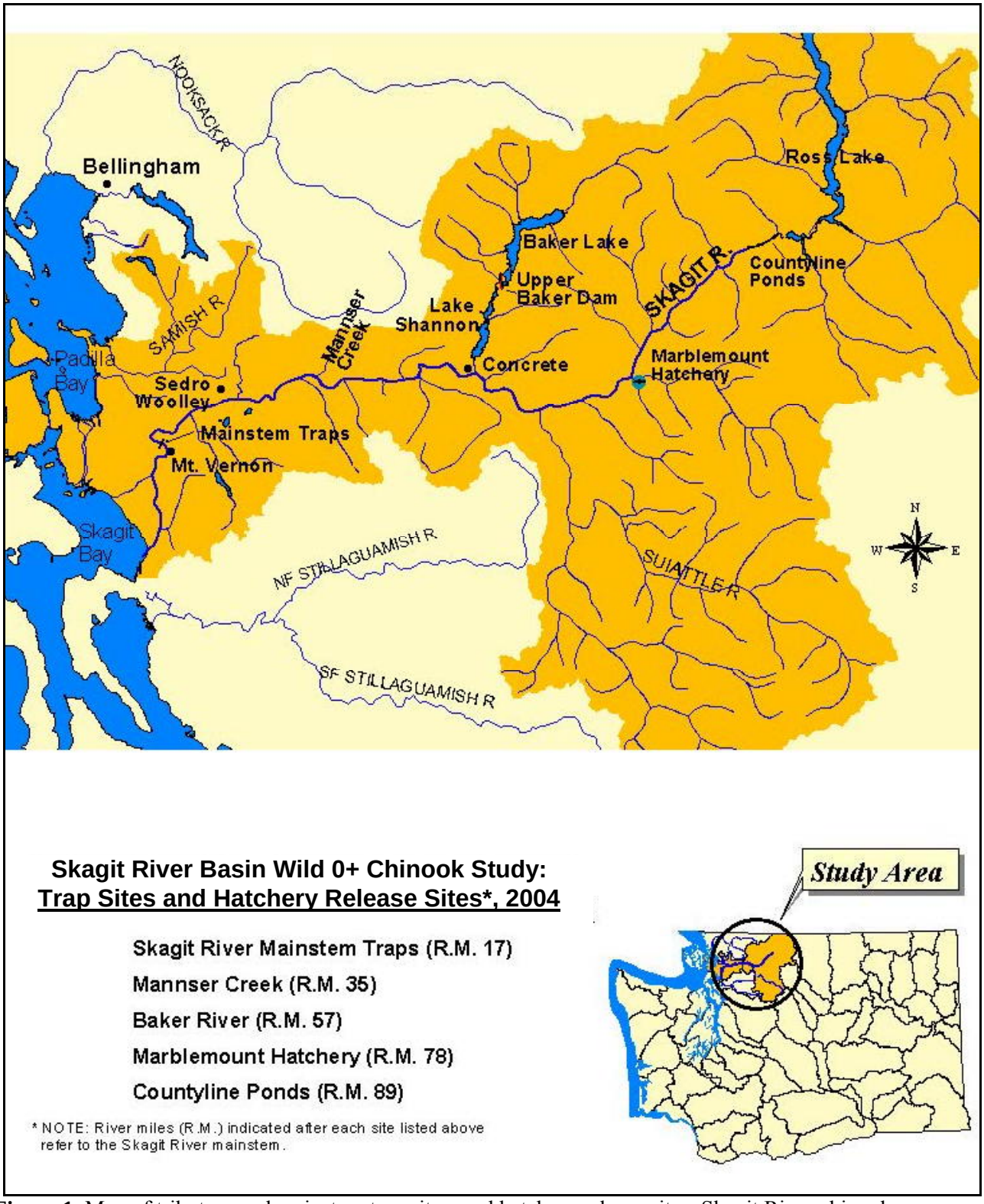

Figure 1. Map of tributary and mainstem trap sites, and hatchery release sites, Skagit River chinook production evaluation 2004

Equation 1: Basic formulas

$$C=Me \qquad M=\frac{C}{e}$$

Where: M = *migrants;*
C = *catch; and*
e = *trap efficiency.*

To assess catch rates of wild and hatchery 0+ chinook for day and night periods, we selected sunrise and sunset as the strata breaks. For each trap, we sorted through the trapping interval database to select daytime fishing periods that were preceded and followed by night fishing intervals. Catch rates from the nights before and after the day fished were analyzed to account for changing migration rates. Catch data were standardized by time fished in each interval and expressed as fish/hour rates. The ratio of day catch rate to night catch rate (d:n) was used to indicate relative catch rates as a function of daylight (Equation 2). We also computed season statistics for the day:night (d:n) catch ratios (Equation 3).

Equation 2: Comparing day catch rates to night catch rates

$$R_i = \frac{C_{di}}{h_{di}}\left(\frac{h_{ni-1}+h_{ni}}{C_{ni-1}+C_{ni}}\right)$$

Where: i = *24-hour period from sunrise to sunrise;*
R_i = *ratio of day to night catch rates for period i;*
C_{di} = *catch during daylight for period i;*
C_{ni-1} = *catch during the night before period i;*
C_{ni} = *catch during the night for period i;*
h_{ni-1} = *hours fished during the night before period i; and*
h_{ni} = *hours fished during the night for period i; and*
h_{di} = *hours fished during the day for period i.*

Equation 3: Season average ratio of day:night catch rates

$$\overline{R} = \frac{\sum R_i}{n}$$

Where: n = *total number of comparisons over the season.*

We expanded catch data to the standard of continuous trapping. To estimate catches for the nights that the traps did not fish, we expanded catches by the catch per hour rate using data from the nights prior to and after the trap outages. Catches during the daylight intervals that we did not fish were estimated from the d:n ratios correlated with the environmental parameter that best explained variation in d:n catch ratios.

Trap Efficiency

An estimate of instantaneous capture rate for both day and night intervals as a function of flow would be optimal. However, this may not be feasible with chinook for the reasons discussed above. We had three primary indicators of trap efficiency in 2004: recaptures of the wild coho marked at the Mannser Creek trap over the season; recaptures of the four groups of marked hatchery chinook that

we released one mile upstream of the mainstem traps; and recoveries of the hatchery chinook fingerlings released from Skagit Hatchery, Countyline Ponds, and the Baker River. While the hatchery chinook are the same species and age, because they may behave differently than wild fish, their capture rate may not represent that of wild chinook. In addition, because the mortality and residualism of hatchery chinook between release and passing the trap is unknown, but probably substantial, the resulting unadjusted estimates of capture rate are biased low. While wild coho are a different species, age, and somewhat larger size, because they are actively migrating smolts released over an extended period, their recaptures may actually represent season average trap efficiency for wild chinook better than the hatchery released chinook groups.

To project recapture rates for both hatchery chinook and the marked wild coho to the standard of continuous trapping, we expanded mark recoveries with the process described above. Recaptures of ad-marked hatchery chinook were complicated by the release of three different groups/stocks with the same external mark. Prior to the release of the summer chinook from Countyline Ponds on May 26 we systematically sacrificed a sample of ad-marked 0+ chinook over the rest of the migration to recover tags and thereby estimate catches of each group.

Egg-to-Migrant Survival

When we expanded our trapping season in 1997, we began to examine survival from egg deposition to migration based on the following equation.

Equation 4: Egg-to-migrant survival

$$\hat{S} = \frac{\hat{M}_{i+1}}{\hat{R}_{si}\hat{E}_i\hat{F}_i}$$

Where: $\hat{M}_{i+1}$ = e*stimated age-0+ chinook migration in year i+1;*

$\hat{R}_{si}$ = e*stimated proportion of females in chinook spawning population in year i;*

$\hat{E}_i$ = e*stimated chinook escapement in year i; and*

$\hat{F}_i$ = e*stimated chinook fecundity in year i.*

To estimate $\hat{R}$ and $\hat{F}$, we assumed females comprised 45% of the adult escapement, and assumed a fecundity of 5,500 eggs/female (Pete Castle, pers. comm.).

Results

Trap Operation and Flow

The traps were installed on January 23. Trapping operations began that night, and ended on July 28. Over this 187-day season, we operated the scoop trap every night with the exception of 17 nights. Trap operation on nine of these nights was interrupted due to mechanical problems and/or high flows and debris. We also fished the scoop trap throughout the daytime on 52 days, usually at a frequency of every third day. In total, we fished this trap 2,476 hours out of a possible 4,485 hours, 55.2% of the total season. The screw trap fished on nearly the same schedule for a season total of 2,493 hours, 55.6 % of the total season (Table 1). From July 12 through 28 we operated the traps on a two nights on/two nights off basis due to low catches of chinook (less than five fish per night).

Flows generally remained near the 63-year mean daily stream flow throughout the year. During the 2004 trapping period daily mean flow ranged from 10,000 to 34,000 cfs, with peak flows occurring in January (Figure 2).

Table 1. Record of Skagit River downstream migrant trap operations, all years.

Year	Gear Type	TRAPPING INTERVAL										
		Date		Season Total Days	Number of Days Fished					Hours		
					Nighttime		Daytime		Trap Out	Total	Trapped	Percent Fished
		Start	End		Full	Partial	Full	Partial				
1990	Scp/Scr	04/13	06/19	66	50	1	5	10	11	1,602.5	590.5	36.8%
1991	Scoop	04/08	06/20	73	72	1	4	18	0	1,741.5	858.0	49.3%
1992	Scoop	04/10	06/21	72	65		3	5	7	1,717.0	667.0	38.8%
1993	Scoop	04/11	06/07	57	53	2	0	8	2	1,355.5	539.5	39.8%
	Screw	04/22	06/07	46	32	0	4	5	14	1,095.0	366.5	33.5%
1994	Scoop	04/09	06/29	81	78	3	5	4	0	1,931.0	828.0	42.9%
	Screw	04/09	06/29	81	78	1	10	6	2	1,931.0	917.0	47.5%
1995	Scoop	03/25	07/15	112	112	0	5	8	0	2,724.0	1,189.0	43.6%
	Screw	03/25	07/17	114	110	2	8	8	2	2,729.5	1,207.0	44.2%
1996	Scoop	04/12	07/18	97	95	0	6	28	2	2,321.5	1,110.5	47.8%
	Screw	04/12	07/18	97	91	3	7	25	3	2,321.5	1,112.0	47.9%
1997	Scoop	02/14	09/10	208	182	9	58	53	17	4,996.0	2,719.0	54.4%
	Screw	02/14	09/10	208	174	11	56	21	23	4,996.0	2,667.0	53.4%
1998	Scoop	01/18	09/11	236	231	0	85	3	5	5,640.0	3,599.0	63.8%
	Screw	01/18	09/11	236	188	0	69	1	48	5,640.0	2,992.0	53.0%
1999	Scoop	01/16	09/06	234	223	0	72	3	11	5,595.3	3,326.9	59.5%
	Screw	01/16	09/06	234	215	0	70	1	19	5,594.8	2,353.2	42.1%
2000	Scoop	01/15	08/18	216	205	0	62	0	11	5,206.0	3,042.1	58.6%
	Screw	01/15	10/27	286	209	0	65	0	77	6,860.5	3,116.1	45.6%
2001	Scoop	01/16	07/30	195	191	1	57	3	4	4,648.7	2,701.2	58.1%
	Screw	01/16	07/30	195	184	6	53	6	5	4,648.7	2,712.8	58.4%
2002	Scoop	01/16	07/30	197	175	7	57	3	15	4,728.0	2,665.0	56.4%
	Screw	01/16	07/30	197	174	4	53	4	19	4,728.0	2,631.0	55.7%
2003	Scoop	01/15	07/30	198	180	5	56	0	13	4,693.0	2,658.0	56.6%
	Screw	01/15	07/30	198	181	2	58	2	15	4,693.0	2,651.0	56.5%
2004	Scoop	01/23	07/28	187	181	6	52	7	17	4,484.5	2,475.7	55.2%
	Screw	01/23	07/28	187	183	4	52	7	15	4,484.5	2,492.8	55.6%

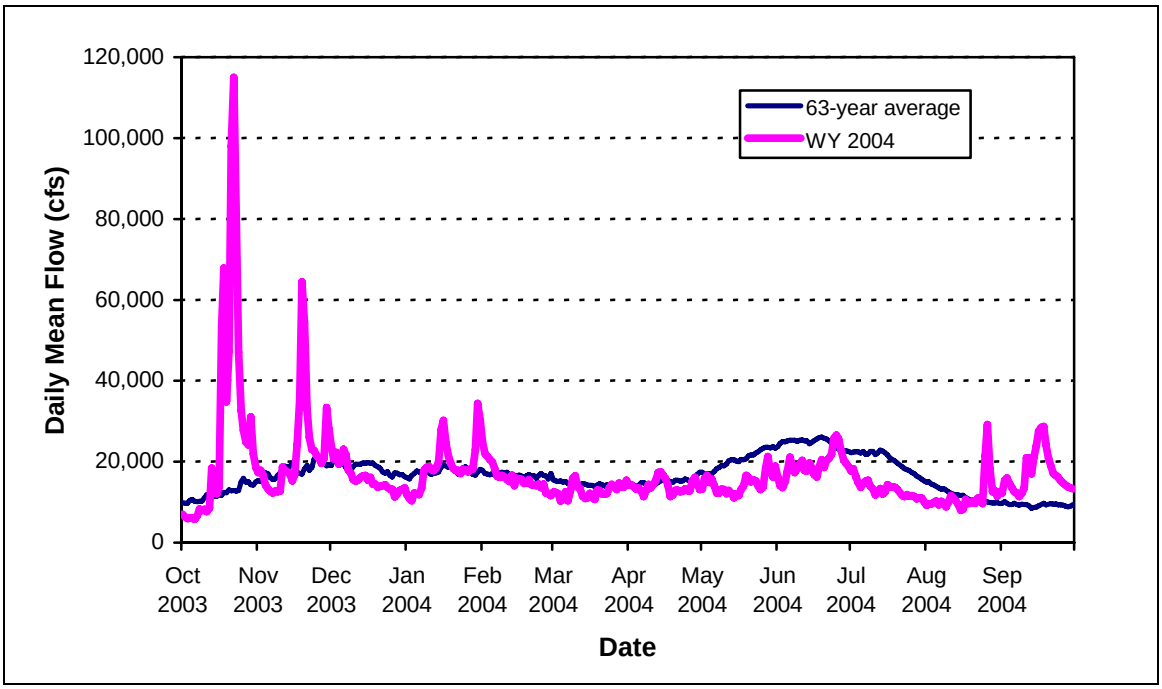

Figure 2. Comparison of daily mean flows in water year 2004 with 63-year average (water years 1940-2003), Skagit River near Mount Vernon (USGS data).

Juvenile Chinook Catches

Chinook fry were moving downstream when we began trapping in mid-January (Appendix A and Appendix B). Two high flow events occurred in January: 30,200 cfs on January 16, before trapping started; and 34,400 cfs on January 30 (Figure 2). Flows declined after the second event, averaging around 13,750 cfs through May. Thereafter, flows increased to average 19,000 cfs through June, and declined to around 12,000 cfs through July. Catch rates remained low through May, rarely exceeding 10 fish/hour. The highest average catch rate of wild chinook during a night (47 fish/hour in the scoop trap) occurred on the night of May 28. Over the remaining season, wild 0+ chinook catch rates fluctuated, but generally declined. Day-to-day variation in wild chinook catch rates was nearly identical between traps. The scoop trap, however, consistently out-fished the screw trap. Through the season, the scoop and screw traps captured wild 0+ chinook at average rates of 5 and 3 fry/hour, respectively. These rates are simply the ratio of total catches to the total hours fished for each trap.

Over the season, we captured 19,703 wild and 19,474 hatchery 0+ chinook (Table 2). This hatchery catch includes 1,031 unmarked/untagged hatchery fry (690 and 341 fry in the scoop and screw traps, respectively) from an unknown number released at Marblemount Hatchery. (These fry were not marked or CWT'd because of their small size and poor condition.) We were able to identify these fish at the mainstem traps based on their appearance after previously observing them in the hatchery ponds while marking fish for our calibration groups. The hatchery 0+ chinook catch does not include the numbers of hatchery chinook that we released above the traps to estimate trap efficiency.

Over the previous fourteen seasons, catches have ranged between 1,700 and 96,000 wild zero-age chinook (Table 2 and Table 3). The catch of hatchery 0+ chinook in 2004 far exceeded that of any previous season. In comparison, over the previous six years, total catches of hatchery chinook have ranged between 3,000 and 8,000 smolts, and averaged just over 5,000 smolts.

