STATE OF WASHINGTON
DEPARTMENT OF FISH AND WILDLIFE

Annual Project Report

2000 Skagit River
Wild 0+ Chinook Production Evaluation

Funded by Seattle City Light

Dave Seiler
Steve Neuhauser
Lori Kishimoto

April 2001

Table of Contents

List of Tables

List of Figures

Acknowledgments

Evaluation of the wild 0+ chinook production from the Skagit River in 2000 was made possible with funding from Seattle City Light. This fourth year of such support, combined with funds from the Dingle-Johnson/Wallop-Breaux program and matched with Washington Department of Fish & Wildlife funds, enabled the *Wild Salmon Production & Survival Evaluation* unit to trap downstream migrants in the lower Skagit River from mid-January through early-September.

We acknowledge the contributions of field staff of the National Park Service who installed, operated and maintained traps to capture, enumerate, and mark wild coho in the upper Skagit Basin. We also appreciate the contributions of a number 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; Burlington Northern continued to allow us to anchor the traps 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 Dave Collins, Jim Repoz, Scott McGrath, Mat Gillum, Paul Lorenz, Bruce Brown, and Dean Toba worked long hours operating and maintaining the traps, and enumerating and sampling catches. Special thanks to unit biologists: Mike Ackley and Pete Topping, who provided valuable logistical support during trap installation and removal; Mark Hino, who developed the computer database and programs which analyzed much of the trap data contained in this report; and Greg Volkhardt and Laurie Peterson, for their timely and thorough review.

2000 Skagit River Wild 0+ Chinook Production Evaluation

Introduction

Skagit River chinook returns (spring and summer/fall combined) have steadily declined over the last fifty years (*PSSSRG* 1992)(*PSSSRG* 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, in 1995, resource managers formed the Skagit River Chinook work group. 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 factors of decline 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 monitoring this stock's population over time 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, Federal agencies (NMFS, USFWS, USFS, and NPS), and the Skagit Tribes 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 2000 downstream migrant trapping project in the Skagit River which, with funding from the NCC, we conducted the fourth year of expanded monitoring of wild juvenile chinook production.

Understanding the major sources of interannual 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 excluded. 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 interannual 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, 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 2000 was in its eleventh year, involves trapping and marking wild coho smolts emigrating from a number of tributaries, and sampling a portion of the entire population via floating traps in the lower mainstem (R.M. 17, Burlington Northern

railroad bridge). In addition, we continued to evaluate returns of coho adults coded-wire tagged as smolts at the gulper in Baker Lake. The upstream migrant trap below the dam provides a reliable accounting of all salmon returning to this system. Applying the marine survival estimated from the tag-based estimates of harvest and escapement to respective estimates of total system wild coho smolt production yields estimates of adult recruits, escapement, and harvest for the entire Skagit River system (*Seiler et al.*1995).

Although our trapping in the mainstem was initially directed at coho smolts, we identify and enumerate all fish captured. For the first seven years (1990-1996), season total 0+ chinook catches in the one scoop trap have varied six-fold, from 1,700 to 10,500 chinook. (As of 1993, we have simultaneously operated both a scoop and a screw trap.) In addition to abundance, these catch totals are influenced by fishing effort (the time fished on each date and for the season), migration timing relative to the interval we trapped, and instantaneous trap efficiency. Many such variables as discharge, water velocity, turbidity, debris, channel configuration, trap placement, and fish size combine to affect instantaneous trap efficiency.

Preliminary expansion of these 0+ chinook catches, based on the season average recapture rates of wild coho and several other assumptions held consistent between years, has yielded chinook production estimates that range from 0.5 to 6.4 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 even sex ratio and a fecundity of 5,500 eggs/female. This relationship indicates that overall egg-to-migrant survival for Skagit River chinook has varied over ten-fold within just these ten broods, primarily as a function of flow during egg incubation.

In 1997, with funding from Seattle City Light, we began trapping in mid-February and continued into September. This season of extended trapping produced our first insight into the migration timing of wild chinook over nearly the entire migration interval. For the season, we estimated 4.5 million 0+ chinook.

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 selected tributaries located throughout the basin;
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 (CV<5%) and (we believe) unbiased production estimates, because a representative portion of the coho smolt population is marked at the tributary traps. 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 population 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-programed 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. In addition to fish size and behavior, susceptibility of migrants to capture also varies as a function of flow and environmental conditions in effect upstream of the trap and at the trap.

Operating downstream migrant traps over an extended period in the dynamic environment of the lower mainstem of a large river is challenging when conditions are optimal. During the spring runoff, however, as flows and debris levels exceed some threshold, it becomes impossible. Above a certain discharge, capture efficiency is generally some negative function of flow. When the traps are inoperable, however, it is zero. For these periods, migration has to be estimated by interpolation. Such estimates are biased if smolt migration rates are affected by flow changes, which we believe they are.

Calibrating the traps in the lower Skagit River with wild chinook caught in the traps is not feasible; catches within a sufficiently narrow time strata are simply too low. While hatchery chinook offer the potential of sufficient release group sizes on some broods, the requisite assumptions that they survive, distribute vertically and laterally, behave, and consequently, are caught at the same rate as wild chinook, are unverifiable and therefore, problematic as well.

Sources of Variation Affecting Wild 0+ chinook Estimates

Given the foregoing problems, estimating wild juvenile 0+ chinook production from the trapping data we have collected in the lower Skagit River involves a number of assumptions. Accuracy of the resultant estimates are 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 discharge.

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 15-40 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 turbidity. If true, this results either from increased migration rate and/or from 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 previous years was conducted almost entirely at night, when we capture coho smolts.

4. **Migration interval**. Skagit River 0+ chinook emigrate over a wider season than coho smolts. Chinook begin their downstream migration in January or earlier, and continue through the summer. In most years, we operated the traps over the coho smolt migration period, early-April through mid-June. Beginning in 1994, and continuing through 1996, we extended trapping longer, 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 and 1999, we began trapping in mid-January

and extended trapping into September. In 1999 and 2000 we attempted to assess fall 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 both 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 2000

The study plan for the 2000 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 eight years, the 2000 work plan included the following six operational elements.

1. **Trapping season**. A critical uncertainty in estimating Skagit River wild 0+ chinook production is their emigration timing. In 2000 we began trapping in mid-January and continued through mid-August, with intermittent sampling in September and October. We operated the screw trap one night in mid-September and over five days in October before removing the traps from the river on October 27.

2. **Nightly trap operation**. Nightly trapping with both the scoop trap and screw trap was continued throughout the season.

3. **Daytime trap operation**. Daytime trapping occurred every third day. We enumerated catches shortly after dawn and around dusk to enable separating day and night catches.

4. **Right and left ventral-marking**. To continue assessing a potential bias in our coho smolt production estimates, we continued differential fin-marking. As in 1999, we marked the smolts captured at Mannser Creek with a partial right ventral (RV) fin-clip. The National Park Service (NPS) continued marking the coho smolts they trapped in several upper tributaries with an LV-mark

5. **Trap efficiency**. In addition to the marked wild coho released from the tributary traps and the groups of hatchery fingerlings released from the two production facilities, we marked and released above the trap four groups of hatchery chinook, and four groups of dye-marked pink and chum fry.

6. **Measuring visibility**. To better understand the influence of water clarity on migration behavior, we measured visibility each day over the 2000 season. Visibility data will be correlated with flow and fish catch data.

Methods

Trapping Gear and Operation

We installed two floating downstream migrant traps in the lower Skagit River (R.M. 17) on January 15. With the permission of Burlington Northern, we attached the four anchor lines to the bridge support structures. The traps were positioned side by side in the zone of highest water velocity, which is just south of the southernmost pier, approximately 70 ft from the south bank. Velocity at this site varies as a function of discharge. At low flows it averages around 5 fps, and increases to around 7 fps at high flows.

Two trap types were used: a floating inclined-plane screen trap (scoop trap), (*Seiler et al.* 1981) and a screw trap (*Busack et al.* 1991). Both traps are contained in steel pontoon barges, outfitted with two five-ton bow-mounted anchor winches loaded with up to 600 ft of ⅜ 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 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 fished every night and every third day unless flows and associated debris loads were excessive. All captured fish were enumerated by species and age and examined for appropriate external marks. Samples of wild chinook were measured (fork length) over the season.

Environmental Parameters

In addition to fish counts for intervals trapped, we also measured water temperature. Turbidity was measured daily using a standard secchi disk. Mean daily flow data was provided by the USGS gauge at Mount Vernon.

Estimating Migration

Estimating migration for any period, whether 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 visibility data. These correlations were employed to project 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.

Equation #1: Basic formulas

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

where: M = migration
C = catch
e = trap efficiency

To assess catch rates of wild coho smolts and wild and hatchery 0+ chinook for light and dark periods, we selected sunrise and sunset as the strata breaks. For each trap, we sorted through the trapping interval database to select daytime fishing periods which were preceded and followed by night fishing intervals. Catch rates from the nights before and after the day fished were averaged to account for changing migration rates. Catch data were standardized by time fished in each interval and expressed as fish/hour rates. We used only respective day:night (d:n) intervals which had at least one fish captured during night intervals. Only respective d:n intervals which had at least one fish captured in the night were included in the analysis. The ratio of day catch rate-to-night catch rate (d:n) was used to indicate relative catch rates as a function of daylight (Equation #2). We also computed season average d:n catch ratios (Equation #3).

Equation #2: Comparing day catch rates to night catch rates:

$$R_i = C_{h_{di}} \div \frac{C_{ni\&1} \% C_{ni}}{h_{ni\&1} \% h_{ni}}$$

where:
- i = 24-hour period (from sunrise to sunrise)
- R_i = ratio of day to night catch rates for period i
- $C_{h(di)}$ = catch/hour during daylight for period i
- C_{ni-1} = catch during night before period i
- C_{ni} = catch during night for period i
- h_{ni-1} = hours fished the night before period i
- h_{ni} = hours fished during the night for period i

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

$$PR_i = \frac{ER_i}{n}$$

where:
- n = total number of comparisons over the season

Catch data were expanded to the standard of continuous trapping. Catches during the day light intervals that we did not fish were estimated from night catches and the d:n ratio correlations with the environmental parameter that best explained variation in d:n catch ratios.
An estimate of instantaneous capture rate for both day and night intervals as a function of flow would be optimal. As discussed above, however, this may not be feasible with chinook. We have several indicators of trap efficiency in 2000: recaptures of the wild coho marked at the tributary traps over the season; recaptures of the groups of fin-marked hatchery chinook that we released, recoveries of the hatchery chinook fingerlings released from Skagit Hatchery, Countyline Ponds, and Baker River; and recoveries of the pink and chum fry dye-mark groups. While the hatchery chinook are the same species and age, because they may behave significantly different than wild fish, their capture rate may not represent that of wild chinook. In addition, because the mortality and residualism of hatchery chinook between release and passing the trap is unknown, but probably significant, the resultant unadjusted estimates of capture rate are biased low. While wild coho are a different species, age, and somewhat larger size, because they are actively migrating smolts released over an extended period, their recaptures may actually represent season average trap efficiency for wild chinook better than the hatchery chinook groups.

We released the four groups of fin-marked chinook and two groups of dye-marked pink and chum fry approximately one mile upstream of the traps. Each of these groups were released evenly across the river, from a skiff, via buckets, with the exception of the last chinook group.

To project recapture rates for both hatchery chinook and the marked wild coho to the standard of continuous trapping, we expanded mark recoveries with the process described above. Recaptures

of ad-marked chinook were complicated by the release of three different groups/stocks with the same external mark. Countyline Ponds summer chinook, released in mid-May, were not sacrificed, as they were the only ad-marked chinook in the river until the release of the Skagit Hatchery zero-age chinook on June 2. Following the second release, 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.

Results

Trap Operation and Flow

Trapping began on the night of January 15, with both the scoop and the screw trap. Nearly every night and every third day was fished with each trap through mid-August. We stopped fishing the scoop trap on the morning of August 19. Over this 216-day interval, we fished the scoop trap throughout 205 nights and 62 days, and missed only one night (June 12) before July 19. The other ten nights that were not fished occurred in late-July and August, when catches were extremely low. The screw trap fished a similar schedule, but we operated the trap on several more days through the morning of October 27. We elected to leave the traps in the river in an attempt to assess migration during the period of increasing flow in the fall. Because flows did not increase (Fall 2000 was extremely dry), we only fished the screw trap three nights and three days during October. For the season, the scoop and screw traps were operated a combined total of 6,158.2 hours (Table 1).

Flow is the dominant factor affecting downstream migrant trapping operations in any system. This is particularly true in the lower Skagit River because of the quantity of large woody debris this system transports during rising and high flows. Daily mean flows during trap operation (January through August) varied from lows around 10,000 cfs to a peak of 37,000 cfs in June, before declining through the summer (Figure 1). Flows during the 2000 season were very similar to those of the previous two years through May. From June through the summer, the 2000 flows were intermediate to the 1998 and 1999 flow levels.

Catch

Chinook fry were already moving downstream when we began trapping in mid-January, although catch rates were low. Over the first three nights of trapping, the scoop and screw traps captured an average of just over 1 chinook fry/hour. Catches varied throughout the month, and by the last three nights of January, the traps were averaging just over 3 chinook fry/hour. The highest nightly average catch rates of wild chinook (95 and 57 fish/hour in the scoop and screw traps, respectively), occurred on the night of March 3. Wild 0+ chinook catch rates fluctuated over the season but generally declined beginning in late-March. By late-July, wild chinook catch rates averaged less than 1 fish/hour.

Day-to-day variation in wild chinook catch rates was nearly identical between traps (Figure 2). As this figure shows raw catch, some of the day-to-day variation results from fishing during daylight hours every third day. The scoop trap, however, consistently out-fished the screw trap, accounting for 60% of the combined wild chinook catch. The hatchery 0+ chinook catch includes 365 fin-marked chinook recovered from the four calibration groups that we released above the traps.

We captured a total of 28,310 wild coho smolts. This catch, the highest on record, is more than 5,000 fish higher than the previous high catch of 22,955 wild coho smolts in 1998 (Table 2).

Pink fry were the most abundant migrant captured, followed by chum. Season catches of pink and chum totaled 405,545, and 79,842, respectively. While the pink fry catch was nearly as high as the record catch (440,858 fry in 1998), the chum catch was a record high for even years. The previous high even-year chum catch (55,660 fry) also occurred in 1998 (Table 2).

Day:Night Catch Ratios

We compared wild 0+ chinook catch rates during daylight hours to respective nighttime catch rates for the scoop trap on 61 days and the screw trap on 63 days (Tables 3a-b). Day:night catch rate ratios varied from zero to over 190% in the scoop trap, and up to 170% in the screw trap. For the season, mean d:n catch rate ratios were 32% and 48% for the scoop and screw traps, respectively. These rates are similar to those observed in the previous two seasons in which flows were also moderate but lower than the high d:n ratios (80%) measured in 1997 when flows were very high.

Over the dates that we computed d:n ratios, flows ranged three-fold (9,480 cfs to 28,400 cfs). Regression analysis determined that flow explained around 32% of the variation in d:n ratios in the scoop trap and only 15% in the screw trap (Figure 3).

Analysis of d:n catch ratios for hatchery 0+ chinook (26 for the scoop and 21 for the screw trap) were limited by release timing and low abundance (Tables 4a and 4b). On average, hatchery chinook were caught at lower rates during daylight hours than wild chinook. Overall, d:n ratios for hatchery chinook averaged 26% in the scoop trap and 27% in the screw trap. As with wild chinook, d:n ratios for hatchery chinook indicated similar weak positive correlations with flows (Figure 4). Hatchery 0+ chinook d:n ratios tracked wild ratios, indicating that these fish responded to the same stimuli as wild migrants (Figure 5).

D:N catch ratios for wild coho smolts averaged 8% in the scoop trap and 3% in the screw trap (Tables 5a-b). We restricted the analysis of d:n catch ratios to the main coho migration period (April through June). Flows during the coho migration which varied just over two-fold, explained around half of the variation in d:n ratios for wild coho (Figures 6 and 7). During the 1997 season (when flows were considerably higher), the relationship between d:n ratios and flow

indicated that relatively few coho would be caught during the daytime at flows <20,000 cfs. This finding is consistent with our results in the last three seasons in which flows were lower.

Visibility

We measured visibility from January 19 through August 18. Visibility values ranged over the season between 42 and 350 cm. Day-to-day variation rarely exceeded a factor of two. Visibility generally decreased through mid-June, and then generally increased through August. Monthly averages ranged from a high of 240 cm in February, to 112 cm in June (Table 6). Over the season, flow explained a significant portion (65%) of the daily variation (Figure 8).

We correlated d:n catch ratios for wild chinook 0+ with the daily visibility data through the trapping season and found that daytime migration rates were negatively correlated with visibility, though, as with flow, the relationships were weak (Figure 9). Visibility data explained 31% and 26% of the variation in d:n catch ratios for the scoop and screw traps, respectively.

Wild Coho Smolt Production Evaluation

Over the season, we captured 407 RV-marked smolts from the 22,201 wild coho that we trapped, marked and released at Mannser Creek. We caught 124 LV-marked smolts from the 14,393 coho smolts that the NPS marked and released from their traps on three streams in the upper basin (County Line Ponds, Park Sloughs 1 and 2, and Zander Creek). Mannser Creek smolts were captured at a rate of 1.83%, over twice the rate (0.86%) of the smolts trapped and marked from the upper basin streams. This discrepancy is half of that measured in 1999, when we caught Mannser Creek smolts at a rate of 1.24%, nearly four times higher than the rate (0.34%) of smolts marked in the upper basin tributaries.

Prior to the 1999 season, all wild coho marked at the tributary smolt traps were identified with a LV-mark. In 1997, we began to have reservations about the assumption that all marked wild coho, regardless of where in the system they originated, survived to pass the mainstem traps. In this year, we estimated the highest odd-year production thus far observed. After estimating a record even-year production in 1998 of 1.7 million wild coho, we developed and implemented the study plan to assess the veracity of this critical assumption. While there is no way to measure actual survival, we can assess relative rates between the two mark groups.

The data collected over these last two seasons indicate that smolts marked at tributaries in the upper basin survived at significantly lower rates than those marked at Mannser Creek. We have identified several factors that likely contributed to this survival difference.

1. **Migration distance**. Smolts marked at the upper tributaries in 2000, migrated about 50 miles further than the Mannser Creek smolts. While in-river survival is certainly some function of migration distance, a mortality rate of 50% for wild coho smolts migrating just 50 miles seems too high.

2. **Coho size at marking**. In the higher elevation cold water habitats trapped by the NPS, a number of the coho marked were very small.

3. **Marking non-migratory coho**. Marking commenced in February, yet we did not recover the first LV-marked smolt until April 23.

Across the three streams trapped in the upper basin, the coho averaged just 79 mm and ranged down to 46 mm. Upon recapture in the mainstem traps, LV-marked smolts were significantly larger (Kolmogorov-Smirnov test, p= 0.05), averaging 87 mm. This difference may result from size-related survival rates and/or growth between marking and recovery. However, marked fish which reared for some interval rather than migrating would also have been subjected to mortality. Under some threshold size, a high proportion of small coho may remain in the stream for another year before migrating. Some of these small coho may also have been fry of the year and therefore also did not emigrate. In comparison, the Mannser Creek smolts, which averaged 94 mm at marking, showed no significant difference (93 mm) at recapture. Mannser Creek smolts were also significantly larger than unmarked wild coho caught in the mainstem traps, which averaged 87 mm.

Given the lower recovery rate of smolts marked in the upper basin, we elected to exclude this group from the coho smolt estimate. Relating the season catch of 407 RV-marked smolts from Mannser Creek to the total wild coho catch of 28,310 smolt estimates their incidence at 1.44%. Total production is estimated at 1,541,000 wild coho smolts (CV= 4.87%) (Table 7).

Capture Rate Indicators

Wild coho

Projecting night catches of RV-marked wild coho smolts on the basis of season average wild coho d:n catch ratios, estimates we would have caught 12 and 1 additional marked smolts in the scoop and screw traps, respectively, had we operated both traps continuously. Relating the sum of actual and projected catches (420) to the 22,201 wild coho smolts marked at Mannser Creek (18 miles above the mainstem traps), estimates the season average combined scoop and screw trap capture rate at 1.9%. This estimate assumes that all of the RV-marked wild coho smolts survived and passed the scoop and screw traps during the season. If any marked smolts failed to pass the traps, then this estimate is biased low. For example, at survival rates of 90% and 80%, the combined trap recovery rate increases to 2.1% and 2.4%, respectively.

