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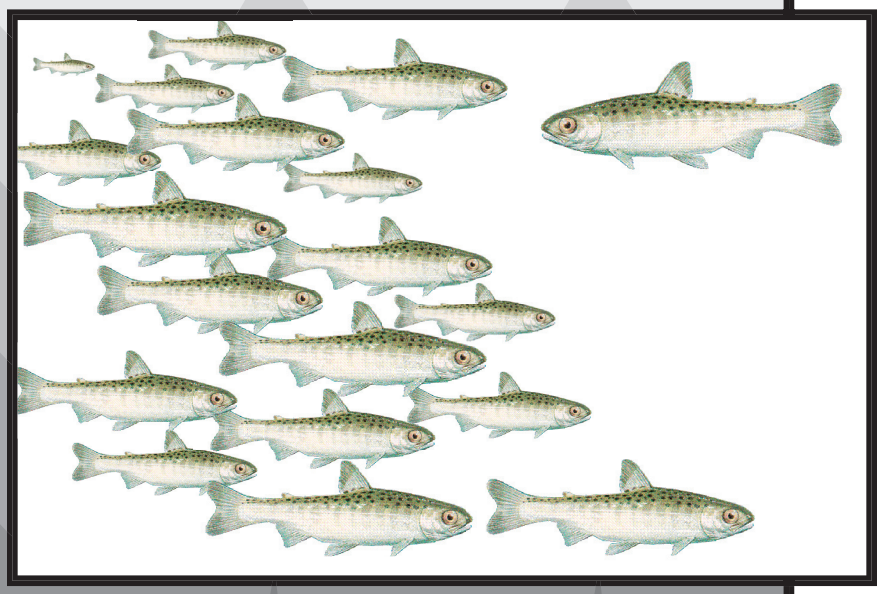
2005 Skagit River 0+ Chinook Production Evaluation



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STATE OF WASHINGTON
DEPARTMENT OF FISH AND WILDLIFE

Annual Report

2005 Skagit River
Wild 0+ Chinook Production Evaluation

Funded by Seattle City Light

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Table of Contents

List of Tables

Appendices

List of Figures

Acknowledgements

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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 Jim Repoz, Dean Toba, Mat Gillum 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 that helped analyze much of the trap data contained in this report. We would also like to thank Brett Barkdull 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 2005, the sixteenth 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 2005. The traps were operated from January 21 through July 25, and were fished every night and every third day unless flows and associated debris loads were excessive. To calibrate trap efficiency, we marked and released seven chinook groups (4 hatchery, 3 wild) above the trap. Recovery rates for these calibration groups were higher (3.6%) than the long-term mean capture rate (2.0%) of 29 zero-age chinook calibration groups that we released upstream of the main stem traps from 1998 through 2004.

Over the season we captured 44,737 and 34,470 wild 0+ chinook in the scoop and screw traps, respectively. The months of January, February, March, and April accounted for 90% of the season total migration, with about 50% of the wild 0+ chinook out migrants passing the main stem traps by March 21. This migration timing is earlier than the median migration date we have observed from 1997-2004. Expanding catches for the intervals not fished estimates an additional 13,603 and 15,475 wild 0+ chinook would have been captured in the scoop and screw traps, respectively. Combining these projected catches with the actual catches estimates 108,285 wild 0+ chinook would have been caught in the two traps had we fished continuously from January 21 through July 25. Expanding the projected season catch in both traps by two average flow related efficiency rates yields a system production estimate of approximately 4.6-million zero-age wild chinook. Average survival-to-migration is estimated at 7.38% this estimate is based on a potential deposition of 62.3 million eggs (11,329 females and an average fecundity of 5,500 eggs/female) for the 2004 brood.

Over the previous fifteen seasons, flow during egg incubation has explained most of the inter-annual variation in our estimates of egg-to-migrant survival rates. The production in 2005 is somewhat lower than predicted by this relationship, which may indicate other factors at work. One explanation for this lower-than-predicted survival may be the effects of the high spawning population in 2004.

This return, an estimated 25,175 adult chinook (Brett Barkdull, pers. comm.), is the highest from which we have estimated production in this system. Another factor that contributed to this lower survival was the unusually low flow conditions that occurred for the duration of the chinook emigration. 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.

In addition to wild chinook, we caught a total of 1,097 ad-marked and coded-wire tagged hatchery 0+ chinook in the mainstem traps. We estimate that, had the trap fished continuously, we would have caught an additional 365 fish. The projected total catch of 1,462-hatchery chinook includes 845 summer 0+ chinook and 190 fall 0+ chinook (both released at Countyline Ponds), and 427 spring 0+ chinook (released at Marblemount Hatchery). Application of two average flow-related efficiency rates yields a combined estimate of 59,469 zero-age hatchery chinook. Relating this estimate to the 605,390 hatchery chinook released (Steve Stout, pers. comm.) estimates in-river survival above Mt. Vernon at 9.8%.

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 2005 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 2005 was in its sixteenth 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 variables such 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 aforementioned 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 2005

The study plan for the 2005 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 fifteen years, the 2005 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 production facilities (Countyline Ponds and Marblemount Hatchery), we marked and released seven groups of zero-age Chinook, four hatchery groups and three wild groups 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 ft/sec (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 evaluate differences in the size distributions between the scoop and screw trap catches.

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 took daily measurements of water temperature 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 investigated the possibility of using 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.

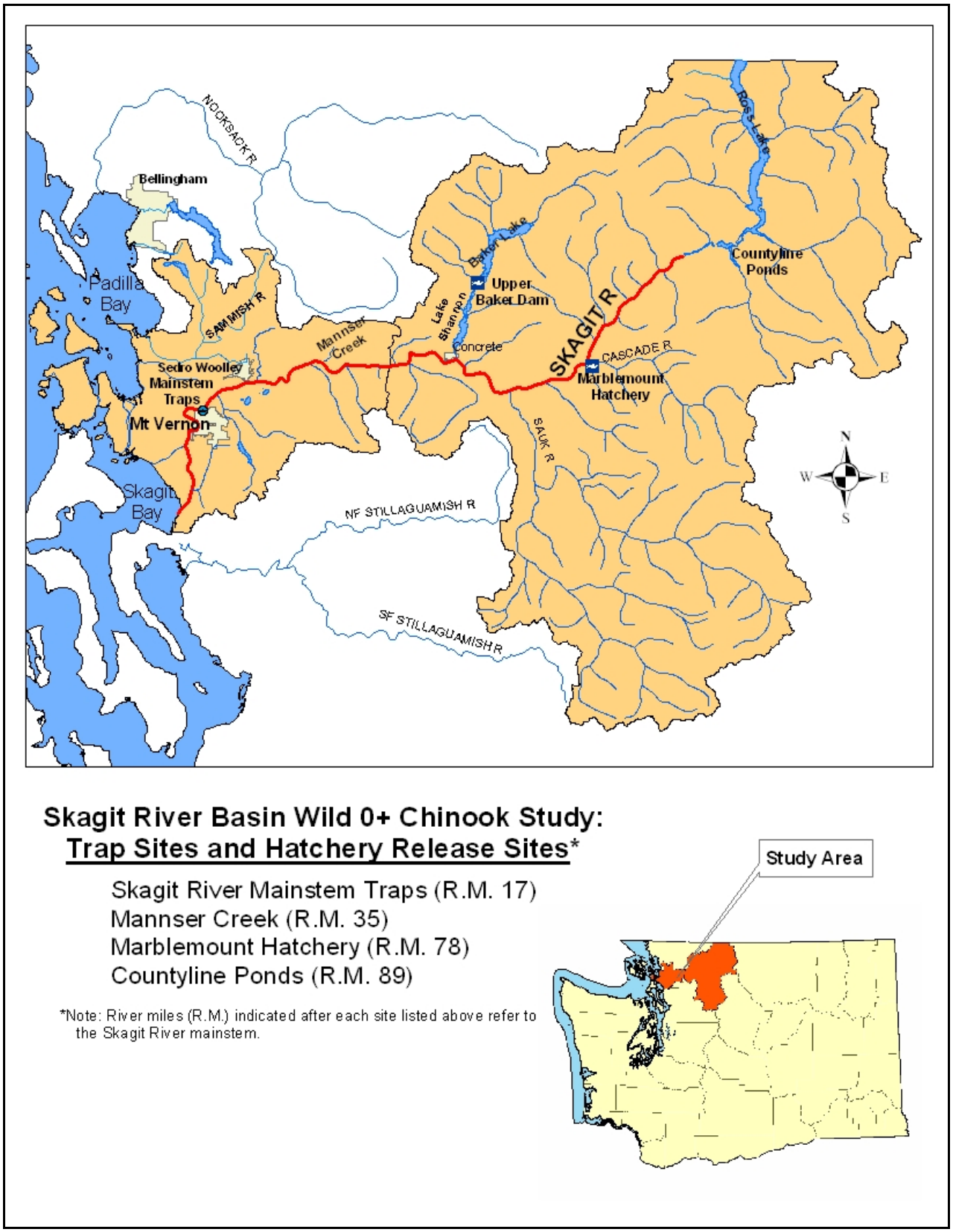

Figure 1. Map of tributary and mainstem trap sites, and hatchery release sites, Skagit River chinook production evaluation 2005

Equation 1: Basic formulas

$$c = \hat{N}\hat{e} \qquad \hat{N} = \frac{c}{\hat{e}}$$

Where: $\hat{N}$ = migrants;
c = catch; and
$\hat{e}$ = trap efficiency.

We expanded catch data to the standard of continuous trapping. To estimate catch for day periods where the traps were not operated, we evaluated the relative migration rates between day and night fishing periods, selecting sunrise and sunset as the strata breaks. For each trap, we selected daytime fishing periods that were preceded and followed by night fishing intervals. Catch data were standardized by time fished in each interval and expressed as fish/hour rates. The ratio of day catch rate to the adjacent night catch rates (d:n) was used to indicate differences in migration rates as a function of diel period (Equation 2). Day:night ratios were applied to night catch rates from periods adjacent to days not fished to estimate day catch rates. These estimated rates were applied to the number of daytime hours not fished to estimate catch.

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;
$c_{ni\text{-}1}$ = catch during the night before period i;
c_{ni} = catch during the night for period i;
$h_{ni\text{-}1}$ = 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.

We attempted to correlate the d:n ratios with environmental parameters (flow, turbidity) to explain the variation in d:n catch ratios. If the relationships between d:n ratios and environmental factors were not significant ($\alpha = 0.05$), we used either the seasonal average or the seasonal median, by gear, to estimate day catch rates.

To estimate catches for the nights that the traps did not fish, we interpolated the catch/hour rate from the adjacent night fishing periods and applied it to the number of night hours not fished.

Trap Efficiency

We had three primary indicators of trap efficiency in 2005: 1) recaptures of the wild coho marked at the Mannser Creek trap over the season; 2) recaptures of the seven marked-efficiency groups of wild and hatchery chinook that we released one mile upstream of the mainstem traps; and 3) recoveries of the hatchery chinook fingerlings released from Marblemount Hatchery and Countyline Ponds. We were concerned that the capture rates measured using groups of hatchery chinook were different from

those of wild fish. Therefore, to assess this potential bias, two of the trap efficiency groups described in approach #2 employed paired releases of marked hatchery and wild chinook. To assess bias in recapture rates from gear selectivity, we used a K-S test ($\alpha = 0.05$) to evaluate differences in the size distribution of coho marked at Mannser Creek and recovered in the mainstem traps.

To estimate recapture rates for the large hatchery release groups, we expanded mark recoveries to the standard of continuous trapping using 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. Beginning with the release of the summer chinook from Countyline Ponds on May 27, 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, $\hat{S}$, based on the following equation.

Equation 3: Egg-to-migrant survival

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

Where: $\hat{N}_{i+1}$ = estimated age-0+ chinook migration in year i+1;

$\hat{K}_{si}$ = estimated proportion of females in chinook spawning population in year i;

$\hat{E}_i$ = estimated chinook escapement in year i; and

$\hat{F}_i$ = estimated chinook fecundity in year i.

To estimate $\hat{K}$ 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.).

Wild Coho Smolt Production Estimate

The Peterson equation (modified by Chapman 1951) was used to estimate wild coho smolt production from the Skagit River, as follows:

Equation 4: Modified Peterson estimate:

$$\hat{N} = \frac{(m+1)(c+1)}{(r+1)} - 1$$

Where: $\hat{N}$ = total wild coho smolt population estimate in the Skagit River;
m = the number of wild coho smolts left ventral fin-marked and released at the tributary trap (Mannser Creek);
c = the number of wild coho smolts captured in the mainstem traps; and
r = the number of ventral fin-marks recaptured in the mainstem traps.

Equation 5: Variance of the coho smolt population estimate:

$$Var(\hat{N}) = \frac{(m+1)(c+1)(m-r)(c-r)}{(r+1)^2(r+2)}$$

Results

Trap Operation and Flow

The traps were installed on January 21. Trapping operations began that morning, and ended on July 25. Over this 185-day season, we operated the scoop trap every night with the exception of nine nights. Trap operation on three 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 54 days, usually at a frequency of every third day. In total, we fished this trap 2,567 hours out of a possible 4,452 hours, 57.7% of the total season. The screw trap fished on nearly the same schedule for a season total of 2,575 hours, 57.8 % of the total season (Table 1). From July 16 through 25, 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 well below the 64-year mean daily stream flow throughout the year. During the 2005 trapping period daily mean flow ranged from 7,010 to 51,800 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%
2005	Scoop	01/21	07/25	185	171	5	54	14	9	4,451.7	2,567.3	57.7%
	Screw	01/21	07/25	185	170	7	56	13	8	4.451.7	2,574.9	57.8%

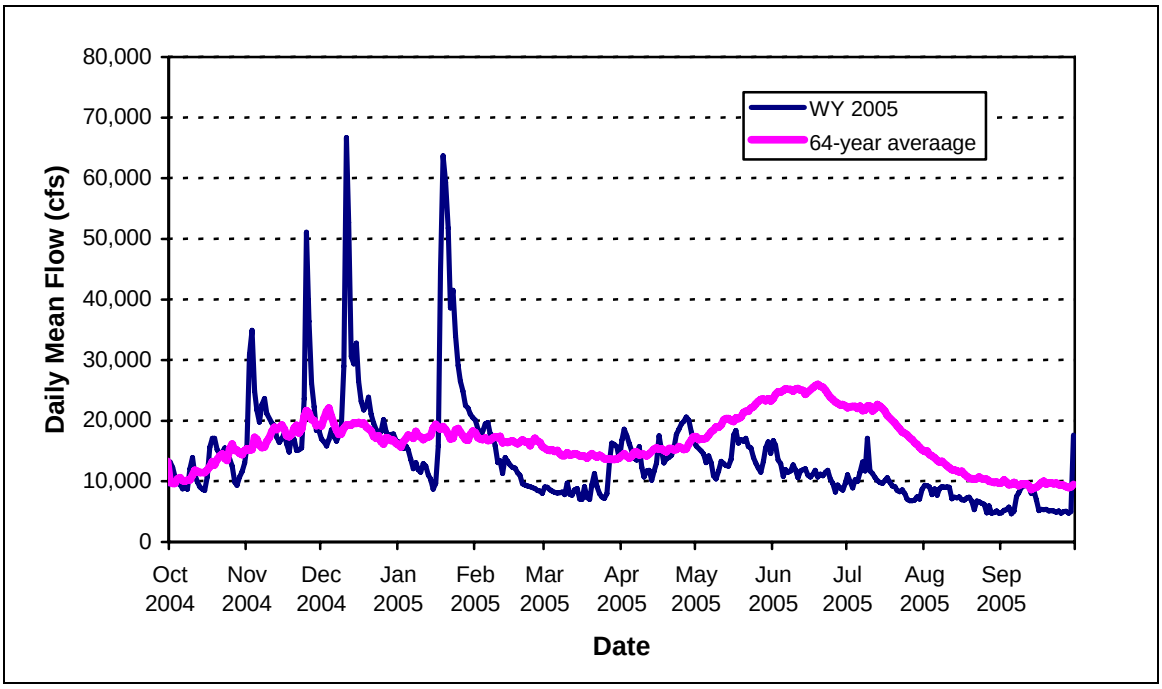

Figure 2. Comparison of daily mean flows in water year 2005 with 64-year average (Water Years 1940-2004), Skagit River near Mount Vernon (USGS data).

