

**Smolt Release Strategy for Cheakamus River
Steelhead (*Oncorhynchus mykiss*)
Spring 2007**

Prepared

for

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Executive Summary

Steelhead hatchery smolt release strategies may affect outmigration survival, residualization rates and competition with wild fish. To balance the benefits and risks of various release options, a multi- release strategy has been developed using available information from the literature combined with local operational restrictions. The releases will endeavor to encourage a wide geographic distribution of returning hatchery fish into preferred spawning habitat while minimizing the risk of high levels of residualization and potential swamping of remnant populations of wild spawners. A portion of released fish will be tagged with unique coded internal tags to assist in evaluating the success of these project goals.

Four release sites and two release methods will be utilized. These include:

Steelhead juveniles raised in the Tenderfoot hatchery should be volitionally released into the Cheakamus River via Tenderfoot Lake/Creek. N= ~10,000. Reach 4.

Steelhead juveniles raised in the Fraser Valley Trout Hatchery will be released in three locations;

- 1) Upper River Forced Release N= ~2000 Reach 8*
- 2) Lower River Forced Release N= ~6000, Reach 3*
- 3) Lower River acclimatized release into NVOS spawning channel, N=~2000 Reach 4.*

Plans for assessing residualization and outmigration will be implemented as part of the Acoustic tracking of hatchery-reared and wild Cheakamus River steelhead smolts to address residualization and early ocean survival that commenced in May of 2007.

1. Introduction

In August of 2005 a CN rail car spilled 45,000 liters of sodium hydroxide onto the bank and into the Cheakamus River. This spill resulted in an extensive multi-species fish kill (McCubbing et al. 2006) which included wild, native steelhead trout (*Oncorhynchus mykiss*). A variety of restoration options were explored and evaluated by stakeholders, first nations, fisheries scientists and managers (Labell 2006). One restoration project is a conservation hatchery program. Small, well-managed conservation hatchery programs have been argued as an effective strategy for supplementation (Fleming and Peterson 2001, Hayes et al. 2004).

The Cheakamus program will consist of two years broodstock collection (2006 & 2007) and subsequently two years of smolt releases. Smolt releases are targeted to years where natural production will likely be low following significant year class losses as documented after the spill (McCubbing et al 2006). The first of these two years is 2007 and this proposal evaluates the options and perceived best practice for smolt releases.

Progeny of the 2006 brood year are currently being reared in two hatcheries to minimize potential losses through equipment failure or disease (MoE Supplementation Update November 2006). Approximately 10,000 steelhead smolts are being reared at the Tenderfoot Hatchery located adjacent to Tenderfoot Lake, east of the Cheakamus River at approximately KM5. A similar number of smolts are being raised at the Fraser Valley Trout Hatchery in Abbotsford, BC. The proposed smolt release strategy is presented based upon the current state of knowledge for wild steelhead and an extensive survey of the relevant scientific literature.

2. Hatchery Protocols and Logistical Limitations

Incubation

Each family group was split into two lots. One lot was incubated on 14 degree water, Tenderfoot (TCH group) in order to facilitate smolt size attainment by May 15th of 2007; the second group, Fraser Valley (FVTH group) was incubated on ground water as FVH temperatures will allow for target smolt size attainment (80 g).

Rearing - TCH

In order to meet established smolt size goals (80 grams by May 2007) the TCH group was accelerated on 14 degree C water throughout their stay at FVH. The plan was to transfer these fish to TCH in mid to late October. Unfortunately one group of these fish began to exhibit a minor outbreak of internal myxobacteria (Flavo-bacterium). Due to this, transfer of the TCH group had to be delayed until these fish were treated with anti-biotics and re-examined by a Fish Health Biologist to ensure the fish were acceptable for transfer. This process was completed by late November and a report was submitted to Inter Basin Transfer Committee (ITC) for approval to transfer. Approval was given in early December and 5,477 fish at 27.7 grams were transferred on December 12, 2006 and another 5,373 fish at 44.5 grams were transferred on December 27, 2006.

Rearing - FVTH

The second group of fish being reared at FVTH were kept on groundwater (9.7 degrees C) throughout their rearing cycle until they reached an average weight of 80 grams. At that time it was decided to accelerate them for about 1 month to ensure target smolt size was attained.