Fin-marked hatchery 0+ chinook

We released groups of ad-marked hatchery spring chinook on four evenings, from May 8 to June 1. Recoveries of these groups, most of which occurred on the release night but continued up to three days following release, varied from 1.8% to 5.7% (Table 8). The first three groups were released using our standard protocol: scatter-planting from buckets as we idled a skiff across the river channel. On the last group, we released the majority of the group at one location towards the left bank from the center of the river. This group was recovered at a rate of 5.7%, twice the average of the other three groups.

Recovery rates of the three groups which were not biased by release location were inversely correlated with flows, which ranged from 13,500 cfs to 21,500 cfs (Figure 10). Because flows varied during the recapture interval, for this correlation we computed mean flow from 15-minute measurements (USGS data) over the interval from release to daylight the following morning. Migration rates past the traps, as indicated by the proportional recovery of marked smolts at time, were positively correlated with flows (Figures11a-c). The capture rate for these three groups averaged 2.8%.

Hatchery 0+ chinook production groups

Over the season, we caught 4,706 ad-marked hatchery 0+ chinook: 2,554 in the scoop trap and 2,152 in the screw trap (Table 2). These totals include the 365 marked fry (195 and 170 in the scoop and screw trap, respectively) recovered from the 10,193 Skagit Hatchery spring chinook that we released in four groups to calibrate the trap, as described above.

Three different stocks of hatchery-produced chinook 0+ fingerlings occurred at different locations and dates in Spring 2000:

1. May 15 through 20, the volitional release of 194,584 summers from Countyline Ponds;
2. June 2, Skagit Hatchery released 254,920 springs;
3. July 2, Skagit Hatchery released 31,619 falls into the Baker River.

All hatchery chinook were ad-marked and coded-wire tagged. Consequently, estimating our catch of each group required recovering tags. On June 3, the evening that the second group of hatchery chinook first arrived at the trap, we began sampling ad-marked smolts for tag recovery. Through August 3, we sacrificed 177 ad-marked chinook and recovered 175 tags (Table 9).

Applying tag recovery results to the sum of actual and projected catches of hatchery chinook, estimates combined trap catches of 3,062 summer, 2,686 spring, and 25 fall chinook (Table 10). Relating these catches to the numbers released, yields capture rates of 1.6%, 1%, and 0.1%, respectively. These rates underestimate trap efficiency for hatchery fingerlings because no adjustment was made for mortality or residualism.

Chum and pink fry

Because large numbers of wild pink and chum fry were available, we dye-marked (bismark brown) and released two groups of pink and chum fry. On March 31 at 1940 hrs, we released the first group of 3,566 dye-marked pink and 611 chum fry. By the following morning, we had recovered 16 pinks and 9 chum (0.4% and 1.5%, respectively) from this mark group. The second release on April 19, totaled 4,008 pinks and 227 chum fry. Of these, we recovered 26 pinks and 2 chum (0.6% and 0.9%, respectively) by the following morning (Table 8).

Wild 0+ Chinook Estimates

Catch projection
Expansion of catch rates for the intervals not fished estimates an additional 5,462 and 5,497 wild 0+ chinook in the scoop and screw traps, respectively. Combined with the actual catches (23,289 and 14,943), these projections estimate that had we fished continuously from January 18 through September 11, we would have caught around 49,000 wild 0+ chinook in the two traps (Table 11). Actual catches comprise 78% of the total estimated catches.

Production
Applying the average capture rate (2.8%) of the three groups of fin-marked 0+ chinook we released above the traps to the projected catch of 49,000 chinook, yields an estimate of 1.7 million fry and fingerlings.

Migration timing
We caught wild 0+ chinook on the first night of trap operation (January 15), indicating that the migration was under way before we began trapping. Based on the low initial catches, however, we believe that relatively few chinook fry had passed the trap before we started. Similarly, extremely low catches beginning in mid-August indicated the chinook migration was virtually over. While catch data exhibited considerable day to day variation, the months of March, April, May, and June accounted for 70% of the season total migration (Figures 12 and 13). The median migration date in 2000 (March 23) occurred fifteen days later than we estimated in 1999 (March 8), and about one week earlier than the median dates estimated in 1997 and 1998 (April 30 and May 2, respectively).

Hatchery Chinook Migration Timing

Ad-marked hatchery 0+ chinook groups were released at three sites in the Skagit River basin; summer chinook from the Countyline acclimation ponds (RM 87), spring chinook from Skagit Hatchery (RM 70), and fall chinook transported to the Baker River (RM 56). Recoveries of the first two groups began within three days of the release and exhibited similar timing. Half of the projected recoveries of the summer chinook were captured by May 28, fourteen days after release. The spring chinook migrated faster: half were recovered within three days of release (Figure 14). Although the fall chinook released into the Baker River first arrived on the release day, we estimate that only 25 fry were recovered. With a recapture rate of less than 0.1%, little can be inferred about this group's emigration timing.

Wild 0+ Chinook Size

Over the season, wild 0+ chinook captured in the traps increased in size from an average around 40 mm through the end of March, to around 90 mm by early-August (Table 12, Figure 15). The lower end of the weekly size range did not exceed 40 mm until early-June, indicating protracted

emergence and/or slow growth for a component of the population. No difference in size at time between traps was evident (Figure 16).

Egg-to-Migrant Survival

Relating our estimate of 1.7 million chinook to a potential deposition of 13.4 million eggs, results in an average survival-to-migration of 12.7%. This estimate of potential egg deposition (P.E.D.) is the product of 2,428 females and a fecundity of 5,500 eggs/female (Table 13).

Assumptions

Every estimate relies on assumptions. Although we know that trap efficiency is not constant, because we presently have no flow-based correlation model to indicate its variation, we selected a value, indicated by the recapture rates of several groups of marked chinook, to represent a season average rate. Therefore, the overall assumption is that catch is a relatively constant fraction of abundance, that averages this rate. Component assumptions for estimating the numbers of wild 0+ chinook migrating from the Skagit River follow.

1. **Catch expansion**. Because we fished almost every night, expansion of catch up to the standard of continuous trap operation involved primarily estimating catch for the daytime periods that we did not fish. We assumed that the seasonal d:n catch ratio applied to night catches provides an unbiased estimate of the number of fish that we would have caught had the traps fished each day.

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.
    a. Basic assumptions for every trap calibration group of marked fish include:
        1) The number passing the gear is known (survival from release to the trap is 100%);
        2) All marked fish captured are identified and enumerated.
    b. Marked hatchery chinook were captured at the same rate as wild 0+ chinook.
    c. Instantaneous trap efficiency is not a function of light.

Discussion of Assumptions

Although direct assessment of these 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 0+ chinook production from the Skagit River follows.

Assumption #1: catch projection
We have no reason to believe that the catch projections 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 0+ chinook we would have caught in both traps had we fished continuously from mid-January to early-September.

Assumption #2a1: 100% survival of calibration fish
It is unlikely that all of the calibration fish in each group survived to pass the trap. However, the short distance of about 1 mile, and condensed recovery time should contribute to high survival to the traps. Overall recoveries for the three hatchery release groups averaged 1.2%, less than half the recovery rate for the calibration fish (2.8%), indicating that less than half the hatchery-produced chinook survived to migrate past the traps.

Assumption # 2a2: complete identification/enumeration of all marked fish captured
We are confident that virtually every marked fish captured was identified and recorded. The 2000 trap crew was comprised of experienced Scientific Technicians dedicated to collecting the highest quality data. Consequently, we don't consider this potential bias to be significant.

Assumption # 2b: marked hatchery chinook were captured at the same rate as wild chinook
The degree to which the hatchery chinook represented wild 0+ chinook is unknown. The similarity in d:n ratios over the season (Figure 5) provides some evidence that hatchery fish are responding to the river conditions in a manner similar to that of the wild chinook. Presently, we do not have any indication that hatchery produced 0+ chinook are caught at higher or lower rates than wild chinook.

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

Conclusion
We conclude that the critical assumption for producing unbiased estimates of wild 0+ chinook production is how well hatchery fish represent their wild cohorts in every aspect that affect capture rate. Based on this assumption, we believe that the number of wild 0+ chinook passing the traps in the Skagit River in 2000 is in the range of 1.4 to 2.0 million fish (± 0.3 million).

Relating our projected catch of 49,000 wild chinook to these estimates yields season average capture rates of 3.8% to 2.5%.

Discussion

Unlike 1997, moderate flows throughout the last three seasons (1998-2000) allowed almost continuous trapping. As a result, this fourth year of extended trapping provided another measure of the "shape" of the 0+ chinook migration from the Skagit River. Despite the differences in flow, timing of our migration estimates were very similar between 1997 and 1998. However, the 1999 and 2000 migration timing was earlier than the two previous years (Figure 17). The influence of flow on migration timing may become more evident by comparing results from subsequent seasons which will include a range of flow patterns. It is important to remember that these estimates are based on catch and the assumption of constant trap efficiency within each season.

Trap efficiency is the link between catch and production. The accuracy of all of our within-season estimates and interannual comparisons depend on the veracity of each season's estimate of this most critical parameter. In 1998, 1999, and 2000, we conducted several test releases in an attempt to improve our understanding of capture rates. Recovery rates of the eleven chinook calibration groups have been variable over the years, ranging from 0.7% to 3.5%. In contrast, recovery rates of the on-station releases of hatchery chinook over the four years have varied by less than 50% (1.2% to 1.7%). This outcome indicates that seasonal variation in trap efficiency for these large groups is relatively low. In 2000, these fish were caught at two thirds the rate of the wild fin-marked coho smolts released from the tributary traps (1.2% vs 1.8%). This ratio is similar to that observed in the previous three years.

In-river mortality is, among other variables, a function of the migration distance. Therefore, release location affects capture rate. This and release timing are also the likely explanations for at least some of the differences between the recovery rates for the Countyline Ponds, Skagit Hatchery production, Baker River releases, and the calibration fish released approximately one mile upstream of the traps.

Improving our estimates of 0+ chinook production from the Skagit River largely depends on calibrating the traps for a range of conditions. Instantaneous trap efficiency is not constant over the season; it varies as a function of flow, velocity, turbidity, light, water temperature (possibly), and fish size. Flow is undoubtedly the most important variable because it integrates other physical parameters which affect fish behavior and trap operation. At the site we have placed the traps, velocity is a positive function of flow, as evidenced by the rotational speed of the screw trap. Even for a given discharge, however, velocity and flow vectors can be altered by large woody debris upstream of the railroad bridge, and locally at the trap site. Turbidity also appears to be an important parameter that affects the rate that chinook migrate during the day, their vertical and lateral locations in the channel, and their ability to avoid the gear. Using hatchery

fish to represent the responses of wild fish to the complex interactions of these variables with fish size, their physiological status, and the traps may present incalculable biases. Despite these uncertainties, because the numbers of wild fish captured at any one time are inadequate for trap calibration, releasing groups of marked hatchery 0+ chinook offer the only option other than the wild marked-coho we release over the entire season.

Flow during egg incubation has explained most of the interannual variation in our estimates of egg-to-migrant survival rates (Figure 18). For the first seven broods in which trapping was limited to the coho migration interval (April-June), we estimated chinook migration based on assumptions regarding their migration duration and timing. Now that we have estimated zero-age chinook migration over the last four years, we are re-evaluating these assumptions. This analysis includes correlating interannual variation in timing, relative to such variables as abundance and flow.

Recommendations

The following recommendations, taken from previous reports, are listed here so that an accounting of the progress we made implementing them in the 2000 season can be assessed. 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 the extended season trapping over a sufficient span of years and flow conditions to gain an understanding of the interannual variation in migration timing.
2. Count catches at or near sunrise and sunset to increase the data base for day:night catch comparisons.
3. Measure turbidity and assess the correlation with flow.
4. Increase the numbers of release groups (2,000/group) of marked hatchery 0+ chinook and continue to assess the feasibility of using these fish to calibrate the traps.
5. Engage a biometrician to optimize sampling design and analytical methods, assess assumptions, and compute variance estimates.

Progress in 2000

1. **Accomplished**. Aided by moderate flows, we trapped each night from January 15 through mid-July. After this date we fished the traps on a schedule operating the gear through mid-August. We continued to operate the traps for periods in September and October to assess chinook migration in these months.
2. **Accomplished**. On most dates over the season, we counted catches near dusk and dawn.

3. **Accomplished**. We collected turbidity data throughout the 1998, 1999, and 2000 seasons.
4. **Accomplished**. As documented in this report, we released three groups of marked chinook, and four groups of dye-marked pink and chum fry.
5. **In progress**. With funding from Seattle City Light, WDFW has contracted a biometrician to review the basic assumptions and the associated production estimation methods.

Recommendations for 2001

Our study plan for the 2001 season includes continuing all of the above recommendations. We will continue to collect turbidity data to and assess the relationship of flow, visibility, and migration rates. Also, we will increase the number of marked hatchery chinook 0+ (2000/groups) to assess recapture rates at various flow levels.

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

Year	Gear Type	TRAPPING INTERVAL[a]										
		Date		Season Total Days	Number of Days Fished					Hours		
					Nighttime		Daytime		Trap Out	Total	Trapped	Percent Fished
		Start	End		Full	Partial	Full	Partial				
1990[b]	Scr/Scp	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	26	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%

[a] Trapping intervals are defined as follows: "Full Nighttime" is from dusk to dawn; "Partial Nighttime" is a sub-interval of time between dusk and

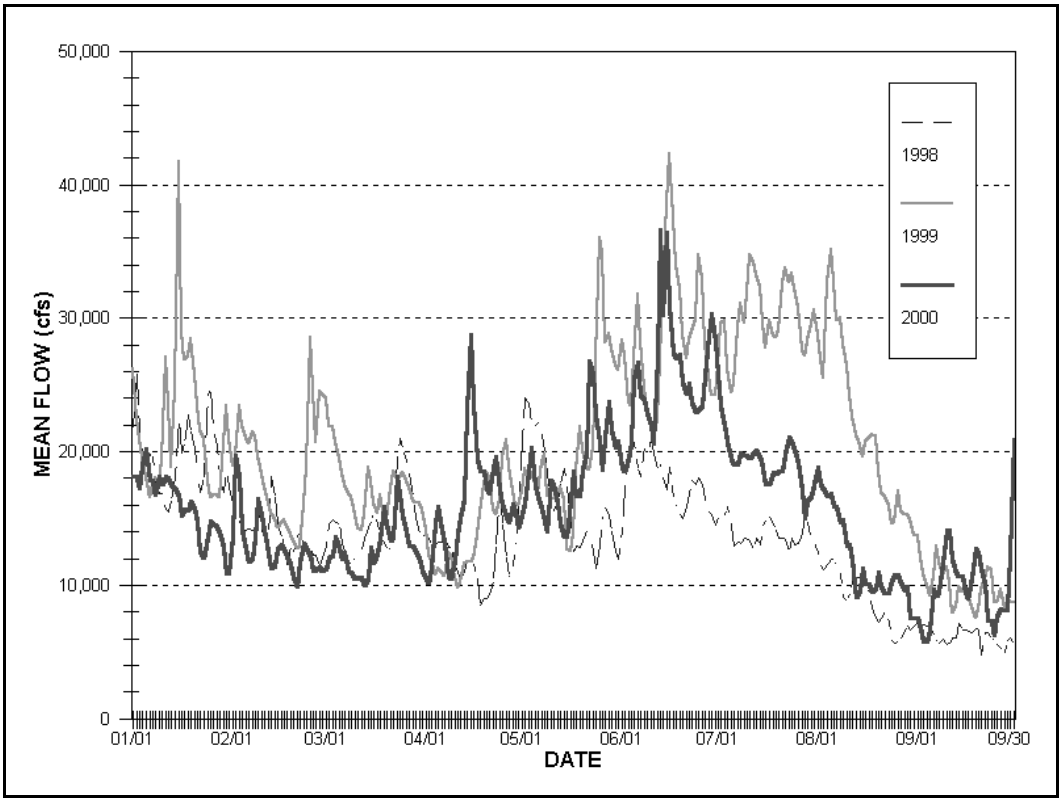

Figure 1. Comparison of daily mean flows in 1998, 1999, and 2000 (January through September), Skagit River near Mt. Vernon.

dawn; “Full Daytime” is from dawn to dusk; and “Partial Daytime” is a sub-interval of time between dawn and dusk.

[b] In 1990, we initially started trapping with a screw trap, but because of mechanical problems, replaced it with a scoop trap on May 7.

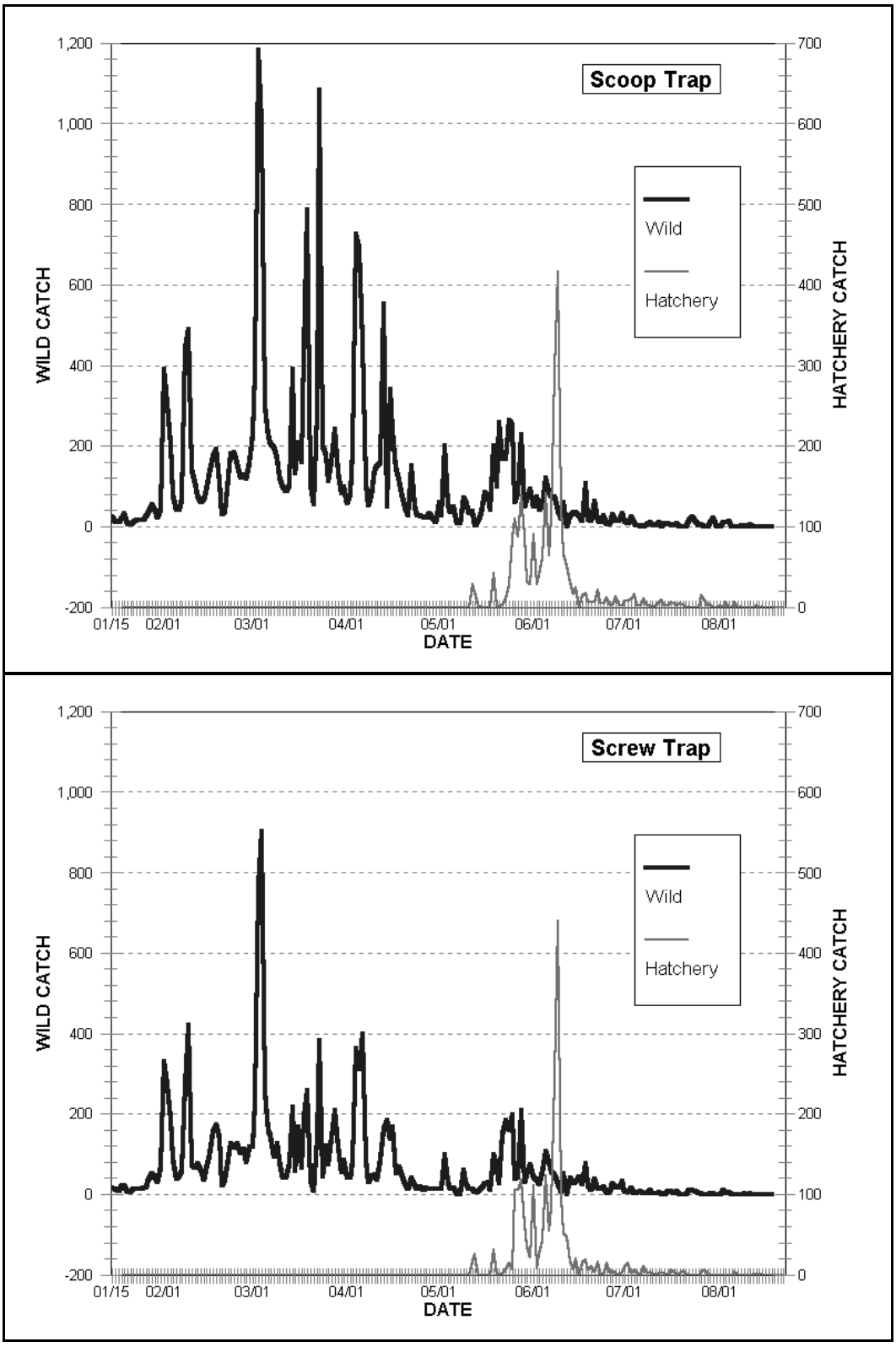

Figure 2. Wild and hatchery 0+ chinook catches, Skagit River mainstem traps, 2000.

Table 2. Downstream migrant salmonids captured in the Skagit River mainstem scoop and screw traps, all years.

