

**Smolt Release Strategy for Cheakamus River  
Steelhead (*Oncorhynchus mykiss*)  
Spring 2008**

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. The 2008 release strategies take into account information collected following the 2007 release of smolts.

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

*Steelhead juveniles raised in the Tenderfoot hatchery will be volitionally released into the Cheakamus River via Tenderfoot Lake/Creek. N= ~8,000. Reach 4.*

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

- 1) Upper River Forced Release N= ~4000, Reach 8*
- 2) Lower River Forced Release N= ~3000, Reach 3*
- 3) Lower River acclimatized release into Gorbushca spawning channel, N=~1000 Reach 4.*

Plans for assessing residualization and outmigration will be developed as part of the Cheakamus River Supplementation Terms of Reference Monitors.

## 1. Introduction

In August of 2005 a CN rail car spilled approximately 41,000 liters of sodium hydroxide 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 recovery options for steelhead trout were explored and evaluated by stakeholders, First Nations, fisheries scientists and managers (Labell 2006; Triton 2006). One of those recovery options 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 River program consists 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 second of these two years is 2008 and this proposal evaluates the options and perceived best practice for smolt releases based on a literature review and observations following year 1 (2007) smolt releases.

Progeny of the 2007 brood year are currently being reared in two hatcheries to minimize potential losses through equipment failure or disease (MoE Supplementation Update November 2006; www.certc.ca). Approximately 8,000 steelhead smolts are being reared at the Tenderfoot Hatchery located adjacent to Tenderfoot Lake, east of the Cheakamus River at approximately river 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. 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 subsequent release

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 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 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 survival.

### *Migration Timing*

Hatchery produced smolts appear to emigrate relatively quickly after their release date (Hayes et al. 2004, Hill et al. 2006, Kenaston et al. 2001, Kostow 2004). 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), with some smolts leaving the river throughout the spring, summer and into the fall, but the ocean survival of these late migrants is unknown. 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 rotary screw trap (RST) operations in the Cheakamus River may also provide guidance on the best time for smolt releases (Melville and McCubbing 2005). Some studies have indicated increased survival of steelhead smolts may be observed in hatchery releases undertaken prior to peak wild fish movement, in particular when co-incidental with peak coho smolt migration. Reasons for these observations are unclear, but may be linked to reduced predation due to the high number 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). Therefore in order to minimize competition between hatchery and wild steelhead juveniles it is desirable to minimize the amount of time hatchery juveniles spend in the river after their release.

### *Survival*

Hatchery fish have high egg-to-smolt survival resulting from 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 is 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, food and spawning opportunity (McMichael et al. 2000, Werlen 2004, Walters 2005). It appears 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 residualized steelhead can move as much as 7 km (Walters 2005, Werlen 2004) to over 12 km upstream from their release site into areas where other salmonids reside (McMichael and Pearsons 2001). Others studies however, suggest 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 2005, 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, be as close to optimal as possible for smolting. Cannamela (1992) suggests smolts should average 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 living gene bank releases.

## **2. Smolt Release Review 2007**

### **Release Numbers and Dates**

A total of 21,480 smolts were released in Year 1 of the program. The method and location of release followed broadly the proposed smolt release strategy of varying release dates, methods and sites to potentially maximize survival and distribution of returning adults while minimizing affects of residuals (McCubbing and Ladell (2006) – available at [www.certc.ca](http://www.certc.ca)).

#### **FVTH Reared Fish**

A total of 10,679 smolts (ave. weight 77 g) were released directly from the Fraser Valley Trout Hatchery (FVTH) of which 81 were tagged with POST acoustic tags. Of these 2,000 were released at an upstream site (river kilometre 14.5) and 2,000 into Sues' Channel at the NVOs property on May 11, 2007. The remaining 6,679 fish were released at Sunwolf (including the acoustic tagged fish) on May 23, 2007.

#### **Tenderfoot Hatchery Reared Fish**

A total of 10,826 steelhead smolts with average weight of 66g were released volitionally from Tenderfoot Creek Hatchery (TCH) on May 6, 2007. Many of these fish passed through the BC Hydro fish enumeration site on Tenderfoot Creek within a few days, and some were observed several weeks later on the BC Rail channel fish counter upstream of the Tenderfoot confluence.