Table 2. Downstream-migrant salmonids captured in the Skagit River mainstem traps, 1998-2004.

Species	1998		1999		2000		2001		2002		2003		2004	
	Scoop	Screw	Scoop	Screw	Scoop	Screw	Scoop	Screw	Scoop	Screw	Scoop	Screw	Scoop	Screw
Coho 1+														
Wild	13879	9076	4904	3314	13449	14861	2581	4354	8807	9347	6236	7537	10440	6615
Hatchery	623	1028	673	635	624	946	103	398	453	668	447	1229	647	1511
Coho 0+	1216	409	744	311	115	27	2604	871	1896	435	1303	366	2786	510
Chinook 1+														
Wild	876	350	198	87	129	105	32	26	199	228	95	94	342	205
Hatchery	24	12	201	41	511	360	26	50	177	161	170	122	172	212
Chinook 0+														
Wild	33698	20001	55254	41492	23289	14944	54762	40180	35332	24908	51316	34498	13009	6694
Hatchery	5837	2127	3449	2213	2554	2152	1667	1354	3310	2726	2033	1611	[a]12874	[b]6600
Sockeye 1+	111	84	72	23	9	11	5	1	27	35	1	7	88	83
Chum 0+	37162	18498	172774	108730	39608	40234	133890	105200	16526	16664	82668	70059	66739	58488
Pink 0+	338520	102338	476	265	207530	198015	2644	1350	104782	153668	1604	1731	113975	99507
Steelhead 1+														
Wild	389	1,100	99	334	95	597	32	317	118	437	32	366	337	1287
Hatchery	446	2,325	122	511	75	736	23	465	75	534	26	474	213	2401
Steelhead Adult	1	3	11	1	1	2	0	0	1	2	0	0	0	0
Cutthroat 1+	98	401	30	150	51	248	11	318	53	196	32	151	34	233
Cutthroat adult	2	5	4	0	0	7	0	0	0	7	0	0	0	18
Native char 1+	153	206	101	98	109	138	20	125	74	115	81	73	91	101
Trout Parr	90	83	42	57	116	155	86	123	31	44	83	102	64	61

[a] Includes 690 unmarked hatchery chinook.
[b] Includes 341 unmarked hatchery chinook.

Table 3. Downstream-migrant salmonids captured in the Skagit River mainstem traps, 1990-1997.

Species	1990	1991	1992	1993		1994		1995		1996		1997	
	Scoop	Scoop	Scoop	Scoop	Screw	Scoop	Screw	Scoop	Screw	Scoop	Screw	Scoop	Screw
Coho 1+													
Wild	10,204	6,904	8,620	3,636	3,690	10,767	10,211	8,661	8,824	11,520	9,134	6,437	5,975
Hatchery	234	382	596	[a]714	[a]723	1,880	1,873	4,800	5,274	973	1,208	334	362
Coho 0+	48	22	64	79	4	57	5	204	57	246	50	364	220
Chinook 1+													
Wild	[b]45	[b]1,132	[b]299	[b]3,567	[b]262	308	212	184	112	80	32	46	52
Hatchery	---	---	---	---	---	---	---	1,754	570	415	117	376	249
Chinook 0+													
Wild	[c]8,528	[d]1,706	[e]8,812	[f]7,463	[f]3,415	9,721	4,743	10,536	5,767	2,834	1,731	26,798	20,780
Hatchery	---	---	---	---	---	2,320	1,098	6,083	2,022	4,165	2,888	1,163	684
Sockeye 1+	2	21	2	32	16	108	45	31	17	36	56	59	48
Chum 0+	617	48,505	3,081	66,790	13,939	5,113	7,689	66,139	55,824	10,578	5,384	38,243	39,174
Pink 0+	697	0	18,682	0	0	48,532	22,952	0	0	27,482	9,778	9	17
Steelhead 1+													
Wild	198	301	332	304	663	601	1,297	532	1,184	364	778	319	531
Hatchery	223	66	124	658	2,381	670	3,107	1,282	4,579	751	1,751	982	2,401
Steelhead Adult	0	0	0	0	0	0	0	4	1	1	0	3	4
Cutthroat 1+	117	60	153	45	91	198	437	107	263	165	332	58	89
Cutthroat adult	0	0	0	0	0	0	0	1	0	0	2	2	13
Native char 1+	130	112	132	76	74	197	255	189	179	142	102	65	77
Trout Parr	N/A	N/A	N/A	12	7	47	69	56	47	110	68	40	61

[a] Estimated by proportion of total catch.
[b] Includes both hatchery and wild.
[c] 1989 brood released from Clark Creek = 1,728,100: falls = 1,170,800 Samish stock + 236,000 Clark Creek stock, released on June 8, 1990; and summers = 73,800 + 246,900 Clark Creek stock released on June 28, 1990.
[d] Clark Creek stock released on June 18, 1991: 1,144,500 falls and 111,120 summers.
[e] Clark Creek stock: 786,100 falls released February 25, 1992; 483,280 summers released on April 20, 1992; and 120,000 released on May 21, 1992.
[f] Clark Creek stock: 1,588,800 falls released in February 1993; 250,000 falls released on March 16, 1993; and 160,000 summers released on May 16, 1993.

Day:Night Catch Ratios

Wild Chinook 0+

We compared wild 0+ chinook catch rates during daylight hours to respective nighttime catch rates for the scoop and screw traps on 51 and 44 days, respectively (Table 4 and Table 5). Day:night catch rate ratios (d:n ratios) varied from 0% to 195% in the scoop trap, and from 6% to 335% in the screw trap. For the season, d:n catch rate ratios averaged 57% and 101% for the scoop and screw traps, respectively.

To better predict catch on days the trap was not fished, we correlated d:n ratios with river discharge and turbidity. Over the dates that we computed d:n catch rate ratios for wild 0+ chinook, flows varied just over two-fold (10,400 to 21,300 cfs). Given the moderate flows that dominated much of the season, we expected the brief flow increases to positively affect d:n ratios. Regression analysis found, however, that flow explained virtually none of the variation in d:n ratios for wild zero-age chinook in the scoop and screw traps over the season.

Similarly, we correlated d:n ratios for wild 0+ chinook with daily turbidity data through the season, and found that, as with flow, the effect of turbidity on d:n ratios was very weak. We opted, therefore, to use a measure of central tendency to estimate d:n ratios for the scoop and screw traps. Since the ratios were not normally distributed, the seasonal median scoop and screw trap d:n ratios were used to project catch during unfished daytime periods. These values were estimated for both the wild (44% and 78%)(Table 4 and Table 5) and hatchery (33% and 23%)(Table 6 and Table 7) zero-age chinook captured in the scoop and screw traps, respectively.

Table 4. Catch/hour rates, day:night catch rate ratios of wild 0+ chinook during day and night periods, and corresponding flow and turbidity measurements, Skagit River scoop trap 2004.

NIGHT TIME							DAY TIME								
Trap Down		Trap Up		Hours	Chin	Catch	Date	Time		Hours	Chin	Catch	D:N	Flow	Turbidity
Date	Time	Date	Time	Fished	0+	Rate		Down	Up	Fished	0+	Rate	Ratio	cfs	NTU
01/27	1730	01/29	730	28.58	9	0.31	01/28	755	1700	9.08	5	0.55	174.9%	18,200	11.3
02/02	1730	02/04	730	27.83	18	0.65	02/03	745	1730	9.75	1	0.10	15.9%	21,300	17.1
02/06	1745	02/08	730	27.58	11	0.40	02/07	740	1730	9.83	0	0.00	0.0%	16,400	8.3
02/09	1730	02/11	800	28.25	36	1.27	02/10	745	1730	9.75	6	0.62	48.3%	16,200	10.7
02/12	1800	02/14	730	27.58	27	0.98	02/13	755	1730	9.58	3	0.31	32.0%	16,700	10.3
02/15	1800	02/17	730	27.08	38	1.40	02/16	740	1745	10.08	5	0.50	35.3%	15,700	9
02/19	1800	02/21	730	26.83	25	0.93	02/20	740	1800	10.33	10	0.97	103.9%	15,600	8.4
02/21	1800	02/23	730	27.42	52	1.90	02/22	740	1730	9.83	7	0.71	37.5%	14,200	6.3
02/24	1800	02/26	730	26.83	71	2.65	02/25	740	1800	10.33	0	0.00	0.0%	13,600	7.6
02/26	1800	02/28	700	26.08	30	1.15	02/27	735	1815	10.67	9	0.84	73.3%	12,200	7.3
02/29	1800	03/02	700	25.75	43	1.67	03/01	715	1800	10.75	4	0.37	22.3%	12,500	9.5
03/03	1815	03/05	700	25.50	37	1.45	03/04	720	1800	10.67	5	0.47	32.3%	12,400	8.3
03/06	1815	03/08	700	25.50	17	0.67	03/07	715	1800	10.75	3	0.28	41.9%	10,400	11.7
03/09	1830	03/11	645	24.25	281	11.59	03/10	700	1830	11.50	53	4.61	39.8%	16,500	15.7
03/12	1830	03/14	630	23.75	59	2.48	03/13	645	1830	11.75	40	3.40	137.0%	11,500	6.1
03/15	1830	03/17	630	23.83	220	9.23	03/16	645	1830	11.75	48	4.09	44.2%	12,200	7.1
03/18	1830	03/20	630	23.83	291	12.21	03/19	640	1830	11.83	206	17.41	142.6%	13,000	8.8
03/21	1845	03/23	630	23.25	125	5.38	03/22	640	1845	12.08	34	2.81	52.4%	12,000	6.8
03/23	1845	03/25	630	23.42	184	7.86	03/24	655	1900	12.08	124	10.26	130.7%	13,600	6.9
03/27	1900	03/29	600	21.75	398	18.30	03/28	615	1900	12.75	83	6.51	35.6%	14,700	9.4
03/31	1900	04/02	600	21.50	182	8.47	04/01	615	1900	12.75	40	3.14	37.1%	14,200	7.6
04/02	1900	04/04	700	22.75	144	6.33	04/03	620	1900	12.67	30	2.37	37.4%	13,800	8.4
04/05	2000	04/07	700	21.67	58	2.68	04/06	715	2010	12.92	12	0.93	34.7%	12,700	8
04/08	2000	04/10	630	21.50	256	11.91	04/09	715	1945	12.50	45	3.60	30.2%	14,400	8.4
04/11	2100	04/13	630	20.25	283	13.98	04/12	715	2000	12.75	71	5.57	39.8%	15,400	8.1
04/14	2015	04/16	630	20.25	303	14.96	04/15	645	2015	13.50	73	5.41	36.1%	16,600	11.5
04/17	2030	04/19	630	20.25	53	2.62	04/18	640	2010	13.50	4	0.30	11.3%	11,400	6.2
04/21	2015	04/23	630	20.08	42	2.09	04/22	640	2030	13.83	13	0.94	44.9%	12,600	5.3
04/24	2030	04/26	600	19.33	41	2.12	04/25	645	2030	13.75	6	0.44	20.6%	12,800	4.9
04/29	2000	05/01	615	19.58	55	2.81	04/30	610	2030	14.33	1	0.07	2.5%	13,100	6.3
05/02	2045	05/04	600	18.50	336	18.16	05/03	645	2030	13.75	167	12.15	66.9%	16,600	28.6
05/05	2100	05/07	630	19.25	104	5.40	05/06	640	2030	13.83	52	3.76	69.6%	14,000	20.2
05/09	2100	05/11	600	18.33	71	3.87	05/10	640	2100	14.33	34	2.37	61.3%	13,100	11.2
05/13	2030	05/15	600	18.58	50	2.69	05/14	615	2045	14.50	4	0.28	10.3%	11,100	7.8
05/16	2100	05/18	600	17.83	69	3.87	05/17	615	2100	14.75	9	0.61	15.8%	13,100	7.5
05/20	2000	05/22	600	19.00	383	20.16	05/21	610	2045	14.58	226	15.50	76.9%	15,000	22.4
05/23	2130	05/25	600	17.08	235	13.76	05/24	615	2115	15.00	105	7.00	50.9%	13,900	17.6
05/29	2130	05/31	600	17.33	483	27.87	05/30	615	2100	14.75	397	26.92	96.6%	16,200	30.5
06/01	2115	06/03	530	17.00	88	5.18	06/02	530	2045	15.25	54	3.54	68.4%	14,100	18.2
06/07	2130	06/09	530	15.75	162	10.29	06/08	545	2130	15.75	88	5.59	54.3%	17,300	17
06/10	2130	06/12	530	16.00	114	7.13	06/11	545	2130	15.75	61	3.87	54.4%	20,300	22.6
06/13	2130	06/15	530	15.83	36	2.27	06/14	545	2130	15.75	70	4.44	195.4%	19,700	12.7
06/16	2130	06/18	530	15.75	30	1.90	06/17	540	2130	15.83	8	0.51	26.5%	16,200	6.8
06/18	2130	06/20	530	15.75	60	3.81	06/19	540	2130	15.83	21	1.33	34.8%	20,500	11.1
06/27	2130	06/29	530	15.75	47	2.98	06/28	540	2130	15.83	30	1.90	63.5%	20,400	26.9
06/30	2130	07/02	530	15.67	26	1.66	07/01	540	2140	16.00	37	2.31	139.4%	17,700	24.2
07/06	2115	07/08	530	16.50	15	0.91	07/07	600	2100	15.00	23	1.53	168.7%	15,200	11.9
07/10	2145	07/12	530	15.75	8	0.51	07/11	540	2130	15.83	4	0.25	49.7%	11,800	6.3
07/18	2115	07/20	545	15.75	18	1.14	07/19	600	1600	10.00	3	0.30	26.3%	13,700	12.6
07/22	2200	07/24	545	16.00	10	0.63	07/23	615	2130	15.25	5	0.33	52.5%	11,400	6.5
07/26	2130	07/28	730	18.25	5	0.27	07/27	615	2130	15.25	2	0.13	47.9%	11,400	12.4
		SEASON TOTAL		1,077.70	5,739	5.33				660.45	2,341	3.54	66.6%		
		SEASON AVERAGE											57.3%		
		SEASON MEDIAN											44.2%		

Table 5. Catch/hour rates, day:night catch rate ratios of wild 0+ chinook during day and night periods, and corresponding flow and turbidity measurements, Skagit River screw trap 2004.