Species/age	1990 Scoop	1991 Scoop	1992 Scoop	1993		1994		1995		1996		1997		1998		1999		2000	
				Scoop	Screw	Scoop	Screw	Scoop	Screw	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	8,861	8,824	11,520	9,134	6,437	5,975	13,879	9,076	4,904	3,314	13,449	14,861
Hatchery	234	382	596	[a]714	[a]723	1,880	1,873	4,800	5,274	973	1,208	334	362	623	1,028	673	635	624	946
Coho 0+	48	22	64	79	4	57	5	204	57	246	50	364	220	1,216	409	744	311	115	27
Chinook 1+ Wild	[b]45	[b]1,132	[b]299	[b]3,567	[b]262	308	212	184	112	80	32	46	52	876	350	198	87	129	105
Hatchery								1,754	570	415	117	376	249	24	12	201	41	511	360
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	33,698	20,001	55,254	41,492	23,289	14,943
Hatchery						2,320	1,098	6,083	2,022	4,165	2,888	1,163	684	5,837	2,127	3,449[g]	2,213[g]	2,554	2,152
Sockeye 1+	2	21	2	32	16	106	45	31	17	36	56	59	48	111	84	72	23	9	11
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	37,162	18,498	172,774	108,730	39,608	40,234
Pink 0+	697	0	18,682	0	0	48,532	22,952	0	0	27,482	9,778	9	17	338,520	102,338	476	265	207,530	198,015
Steelhead 1+ Wild	198	301	332	304	663	601	1,297	532	1,184	364	778	319	531	389	1,100	99	334	95	597
Hatchery	223	66	124	658	2,381	670	3,107	1,282	4,579	751	1,751	982	2,401	446	2,325	122	511	75	736
Stthd adult	0	0	0	0	0	0	0	4	1	1	0	3	4	1	3	11	1	1	2
Cutthroat 1+	117	60	153	45	91	198	437	107	263	165	332	58	89	98	401	30	150	51	248
Cutthroat adult	0	0	0	0	0	0	0	1	0	0	2	2	13	2	5	4	0	0	7
Dolly Varden	130	112	132	76	74	197	255	189	179	142	102	65	77	153	206	101	98	109	138
Trout parr	N/A	N/A	N/A	12	7	47	69	56	47	110	68	40	61	90	83	42	57	116	155

[a] Estimated by proportion of total catch.
[b] Includes both hatchery and wild.
[c] 1989 brood released from Clark Creek = 1,728,100: Fall = 1,170,800 Samish stock + 236,600 Clark Creek stock, released on June 8, 1990; and Summer = 73,800 + 246,900 Clark Creek stock released on June 28, 1990.
[d] Clark Creek stock released on June 18, 1991: 1,144,500 Fall and 111,120 Summer.
[e] Clark Creek stock: 786,100 Fall, released February 25, 1992; 483,280 Summer, released April 20, 1992; and 120,000 released May 21, 1992.
[f] Clark Creek stock: 1,588,800 Fall released in February 1993, and 250,000 Fall released on March 16, 1993; and 160,000 Summer released on May 16, 1993.
[g]

Table 3a. Summary of catch rates of wild 0+ chinook during day and night periods, Skagit River mainstem scoop trap, 2000.

NIGHT INTERVAL				TOTAL NIGHT			DAY INTERVAL			TOTAL DAY			Diff	Ratio	Flow
Trap Down		Trap Up		Hours	Catch	Catch/	Date	Time		Hours	Catch	Catch/	(D-N)	(D/N)	(cfs)
Date	Time	Date	Time	Fished		Hour		Down	Up	Fished		Hour			
01/18	17.25	01/20	8.00	29.50	52	1.76	01/19	8.17	17.00	8.83	1	0.11	-1.65	6.42%	16,300
01/21	17.25	01/23	8.50	29.83	13	0.44	01/22	8.17	17.25	9.08	2	0.22	-0.22	50.54%	12,500
01/24	17.50	01/26	8.25	29.50	33	1.12	01/25	8.50	17.00	8.50	1	0.12	-1.00	10.52%	14,800
01/27	17.50	01/29	8.25	29.25	81	2.77	01/28	8.17	17.33	9.16	12	1.31	-1.46	47.31%	13,900
01/30	18.08	02/01	8.00	28.25	63	2.23	01/31	8.17	17.50	9.33	3	0.32	-1.91	14.42%	11,000
02/02	17.50	02/04	8.00	28.58	394	13.79	02/03	8.00	17.58	9.58	116	12.11	-1.68	87.83%	18,100
02/05	17.50	02/07	8.00	28.25	76	2.69	02/06	7.75	17.50	9.75	9	0.92	-1.77	34.31%	11,800
02/08	18.00	02/10	8.00	27.50	799	29.05	02/09	8.00	18.00	10.00	135	13.50	-15.55	46.46%	16,500
02/11	18.00	02/13	7.83	27.25	160	5.87	02/12	8.00	18.00	10.00	26	2.60	-3.27	44.28%	12,500
02/14	18.00	02/16	7.25	26.50	154	5.81	02/15	7.67	18.00	10.33	7	0.68	-5.13	11.66%	12,700
02/17	18.25	02/19	7.75	26.58	334	12.57	02/18	7.50	18.00	10.50	34	3.24	-9.33	25.77%	12,300
02/20	18.00	02/22	7.25	26.58	68	2.56	02/21	7.75	18.00	10.25	2	0.20	-2.36	7.63%	9,880
02/23	18.00	02/25	7.50	26.08	346	13.27	02/24	7.25	18.25	11.00	18	1.64	-11.63	12.33%	12,700
02/26	18.50	02/28	7.00	25.16	227	9.02	02/27	7.50	18.50	11.00	25	2.27	-6.75	25.19%	11,200
02/29	18.50	03/02	7.25	25.58	384	15.01	03/01	7.50	18.25	10.75	9	0.84	-14.17	5.58%	11,300
03/03	18.50	03/05	7.25	24.83	1,837	73.98	03/04	7.17	18.67	11.50	346	30.09	-43.90	40.67%	13,600
03/06	18.58	03/08	7.00	25.25	364	14.42	03/07	7.42	18.25	10.83	66	6.09	-8.32	42.27%	12,400
03/09	18.58	03/11	7.50	25.25	272	10.77	03/10	7.25	18.75	11.50	22	1.91	-8.86	17.76%	10,500
03/12	18.75	03/14	7.17	24.83	184	7.41	03/13	7.58	18.67	11.09	6	0.54	-6.87	7.30%	9,950
03/15	18.50	03/17	7.00	25.67	273	10.63	03/16	7.83	18.25	10.42	67	6.43	-4.21	60.46%	11,700
03/18	18.75	03/20	7.25	25.25	1,088	43.09	03/19	8.00	18.75	10.75	131	12.19	-30.90	28.28%	15,900
03/21	19.00	03/23	6.00	23.42	331	14.13	03/22	7.42	18.50	11.08	6	0.54	-13.59	3.83%	13,600
03/24	19.00	03/26	7.00	24.00	334	13.92	03/25	7.75	19.25	11.50	46	4.00	-9.92	28.74%	15,300
03/27	18.75	03/29	6.50	23.75	346	14.57	03/28	7.50	18.75	11.25	60	5.33	-9.24	36.61%	12,900
03/30	18.50	04/01	6.50	23.83	159	6.67	03/31	6.83	18.50	11.67	23	1.97	-4.70	29.54%	11,200
04/05	20.00	04/07	7.00	21.75	946	43.49	04/06	7.00	20.00	13.00	203	15.62	-27.88	35.90%	14,200
04/08	20.25	04/10	7.00	22.83	125	5.48	04/09	8.08	19.50	11.42	7	0.61	-4.86	11.20%	10,500
04/11	20.25	04/13	6.58	22.99	282	12.27	04/12	8.00	19.00	11.00	30	2.73	-9.54	22.23%	15,100
04/15	21.00	04/17	6.50	20.08	509	25.35	04/16	7.00	20.00	13.00	69	5.31	-20.04	20.94%	23,600
04/18	19.50	04/20	7.33	22.83	160	7.01	04/19	7.83	20.50	12.67	38	3.00	-4.01	42.79%	18,500
04/19	20.67	04/21	7.00	21.66	89	4.11	04/20	8.00	19.67	11.67	6	0.51	-3.59	12.51%	17,400
04/23	21.00	04/25	6.50	19.50	70	3.59	04/24	6.83	20.00	13.17	10	0.76	-2.83	21.15%	17,200
04/26	20.50	04/28	6.50	22.25	48	2.16	04/27	7.00	18.50	11.50	0	0.00	-2.16	0.00%	14,700
04/29	20.50	05/01	6.50	21.00	32	1.52	04/30	7.75	20.25	12.50	1	0.08	-1.44	5.25%	14,300
05/02	21.00	05/04	5.75	18.17	194	10.68	05/03	6.25	20.33	14.08	36	2.56	-8.12	23.95%	18,500
05/05	21.00	05/07	6.50	19.25	65	3.38	05/06	6.75	20.50	13.75	21	1.53	-1.85	45.23%	18,450
05/08	20.50	05/10	5.92	19.42	76	3.91	05/09	6.83	20.50	13.67	5	0.37	-3.55	9.35%	14,000
05/11	21.00	05/13	6.00	19.25	57	2.96	05/12	7.17	20.67	13.50	14	1.04	-1.92	35.02%	16,200
05/15	20.75	05/17	6.50	19.17	89	4.64	05/16	6.67	21.00	14.33	31	2.16	-2.48	46.60%	16,400
05/18	21.00	05/20	6.50	19.67	220	11.18	05/19	7.25	20.67	13.42	23	1.71	-9.47	15.32%	16,800
05/24	21.00	05/26	6.00	17.75	341	19.21	05/25	6.25	21.00	14.75	175	11.86	-7.35	61.76%	20,800
05/27	21.50	05/29	6.50	18.00	208	11.56	05/28	6.25	20.83	14.58	106	7.27	-4.29	62.92%	23,700
05/30	21.00	06/01	6.00	18.50	130	7.03	05/31	6.92	21.00	14.08	35	2.49	-4.54	35.37%	20,800
06/01	20.00	06/03	6.75	20.00	105	5.25	06/02	6.50	21.25	14.75	19	1.29	-3.96	24.54%	18,500
06/07	21.50	06/09	6.00	18.25	117	6.41	06/08	7.08	21.00	13.92	32	2.30	-4.11	35.86%	23,900
06/10	21.50	06/12	6.50	18.50	66	3.57	06/11	6.50	21.00	14.50	12	0.83	-2.74	23.20%	20,600
06/17	22.00	06/19	6.50	17.25	61	3.54	06/18	6.17	21.00	14.83	60	4.05	0.51	114.41%	27,000
06/20	21.75	06/22	6.75	17.75	39	2.20	06/21	6.75	21.75	15.00	38	2.53	0.34	115.30%	24,300
06/23	22.00	06/25	6.00	16.17	19	1.18	06/24	6.50	21.92	15.42	20	1.30	0.12	110.38%	23,000
06/26	22.00	06/28	6.00	16.33	27	1.65	06/27	6.25	21.50	15.25	9	0.59	-1.06	35.69%	25,600
06/29	22.00	07/01	5.00	15.75	18	1.14	06/30	6.50	21.75	15.25	32	2.10	0.96	183.61%	28,400
07/02	22.50	07/04	6.50	16.42	14	0.85	07/03	6.67	21.92	15.25	18	1.18	0.33	138.44%	22,000
07/05	22.00	07/07	6.50	16.75	6	0.36	07/06	6.50	21.75	15.25	1	0.07	-0.29	18.31%	19,000
07/08	22.00	07/10	6.00	16.25	16	0.98	07/09	6.25	21.50	15.25	1	0.07	-0.92	6.66%	19,700
07/11	22.00	07/13	7.00	17.66	5	0.28	07/12	7.00	21.83	14.83	8	0.54	0.26	190.53%	19,900
07/14	22.00	07/16	6.75	17.42	9	0.52	07/15	6.92	21.92	15.00	6	0.40	-0.12	77.42%	18,800
07/17	21.50	07/19	6.50	17.83	9	0.50	07/18	6.50	21.50	15.00	2	0.13	-0.37	26.41%	18,400
07/23	21.50	07/25	6.50	18.00	32	1.78	07/24	6.67	21.33	14.66	5	0.34	-1.44	19.18%	20,800
07/29	21.50	07/31	7.00	18.50	24	1.30	07/30	6.83	21.50	14.67	7	0.48	-0.82	36.78%	16,700
08/03	22.00	08/05	8.00	20.00	19	0.95	08/04	7.50	21.50	14.00	5	0.36	-0.59	37.59%	16,700
08/08	23.50	08/10	9.50	20.50	6	0.29	08/09	8.50	21.50	13.50	0	0.00	-0.29	0.00%	14,900
08/17	22.00	08/19	9.00	24.00	0	0.00	08/18	10.00	21.00	11.00	0	0.00	0.00	0.00%	9,480
TOTAL SEASON				1,343.87	12,605	9.38				762.07	2,258	2.96	-6.42	31.59%	16,600

Note: Trapping periods without nighttime catch were not included in the analysis.

Table 3b. Summary of catch rates of wild 0+ chinook during day and night periods, Skagit River mainstem screw trap, 2000.

NIGHT INTERVAL				TOTAL NIGHT			DAY INTERVAL			TOTAL DAY			Diff	Ratio	Flow
Trap Down		Trap Up		Hours	Catch	Catch/	Date	Time		Hours	Catch	Catch/	(D-N)	(D/N)	(cfs)
Date	Time	Date	Time	Fished		Hour		Down	Up	Fished		Hour			
01/18	17.25	01/20	8.08	29.33	39	1.33	01/19	8.25	17.25	9.00	4	0.44	-0.89	33.42%	16,300
01/21	17.25	01/23	8.50	30.00	18	0.60	01/22	8.17	17.42	9.25	4	0.43	-0.17	72.07%	12,500
01/24	17.50	01/26	8.00	29.00	30	1.03	01/25	8.50	17.00	8.50	1	0.12	-0.92	11.37%	14,800
01/27	17.25	01/29	8.00	29.33	77	2.63	01/28	8.25	17.50	9.25	14	1.51	-1.11	57.65%	13,900
01/30	18.00	02/01	8.00	28.50	94	3.30	01/31	8.17	17.67	9.50	6	0.63	-2.67	19.15%	11,000
02/02	17.50	02/04	8.00	28.25	343	12.14	02/03	7.92	17.67	9.75	116	11.90	-0.24	97.99%	18,100
02/05	17.50	02/07	7.75	28.50	80	2.81	02/06	8.00	17.75	9.75	7	0.72	-2.09	25.58%	11,800
02/08	18.00	02/10	8.00	27.75	555	20.00	02/09	8.00	18.25	10.25	138	13.46	-6.54	67.32%	16,500
02/11	18.00	02/13	7.83	27.50	118	4.29	02/12	7.75	18.00	10.25	25	2.44	-1.85	56.84%	12,500
02/14	18.00	02/16	7.50	26.75	91	3.40	02/15	7.75	18.17	10.42	9	0.86	-2.54	25.39%	12,700
02/17	18.25	02/19	7.75	26.75	302	11.29	02/18	7.50	18.25	10.75	26	2.42	-8.87	21.42%	12,300
02/20	18.00	02/22	7.25	26.67	60	2.25	02/21	7.75	18.00	10.25	2	0.20	-2.05	8.67%	9,880
02/23	18.00	02/25	7.50	26.25	222	8.46	02/24	7.17	18.42	11.25	18	1.60	-6.86	18.92%	12,700
02/26	18.50	02/28	7.00	25.33	203	8.01	02/27	7.50	18.67	11.17	12	1.07	-6.94	13.41%	11,200
02/29	18.50	03/02	7.25	25.67	225	8.77	03/01	7.42	18.25	10.83	11	1.02	-7.75	11.59%	11,300
03/03	18.50	03/05	7.25	26.58	1,234	46.43	03/04	7.83	18.00	10.17	433	42.58	-3.85	91.71%	13,600
03/06	18.50	03/08	7.00	25.42	242	9.52	03/07	7.25	18.33	11.08	61	5.51	-4.01	57.83%	12,400
03/09	18.58	03/11	7.75	25.84	197	7.62	03/10	7.50	18.50	11.00	11	1.00	-6.62	13.12%	10,500
03/12	18.50	03/14	7.17	25.34	112	4.42	03/13	7.25	18.58	11.33	9	0.79	-3.63	17.97%	9,950
03/15	18.50	03/17	7.00	24.58	137	5.57	03/16	7.00	18.92	11.92	89	7.47	1.89	133.96%	11,700
03/18	18.50	03/20	7.25	25.50	363	14.24	03/19	8.00	18.50	10.50	85	8.10	-6.14	56.87%	15,900
03/21	19.00	03/23	6.00	24.17	142	5.88	03/22	7.17	18.00	10.83	4	0.37	-5.51	6.29%	13,600
03/24	19.00	03/26	7.00	24.50	128	5.22	03/25	7.00	18.50	11.50	36	3.13	-2.09	59.92%	15,300
03/27	18.83	03/29	6.50	24.00	255	10.63	03/28	7.33	18.00	10.67	99	9.28	-1.35	87.33%	12,900
03/30	18.50	04/01	7.75	25.25	94	3.72	03/31	6.50	18.50	12.00	47	3.92	0.19	105.21%	11,200
04/02	20.00	04/04	6.83	22.58	122	5.40	04/03	7.50	19.75	12.25	4	0.33	-5.08	6.04%	11,400
04/05	20.00	04/07	7.00	23.00	448	19.48	04/06	7.00	18.75	11.75	261	22.21	2.73	114.04%	14,200
04/08	20.25	04/10	7.00	22.25	70	3.15	04/09	7.00	19.50	12.50	9	0.72	-2.43	22.89%	10,500
04/11	20.25	04/13	6.25	21.50	97	4.51	04/12	7.00	19.50	12.50	27	2.16	-2.35	47.88%	15,100
04/15	21.00	04/17	6.50	21.00	233	11.10	04/16	7.25	19.50	12.25	74	6.04	-5.05	54.45%	23,600
04/18	19.50	04/20	6.75	22.25	106	4.76	04/19	7.00	20.00	13.00	15	1.15	-3.61	24.22%	18,500
04/19	20.00	04/21	7.00	22.00	61	2.77	04/20	8.00	19.50	11.50	4	0.35	-2.42	12.54%	17,400
04/23	21.00	04/25	6.50	21.25	31	1.46	04/24	8.00	20.00	12.00	6	0.50	-0.96	34.27%	17,200
04/26	20.50	04/28	6.50	21.50	23	1.07	04/27	6.75	19.00	12.25	4	0.33	-0.74	30.52%	14,700
04/29	20.50	05/01	6.50	20.50	28	1.37	04/30	6.50	20.00	13.50	1	0.07	-1.29	5.42%	14,300
05/02	21.00	05/04	5.75	20.00	97	4.85	05/03	7.25	20.00	12.75	19	1.49	-3.36	30.73%	18,500
05/05	21.00	05/07	6.00	18.75	26	1.39	05/06	6.25	20.00	13.75	5	0.36	-1.02	26.22%	18,450
05/08	20.50	05/10	6.00	19.08	60	3.14	05/09	6.33	20.75	14.42	1	0.07	-3.08	2.21%	18,450
05/11	21.00	05/13	6.00	18.50	22	1.19	05/12	6.00	20.50	14.50	6	0.41	-0.78	34.80%	16,200
05/15	21.00	05/17	6.00	19.08	34	1.78	05/16	6.33	20.00	13.67	10	0.73	-1.05	41.05%	16,400
05/18	21.00	05/20	6.50	19.25	102	5.30	05/19	6.00	20.25	14.25	9	0.63	-4.67	11.92%	16,800
05/24	21.00	05/26	5.75	17.00	277	16.29	05/25	5.25	20.50	15.25	80	5.25	-11.05	32.20%	20,800
05/27	21.50	05/29	6.50	16.83	126	7.49	05/28	5.33	21.42	16.09	126	7.83	0.34	104.60%	23,700
05/30	21.00	06/01	6.00	18.50	95	5.14	05/31	6.00	20.50	14.50	31	2.14	-3.00	41.63%	20,800
06/01	20.00	06/03	6.50	19.75	59	2.99	06/02	7.00	21.75	14.75	21	1.42	-1.56	47.66%	18,500
06/07	21.50	06/09	6.00	18.17	88	4.84	06/08	6.50	20.83	14.33	19	1.33	-3.52	27.38%	23,900
06/10	21.50	06/12	6.50	18.50	51	2.76	06/11	6.50	21.00	14.50	8	0.55	-2.21	20.01%	20,600
06/17	22.00	06/19	6.50	17.50	48	2.74	06/18	6.50	21.50	15.00	54	3.60	0.86	131.25%	27,000
06/20	21.50	06/22	6.75	17.75	21	1.18	06/21	6.50	22.00	15.50	27	1.74	0.56	147.24%	24,300
06/23	22.00	06/25	6.00	16.75	23	1.37	06/24	6.50	21.75	15.25	10	0.66	-0.72	47.75%	23,000
06/26	22.00	06/28	6.00	17.25	24	1.39	06/27	6.50	21.25	14.75	9	0.61	-0.78	43.86%	25,600
06/29	22.00	07/01	6.00	17.00	20	1.18	06/30	6.50	21.50	15.00	30	2.00	0.82	170.00%	28,400
07/02	22.50	07/04	6.50	16.25	13	0.80	07/03	6.00	21.75	15.75	8	0.51	-0.29	63.49%	22,000
07/05	22.00	07/07	6.50	17.00	13	0.76	07/06	6.00	21.50	15.50	1	0.06	-0.70	8.44%	19,000
07/08	22.00	07/10	6.00	16.50	12	0.73	07/09	6.00	21.50	15.50	1	0.06	-0.66	8.87%	19,700
07/11	22.00	07/13	7.00	17.50	6	0.34	07/12	6.50	22.00	15.50	2	0.13	-0.21	37.63%	19,900
07/14	22.00	07/16	6.75	17.50	5	0.29	07/15	6.50	21.75	15.25	3	0.20	-0.09	68.85%	18,800
07/17	21.50	07/19	6.50	17.50	6	0.34	07/18	6.25	21.75	15.50	5	0.32	-0.02	94.09%	18,400
07/23	21.50	07/25	6.50	17.75	12	0.68	07/24	6.25	21.50	15.25	7	0.46	-0.22	67.90%	20,800
07/29	21.50	07/31	7.00	18.17	6	0.33	07/30	6.50	21.83	15.33	1	0.07	-0.26	19.75%	16,700
08/03	22.00	08/05	8.00	20.00	9	0.45	08/04	7.50	21.50	14.00	0	0.00	-0.45	0.00%	16,700
08/08	23.50	08/10	9.50	20.50	3	0.15	08/09	8.00	21.50	13.50	0	0.00	-0.15	0.00%	14,900
08/10	21.50	08/12	9.00	22.00	3	0.14	08/11	8.00	21.50	13.50	0	0.00	-0.14	0.00%	13,000
TOTAL SEASON				1,394.92	7,841	5.62				797.51	2,165	2.71	-2.91	48.29%	16,551