## **Marine Survival**

Smolts reared at Tenderfoot Creek Hatchery had higher estimated survivorship downstream ( $0.56 + 0.10$  s.e.) and through the Strait of Georgia ecosystem ( $0.18 + 0.10$  s.e.) than smolts reared at Fraser Valley Trout Hatchery (downstream,  $0.32 + 0.06$  s.e.; SOG,  $0.024 + 0.047$  s.e.) (Melnychuk et al. 2008). This difference could be due to several factors including release time, body size, fish transport, and rearing histories. Both hatchery-reared smolt groups in 2007 had lower survivorship downstream and through the early ocean migration than wild Cheakamus River smolts in 2004 and 2005 (Melnychuk et al. 2008). Due to the possibility of interannual variability in survival and/or residualisation rates, conclusions should be made with caution involving comparisons between wild and hatchery-reared groups from these studies in different years, but direct comparisons should be possible in the 2008 portion of the study when both hatchery and wild reared smolts are expected to be tagged.

## **Residual Monitoring**

Observations of residualized smolts and delayed outmigrants at the Cheakamus River following the release of smolts in 2007 was limited. A full channel trap on Upper Paradise channel recorded 3 fish emigrating in late June when water levels allowed operation. These fish were tagged with a PIT tag and released. A few fish (3) were captured during juvenile steelhead population evaluations in the fall months (October) with distribution appearing widespread (J. Korman, Esq., pers comm.). These fish were captured in reach 3, 4 and 5 and measured 263, 325 and 290 mm fork length. As 6,591 wild fish were also sampled in these surveys, overall densities of residuals appeared to be low relative to wild fish. Incidental angler catches of small clipped rainbow trout were also reported in the fall of 2007, in the area of the Cheekye/Cheakamus confluence (B. Klassen, pers comm.).

Acoustic tracking surveys undertaken in the spring of 2007 indicated between 20 and 35% of tagged smolts were not detected entering the ocean arrays in Howe Sound (Melnychuk et al. 2008). However, no detections of these tagged fish were observed post June on the in-river arrays. This may be a result of tagged fish leaving the immediate area of the Cheakamus River without detection due to array efficiency issues, or tagged fish remained in the local area. If present in the river post June 2007, the fish either moved only short distances or were removed from the population by mortality (possibly linked with predation), or by anglers. Further work is proposed to address these uncertainties in the spring of 2008.

More recent surveys in the spring of 2008; RST trapping, angler questioning and diver surveys have not identified any remaining residuals.

## **3. 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 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 River should take into account recommendations from peer reviewed literature discussed previously in this document to maximize survival and minimize residualization. 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 and McCubbing 2005) 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. Data collected at this trap since 2001, indicates peak migration timing of steelhead smolts leaving the Cheakamus River appears to occur between approximately May 1 and 15 (Figure 3). In all years  $\geq 85\%$  of fish captured at the Paradise channel trap have been caught by May 20<sup>th</sup> (Figure 4). This timing is slightly earlier than at the Keogh River where peak out migration 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 (Figure 6).

In an effort to limit residualization and maximize survival of hatchery released steelhead smolts the proposed release timing is between May 4 and May 20, 2008.

### **Proposed 2008 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= ~8,000. Reach 4 in early May.*

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 as it requires loading, movement and unloading. The pen gates can be opened during the early part of the wild smolt migration period (early May) allowing passive rather than forced out-migration with Tenderfoot Lake allowing 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 (Zydlewski et al. 2003).

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 being operated at Tenderfoot Creek during the smolt out migration period. This facility might be operated in late June and July under a separate project and with BC Hydro approval could capture and sample/remove late outmigrants which otherwise would be expected to remain within the Cheakamus watershed as residuals.

All fish will have their adipose fin removed prior to release, so they can be identified upon return. Steelhead smolts from Fraser Valley Trout Hatchery (FVTH) have also been implanted with coded wire tags while smolts from Tenderfoot Creek (TCH), only had their adipose fins removed. This will allow for differentiating the two rearing groups when they return as adults.

***Within this release group will be 40 acoustic tagged individuals (tagged on April 14, 2008).***

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.

*1) Upper River Forced Release N= ~4000 Reach 8*

The upper river release will be undertaken at "road end". This release will occur in the period May 1 to May 10, 2008 about the same time as Tenderfoot fish will be voluntarily released.

***Within this release group will be 40 acoustic tagged individuals (tagged on April 15, 2008).***

*2) Lower River Forced Release N= ~3000 Reach 3*

The lower river release will be undertaken at the Cheekye confluence. This release will occur in the period May 4 to May 20, 2008.