NIGHT TIME							DAY TIME								
Trap Down		Trap Up		Hours	Chin	Catch	Date	Time		Hours	Chin	Catch	D:N	Flow	Turbidity
Date	Time	Date	Time	Fished	0+	Rate		Down	Up	Fished	0+	Rate	Ratio	cfs	NTU
01/27	1730	01/29	730	28.75	6	0.21	01/28	745	1700	9.25	3	0.32	155.4%	18,200	13.8
02/02	1730	02/04	730	28.00	6	0.21	02/03	730	1730	10.00	3	0.30	140.0%	21,300	20.2
02/06	1730	02/08	730	28.00	7	0.25	02/07	730	1730	10.00	1	0.10	40.0%	16,400	11.8
02/09	1730	02/11	800	28.50	14	0.49	02/10	730	1730	10.00	3	0.30	61.1%	16,200	10.1
02/12	1800	02/14	730	27.50	10	0.36	02/13	730	1730	10.00	6	0.60	165.0%	16,700	7.5
02/19	1800	02/21	730	27.00	17	0.63	02/20	730	1800	10.50	12	1.14	181.5%	15,600	6.2
02/21	1800	02/23	730	27.25	31	1.14	02/22	730	1745	10.25	10	0.98	85.8%	14,200	7.4
02/24	1800	02/26	730	27.00	29	1.07	02/25	730	1800	10.50	1	0.10	8.9%	13,600	8.2
02/26	1800	02/28	700	26.25	20	0.76	02/27	730	1815	10.75	6	0.56	73.3%	12,200	8.8
02/29	1800	03/02	700	26.00	14	0.54	03/01	700	1800	11.00	8	0.73	135.1%	12,500	6.4
03/03	1815	03/05	700	25.75	13	0.50	03/04	700	1800	11.00	14	1.27	252.1%	12,400	9.5
03/06	1815	03/08	700	25.75	29	1.13	03/07	700	1800	11.00	5	0.45	40.4%	10,400	12.2
03/09	1830	03/11	645	24.50	162	6.61	03/10	645	1830	11.75	85	7.23	109.4%	16,500	13.4
03/12	1830	03/14	630	24.00	41	1.71	03/13	630	1830	12.00	39	3.25	190.2%	11,500	9.3
03/15	1830	03/17	630	24.00	160	6.67	03/16	630	1830	12.00	32	2.67	40.0%	12,200	4.8
03/18	1830	03/20	630	24.00	238	9.92	03/19	630	1830	12.00	174	14.50	146.2%	13,000	5
03/21	1845	03/23	630	23.50	73	3.11	03/22	630	1845	12.25	26	2.12	68.3%	12,000	8.2
03/23	1845	03/25	630	23.42	84	3.59	03/24	640	1900	12.33	148	12.00	334.7%	13,600	6.8
03/27	1900	03/29	600	22.00	174	7.91	03/28	600	1900	13.00	73	5.62	71.0%	14,700	7.5
04/02	1900	04/04	700	23.00	39	1.70	04/03	610	1900	12.83	31	2.42	142.5%	13,800	8.8
04/05	2000	04/07	700	22.00	37	1.68	04/06	710	1955	12.75	9	0.71	42.0%	12,700	7.6
04/08	2000	04/10	630	21.50	102	4.74	04/09	710	2000	12.83	52	4.05	85.4%	14,400	6
04/11	2100	04/13	630	20.50	62	3.02	04/12	710	2000	12.83	59	4.60	152.1%	15,400	8.3
04/17	2030	04/19	630	20.25	27	1.33	04/18	635	2010	13.59	8	0.59	44.2%	11,400	7.8
04/21	2015	04/23	630	20.25	11	0.54	04/22	635	2030	13.92	17	1.22	224.8%	12,600	5.5
04/24	2030	04/26	600	19.50	12	0.62	04/25	630	2030	14.00	4	0.29	46.4%	12,800	5.2
04/29	2000	05/01	615	20.50	14	0.68	04/30	645	2030	13.75	2	0.15	21.3%	13,100	8
05/02	2045	05/04	600	18.75	78	4.16	05/03	600	2030	14.50	78	5.38	129.3%	16,600	12.3
05/05	2100	05/07	630	19.00	40	2.11	05/06	600	2030	14.50	51	3.52	167.1%	14,000	22.6
05/09	2100	05/11	600	18.00	29	1.61	05/10	600	2100	15.00	13	0.87	53.8%	13,100	13.4
05/13	2030	05/15	600	18.75	9	0.48	05/14	600	2045	14.75	7	0.47	98.9%	11,100	10
05/16	2100	05/18	600	18.00	20	1.11	05/17	600	2100	15.00	3	0.20	18.0%	13,100	6.7
05/20	2000	05/22	600	19.25	162	8.42	05/21	545	2030	14.75	94	6.37	75.7%	15,000	29.6
05/23	2130	05/25	600	17.50	106	6.06	05/24	600	2100	15.00	61	4.07	67.1%	13,900	21.4
05/29	2130	05/31	600	16.83	241	14.32	05/30	550	2130	15.67	193	12.32	86.0%	16,200	45.1
06/01	2115	06/03	530	17.25	54	3.13	06/02	600	2100	15.00	28	1.87	59.6%	14,100	32.5
06/07	2130	06/09	530	15.50	73	4.71	06/08	500	2130	16.50	28	1.70	36.0%	17,300	31.3
06/10	2130	06/12	530	16.00	68	4.25	06/11	530	2130	16.00	54	3.38	79.4%	20,300	17.9
06/13	2130	06/15	530	16.00	23	1.44	06/14	530	2130	16.00	46	2.88	200.0%	19,700	12.4
06/16	2130	06/18	530	16.00	17	1.06	06/17	530	2130	16.00	1	0.06	5.9%	16,200	7.5
06/30	2130	07/02	530	16.00	22	1.38	07/01	530	2130	16.00	11	0.69	50.0%	17,700	21.9
07/10	2145	07/12	530	15.75	3	0.19	07/11	530	2130	16.00	1	0.06	32.8%	11,800	6.7
07/22	2200	07/24	545	16.25	2	0.12	07/23	600	2130	15.50	3	0.19	157.3%	11,400	6.7
07/26	2130	07/28	730	18.50	2	0.11	07/27	600	2130	15.50	1	0.06	59.7%	11,400	16.3
		SEASON TOTAL		952.00	2,381	2.50				577.75	1,504	2.60	104.1%		
		SEASON AVERAGE											100.8%		
		SEASON MEDIAN											77.6%		

Table 6. Catch/hour rates, day:night catch rate ratios of hatchery 0+ chinook during day and night periods, and corresponding flow and turbidity measurements, Skagit River scoop trap 2004.

NIGHT TIME							DAY TIME								
Trap Down		Trap Up		Hours	Chin	Catch	Date	Time		Hours	Chin	Catch	D:N	Flow	Turbidity
Date	Time	Date	Time	Fished	0+	Rate		Down	Up	Fished	0+	Rate	Ratio	cfs	NTU
05/29	2130	05/31	600	17.33	1,429	82.46	05/30	615	2100	14.75	375	25.42	30.8%	16,200	30.5
06/01	2115	06/03	530	17.00	372	21.88	06/02	530	2045	15.25	52	3.41	15.6%	14,100	18.2
06/07	2130	06/09	530	15.75	135	8.57	06/08	545	2130	15.75	17	1.08	12.6%	17,300	17
06/10	2130	06/12	530	16.00	1,623	101.44	06/11	545	2130	15.75	556	35.30	34.8%	20,300	22.6
06/13	2130	06/15	530	15.83	1,071	67.66	06/14	545	2130	15.75	853	54.16	80.0%	19,700	12.7
06/16	2130	06/18	530	15.75	347	22.03	06/17	540	2130	15.83	63	3.98	18.1%	16,200	6.8
06/18	2130	06/20	530	15.75	605	38.41	06/19	540	2130	15.83	173	10.93	28.5%	20,500	11.1
06/27	2130	06/29	530	15.75	139	8.83	06/28	540	2130	15.83	89	5.62	63.7%	20,400	26.9
06/30	2130	07/02	530	15.67	140	8.93	07/01	540	2140	16.00	192	12.00	134.3%	17,700	24.2
07/06	2115	07/08	530	16.50	63	3.82	07/07	600	2100	15.00	41	2.73	71.6%	15,200	11.9
07/10	2145	07/12	530	15.75	8	0.51	07/11	540	2130	15.83	8	0.51	99.5%	11,800	6.3
07/18	2115	07/20	545	15.75	31	1.97	07/19	600	1600	10.00	3	0.30	15.2%	13,700	12.6
07/22	2200	07/24	545	16.00	2	0.13	07/23	615	2130	15.25	2	0.13	104.9%	11,400	6.5
07/26	2130	07/28	730	18.25	2	0.11	07/27	615	2130	15.25	0	0.00	0.0%	11,400	12.4
		SEASON TOTAL		227.08	5,967	26.28				212.07	2,424	11.43	43.5%		
		SEASON AVERAGE											50.7%		
		SEASON MEDIAN											32.8%		

Table 7. Catch/hour rates, day:night catch rate ratios of hatchery 0+ chinook during day and night periods, and corresponding flow and turbidity measurements, Skagit River screw trap 2004.

NIGHT TIME							DAY TIME								
Trap Down		Trap Up		Hours	Chin	Catch	Date	Time		Hours	Chin	Catch	D:N	Flow	Turbidity
Date	Time	Date	Time	Fished	0+	Rate		Down	Up	Fished	0+	Rate	Ratio	cfs	NTU
05/29	2130	05/31	600	16.83	684	40.64	05/30	550	2130	15.67	221	14.10	34.7%	16,200	45.1
06/01	2115	06/03	530	17.25	203	11.77	06/02	600	2100	15.00	28	1.87	15.9%	14,100	32.5
06/07	2130	06/09	530	15.50	51	3.29	06/08	500	2130	16.50	9	0.55	16.6%	17,300	31.3
06/10	2130	06/12	530	16.00	927	57.94	06/11	530	2130	16.00	216	13.50	23.3%	20,300	17.9
06/13	2130	06/15	530	16.00	633	39.56	06/14	530	2130	16.00	312	19.50	49.3%	19,700	12.4
06/16	2130	06/18	530	16.00	169	10.56	06/17	530	2130	16.00	22	1.38	13.0%	16,200	7.5
06/30	2130	07/02	530	16.00	63	3.94	07/01	530	2130	16.00	77	4.81	122.2%	17,700	21.9
07/10	2145	07/12	530	15.75	5	0.32	07/11	530	2130	16.00	2	0.13	39.4%	11,800	6.7
07/22	2200	07/24	545	16.25	3	0.18	07/23	600	2130	15.50	0	0.00	0.0%	11,400	6.7
		SEASON TOTAL		145.58	2,738	18.81				142.67	887	6.22	33.1%		
		SEASON AVERAGE											34.9%		
		SEASON MEDIAN											23.3%		

Chinook Trap Efficiency

Over the season, we released four groups of hatchery 0+ chinook, all ad-marked/CWT'd. The first group was released on the night of March 23 and the last on the night of May 23. We operated the traps continuously for more than 36 hours after each release. Recapture rates ranged from 0.27% to 2.26% (Table 8).

Hatchery 0+ Chinook Production Groups

Three groups of ad-CWT hatchery chinook fingerlings were released from production facilities in Spring 2004 (Table 8). The location of these releases are shown in Figure 1:

- May 24, the volitional release of 230,161 summer chinook from Countyline Ponds (R.M. 89);
- June 8, the release of 267,011 spring chinook from the Marblemount Hatchery (R.M. 78);
- June 10 the release of 238,591 fall chinook from Baker River (R.M. 57).

Over the season, we caught a total of 18,443 ad-marked and coded-wire tagged (ad-CWT) hatchery 0+ chinook in the mainstem traps, 12,184 in the scoop trap and 6,259 in the screw trap (not including the calibration groups).

Apportioning the catch among the three release groups required recovering tags. On May 27, we began sampling hatchery smolts for tag recovery. Over the season, we sacrificed 1,844 ad-marked chinook and recovered 1,838 tags, which we used to estimate the proportions of Countyline Ponds summers, Skagit Hatchery springs, and Baker River fall chinook in our total hatchery catch (Table 9).

Table 8. Groups of marked salmon released into the Skagit River in 2004 and the numbers recovered at the mainstem traps.

Stock		Species/ Age	Mark Type	RELEASE		Recapture Dates	ACTUAL CATCH			CAPTURE RATE		
				Date	Number		Scoop	Screw	Total	Scoop	Screw	Total
Wild (Mannser Creek)		Coho 1+	LV	April 08-June 10	22,728	April 15-June 09	279	158	437	1.22%	0.70%	1.92%
Calibration Groups[a]	Hatchery/ spring	Chinook 0+	Ad/CWT	March 23	771	March 23-24	3	6	9	0.39%	0.78%	1.17%
	Hatchery/ spring	Chinook 0+	Ad/CWT	April 29	945	April 29-30	5	5	10	0.52%	0.52%	1.05%
	Hatchery/ spring	Chinook 0+	Ad/CWT	May 13	737	May 13-15	1	1	2	0.14%	0.14%	0.27%
	Hatchery/ spring	Chinook 0+	Ad/CWT	May 20-23	930	May 20-23	13	8	21	1.40%	0.86%	2.26%
Hatchery Releases[b]	Countyline Ponds/ summer	Chinook 0+	Ad/CWT	May 24	230,161	May 27-July 08	n/a	n/a	n/a	See Table 11		
	Marblemount Hatchery/ spring	Chinook 0+	Ad/CWT	June 08	267,011	June 10-July 19	n/a	n/a	n/a			
	Baker River Hatchery/ fall	Chinook 0+	Ad/CWT	June 10-14	238,591	June 11- July 26	n/a	n/a	n/a			

[a] Mark groups used for trap efficiency tests; not included in the wild and hatchery migration estimate.
[b] Hatchery 0+ chinook catch is apportioned, based on tag recovery results.

Table 9. Results of CWTs recovered from ad-marked/CWT 0+ chinook sampled at the Skagit River mainstem traps 2004.

Date	H-Admk Catch			Number Sampled			Marblemt-Spring		Baker R-Fall		Cntyln-Summer	
	Scoop	Screw	Total	Scoop	Screw	Total	Total	%	Total	%	Total	%
05/27/04	73	42	115	8	3	11	0	0.0%	0	0.0%	11	100.0%
05/28/04	0	0	0	0	0	0	0	0.0%	0	0.0%	0	100.0%
05/29/04	143	88	231	14	9	23	0	0.0%	0	0.0%	23	100.0%
05/30/04	702	365	1,067	69	36	105	0	0.0%	0	0.0%	105	100.0%
05/31/04	944	450	1,394	94	45	139	0	0.0%	0	0.0%	139	100.0%
06/01/04	525	373	898	51	37	88	0	0.0%	0	0.0%	88	100.0%
06/02/04	292	178	470	29	17	46	0	0.0%	0	0.0%	46	100.0%
06/03/04	122	51	173	11	5	16	0	0.0%	0	0.0%	16	100.0%
06/04/04	129	71	200	13	7	20	0	0.0%	0	0.0%	20	100.0%
06/05/04	652	265	917	65	27	92	0	0.0%	0	0.0%	92	100.0%
06/06/04	203	129	332	20	12	32	0	0.0%	0	0.0%	32	100.0%
06/07/04	235	144	379	24	15	39	0	0.0%	0	0.0%	39	100.0%
06/08/04	78	43	121	7	4	11	0	0.0%	0	0.0%	11	100.0%
06/09/04	56	11	67	6	1	7	0	0.0%	0	0.0%	7	100.0%
06/10/04	751	293	1,044	75	29	104	101	97.1%	0	0.0%	3	2.9%
06/11/04	1,403	737	2,140	140	74	214	128	59.8%	70	32.7%	16	7.5%
06/12/04	721	382	1,103	73	38	111	44	39.6%	63	56.8%	4	3.6%
06/13/04	289	156	445	28	16	44	5	11.4%	36	81.8%	3	6.8%
06/14/04	1,392	618	2,010	140	62	202	60	29.7%	132	65.3%	10	5.0%
06/15/04	473	299	772	47	30	77	15	19.5%	62	80.5%	0	0.0%
06/16/04	168	93	261	17	9	26	14	53.8%	11	42.3%	1	3.8%
06/17/04	208	92	300	21	9	30	9	30.0%	18	60.0%	3	10.0%
06/18/04	187	96	283	18	10	28	4	14.3%	24	85.7%	0	0.0%
06/19/04	518	279	797	52	29	81	31	38.3%	46	56.8%	4	4.9%
06/20/04	193	36	229	19	3	22	4	18.2%	18	81.8%	0	0.0%
06/21/04	98	57	155	10	6	16	6	37.5%	10	62.5%	0	0.0%
06/22/04	81	35	116	8	3	11	4	36.4%	7	63.6%	0	0.0%
06/23/04	56	18	74	6	2	8	6	75.0%	2	25.0%	0	0.0%
06/24/04	211	100	311	21	10	31	27	87.1%	2	6.5%	2	6.5%
06/25/04	198	148	346	20	15	35	28	80.0%	5	14.3%	2	5.7%
06/26/04	123	166	289	12	19	31	24	77.4%	4	12.9%	3	9.7%
06/27/04	150	117	267	15	11	26	22	84.6%	3	11.5%	1	3.8%
06/28/04	138	77	215	14	8	22	14	63.6%	5	22.7%	3	13.6%
06/29/04	56	27	83	5	0	5	4	80.0%	1	20.0%	0	0.0%
06/30/04	60	25	85	6	2	8	5	62.5%	2	25.0%	1	12.5%
07/01/04	234	100	334	18	10	28	23	82.1%	3	10.7%	2	7.1%
07/02/04	64	27	91	6	3	9	8	88.9%	1	11.1%	0	0.0%
07/03/04	34	15	49	4	1	5	4	80.0%	1	20.0%	0	0.0%
07/04/04	37	8	45	3	1	4	3	75.0%	0	0.0%	1	25.0%
07/05/04	0	0	0	0	0	0	0	0.0%	0	0.0%	0	0.0%
07/06/04	15	8	23	2	1	3	1	33.3%	0	0.0%	2	66.7%
07/07/04	49	10	59	11	1	12	10	83.3%	2	16.7%	0	0.0%
07/08/04	35	8	43	3	1	4	3	75.0%	0	0.0%	1	25.0%
07/09/04	8	3	11	0	0	0	0	62.5%	0	25.0%	0	12.5%
07/10/04	9	2	11	1	1	2	1	50.0%	1	50.0%	0	0.0%
07/11/04	9	2	11	1	0	1	1	100.0%	0	0.0%	0	0.0%
07/12/04	7	5	12	1	0	1	0	0.0%	1	100.0%	0	0.0%
07/13/04	0	0	0	0	0	0	0	50.0%	0	50.0%	0	0.0%
07/14/04	0	0	0	0	0	0	0	50.0%	0	50.0%	0	0.0%
07/15/04	9	4	13	0	1	1	0	0.0%	1	100.0%	0	0.0%
07/16/04	7	0	7	1	0	1	1	100.0%	0	0.0%	0	0.0%
07/17/04	0	0	0	0	0	0	0	0.0%	0	0.0%	0	0.0%
07/18/04	0	0	0	0	0	0	0	0.0%	0	0.0%	0	0.0%
07/19/04	18	3	21	3	1	4	1	25.0%	3	75.0%	0	0.0%
07/20/04	15	0	15	1	0	1	0	0.0%	0	0.0%	1	100.0%
07/21/04	0	0	0	0	0	0	0	0.0%	0	100.0%	0	0.0%
07/22/04	0	0	0	0	0	0	0	0.0%	0	100.0%	0	0.0%
07/23/04	3	2	5	1	0	1	0	0.0%	1	100.0%	0	0.0%
07/24/04	1	1	2	0	0	0	0	0.0%	0	100.0%	0	0.0%
07/25/04	0	0	0	0	0	0	0	0.0%	0	100.0%	0	0.0%
07/26/04	0	0	0	0	0	0	0	0.0%	0	100.0%	0	0.0%
07/27/04	1	0	1	0	0	0	0	0.0%	0	100.0%	0	0.0%
07/28/04	1	0	1	0	0	0	0	0.0%	0	100.0%	0	0.0%
TOTAL	12,184	6,259	18,443	1,214	624	1,838	611	33.2%	535	29.1%	692	37.6%

Notes: Tag results do not include lost tags and no tags.
Shading indicates days when no samples were collected: tags were allocated by interpolation.