Juvenile Chinook Catches

Chinook fry were moving downstream when we began trapping on January 21. A high flow event occurred in January just before our trapping got underway (63,700 cfs on January 19). Flows declined after this event through the month of February, with an average daily mean of 10,842 cfs from February 1 through March 26, well below the 64-year average of 15,624 cfs for this period. Flows increased to average 15,349 cfs through April, nearly average for this month. Thereafter, from June 1 to July 31, flows averaged 11,790 cfs, well below the 64-year average of 21,656 cfs. Combined nightly catch rates for both scoop and screw trap averaged 13 fish per hour until February 28, and peaked in both traps on March 20. The largest average catch rate occurred on the night of March 16 (154 fish/hour in the scoop trap), and thereafter generally declined over the remaining season. 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 17 and 13 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 79,207 wild and 1,097 hatchery 0+ chinook. 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 fifteen seasons, catches have ranged between 1,700 and 96,000 wild 0+ chinook (Table 2 and Table 3). Hatchery 0+ chinook catches in 2005 were far lower than any previous season. Over the previous seven years, total hatchery chinook catches have ranged between 3,000 and 19,500 smolts, and averaged just over 7,000 smolts.

Table 2. Downstream-migrant salmonids captured in the Skagit River mainstem traps, 1998-2005.

Species	1998		1999		2000		2001		2002		2003		2004		2005	
	Scoop	Screw	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	4589	3794
Hatchery	623	1028	673	635	624	946	103	398	453	668	447	1229	647	1511	119	246
Coho 0+	1216	409	744	311	115	27	2604	871	1896	435	1303	366	2786	510	1453	420
Chinook 1+																
Wild	876	350	198	87	129	105	32	26	199	228	95	94	342	205	59	57
Hatchery	24	12	201	41	511	360	26	50	177	161	170	122	172	212	33	24
Chinook 0+																
Wild	33698	20001	55254	41492	23289	14944	54762	40180	35332	24908	51316	34498	13009	6694	44737	34470
Hatchery	5837	2127	3449	2213	2554	2152	1667	1354	3310	2726	2033	1611	[a]12874	[b]6600	657	440
Sockeye 1+	111	84	72	23	9	11	5	1	27	35	1	7	88	83	17	4
Chum 0+	37162	18498	172774	108730	39608	40234	133890	105200	16526	16664	82668	70059	66739	58488	47439	34087
Pink 0+	338520	102338	476	265	207530	198015	2644	1350	104782	153668	1604	1731	113975	99507	26	18
Steelhead 1+																
Wild	389	1,100	99	334	95	597	32	317	118	437	32	366	337	1287	45	289
Hatchery	446	2,325	122	511	75	736	23	465	75	534	26	474	213	2401	16	183
Steelhead Adult	1	3	11	1	1	2	0	0	1	2	0	0	0	0	2	0
Cutthroat 1+	98	401	30	150	51	248	11	318	53	196	32	151	34	233	19	279
Cutthroat adult	2	5	4	0	0	7	0	0	0	7	0	0	0	18	0	21
Native char 1+	153	206	101	98	109	138	20	125	74	115	81	73	91	101	10	21
Trout Parr	90	83	42	57	116	155	86	123	31	44	83	102	64	61	19	13

[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.

Wild 0+ Chinook Day:Night Catch Ratios

We compared wild 0+ chinook catch rates during daylight hours to nighttime catch rates for the scoop and screw traps on 44 and 48 days, respectively (Table 4 and Table 5). Day:night catch rate ratios (d:n ratios) varied from 0% to 188.9% in the scoop trap, and from 0% to 283.5% in the screw trap. For the season, d:n catch rate ratios averaged 56.4% and 93.0% 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 under three-fold (7,060 to 20,100 cfs). However, flow explained virtually none of the variation in d:n ratios in the scoop and screw traps.

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. Because the ratios were not normally distributed, the seasonal median scoop and screw trap d:n ratios were used to project catch during daytime periods when the trap was not fishing. Median d:n ratios for wild 0+ chinook were 35.5% and 59.5% in the scoop and screw trap, respectively (Table 4, Table 5). Sample sizes were inadequate to calculate d:n ratios for hatchery chinook. We therefore used a relationship between wild and hatchery median d:n ratios ($R^2 = 69\%$) over the past eight years to predict hatchery d:n ratios (22.7% and 26.1%) for the scoop and screw traps, respectively.

Chinook Trap Efficiency

We had two primary indicators of trap efficiency in 2005: 1) recaptures of the seven marked-efficiency groups of wild and hatchery chinook that we released one mile upstream of the mainstem traps; and 2) recoveries of the hatchery chinook fingerlings released from Marblemount Hatchery and Countyline Ponds.

Mark Groups

Over the season, we released four groups of hatchery and three groups of wild 0+ chinook, using two different mark types (Bismarck-brown dye or upper caudal fin-clip). The first group was released on the night of February 23, and the last on the night of June 9. We operated the traps continuously for approximately 36 hours after each release. Recapture rates ranged from 2.41% to 4.92%, and averaged 3.57% (Table 6).

Each trap efficiency test measures a capture rate or a probability of capture, *e*. To evaluate the use of hatchery chinook for measuring capture rates of wild chinook, we released two paired efficiency groups of hatchery and wild fish, and tested the differences between the captures rates measured in each paired test under the null hypothesis that $\hat{e}_{wild} - \hat{e}_{hatchery} = 0$.

In both of the paired experiments, the capture rates were not found to be significantly different ($\alpha = 0.05$), although wild chinook (3.49% and 3.05%) were caught at a slightly lower rate than hatchery chinook (4.58% and 3.69%).

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 2005.

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
01/31/05	1745	02/02/05	730	27.83	334	12.00	02/01/05	740	1715	9.58	149	15.55	129.6%	20,100	19.3
02/03/05	1745	02/05/05	730	27.50	281	10.22	02/04/05	740	1730	9.83	164	16.68	163.3%	18,300	11.6
02/06/05	1800	02/08/05	800	27.83	329	11.82	02/07/05	740	1730	9.83	217	22.08	186.7%	17,900	9.3
02/09/05	1730	02/11/05	730	28.08	314	11.18	02/10/05	755	1730	9.58	144	15.03	134.4%	13,100	6.4
02/12/05	1745	02/14/05	730	26.75	348	13.01	02/13/05	715	1745	10.50	258	24.57	188.9%	13,900	7.6
02/15/05	1800	02/17/05	730	26.33	495	18.80	02/16/05	745	1830	10.75	174	16.19	86.1%	12,300	7
02/18/05	1800	02/20/05	730	27.08	474	17.50	02/19/05	740	1745	10.08	139	13.79	78.8%	11,000	5.2
02/21/05	1730	02/23/05	715	27.08	478	17.65	02/22/05	730	1745	10.25	52	5.07	28.7%	9,210	3.3
02/23/05	1800	02/25/05	730	26.83	449	16.73	02/24/05	740	1800	10.33	43	4.16	24.9%	8,950	3
02/26/05	1815	02/28/05	700	26.08	356	13.65	02/27/05	740	1800	10.33	77	7.45	54.6%	8,410	3
03/02/05	1815	03/04/05	700	25.33	733	28.94	03/03/05	655	1800	11.08	170	15.34	53.0%	8,580	3.1
03/05/05	1830	03/07/05	700	25.58	882	34.48	03/06/05	725	1800	10.58	66	6.24	18.1%	8,090	2.2
03/11/05	1815	03/13/05	645	24.83	1089	43.86	03/12/05	700	1815	11.25	238	21.16	48.2%	7,720	3.7
03/14/05	1845	03/16/05	645	24.00	615	25.63	03/15/05	645	1820	11.58	129	11.14	43.5%	7,060	4.1
03/17/05	1900	03/19/05	645	24.00	1010	42.08	03/18/05	655	1820	11.41	161	14.11	33.5%	7,320	4.3
03/20/05	1830	03/22/05	630	23.75	2532	106.61	03/21/05	730	1830	11.00	808	73.45	68.9%	11,300	8.8
03/23/05	1900	03/25/05	630	23.33	332	14.23	03/24/05	640	1830	11.83	29	2.45	17.2%	7,450	3.3
03/31/05	1900	04/02/05	600	22.58	1284	56.86	04/01/05	645	1845	12.00	1236	103.00	181.1%	16,800	16.5
04/03/05	2000	04/05/05	700	21.83	1156	52.95	04/04/05	710	2000	12.83	509	39.67	74.9%	16,200	11.6
04/06/05	2000	04/08/05	645	21.83	568	26.02	04/07/05	655	1930	12.58	146	11.61	44.6%	13,500	8.4
04/09/05	2015	04/11/05	700	21.58	323	14.97	04/10/05	710	2000	12.83	69	5.38	35.9%	10,700	5.6
04/12/05	2015	04/14/05	700	21.33	344	16.13	04/13/05	700	2000	13.00	92	7.08	43.9%	10,200	4.9
04/15/05	2015	04/17/05	630	20.25	656	32.40	04/16/05	645	2000	13.25	739	55.77	172.2%	17,500	24.1
04/21/05	2030	04/23/05	630	20.00	178	8.90	04/22/05	640	2020	13.66	59	4.32	48.5%	15,300	7.3
04/24/05	2030	04/26/05	630	20.25	278	13.73	04/25/05	645	2015	13.50	65	4.81	35.1%	19,500	10.8
04/27/05	2030	04/29/05	630	19.33	356	18.42	04/28/05	615	2030	14.25	101	7.09	38.5%	20,100	12.7
04/30/05	2030	05/02/05	615	19.58	117	5.98	05/01/05	635	2030	13.92	21	1.51	25.2%	15,800	7.5
05/03/05	2040	05/05/05	600	18.50	90	4.86	05/04/05	615	2040	14.42	7	0.49	10.0%	14,500	5.9
05/06/05	2100	05/08/05	600	18.33	142	7.75	05/07/05	615	2030	14.25	14	0.98	12.7%	13,000	5.4
05/09/05	2100	05/11/05	600	18.08	79	4.37	05/10/05	610	2045	14.58	12	0.82	18.8%	11,700	5
05/11/05	2030	05/13/05	600	18.67	120	6.43	05/12/05	615	2045	14.50	16	1.10	17.2%	12,900	6
05/15/05	2100	05/17/05	600	18.25	540	29.59	05/16/05	610	2030	14.33	559	39.01	131.8%	17,600	8.9
05/18/05	2100	05/20/05	600	17.83	288	16.15	05/19/05	610	2100	14.83	134	9.04	55.9%	16,900	6.4
05/21/05	2115	05/23/05	600	17.58	135	7.68	05/22/05	610	2100	14.83	35	2.36	30.7%	15,700	5.6
05/25/05	2115	05/27/05	545	17.33	43	2.48	05/26/05	610	2100	14.83	4	0.27	10.9%	12,200	3.8
05/28/05	2130	05/30/05	545	16.58	190	11.46	05/29/05	600	2115	15.25	46	3.02	26.3%	15,500	4.8
05/31/05	2130	06/02/05	545	16.75	197	11.76	06/01/05	600	2100	15.00	57	3.80	32.3%	16,700	6.4
06/03/05	2130	06/05/05	545	16.67	103	6.18	06/04/05	555	2110	15.25	7	0.46	7.4%	12,900	4
06/06/05	2130	06/08/05	530	16.33	54	3.31	06/07/05	555	2115	15.33	4	0.26	7.9%	12,900	3.2
06/09/05	2130	06/11/05	530	16.08	49	3.05	06/10/05	540	2115	15.58	5	0.32	10.5%	11,900	3
06/15/05	2145	06/17/05	530	15.83	16	1.01	06/16/05	540	2115	15.58	2	0.13	12.7%	10,700	2.8
06/18/05	2130	06/20/05	530	16.00	18	1.13	06/19/05	540	2120	15.66	1	0.06	5.7%	10,700	2.9
06/21/05	2130	06/23/05	530	16.00	28	1.75	06/22/05	540	2115	15.58	2	0.13	7.3%	11,500	4.5
07/05/05	2130	07/07/05	545	16.42	21	1.28	07/06/05	555	2125	15.50	5	0.32	25.2%	11,500	9.2
			SEASON TOTAL	942.00	18,424	19.56				566.91	6,965	12.29	62.8%		
			SEASON AVERAGE										56.4%		
			SEASON MEDIAN										35.5%		

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 2005.