3. Technical Considerations

Acclimatization

One available option for the release of hatchery reared salmonid smolts is to hold the fish for a short period at the release site prior to their release into the stream. The purpose of acclimatization is to increase survival and improve the accuracy of homing to the stream of release. This is thought to be of particular importance when fish are reared outside of the watershed of origin and subsequently released

Information in the peer-reviewed literature regarding the use of acclimatization prior to the release of salmonid smolts is equivocal. Kostow (2004) found that acclimatized steelhead hatchery stock had lower smolt-to-adult, egg-to-adult and adult offspring per parent than hatchery smolts directly released into the river. Other studies have found no measurable difference between the homing of steelhead smolts that were acclimatized or released directly (Kenaston et al. 2001). Furthermore, there appears to be little evidence that acclimatization has any positive effect upon marine survival or natal stream selection upon return.

Migration Timing

Hatchery produced steelhead smolts appear to emigrate relatively quickly after their release date (Hayes et al. 2004, Hill et al. 2006, Kenaston et al. 2001, Kostow 2004). Those fish remaining in the river after this point are likely to remain in the river as residualized trout. That is not to say that some of those fish will not leave to the ocean as older fish (McCubbing and Ward 2005, Walters 2006). Wild steelhead generally migrate to the ocean in the spring months of April through June (McCubbing and Ward 1998, 2006) but with some smolts leaving the river throughout the spring, summer and into the fall. Nevertheless, the median emigration date for hatchery and wild smolts appears to be similar and may serve as an appropriate proxy for releasing hatchery reared steelhead smolts (Ostrand 2005). Data from RST operations on the Cheakamus River may also provide guidance on the best time for smolt releases (Melville and McCubbing 2005, 2006). Some studies have indicated that increased survival of steelhead smolts may be observed in hatchery releases that are undertaken prior to peak wild fish movement, in particular when co-incident with peak coho smolt migration (REF). Reasons for these observations are unclear, but may be linked to reduced predation due to high numbers of outmigrants or early smoltification in hatchery reared individuals.

Competition

Hatchery reared smolts are usually larger than their wild counterparts at similar ages. The introduction of large numbers of hatchery smolts into a natural system containing wild fish presents the opportunity for competition between the two forms. Researchers have found that

both types of smolts will use similar habitat (Hill et al. 2006) and that residualized smolts will out compete other resident species, i.e. Cutthroat trout (MoE Keogh River data on file).

Survival

Hatchery fish have high egg-to-smolt survival because of the characteristics of being reared in captivity. Kostow (2004) found hatchery steelhead to have greater than 60% survival as compared to under 2% egg-to-smolt survival for wild fish. The opposite pattern was seen, however, for smolt-to-adult survival with wild steelhead having higher survival than hatchery reared smolts. Recent data collected at the Keogh River research station indicates hatchery fish survive at approximately one half to one third the rate of wild fish (McCubbing 2005 and McCubbing and Ward 2006) which is currently less than 2% in most smolt year classes.

Residualization

Any hatchery released smolt, which fails to migrate to the ocean after a short period of time is termed a residual. Residual steelhead can be problematic in that they may compete with wild salmonids and other species for habitat and food (McMichael et al. 2000, Werlen 2004, Walters 2005). It appears that hatchery reared smolts that occupy the smaller and larger end of the size distribution will be more likely to remain in the stream as residuals (Tipping et al. 2003, Walters 2005). Residualism rates are the byproduct of a large number of factors (rearing density, release size, survival, etc.) and cannot be accurately predicted. McMichael et al 2000 estimated that 26-39% of steelhead smolts released in the Yakima River, Washington failed to migrate one month after release. Much lower residual rates (1-6%) were seen for steelhead released in Abernathy Creek, Washington (Ostrand 2005). While on the Keogh River, North Vancouver Island residualization varied annually from less than 5% to over 15% (Walters 2005 and data on file).

Residualized steelhead may not stay in the area of their initial release (Slaney and Harrower 1981). Studies have found that residualized steelhead can move as much as 7km (Walters 2005, Werlen 2004) to over 12 km upstream from their release site into areas where other salmonids reside (McMichael and Pearsons 2001). Others, however, have shown that residual steelhead distribute themselves within one kilometer downstream of the release site (Ostrand 2005).