***Within this release group will be 20 acoustic tagged individuals (tagged on April 15, 2008).***

*3) Lower River acclimatized release N=~1000 Reach 4*

A mid river release of 2000 fish is proposed into the Gorbushca spawning channel. These fish will be released in the first week of May.

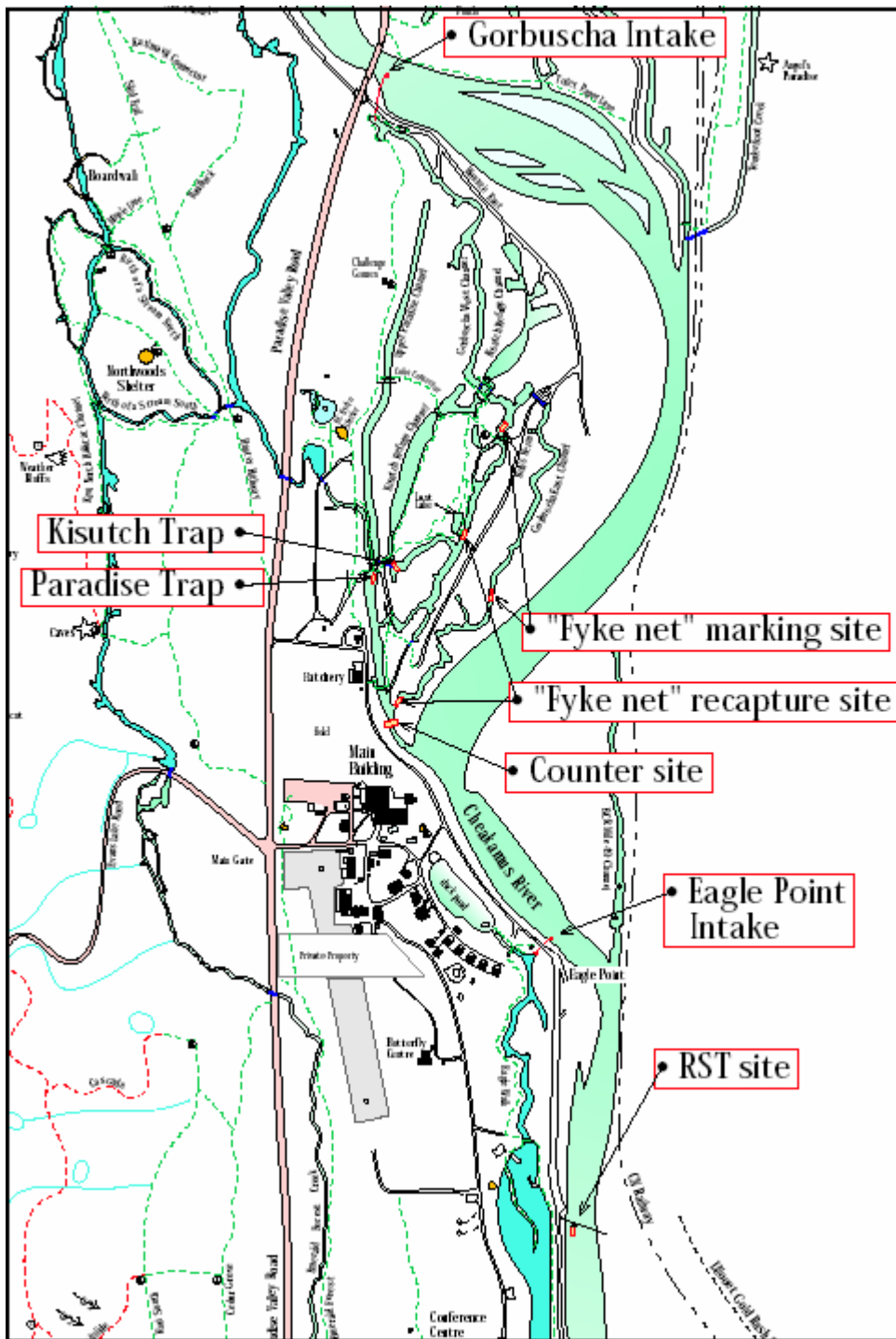
***Within this release group will be 20 acoustic tagged individuals (tagged on April 15, 2008).***

The outmigration of this release may be monitored through operation of a proposed full channel smolt trap as part of BC Hydro's Water Use Plan monitors and subsequent to operations (post June 15, 2008) 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.