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
01/31/05	1745	02/02/05	730	28.00	174	6.21	02/01/05	730	1715	9.75	92	9.44	151.8%	20,100	19.3
02/03/05	1745	02/05/05	730	27.75	312	11.24	02/04/05	730	1730	10.00	292	29.20	259.7%	18,300	11.6
02/06/05	1800	02/08/05	800	28.00	242	8.64	02/07/05	730	1730	10.00	245	24.50	283.5%	17,900	9.3
02/09/05	1730	02/11/05	730	27.92	317	11.35	02/10/05	735	1730	9.92	203	20.46	180.2%	13,100	6.4
02/12/05	1745	02/14/05	730	26.75	427	15.96	02/13/05	700	1745	10.75	370	34.42	215.6%	13,900	7.6
02/15/05	1800	02/17/05	730	26.50	292	11.02	02/16/05	730	1830	11.00	192	17.45	158.4%	12,300	7
02/18/05	1800	02/20/05	730	27.25	307	11.27	02/19/05	745	1745	10.00	102	10.20	90.5%	11,000	5.2
02/21/05	1730	02/23/05	700	26.92	532	19.76	02/22/05	720	1745	10.42	71	6.81	34.5%	9,210	3.3
02/23/05	1800	02/25/05	730	27.00	401	14.85	02/24/05	730	1800	10.50	62	5.90	39.8%	8,950	3
02/26/05	1815	02/28/05	700	26.25	259	9.87	02/27/05	730	1800	10.50	126	12.00	121.6%	8,410	3
03/02/05	1815	03/04/05	700	25.50	653	25.61	03/03/05	645	1800	11.25	189	16.80	65.6%	8,580	3.1
03/05/05	1830	03/07/05	700	25.75	810	31.46	03/06/05	715	1800	10.75	76	7.07	22.5%	8,090	2.2
03/11/05	1815	03/13/05	645	25.00	816	32.64	03/12/05	700	1815	11.25	373	33.16	101.6%	7,720	3.7
03/14/05	1845	03/16/05	645	24.17	451	18.66	03/15/05	630	1820	11.83	161	13.61	72.9%	7,060	4.1
03/17/05	1900	03/19/05	645	24.17	913	37.77	03/18/05	645	1820	11.58	164	14.16	37.5%	7,320	4.3
03/20/05	1830	03/22/05	630	23.92	1199	50.13	03/21/05	700	1830	11.50	1188	103.30	206.1%	11,300	8.8
03/23/05	1900	03/25/05	630	23.50	260	11.06	03/24/05	630	1830	12.00	41	3.42	30.9%	7,450	3.3
03/31/05	1900	04/02/05	600	22.75	900	39.56	04/01/05	630	1845	12.25	1199	97.88	247.4%	16,800	16.5
04/03/05	2000	04/05/05	700	22.00	661	30.05	04/04/05	700	2000	13.00	514	39.54	131.6%	16,200	11.6
04/06/05	2000	04/08/05	645	22.00	447	20.32	04/07/05	645	1930	12.75	144	11.29	55.6%	13,500	8.4
04/09/05	2015	04/11/05	700	21.75	235	10.80	04/10/05	700	2000	13.00	88	6.77	62.7%	10,700	5.6
04/12/05	2015	04/14/05	700	21.50	303	14.09	04/13/05	645	2000	13.25	125	9.43	66.9%	10,200	4.9
04/15/05	2015	04/17/05	630	19.75	317	16.05	04/16/05	645	2000	13.25	537	40.53	252.5%	17,500	24.1
04/21/05	2030	04/23/05	630	20.17	63	3.12	04/22/05	630	2020	13.83	52	3.76	120.4%	15,300	7.3
04/24/05	2030	04/26/05	630	20.25	68	3.36	04/25/05	630	2015	13.75	82	5.96	177.6%	19,500	10.8
04/27/05	2030	04/29/05	630	20.00	84	4.20	04/28/05	630	2030	14.00	63	4.50	107.1%	20,100	12.7
04/30/05	2030	05/02/05	615	19.75	47	2.38	05/01/05	630	2030	14.00	17	1.21	51.0%	15,800	7.5
05/03/05	2040	05/05/05	600	18.50	48	2.59	05/04/05	615	2040	14.42	10	0.69	26.7%	14,500	5.9
05/06/05	2100	05/08/05	600	18.50	56	3.03	05/07/05	600	2030	14.50	22	1.52	50.1%	13,000	5.4
05/09/05	2100	05/11/05	600	18.25	71	3.89	05/10/05	600	2045	14.75	8	0.54	13.9%	11,700	5
05/11/05	2030	05/13/05	600	18.75	114	6.08	05/12/05	600	2045	14.75	23	1.56	25.6%	12,900	6
05/15/05	2100	05/17/05	600	18.25	189	10.36	05/16/05	600	2045	14.75	368	24.95	240.9%	17,600	8.9
05/18/05	2100	05/20/05	600	18.00	179	9.94	05/19/05	600	2100	15.00	69	4.60	46.3%	16,900	6.4
05/21/05	2115	05/23/05	600	17.75	79	4.45	05/22/05	600	2100	15.00	23	1.53	34.5%	15,971	5.6
05/25/05	2115	05/27/05	545	17.50	24	1.37	05/26/05	600	2100	15.00	1	0.07	4.9%	16,307	3.8
05/28/05	2130	05/30/05	545	16.75	71	4.24	05/29/05	545	2115	15.50	37	2.39	56.3%	16,643	4.8
05/31/05	2130	06/02/05	545	17.00	108	6.35	06/01/05	545	2100	15.25	31	2.03	32.0%	16,979	6.4
06/03/05	2130	06/05/05	545	16.75	45	2.69	06/04/05	530	2100	15.50	2	0.13	4.8%	12,900	4
06/06/05	2130	06/08/05	530	16.25	55	3.38	06/07/05	530	2115	15.75	5	0.32	9.4%	12,900	3.2
06/09/05	2130	06/11/05	530	16.25	55	3.38	06/10/05	530	2115	15.75	3	0.19	5.6%	11,900	3
06/12/05	2130	06/14/05	530	16.00	59	3.69	06/13/05	530	2130	16.00	4	0.25	6.8%	11,900	3
07/05/05	2130	07/07/05	545	16.42	25	1.52	07/06/05	545	2115	15.50	1	0.06	4.2%	11,500	9.2
		SEASON TOTAL		915.19	12,668	13.84				543.50	7,375	13.57	98.0%		
		SEASON AVERAGE											93.0%		
		SEASON MEDIAN											59.5%		

Table 6. Groups of marked salmon released into the Skagit River in 2005 and the numbers recovered at the mainstem traps.

Stock		Species/ Age	Mark Type	RELEASES		Recapture Dates	ACTUAL CATCH			CAPTURE RATE		
				Date	Number		Scoop	Screw	Total	Scoop	Screw	Total
Wild (Mannser Creek)		Coho 1+	LV	April 08-June 10	15,655	April 24-June 07	74	54	128	0.47%	0.34%	0.82%
Calibration Groups[a]	Wild	Chinook 0+	Dye	February 23	732	February 24-25	21	15	36	2.87%	2.05%	4.92%
	Wild	Chinook 0+	Dye	March 2	921	March 3-4	15	19	34	1.63%	2.06%	3.69%
	Hatchery/ spring	Chinook 0+	Dye/Admk	March 2	895	March 3-4	15	26	41	1.68%	2.91%	4.58%
	Wild	Chinook 0+	Dye	March 31	722	April 1-2	10	12	22	1.39%	1.66%	3.05%
	Hatchery/ spring	Chinook 0+	Dye/Ad	March 31	859	April 1-2	13	17	30	1.51%	1.98%	3.49%
	Hatchery/ spring	Chinook 0+	Dye/Admk/CWT	May 11	879	May 12-17	13	12	25	1.48%	1.37%	2.84%
	Hatchery/ spring	Chinook 0+	UC/Admk/CWT	June 9	789	June 10	12	7	19	1.52%	0.89%	2.41%
Hatchery Releases[b,c]	Countyline Ponds/ summer	Chinook 0+	Admk/CWT	May 27	192,000	May 28-July 10	n/a	n/a	n/a	See Table 8		
	Countyline Ponds/ fall	Chinook 0+	Admk/CWT	June 17	157,200	June 23-July 10	n/a	n/a	n/a			
	Marblemount/ spring	Chinook 0+	Admk/CWT	June 6	256,190	May 30[c]- July 08	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.
[c] Personal communication, Steve Stout WDFW
[d] One CWT Marblemount spring chinook captured on May30th, before reported release of June 6.

Hatchery 0+ Chinook Production Groups

Three groups of ad-CWT hatchery chinook fingerlings were released from production facilities in Spring 2005 (Steve Stout, pers. comm.) (Table 6). The location of these releases are shown in Figure 1:

- May 27, the volitional release of 192,000 summer chinook from Countyline Ponds (R.M. 89);
- June 6, the release of 256,190 spring chinook from the Marblemount Hatchery (R.M. 78);
- June 17 the release of 157,200 fall chinook from Countyline Ponds (R.M. 89).

Over the season, we caught a total of 1,097 ad-marked and coded-wire tagged (ad-CWT) hatchery 0+ chinook in the mainstem traps, 657 in the scoop trap and 440 in the screw trap (not including the calibration groups).

Apportioning the catch among the three release groups required recovering tags. On May 28, we began sampling hatchery smolts for tag recovery. Over the season, we sacrificed 119 ad-marked chinook and recovered 118 tags, which we used to estimate the proportions of Countyline Ponds summers, Marblemount springs, and Countyline fall chinook in our total hatchery catch (Table 7). The low catches of hatchery chinook resulted in a small sample number for CWT recovery. To better apportion these small samples we divided the hatchery catch into three strata based on hatchery release dates (Table 7).

One ad-marked/CWT Marblemount spring chinook 0+ was captured on May 30, before the reported release date of June 6. This fish could have been part of our 879 dyed/ad-marked/CWT calibration group, released on May 11, which did not immediately migrate downstream and lost its dye mark. It also may be an escapee from the hatchery facility.

Interpolating for periods not fished, estimates a total of 1,462 hatchery ad/CWT chinook would have been caught assuming continuous fishing (Table 8), 0.24% of the combined releases. This catch rate is the lowest recorded for hatchery chinook over the 16 years of trap operations, and was an order of magnitude lower than the efficiencies measured from the mark groups. Therefore, we opted not to use this data to evaluate trap efficiencies in 2005.

Final Approach

Trap efficiency is negatively influenced by stream flow in most systems (Seiler *et al* 2005, Seiler *et al* 2003, Volkhardt *et al* 2005). While flows in 2005 were substantially below the long-term average over most of the season (Figure 2), there were periods when flows were above or near the long-term average. Our seven efficiency groups, which averaged 3.6%, were generally released at low flows and were not representative of those periods when flows were near or above seasonal average flows.

Conversely, the long-term average efficiency (~2.0%) reflects more average flow conditions. Given the low flows and generally high recapture rates of efficiency groups in 2005, combined with the possibility of a change in flow dynamics effecting efficiency, we decided against using just the 2005 mark group efficiency data.

Instead we opted to evaluate efficiencies relative to stream flow from recent years (2002-2005). We found a significant difference (ANOVA, α=0.05) between efficiency groups released at two different flow strata, above and below 13,800 cfs. When flows were >13,800 cfs, we used an average efficiency of 1.80% to estimate production; when flows were <13,800 cfs, we used an efficiency of 3.06% (Table 9).

Table 7. Results of coded-wire tags recovered from ad-marked/CWT'd 0+ chinook over three stratum, sampled at the Skagit River mainstem traps in Spring 2005.

	Date	ACTUAL						ESTIMATED BY ALLOCATION				
		H-Admk Catch			Number Sampled			Marblemount/Spring		Cntyln/Fall	Cntyln/Smr	Total
		Scoop	Screw	Total	Scoop	Screw	Total	63-28/75	63-23/91	21-05/99	21-05/91	
Stratum #1	05/27	0	0	0	0	0	0					
	05/28	3	0	3	3	0	3					
	05/29	10	9	19	10	9	19					
	05/30	35	12	47	35	12	47					
	05/31	52	24	76	2	1	3					
	06/01	106	33	139	5	1	6					
	06/02	48	27	75	3	2	5					
	06/03	28	8	36	1	0	1					
	06/04	21	15	36	1	1	2					
	06/05	13	7	20	1	0	1					
	06/06	18	10	28	1	1	2					
	06/07	7	10	17	0	0	0					
	06/08	24	11	35	1	1	2					
	Total	**365**	**166**	**531**	**63**	**28**	**91**	**0**	**0**	**0**	**531**	**531**
	Percent							**0.0%**	**0.0%**	**0.0%**	**100.0%**	
Stratum #2	06/09	124	43	167	6	2	8					
	06/10	22	35	57	1	1	2					
	06/11	14	11	25	1	0	1					
	06/12	21	5	26	1	0	1					
	06/13	11	10	21	1	1	2					
	06/14	14	9	23	0	0	0					
	06/15	7	5	12	1	1	2					
	06/16	5	6	11	0	0	0					
	06/17	2	6	8	0	0	0					
	06/18	3	2	5	0	0	0					
	06/19	12	3	15	1	1	2					
	Total	**235**	**135**	**370**	**12**	**6**	**18**	**123**	**164**	**0**	**82**	**370**
	Percent							**33.3%**	**44.4%**	**0.0%**	**22.2%**	
Stratum #3	06/20	4	7	11	0	0	0					
	06/21	1	6	7	0	0	0					
	06/22	1	6	7	0	0	0					
	06/23	6	11	17	0	1	1					
	06/24	1	6	7	1	0	1					
	06/25	2	15	17	0	1	1					
	06/26	0	0	0	0	0	0					
	06/27	0	1	1	0	0	0					
	06/28	1	1	2	0	0	0					
	06/29	0	1	1	0	0	0					
	06/30	0	0	0	0	0	0					
	07/01	1	2	3	0	0	0					
	07/02	0	4	4	0	1	1					
	07/03	0	0	0	0	0	0					
	07/04	0	1	1	0	0	0					
	07/05	0	0	0	0	0	0					
	07/06	0	3	3	0	0	0					
	07/07	3	8	11	0	0	0					
	07/08	5	39	44	0	2	2					
	07/09	27	8	35	1	0	1					
	07/10	4	15	19	1	1	2					
	07/11	0	4	4	0	0	0					
	07/12	1	0	1	0	0	0					
	07/13	0	0	0	0	0	0					
	07/14	0	0	0	0	0	0					
	07/15	0	0	0	0	0	0					
	07/16	0	0	0	0	0	0					
	07/17	0	0	0	0	0	0					
	07/18	0	0	0	0	0	0					
	07/19	0	1	1	0	0	0					
	Total	**57**	**139**	**196**	**3**	**6**	**9**	**44**	**0**	**131**	**22**	**196**
	Percent							**22.2%**	**0.0%**	**66.7%**	**11.1%**	
	SEASON	**657**	**440**	**1,097**	**78**	**40**	**118**	**167**	**164**	**131**	**635**	**1,097**

Table 8. Projected 24-hour hatchery 0+ chinook catches, by tag group, Skagit River mainstem traps 2005.

Stock	Tag Code	Number Released[b]	Recovery Period	Projected 24-Hour Catch [a]	Catch Rate
Countyline Ponds/summer	21-05/91	192,000	May 28-July 10	845	0.44%
Marblemount/spring	63-28/75	101,410	May 30 -July 8	219	0.22%
	63-23/91	154,780	June 9-June 15	208	0.13%
	Pooled	256,190		427	0.17%
Countyline Ponds/fall	21-05/99	157,200	June 23-July 10	190	0.12%
	Total	605,390	May 26-July 26	1,462	0.24%

[a] Estimated by applying the proportion of cwt recoveries within three strata to projected 24-hour hatchery catch (Table 7).
[b] Personal communication, Steve Stout, WDFW.

Table 9. Average efficiency at two flow strata, Skagit River 2002-2005.

Strata	Trapping Year	Release Date	Efficiency	Flow (cfs)
Stratum 1, Flow >13,800	2002	March 28	1.10%	15,100
	2002	May 16	1.80%	17,700
	2002	June 07	1.60%	26,300
	2002	June 20	1.70%	26,200
	2002	July 16	1.30%	29,100
	2003	February 27	1.34%	14,000
	2003	April 04	1.24%	17,700
	2003	April 10	2.34%	19,800
	2003	April 24	3.64%	16,500
	2004	April 29	1.50%	14,500
	2004	May 20	2.26%	16,100
		Average Efficiency	1.80%	
Stratum 2, Flow<13,800 cf	2003	May 08	3.64%	12,200
	2004	March 23	1.70%	12,100
	2004	May 13	0.27%	12,200
	2005	February 23	4.92%	9,120
	2005	March 02	3.69%	9,030
	2005	March 02	4.58%	9,030
	2005	March 31	3.05%	13,600
	2005	March 31	3.49%	13,600
	2005	May 11	2.84%	13,300
	2005	June 09	2.41%	12,700
		Average Efficiency	3.06%	

Wild & Hatchery 0+ Chinook Production Estimates

Catch Projection

Expansion of catches for the intervals not fished estimates an additional 13,603 and 15,475 wild 0+ chinook would have been captured in the scoop and screw traps, respectively (Table 10). Combining these projected catches with the actual catches (44,737 and 34,470 fry, respectively), estimates 108,285 wild 0+ chinook would have been caught in the two traps had we fished continuously from January 21 through July 25 (Figure 3). Actual catches represent 73.1% of the total projected catches.

Table 10. Summary of actual and projected wild and hatchery 0+ chinook catches in the Skagit River mainstem traps 2005.