Residuals may also consist of two components. These include fish which are generally larger maturing males, whom will remain in the watershed and attempt to breed without an ocean phase (Walters 2005 and Werlen 2004) and smaller individuals of both sexes, which may grow for an additional year in freshwater prior to outmigration (McCubbing 2005, McCubbing and Ward 2006, Walters 2005).

Survival of these fish through the first winter post release is varied and unpredictable (Slaney and Harrower 1981, McCubbing 2005) and may be linked to food availability and predator levels.

Fish Size

Hatchery released steelhead smolt sizes should, if possible, be as close to optimal for smolting. Cannamela (1992) suggests that smolts should average about 200-210 mm fork length at release with a tight distribution around the mean. This will tend to maximize survival and outmigration while minimizing competition and residualization. Walters 2005 and Werlen 2004 found fish >220mm and <170mm were most likely to residualize in Keogh River.

4. Release Strategy Options

General

Release strategies for steelhead smolts fall into a number of general categories;

- Forced: fish released directly into the river from a remote (in or out of basin) source at about the time of typical wild juvenile migration
- Acclimatized: fish moved into the watershed (e.g. in a holding pond) 4 to 8 weeks prior to release for “imprinting” and then force released.
- Volitional: fish reared within the watershed in pens or ponds on local water for a significant period of time (>6 months) prior to an obstacle to migration being removed within the wild migration period in the spring.

Releases of smolts into areas of low adult spawning, Reach 1, 2, 6 & 7 will be avoided in case returning adults home to these locations where spawning conditions may be sub optimal due to high sediment loading during spring freshet or excessive bed load movement.

Optimal Release Dates

Attempts to optimize the release timing of hatchery steelhead juveniles into the Cheakamus should take into account recommendations from peer reviewed literature discussed previously in this document to maximize survival and minimize residulization. In addition information from local sources can be utilized. Steelhead smolt migration timing data are available from the Cheakamus rotary screw traps (RST) and side channel traps (Figure 1, & Melville & McCubbing 2005, 2006) and the Keogh River (McCubbing and Ward 2005). For the Cheakamus River, capture records at the RST site represent only a small proportion of the total outmigration. Instead data from the Paradise side channel trap was examined as it is a full capture fence (Figure 3). Data collected at this trap since 2001, indicates peak migration timing of steelhead smolts leaving the Cheakamus River appear to occur between May 1 and 15th. In all years $\geq 85\%$ of fish captured at the Paradise channel trap have been caught by May 20th (Figure 4). This timing is slightly earlier than at the Keogh River where peak outmigration normally occurs in the third week of May (Figure 5), except in years of high flow when it may be skewed early (McCubbing and Ward 2003, 2005). RST data from the Cheakamus River concurs with this slightly earlier outmigration than Keogh (Figure 6)

In an effort to limit residulization and maximize survival of hatchery released steelhead smolts a likely release time would be from May 1st to 20th.