Wild & Hatchery 0+ Chinook Production Estimates

Catch Projection

Expansion of catches for the intervals not fished estimates an additional 6,019 and 4,389 wild 0+ chinook would have been captured in the scoop and screw traps, respectively (Table 10). Combining these projected catches with the actual catches (13,009 and 6,694 fry, respectively), estimates 30,111 wild 0+ chinook would have been caught in the two traps had we fished continuously from January 23 through July 28 (Figure 3). Actual catches represent 65% of the total projected catches.

Expanding actual catches for the intervals not fished following release of the hatchery production groups, estimates an additional 7,980 hatchery 0+ chinook would have been captured in the scoop and screw traps (Table 10). Actual catches represent 71% of the total projected hatchery catch.

Table 10. Summary of actual and projected wild and hatchery 0+ chinook catches in the Skagit River mainstem traps 2004.

Group	Scoop Trap			Screw Trap			Total		
	Actual	Projected	Total	Actual	Projected	Total	Actual	Projected	Total
Wild	13,009	6,019	19,028	6,694	4,389	11,083	19,703	10,468	30,111
Hatchery	12,874	5,649	18,523	6,600	2,331	8,931	19,474	7,980	27,454

Applying daily tag recovery results to the sum of actual and projected daily catches, estimates the proportion of each group within the ad-marked/CWT hatchery chinook catch: 6,911 fall 0+ chinook (released at Baker River), 10,669 summer 0+ chinook (released at Countyline Ponds) and 8,445 spring 0+ chinook (released at Skagit Hatchery) (Table 11). Relating these projected catches to the numbers released yields capture rates of 4.6%, 3.2%, and 2.9% for summer, spring and fall chinook, respectively.

Table 11. Projected 24-hour hatchery 0+ chinook catches, by tag group, Skagit River mainstem traps 2004.

Stock	Tag Code	Number Released	Recovery Period	Projected 24-Hour Catch [a]	Catch Rate
Countyline Ponds/summer	21-05/58	230,161	May 26-July 08	10,669	4.6%
Marblemount Hatchery/ spring	63-19/77	267,011	June10 -July 19	8,445	3.2%
	Unmk/no CWT	Unknown	May 30-July 14	1,429	n/a
Baker River/ fall	21-05/41	238,591	June 11- July 26	6,911	2.9%
	Total	735,763	May 26-July 26	[c]26,025	[b]3.5%

[a] Estimated by applying the proportion of the tagged groups in the total hatchery catch (Table 9), by day, to the projected 24-hour catch.
[b] Based on the three tagged groups, as unmarked spring chinook release was unknown.
[c] Does not include the unmarked/un-CWT release.

Production

Trap efficiency was evaluated using four mark-release groups early in the trapping season (March 23 to May 23) and the estimated catch rates from three coded wire tagged hatchery release groups later in the season (May 26 to July 26). Catch rates estimated for hatchery release groups, assuming continuous trapping, relating the projected total marked hatchery catch (26,025) to the number released (735,763) estimates the average capture rate at 3.5% (Table 11). Catch rates measured for the three hatchery release groups were substantially higher than those from trap efficiency test groups and their means were significantly different ($\alpha = 0.05$) using a 2-sample t-test. Correlation with river discharge and turbidity failed to explain these differences. Based on these results, we stratified the data, applying a capture rate of 1.2% (mean from the early mark-recapture experiments) to catches prior to May 26, and 3.5% to catches beginning on May 26. Expansion of the projected season catch in both traps (30,111) by these rates yields a system production estimate of approximately 1.8-million zero-age chinook (Figure 4).

These rates may underestimate the actual catch rates for several reasons: 1) delayed migration of chinook pre-smolts used in the early mark-recapture tests until after the 36 hour fishing period, 2) mortality or residualization of some of the fish released from the hatchery may have occurred; and 3) some mortality may have occurred in the hatchery prior to release, but after the final count was made.

Migration Timing

Wild 0+ chinook were caught on the first night of trap operation, indicating that the migration was under way before we began trapping. The low initial catches, however, indicated that relatively few chinook fry had passed the trap before we started. Similarly, low catches in July indicated the chinook migration was virtually over when trapping ceased on July 31. Fifty-percent of the migration had passed the mainstem traps on April 15 (Figure 5); which is later than all but two of the previous seven years (1997 through 2003). Over the eight years in which we have trapped the entire chinook migration period, median migration dates have ranged from March 10 (1999) to May 2 (1998) (Figure 6).

Ad-marked hatchery spring, summer and fall zero-age chinook were released from three sites in the Skagit River basin: Skagit Hatchery, Countyline acclimation ponds, and Baker River, respectively (Table 8, Figure 1). Baker River fall chinook, released lowest in the watershed (R.M. 57), had a median migration timing to the traps of four days (June 10 release), and took 48 days to completely migrate past the traps (Figure 7). Skagit Hatchery spring chinook were released higher in the river (R.M. 78) and had a median migration timing to the traps of six days (June 8 release), and took up to 40 days to emigrate. Countyline summer chinook, released earliest and highest in the watershed (R.M. 89), had a median migration timing of nine days (May 24 release), and took the longest to migrate past the mainstem traps (55 days). In addition to inherent stock differences, migration timing for hatchery 0+ chinook groups is potentially influenced by condition, size, flow, turbidity, release date, and release site.

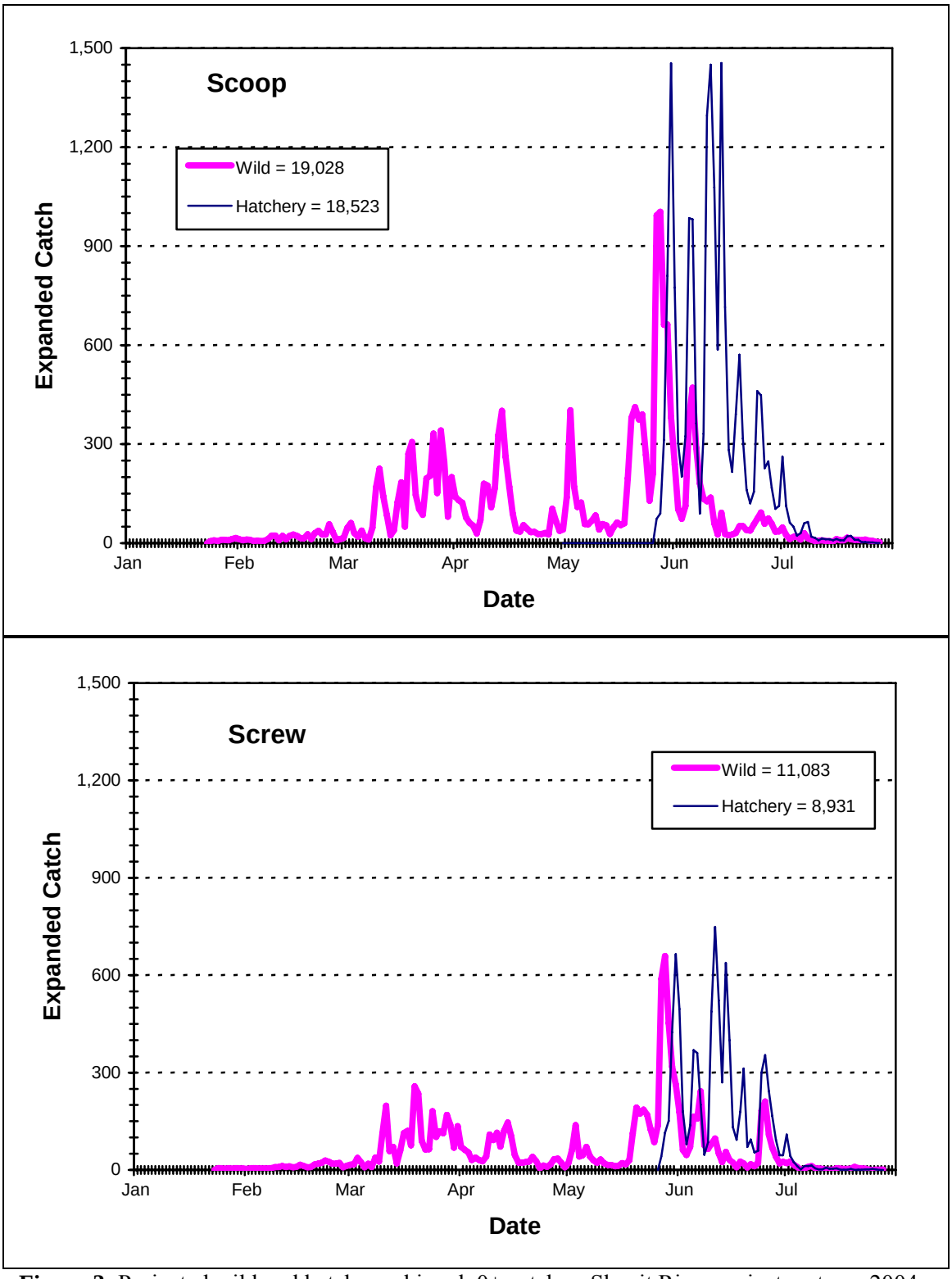

Figure 3. Projected wild and hatchery chinook 0+ catches, Skagit River mainstem traps 2004.

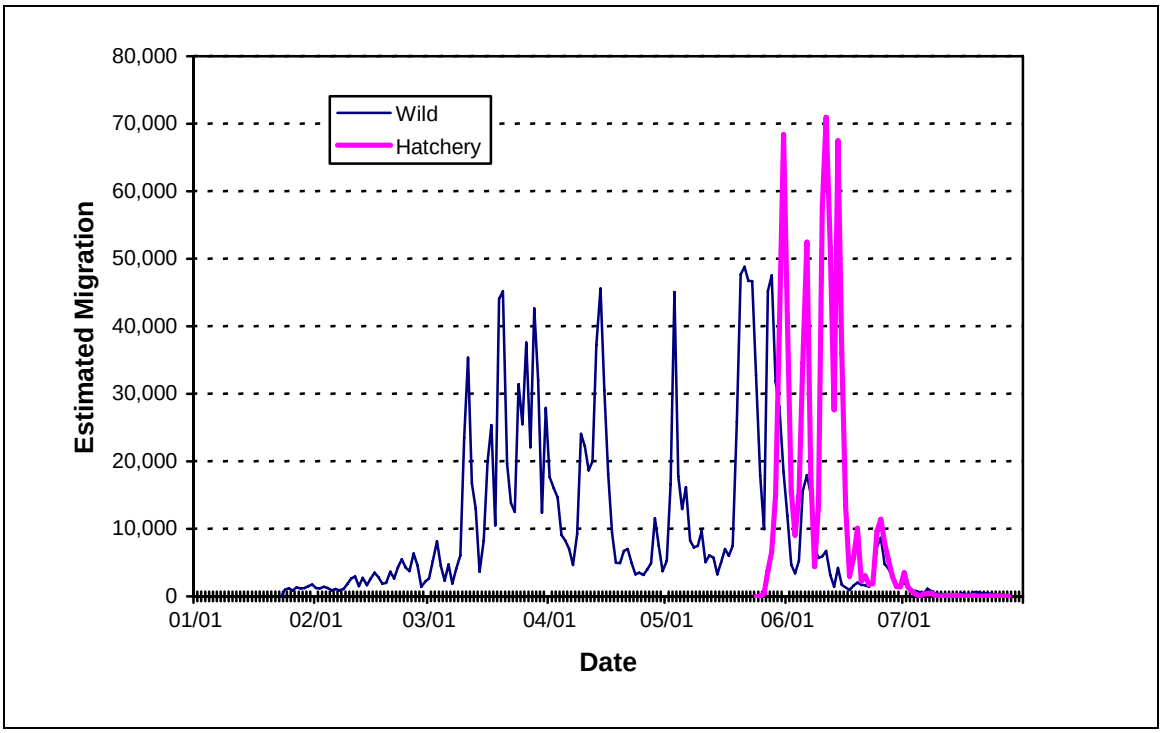

Figure 4. Estimated wild and hatchery 0+ chinook migration past the Skagit River mainstem traps in 2004.

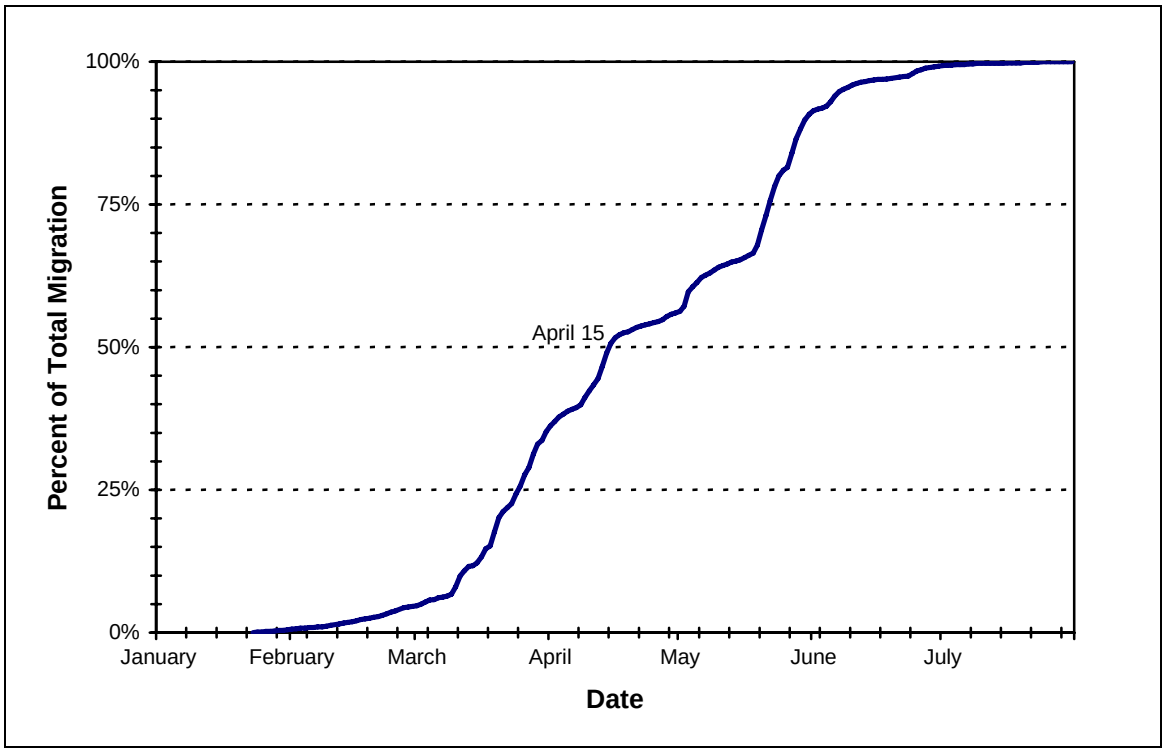

Figure 5. Migration timing of wild 0+ chinook past the Skagit River mainstem traps, 2004.