Group	Scoop Trap			Screw Trap			Total		
	Actual	Projected	Total	Actual	Projected	Total	Actual	Projected	Total
Wild	44,737	13,603	58,340	34,470	15,475	49,945	79,207	29,078	108,285
Hatchery	657	216	873	440	149	589	1,097	365	1,462

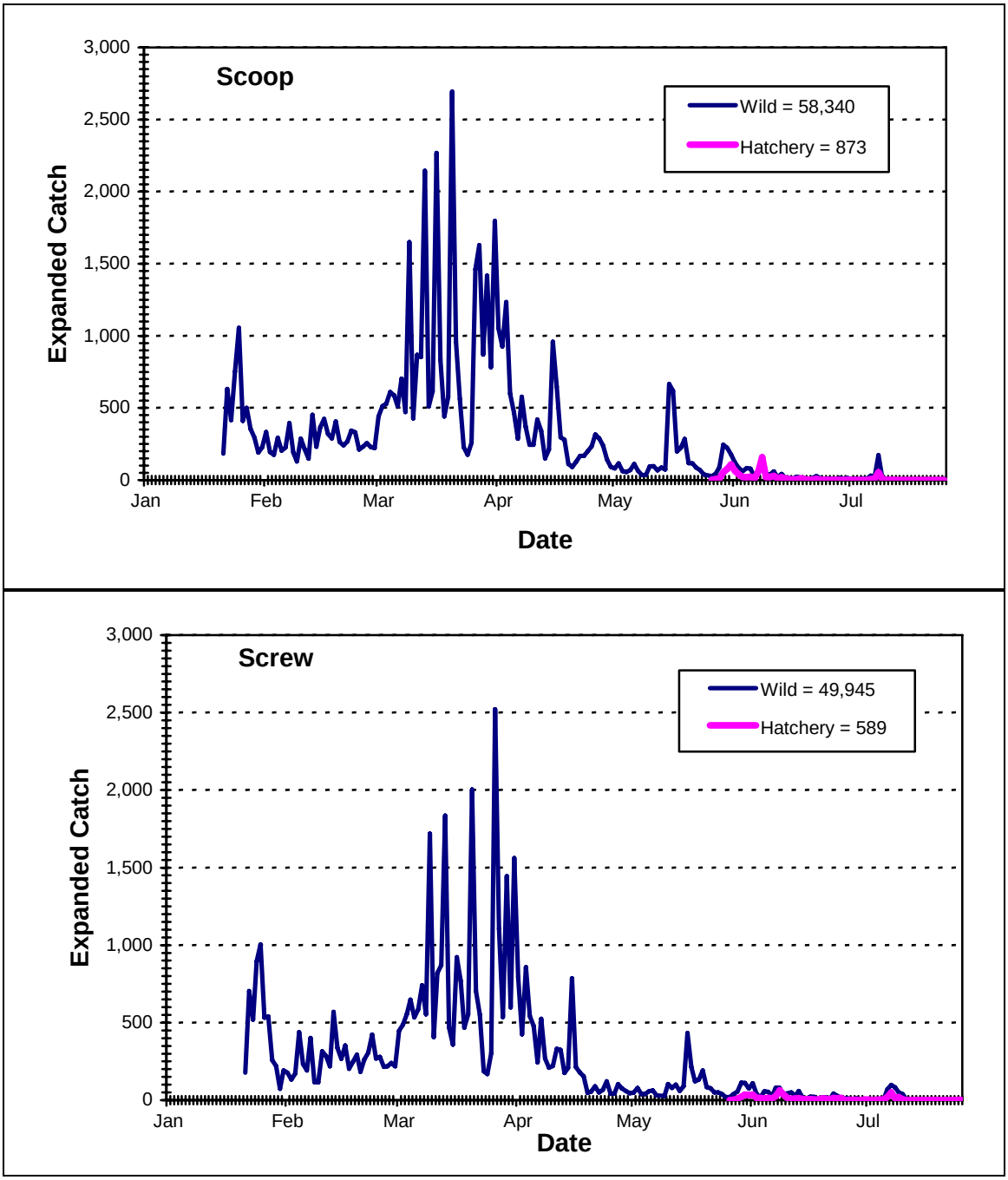

Figure 3. Projected wild and hatchery chinook 0+ catches, Skagit River mainstem traps 2005.

Expanding actual catches for the intervals not fished following release of the hatchery production groups, estimates an additional 365 hatchery 0+ chinook would have been captured in the scoop and screw traps (Table 10). Actual catches represent 75.0% of the total projected hatchery catch.

Applying CWT recovery results to the sum of actual and projected daily catches during selected strata, estimates the proportion of each group within the ad-marked/CWT hatchery chinook catch: 845 summer 0+ chinook (released at Countyline Ponds), 427 spring 0+ chinook (released at Marblemount Hatchery) and 190 fall 0+ chinook (released at Countyline Ponds) (Table 8). Relating these projected catches to the numbers released yields capture rates of 0.4%, 0.2%, and 0.1% for summer, spring and fall chinook, respectively. Because these fish must travel as far as 79 miles before reaching the mainstem traps, we believe that these catch rates are biased low due to in-river mortality.

Production

We selected two values, 3.06% and 1.80% to represent season average trap efficiencies. These rates are the mean capture rates of zero-age chinook calibration groups that we have released upstream of the mainstem traps from 2002 through 2005. The two efficiency numbers are calculated for the two different flow strata: 3.06% when flows are less than 13,800 cfs, and 1.80% when flows are greater than 13,800cfs (Table 9). Expanding the projected season catch in both traps (108,285) by these rates yields a system production estimate of approximately 4.6-million wild 0+ chinook (Figure 4). These two flow-related average efficiencies were used to estimate production since our 2005 calibration group recapture rates (3.6%) were much higher than the average rate of 2% used in the past. We are skeptical that the 3.6% efficiency rate represents our entire 2005 trapping season, so we compared the average over the last four seasons and found the efficiencies at the two flow strata to be significantly different (Anova, $\alpha = 0.05$). This change in our average efficiency from the historical 2% is partially due to lower than average flows during releases of calibration groups, but also may be the results of changes in channel morphology and flow vectoring.

Wild 0+ chinook were caught on the first night of trap operation indicating the migration had already begun. To estimate migration before the starting date we selected a migration start date of January 1. Logarithmic interpolation from January 1 to January 21, resulted in an additional estimated 109,576 wild 0+ chinook. This interpolated portion of the migration accounts for only 2.4% of total wild estimate.

Applying the two strata trap efficiency rates to the projected hatchery catch of 1,462 chinook, estimates production at 59,469 hatchery 0+ chinook. Relating this production estimate to the number released from production facilities (605,390 chinook) estimates in-river survival above Mt. Vernon at 9.8%. This is considerably lower than past years, which average around 50% survival.

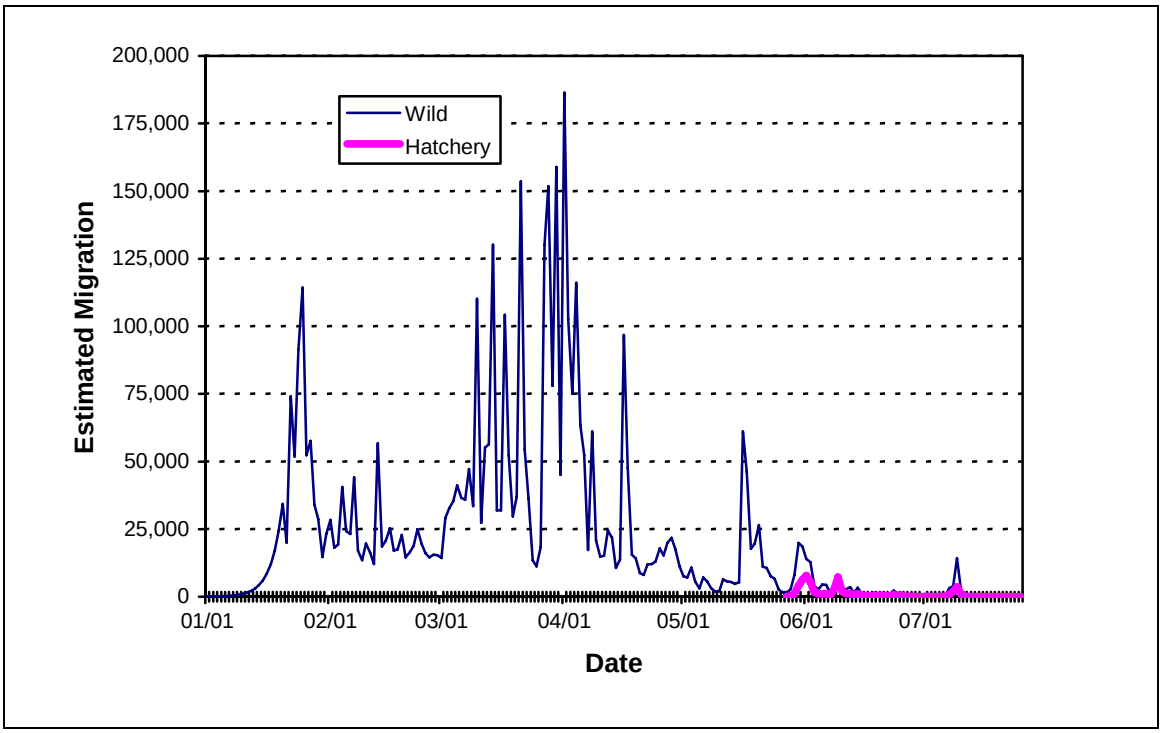

Figure 4. Estimated wild and hatchery 0+ chinook migration past the Skagit River mainstem traps in 2005.

Migration Timing

Although the wild 0+ chinook appeared to be under way before we began trapping. Interpolation estimated that relatively few chinook fry (2.4% of migration) had passed the trap before we started. Low catches in July indicated the chinook migration was virtually over when trapping ceased on July 25. In 2005, the months of January through April accounted for 90% of the season total migration. Fifty-percent of the migration had passed the mainstem traps on March 21 (Figure 5). In the previous eight years that we have trapped throughout the entire migration (1997 through 2004), the median migration date has ranged from March 10 (1999) to May 20 (2004) (Figure 6).

Ad-marked hatchery spring, summer and fall zero-age chinook were released from two sites in the Skagit River basin: Marblemount Hatchery (R.M. 78) and Countyline acclimation ponds (R.M. 89) (Table 6, Figure 1). Because of the poor survival of these fish to the trap and relatively low capture rates, we sampled only a few of these migrants for CWTs. However, sufficient Countyline summer chinook CWT samples were obtained to estimate migration timing of this stock (Figure 7). Countyline summer chinook were released earliest, had a median migration timing to the traps of five days (May 27 release), and the last tagged fish was recovered 54-days after release. Marblemount spring chinook were released lowest in the watershed on June 6, and were captured from June 9 to July 8. One Marblemount spring chinook was caught on May 30, before the reported release date. Countyline fall chinook were released on June 17, and were captured from June 23 to July 10. In addition to inherent stock differences, migration timing for hatchery 0+ chinook groups was potentially influenced by condition, size, flow, turbidity, release date and release site.

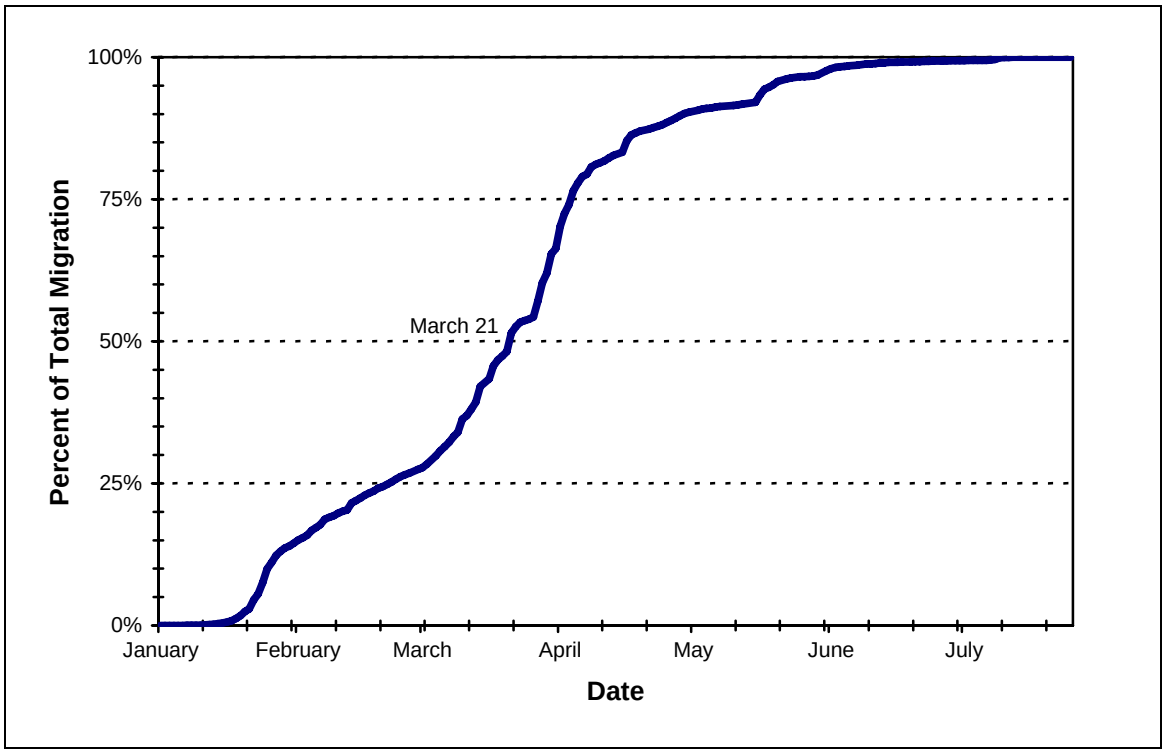

Figure 5. Migration timing of wild 0+ chinook past the Skagit River mainstem traps, 2005.

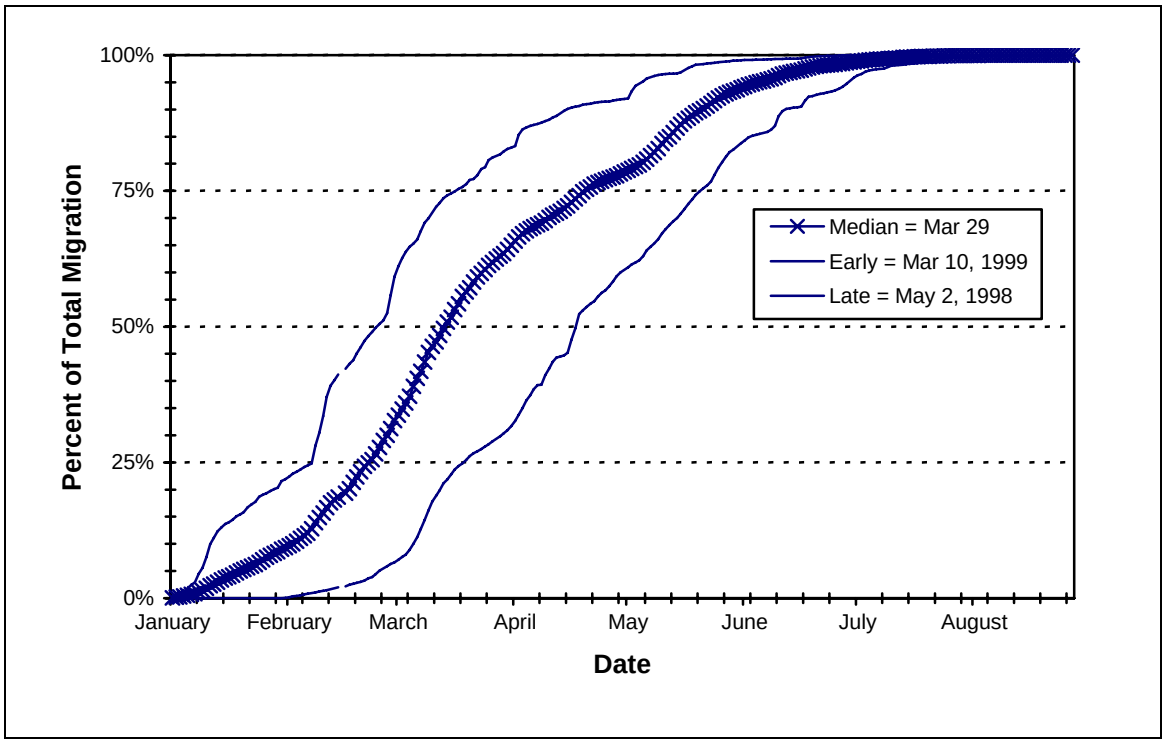

Figure 6. Migration timing variations of wild 0+ chinook, Skagit River mainstem traps 1997-2005.