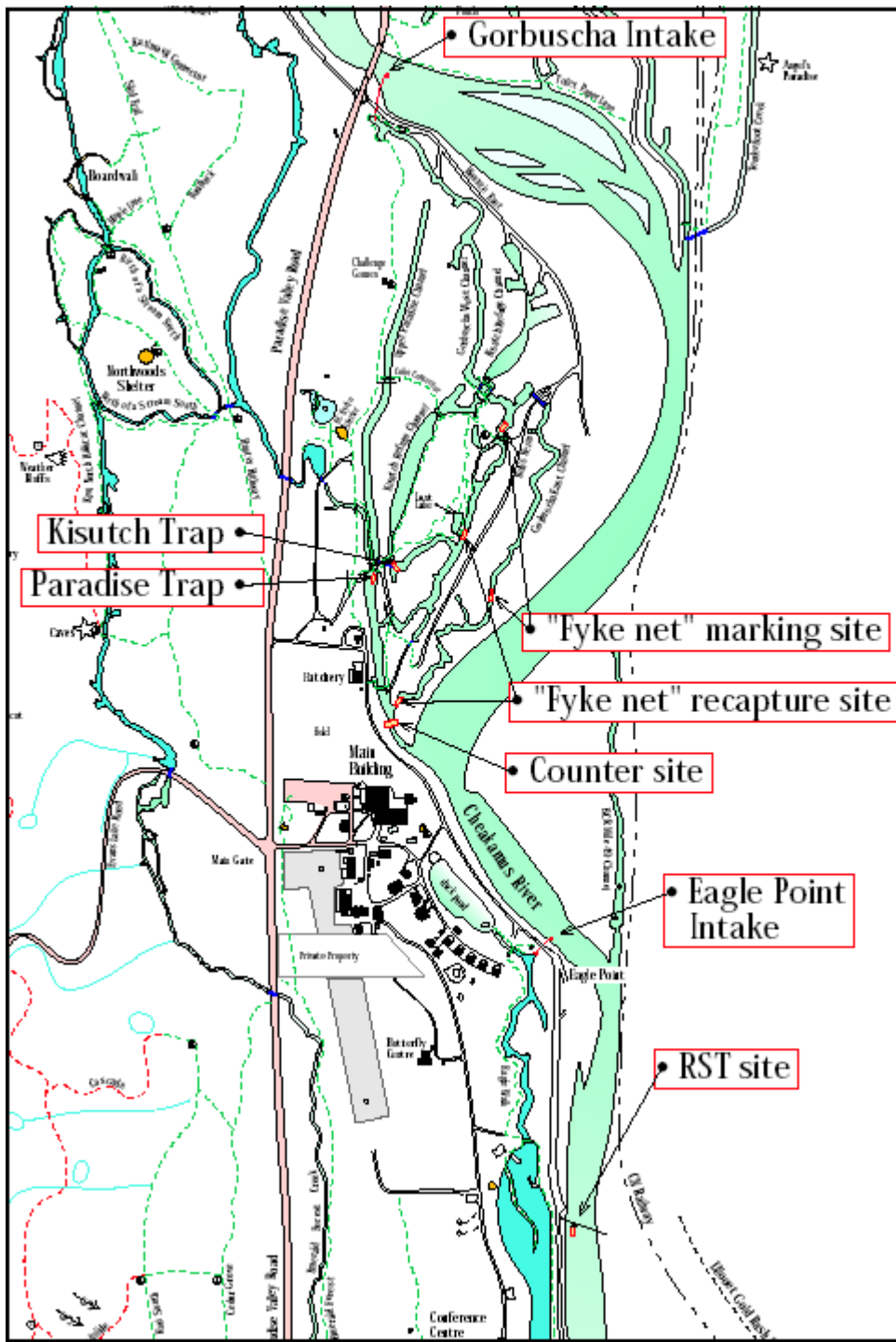


Figure 1. Site Map indicating trap sites utilized in 2006 (Paradise Trap and RST site) as well as proposed trap sites for smolts (Counter site) and fry (Fyke net sites) on the Cheakamus River.