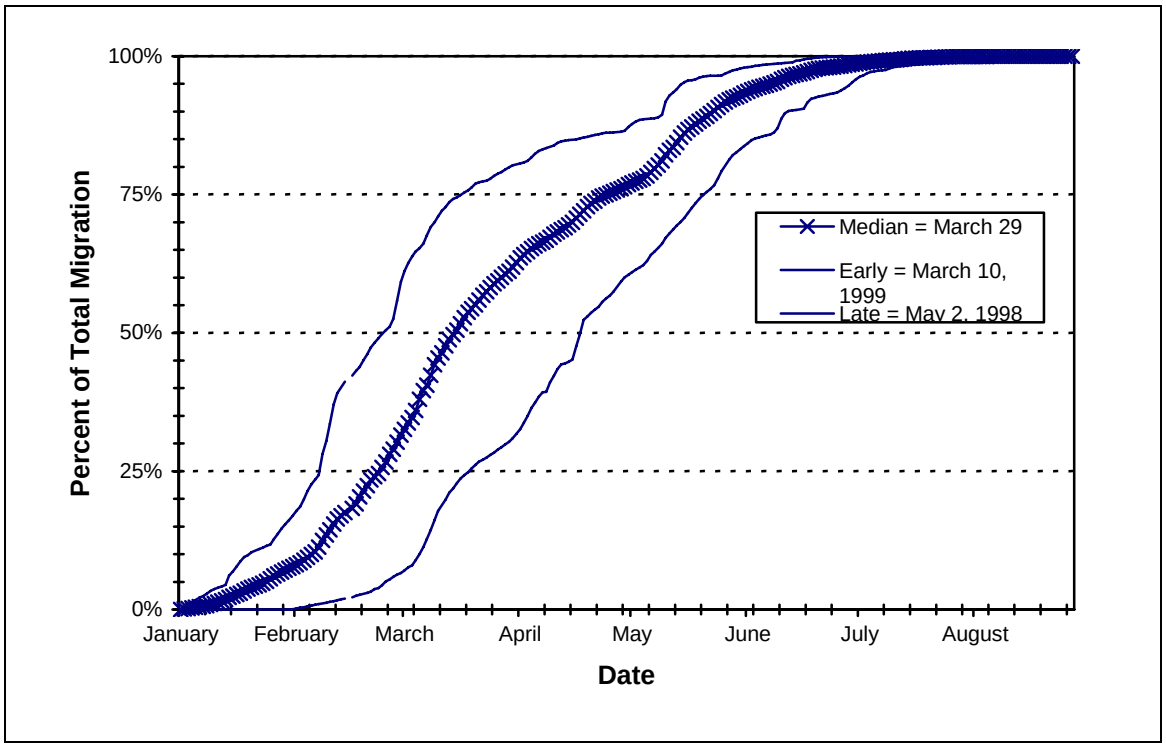

Figure 6. Migration timing variations of wild 0+ chinook, Skagit River mainstem traps 1997-2004.

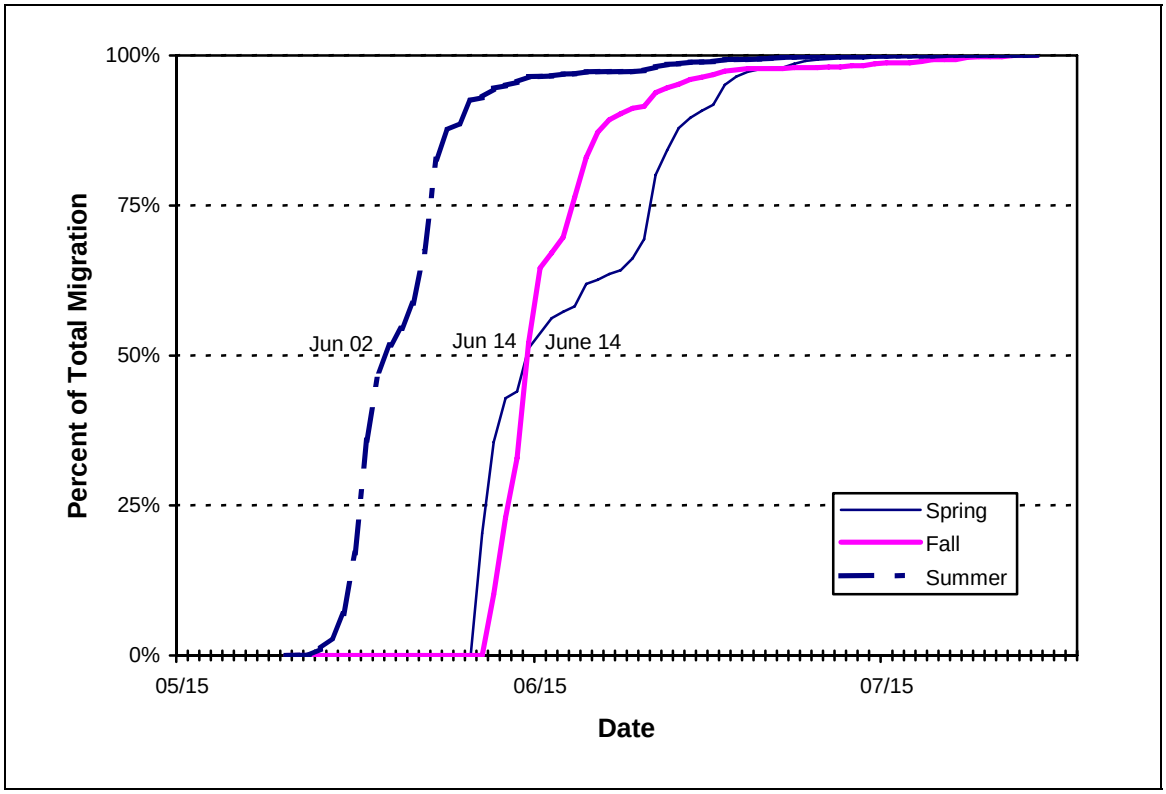

Figure 7. Estimated migration timing of three groups of hatchery 0+ chinook past the Skagit River mainstem traps, 2004.

Wild 0+ Chinook Size

Over the season, wild 0+ chinook captured in the traps increased in size from an average of 38 mm in mid-January, to over 80 mm by mid-July (Table 12 and Figure 8). The lower end of the weekly size range did not exceed 40 mm until mid-May, indicating protracted emergence and/or slow growth for a component of the population. These length distributions are similar to those of previous years. Comparing mean chinook fork lengths between the scoop and screw trap catches by statistical week showed no significant difference (Figure 9).

Length Analysis and Size Selectivity

Moderate river flows dominated the Spring 2004 season, resulting in decreased velocity at the traps. At lower velocities, larger smolts can avoid capture by swimming away from the trap entrance, and/or out of the traps. Each year, to assess this bias, we compare length distributions (fork length) of LV-marked coho smolts captured in the scoop and screw traps with that of the LV-marked smolts released from the Mannser Creek trap (KS test, $\alpha = 0.05$). This weir captures all emigrants, regardless of size.

Length distributions of LV-marked smolts recaptured in the scoop and screw traps showed no statistical differences relative to the size distribution at release. Marked smolts captured in the scoop and screw traps averaged 93.7 mm and 94.9 mm, respectively. Overall, smolts from Mannser Creek averaged 93.5 mm at release.

As in previous years, based on these results, we concluded that since size selectivity in the mainstem traps did not affect capture rates of wild coho smolts, capture of the smaller zero-age chinook was unbiased with respect to size.

Table 12. Mean fork length (mm), standard deviation, range, sample size, and catch, by statistical week, of wild 0+ chinook in the Skagit River mainstem traps, 2004.

STAT WEEK			SCOOP TRAP						SCREW TRAP					
			Mean	s.d.	Range		n	Catch	Mean	s.d.	Range		n	Catch
No.	Begin	End			Min	Max					Min	Max		
4	01/19	01/25	38.0	2.83	36	40	2	2	39.3	0.96	38	40	4	4
5	01/26	02/01	40.1	0.86	39	42	13	25	39.5	0.71	39	40	2	12
6	02/02	02/08	40.1	2.14	37	44	14	36	39.3	1.38	37	41	7	20
7	02/09	02/15	40.3	2.69	37	53	35	102	40.6	1.74	37	44	19	50
8	02/16	02/22	40.7	1.26	38	43	30	129	40.3	1.57	36	43	25	86
9	02/23	03/01	41.2	1.46	39	44	20	166	40.8	1.48	38	44	20	98
10	03/02	03/08	41.2	1.52	39	46	30	180	41.2	1.63	39	45	26	96
11	03/09	03/15	41.6	1.25	38	44	36	567	41.8	2.12	37	48	40	397
12	03/16	03/22	41.6	1.79	38	45	30	919	42.0	1.85	38	47	29	709
13	03/23	03/29	41.9	2.00	39	46	42	1,128	41.9	1.41	38	45	41	618
14	03/30	04/05	42.3	3.20	39	53	43	695	41.9	1.81	39	47	31	347
15	04/06	04/12	43.3	4.76	38	62	41	498	43.2	4.07	39	55	41	276
16	04/13	04/19	44.2	4.00	38	61	70	1,094	45.7	5.66	39	62	66	366
17	04/20	04/26	48.2	6.96	39	63	30	182	46.7	5.56	40	56	16	90
18	04/27	05/03	50.3	7.25	39	70	30	252	54.0	7.98	45	86	25	93
19	05/04	05/10	55.2	4.91	45	64	40	792	58.6	7.14	44	79	43	289
20	05/11	05/17	57.1	5.54	40	69	30	260	57.6	6.92	48	74	22	79
21	05/18	05/24	55.2	8.86	33	72	40	1,230	56.7	5.40	41	69	34	471
22	05/25	05/31	59.2	9.40	39	74	50	2,426	57.2	8.74	40	73	20	1,308
23	06/01	06/07	61.6	10.39	41	86	55	899	59.4	9.04	41	82	51	462
24	06/08	06/14	57.5	9.20	40	85	60	675	59.9	7.64	41	74	59	373
25	06/15	06/21	63.4	8.67	43	82	60	236	63.6	8.43	49	95	48	117
26	06/22	06/28	69.0	7.88	54	90	70	217	68.8	8.04	51	91	63	177
27	06/29	07/05	69.3	8.44	52	81	26	178	67.6	8.47	53	82	21	105
28	07/06	07/12	72.2	5.98	62	80	26	61	71.3	4.76	64	80	10	24
29	07/13	07/19	76.4	9.12	61	89	13	17	77.2	10.88	64	95	9	10
30	07/20	07/26	82.4	8.02	70	96	10	36	----	----	----	----	----	14
31	07/27	08/02	----	----	----	----	----	7	----	----	----	----	----	3
Season Total					33	96	946	13,009			36	95	772	6,694

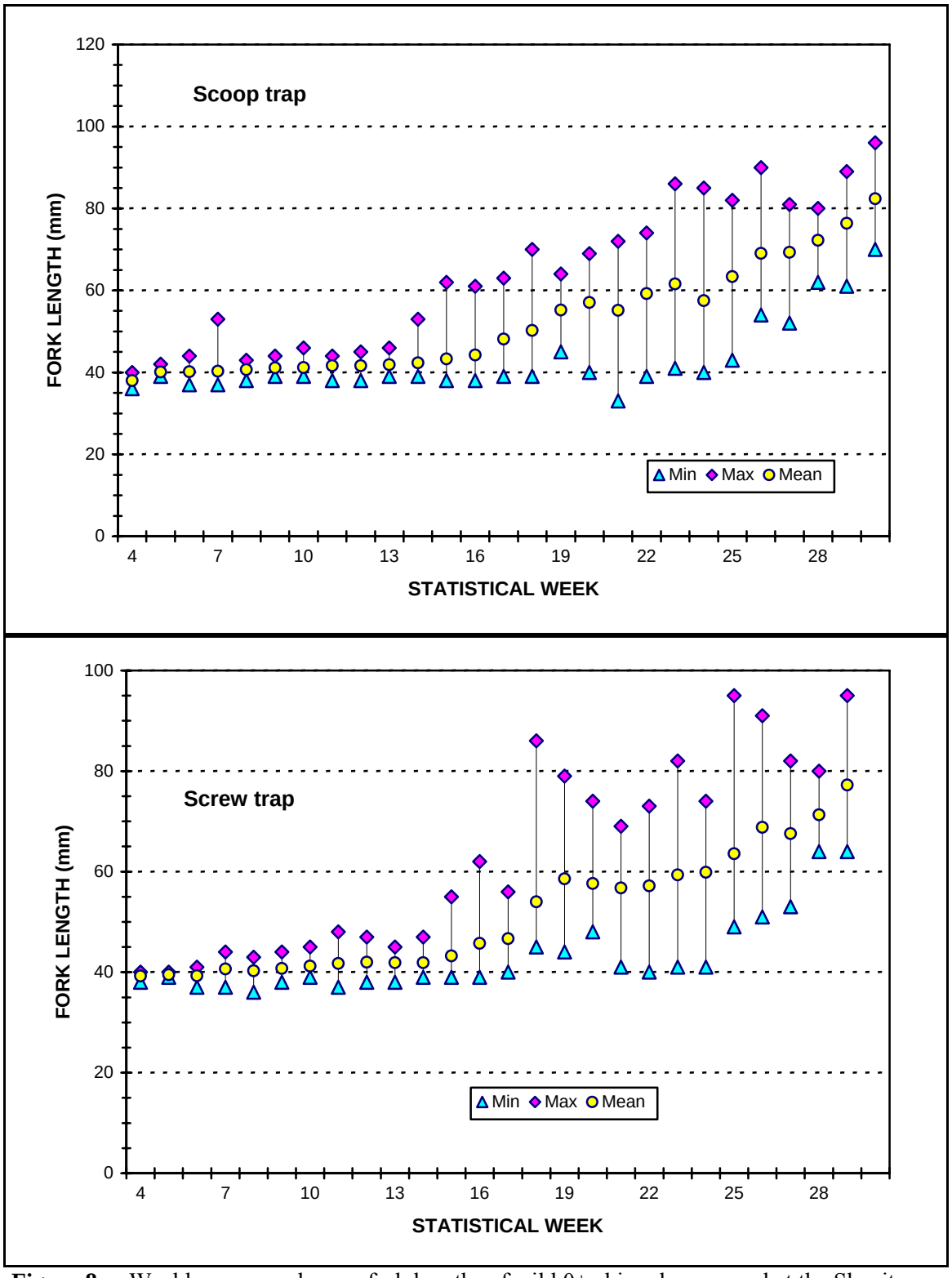

Figure 8. Weekly range and mean fork lengths of wild 0+ chinook measured at the Skagit River mainstem traps, 2004.

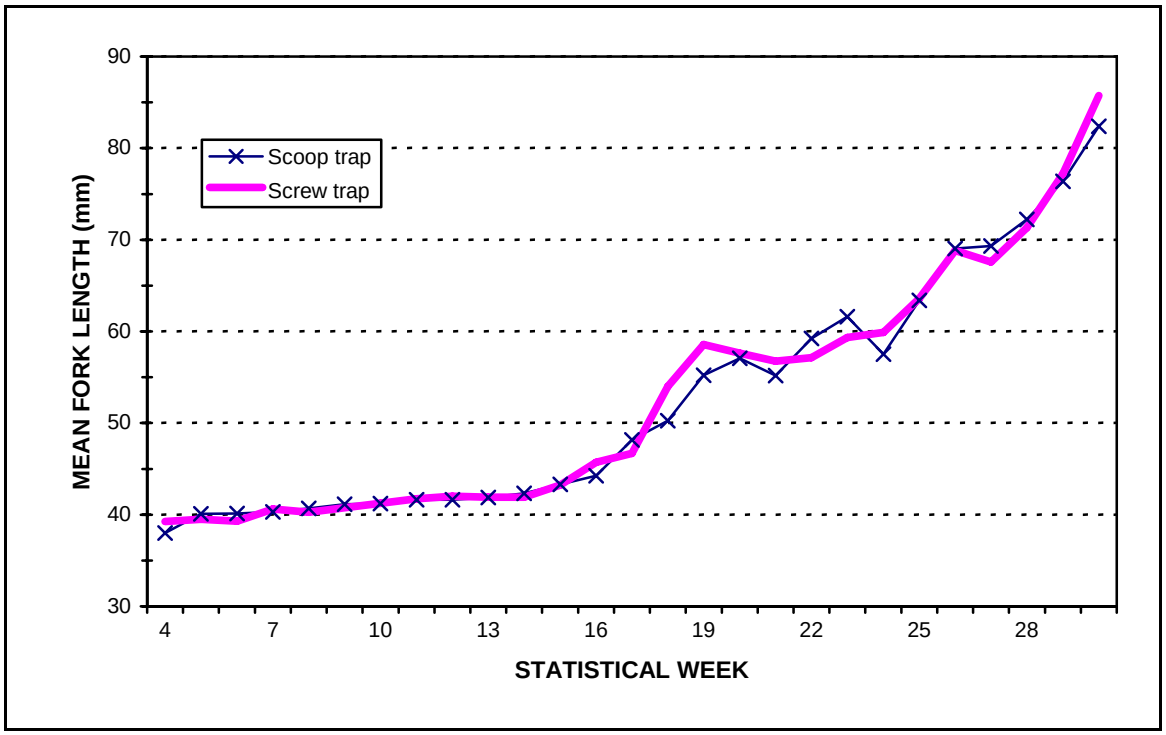

Figure 9. Comparison of mean size of 0+ chinook in the scoop and screw traps, by statistical week, Skagit River 2004.