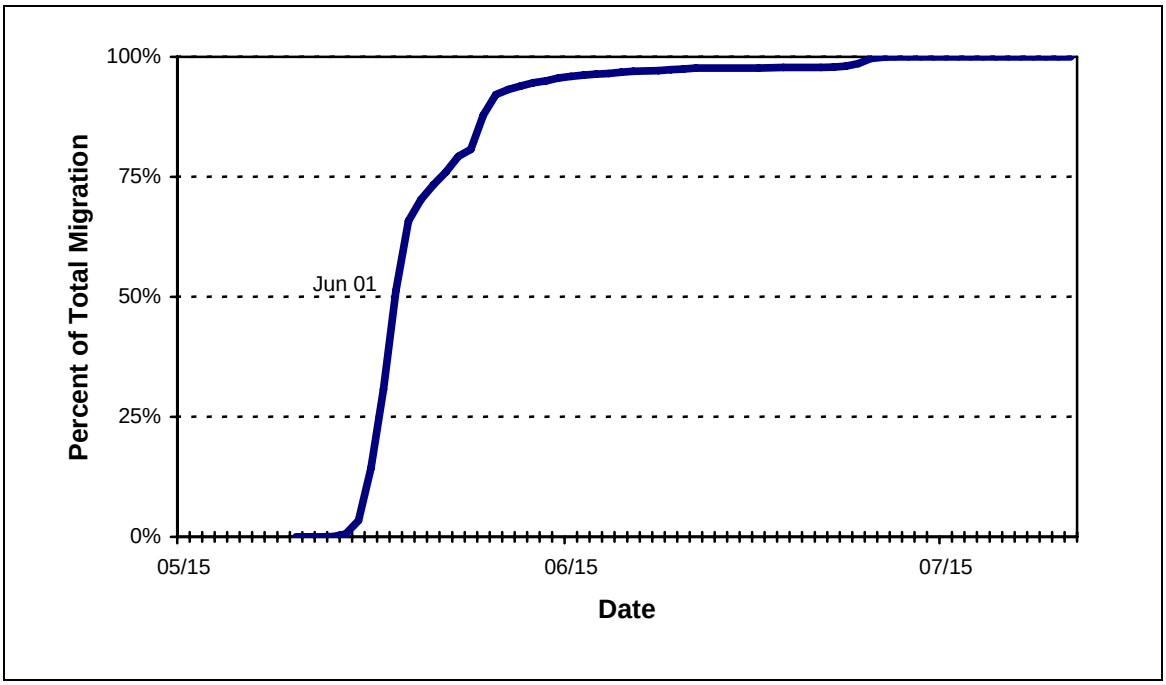

Figure 7. Estimated migration timing of Countyline summer hatchery chinook 0+ past the Skagit River mainstem traps, 2005.

Wild 0+ Chinook Size

Over the season, wild 0+ chinook captured in the traps increased in size from an average of 39-mm in late January, to over 80-mm by mid-July (Table 11 and Figure 8). The lower end of the weekly size range exceeded 40-mm in early May, and reached 50-mm in late April, which is comparable to previous years. Chinook fork length distributions between the scoop and screw trap were not significantly different (KS-test, $\alpha = 0.05$) (Figure 9).

Length Analysis and Size Selectivity

Low river flows dominated the winter and spring of the 2005 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 coho smolts recaptured in the scoop and screw traps showed statistical differences relative to the size distribution at release. This is the first year that we have found there to be a difference between these sites. Marked smolts captured in the scoop and screw traps averaged 90.1 mm and 92.8 mm, respectively. Overall, smolts from Mannser Creek averaged 95.3 mm at release.

Based on these results, we concluded that the mainstem traps did have a small degree of size selectivity that mildly effected recapture rates of wild coho smolts. Capture rates of the smaller zero-age chinook (season average = 51.4-mm) could also be biased for this reason, but are likely substantially less affected than coho because of their smaller size.

Table 11. Mean fork length (mm), standard deviation, range, sample size, and catch, by statistical week, of wild 0+ chinook in the Skagit River mainstem traps, 2005.

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	01/17	01/23	39.5	1.61	36	42	20	265	39.4	1.35	37	42	20	302
5	01/24	01/30	40.6	1.38	38	44	30	1266	40.3	1.17	37	42	30	989
6	01/31	02/06	40.0	1.35	38	44	30	1416	40.5	1.36	38	44	30	1269
7	02/07	02/13	40.8	1.07	39	43	30	1650	40.7	1.42	38	45	30	1866
8	02/14	02/20	41.1	1.57	38	43	20	1980	41.5	2.11	38	48	20	1418
9	02/21	02/27	40.6	1.61	37	44	20	1635	40.6	1.70	38	45	20	1606
10	02/28	03/06	40.5	2.09	37	46	20	2818	41.5	1.76	39	46	20	2609
11	03/07	03/13	41.6	1.19	39	43	20	5404	41.1	2.36	39	50	20	4852
12	03/14	03/20	41.6	1.57	39	45	20	5739	42.1	2.21	39	49	20	3259
13	03/21	03/27	41.8	1.73	39	45	30	4834	42.5	2.78	36	50	30	4335
14	03/28	04/03	42.1	2.25	39	49	19	6500	42.4	2.31	39	46	12	4772
15	04/04	04/10	42.5	3.27	37	53	40	2677	42.4	3.22	37	51	40	2234
16	04/11	04/17	42.9	4.68	38	62	30	2484	44.1	5.88	38	61	30	1673
17	04/18	04/24	44.5	7.37	37	65	28	816	47.4	7.24	38	58	21	353
18	04/25	05/01	49.3	7.11	39	62	30	1117	51.8	5.71	42	61	20	356
19	05/02	05/08	52.5	8.44	37	67	30	386	53.5	7.84	40	72	30	220
20	05/09	05/15	54.2	6.32	46	69	20	413	58.2	6.15	49	73	20	348
21	05/16	05/22	55.3	6.89	42	76	60	1805	57.8	5.94	48	75	50	939
22	05/23	05/29	60.1	7.42	45	76	40	375	60.8	8.55	47	84	32	197
23	05/30	06/05	62.2	7.67	50	82	40	602	63.8	6.18	54	75	40	288
24	06/06	06/12	66.8	6.02	55	80	40	220	63.6	5.70	53	77	40	201
25	06/13	06/19	67.5	4.37	60	75	20	87	68.1	6.49	59	87	20	88
26	06/20	06/26	75.1	7.49	61	82	10	52	68.9	8.13	55	81	10	78
27	06/27	07/03	70.9	9.08	63	89	7	42	75.3	6.75	70	90	7	29
28	07/04	07/10	80.8	7.45	68	97	28	142	80.1	5.77	70	101	30	178
29	07/11	07/17	80.3	2.08	78	82	3	7	71.0	7.07	66	76	2	7
30	07/18	07/24						5						4
Season Total					36	97	685	44,737			36	101	644	34,470

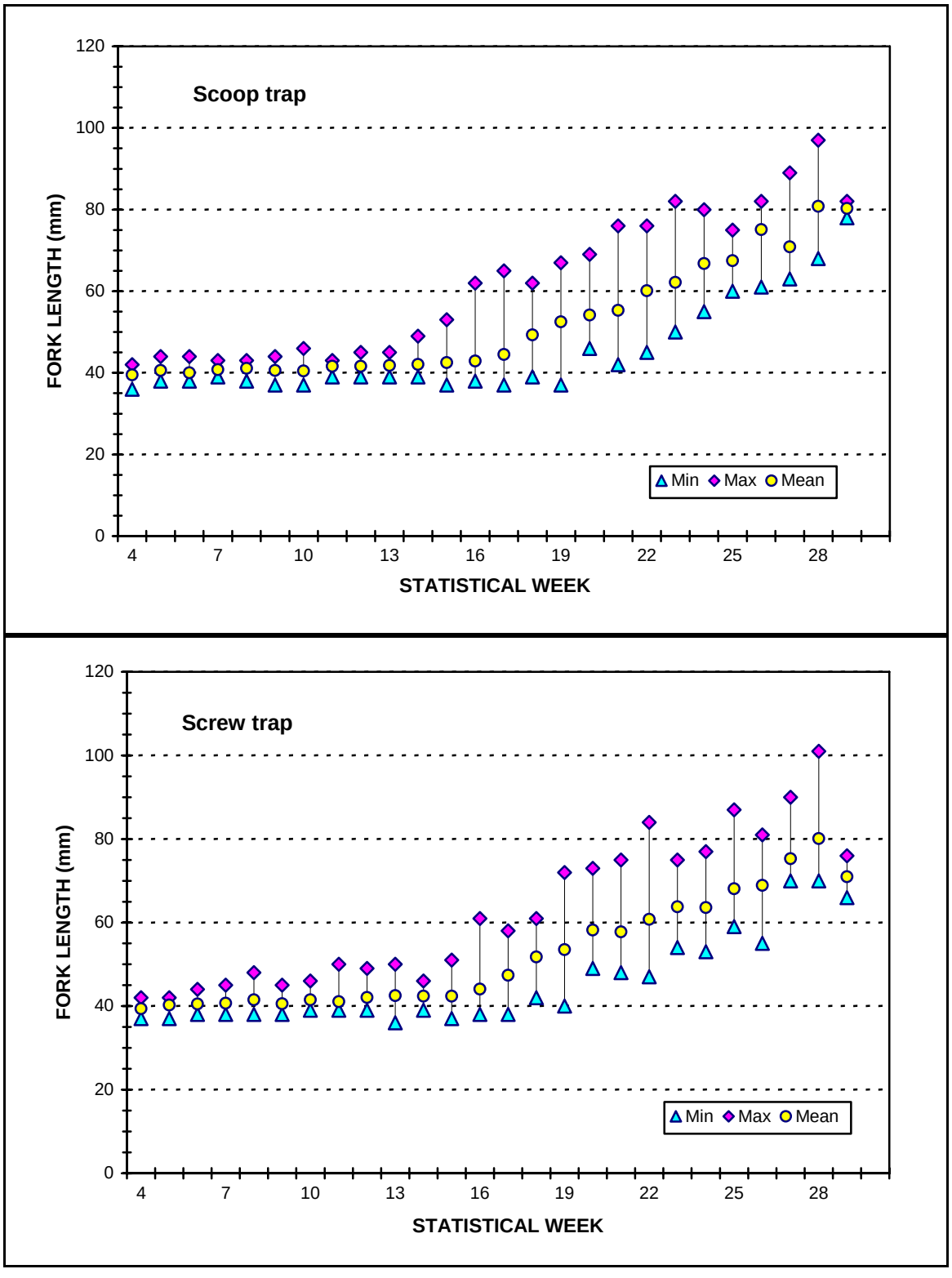

Figure 8. Weekly range and mean fork lengths of wild 0+ chinook measured at the Skagit River mainstem traps, 2005.

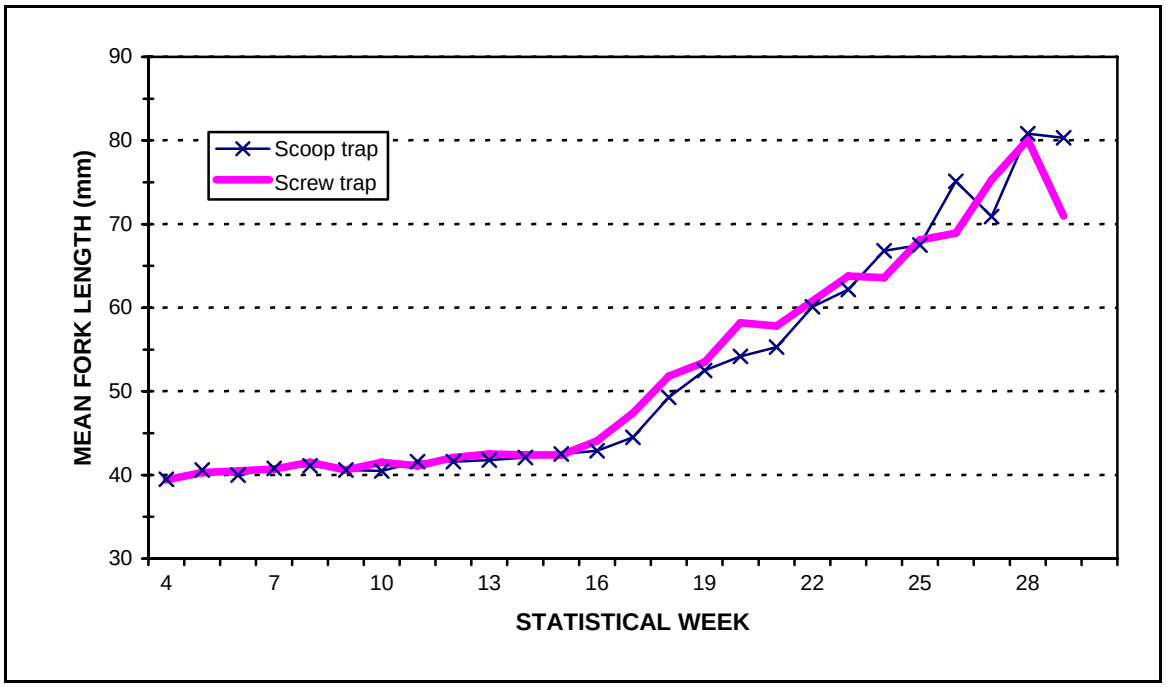

Figure 9. Comparison of mean size of 0+ chinook in the scoop and screw traps, by statistical week, Skagit River 2005.

Egg-to-Migrant Survival

Relating our estimate of 4.6 million downstream-migrant chinook to a potential deposition of 62.3 million eggs, results in an average survival-to-migration of 7.4%. This estimate of potential egg deposition (P.E.D.) is the product of 11,329 females and a fecundity of 5,500 eggs/female (Table 12).

Table 12. 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 Escapement		PED @ 5,500[a] (millions)	Wild Smolts (millions)[b]	Survival to Migration	Peak Flow[c] Oct 22 – 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%	35,600	11/01
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%	19,300	01/06
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
2004	2005	[d]25,175	11,329	62.3	4.6	7.4%	66,700	12/11

[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.
[d] Personal communication, Brett Barkdull.

Wild Coho Smolt Production Evaluation

Smolts marked at Mannser Creek provided the basis for the coho smolt estimate. A total of 128 left ventral-marked (LV) wild coho smolts (r) were recaptured in the mainstem traps out of a total 15,655 LV-marked coho smolts released at the fence weir on Mannser Creek (m) (0.82%). Our total wild coho catch in the mainstem traps (c) was 8,383 smolts. Application of the Chapman's modification of a Peterson population estimate yields a coho production (N) of 1,017,519 smolts past the mainstem traps. Confidence intervals (95%) around this estimate range from 844,003 to 1,191,035 (Table 13). This estimate assumes that all of the LV-marked wild coho smolts survived to pass the mainstem traps during the season.