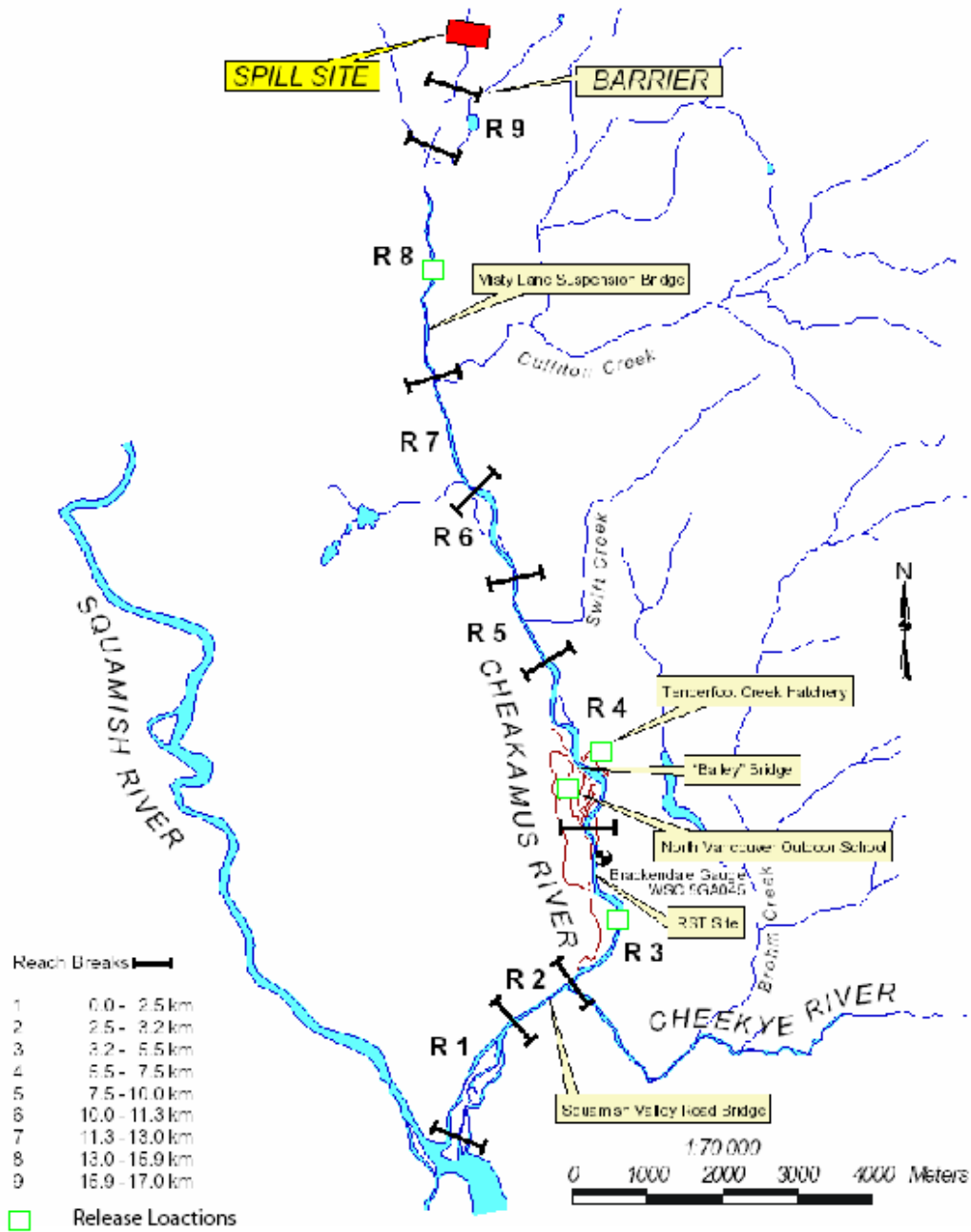


Figure 2. Site map indicating proposed release sites and sampling traps on the Cheakamus River.

Proposed Release Strategies

A) *Tenderfoot Hatchery-reared Steelhead*

Steelhead juveniles raised in the Tenderfoot hatchery should be volitionally released into the Cheakamus River via Tenderfoot Lake/Creek. N= ~10,000. Reach 4.

The reasoning behind this recommendation relates to reduced fish handling and associated stress, natural selection of migration timing and contained residualization. Handling of fish is reduced as pen gates can be opened allowing access to the Cheakamus River via Tenderfoot Lake /Creek. This requires no road transport, which is stressful and potentially deleterious to fish health due to loading, movement and unloading. The pen gates can be opened during the early part of the wild smolt migration period when fish are at release target size and exhibit smoltification (but post April 30th) allowing a passive rather than forced out-migration with Tenderfoot Lake and a further period of acclimatization as required. This method may be of additional benefit as 1-year steelhead smolts reared for their final 5 months in a pond environment showed significantly better seawater tolerance than fish reared in traditional raceways (Zydlowski et al. 2003).

Fish released into the lake should be monitored at Tenderfoot Creek in order to determine the proportion of smolts which out-migrate and evaluate delayed out-migrants. These delayed out-migrants may have or are likely to residualize and can be sampled and removed if required from the watershed. Non-migrant fish remaining in Tenderfoot Lake after June could be sampled and actively removed or the public invited to fish for them in subsequent years.

An opportunity to evaluate late migrants/residuals may occur as part of BC Hydro's evaluation of the new Cheakamus Water Use Plan. A trap/counting facility is proposed for Tenderfoot Creek during the smolt outmigration period. This facility might be operated in late June and July under a separate project and with BC Hydro approval (for equipment loan) to capture and sample/remove late outmigrants which would likely remain within the Cheakamus watershed as residuals.