Egg-to-Migrant Survival

Relating our estimate of 1.8 million downstream-migrant chinook to a potential deposition of 25.7 million eggs, results in an average survival-to-migration of 7.0%. This estimate of potential egg deposition (P.E.D.) is the product of 4,668 females and a fecundity of 5,500 eggs/female (Table 13)

Table 13: Estimated freshwater survival (egg deposition to migration), by brood year, Skagit River wild 0+ chinook (includes spring chinook).

Brood Year (i)	Migr Year (i+1)	Estimated Esc		PED @ 5,500[a] (millions)	Wild Smolts (millions)[b]	Survival to Migration	Peak Flow[c] Oct 20 – Feb 15	
		Total	Females (@45%)				cfs	Date
1989	1990	8,084	3,638	20.0	1.8	9.0%	88,200	12/05
1990	1991	18,303	8,236	45.3	0.5	1.2%	142,000	11/25
1991	1992	7,062	3,178	17.5	2.4	13.7%	40,100	02/01
1992	1993	8,334	3,750	20.6	3.0	14.4%	27,600	01/26
1993	1994	6,584	2,963	16.3	2.7	16.7%	32,100	12/11
1994	1995	6,019	2,709	14.9	1.5	10.2%	55,700	12/28
1995	1996	7,932	3,569	19.6	0.7	3.8%	132,000	11/30
1996	1997	11,664	5,249	28.9	4.5	15.6%	47,600	01/20
1997	1998	5,913	2,661	14.6	2.4	16.4%	60,600	10/21
1998	1999	15,695	7,063	38.8	6.4	16.5%	51,900	12/14
1999	2000	5,395	2,428	13.4	1.7	12.7%	76,800	11/13
2000	2001	17,951	8,078	44.4	6.0	13.5%	26,700	10/21
2001	2002	15,649	7,042	38.7	5.0	12.9%	73,700	01/08
2002	2003	20,656	9,295	51.1	5.5	10.8%	53,000	01/27
2003	2004	10,374	4,668	25.7	1.8	7.0%	115,000	10/22

[a] Personal communication, Pete Castle, WDFW.
[b] Prior to the 1996 brood, estimates were based on trapping during the coho migration period (April-June). Full-season trapping commenced in 1997.
[c] USGS mean daily flow at Mt Vernon.

Assumptions

Every estimate relies on assumptions. We estimated chinook production in 2004 using two separate trap efficiency strata. Trap efficiency for the earlier stratum was estimated from the mean of four efficiency tests conducted by releasing ad-marked hatchery chinook fry approximately one mile upstream of the traps. Efficiency for the later stratum was estimated by the capture rate on ad-marked and coded wire tagged hatchery chinook released from three facilities ranging from 40 to 72 miles upstream of the traps. While these are distinctly different approaches for estimating trap efficiency, we assume both accurately reflect the proportion of wild downstream migrant chinook captured during the migration periods in which they were used. In addition, we made the following assumptions to estimate the numbers of wild 0+ chinook migrating from the Skagit River in 2004.

1. **Catch Expansion**. Expansion of catch to the standard of continuous trap operation involved estimating fish passing the traps on the nights and daytime periods that we did not fish.

2. **Trap Efficiency**. Estimating trap efficiency also involves the expansion for daytime catch for all marked fish categories used to indicate capture rates. Inherent in this approach is the assumption that trap efficiency during the daytime is identical to that during the night hours. Basic assumptions for every trap calibration group of marked fish include:
    a. The number passing the gear is known (survival from release to the trap is 100%);
    b. All marked fish captured are identified and enumerated;
    c. Marked hatchery chinook were captured at the same rate as wild chinook; and
    d. Instantaneous trap efficiency is not a function of light.

Discussion of Assumptions

Although direct assessment of the above assumptions is not possible, we have some intuition as to how important they are and in which direction some of them may be violated. These beliefs and their effects on our estimate of the zero-age chinook production from the Skagit River follows:

Assumption #1: Catch Projection
We have no reason to believe that the catch projections using expansions of the day/night ratios for the day light periods not fished are biased. We believe that the catch projection for the season is a reasonable estimate of the numbers of wild zero-age chinook that we would have caught in both traps had we fished continuously from mid-January to July 28.

Assumption #2a: 100% Survival of Calibration Fish
It is unlikely that all of the calibration fish in each group survived to pass the trap. However, for the trap efficiency tests conducted earlier in the season involving the release of marked hatchery chinook, we expect high survival to the traps given the short distance from the release site to the traps (about one mile), and condensed recovery time. We are less certain of the survival of the ad-marked CWT chinook released from the hatchery facilities located as far as 72 miles upstream of our trap. Mortality or residualism occurring upstream of the traps would reduce the number of migrants passing the traps. Migration estimated for the later stratum would be over-estimated if this occurs. Nevertheless, the recapture rates on these fish were much higher than had been observed in all previous years, which we believe indicates high survival to the trap.

Assumption # 2b: Complete Identification/enumeration of All Marked Fish Captured
We are confident that virtually every marked fish captured was identified and recorded. The 2004 trap crew was comprised of trained and dedicated scientific technicians with many years of experience at this site. Consequently, we don't consider this potential bias to be significant.

Assumption # 2c: Marked Hatchery Chinook Were Captured at the Same Rate as Wild Chinook
The degree to which the hatchery chinook represent wild 0+ chinook is unknown. The similarity of d:n ratios over the season provides some evidence that hatchery fish are responding to the river conditions in a manner similar to that of the wild chinook. Presently, we do not have any indication that hatchery produced 0+ chinook are caught at different rates than wild chinook.

Assumption #2d: Trap Efficiency Is Not Affected by Light
If this assumption is not correct, then it is likely that efficiency during the day is lower relative to the night rate; trap avoidance enhanced by daylight is the likely reason, if a difference exists. Another factor that would contribute to lower capture rates during the daylight could be any shifting in the migration path to deeper water as a function of light. In an attempt to measure trap efficiency during the day and night, in Spring 1999, we released paired groups of hatchery chinook. As we expected, however, these fish did not pass the gear within their release strata (catches occurred primarily at night), so these tests provided no insight into this potential problem. If the hatchery calibration groups have the same diel migration behavior as wild fish, then different capture rates for day and night would not constitute a source of bias. Therefore, this assumption is really the same as #2c, for which we have little intuition.

Conclusion

As in previous years, we conclude that the critical assumption for producing unbiased estimates of wild 0+ chinook production is the estimate of trap efficiency. Bias in the production estimate results largely from variation in this critical parameter. Trap efficiency in 2004 was stratified by migration timing. Application of the resulting two rates (1.2% and 3.5%) estimates that 1.8 million wild 0+ chinook passed the traps in the Skagit River in 2004. If this production estimate is biased, we believe that it is high, because it is unlikely that all marked hatchery chinook survived to pass the traps. Therefore, the actual migration may be somewhat lower than is predicted by these rates. In previous years, a season-long trap efficiency rate was estimated using either the average trap efficiency from the efficiency tests conducted in all years, or from the average efficiency tests from the current year. In 2004, we incorporated the capture rate from the ad-marked/CWT hatchery release groups into our efficiency estimates for the first time. The substantially higher capture rates measured from all three hatchery releases was a strong indication that the traps were operating at a higher efficiency later in the season than they were earlier.

Discussion

The two floods in October 2003 (65,800 and 115,000 cfs on October 18 and 22) caused significant mortality on recently deposited eggs throughout the system, especially in the upper river. As a result, this brood's freshwater survival rate (7.0%) was only a little more than half of the average rate observed over the previous 14 years (13.3%). The small portion of the chinook population spawning after these flood events, primarily in the lower river, experienced relatively benign incubation conditions. Consequently, progeny from later spawners apparently attained relatively high survival, offsetting the very poor survival of the majority of the population, which spawned early.

The severity and timing of these flows are evident in the production rate and outmigration timing that we measured during the 2004 season. Trapping began in late January following a peak flow on January 16 (30,200 cfs). Another peak flow occurred on January 30 (34,400 cfs). Low fry catches during and following these events indicated relatively few fry were emerging at this time (Figure 3). This outcome is consistent with poor survival of the early portion of the spawning population. Median migration date in 2004 occurred on April 15, 20-days after the previous average median date (through 2003).

Over the previous fourteen seasons, flow during egg incubation has explained most of the inter-annual variation in our estimates of egg-to-migrant survival rates (Figure 10). The survival rate for the 2003 brood is essentially equal to the rate predicted by the peak egg incubation flow. While these flows largely predict egg-to-migrant survival at higher flow levels, more variation about the curve is observed at the more frequent, smaller peak flows. Continued monitoring including future broods with higher spawning populations will help further define the constraints to chinook production in the Skagit River.

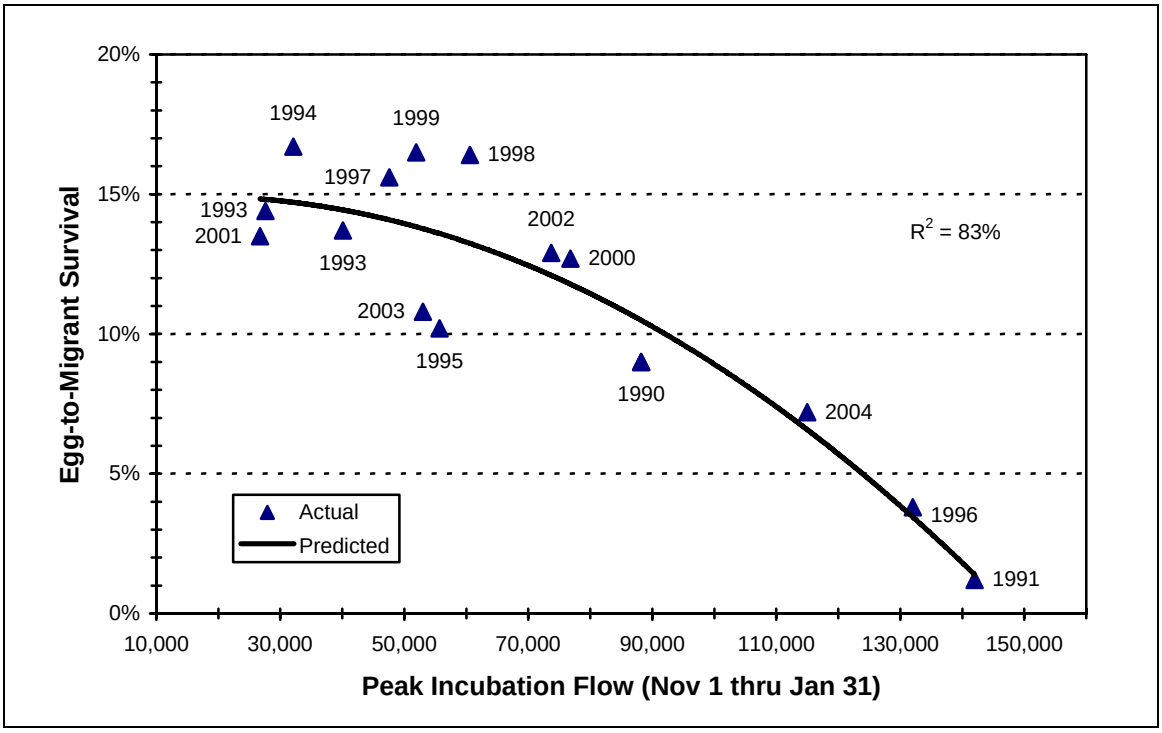

Figure 10. Wild 0+ chinook egg-to-migrant survival and peak incubation flow, migration years 1990-2004, Skagit River.

Recommendations

The following recommendations, compiled from the past five years' work, are listed so that we can assess the progress made during the 2004 season. As noted in last year's report, these measures include actions that we may reasonably and cost-effectively implement within the current scope and funding level of our trapping program in the lower Skagit River.

1. Continue trapping during an extended season over a sufficient span of years and flow conditions to gain an understanding of the inter-annual variation in migration timing.

2. Count catches at or near sunrise and sunset to increase information in the database to enable day:night catch comparisons.

3. Increase the numbers of release groups of marked wild and hatchery 0+ chinook and, if possible, release paired groups of hatchery and wild chinook to assess differences in recovery rates.

Progress:

1. **Accomplished**. We trapped each night with the exception of 17 nights, from January 15 through July.

2. **Accomplished**. On most dates over the season, we counted catches at dusk and dawn.

3. **Not Accomplished**. The low production and resultant low catches in 2004 precluded using wild chinook for trap calibration.

Recommendations for 2005

Our study plan for the 2005 season includes continuing all of the above recommendations.

1. We will continue to assess the relationship of flow, turbidity, and migration rates

2. Increase the number of marked wild and hatchery 0+ chinook release groups to assess recapture rates at various flow levels.

3. When possible, conduct paired releases of hatchery and wild fish to test the assumption of similar capture rates.

4. Conduct pilot 0+ chinook releases early in the season supplemented with dye-marked chum or pink fry to assess recapture rates.

References

Literature Cited

Busack, C., C. Knudsen, A. Marshall, S. Phelps, and D. Seiler. 1991. Yakima Hatchery experimental design. WA Dept of Fish Ann Prog Rpt prepared for BPA Div of Fish & Wildl. Olympia, Washington. 266pp. 7

Conrad, R.H., R.A. Hayman, E. Beamer, and P.J. Goddard. 1997. Coho Salmon Escapement to the Skagit River Estimated Using a Mark-Recapture Method: 1986. Northwest Fishery Resource Bulletin. Proj Rep Series No. 6. NWIFC. Olympia, Washington 3

Puget Sound Salmon Stock Review Group. 1992. Assessment of the Status of Five Stocks of Puget Sound Chinook and Coho: As Required Under the PFMC Definition of Overfishing. Tech Rpt for the Pacific Fisheries Management Council. Portland, Oregon. 113 pp. 3

Puget Sound Salmon Stock Review Group. 1997. An Assessment Of The Status Of Puget Sound Chinook And Strait Of Juan De Fuca Coho Stocks: As Required Under The Salmon Fishery Management Plan. Tech Rpt for the Pacific Fisheries Management Council. Portland, Oregon. 78pp. 3

Seber, G.A.F. 1982. *The Estimation of Animal Abundance and Related Parameters*. Charles Griffin & Co Ltd. High Wycombe, England. 4

Seiler, D., P. Hanratty, S. Neuhauser, and M. Ackley. 1984. Upstream/Downstream Salmonid Trapping Project 1980-1982. WA Dept of Fish Prog Rpt No. 200. Olympia, Washington..... 3

Seiler, D., S. Neuhauser and L. Kishimoto. 2002. 2001 Skagit River Wild 0+ Chinook Production Evaluation. WA Dept Fish Ann Rpt. Olympia, Washington. 47 pp. 32

Seiler, D., S. Neuhauser, and M. Ackley. 1981. Upstream/Downstream Salmonid Trapping Project 1977-1980. WA Dept of Fish Prog Rpt No. 144. Olympia, Washington. 195 pp..... 3, 7

Sokal, R.R. and F.J. Rohlf. 1981. *Biometry: Principals and Practice of Statistics in Biological Research*. 2nd ed. New York : W.H. Freemand and Company. p440..... 7

SPSS Inc. 1998. *Systat 8.0*. IL: SPSS Inc. 7

Personal Communications

Pete Castle. WDFW Region 4. September 20, 2001. 4

Appendices: Daily Catches in the Mainstem Skagit River Scoop and Screw Traps, 2004

Appendix A: Total daily catches, by species and age, in the Skagit River mainstem scoop trap, 2004.