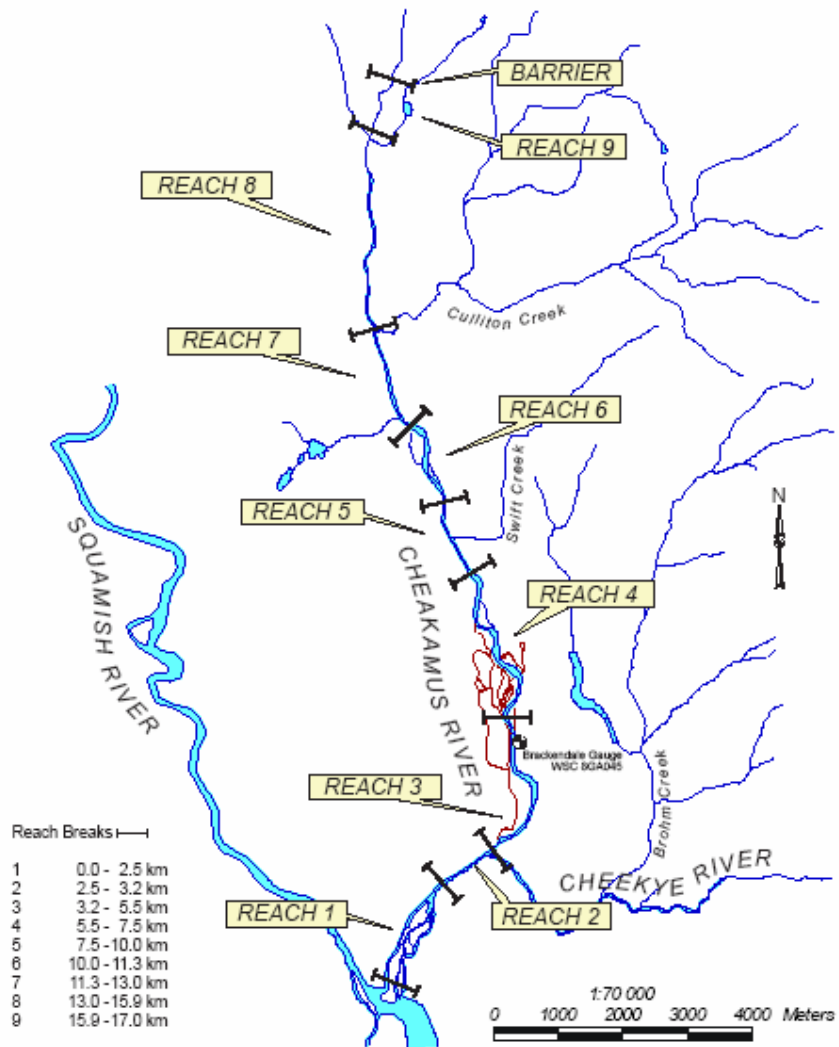
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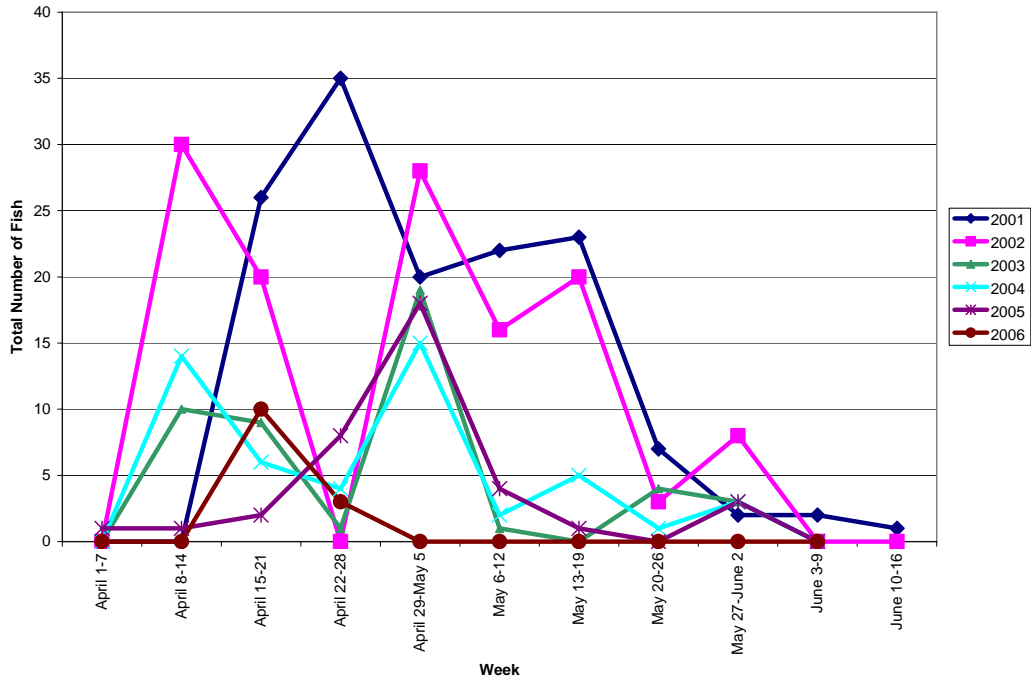
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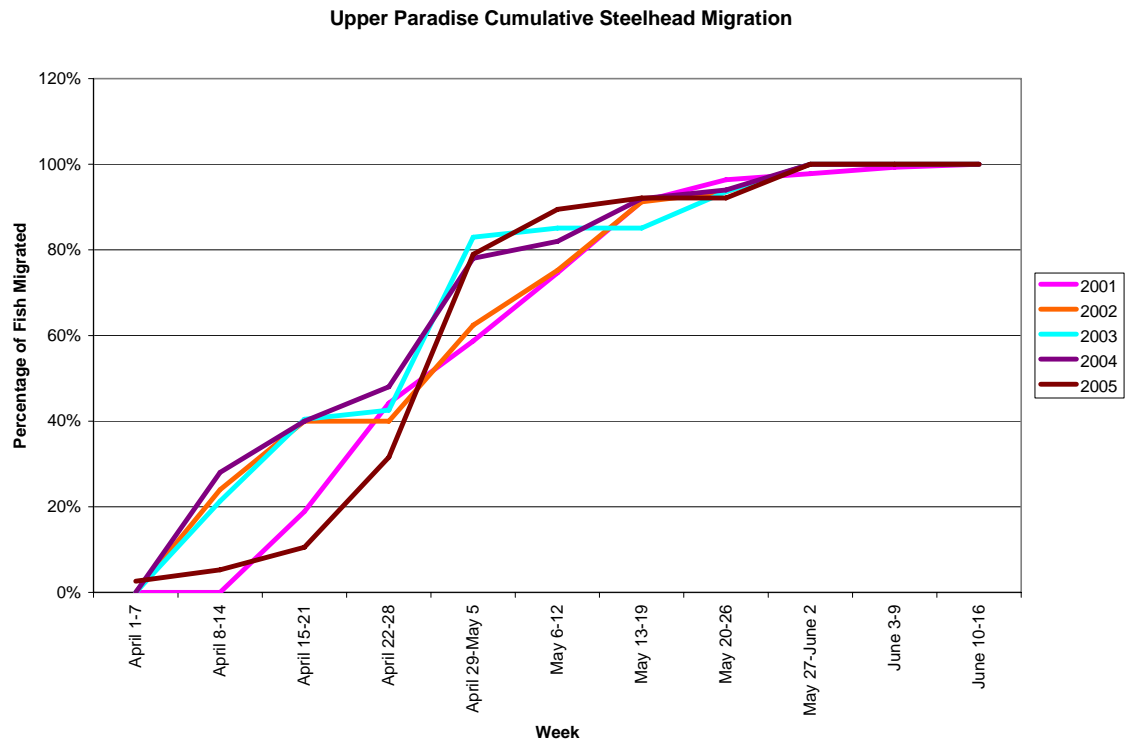
**Figure 1.** Site Map indicating trap sites utilized in 2008 (Paradise Trap and RST site) as well as proposed trap sites for smolts (Counter site) on the Cheakamus River.