B) *Fraser Valley Trout Hatchery (FVTH)-reared Steelhead*

Several release strategies are proposed for Steelhead juveniles raised at the FVTH.

Smolt releases directly into the Cheakamus River should be spread over an extended area of the mainstem to avoid localized impacts. Large numbers of releases should be avoided where high densities of wild steelhead reside to minimize ecological risks to wild stocks. Releasing hatchery fish at dusk may further reduce competitive interactions because these smolts move quickly downstream and naturally move at night (McMichael et al. 2000, Ostrand 2005). Hatchery releases should be, if possible, in areas of high habitat complexity to allow for habitat partitioning and subsequent reduction of competition between wild and hatchery smolts. Exact release timing will be in part determined by the size and maturation of smolts, but will fall within the timing set by natural smolt outmigration.

1) Upper River Forced Release N= ~2000 Reach 8

The upper river release will be undertaken at “road end”. This release will occur in the period May 1st to May 20th. These fish will have cwt.

2) Lower River Forced Release N= ~6000 Reach 3

The lower river release will be undertaken at “Moody’s”. This release will occur in the period May 1st to May 20th. Fish will be adipose clipped with no additional tags. These fish have a CWT at this time.

3) Lower River acclimatized release N=~2000 Reach 4

A mid river release of approximately 2000 fish is proposed into an NVOS spawning channel. These fish will be released in the week of May 15th. These fish have CWT at this time

The outmigration of this release may be monitored through operation of a full channel smolt trap as part of BC Hydro’s Water Use Plan monitors and subsequent to operations (post June 15th) residuals may be sampled/removed. Returns of adults to these spawning channels will be monitored through the operation of an adult trap facility at the same location in future years.

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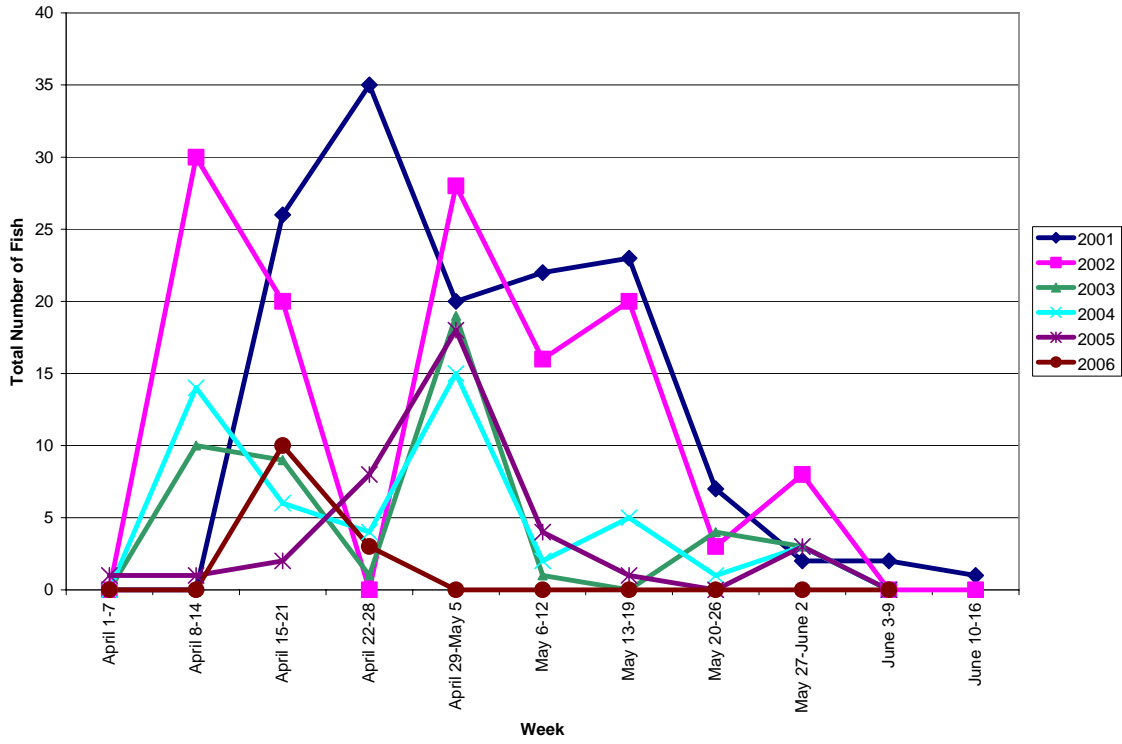