Table 13. Estimation of wild coho smolt production, Skagit River 2005.

	Number	Formula
Total mainstem trap catches	8,748	
Skagit Hatchery/Lake Shannon	-365	
Wild coho captured (c)	**8,383**	
LVs recaptured (r)	128	$N = \frac{(m+1)(c+1)}{(r+1)}$
LVs released (m)	15,655	
Total production (N)	**1,017,519**	
Variance (Var)	7.84E+09	$Var = \frac{(m+1)(c+1)(m-r)(c-r)}{(r+1)^2(r+1)}$
Standard Deviation (sd)	88,529	
Coefficient of Var (CV)	8.70%	CV = sd/N
Confidence Interval (CI)	173,516	CI = +/- 1.96(sd)
Estimated coho production		
Skagit River	1,017,519	
Upper CI (95%)	1,191,035	
Lower CI (95%)	844,003	

Notes: Baker River smolts are included in the total mainstem trap catches (53 total recaptured). Skagit Hatchery/Lake Shannon smolts (ad-marked and unmarked) counts are by visual identification and tag detection at the mainstem traps.

Assumptions

Every estimate relies on assumptions. Although we know that trap efficiency varies over time, we assume it is a relatively constant fraction of smolt abundance. We presently do not have a specific flow-based correlation model to indicate its variation but it is known that flows are a major component that effect trap efficiency. Therefore, we elected to use recent average efficiencies of groups of marked chinook released at two different flow strata that we found to be significantly different. In addition, we made the following assumptions to estimate the numbers of wild 0+ chinook migrating from the Skagit River in 2005.

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 25.

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 calibration tests involving the release of marked 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.

Assumption # 2b: Complete Identification/enumeration of All Marked Fish Captured
We are confident that virtually every marked fish captured was identified and recorded. The 2005 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 uncertain. Differences between the two efficiency tests conducted using paired releases of hatchery and wild fish were not significant. Furthermore, the similarity of d:n ratios over the past seasons provides some evidence that hatchery fish are responding to the river conditions in a manner similar to that of the wild chinook. Given the low number of paired tests conducted to date, however, we feel the data is insufficient to draw firm conclusions.

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. Potential mechanisms include increased trap avoidance during daylight hours and a shift 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 1998, Seiler et al (1999) released paired groups of hatchery chinook in adjacent day and night strata. However, fish released during the day did not pass the gear within their release stratum (catches occurred primarily at night). The resulting efficiencies measured from each paired release were not significantly different ($\alpha = 0.05$). From this we conclude few, if any, migrants from the day release migrated and avoided the trap during the daytime stratum. Therefore, this experiment failed to validate this assumption, since daytime migration did not occur.

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 2005 was estimated by comparing average trap efficiencies since 2002 with flow. Using 13,800 cfs (average daily mean flow) as the threshold discharge separating the strata, statistical analysis showed that efficiencies in the two strata were normally distributed and significantly different ($\alpha = 0.05$). Our two average efficiencies calculated for the 2005 season are 1.80% when flows are greater than 13,800 cfs, and 3.06% when flows are less than 13,800 cfs. Application of these rates estimates that 4.6 million wild 0+ chinook passed the Skagit River mainstem traps in 2005. If this production estimate is biased, we believe that it is high, because it is unlikely that all marked chinook, wild and hatchery, survived to pass the traps. Therefore, actual capture rates may be somewhat higher than our four-year two-strata averages.

Discussion

Low flows prevailed throughout most of the 2005 season and allowed almost continuous trapping. These low flows were also in effect on days we estimated our trap efficiencies by releasing our calibration groups, which is most likely why average trap efficiency for 2005 was so high (3.57%). Although we suspect that this efficiency rate is accurate for lower flows, we are skeptical that it is a good representative rate for higher flows. Therefore we used the two-strata approach that was described earlier to more accurately represent efficiencies at various flows. We also used more recent years' data (2002-2005) in calculating our efficiencies to best represent current river conditions.

There were three high flow events during the incubation period (October 22 - February 15) for 2004 brood chinook: 51,000 cfs on November 25, 66,700 cfs on January 11, and 63,700 cfs on January 19. The November high flow event is average compared to the peak incubation flow events in the past. Our egg-to-migrant survival rate, as determined by the peak incubation flow relationship we have developed over the years, suggests a survival rate of 11.7%. However, the actual rate we estimated was only 7.4% (Table 12, Figure 10), which implies other factors may have combined with flow to further lower survival. This low survival rate is partially the result of the very low flows during the chinook 0+ out-migration. The average daily mean flows from February 2 to July 25, when a majority of the chinook emigration occurs, was only 69% of the 64-year average (Figure 2). We have seen a significant positive correlation between flows and survival during migration at other streams in which we evaluate production (Seiler *et al* 2005). We believe the reduction in survival observed at lower flows is primarily the result of increased predation.

Another explanation for the lower-than-predicted survival involves the potential density-dependent effects of the spawning population in 2004. This return, estimated at 25,175 adults (Brett Barkdull, pers. comm.), is the highest from which we have estimated production in this system (Table 12). Continued monitoring including future broods with higher spawning population will further define the constraints to chinook production.

Also we believe that the low flows in 2005 decreased survival of hatchery chinook 0+ released from production facilities. Coded-wire tag recoveries indicate that catch rates for each of the stocks are the lowest we have seen to date. We estimated migration to the traps at 59,469 hatchery 0+ chinook from a total of 605,390 fish released from production facilities (Steve Stout, pers. comm.). This estimates in-river survival above Mt. Vernon at 9.8%, considerably lower than in previous years, which averaged around 50%. The low survival of hatchery chinook could also be determined by such other factors as release timing relative to flows, fish health, and fish size at release.

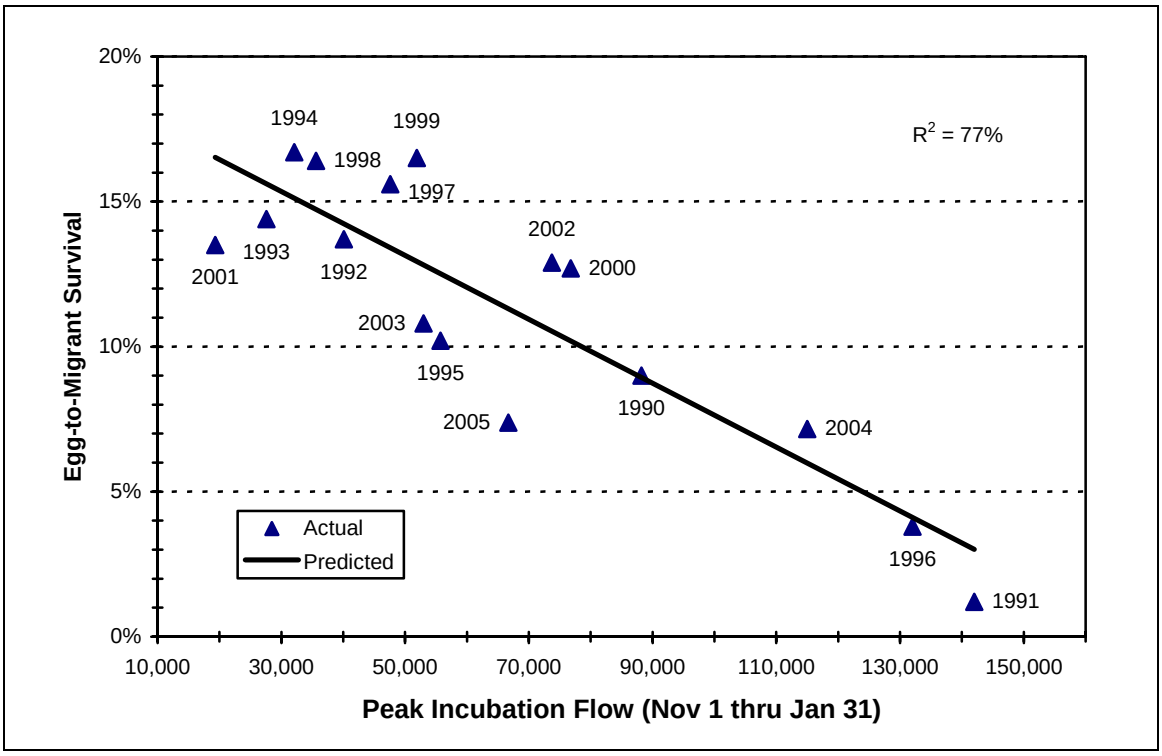

Figure 10. Wild 0+ chinook egg-to-migrant survival and peak incubation flow, migration years 1990-2005, Skagit River

Recommendations

The following recommendations, compiled from the past years' work, are listed so that we can assess the progress made during the 2005 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 nine nights, from January 21 through July.

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

3. **Accomplished**. We released four groups of hatchery and three groups of wild chinook 0+ for calibration groups.

Recommendations for 2006

Our study plan for the 2006 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 0+ chinook calibration groups to assess recapture rates at various flow levels, including more paired releases of hatchery and wild calibration groups if hatchery fish are to be used; and

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

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Appendices: Daily Catches in the Mainstem Skagit River Scoop and Screw Traps, 2005

Appendix A:Total daily catches, by species and age, in the Skagit River mainstem scoop trap, 2005.

Date	HOURS		CHINOOK		Chum	COHO		Pink	Sock	TROUT			Unmarked		
	Fished	Out	0+	1+		0+	1+			Parr	Sthd	Cutt	Chin0	Coho1	Sthd1
01/21	2.02	12.65	36	0	0	0	0	0	1	0	1	0	36	0	1
01/22	3.00	21.00	109	0	0	0	0	0	0	0	0	0	109	0	0
01/23	2.67	21.33	120	0	3	0	1	0	0	0	0	0	120	1	0
01/24	4.00	20.00	161	0	7	0	0	0	0	0	0	0	161	0	0
01/25	5.00	19.00	179	0	11	0	0	0	0	0	0	0	179	0	0
01/26	3.00	21.00	50	0	5	0	0	0	0	0	0	0	50	0	0
01/27	8.50	15.50	144	0	8	0	1	0	0	0	0	0	144	1	0
01/28	17.00	7.00	262	0	4	0	0	0	0	0	0	0	262	0	0
01/29	17.75	6.25	211	0	4	0	0	0	0	0	0	0	211	0	0
01/30	13.50	10.50	158	0	1	0	0	0	0	0	0	0	158	0	0
01/31	14.25	9.75	182	0	6	0	0	0	0	0	0	0	182	0	0
02/01	23.67	0.33	319	0	10	0	0	0	1	0	0	0	319	0	0
02/02	13.75	10.25	146	0	3	0	0	0	0	0	0	0	146	0	0
02/03	14.00	10.00	133	1	2	0	0	0	0	0	0	0	133	0	0
02/04	23.58	0.42	303	2	8	0	0	0	0	0	0	0	303	0	0
02/05	13.50	10.50	166	0	6	0	0	0	0	0	1	0	166	0	1
02/06	13.50	10.50	174	0	6	0	0	0	0	0	0	0	174	0	0
02/07	23.67	0.33	382	2	7	0	1	0	0	0	0	0	382	1	0
02/08	14.50	9.50	135	2	2	0	0	0	1	0	0	0	135	0	0
02/09	14.00	10.00	115	0	3	0	1	0	0	0	1	0	115	1	1
02/10	23.67	0.33	300	1	6	0	0	0	1	0	0	0	300	0	0
02/11	14.00	10.00	147	0	4	0	0	0	0	0	0	0	147	0	0
02/12	13.75	10.25	145	1	6	0	0	0	0	0	0	0	145	0	0
02/13	23.50	0.50	428	1	12	0	0	0	0	0	0	0	428	0	0
02/14	13.25	10.75	219	0	6	0	0	0	0	0	0	0	219	0	0
02/15	13.25	10.75	269	0	7	0	0	0	0	0	0	0	269	0	0
02/16	23.58	0.42	414	1	16	0	1	0	1	0	0	0	414	1	0
02/17	13.50	10.50	245	0	20	0	1	0	0	0	0	0	245	1	0
02/18	13.50	10.50	240	0	20	0	0	0	0	0	0	0	240	0	0
02/19	23.67	0.33	379	0	24	0	0	0	0	1	0	0	379	0	0
02/20	14.00	10.00	205	0	26	0	1	0	0	0	0	0	205	1	0
02/21	14.00	10.00	202	0	34	0	1	0	0	0	0	0	202	1	0
02/22	23.58	0.42	285	0	49	1	1	0	0	0	0	0	285	1	0
02/23	13.25	10.75	271	1	53	0	2	1	0	0	0	0	271	2	0
02/24	23.67	0.33	273	0	39	0	2	0	0	0	0	0	273	2	0
02/25	13.25	10.75	170	0	24	0	0	0	0	0	0	0	170	0	0
02/26	13.25	10.75	179	0	27	0	0	1	0	0	0	0	179	0	0
02/27	23.67	0.33	259	0	41	0	0	2	1	0	0	0	259	0	0
02/28	12.50	11.50	161	0	37	0	1	1	0	0	0	0	161	1	0
03/01	13.25	10.75	242	0	44	0	1	2	0	0	0	0	242	1	0
03/02	15.08	8.92	362	0	61	0	2	0	0	0	0	0	362	2	0
03/03	23.67	0.33	532	0	91	0	1	2	0	0	0	0	532	1	0
03/04	12.75	11.25	421	0	91	0	0	1	0	0	0	0	421	0	0
03/05	12.50	11.50	473	0	128	0	1	1	0	0	0	0	473	1	0
03/06	23.67	0.33	526	0	180	0	0	0	0	0	0	0	526	0	0
03/07	12.50	11.50	444	0	201	0	0	0	0	0	0	0	444	0	0
03/08	12.50	11.50	453	0	174	0	0	0	0	0	0	0	453	0	0
03/09	23.67	0.33	958	0	215	0	0	3	0	0	0	0	958	0	0
03/10	5.92	18.08	465	0	114	0	0	1	0	0	0	0	465	0	0
03/11	12.50	11.50	483	0	253	0	0	3	0	0	0	0	483	0	0
03/12	23.58	0.42	785	0	399	0	0	1	0	0	0	0	785	0	0
03/13	12.25	11.75	1,062	0	338	0	0	1	0	0	0	0	1,062	0	0
03/14	11.75	12.25	1,120	0	332	0	0	0	0	0	0	0	1,120	0	0

Table continued on next page

Appendix A: Total daily catches, by species and age, in the Skagit River mainstem scoop trap, 2005 (cont'd).