Date	HOURS		CHINOOK			COHO				TROUT		
	Fished	Out	0+	1+	Chum	0+	1+	Pink	Sock	Parr	Sthd	Cutt
01/23	12.75	0.25	1	0	0	0	0	1	0	0	1	0
01/24	7.50	16.50	1	1	0	0	0	2	0	0	0	0
01/25	6.75	17.25	1	0	0	0	0	0	0	0	0	0
01/26	7.50	16.50	1	0	0	0	0	0	0	0	0	0
01/27	6.50	17.50	2	0	0	0	0	0	0	0	0	0
01/28	23.67	0.33	10	1	0	0	0	3	0	0	0	0
01/29	7.50	16.50	2	1	0	0	0	2	0	0	0	0
01/30	0.75	23.25	1	0	0	0	0	1	0	0	0	0
01/31	7.00	17.00	4	1	0	0	0	0	0	0	0	0
02/01	7.50	16.50	4	1	0	0	0	1	0	0	0	0
02/02	6.50	17.50	5	0	0	0	0	0	0	0	0	0
02/03	23.58	0.42	10	1	0	0	0	3	0	0	0	0
02/04	7.50	16.50	4	0	0	0	0	4	0	0	0	0
02/05	6.50	17.50	3	0	0	0	0	6	0	1	0	0
02/06	13.75	10.25	6	0	0	0	0	9	0	1	0	0
02/07	23.67	0.33	5	0	0	0	0	25	0	1	0	0
02/08	13.50	10.50	7	1	0	0	0	9	0	1	0	0
02/09	14.00	10.00	13	0	0	0	0	7	0	0	0	0
02/10	23.50	0.50	23	1	0	0	0	15	0	0	0	0
02/11	14.00	10.00	13	0	0	0	0	1	0	0	0	0
02/12	13.75	10.25	11	1	0	0	0	5	0	0	0	0
02/13	23.67	0.33	18	1	0	0	0	24	0	0	0	0
02/14	14.00	10.00	11	0	2	0	0	6	0	0	0	0
02/15	13.50	10.50	18	0	2	0	0	7	0	0	0	0
02/16	23.67	0.33	25	1	2	0	0	45	0	0	0	0
02/17	13.50	10.50	14	1	1	0	0	14	0	0	0	0
02/18	13.50	10.50	10	0	3	0	0	22	0	0	0	1
02/19	13.50	10.50	14	0	3	0	0	25	0	1	0	0
02/20	23.67	0.33	23	0	5	0	0	51	0	0	0	0
02/21	13.50	10.50	14	0	6	0	0	11	0	0	0	0
02/22	23.75	0.25	33	1	8	0	1	80	0	0	0	0
02/23	13.50	10.50	24	2	5	0	0	17	0	0	0	0
02/24	13.50	10.50	22	0	9	0	0	23	0	0	0	0
02/25	23.67	0.33	34	1	14	0	0	72	0	0	0	0
02/26	13.50	10.50	36	1	12	0	1	17	0	0	0	0
02/27	23.75	0.25	25	1	22	0	0	161	0	0	0	0
02/28	13.00	11.00	7	1	8	0	0	82	0	0	0	0
02/29	13.00	11.00	11	0	9	0	0	38	1	0	0	0
03/01	23.50	0.50	24	0	43	0	0	322	0	0	0	0
03/02	12.75	11.25	38	0	39	0	1	39	0	1	0	0
03/03	12.75	11.25	37	0	20	0	0	37	1	0	0	0
03/04	23.42	0.58	24	1	31	0	0	310	0	0	0	0
03/05	12.75	11.25	21	1	69	0	0	59	1	0	0	0
03/06	12.75	11.25	21	0	75	0	0	29	0	0	0	0
03/07	23.50	0.50	12	1	65	0	0	195	0	0	0	0
03/08	12.75	11.25	12	0	70	0	0	88	0	0	0	0
03/09	12.50	11.50	62	0	114	0	1	117	0	0	0	0
03/10	23.50	0.50	189	0	324	2	2	379	0	0	0	0
03/11	12.25	11.75	143	0	114	2	2	112	0	0	0	0
03/12	12.00	12.00	79	1	86	1	2	149	1	1	0	0
03/13	23.50	0.50	70	0	106	0	3	1,013	1	0	0	0
03/14	12.00	12.00	17	0	57	0	2	186	0	1	1	0
03/15	12.00	12.00	44	0	85	1	1	145	0	1	0	0

Table continued on next page

Appendix A: Total daily catches, by species and age, in the Skagit River mainstem scoop trap, 2004 (cont'd).

Date	HOURS		CHINOOK			COHO				TROUT		
	Fished	Out	0+	1+	Chum	0+	1+	Pink	Sock	Parr	Sthd	Cutt
03/16/04	23.58	0.42	154	1	186	0	2	571	0	0	0	0
03/17/04	12.00	12.00	94	0	161	2	1	341	0	0	0	0
03/18/04	12.00	12.00	43	0	263	2	2	551	1	1	0	0
03/19/04	23.67	0.33	343	3	837	5	1	2,575	1	1	0	0
03/20/04	12.00	12.00	176	0	332	5	1	166	0	0	0	0
03/21/04	11.75	12.25	87	0	316	1	1	265	0	0	0	0
03/22/04	23.58	0.42	97	2	437	0	4	1,408	0	1	0	0
03/23/04	11.75	12.25	62	1	245	0	3	380	1	1	0	0
03/24/04	23.75	0.25	213	0	720	1	1	1,969	0	2	0	0
03/25/04	11.50	12.50	175	0	391	3	1	670	1	1	0	0
03/26/04	11.50	12.50	175	0	425	5	2	505	1	0	0	0
03/27/04	11.25	12.75	154	0	575	4	3	713	1	0	1	0
03/28/04	23.50	0.50	285	2	1,217	10	5	3,430	2	0	0	0
03/29/04	9.50	14.50	98	1	549	6	4	630	0	0	1	0
03/30/04	5.00	19.00	63	1	412	0	2	645	0	0	1	0
03/31/04	11.00	13.00	120	2	929	6	6	1,113	0	1	1	1
04/01/04	23.25	0.75	129	3	1,567	9	7	3,795	1	0	0	0
04/02/04	11.00	13.00	89	1	2,091	5	9	2,045	0	0	0	0
04/03/04	23.42	0.58	101	2	2,365	3	7	3,195	0	0	0	0
04/04/04	11.00	13.00	47	0	1,033	3	6	1,064	0	1	0	0
04/05/04	11.00	13.00	40	1	614	3	8	1,060	1	0	1	0
04/06/04	23.58	0.42	44	2	994	5	9	2,073	1	1	0	0
04/07/04	11.00	13.00	21	1	814	2	2	1,790	0	0	1	0
04/08/04	10.75	13.25	65	1	1,402	14	5	1,844	0	1	0	0
04/09/04	23.50	0.50	177	2	4,265	36	14	8,451	1	0	0	0
04/10/04	10.50	13.50	99	1	846	21	13	810	1	0	0	0
04/11/04	9.50	14.50	66	0	406	12	16	345	0	0	0	0
04/12/04	23.50	0.50	206	4	2,527	25	29	3,775	0	2	2	0
04/13/04	10.00	14.00	212	6	530	47	34	501	0	2	1	0
04/14/04	10.25	13.75	240	1	965	81	38	1,631	0	1	0	0
04/15/04	23.50	0.50	232	2	4,231	83	34	8,362	0	0	1	0
04/16/04	10.25	13.75	98	1	804	45	29	1,358	0	1	1	0
04/17/04	10.00	14.00	51	1	970	33	30	1,360	0	0	0	0
04/18/04	23.75	0.25	33	0	3,267	11	21	6,285	0	0	0	1
04/19/04	10.25	13.75	25	1	2,104	13	17	2,260	0	1	0	0
04/20/04	10.00	14.00	32	1	1,253	25	26	1,463	0	1	0	0
04/21/04	10.25	13.75	26	1	1,407	16	45	1,685	0	1	1	0
04/22/04	23.67	0.33	33	1	3,630	12	62	6,729	0	0	0	0
04/23/04	10.00	14.00	21	2	641	16	71	466	0	0	1	0
04/24/04	10.00	14.00	18	4	1,090	21	83	1,155	0	2	1	0
04/25/04	23.58	0.42	27	3	2,203	16	99	7,002	0	1	1	0
04/26/04	9.50	14.50	18	5	563	14	79	562	1	0	0	0
04/27/04	18.50	5.50	40	15	1,933	43	130	2,552	1	0	2	0
04/28/04	10.00	14.00	60	33	1,121	84	188	958	2	0	3	0
04/29/04	10.00	14.00	41	30	605	52	217	393	0	1	1	1
04/30/04	23.67	0.33	30	7	1,651	22	191	7,191	0	0	0	0

Table continued on next page

Appendix A: Total daily catches, by species and age, in the Skagit River mainstem scoop trap, 2004 (cont'd).

Date	HOURS		CHINOOK			COHO				TROUT		
	Fished	Out	0+	1+	Chum	0+	1+	Pink	Sock	Parr	Sthd	Cutt
05/01/04	9.50	14.50	27	3	614	15	175	714	1	0	2	0
05/02/04	9.25	14.75	108	34	278	30	449	172	11	0	59	1
05/03/04	23.00	1.00	351	109	2,405	39	751	647	19	0	124	1
05/04/04	9.50	14.50	97	34	12	35	348	0	5	0	57	1
05/05/04	9.00	15.00	62	13	16	18	253	19	1	0	57	1
05/06/04	23.58	0.42	111	21	2,721	41	337	2,773	1	0	37	0
05/07/04	9.50	14.50	34	1	359	36	190	349	2	0	3	0
05/08/04	9.00	15.00	34	2	520	37	167	338	3	0	3	0
05/09/04	9.00	15.00	40	3	316	55	226	175	2	1	7	0
05/10/04	23.67	0.33	75	2	582	54	209	2,040	1	1	8	0
05/11/04	9.00	15.00	25	0	115	28	130	194	0	1	4	0
05/12/04	9.00	15.00	33	1	75	43	207	108	0	1	8	0
05/13/04	9.50	14.50	32	3	55	23	195	88	0	1	10	1
05/14/04	23.58	0.42	28	1	198	10	161	2,076	0	1	2	0
05/15/04	9.00	15.00	28	0	64	14	146	39	0	1	2	0
05/16/04	9.00	15.00	38	1	43	14	173	24	1	2	3	0
05/17/04	23.58	0.42	47	2	307	12	261	1,839	1	1	5	2
05/18/04	8.75	15.25	39	4	52	24	278	28	1	1	9	1
05/19/04	8.50	15.50	120	17	44	52	457	22	2	0	25	1
05/20/04	10.00	14.00	240	30	107	72	495	3	3	0	35	0
05/21/04	23.58	0.42	401	7	102	40	472	40	0	1	15	2
05/22/04	8.50	15.50	204	6	18	34	260	2	1	0	16	0
05/23/04	8.50	15.50	211	4	29	41	254	4	0	0	17	0
05/24/04	23.58	0.42	241	3	213	36	231	179	0	1	7	1
05/25/04	8.50	15.50	70	2	6	14	155	4	1	2	3	0
05/26/04	8.50	15.50	143	2	8	10	157	6	0	1	4	0
05/27/04	21.58	2.42	948	27	62	99	385	5	1	0	18	2
05/28/04	2.50	21.50	159	1	3	56	64	0	0	0	3	1
05/29/04	8.50	15.50	583	3	10	159	209	0	0	0	9	2
05/30/04	23.58	0.42	1,646	2	15	90	241	1	3	0	4	0
05/31/04	8.50	15.50	1,043	0	3	60	113	0	2	0	4	2
06/01/04	8.75	15.25	592	1	1	34	77	1	1	0	1	3
06/02/04	24.00	0.00	365	2	5	15	88	21	0	2	0	1
06/03/04	8.00	16.00	156	1	3	6	71	2	0	3	0	0
06/04/04	7.75	16.25	277	1	6	12	116	0	0	1	1	0
06/05/04	13.75	10.25	771	2	7	19	164	1	1	0	2	0
06/06/04	5.50	18.50	443	0	6	120	179	0	1	0	0	0
06/07/04	8.00	16.00	345	0	2	117	109	0	0	0	0	1
06/08/04	23.50	0.50	256	0	16	65	88	0	0	1	0	1
06/09/04	8.00	16.00	352	0	1	33	76	0	1	0	0	0
06/10/04	8.00	16.00	865	0	3	29	60	0	0	1	0	0
06/11/04	23.75	0.25	1,521	1	3	20	71	0	0	1	0	0
06/12/04	8.00	16.00	630	0	2	13	26	0	0	0	0	0
06/13/04	8.00	16.00	400	0	2	8	19	0	0	0	0	1
06/14/04	23.58	0.42	1,486	0	5	12	40	0	0	1	0	0
06/15/04	8.00	16.00	415	0	2	13	20	0	0	0	0	0
06/16/04	8.00	16.00	182	0	2	6	7	0	0	0	1	1
06/17/04	23.58	0.42	247	0	5	6	7	0	0	0	0	0
06/18/04	8.00	16.00	281	0	1	7	9	0	0	0	0	1
06/19/04	23.58	0.42	555	0	2	7	15	0	0	0	0	0
06/20/04	8.00	16.00	210	0	0	8	11	0	0	0	0	0
06/21/04	7.50	16.50	108	0	1	6	9	0	0	0	0	0
06/22/04	15.25	8.75	94	0	3	7	10	0	0	0	0	0
06/23/04	5.50	18.50	150	0	2	7	10	0	0	0	0	1
06/24/04	5.50	18.50	192	0	3	4	1	0	0	0	0	0
06/25/04	9.00	15.00	309	0	0	0	4	0	0	0	0	0
06/26/04	8.00	16.00	174	0	1	7	7	0	0	1	0	0
06/27/04	8.00	16.00	177	0	3	18	9	0	0	1	0	0
06/28/04	23.58	0.42	215	0	0	13	3	0	0	0	1	0
06/29/04	8.25	15.75	88	0	1	8	5	0	0	0	0	0
06/30/04	8.00	16.00	85	0	0	2	7	0	0	0	0	0

Table continued on next page

Appendix A: Total daily catches, by species and age, in the Skagit River mainstem scoop trap, 2004 (cont'd).

Date	HOURS		CHINOOK			COHO				TROUT		
	Fished	Out	0+	1+	Chum	0+	1+	Pink	Sock	Parr	Sthd	Cutt
07/01/04	23.67	0.33	307	0	1	5	6	0	0	0	0	0
07/02/04	7.75	16.25	76	0	1	6	6	0	0	0	0	1
07/03/04	8.00	16.00	46	0	0	1	5	0	0	0	0	0
07/04/04	11.75	12.25	36	0	0	1	3	0	0	0	0	0
07/05/04	2.50	21.50	8	0	0	1	2	0	0	0	0	0
07/06/04	8.25	15.75	25	0	0	4	4	0	0	0	0	0
07/07/04	23.25	0.75	97	0	0	6	5	0	0	0	0	0
07/08/04	8.25	15.75	43	0	0	1	4	0	0	0	0	0
07/09/04	8.00	16.00	17	0	0	3	4	0	0	0	0	0
07/10/04	7.75	16.25	11	0	0	4	1	0	0	0	0	0
07/11/04	23.83	0.17	19	0	0	4	2	0	0	1	1	0
07/12/04	5.50	18.50	8	0	1	1	1	0	0	1	0	0
07/13/04		24.00										
07/14/04	2.50	21.50	4	0	0	1	0	0	0	0	0	0
07/15/04	15.25	8.75	15	0	0	2	0	0	0	0	0	0
07/16/04	5.75	18.25	10	0	0	1	1	0	0	0	0	0
07/17/04		24.00										
07/18/04	2.75	21.25	9	0	0	0	0	0	0	0	0	0
07/19/04	17.25	6.75	29	0	0	0	1	0	0	0	0	0
07/20/04	5.75	18.25	17	0	0	2	0	0	0	0	0	0
07/21/04		24.00										
07/22/04	2.00	22.00	1	0	0	0	0	0	0	0	0	0
07/23/04	23.50	0.50	13	0	0	1	0	0	0	0	0	0
07/24/04	5.75	18.25	5	0	0	0	1	0	0	0	0	0
07/25/04		24.00										
07/26/04	2.50	21.50	1	0	0	0	0	0	0	0	0	0
07/27/04	23.50	0.50	5	0	0	0	0	0	0	0	0	0
07/28/04	7.50	0.00	3	0	0	1	0	0	0	1	0	0
TOTAL CATCH			25,883	514	66,739	2,786	11,087	113,975	88	64	590	34

Appendix B: Total daily catches, by species and age, in the Skagit River mainstem screw trap, 2004.