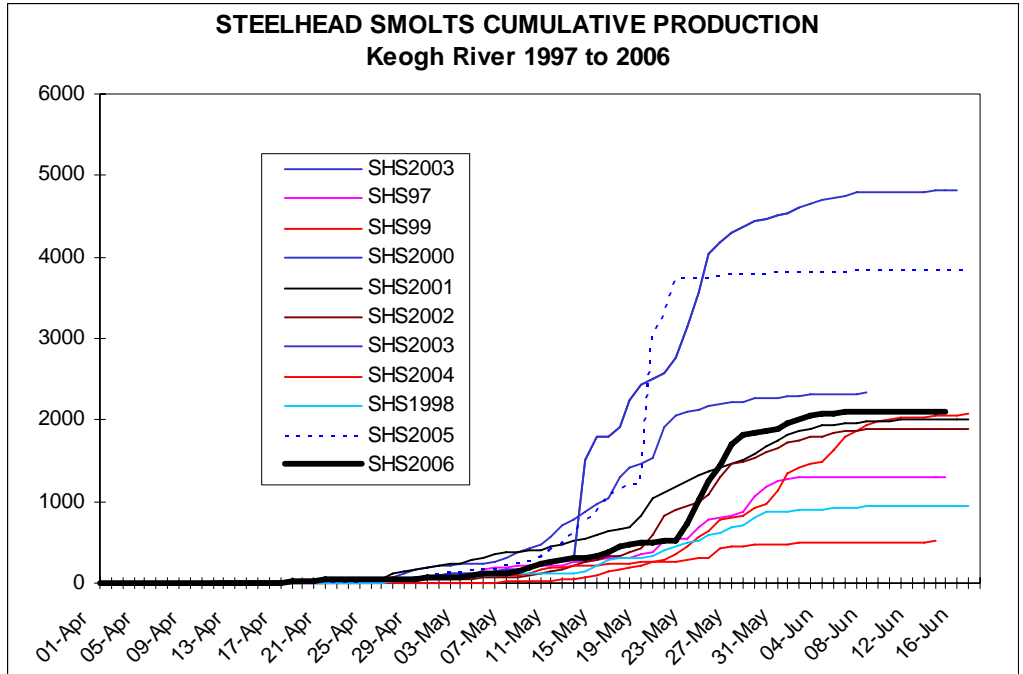
**Figure 2.** Site map indicating proposed release sites (reaches 8 and 3) and sampling traps on the Cheakamus River.