Date	HOURS		CHINOOK		Chum	COHO		Pink	Sock	TROUT			Unmarked		
	Fished	Out	0+	1+		0+	1+			Parr	Sthd	Cutt	Chin0	Coho1	Sthd1
03/15	23.58	0.42	444	0	248	0	1	0	0	0	0	0	444	1	0
03/16	11.75	12.25	903	0	591	0	0	0	0	0	0	0	903	0	0
03/17	11.75	12.25	1,323	0	768	0	0	0	0	0	0	0	1,323	0	0
03/18	23.67	0.33	698	0	325	0	1	0	0	0	0	0	698	1	0
03/19	12.25	11.75	290	0	363	0	0	0	0	1	0	0	290	0	0
03/20	12.00	12.00	941	0	933	3	0	2	0	0	0	0	941	0	0
03/21	22.75	1.25	2,109	0	2,119	9	2	3	1	0	0	0	2,109	2	0
03/22	11.50	12.50	599	0	1,282	6	3	0	0	0	0	0	599	3	0
03/23	11.50	12.50	334	0	1,157	5	2	1	0	0	0	0	334	2	0
03/24	23.67	0.33	201	0	443	4	0	0	0	0	0	0	201	0	0
03/25	11.00	13.00	105	0	186	1	1	0	0	0	0	0	105	1	0
03/26	11.50	12.50	421	0	1,026	4	0	0	0	1	0	0	421	0	0
03/27	14.83	9.17	1,378	0	2,330	13	1	0	0	0	0	0	1,378	1	0
03/28	11.25	12.75	976	0	1,227	25	0	0	0	0	0	0	976	0	0
03/29	11.25	12.75	487	0	408	17	1	0	0	0	0	0	487	1	0
03/30	23.33	0.67	1,497	0	1,834	22	1	0	0	0	2	0	1,497	1	2
03/31	11.00	13.00	529	0	771	16	2	0	1	0	0	0	529	2	0
04/01	23.58	0.42	1,880	4	2,210	27	1	0	0	1	0	0	1,880	1	0
04/02	11.00	13.00	686	1	836	17	1	0	0	0	1	0	686	1	1
04/03	11.00	13.00	643	0	694	18	3	0	0	0	0	0	643	3	0
04/04	23.67	0.33	1,123	0	1,994	22	4	0	0	0	0	0	1,123	4	0
04/05	11.00	13.00	410	0	680	12	3	0	0	0	0	0	410	3	0
04/06	11.00	13.00	281	0	489	7	4	0	0	1	1	0	281	4	1
04/07	23.67	0.33	401	0	1,173	6	2	0	0	1	1	0	401	2	1
04/08	11.08	12.92	370	1	609	9	4	0	0	0	0	0	370	4	0
04/09	10.25	13.75	222	1	696	8	4	0	0	0	0	1	222	4	0
04/10	23.67	0.33	235	0	934	5	2	0	0	0	0	0	235	2	0
04/11	11.00	13.00	205	0	648	7	2	0	0	0	0	0	205	2	0
04/12	10.75	13.25	278	0	893	15	3	0	0	1	0	0	278	3	0
04/13	23.58	0.42	285	0	919	17	1	0	0	0	0	0	285	1	0
04/14	10.75	13.25	113	0	446	13	4	0	0	0	0	0	113	4	0
04/15	10.50	13.50	154	1	695	18	8	0	0	0	0	0	154	8	0
04/16	23.25	0.75	1,019	13	2,529	51	14	0	0	0	1	1	1,019	14	1
04/17	10.25	13.75	390	1	1,349	50	9	0	0	0	0	0	390	8	0
04/18	10.00	14.00	178	1	472	49	12	0	0	0	0	0	178	12	0
04/19	17.08	6.92	185	1	907	20	17	0	0	0	0	0	185	17	0
04/20	10.00	14.00	71	0	356	13	20	0	0	1	0	0	71	20	0
04/21	10.00	14.00	62	0	305	10	15	0	0	0	0	0	62	15	0
04/22	23.67	0.33	141	1	1,097	13	26	0	0	0	0	0	141	25	0
04/23	10.00	14.00	111	0	375	16	32	0	0	0	0	0	111	32	0
04/24	10.00	14.00	117	1	433	23	51	0	0	0	2	0	117	50	2
04/25	23.75	0.25	205	2	1,590	26	95	0	0	0	2	0	205	93	2
04/26	9.75	14.25	162	1	279	37	143	0	1	0	2	0	162	139	2
04/27	10.00	14.00	210	2	252	85	218	0	1	0	1	0	210	215	1
04/28	23.58	0.42	276	4	1,112	65	195	0	0	0	0	0	276	193	0
04/29	10.00	14.00	148	0	83	56	172	0	0	0	1	0	148	171	1
04/30	10.00	14.00	90	4	22	30	132	0	0	0	1	1	90	130	1

Table continued on next page

Appendix A: Total daily catches, by species and age, in the Skagit River mainstem scoop trap, 2005 (cont'd).

Date	HOURS		CHINOOK		Chum	COHO		Pink	Sock	TROUT			Unmarked		
	Fished	Out	0+	1+		0+	1+			Parr	Sthd	Cutt	Chin0	Coho1	Sthd1
05/01	23.75	0.25	82	9	101	27	113	0	0	0	0	0	82	111	0
05/02	9.50	14.50	58	2	20	25	102	0	0	0	1	1	58	101	1
05/03	9.58	14.42	71	4	68	19	119	0	0	1	0	0	71	114	0
05/04	23.58	0.42	54	2	163	29	105	0	0	0	1	0	54	103	1
05/05	9.50	14.50	36	1	61	34	112	0	0	1	1	1	36	110	1
05/06	9.00	15.00	53	0	115	30	149	0	0	1	0	0	53	122	0
05/07	23.58	0.42	95	1	260	34	192	0	0	0	0	0	95	141	0
05/08	9.25	14.75	36	0	32	7	44	0	0	0	1	0	36	40	1
05/09	9.00	15.00	22	1	22	6	33	0	0	0	1	0	22	31	0
05/10	23.67	0.33	46	1	97	8	98	0	0	0	2	0	46	95	0
05/11	9.50	14.50	67	1	93	20	221	0	0	0	0	0	67	214	0
05/12	23.67	0.33	80	0	147	18	174	0	0	0	0	0	80	167	0
05/13	9.25	14.75	47	0	38	10	93	0	0	0	0	0	47	90	0
05/14	9.25	14.75	51	0	33	7	76	0	0	0	0	0	51	72	0
05/15	9.00	15.00	53	0	44	7	94	0	1	0	0	0	53	89	0
05/16	23.58	0.42	778	11	1,430	60	426	0	0	0	22	7	778	407	14
05/17	9.00	15.00	336	7	70	87	275	0	0	1	9	1	336	264	7
05/18	9.00	15.00	117	0	8	8	98	0	0	0	1	1	117	95	1
05/19	23.67	0.33	256	0	37	8	133	0	1	0	1	0	256	128	1
05/20	9.00	15.00	162	0	5	11	119	0	0	0	1	1	162	114	0
05/21	8.75	15.25	72	0	20	12	50	0	0	0	0	0	72	48	0
05/22	23.67	0.33	108	0	65	8	39	0	0	0	0	0	108	37	0
05/23	8.75	15.25	52	0	4	7	54	0	0	1	0	0	52	53	0
05/24	8.75	15.25	39	0	2	7	50	0	0	0	1	0	39	50	0
05/25	8.50	15.50	25	0	1	6	38	0	0	0	0	0	25	38	0
05/26	23.67	0.33	28	0	6	1	30	0	1	0	0	1	28	29	0
05/27	8.25	15.75	18	0	7	5	29	0	0	0	0	0	17	28	0
05/28	8.25	15.75	31	0	7	6	56	0	0	0	0	0	27	55	0
05/29	23.58	0.42	140	1	52	7	108	0	0	0	0	0	121	105	0
05/30	8.25	15.75	184	0	28	3	71	0	1	0	0	1	144	70	0
05/31	8.25	15.75	187	0	28	4	35	0	0	0	0	1	131	34	0
06/01	23.50	0.50	267	0	47	2	31	0	1	0	1	0	165	30	0
06/02	8.25	15.75	109	0	10	1	21	0	0	0	0	0	69	20	0
06/03	8.25	15.75	75	0	2	2	13	0	0	0	0	0	49	13	0
06/04	23.67	0.33	79	0	3	1	15	0	0	0	0	0	60	15	0
06/05	8.25	15.75	64	0	3	1	10	0	0	0	0	0	50	9	0
06/06	8.25	15.75	58	0	7	1	12	0	0	0	0	1	43	7	0
06/07	23.67	0.33	42	0	1	0	6	0	0	0	0	0	29	5	0
06/08	8.00	16.00	93	0	3	1	4	0	0	0	0	0	38	4	0
06/09	8.00	16.00	136	0	6	1	4	0	0	1	0	0	44	4	0
06/10	23.67	0.33	52	0	8	1	6	0	0	0	0	0	33	6	0
06/11	8.00	16.00	40	0	4	1	4	0	0	0	0	0	23	2	0
06/12	8.00	16.00	50	0	2	1	3	0	0	0	0	0	33	2	0
06/13	23.58	0.42	35	0	1	1	2	0	1	0	0	0	23	2	0
06/14	8.00	16.00	35	0	2	0	1	0	1	0	0	0	23	1	0
06/15	7.75	16.25	14	0	1	1	1	0	0	0	0	0	8	0	0

Table continued on next page

Appendix A: Total daily catches, by species and age, in the Skagit River mainstem scoop trap, 2005 (cont'd).

Date	HOURS		CHINOOK		Chum	COHO		Pink	Sock	TROUT			Unmarked		
	Fished	Out	0+	1+		0+	1+			Parr	Sthd	Cutt	Chin0	Coho1	Sthd1
06/16	23.67	0.33	16	0	2	1	2	0	0	0	0	0	11	1	0
06/17	8.00	16.00	9	0	1	0	1	0	0	0	0	0	7	0	0
06/18	8.00	16.00	19	0	1	2	0	0	0	0	0	0	13	0	0
06/19	23.67	0.33	20	0	4	1	1	0	0	0	0	0	11	1	0
06/20	8.00	16.00	9	0	3	0	0	0	0	0	0	0	6	0	0
06/21	8.00	16.00	6	0	0	2	0	0	0	0	0	0	5	0	0
06/22	23.58	0.42	17	0	1	1	0	0	0	0	0	0	14	0	0
06/23	8.00	16.00	19	0	2	1	0	0	0	0	0	0	15	0	0
06/24	8.00	16.00	8	0	1	1	1	0	0	0	0	0	7	1	0
06/25	23.67	0.33	4	0	0	1	0	0	0	0	0	0	2	0	0
06/26	8.00	16.00	5	0	1	1	0	0	0	0	0	0	5	0	0
06/27	8.00	16.00	4	0	0	0	0	0	0	0	0	0	4	0	0
06/28	23.67	0.33	6	0	0	0	0	0	0	0	0	0	5	0	0
06/29	8.25	15.75	8	0	0	3	0	0	0	0	0	0	8	0	0
06/30	8.25	15.75	6	0	0	7	0	0	0	0	0	0	6	0	0
07/01	8.25	15.75	10	0	0	1	1	0	0	0	0	0	9	1	0
07/02	23.67	0.33	5	0	0	1	0	0	0	1	0	0	5	0	0
07/03	8.50	15.50	5	0	0	3	0	0	0	1	0	0	5	0	0
07/04	5.50	18.50	3	0	0	1	0	0	0	0	0	0	3	0	0
07/05	2.50	21.50	1	0	0	0	0	0	0	0	0	0	1	0	0
07/06	23.67	0.33	13	0	1	2	0	0	0	0	0	0	12	0	0
07/07	8.25	15.75	20	0	0	4	1	0	0	0	0	0	16	0	0
07/08	8.25	15.75	18	0	0	1	0	0	0	0	0	0	14	0	0
07/09	15.75	8.25	117	0	1	3	0	0	0	0	0	0	90	0	0
07/10	8.25	15.75	9	0	1	2	0	0	0	0	0	0	6	0	0
07/11	8.50	15.50	4	0	0	2	0	0	0	0	0	0	4	0	0
07/12	8.25	15.75	2	0	0	1	0	0	0	0	0	0	1	0	0
07/13	23.50	0.50	3	0	0	0	0	0	0	1	0	0	3	0	0
07/14	8.00	16.00	1	0	0	1	0	0	0	1	0	0	1	0	0
07/15	23.67	0.33	0	0	0	1	0	0	0	0	0	0	0	0	0
07/16	6.00	0.00	1	0	0	1	0	0	0	0	0	0	1	0	0
07/18	2.75	0.00	1	0	0	0	0	0	0	0	0	0	1	0	0
07/19	23.67	0.33	2	0	0	0	1	0	0	0	0	0	2	1	0
07/20	6.00	0.00	1	0	0	0	0	0	0	0	0	0	1	0	0
07/22	3.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0
07/23	23.58	0.42	0	0	0	0	0	0	0	1	0	0	0	0	0
07/24	6.00	18.00	1	0	0	0	0	0	0	0	0	0	1	0	0
07/25	6.50	14.50	0	0	0	1	0	0	0	0	0	0	0	0	0
	2,567.27	1,758.15	45,394	92	47,439	1,453	4,708	26	17	19	61	19	44,737	4,494	45

Note: The unmarked coho 1+ does not include fish marked at Mannser Creek or Baker Dam.

Appendix B: Total daily catches, by species and age, in the Skagit River mainstem screw trap, 2005.

Date	HOURS		CHINOOK		Chum	COHO		Pink	Sock	TROUT			Unmarked		
	Fished	Out	0+	1+		0+	1+			Parr	Sthd	Cutt	Chin0	Coho1	Sthd1
01/21	2.00	12.67	41	0	0	0	0	0	0	0	0	0	41	0	0
01/22	3.00	21.00	121	0	0	0	0	0	0	0	0	0	121	0	0
01/23	2.83	21.17	140	0	2	0	1	0	0	0	0	0	140	1	0
01/24	4.00	20.00	186	0	3	0	0	0	0	0	0	0	186	0	0
01/25	5.00	19.00	152	1	1	0	1	0	0	0	0	0	152	1	0
01/26	3.00	21.00	68	0	0	0	0	0	0	0	0	0	68	0	0
01/27	8.50	15.50	95	1	0	0	0	0	0	0	0	0	95	0	0
01/28	17.25	6.75	212	0	7	0	0	0	0	0	0	0	212	0	0
01/29	17.75	6.25	114	1	3	0	0	0	0	0	1	0	114	0	1
01/30	13.50	10.50	83	1	0	0	0	0	0	1	0	0	83	0	0
01/31	14.25	9.75	118	0	0	0	0	0	0	0	0	0	118	0	0
02/01	24.00	0.00	181	1	2	0	0	0	0	0	1	0	181	0	1
02/02	13.75	10.25	98	0	1	0	0	0	0	0	0	0	98	0	0
02/03	14.00	10.00	130	0	4	0	0	0	0	0	0	0	130	0	0
02/04	24.00	0.00	449	2	7	0	1	0	0	0	1	0	449	1	1
02/05	13.50	10.50	145	0	2	0	0	0	0	0	0	0	145	0	0
02/06	13.50	10.50	140	1	2	0	0	0	0	0	1	0	140	0	1
02/07	24.00	0.00	370	1	3	0	0	0	0	0	0	0	370	0	0
02/08	14.50	9.50	82	0	0	0	1	0	0	0	1	0	82	1	1
02/09	14.00	10.00	90	0	0	0	1	0	0	0	0	0	90	1	0
02/10	23.83	0.17	357	1	5	0	2	0	0	0	1	0	357	2	1
02/11	14.00	10.00	180	0	5	0	0	0	0	0	0	0	180	0	0
02/12	13.75	10.25	167	0	6	0	0	0	0	0	0	0	167	0	0
02/13	23.75	0.25	576	0	12	0	0	0	0	0	0	0	576	0	0
02/14	13.25	10.75	212	0	8	0	0	0	0	0	0	0	212	0	0
02/15	13.25	10.75	174	0	7	0	0	0	0	0	0	0	174	0	0
02/16	24.00	0.00	337	0	7	0	1	0	0	0	0	0	337	1	0
02/17	13.50	10.50	149	0	5	0	1	0	0	0	0	0	149	1	0
02/18	13.50	10.50	176	0	9	0	1	0	0	0	0	0	176	1	0
02/19	23.75	0.25	260	0	14	0	0	0	0	0	0	0	260	0	0
02/20	14.00	10.00	147	0	14	0	1	0	0	1	0	0	147	1	0
02/21	14.00	10.00	205	0	18	0	0	0	0	0	0	0	205	0	0
02/22	23.83	0.17	334	0	22	0	0	0	0	0	0	0	334	0	0
02/23	13.00	11.00	250	0	29	0	0	0	0	0	0	0	250	0	0
02/24	24.00	0.00	263	0	32	0	0	0	0	0	0	0	263	0	0
02/25	13.25	10.75	175	0	15	0	0	0	0	0	0	0	175	0	0
02/26	13.25	10.75	128	0	8	0	0	0	0	0	0	0	128	0	0
02/27	24.00	0.00	255	0	21	0	1	1	0	0	0	0	255	1	0
02/28	12.50	11.50	137	0	23	0	1	0	0	0	0	0	137	1	0
03/01	13.25	10.75	215	0	35	0	0	1	0	0	0	0	215	0	0
03/02	15.00	9.00	341	0	44	0	0	1	0	0	0	0	341	0	0
03/03	24.00	0.00	514	0	69	0	0	1	0	0	0	0	514	0	0
03/04	12.75	11.25	378	0	53	0	0	0	0	0	0	0	378	0	0
03/05	12.50	11.50	425	0	59	0	0	0	0	0	0	0	425	0	0
03/06	24.00	0.00	499	0	98	0	0	0	0	0	0	0	499	0	0
03/07	12.50	11.50	413	0	115	0	0	1	0	0	0	0	413	0	0
03/08	12.50	11.50	439	0	118	0	0	1	0	0	0	0	439	0	0
03/09	24.00	0.00	1,057	0	157	0	0	2	0	0	0	0	1,057	0	0
03/10	6.00	18.00	458	0	79	0	0	1	0	0	0	0	458	0	0
03/11	12.42	11.58	353	0	193	0	0	1	0	0	0	0	353	0	0
03/12	23.75	0.25	783	0	358	0	0	3	0	0	0	0	783	0	0
03/13	12.25	11.75	816	0	250	0	1	0	0	0	0	0	816	1	0
03/14	11.75	12.25	861	0	227	0	0	0	0	0	0	0	861	0	0
03/15	23.58	0.42	444	0	248	0	1	0	0	0	0	0	444	1	0

Table continued on next page

Appendix B: Total daily catches, by species and age, in the Skagit River mainstem screw trap, 2005 (cont'd).