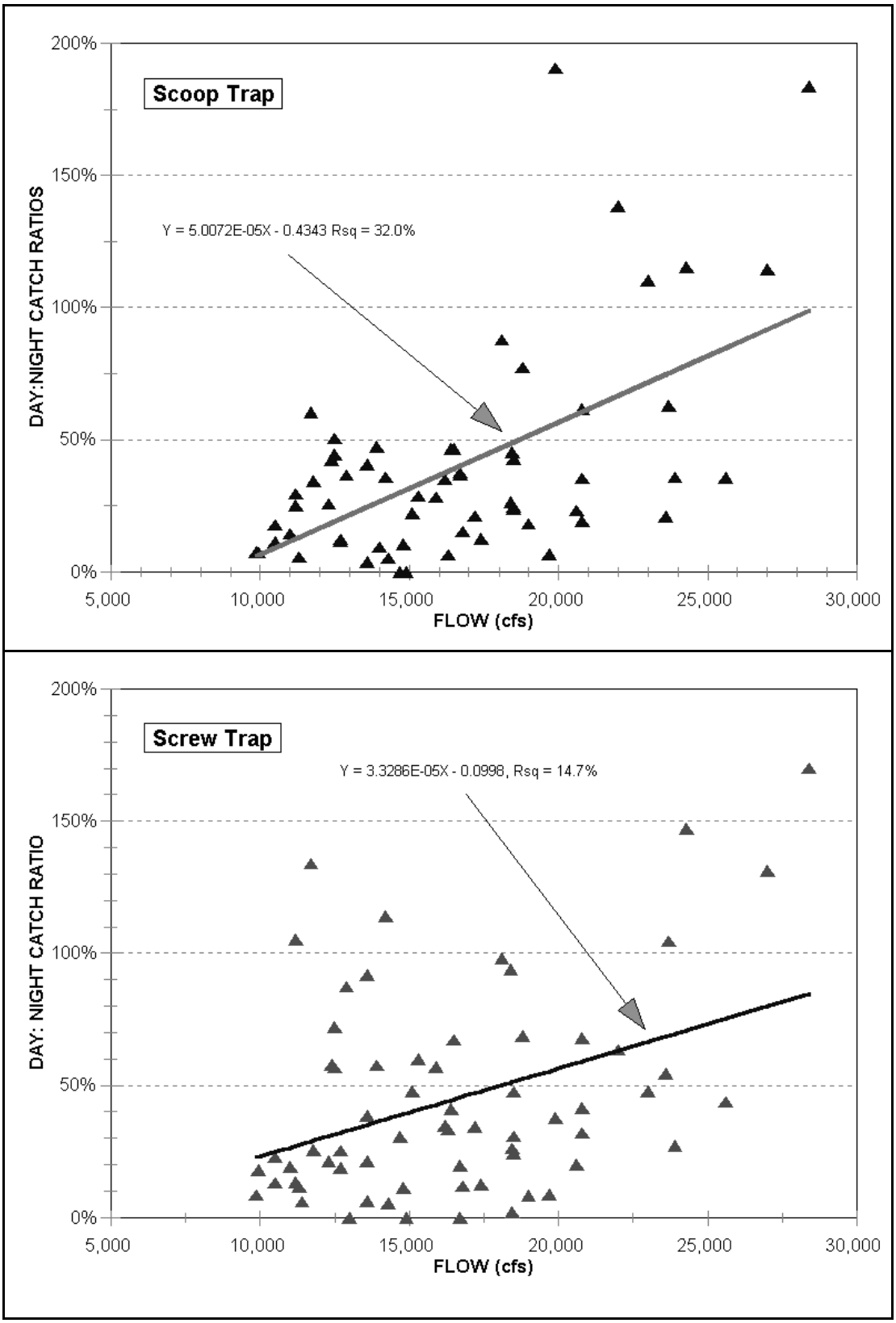

Figure 3. Day:night catch ratios for wild 0+ chinook and daily mean flow, Skagit River mainstem traps, 2000.

Table 4a. Summary of catch rates of hatchery 0+ chinook during day and night periods, Skagit River mainstem scoop trap, 2000.

NIGHT INTERVAL				TOTAL NIGHT			DAY INTERVAL			TOTAL DAY					
Trap Down		Trap Up		Hours Fished	Catch	Catch/ Hour	Date	Time		Hours Fished	Catch	Catch/ Hour	Diff (D-N)	Ratio (D/N)	Flow (cfs)
Date	Time	Date	Time					Down	Up						
05/08[a]	20.50	05/10	5.92	19.42	47	2.42	05/09	6.83	20.50	13.67	1	0.07	-2.35	3.02%	14,000
05/11[a]	21.00	05/13	6.00	19.25	0	0.00	05/12	7.17	20.67	13.50	0	0.00	0.00	0.00%	16,200
05/15[a]	20.75	05/17	6.50	19.17	43	2.24	05/16	6.67	21.00	14.33	1	0.07	-2.17	3.11%	16,400
05/18	21.00	05/20	6.50	19.67	13	0.66	05/19	7.25	20.67	13.42	1	0.07	-0.59	11.27%	16,800
05/24	21.00	05/26	6.00	17.75	195	10.99	05/25	6.25	21.00	14.75	34	2.31	-8.68	20.98%	20,800
05/27	21.50	05/29	6.50	18.00	78	4.33	05/28	6.25	20.83	14.58	41	2.81	-1.52	64.89%	23,700
05/30	21.00	06/01	6.00	18.50	85	4.59	05/31	6.92	21.00	14.08	18	1.28	-3.32	27.82%	20,800
06/01	20.00	06/03	6.75	20.00	198	9.90	06/02	6.50	21.25	14.75	7	0.47	-9.43	4.79%	18,500
06/07	21.50	06/09	6.00	18.25	105	5.75	06/08	7.08	21.00	13.92	12	0.86	-4.89	14.98%	23,900
06/10	21.50	06/12	6.50	18.50	34	1.84	06/11	6.50	21.00	14.50	6	0.41	-1.42	22.52%	20,600
06/17	22.00	06/19	6.50	17.25	14	0.81	06/18	6.17	21.00	14.83	14	0.94	0.13	116.32%	27,000
06/20	21.75	06/22	6.75	17.75	11	0.62	06/21	6.75	21.75	15.00	6	0.40	-0.22	64.55%	24,300
06/23	22.00	06/25	6.00	16.17	7	0.43	06/24	6.50	21.92	15.42	9	0.58	0.15	134.82%	23,000
06/26	22.00	06/28	6.00	16.33	9	0.55	06/27	6.25	21.50	15.25	2	0.13	-0.42	23.80%	25,600
06/29	22.00	07/01	5.00	15.75	13	0.83	06/30	6.50	21.75	15.25	13	0.85	0.03	103.28%	28,400
07/02	22.50	07/04	6.50	16.42	9	0.55	07/03	6.67	21.92	15.25	5	0.33	-0.22	59.82%	22,000
07/05	22.00	07/07	6.50	16.75	3	0.18	07/06	6.50	21.75	15.25	0	0.00	-0.18	0.00%	19,000
07/08	22.00	07/10	6.00	16.25	15	0.92	07/09	6.25	21.50	15.25	0	0.00	-0.92	0.00%	19,700
07/11	22.00	07/13	7.00	17.66	8	0.45	07/12	7.00	21.83	14.83	1	0.07	-0.39	14.89%	19,900
07/14	22.00	07/16	6.75	17.42	6	0.34	07/15	6.92	21.92	15.00	2	0.13	-0.21	38.71%	18,800
07/17	21.50	07/19	6.50	17.83	1	0.06	07/18	6.50	21.50	15.00	0	0.00	-0.06	0.00%	18,400
07/23	21.50	07/25	6.50	18.00	11	0.61	07/24	6.67	21.33	14.66	1	0.07	-0.54	11.16%	20,800
07/29	21.50	07/31	7.00	18.50	3	0.16	07/30	6.83	21.50	14.67	3	0.20	0.04	126.11%	16,700
08/03	22.00	08/05	8.00	20.00	1	0.05	08/04	7.50	21.50	14.00	0	0.00	-0.05	0.00%	16,700
08/08	23.50	08/10	9.50	20.50	3	0.15	08/09	8.00	21.50	13.50	0	0.00	-0.15	0.00%	14,900
08/17	22.00	08/19	9.00	24.00	0	0.00	08/18	10.00	21.00	11.00	0	0.00	0.00	0.00%	9,480
TOTAL SEASON				393.25	822	2.09				323.16	175	0.54	-1.55	25.91%	20,900

[a] Recoveries of the calibration groups on May 8-15 were not included in the d:n analysis, their migration timing is not representative of hatchery production groups.

[b] Trapping periods without nighttime catch were not included in the analysis.

Table 4b. Summary of catch rates of hatchery 0+ chinook during day and night periods, Skagit River mainstem screw trap, 2000.

NIGHT INTERVAL				TOTAL NIGHT			DAY INTERVAL			TOTAL DAY			Diff (D-N)	Ratio (D/N)	Flow (cfs)
Trap Down		Trap Up		Hours Fished	Catch	Catch/ Hour	Date	Time		Hours Fished	Catch	Catch/ Hour			
Date	Time	Date	Time					Down	Up						
05/08[a]	20.50	05/10	6.00	19.08	43	2.25	05/09	6.33	20.75	14.42	0	0.00	-2.25	0.00%	18,450
05/11[a]	21.00	05/13	6.00	18.50	0	0.00	05/12	6.00	20.50	14.50	0	0.00	0.00	0.00%	16,200
05/15[a]	21.00	05/17	6.00	19.08	31	1.62	05/16	6.33	20.00	13.67	1	0.00	-1.55	0.00%	16,400
05/18	21.00	05/20	6.50	19.25	9	0.47	05/19	6.00	20.25	14.25	1	0.07	-0.40	15.01%	16,800
05/24	21.00	05/26	5.75	17.00	167	9.82	05/25	5.25	20.50	15.25	14	0.92	-8.91	9.35%	20,800
05/27	21.50	05/29	6.50	16.83	51	3.03	05/28	5.33	21.42	16.09	81	5.03	2.00	166.13%	23,700
05/30	21.00	06/01	6.00	18.50	64	3.46	05/31	6.00	20.50	14.50	6	0.41	-3.05	11.96%	20,800
06/01	20.00	06/03	6.50	19.75	171	8.66	06/02	7.00	21.75	14.75	7	0.47	-8.18	5.48%	18,500
06/07	21.50	06/09	6.00	18.17	92	5.06	06/08	6.50	20.83	14.33	7	0.49	-4.57	9.65%	23,900
06/10	21.50	06/12	6.50	18.50	27	1.46	06/11	6.50	21.00	14.50	0	0.00	-1.46	0.00%	20,600
06/17	22.00	06/19	6.50	17.50	9	0.51	06/18	6.50	21.50	15.00	11	0.73	0.22	142.59%	27,000
06/20	21.50	06/22	6.75	17.75	8	0.45	06/21	6.50	22.00	15.50	7	0.45	0.00	100.20%	24,300
06/23	22.00	06/25	6.00	16.75	7	0.42	06/24	6.50	21.75	15.25	1	0.07	-0.35	15.69%	23,000
06/26	22.00	06/28	6.00	17.25	12	0.70	06/27	6.50	21.25	14.75	3	0.20	-0.49	29.24%	25,600
06/29	22.00	07/01	6.00	17.00	4	0.24	06/30	6.50	21.50	15.00	5	0.33	0.10	141.67%	28,400
07/02	22.50	07/04	6.50	16.25	6	0.37	07/03	6.00	21.75	15.75	4	0.25	-0.12	68.78%	22,000
07/05	22.00	07/07	6.50	17.00	7	0.41	07/06	6.00	21.50	15.50	0	0.00	-0.41	0.00%	19,000
07/08	22.00	07/10	6.00	16.50	6	0.36	07/09	6.00	21.50	15.50	0	0.00	-0.36	0.00%	19,700
07/11	22.00	07/13	7.00	17.50	4	0.23	07/12	6.50	22.00	15.50	4	0.26	0.03	112.90%	19,900
07/14	22.00	07/16	6.75	17.50	3	0.17	07/15	6.50	21.75	15.25	1	0.07	-0.11	38.25%	18,800
07/17	21.50	07/19	6.50	17.50	3	0.17	07/18	6.25	21.75	15.50	0	0.00	-0.17	0.00%	18,400
07/23	21.50	07/25	6.50	17.75	9	0.51	07/24	6.25	21.50	15.25	1	0.07	-0.44	12.93%	20,800
07/29[b]	21.50	07/31	7.00	18.17	0	0.00	07/30	6.50	21.83	15.33	0	0.00	0.00	0.00%	16,700
08/03[b]	22.00	08/05	8.00	20.00	0	0.00	08/04	7.50	21.50	14.00	0	0.00	0.00	0.00%	16,700
08/08[b]	23.50	08/10	9.50	20.50	0	0.00	08/09	8.00	21.50	13.50	0	0.00	0.00	0.00%	16,700
08/10[b]	21.50	08/12	9.00	22.00	0	0.00	08/11	8.00	21.50	13.50	0	0.00	0.00	0.00%	13,000
TOTAL SEASON				334.25	659	1.97				287.42	153	0.53	-1.44	27.00%	21,700

[a] Recoveries of the calibration groups on May 8-15 were not included in the d:n analysis, their migration timing is not representative of hatchery production groups.
[b] Trapping periods without nighttime catch were not included in the analysis.

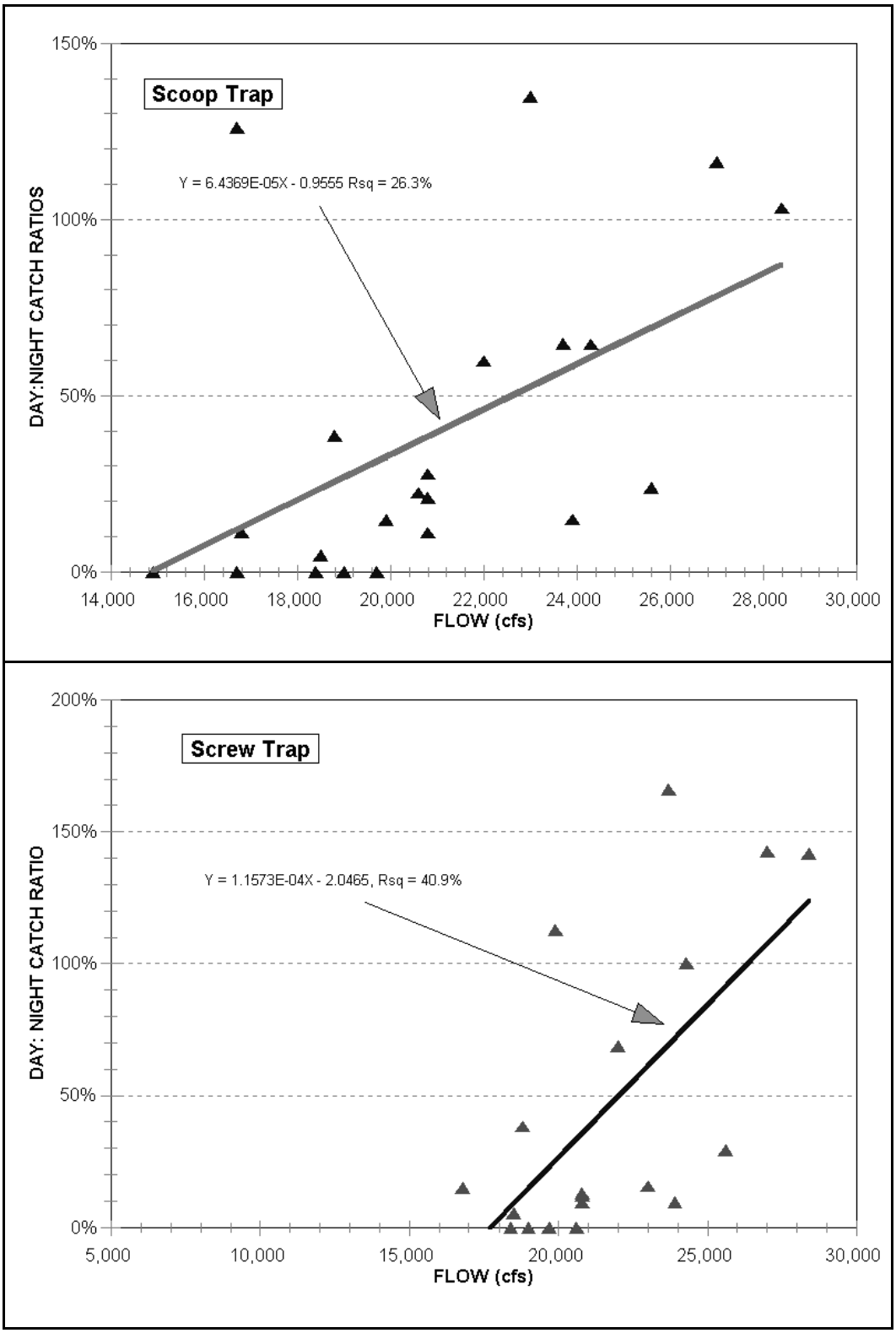

Figure 4. Day:night catch ratios for hatchery 0+ chinook and daily mean flow, Skagit River mainstem traps, 2000.