Date	HOURS		CHINOOK			COHO				TROUT		
	Fished	Out	0+	1+	Chum	0+	1+	Pink	Sock	Parr	Sthd	Cutt
01/23/04	13.00	0.00	2	0	0	0	0	5	0	0	0	0
01/24/04	7.50	16.50	2	0	0	0	0	1	0	0	0	0
01/25/04	6.75	17.25	1	0	0	0	0	2	0	0	0	0
01/26/04	7.50	16.50	1	0	0	0	0	2	0	0	0	0
01/27/04	6.50	17.50	0	1	0	0	0	0	0	0	0	0
01/28/04	24.00	0.00	6	1	0	0	0	2	0	0	0	0
01/29/04	7.50	16.50	3	0	0	0	0	0	0	0	0	0
01/30/04	0.00	24.00										
01/31/04	6.50	17.50	0	0	0	0	0	0	0	0	0	0
02/01/04	7.50	16.50	1	0	0	0	0	1	0	0	0	0
02/02/04	6.50	17.50	1	0	0	0	0	1	0	0	0	0
02/03/04	24.00	0.00	6	0	0	0	0	4	1	0	0	0
02/04/04	7.50	16.50	2	0	0	0	0	1	0	0	0	0
02/05/04	6.50	17.50	1	0	0	0	0	1	0	0	0	0
02/06/04	14.00	10.00	4	0	0	0	0	4	0	0	0	0
02/07/04	24.00	0.00	4	0	0	0	0	8	0	0	0	0
02/08/04	13.50	10.50	5	0	0	0	0	4	0	0	0	0
02/09/04	14.00	10.00	6	1	0	0	1	1	0	0	0	0
02/10/04	24.00	0.00	10	0	0	0	0	5	0	0	0	1
02/11/04	14.00	10.00	7	1	0	0	0	1	0	0	0	0
02/12/04	13.75	10.25	5	0	0	0	0	1	0	0	2	1
02/13/04	24.00	0.00	11	0	0	0	0	7	0	0	1	0
02/14/04	14.00	10.00	5	0	1	0	0	3	0	0	0	0
02/15/04	13.50	10.50	8	0	2	0	1	8	0	0	0	0
02/16/04	24.00	0.00	15	0	1	0	0	21	0	0	0	0
02/17/04	13.50	10.50	6	0	0	0	0	5	0	0	0	0
02/18/04	13.50	10.50	6	1	0	0	1	8	0	0	0	0
02/19/04	13.50	10.50	5	0	1	0	0	9	0	0	0	0
02/20/04	24.00	0.00	20	1	6	0	1	75	0	1	0	0
02/21/04	13.50	10.50	12	0	2	0	0	14	0	1	0	0
02/22/04	24.00	0.00	26	0	2	0	0	44	0	0	0	0
02/23/04	13.50	10.50	17	1	2	0	0	13	0	0	0	0
02/24/04	13.50	10.50	16	0	3	0	0	13	0	0	0	0
02/25/04	24.00	0.00	16	0	6	0	0	45	0	0	0	0
02/26/04	13.50	10.50	13	1	4	0	0	10	0	0	0	0
02/27/04	24.00	0.00	17	1	6	0	0	104	1	0	0	0
02/28/04	13.00	11.00	6	1	5	0	1	37	0	0	0	0
02/29/04	13.00	11.00	8	0	8	0	0	57	0	0	0	0
03/01/04	24.00	0.00	15	0	16	0	1	213	0	0	0	0
03/02/04	12.75	11.25	14	0	4	0	0	24	0	0	0	0
03/03/04	12.75	11.25	19	0	2	0	0	19	0	0	0	0
03/04/04	24.00	0.00	20	0	19	0	0	175	0	0	0	0
03/05/04	12.75	11.25	8	0	37	0	0	34	0	0	0	1
03/06/04	12.75	11.25	9	0	38	0	0	24	0	0	0	0
03/07/04	24.00	0.00	19	0	54	0	0	177	0	0	0	0
03/08/04	12.75	11.25	18	0	54	0	2	97	0	0	0	1
03/09/04	12.50	11.50	19	0	30	0	3	46	1	0	1	1
03/10/04	24.00	0.00	161	1	135	0	2	332	0	0	1	0
03/11/04	12.25	11.75	89	1	36	0	2	29	0	0	0	0
03/12/04	12.00	12.00	33	0	33	0	1	51	0	0	0	0
03/13/04	24.00	0.00	60	1	80	0	1	505	0	1	1	0
03/14/04	12.00	12.00	14	0	52	0	0	230	0	1	1	1
03/15/04	12.00	12.00	49	0	82	0	1	271	0	0	0	0

Table continued on next page

Appendix B: Total daily catches, by species and age, in the Skagit River mainstem screw trap, 2004 (cont'd).

Date	HOURS		CHINOOK			COHO				TROUT		
	Fished	Out	0+	1+	Chum	0+	1+	Pink	Sock	Parr	Sthd	Cutt
03/16/04	24.00	0.00	112	0	146	0	1	935	0	0	0	0
03/17/04	12.00	12.00	56	0	122	1	1	261	0	0	0	1
03/18/04	12.00	12.00	56	0	210	2	1	324	0	0	0	0
03/19/04	24.00	0.00	290	0	800	2	2	2,942	0	1	0	1
03/20/04	12.00	12.00	108	1	216	3	0	154	0	0	1	0
03/21/04	11.75	12.25	46	1	174	0	0	270	0	1	1	0
03/22/04	24.00	0.00	62	0	365	0	0	1,049	0	1	0	0
03/23/04	11.75	12.25	35	0	195	0	2	389	0	1	1	0
03/24/04	24.00	0.00	188	0	915	2	3	1,963	0	0	1	0
03/25/04	11.50	12.50	59	1	228	0	5	327	0	0	0	0
03/26/04	11.50	12.50	60	2	213	1	5	399	0	0	1	1
03/27/04	11.25	12.75	71	0	317	2	3	545	0	0	1	1
03/28/04	24.00	0.00	161	1	713	2	2	2,481	0	0	0	0
03/29/04	9.50	14.50	53	0	311	1	2	743	1	1	0	1
03/30/04	5.00	19.00	39	0	330	0	2	685	0	0	0	0
03/31/04	11.00	13.00	57	0	524	0	5	1,051	0	0	1	0
04/01/04	23.50	0.50	73	0	764	1	4	2,959	0	1	0	0
04/02/04	11.00	13.00	30	0	501	0	3	786	1	0	0	0
04/03/04	23.83	0.17	51	1	918	0	4	2,960	1	1	0	0
04/04/04	11.00	13.00	16	0	439	1	2	1,085	0	0	0	0
04/05/04	11.00	13.00	20	0	305	0	6	771	0	1	1	0
04/06/04	23.75	0.25	28	0	793	2	6	2,530	0	0	0	0
04/07/04	11.00	13.00	14	0	629	1	6	1,327	0	1	0	0
04/08/04	10.75	13.25	26	1	1,015	1	7	1,506	0	2	1	0
04/09/04	23.83	0.17	106	1	3,319	7	10	6,637	0	0	1	1
04/10/04	10.50	13.50	46	0	1,639	7	5	2,671	1	0	1	0
04/11/04	9.50	14.50	33	1	1,458	13	5	2,214	0	0	1	1
04/12/04	23.83	0.17	86	4	3,412	19	19	5,674	0	1	4	0
04/13/04	10.00	14.00	60	2	279	18	31	905	0	0	6	2
04/14/04	10.25	13.75	67	1	378	9	24	1,007	0	1	7	1
04/15/04	23.75	0.25	100	1	3,942	9	25	8,038	0	2	1	1
04/16/04	10.25	13.75	21	1	734	7	22	1,205	0	1	1	0
04/17/04	10.00	14.00	11	0	1,031	7	17	1,100	0	1	1	1
04/18/04	23.83	0.17	22	0	2,975	3	15	5,300	0	0	0	0
04/19/04	10.25	13.75	11	0	2,241	2	13	1,527	0	1	1	0
04/20/04	10.00	14.00	14	1	1,946	3	19	992	0	0	1	0
04/21/04	10.25	13.75	19	1	1,667	5	26	1,190	0	1	2	0
04/22/04	23.92	0.08	23	3	3,529	3	36	4,892	0	1	3	1
04/23/04	10.00	14.00	3	5	909	5	41	908	0	1	3	1
04/24/04	10.00	14.00	7	4	1,324	5	46	1,062	0	2	3	0
04/25/04	24.00	0.00	10	3	3,009	2	54	6,205	0	1	5	1
04/26/04	9.50	14.50	8	6	526	3	48	618	0	0	6	1
04/27/04	18.50	5.50	27	21	3,057	17	100	3,015	0	1	36	2
04/28/04	10.00	14.00	17	44	353	23	179	450	0	0	69	3
04/29/04	10.00	14.00	10	31	191	1	160	88	0	1	28	3
04/30/04	24.00	0.00	9	7	1,186	0	136	6,090	0	1	8	2

Table continued on next page

Appendix B: Total daily catches, by species and age, in the Skagit River mainstem screw trap, 2004 (cont'd).

Date	HOURS		CHINOOK			COHO				TROUT		
	Fished	Out	0+	1+	Chum	0+	1+	Pink	Sock	Parr	Sthd	Cutt
05/01/04	9.50	14.50	10	3	408	1	136	230	1	0	15	2
05/02/04	9.25	14.75	31	33	426	8	268	112	16	0	155	7
05/03/04	24.00	0.00	124	85	2,920	15	438	753	29	0	394	9
05/04/04	9.50	14.50	18	23	2	0	196	1	3	1	368	6
05/05/04	9.00	15.00	20	8	25	1	166	4	1	1	310	1
05/06/04	24.00	0.00	71	13	2,176	4	166	1,354	0	0	162	1
05/07/04	9.50	14.50	18	1	168	2	113	50	1	0	105	2
05/08/04	9.00	15.00	13	1	246	2	99	81	1	0	73	3
05/09/04	9.00	15.00	10	0	99	1	138	24	0	0	145	2
05/10/04	24.00	0.00	29	1	419	1	136	1,484	1	0	136	1
05/11/04	9.00	15.00	9	0	13	1	82	13	1	0	63	3
05/12/04	9.00	15.00	7	2	5	2	128	6	0	0	91	7
05/13/04	9.50	14.50	6	1	7	2	142	12	0	1	59	5
05/14/04	24.00	0.00	12	1	87	1	90	1,250	0	0	45	3
05/15/04	9.00	15.00	5	1	3	2	81	10	0	0	40	4
05/16/04	9.00	15.00	10	0	2	1	96	1	0	0	32	2
05/17/04	24.00	0.00	14	0	188	2	145	897	1	1	54	3
05/18/04	8.75	15.25	13	2	5	0	195	6	0	2	63	7
05/19/04	8.50	15.50	46	12	3	2	321	4	4	2	193	10
05/20/04	10.00	14.00	97	26	6	6	342	5	6	1	342	6
05/21/04	24.00	0.00	171	7	16	5	262	7	0	0	186	8
05/22/04	8.50	15.50	73	6	5	1	153	0	1	0	147	8
05/23/04	8.50	15.50	71	7	2	2	165	0	2	0	89	6
05/24/04	24.00	0.00	120	1	175	4	160	221	1	0	49	9
05/25/04	8.50	15.50	34	0	3	1	101	1	0	0	26	9
05/26/04	8.50	15.50	62	2	4	2	116	2	0	0	11	6
05/27/04	21.50	2.50	585	11	37	20	305	2	1	1	38	8
05/28/04	2.50	21.50	88	1	0	5	43	0	0	0	6	3
05/29/04	8.50	15.50	310	3	1	15	146	0	1	1	22	8
05/30/04	24.00	0.00	820	2	22	20	192	0	2	1	22	10
05/31/04	8.50	15.50	561	3	1	6	88	0	1	0	11	0
06/01/04	8.75	15.25	395	0	1	9	65	0	1	0	8	1
06/02/04	24.00	0.00	208	0	10	8	115	1	0	0	4	5
06/03/04	8.00	16.00	73	1	1	2	245	0	0	0	3	8
06/04/04	7.75	16.25	134	0	0	3	305	0	0	1	5	4
06/05/04	13.00	11.00	314	0	4	2	306	1	0	0	2	4
06/06/04	5.50	18.50	264	1	4	35	194	0	1	0	1	0
06/07/04	8.00	16.00	214	1	2	38	118	0	0	0	1	2
06/08/04	24.00	0.00	106	0	2	15	70	0	0	1	2	2
06/09/04	8.00	16.00	127	0	2	7	51	0	0	0	1	0
06/10/04	8.00	16.00	401	0	1	5	67	0	0	0	1	0
06/11/04	24.00	0.00	797	0	0	2	73	0	0	1	1	1
06/12/04	8.00	16.00	340	0	0	1	25	0	0	1	1	1
06/13/04	8.00	16.00	219	0	0	1	19	0	0	0	0	1
06/14/04	24.00	0.00	689	0	3	4	25	0	0	0	1	3
06/15/04	8.00	16.00	253	0	1	1	10	0	0	0	1	1
06/16/04	8.00	16.00	95	0	1	1	6	0	0	0	0	1
06/17/04	24.00	0.00	111	0	4	0	10	0	0	0	0	1
06/18/04	8.00	16.00	155	0	2	1	9	0	0	0	0	0
06/19/04	22.75	1.25	258	0	2	1	9	0	0	1	0	1
06/20/04	8.00	16.00	57	0	0	1	5	0	0	1	0	0
06/21/04	7.50	16.50	62	0	0	0	7	0	0	0	0	0
06/22/04	15.50	8.50	39	0	2	0	4	1	0	0	0	1
06/23/04	5.50	18.50	66	0	0	1	4	0	0	0	0	0
06/24/04	5.50	18.50	98	0	1	2	3	0	0	0	0	0
06/25/04	9.00	15.00	275	0	1	6	9	0	0	0	0	0
06/26/04	8.00	16.00	201	0	0	2	7	0	0	0	0	1
06/27/04	8.00	16.00	127	0	0	1	5	0	0	1	0	1
06/28/04	23.83	0.17	128	0	0	2	5	0	0	2	0	0
06/29/04	8.25	15.75	39	0	1	2	1	0	0	1	0	1
06/30/04	8.00	16.00	40	0	0	1	3	0	0	0	0	0

Table continued on next page

Appendix B: Total daily catches, by species and age, in the Skagit River mainstem screw trap, 2004 (cont'd).

Date	HOURS		CHINOOK			COHO				TROUT		
	Fished	Out	0+	1+	Chum	0+	1+	Pink	Sock	Parr	Sthd	Cutt
07/01/04	24.00	0.00	130	0	0	0	1	0	0	1	0	0
07/02/04	7.75	16.25	37	0	0	2	1	0	0	1	0	0
07/03/04	8.00	16.00	21	0	0	1	3	0	0	1	0	0
07/04/04	12.00	12.00	14	0	0	0	3	0	0	0	0	0
07/05/04	2.50	21.50	3	0	0	0	0	0	0	0	0	0
07/06/04	8.25	15.75	9	0	0	3	2	0	0	0	0	0
07/07/04	23.25	0.75	26	0	0	4	2	0	0	0	0	1
07/08/04	8.25	15.75	13	0	0	2	4	0	0	0	0	0
07/09/04	8.00	16.00	5	0	0	3	1	0	0	0	0	0
07/10/04	7.75	16.25	4	0	0	2	0	0	0	0	0	0
07/11/04	24.00	0.00	6	0	0	3	0	0	0	1	0	0
07/12/04	5.50	18.50	4	0	0	1	0	0	0	2	0	0
07/13/04		24.00										
07/14/04	2.50	21.50	3	0	0	1	1	0	0	1	0	0
07/15/04	16.00	8.00	9	0	0	4	1	0	0	1	0	0
07/16/04	5.75	18.25	2	0	0	2	1	0	0	0	0	0
07/17/04		24.00										
07/18/04	2.75	21.25	2	0	0	0	0	0	0	0	0	0
07/19/04	17.50	6.50	5	0	0	0	1	0	0	0	0	1
07/20/04	5.75	18.25	5	0	0	0	0	0	0	0	0	0
07/21/04		24.00										
07/22/04	2.00	22.00	1	0	0	0	0	0	0	0	0	0
07/23/04	24.00	0.00	6	0	0	0	0	0	0	0	0	0
07/24/04	5.75	18.25	1	0	0	1	0	0	0	0	0	0
07/25/04		24.00										
07/26/04	2.50	21.50	0	0	0	0	0	0	0	0	0	0
07/27/04	24.00	0.00	2	0	0	2	0	0	0	0	0	0
07/28/04	7.50	0.00	1	0	0	0	0	0	0	0	0	0
TOTAL CATCH			13,294	417	58,488	510	8,126	99,507	83	61	3,688	233