Date	HOURS		CHINOOK		Chum	COHO		Pink	Sock	TROUT			Unmarked		
	Fished	Out	0+	1+		0+	1+			Parr	Sthd	Cutt	Chin0	Coho1	Sthd1
03/15	24.00	0.00	396	0	192	0	1	0	0	0	0	0	396	1	0
03/16	11.75	12.25	316	0	219	0	0	0	0	1	0	0	316	0	0
03/17	11.75	12.25	580	0	303	0	1	0	0	0	0	0	580	1	0
03/18	24.00	0.00	652	0	289	0	0	1	0	0	0	1	652	0	0
03/19	12.25	11.75	283	0	220	0	0	2	0	0	0	0	283	0	0
03/20	12.00	12.00	485	0	388	0	0	1	0	0	0	0	485	0	0
03/21	23.42	0.58	1,798	0	1,717	7	3	0	0	0	0	1	1,798	3	0
03/22	11.50	12.50	408	0	877	0	3	1	0	0	0	2	408	3	0
03/23	11.50	12.50	278	0	941	1	1	0	0	0	0	1	278	1	0
03/24	24.00	0.00	176	0	308	0	1	0	0	0	0	0	176	1	0
03/25	11.00	13.00	80	0	136	0	0	0	0	0	0	0	80	0	0
03/26	11.50	12.50	353	0	600	0	0	0	0	0	0	0	353	0	0
03/27	15.00	9.00	1,258	1	1,480	5	1	0	0	0	0	0	1,258	1	0
03/28	11.33	12.67	542	0	526	6	1	0	1	0	0	1	542	1	0
03/29	11.25	12.75	323	0	257	11	1	0	0	1	0	2	323	1	0
03/30	23.75	0.25	1,434	1	1,604	26	5	0	0	0	0	0	1,434	5	0
03/31	11.00	13.00	351	1	397	12	5	0	0	0	0	0	351	5	0
04/01	24.00	0.00	1,655	5	2,083	10	3	0	0	0	0	3	1,655	3	0
04/02	11.00	13.00	382	3	427	4	2	0	0	0	1	0	382	2	1
04/03	11.00	13.00	259	1	217	4	1	0	0	0	2	0	259	1	2
04/04	24.00	0.00	848	1	1,581	7	2	0	0	1	0	0	848	2	0
04/05	11.00	13.00	321	1	522	3	2	0	0	0	1	1	321	2	1
04/06	11.00	13.00	245	0	463	4	2	0	0	0	0	1	245	2	0
04/07	24.00	0.00	345	3	1,336	10	4	0	0	0	0	0	345	4	0
04/08	11.08	12.92	274	1	423	15	3	0	0	0	1	0	274	3	1
04/09	10.25	13.75	139	1	312	15	3	0	0	0	1	0	139	3	1
04/10	24.00	0.00	208	0	700	3	6	0	0	0	1	0	208	6	1
04/11	11.00	13.00	142	0	387	4	2	0	0	1	0	2	142	2	0
04/12	10.75	13.25	191	1	629	8	6	0	0	0	1	2	191	6	1
04/13	24.00	0.00	291	0	1,233	15	6	0	0	0	1	1	291	6	1
04/14	10.75	13.25	100	1	318	3	4	0	0	1	0	0	100	4	0
04/15	10.50	13.50	132	0	587	5	8	0	0	1	1	1	132	8	1
04/16	22.75	1.25	701	5	2,122	24	14	0	0	0	6	1	701	14	6
04/17	10.25	13.75	121	1	303	7	13	0	0	0	4	1	121	13	4
04/18	10.00	14.00	91	0	161	6	16	0	0	0	4	4	91	16	4
04/19	17.25	6.75	97	1	319	7	21	0	0	0	5	2	97	20	5
04/20	10.00	14.00	26	1	188	2	17	0	1	0	1	2	26	17	1
04/21	10.00	14.00	31	0	162	0	14	0	0	0	0	1	31	14	0
04/22	24.00	0.00	85	0	579	1	23	0	0	0	3	0	85	23	3
04/23	10.00	14.00	29	1	180	1	32	0	0	0	3	1	29	32	3
04/24	10.00	14.00	37	0	222	2	41	0	0	0	3	4	37	40	3
04/25	24.00	0.00	118	4	1,832	0	77	0	0	0	10	7	118	77	10
04/26	6.75	17.25	18	1	23	0	73	0	0	0	9	3	18	72	9
04/27	3.50	20.50	14	1	10	1	76	0	0	0	12	1	14	74	12
04/28	24.00	0.00	104	2	1,132	3	202	0	0	0	27	1	104	197	26
04/29	10.00	14.00	41	0	13	3	125	0	0	0	9	0	41	123	9
04/30	10.00	14.00	32	2	18	4	92	0	0	0	5	1	32	90	3

Table continued on next page

Appendix B: Total daily catches, by species and age, in the Skagit River mainstem screw trap, 2005 (cont'd).

Date	HOURS		CHINOOK		Chum	COHO		Pink	Sock	TROUT			Unmarked		
	Fished	Out	0+	1+		0+	1+			Parr	Sthd	Cutt	Chin0	Coho1	Sthd1
05/01	24.00	0.00	42	4	62	1	96	0	0	0	10	1	42	92	8
05/02	9.50	14.50	27	1	19	4	71	0	0	0	7	1	27	68	4
05/03	9.58	14.42	40	0	75	11	70	0	0	0	4	0	40	69	0
05/04	23.58	0.42	36	1	116	8	86	0	1	0	12	1	36	85	4
05/05	9.50	14.50	22	1	35	4	82	0	0	0	17	5	22	81	2
05/06	9.00	15.00	29	0	74	4	138	0	0	0	18	5	29	108	8
05/07	24.00	0.00	55	1	140	7	199	0	0	0	12	5	55	137	8
05/08	9.25	14.75	15	0	19	1	60	0	0	0	4	3	15	50	1
05/09	9.00	15.00	14	0	8	1	34	0	0	0	4	1	14	33	2
05/10	24.00	0.00	39	0	93	3	103	0	0	0	7	3	39	97	2
05/11	9.50	14.50	54	2	85	6	203	0	0	0	14	6	54	192	10
05/12	24.00	0.00	79	1	142	6	175	0	0	0	18	5	79	166	15
05/13	9.25	14.75	48	0	27	2	94	0	1	0	7	4	48	90	4
05/14	9.25	14.75	32	0	33	1	66	0	0	0	4	3	32	63	3
05/15	9.00	15.00	47	1	57	1	76	0	0	0	5	6	47	73	4
05/16	24.00	0.00	455	8	1,656	7	296	0	0	0	62	15	455	278	41
05/17	9.00	15.00	100	8	35	2	202	0	0	0	53	3	100	191	31
05/18	9.00	15.00	61	0	5	1	75	0	0	0	6	4	61	71	3
05/19	24.00	0.00	150	0	78	2	90	0	0	0	11	6	150	83	2
05/20	9.00	15.00	89	1	7	1	83	0	0	0	13	6	89	78	3
05/21	8.75	15.25	42	0	6	0	72	0	0	0	12	5	42	67	2
05/22	24.00	0.00	68	0	54	2	87	0	0	0	10	7	68	80	3
05/23	8.75	15.25	25	0	3	1	45	0	0	0	10	5	25	42	2
05/24	8.75	15.25	24	0	1	0	34	0	0	0	7	5	24	33	0
05/25	8.50	15.50	19	0	1	1	38	0	0	0	7	8	19	37	3
05/26	24.00	0.00	15	0	8	0	45	0	0	0	6	10	15	43	2
05/27	8.25	15.75	10	0	6	0	51	0	1	1	3	8	10	49	1
05/28	8.25	15.75	20	0	6	1	36	0	0	1	2	3	18	34	1
05/29	24.00	0.00	78	0	41	1	55	0	0	0	5	10	67	54	2
05/30	8.25	15.75	68	0	9	1	62	0	0	0	3	8	53	60	2
05/31	8.25	15.75	74	0	4	1	43	0	0	0	1	6	51	42	1
06/01	24.00	0.00	120	0	27	1	25	0	0	0	0	5	84	25	0
06/02	8.25	15.75	68	0	8	1	15	0	0	0	0	3	48	15	0
06/03	8.25	15.75	29	0	7	0	12	0	0	0	0	2	18	11	0
06/04	24.00	0.00	37	0	1	0	12	0	0	0	0	5	25	10	0
06/05	8.25	15.75	34	0	2	1	8	0	0	0	0	4	26	8	0
06/06	8.25	15.75	34	0	2	1	12	0	0	0	0	2	24	11	0
06/07	24.00	0.00	41	0	1	0	12	0	0	0	0	5	30	10	0
06/08	8.00	16.00	57	0	3	1	12	0	0	0	0	4	37	6	0
06/09	8.00	16.00	76	0	5	0	24	0	0	0	1	3	35	6	1
06/10	24.00	0.00	62	0	10	1	20	0	0	0	0	6	34	11	0
06/11	8.00	16.00	29	0	2	2	6	0	0	0	0	1	20	2	0
06/12	8.00	16.00	29	0	1	1	8	0	0	0	0	2	23	3	0
06/13	24.00	0.00	42	0	1	0	16	0	0	0	0	4	32	9	0
06/14	8.00	16.00	34	0	1	1	10	0	0	0	0	0	26	3	0
06/15	7.75	16.25	12	0	2	1	9	0	0	1	0	0	7	2	0

Table continued on next page

Appendix B: Total daily catches, by species and age, in the Skagit River mainstem screw trap, 2005 (cont'd).

Date	HOURS		CHINOOK		Chum	COHO		Pink	Sock	TROUT			Unmarked		
	Fished	Out	0+	1+		0+	1+			Parr	Sthd	Cutt	Chin0	Coho1	Sthd1
06/16	24.00	0.00	17	0	5	0	8	0	0	0	0	2	11	1	0
06/17	8.00	16.00	15	0	5	1	5	0	0	0	0	1	10	0	0
06/18	8.00	16.00	12	0	2	1	5	0	0	0	0	1	10	2	0
06/19	23.58	0.42	8	0	2	0	6	0	0	0	0	1	4	3	0
06/20	8.00	16.00	14	0	0	0	6	0	0	0	0	2	7	2	0
06/21	8.00	16.00	14	0	1	0	4	0	0	0	0	2	8	2	0
06/22	23.75	0.25	21	0	1	0	2	0	0	0	0	1	14	2	0
06/23	8.00	16.00	28	0	1	1	2	0	0	0	0	0	18	1	0
06/24	8.00	16.00	21	0	0	1	0	0	0	0	0	1	13	0	0
06/25	24.00	0.00	24	0	0	1	1	0	0	0	0	2	13	0	0
06/26	8.00	16.00	6	0	0	0	1	0	0	0	0	1	6	1	0
06/27	8.00	16.00	6	0	0	0	0	0	0	0	0	1	5	0	0
06/28	24.00	0.00	7	0	1	1	0	0	0	0	0	0	6	0	0
06/29	8.25	15.75	6	0	1	6	1	0	0	0	0	0	5	0	0
06/30	8.25	15.75	4	0	0	10	0	0	0	0	0	0	3	0	0
07/01	8.25	15.75	6	0	0	7	0	0	0	0	0	1	4	0	0
07/02	24.00	0.00	9	0	0	8	1	0	0	1	0	1	6	1	0
07/03	8.50	15.50	2	0	0	9	0	0	0	1	0	1	2	0	0
07/04	5.50	18.50	3	0	0	3	0	0	0	0	0	1	2	0	0
07/05	2.50	21.50	1	0	0	1	0	0	0	0	0	0	0	0	0
07/06	23.67	0.33	13	1	0	2	0	0	0	0	0	1	9	0	0
07/07	8.25	15.75	51	1	0	4	1	0	0	0	0	2	33	1	0
07/08	8.25	15.75	74	0	1	6	0	0	0	0	0	2	46	0	0
07/09	15.75	8.25	62	0	0	6	1	0	0	0	0	0	50	1	0
07/10	8.25	15.75	34	0	1	8	1	0	0	0	0	0	23	1	0
07/11	8.50	15.50	21	0	0	4	0	0	0	0	0	1	18	0	0
07/12	8.25	15.75	2	0	0	2	0	0	0	0	0	1	2	0	0
07/13	24.00	0.00	2	0	0	3	0	0	0	0	0	1	2	0	0
07/14	8.00	16.00	0	0	0	1	0	0	0	0	0	0	0	0	0
07/15	24.00	0.00	2	0	0	0	0	0	0	0	0	0	2	0	0
07/16	6.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0
07/18	2.75	0.00	1	0	0	0	0	0	0	0	0	0	1	0	0
07/19	24.00	0.00	2	0	0	0	0	0	0	0	0	0	1	0	0
07/20	6.00	0.00	1	0	0	0	0	0	0	0	0	0	1	0	0
07/22	3.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0
07/23	24.00	0.00	0	0	0	2	0	0	0	0	0	0	0	0	0
07/24	6.00	18.00	1	0	0	1	0	0	0	0	0	0	1	0	0
07/25	6.50	14.50	0	0	0	0	0	0	0	0	0	0	0	0	0
	2,574.92	1,750.50	34,910	81	34,087	420	4,040	18	5	13	472	279	34,470	3,709	289

Note: The unmarked coho 1+ does not include fish marked at Mannser Creek or Baker Dam.