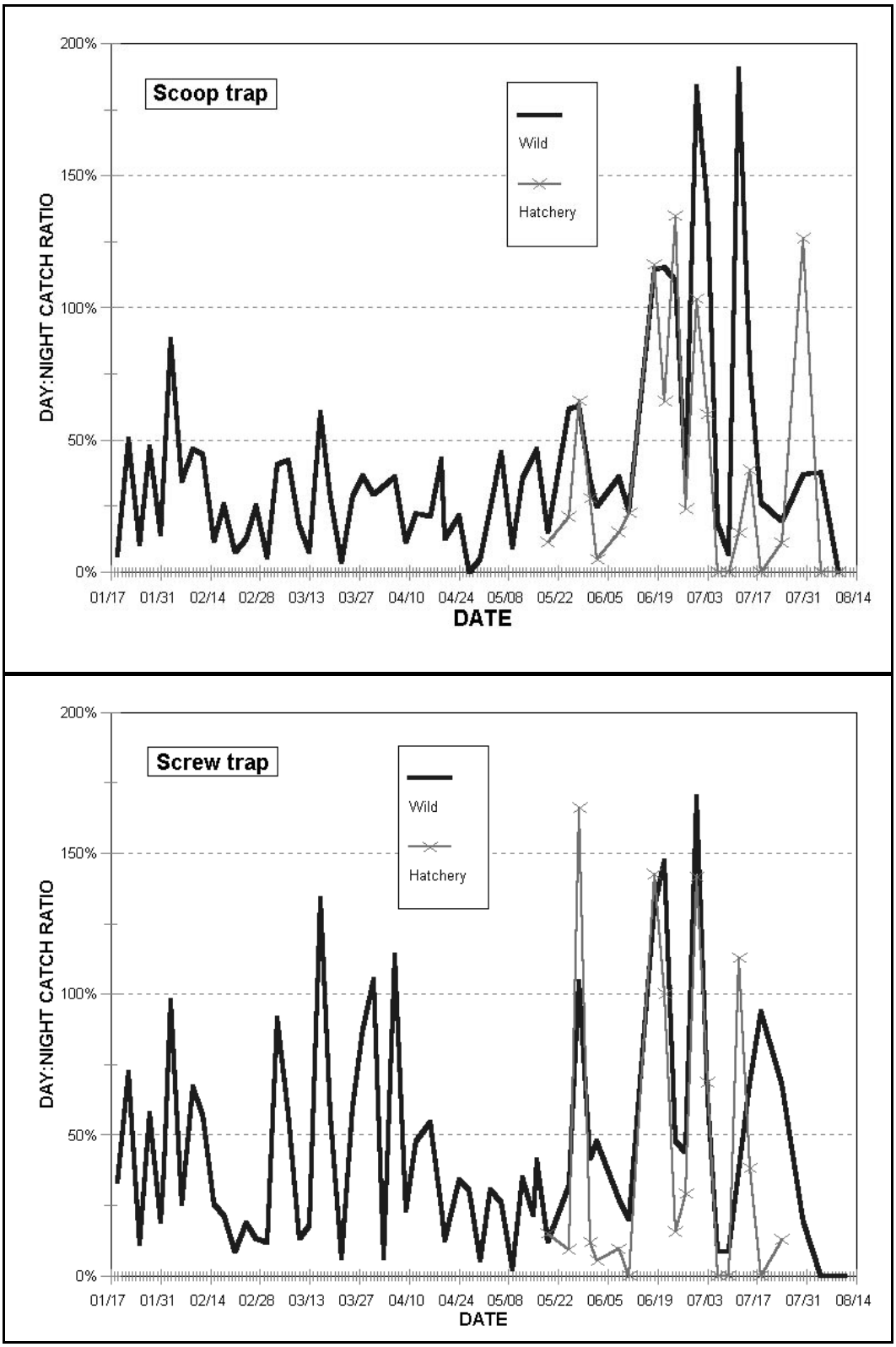

Figure 5. Comparison of day:night catch ratios for wild & hatchery 0+ chinook in the Skagit River mainstem scoop & screw traps, 2000.

Table 5a. Catch rates of wild coho smolts during day and night periods in the Skagit River mainstem scoop trap, 2000.

NIGHT INTERVAL				TOTAL NIGHT			DAY INTERVAL			TOTAL DAY			Diff	Ratio	Flow
Trap Down		Trap Up		Hours	Catch	Catch/	Date	Time		Hours	Catch	Catch/	(D-N)	(D/N)	(cfs)
Date	Time	Date	Time	Fished		Hour		Down	Up	Fished		Hour			
01/18	17.25	01/20	8.00	29.50	0	0.00	01/19	8.17	17.00	8.83	0	0.00	0.00	0.00%	16,300
01/21	17.25	01/23	8.50	29.83	0	0.00	01/22	8.17	17.25	9.08	0	0.00	0.00	0.00%	12,500
01/24	17.50	01/25	8.25	29.50	0	0.00	01/25	8.50	17.00	8.50	0	0.00	0.00	0.00%	14,800
01/27	17.50	01/29	8.25	29.25	0	0.00	01/28	8.17	17.33	9.16	0	0.00	0.00	0.00%	13,900
01/30	18.08	02/01	8.00	28.25	1	0.04	01/31	8.17	17.50	9.33	0	0.00	-0.04	0.00%	11,000
02/02	17.50	02/04	8.00	28.58	1	0.03	02/03	8.00	17.58	9.58	0	0.00	-0.03	0.00%	18,100
02/05	17.50	02/07	8.00	28.25	1	0.04	02/06	7.75	17.50	9.75	0	0.00	-0.03	0.00%	11,800
02/08	18.00	02/10	8.00	27.50	2	0.07	02/09	8.00	18.00	10.00	1	0.04	-0.04	50.00%	16,500
02/11	18.00	02/13	7.83	27.25	2	0.07	02/12	8.00	18.00	10.00	0	0.00	-0.07	0.00%	12,500
02/14	18.00	02/16	7.25	26.50	1	0.04	02/15	7.67	18.00	10.33	0	0.00	-0.04	0.00%	12,700
02/17	18.25	02/19	7.75	26.58	1	0.04	02/18	7.50	18.00	10.50	0	0.00	-0.04	0.00%	12,300
02/20	18.00	02/22	7.25	26.58	1	0.04	02/21	7.75	18.00	10.25	0	0.00	-0.04	0.00%	9,880
02/23	18.00	02/25	7.50	26.08	2	0.08	02/24	7.25	18.25	11.00	0	0.00	-0.08	0.00%	12,700
02/26	18.50	02/28	7.00	25.16	1	0.04	02/27	7.50	18.50	11.00	1	0.04	0.00	100.00%	11,200
02/29	18.50	03/02	7.25	25.58	5	0.20	03/01	7.50	18.25	10.75	1	0.04	-0.16	20.00%	11,300
03/03	18.50	03/05	7.25	24.83	4	0.16	03/04	7.17	18.67	11.50	2	0.08	-0.08	50.00%	13,600
03/06	18.58	03/08	7.00	25.25	2	0.08	03/07	7.42	18.25	10.83	0	0.00	-0.08	0.00%	12,400
03/09	18.58	03/11	7.50	25.25	2	0.08	03/10	7.25	18.75	11.50	0	0.00	-0.08	0.00%	10,500
03/12	18.75	03/14	7.17	24.83	5	0.20	03/13	7.58	18.67	11.09	0	0.00	-0.20	0.00%	9,950
03/15	18.50	03/17	7.00	25.67	11	0.43	03/16	7.83	18.25	10.42	0	0.00	-0.43	0.00%	11,700
03/18	18.75	03/20	7.25	25.25	18	0.71	03/19	8.00	18.75	10.75	0	0.00	-0.71	0.00%	15,900
03/21	19.00	03/23	6.00	23.42	7	0.30	03/22	7.42	18.50	11.08	0	0.00	-0.30	0.00%	13,600
03/24	19.00	03/26	7.00	24.00	7	0.29	03/25	7.75	19.25	11.50	0	0.00	-0.29	0.00%	15,300
03/27	18.75	03/29	6.50	23.75	10	0.42	03/28	7.50	18.75	11.25	0	0.00	-0.42	0.00%	12,900
03/30	18.50	04/01	6.50	23.83	9	0.38	03/31	6.83	18.50	11.67	0	0.00	-0.38	0.00%	11,200
04/05	20.00	04/07	7.00	21.75	16	0.74	04/06	7.00	20.00	13.00	0	0.00	-0.74	0.00%	14,200
04/08	20.25	04/10	7.00	22.83	27	1.18	04/09	8.08	19.50	11.42	0	0.00	-1.18	0.00%	10,500
04/11	20.25	04/13	6.58	22.99	52	2.26	04/12	8.00	19.00	11.00	0	0.00	-2.26	0.00%	15,100
04/15	21.00	04/17	6.50	20.08	73	3.64	04/16	7.00	20.00	13.00	5	0.25	-3.39	6.85%	23,600
04/18	19.50	04/20	7.33	22.83	97	4.25	04/19	7.83	20.50	12.67	2	0.09	-4.16	2.06%	18,500
04/19	20.67	04/21	7.00	21.66	106	4.89	04/20	8.00	19.67	11.67	1	0.05	-4.85	0.94%	17,400
04/23	21.00	04/25	6.50	19.50	195	10.00	04/24	6.83	20.00	13.17	0	0.00	-10.00	0.00%	17,200
04/26	20.50	04/28	6.50	22.25	229	10.29	04/27	7.00	18.50	11.50	1	0.04	-10.25	0.44%	14,700
04/29	20.50	05/01	6.50	21.00	310	14.76	04/30	7.75	20.25	12.50	1	0.05	-14.71	0.32%	14,300
05/02	21.00	05/04	5.75	18.17	1,035	56.96	05/03	6.25	20.33	14.08	22	1.21	-55.75	2.13%	18,500
05/05	21.00	05/07	6.50	19.25	553	28.73	05/06	6.75	20.50	13.75	86	4.47	-24.26	15.55%	18,450
05/08	20.50	05/10	5.92	19.42	635	32.70	05/09	6.83	20.50	13.67	5	0.26	-32.44	0.79%	14,000
05/11	21.00	05/13	6.00	19.25	806	41.87	05/12	7.17	20.67	13.50	26	1.35	-40.52	3.23%	16,200
05/15	20.75	05/17	6.50	19.17	1,207	62.96	05/16	6.67	21.00	14.33	130	6.78	-56.18	10.77%	16,400
05/18	21.00	05/20	6.50	19.67	786	39.96	05/19	7.25	20.67	13.42	18	0.92	-39.04	2.29%	16,800
05/24	21.00	05/26	6.00	17.75	459	25.86	05/25	6.25	21.00	14.75	30	1.69	-24.17	6.54%	20,800
05/27	21.50	05/29	6.50	18.00	354	19.67	05/28	6.25	20.83	14.58	47	2.61	-17.06	13.28%	23,700
05/30	21.00	06/01	6.00	18.50	301	16.27	05/31	6.92	21.00	14.08	8	0.43	-15.84	2.66%	20,800
06/01	20.00	06/03	6.75	20.00	212	10.60	06/02	6.50	21.25	14.75	6	0.30	-10.30	2.83%	18,500
06/07	21.50	06/09	6.00	18.25	90	4.93	06/08	7.08	21.00	13.92	11	0.60	-4.33	12.22%	23,900
06/10	21.50	06/12	6.50	18.50	36	1.95	06/11	6.50	21.00	14.50	0	0.00	-1.95	0.00%	20,600
06/17	22.00	06/19	6.50	17.25	51	2.96	06/18	6.17	21.00	14.83	14	0.81	-2.14	27.45%	27,000
06/20	21.75	06/22	6.75	17.75	23	1.30	06/21	6.75	21.75	15.00	5	0.28	-1.01	21.74%	24,300
06/23	22.00	06/25	6.00	16.17	12	0.74	06/24	6.50	21.92	15.42	4	0.25	-0.49	33.33%	23,000
06/26	22.00	06/28	6.00	16.33	27	1.65	06/27	6.25	21.50	15.25	2	0.12	-1.53	7.41%	25,600
06/29	22.00	07/01	5.00	15.75	8	0.51	06/30	6.50	21.75	15.25	5	0.32	-0.19	62.50%	28,400
07/02	22.50	07/04	6.50	16.42	6	0.37	07/03	6.67	21.92	15.25	0	0.00	-0.37	0.00%	22,000
07/05	22.00	07/07	6.50	16.75	3	0.18	07/06	6.50	21.75	15.25	0	0.00	-0.18	0.00%	19,000
07/08	22.00	07/10	6.00	16.25	0	0.00	07/09	6.25	21.50	15.25	0	0.00	0.00	0.00%	19,700
07/11	22.00	07/13	7.00	17.66	0	0.00	07/12	7.00	21.83	14.83	0	0.00	0.00	0.00%	19,900
07/14	22.00	07/16	6.75	17.42	0	0.00	07/15	6.92	21.92	15.00	0	0.00	0.00	0.00%	18,800
07/17	22.00	07/19	6.50	17.83	1	0.00	07/18	6.50	21.50	15.00	0	0.00	0.00	0.00%	18,400
07/23	21.50	07/25	6.50	18.00	2	0.11	07/24	6.67	21.33	14.66	0	0.00	-0.11	0.00%	20,800
07/29	21.50	07/31	7.00	18.50	3	0.16	07/30	6.83	21.50	14.67	0	0.00	-0.16	0.00%	16,700
08/03	22.00	08/05	8.00	20.00	0	0.00	08/04	7.50	21.50	14.00	0	0.00	0.00	0.00%	16,700
08/08	23.50	08/10	9.50	20.50	0	0.00	08/09	8.00	21.50	13.50	0	0.00	0.00	0.00%	14,900
08/17	22.00	08/19	9.00	24.00	0	0.00	08/18	10.00	21.50	11.00	0	0.00	0.00	0.00%	9,480
TOTAL SEASON				504.07	7,700	15.28				355.01	429	1.21	-14.07	7.91%	19,300

Note: Only the April through June period of the coho migration was used in the analysis.

Table 5b. Catch rates of wild coho smolts during day and night periods in the Skagit River mainstem screw trap, 2000.

NIGHT INTERVAL				TOTAL NIGHT			DAY INTERVAL			TOTAL DAY			Diff	Ratio	Flow
Trap Down		Trap Up		Hours	Catch	Catch/	Date	Time		Hours	Catch	Catch/	(D-N)	(D/N)	(cfs)
Date	Time	Date	Time	Fished		Hour		Down	Up	Fished		Hour			
01/18	17.25	01/20	8.08	29.33	1	0.03	01/19	8.25	17.25	9.00	0	0.00	0.03	0.00%	16,300
01/21	17.25	01/23	8.50	30.00	3	0.10	01/22	8.17	17.42	9.25	0	0.00	-0.10	0.00%	12,500
01/24	17.50	01/26	8.00	29.00	0	0.00	01/25	8.50	17.00	8.50	0	0.00	0.00	0.00%	14,800
01/27	17.25	01/29	8.00	29.33	0	0.00	01/28	8.25	17.50	9.25	0	0.00	0.00	0.00%	13,900
01/30	18.00	02/01	8.00	28.50	1	0.04	01/31	8.17	17.67	9.50	0	0.00	-0.04	0.00%	11,000
01/31	17.67	02/02	7.50	23.16	0	0.00	02/01	17.50	21.75	4.25	0	0.00	0.00	0.00%	13,600
02/02	17.50	02/04	8.00	28.25	1	0.04	02/03	7.92	17.67	9.75	0	0.00	0.04	0.00%	18,100
02/05	17.50	02/07	7.50	28.50	0	0.00	02/06	8.00	17.75	9.75	1	0.10	0.10	0.00%	11,800
02/08	18.00	02/10	8.00	27.75	3	0.11	02/09	8.00	18.25	10.25	1	0.10	-0.01	90.24%	16,500
02/11	18.00	02/13	7.83	27.50	4	0.15	02/12	7.75	18.00	10.25	0	0.00	-0.15	0.00%	12,500
02/14	18.00	02/16	7.50	26.75	4	0.15	02/15	7.75	18.17	10.42	0	0.00	-0.15	0.00%	12,700
02/17	18.25	02/19	7.75	26.75	4	0.15	02/18	7.50	18.25	10.75	0	0.00	-0.15	0.00%	12,300
02/20	18.00	02/22	7.25	26.67	2	0.07	02/21	7.75	18.00	10.25	0	0.00	-0.07	0.00%	9,880
02/23	18.00	02/25	7.50	26.25	4	0.15	02/24	7.17	18.42	11.25	0	0.00	-0.15	0.00%	12,700
02/26	18.50	02/28	7.00	25.33	1	0.04	02/27	7.50	18.67	11.17	0	0.00	-0.04	0.00%	11,200
02/29	18.50	03/02	7.25	25.67	6	0.23	03/01	7.42	18.25	10.83	0	0.00	-0.23	0.00%	11,300
03/03	18.50	03/05	7.25	26.58	12	0.45	03/04	7.83	18.00	10.17	1	0.10	-0.35	21.78%	13,600
03/06	18.50	03/08	7.00	25.42	13	0.51	03/07	7.25	18.33	11.08	1	0.09	-0.42	17.65%	12,400
03/09	18.58	03/11	7.75	25.84	3	0.12	03/10	7.50	18.50	11.00	0	0.00	-0.12	0.00%	10,500
03/12	18.50	03/14	7.17	25.34	4	0.16	03/13	7.25	18.58	11.33	0	0.00	-0.16	0.00%	9,950
03/15	18.50	03/17	7.00	24.58	28	1.14	03/16	7.00	18.92	11.92	2	0.17	-0.97	14.73%	11,700
03/18	18.50	03/20	7.25	25.50	17	0.67	03/19	8.00	18.50	10.50	0	0.00	-0.67	0.00%	15,900
03/21	19.00	03/23	6.00	24.17	14	0.58	03/22	7.17	18.00	10.83	0	0.00	-0.58	0.00%	13,600
03/24	19.00	03/26	7.00	24.50	20	0.82	03/25	7.00	18.50	11.50	0	0.00	-0.82	0.00%	15,300
03/27	18.83	03/29	6.50	24.00	15	0.63	03/28	7.33	18.00	10.67	0	0.00	-0.63	0.00%	12,900
03/30	18.50	04/01	7.75	25.25	8	0.32	03/31	6.50	18.50	12.00	0	0.00	-0.32	0.00%	11,200
04/02	20.00	04/04	6.83	22.58	14	0.62	04/03	7.50	19.75	12.25	0	0.00	-0.62	0.00%	11,400
04/05	20.00	04/07	7.00	23.00	37	1.61	04/06	7.00	18.75	11.75	0	0.00	-1.61	0.00%	14,200
04/08	20.25	04/10	7.00	22.25	28	1.26	04/09	7.00	19.50	12.50	0	0.00	-1.26	0.00%	10,500
04/11	20.25	04/13	6.25	21.50	47	2.19	04/12	7.00	19.50	12.50	0	0.00	-2.19	0.00%	15,100
04/15	21.00	04/17	6.50	21.00	82	3.90	04/16	7.25	19.50	12.25	10	0.82	-3.09	20.91%	23,600
04/18	19.50	04/20	6.75	22.25	152	6.83	04/19	7.00	20.00	13.00	1	0.08	-6.75	1.13%	18,500
04/19	20.00	04/21	7.00	22.00	147	6.68	04/20	8.00	19.50	11.50	0	0.00	-6.68	0.00%	17,400
04/23	21.00	04/25	6.50	21.25	219	10.31	04/24	8.00	20.00	12.00	3	0.25	-10.06	2.43%	17,200
04/26	20.50	04/28	6.50	21.50	304	14.14	04/27	6.75	19.00	12.25	0	0.00	-14.14	0.00%	14,700
04/29	20.50	05/01	6.50	20.50	316	15.41	04/30	6.50	20.00	13.50	1	0.07	-15.34	0.48%	14,300
05/02	21.00	05/04	5.75	20.00	1,221	61.05	05/03	7.25	20.00	12.75	4	0.31	-60.74	0.51%	18,500
05/05	21.00	05/07	6.00	18.75	809	43.15	05/06	6.25	20.00	13.75	3	0.22	-42.93	0.51%	18,450
05/08	20.50	05/10	6.00	19.08	730	38.26	05/24	6.50	20.30	14.42	1	0.07	-38.19	0.18%	18,450
05/11	21.00	05/13	6.00	18.50	854	46.16	05/12	6.00	20.00	14.50	5	0.34	-45.82	0.75%	16,200
05/15	21.00	05/17	6.00	19.08	1,658	86.90	05/16	6.30	20.00	13.67	1	0.07	-86.82	0.08%	16,400
05/18	21.00	05/20	6.50	19.25	982	51.01	05/19	6.00	20.25	14.25	15	1.05	-49.96	2.06%	16,800
05/24	21.00	05/26	5.75	17.00	489	28.76	05/25	5.25	20.50	15.25	12	0.79	-27.98	2.74%	20,800
05/27	21.50	05/29	6.50	16.83	334	19.85	05/28	5.33	21.42	16.09	58	3.60	-16.24	18.16%	23,700
05/30	21.00	06/01	6.00	18.50	306	16.54	05/31	6.00	20.50	14.50	9	0.62	-15.92	3.75%	20,800
06/01	20.00	06/03	6.50	19.75	172	8.71	06/02	7.00	21.75	14.75	22	1.49	-7.22	17.13%	18,500
06/07	21.50	06/09	6.00	18.17	74	4.07	06/08	6.50	20.83	14.33	2	0.14	-3.93	3.43%	23,900
06/10	21.50	06/12	6.50	18.50	67	3.62	06/11	6.50	21.00	14.50	4	0.28	-3.35	7.62%	20,600
06/17	22.00	06/19	6.50	17.50	61	3.49	06/18	6.50	21.50	15.00	10	0.67	-2.82	19.13%	27,000
06/20	21.50	06/22	6.75	17.75	35	1.97	06/21	6.50	22.00	15.50	1	0.06	-1.91	3.27%	24,300
06/23	22.00	06/25	6.00	16.75	17	1.01	06/24	6.50	21.75	15.25	4	0.26	-0.75	25.84%	23,000
06/26	22.00	06/28	6.00	17.25	20	1.16	06/27	6.50	21.25	14.75	3	0.20	-0.96	17.54%	25,600
06/29	22.00	07/01	6.00	17.00	4	0.24	06/30	6.50	21.50	15.00	2	0.13	-0.10	56.67%	28,400
07/02	22.50	07/04	6.50	16.25	6	0.37	07/03	6.00	21.75	15.75	0	0.00	-0.37	0.00%	22,000
07/05	22.00	07/07	6.50	17.00	2	0.12	07/06	6.00	21.50	15.50	0	0.00	-0.12	0.00%	19,000
07/08	22.00	07/10	6.00	16.50	3	0.18	07/09	6.00	21.50	15.50	0	0.00	-0.18	0.00%	19,700
07/11	22.00	07/13	7.00	17.50	3	0.17	07/12	6.50	22.00	15.50	0	0.00	-0.17	0.00%	19,900
07/14	22.00	07/16	6.75	17.50	1	0.06	07/15	6.50	21.75	15.25	0	0.00	-0.06	0.00%	18,800
07/17	21.50	07/19	6.50	17.50	2	0.11	07/18	6.25	21.75	15.50	0	0.00	-0.11	0.00%	18,400
07/23	21.50	07/25	6.50	17.75	0	0.00	07/24	6.25	21.50	15.25	1	0.07	0.00	0.00%	20,800
07/29	21.50	07/31	7.00	18.17	0	0.00	07/30	6.50	21.83	15.33	0	0.00	0.00	0.00%	16,700
08/03	22.00	08/05	8.00	20.00	0	0.00	08/04	7.50	21.50	14.00	0	0.00	0.00	0.00%	16,700
08/08	23.50	08/10	9.50	20.50	0	0.00	08/09	8.00	21.50	13.50	0	0.00	0.00	0.00%	14,900
08/10	21.50	08/12	9.00	22.00	0	0.00	08/11	8.00	21.50	13.50	0	0.00	0.00	0.00%	13,000
TOTAL SEASON				527.49	9,179	17.40				371.76	171	0.46	-16.94	2.64%	19,200

Note: Only the April through June period of the coho migration was used in the analysis.