Figure 3. Outmigration timing of steelhead smolts leaving Paradise channel on the Cheakamus River 2001-2006

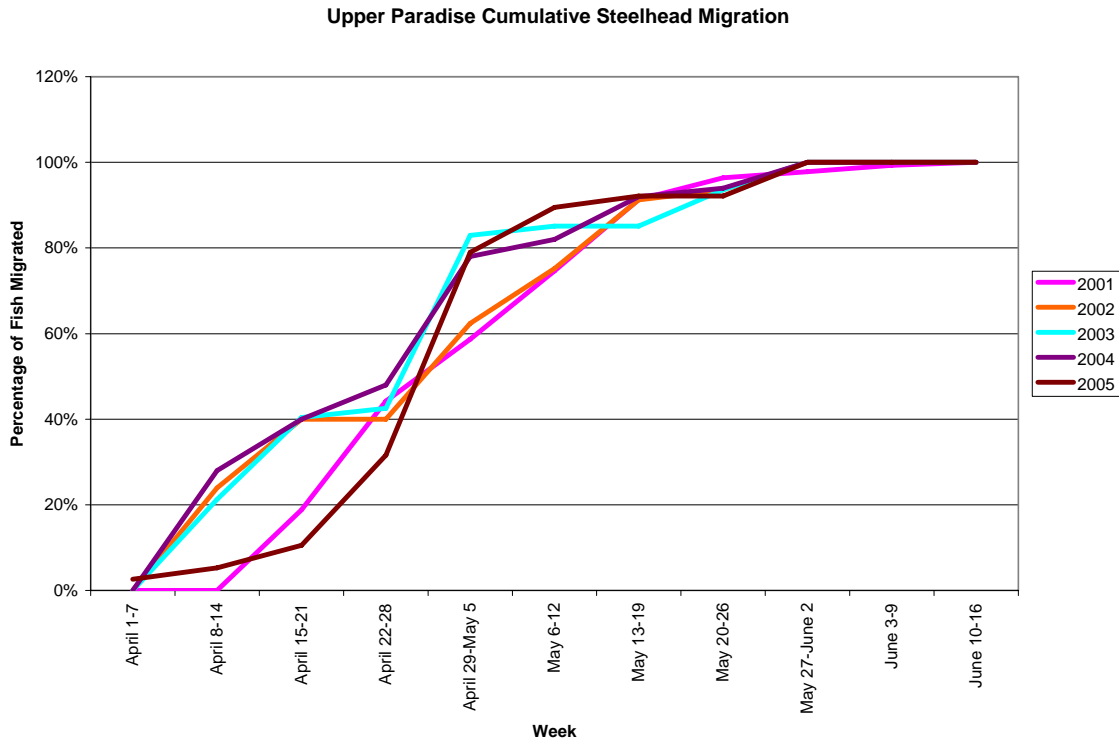


Figure 4. Upper Paradise Channel cumulative steelhead smolt outmigration run time data at the fish fence from 2000 through 2005.