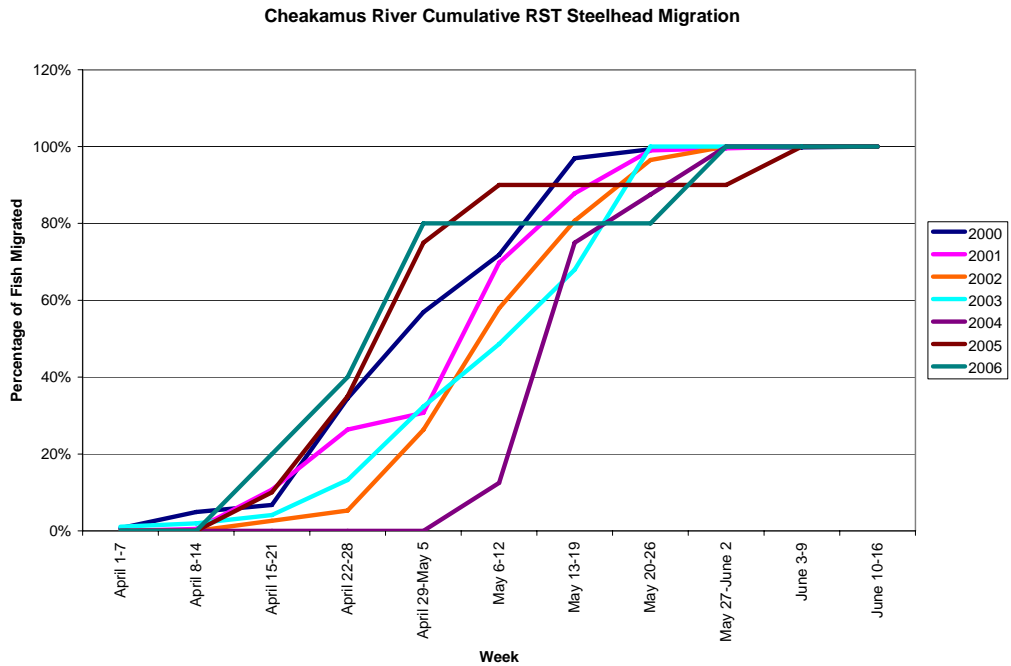
**Figure 3.** Out migration timing of steelhead smolts leaving Paradise channel on the Cheakamus River 2001-2006.



**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.



**Figure 6.** Cheakamus River RST catch an indicator of cumulative steelhead smolt outmigration run time data from 2000 through 2006.