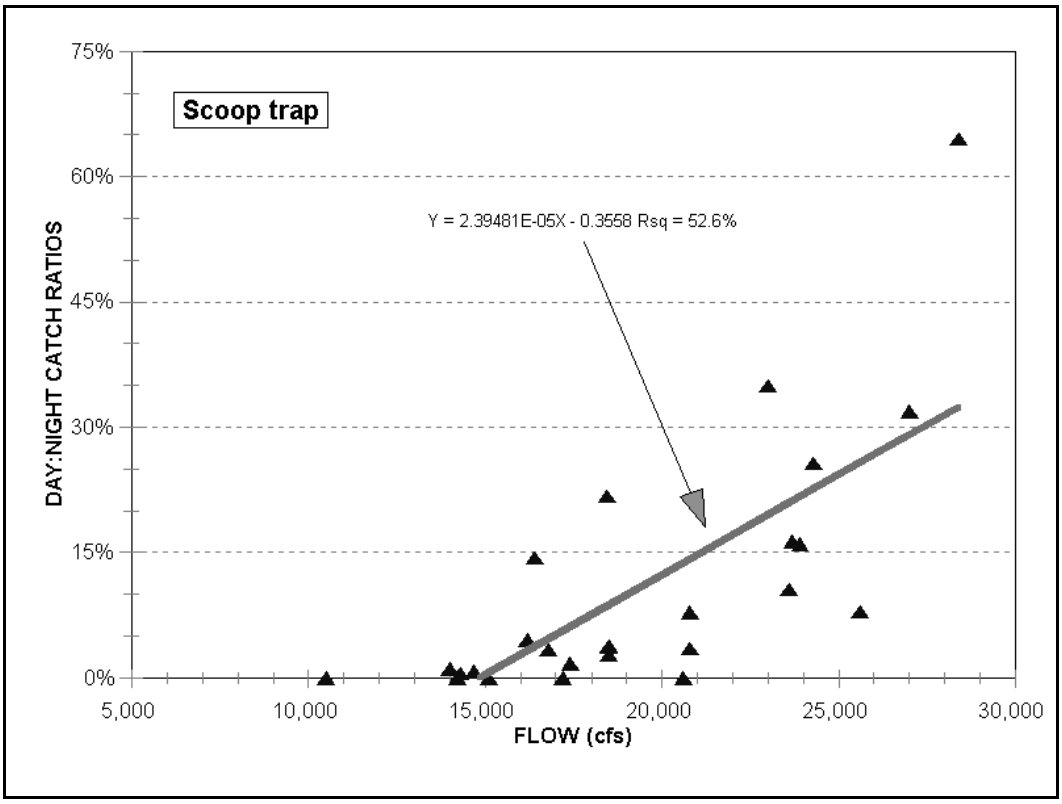

Figure 6. Comparison of day:night catch ratios of wild coho smolts and daily mean flow, Skagit River scoop trap, April through June, 2000.

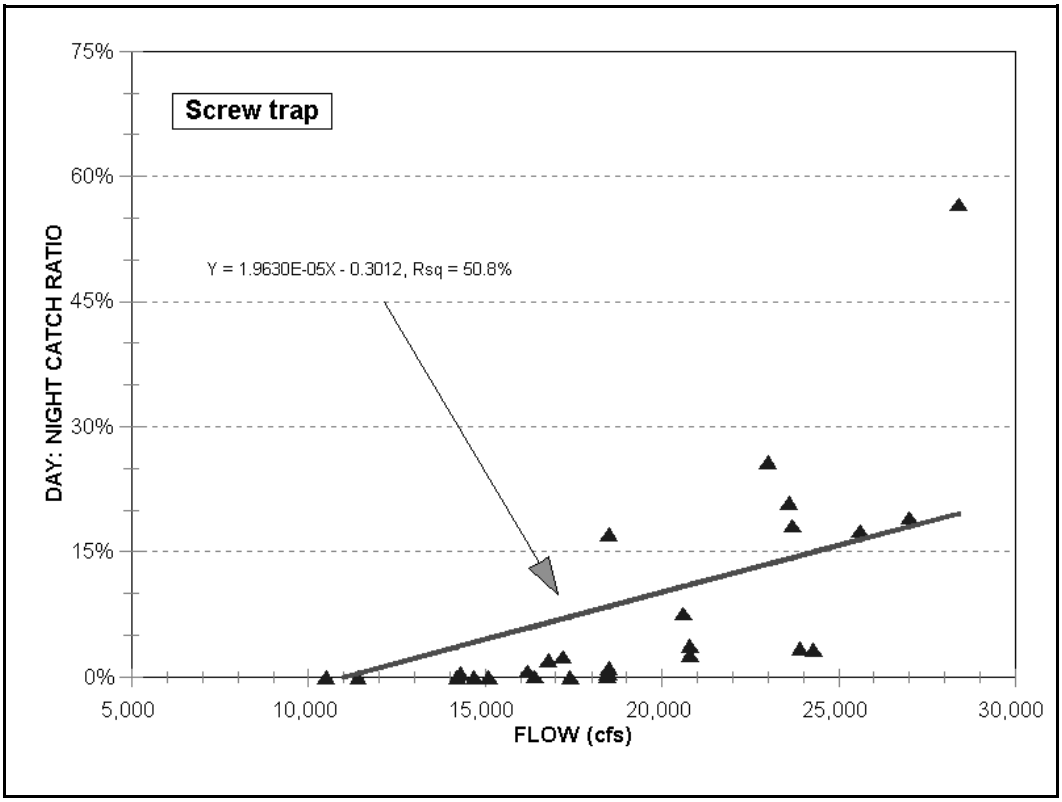

Figure 7. Comparison of day:night catch ratios of wild coho smolts and daily mean flow, Skagit River screw trap, April through June, 2000.

Table 6. Summary of visibility and flow data, Skagit River mainstem traps at Mt. Vernon, 2000.

Interval	FLOW (cfs)			VISIBILITY (cm)			R^2
	Min	Max	Avg	Min	Max	Avg	
January	12,100	15,800	14,420	150	206	182	19.0%
February	9,880	16,500	12,343	73	350	240	65.6%
March	9,950	18,100	12,775	56	310	204	56.8%
April	10,200	23,600	15,548	65	320	200	84.9%
May	13,600	26,800	18,547	70	248	153	55.8%
June	18,500	36,400	25,207	42	206	112	81.7%
July	16,400	25,800	19,600	85	195	150	52.5%
August	9,480	17,300	12,711	92	244	171	94.4%
All	9,480	36,400	17,393	42	350	171	64.9%[a]

[a] Monthly analyses use straight-line regression. Season total uses log(flow) – see Figure 8 below.

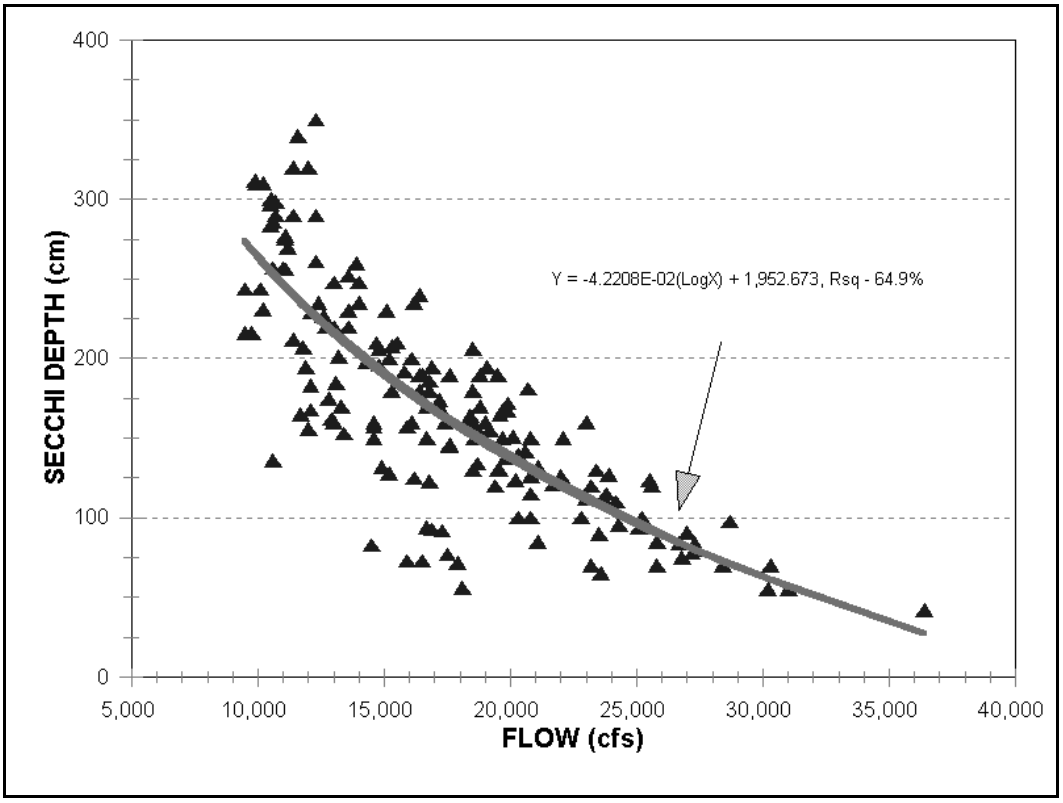

Figure 8. Visibility and flow, Skagit River near Mt. Vernon, 2000.

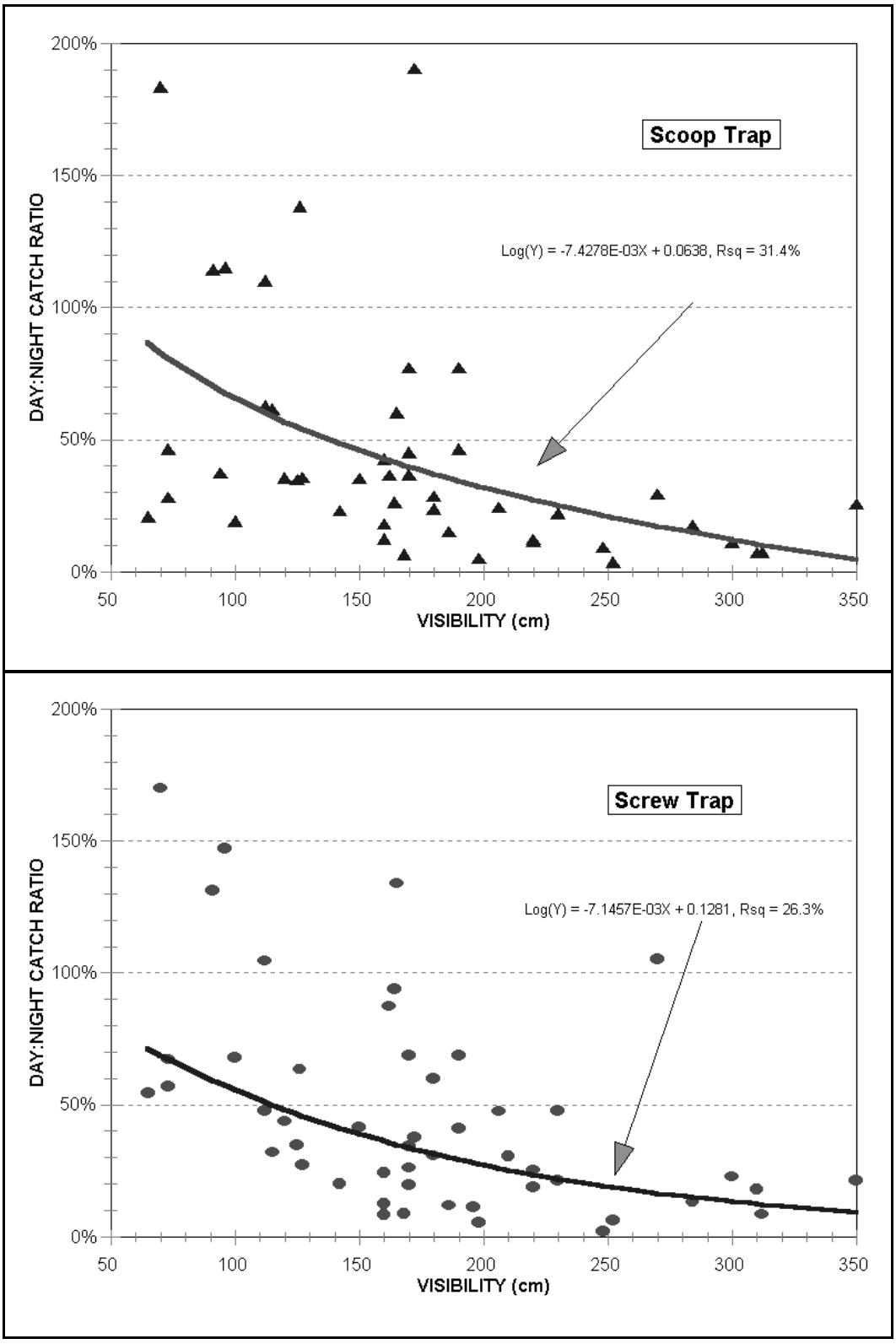

Figure 9. Day:night wild 0+ chinook catch ratios and visibility, Skagit River mainstem scoop and screw traps, 2000.

Table 7. Estimation of wild coho smolt production, Skagit River, 2000.

	Number	Formula
Total mainstem trap catches	29,880	
Skagit Hatchery/Lake Shannon	[a]-1570	
Wild coho captured (c)	**28,310**	
RVs recaptured (r)	407	$N = \frac{(m+1)(c+1)}{(r+1)}$
RVs released (m)	22,201	
Total production (N)	**1,540,590**	
Variance (Var)	5.61e+09	$Var = \frac{(m+1)(c+1)(m-r)(c-r)}{(r+1)^2(r+2)}$
Standard deviation (sd)	75,020	
Coefficient of Var (CV)	4.87%	CV = sd ÷ N
Confidence interval (CI)	147,039	CI = ± 1.96(sd)
Estimated coho production	1,540,590	
Upper CI (95%)	1,687,629	
Lower CI (95%)	1,393,551	

[a] Hatchery ad-marked and unmarked smolt total from counts obtained by visual identification at trapping.

Table 8. Capture rates on various groups of marked salmon smolts, Skagit River mainstem traps, 2000.

Stock	Species	Age	Mark	RELEASE			ACTUAL CATCH			RECOVERY RATE		
				Date	Number	Location	Scoop	Screw	Total	Scoop	Screw	Total
Wild	Coho	1+	RV	April-June	22,201	Mannser Creek (R.M. 35)	185	222	407	0.8%	1.0%	1.8%
Wild	Coho	1+	LV	March-June	14,393	Park Slough 1&2 Zander Slough Countyline Ponds (R.M. 87)	60	64	124	0.4%	0.4%	0.9%
Hatchery	Coho	1+	Ad/CWT	May 21	249,600	Skagit Hatchery (R.M. 79)	624	946	1,739	0.3%	0.4%	0.6%
Hatchery/Spring	Chinook	0+	Ad-only[a]	May 08, 2100 hrs	2,604	Gardner Bar (R.M. 18)	49	43	92	1.9%	1.7%	3.5%
Hatchery/Spring	Chinook	0+	Ad/LC[a]	May 15, 2130 hrs	2,351	Gardner Bar (R.M. 18)	44	32	76	1.9%	1.4%	3.2%
Hatchery/Spring	Chinook	0+	Ad/UC[a]	May 24, 2130 hrs	2,588	Gardner Bar (R.M. 18)	26	20	46	1.0%	0.8%	1.8%
Hatchery/Spring	Chinook	0+	Ad/LC[a]	June 01, 2300 hrs	2,650	Gardner Bar (R.M. 18)	76	75	151	2.9%	2.8%	5.7%
Hatchery/Spring	Chinook	1+	Ad/CWT	March 06-13	135,000	Skagit Hatchery (R.M. 70)	511	361	872	0.4%	0.3%	0.6%
Hatchery/Summer	Chinook	0+	Ad/CWT	May 15-20	194,584	Countyline Ponds (R.M. 87)	n/a	n/a	2,327	n/a	n/a	1.2%
Hatchery/Spring	Chinook	0+	Ad/CWT	June 02	254,920	Skagit Hatchery (R.M. 70)	n/a	n/a	2,001	n/a	n/a	0.8%
Hatchery/Fall	Chinook	0+	Ad/CWT	July 02-03	31,619	Baker River (R.M. 56)	n/a	n/a	13	n/a	n/a	0.0%
Wild	Pink	0+	dye	Mar. 31, 1940 hrs.	3,566	Gardner Bar (R.M. 18)	14	2	16	0.4%	0.1%	0.4%
Wild	Pink	0+	dye	April 19, 2030 hrs.	4,008	Gardner Bar (R.M. 18)	26	0	26	0.6%	0.0%	0.6%
Wild	Chum	0+	dye	Mar. 31, 1940 hrs.	611	Gardner Bar (R.M. 18)	6	3	9	1.0%	0.5%	1.5%
Wild	Chum	0+	dye	April 19, 2030 hrs.	227	Gardner Bar (R.M. 18)	0	2	2	0.0%	0.9%	0.9%

[a] The four groups of hatchery spring chinook used for the calibration groups were also coded-wire tagged.

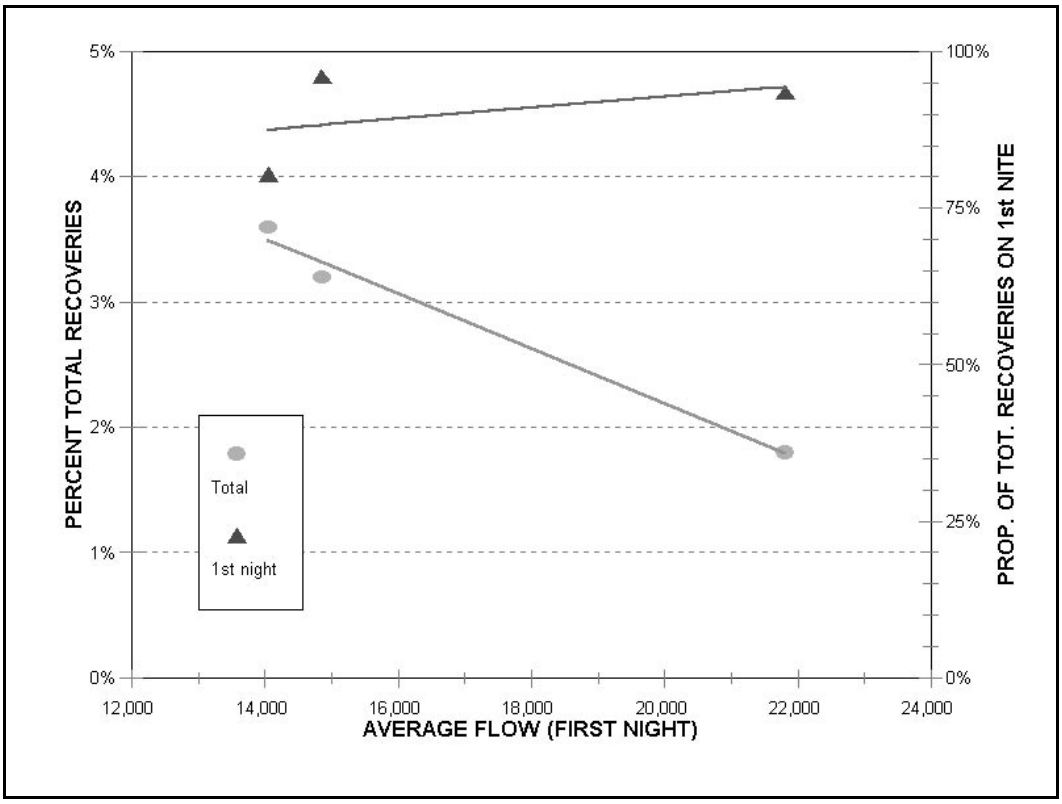

Figure 10. Proportions of total recoveries captured during the night of release and overall capture rates (scoop and screw traps, combined), as a function of flow, Skagit River fin-marked hatchery 0+ chinook, 2000.