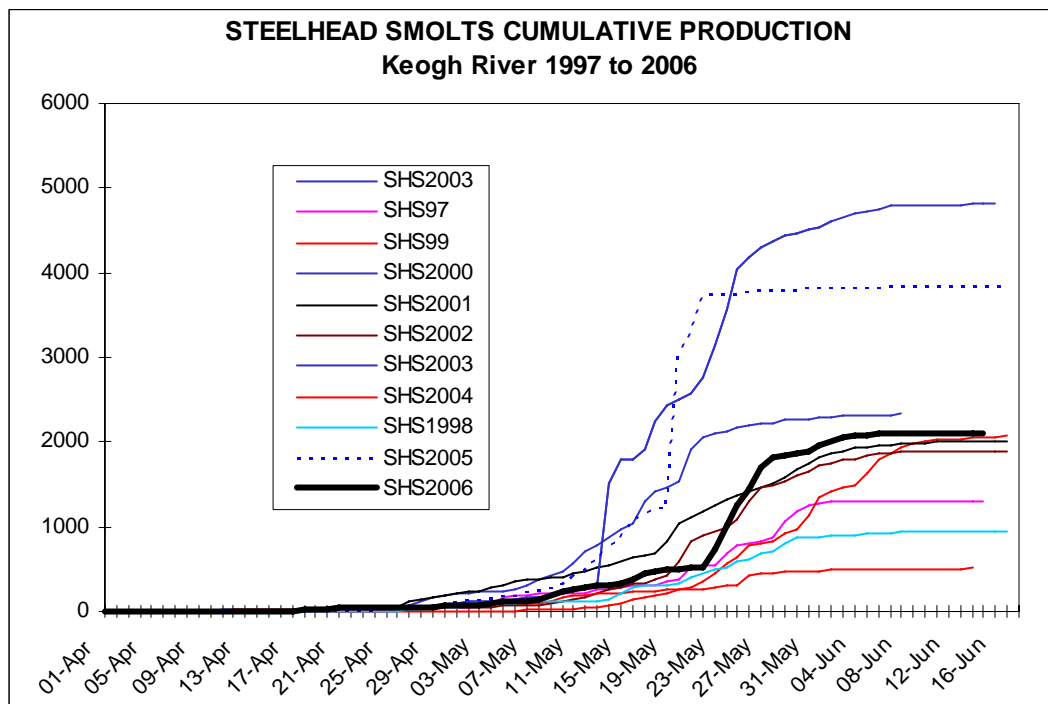


Figure 5. Keogh River cumulative steelhead smolt outmigration run time data at the fish fence from 1997 through 2006.

Cheakamus River Cumulative RST Steelhead Migration

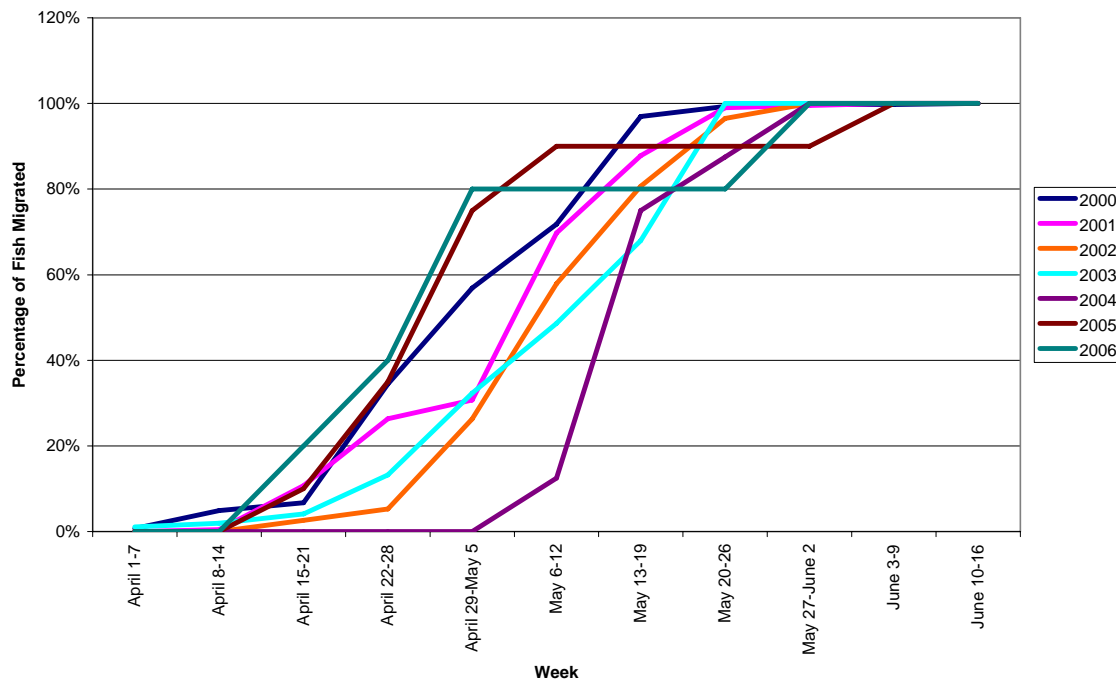


Figure 6. Cheakamus River RST raw catch catch as an indicator of cumulative steelhead smolt outmigration run time data from 2000 through 2006. Note: Trap efficiencies change with time and are lower later in the season and may bias results.