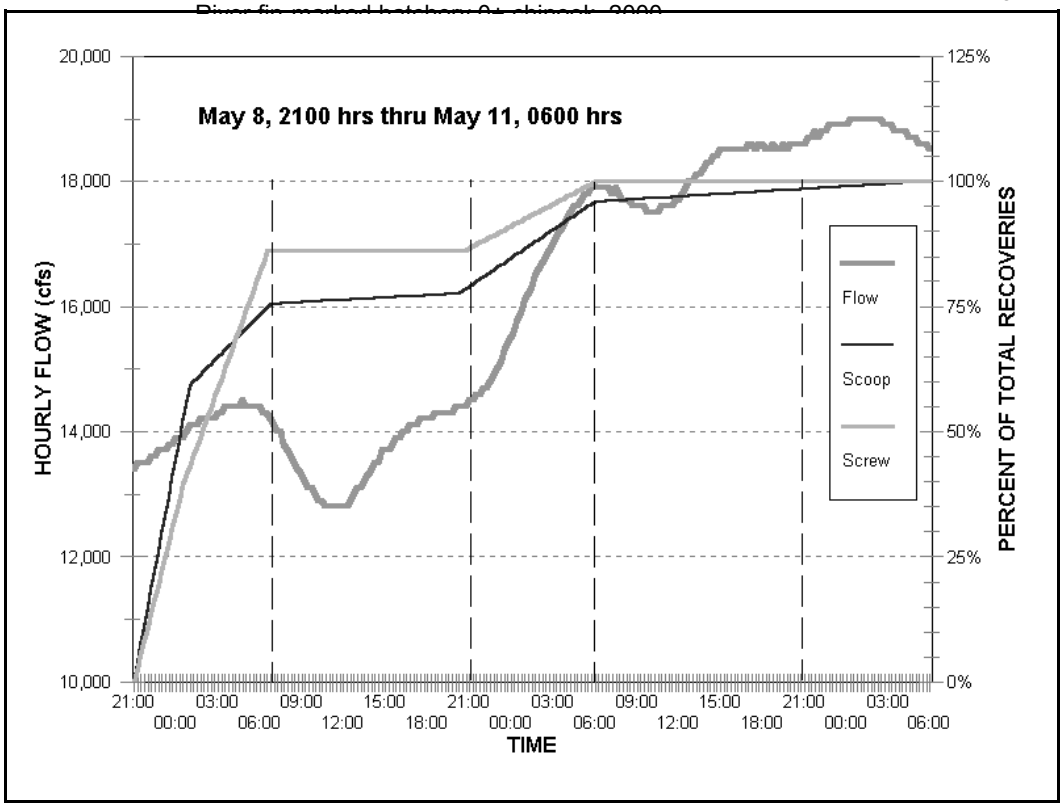

Figure 11a. Hourly flow and percent recoveries of fin-marked hatchery 0+ spring chinook (scoop and screw traps combined) released on May 8, Skagit River 2000.

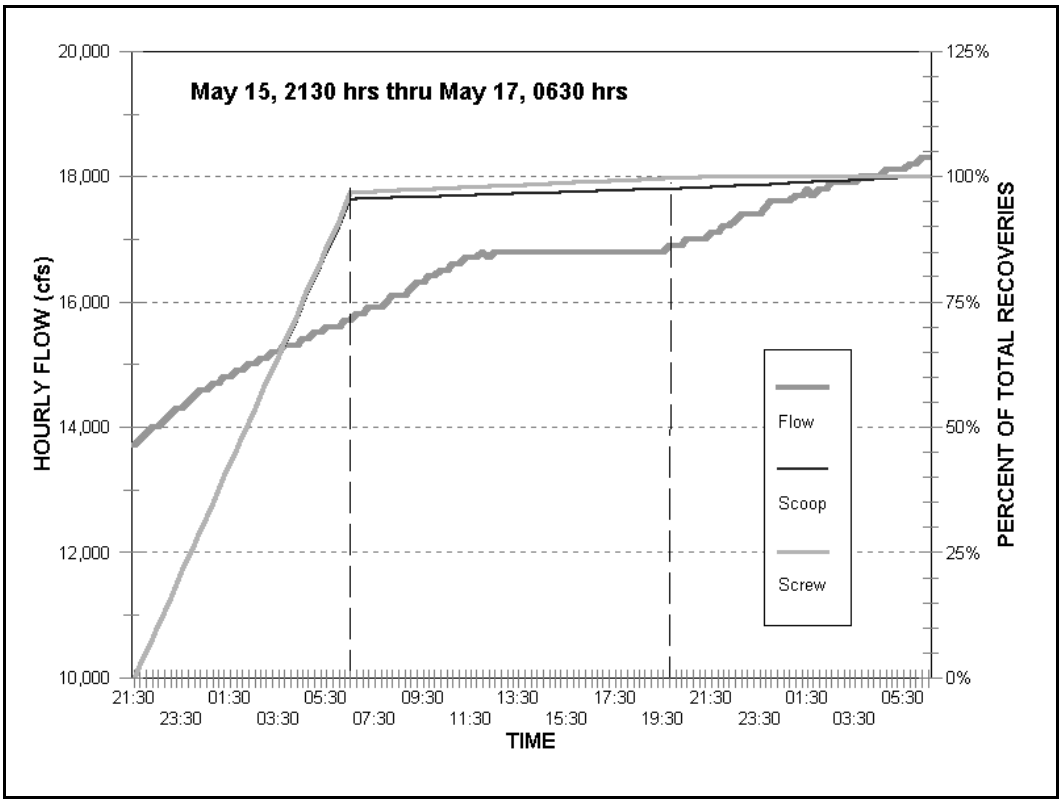

Figure 11b. Hourly flow and percent recoveries of fin-marked hatchery 0+ spring chinook (scoop and screw traps combined) released on May 15, Skagit River 2000.

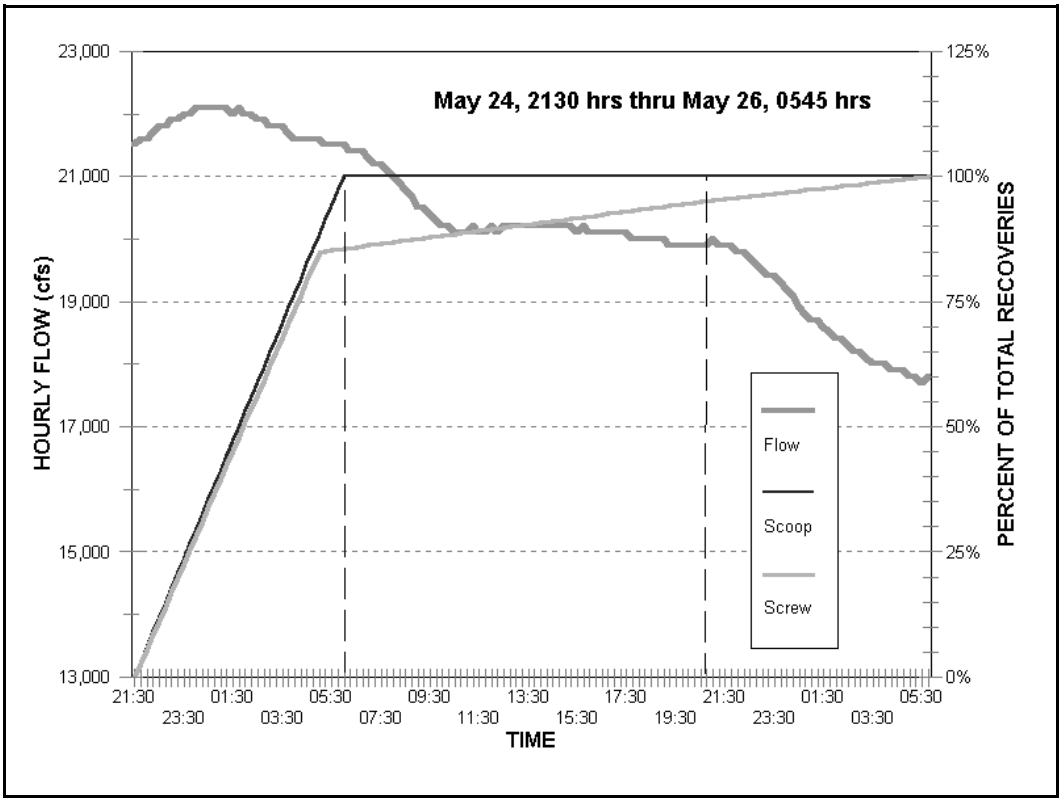

Figure 11c. Hourly flow and percent recoveries of fin-marked hatchery 0+ spring chinook (scoop and screw traps combined) released on May 24, Skagit River 2000.

Table 9. Breakdown of CWT recoveries from ad-marked chinook sacrificed at the Skagit River mainstem scoop and screw traps, 2000.

Date	NUMBER SAMPLED[a]			Spring 63-01/64		Summer[b] 63-01/66		Fall 21-01/86	
	Heads	No Tags	Tags	#	%	#	%	#	%
06/03	7	0	7		0%	7	100%		0%
06/04	10	0	10	10	100%		0%		0%
06/05	26	0	26	24	92%	2	8%		0%
06/06	40	0	40	32	80%	8	20%		0%
06/07	10	0	10	9	90%	1	10%		0%
06/08	5	0	5	2	40%	3	60%		0%
06/09	4	0	4	4	100%	0	0%		0%
06/10	5	0	5	4	80%	1	20%		0%
06/11 - 06/13	0	0	0		57%		43%		0%
06/14	3	0	3	1	33%	2	67%		0%
06/15	3	0	3	1	33%	2	67%		0%
06/16 - 06/17	0	0	0		50%		50%		0%
06/18	4	1	3	2	67%	1	33%		0%
06/19 - 06/20	0	0	0		58%		42%		0%
06/21	2	0	2	1	50%	1	50%		0%
06/22	0	0	0		38%		63%		0%
06/23	4	0	4	1	25%	3	75%		0%
06/24	2	0	2		0%	2	100%		0%
06/25	0	0	0		25%		75%		0%
06/26	2	0	2	1	50%	1	50%		0%
06/27	0	0	0		50%		50%		0%
06/28	4	0	4	2	50%	2	50%		0%
06/29	0	0	0		25%		75%		0%
06/30	4	1	3		0%	3	100%		0%
07/01 - 07/02	0	0	0		17%		83%		0%
07/03	3	0	3	1	33%	2	67%		0%
07/04	0	0	0		67%		33%		0%
07/05	4	0	4	4	100%		0%		0%
07/06	0	0	0		67%		17%		0%
07/07	3	0	3	1	33%	1	33%	1	33%
07/08	0	0	0		54%		29%		17%
07/09	4	0	4	3	75%	1	25%		0%
07/10 - 07/11	0	0	0		75%		25%		0%
07/12	4	0	4	3	75%	1	25%		0%
07/13	0	0	0		63%		38%		0%
07/14	4	0	4	2	50%	2	50%		0%
07/15	0	0	0		38%		63%		0%
07/16	4	0	4	1	25%	3	75%		0%
07/17	0	0	0		63%		38%		0%
07/18	2	0	2	2	100%		0%		0%
07/19 - 07/22	0	0	0		100%		0%		0%
07/23	4	0	4	4	100%		0%		0%
07/24	0	0	0		70%		0%		30%
07/25	5	0	5	2	40%		0%	3	60%
07/26 - 07/28	0	0	0		45%		0%		55%
07/29	2	0	2	1	50%		0%	1	50%
07/30 - 08/02	0	0	0		60%		0%		40%
08/03	3	0	3	2	67%		0%	1	33%
Total	177	2	175	120		49		6	

[a] The tag breakdown for the days not sampled used the average of the previous and following days sampled.
[b] Assumed 100% summer chinook prior to spring and fall chinook releases on June 2.

Table 10. Projected zero-age hatchery chinook catches, by tag group, Skagit River mainstem traps, 2000.

Group/age	Tag Code	Recovery Period	Releases	Projected Catch	Capture Rates
Countyline Ponds/summer	63-01/66	May 15 - July 18	194,584	3,062	1.6%
Skagit Hatchery/spring	63-01/64	June 02 - August 18	254,920	2,686	1.1%
Baker River/fall	21-01/86	July 01 - August 02	31,619	25	0.1%
		Total	481,123	5,773	

Table 11. Summary of actual and projected wild and hatchery 0+ chinook catches in the Skagit River mainstem scoop and screw traps, 2000.

Species/ Age	SCOOP TRAP			SCREW TRAP			TOTAL		
	Actual	Projected	Total	Actual	Projected	Total	Actual	Projected	Total
Chinook 0+									
Wild	23,289	5,462	28,751	14,943	5,497	20,440	38,232	10,959	49,191
Hatchery	2,359[a]	792	3,151	1,982[b]	640	2,622	4,341	1,432	5,773

[a] Does not include 195 mark-recaptures from the trap efficiency release groups.
[b] Does not include 170 mark-recaptures from the trap efficiency release groups.

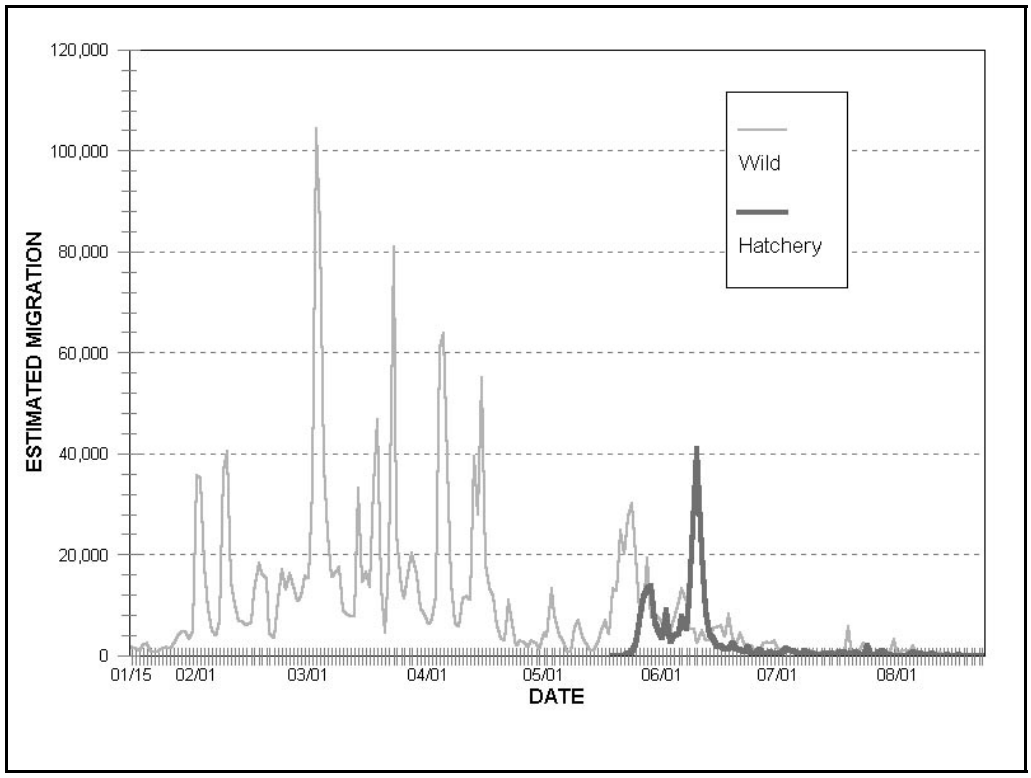

Figure 12. Estimated wild and hatchery migration, age 0+ chinook, Skagit River 2000.

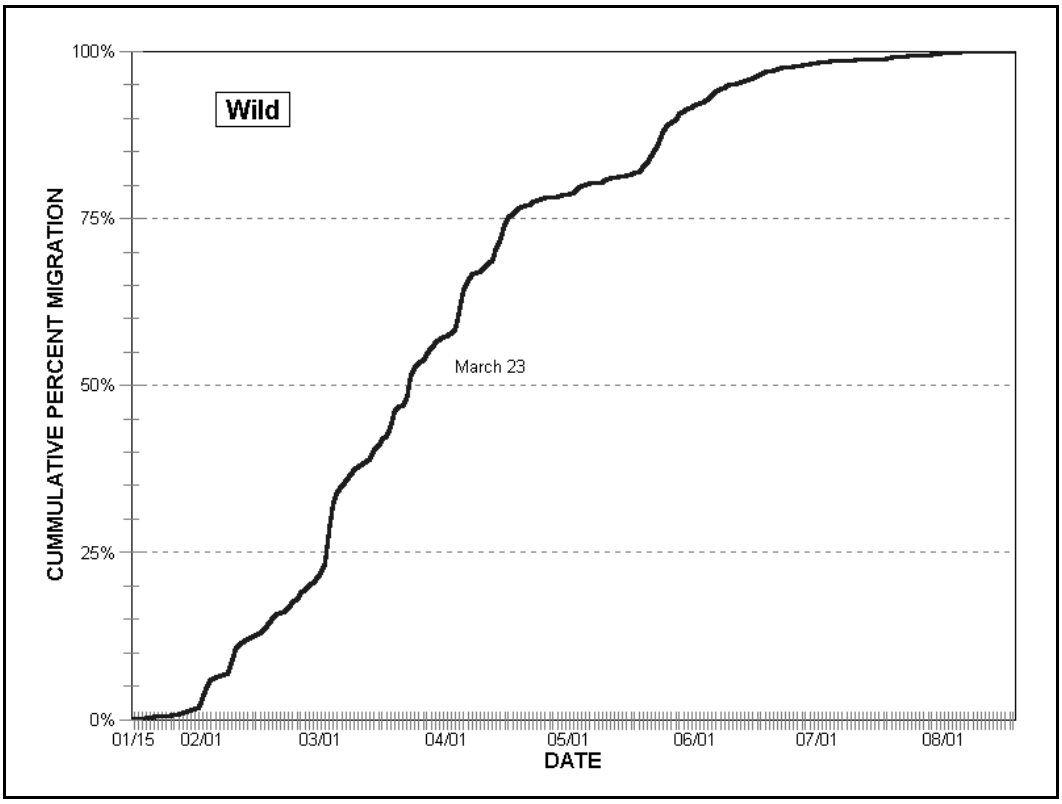

Figure 13. Migration timing of wild 0+ chinook past the mainstem traps, Skagit River 2000.

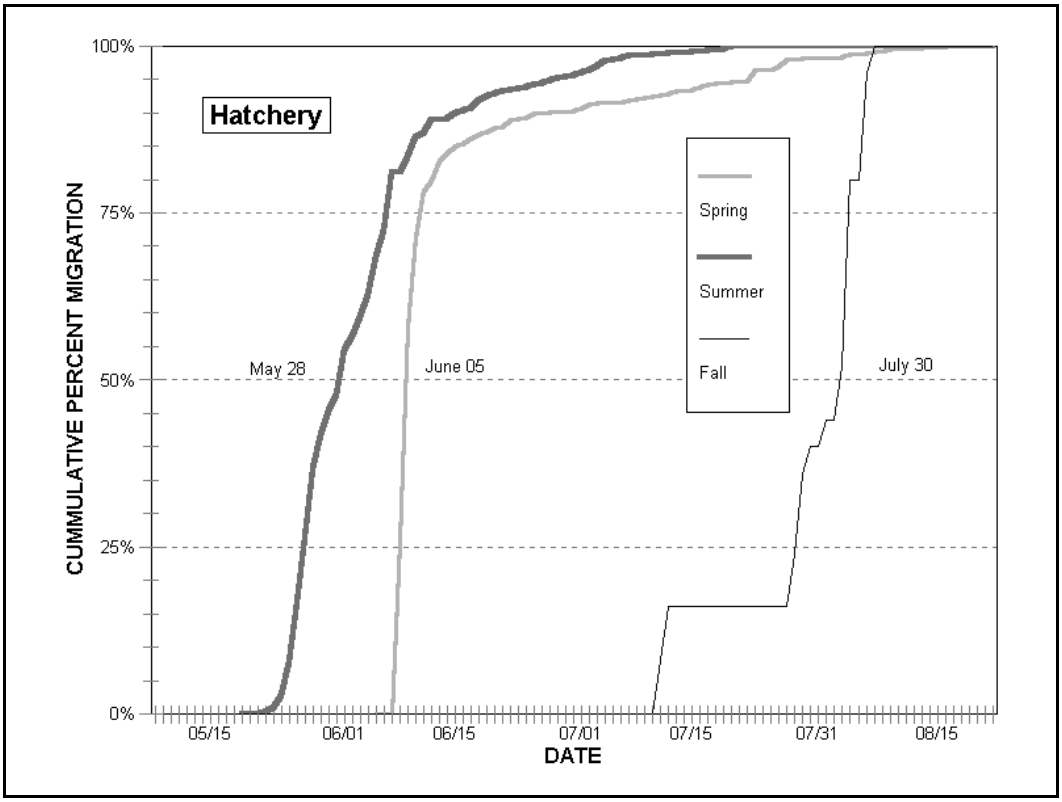

Figure 14. Migration timing of three groups of hatchery 0+ chinook, past the mainstem traps, Skagit River 2000.

Table 12. Mean fork length, standard deviation, range, sample, and catches of 0+ chinook in the Skagit River mainstem traps, 2000.

STAT WEEK			SCOOP TRAP						SCREW TRAP					
Begin	End	No.	Avg	sd	Range		n	Catch	Avg	sd	Range		n	Catch
					Min	Max					Min	Max		
01/15	01/16	3	37.4	2.31	32	41	20	37	35.3	2.05	31	38	15	31
01/17	01/23	4	38.2	1.97	33	42	29	103	38.0	1.53	35	41	27	91
01/24	01/30	5	39.2	1.50	35	41	18	219	38.7	1.76	36	42	29	213
01/31	02/06	6	37.7	1.92	34	42	29	1,111	38.9	2.19	33	43	38	1,033
02/07	02/13	7	39.1	1.87	36	42	28	1,387	38.7	1.96	35	43	22	1,031
02/14	02/20	8	39.5	2.16	35	44	40	806	39.8	1.81	35	43	33	691
02/21	02/27	9	40.1	1.48	38	44	31	935	39.3	1.65	36	42	31	712
02/28	03/05	10	69.8	2.07	35	45	78	3,374	39.8	2.12	36	45	75	2,468
03/06	03/12	11	39.5	2.46	35	46	30	1,108	39.7	1.81	37	43	26	689
03/13	03/19	12	40.9	4.52	35	60	25	2,211	39.8	1.71	37	44	25	1,034
03/20	03/26	13	40.6	2.39	36	51	87	2,022	41.1	2.22	38	48	54	802
03/27	04/02	14	42.1	3.38	36	53	64	863	41.5	3.24	36	51	48	697
04/03	04/09	15	43.7	3.74	36	57	46	2,306	44.5	7.81	39	55	34	1,325
04/10	04/16	16	45.3	4.96	37	55	22	1,637	43.7	7.81	36	67	18	827
04/17	04/23	17	50.1	7.35	39	76	54	623	49.7	6.88	37	70	41	278
04/24	04/30	18	48.6	6.34	39	62	38	170	52.5	4.46	45	65	25	103
05/01	05/07	19	52.6	7.45	37	76	60	437	53.6	7.05	38	72	67	190
05/08	05/14	20	57.0	7.81	38	68	27	233	58.3	8.11	46	77	25	129
05/15	05/21	21	59.5	7.94	45	78	35	795	59.0	6.47	46	71	20	278
05/22	05/28	22	57.7	6.61	38	71	97	1,228	57.7	7.15	41	76	71	983
05/29	06/04	23	58.1	6.74	40	72	73	435	59.6	5.74	48	76	50	316
06/05	06/11	24	59.4	6.18	49	75	60	474	61.1	6.17	48	84	60	381
06/12	06/18	25	62.4	9.80	46	88	57	248	62.6	8.05	43	79	60	248
06/19	06/25	26	65.3	6.69	52	82	58	157	65.1	7.18	50	81	56	122
06/26	07/02	27	67.9	8.32	48	80	29	121	67.3	9.91	51	91	23	112
07/03	07/09	28	69.5	11.58	39	86	18	57	71.6	9.17	51	90	19	47
07/10	07/16	29	77.9	7.33	68	95	27	40	74.3	8.83	62	92	22	31
07/17	07/23	30	84.1	7.01	72	96	28	52	83.5	7.3	66	96	22	34
07/24	07/30	31	59.9	6.19	72	97	26	52	84.1	11.32	61	103	11	21
07/31	08/06	32	88.6	8.79	75	105	11	35	87.9	9.02	78	105	12	20
08/07	08/13	33	84.0	8.12	75	100	6	12						6
08/14	08/18	34						1						0
Season Total			44.8	3.57	32	105	1,251	23,289	44.7	3.65	31	105	1,059	14,943

Note: Season total average and standard deviations are weighted by catch.

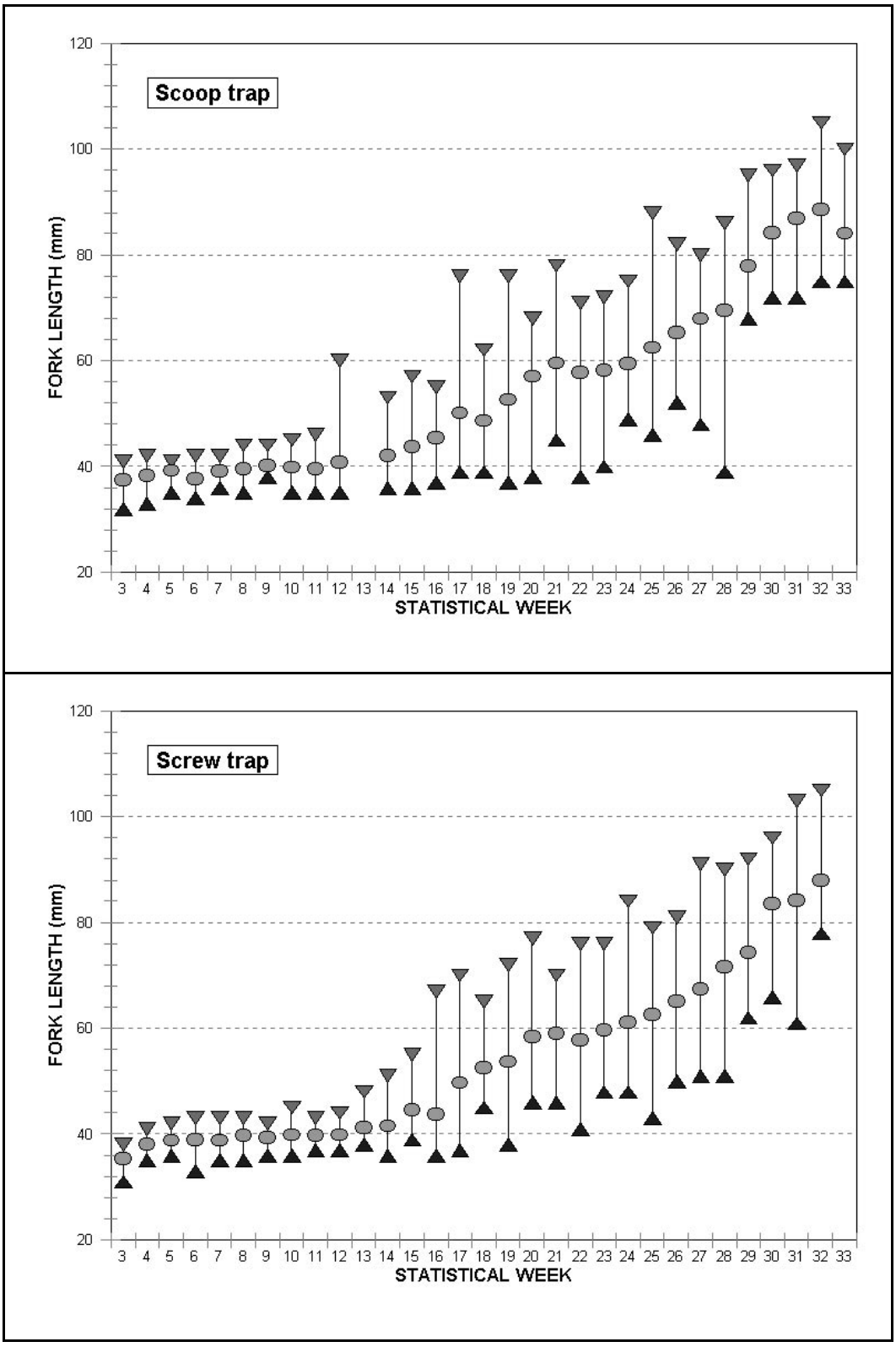

Figure 15. Wild 0+ chinook minimum, maximum, and average fork lengths, by week, Skagit River 2000.

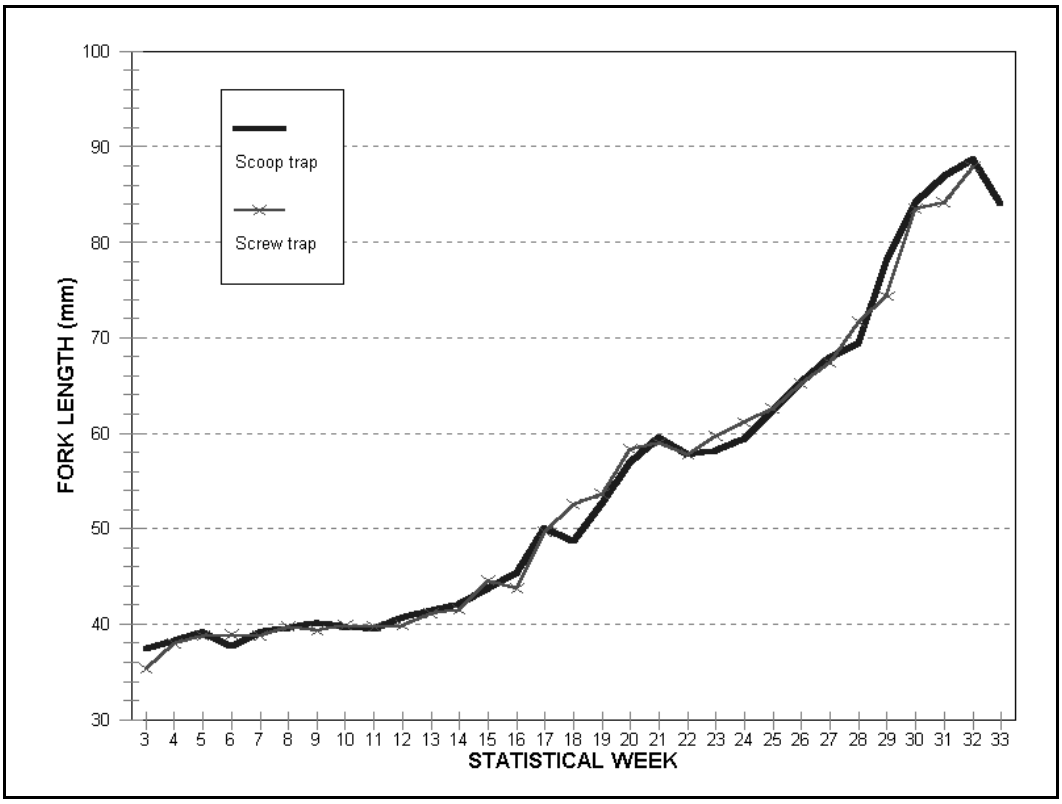

Figure 16. Comparison of weekly mean size, by trapping gear, Skagit River 0+ chinook, 2000.

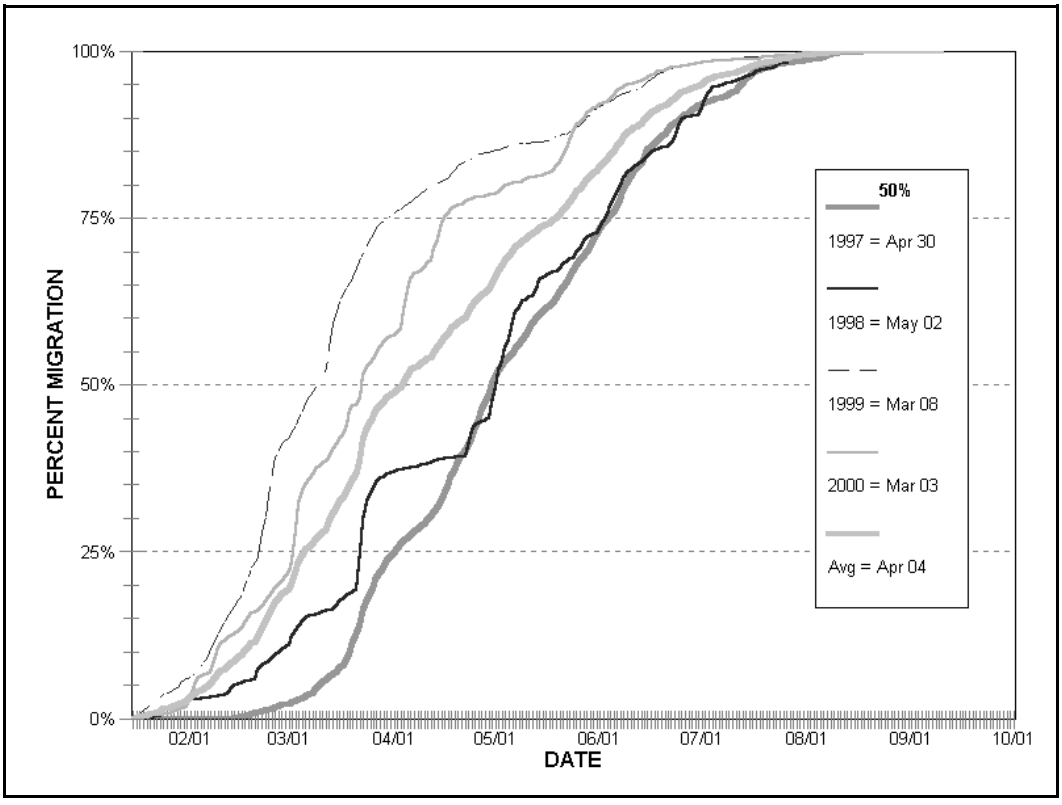

Figure 17. Wild 0+ chinook migration timing, Skagit River 1997-2000.

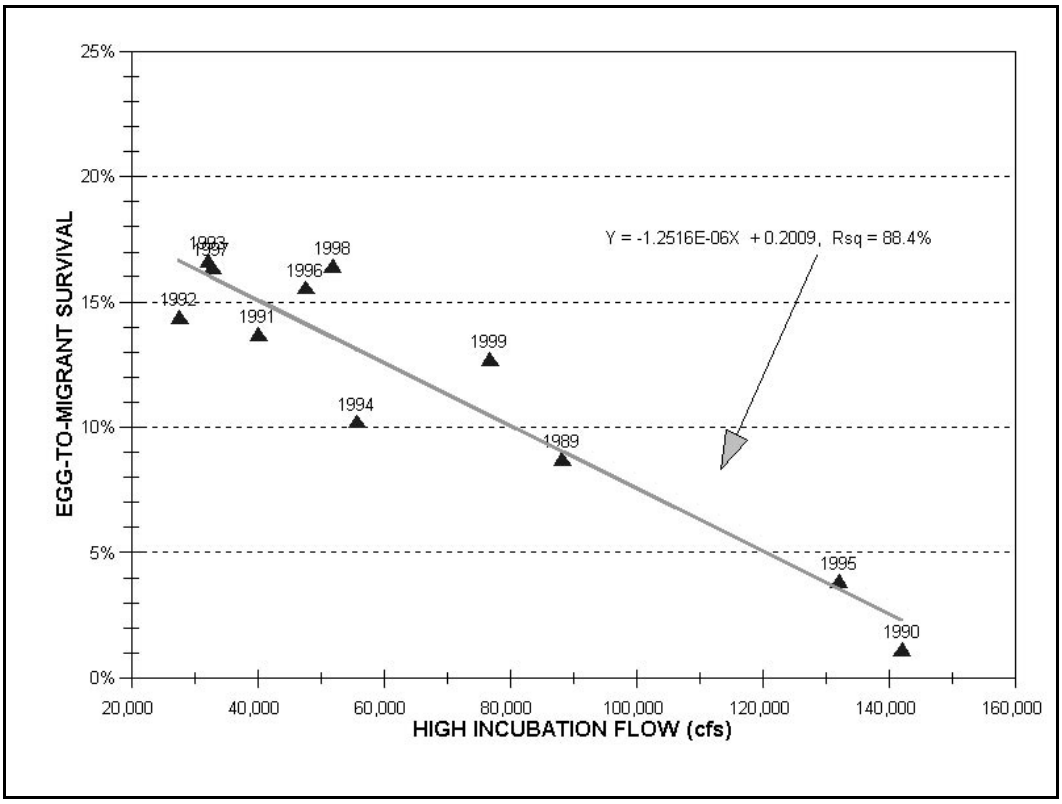

Figure 18. Egg-to-migrant survival estimates of wild 0+ chinook, by brood year, Skagit River.

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

Brood Year (i)	Estimated Esc.[a]		PED @5,500 (million)	Wild Smolts (millions)	Survival to Migration	Winter High Flow	
	Total	Females (@45%)				cfs	Date
1989	8,084	3,638	20.0	1.7	8.7%	88,200	12/05
1990	18,303	8,236	45.3	0.5	1.2%	142,000	11/25
1991	7,060	3,177	17.5	2.4	13.7%	40,100	02/01
1992	8,334	3,750	20.6	3.0	14.4%	27,600	01/26
1993	6,584	2,963	16.3	2.7	16.7%	32,100	12/11
1994	6,019	2,709	14.9	1.5	10.2%	55,700	12/28
1995	7,732	3,479	19.1	0.7	3.9%	132,000	11/30
1996[b]	11,664	5,249	28.9	4.5	15.6%	47,600	01/20
1997	5,913	2,661	14.6	2.4	16.4%	32,800	12/17
1998	15,695	7,063	38.8	6.4	16.5%	51,900	12/14
1999	5,395	2,428	13.4	1.7	12.7%	76,000	11/13

[a] Estimated escapement (from SASSI) does not include returns to the Baker trap or the spring chinook component.

[b] Prior to the 1996 brood, estimates were based on trapping during the coho migration period (April-June). Full-season trapping commenced in 1997.

Literature Cited

Busack, C., C. Knudsen, A. Marshall, S. Phelps, and D. Seiler. 1991. Yakima Hatchery experimental design. WA Dept. of Fish. Ann. Prog. Rpt. prepared for BPA Div. of Fish & Wildlife. Olympia, Washington. 226pp. 6

Conrad, R.H., R.A. Hayman, E. Beamer, and P.J. Goddard. 1997. Coho Salmon Escapement to the Skagit River Estimated Using a Mark-Recapture Method: 1986. Northwest Fishery Resource Bulletin. Proj. Rep. Series No. 6. NWIFC. Olympia, Washington. 1

Puget Sound Salmon Stock Review Group. 1992a. Status of five stocks of Puget Sound chinook and coho -- technical report. Pacific Fishery Management Council. Portland, Oregon. 113pp. 1

Puget Sound Salmon Stock Review Group. 1997. An assessment of the status of Puget Sound chinook and Strait of Juan De Fuca coho stocks, as required under the Salmon Fishery Management Plan. Pacific Fishery Management Council. Portland, Oregon. 1

Seber, G.A.F. 1982. The Estimation of Animal Abundance and Related Parameters. Charles Griffin & Co. Ltd. High Wycombe, England. 3

Seiler, D., P. Hanratty, S. Neuhauser, and M. Ackley. 1984. Upstream/Downstream Salmonid Trapping Project, 1980-1982. WA Dept.of Fish. Prog. Rpt. No. 200. Olympia, Washington. 1

Seiler, D., P. Hanratty, S. Neuhauser, P. Topping, M. Ackley, and L.E. Kishimoto. 1995. Wild Salmon Production and Survival Evaluation Annual Performance Report: October 1993 - September 1994. WA Dept. of Fish & Wildl. Progress Report. Olympia, Washington. 113pp. 2

Seiler, D., S. Neuhauser, and M. Ackley. 1981. Upstream/Downstream Salmonid Trapping Project 1977-1980. WA Dept. of Fish. Prog. Rpt. No. 144. Olympia, Washington. 195pp. 1, 6