

Steelhead Broodstock Capture 2007 Cheakamus River Proposed Protocol CN Spill Recovery Supplementation

Prepared

for

Greg Wilson

Ministry of Environment

by

D.J.F. McCubbing and C. Melville

December 2006



InStream Fisheries Research Inc.
223-2906 West Broadway, Vancouver, BC, V6K 2G8
Tel 604-737-1510
Fax 604-737-1595
email don@instream.net
www.instream.net

Executive Summary

The collection of suitable broodstock is a key element of the potential success of any conservation hatchery supplementation program. In principle a diverse selection of genetic material is the key goal, avoiding the risk of selecting individuals destined to be from one life history strategy, for example, skewed to early return, smaller fish. This may be achieved by selecting individuals from a range of sizes over a period of several weeks or months, and from different geographic locations. This should ensure broodstock encompass different adult return strategies and potentially a broad genetic diversity.

In the case of the Cheakamus River, broodstock can be adequately collected through angling and various age classes of fish represented through selection of a variety of sizes of fish. As Brohm Creek adult spawners appear to exhibit a return strategy somewhat different from other Cheakamus steelhead (early run, smaller fish, with low repeat spawner frequency), selection of these should be avoided where possible. This potential sub-stock was largely unaffected by the 2005 spill and is thus likely to be present in numbers sufficient to seed the Brohm to capacity even in affected years. If used they may not migrate sufficiently far up the Cheakamus to seed the upper river area on return and are perhaps maladapted for spawning and rearing in lower river conditions.

Based on 5 years of radio telemetry observations a broodstock collection protocol has been developed for the collection of 10 pairs of broodstock. The following guidelines should ensure a broad variety of genetic material, while reducing the risk of magnification of Brohm Creek genetics in the hatchery produced smolts:

Protocol 1: Fish above 750mm in length should represent >70% of the total broodstock collection to avoid selecting Brohm Creek and over selection of lower river spawners.

Note: Targeting some fish larger than 900mm would increase the chances of selecting upper river spawners

Protocol 2: Fish captures should be targeted after March 1st to reduce Brohm Creek fish being introduced to the broodstock.

Note: Captures post March 15th will favour the capture of Upper River spawners which may form a discrete genetic population.

Protocol 3: Fish for brood stock collection should be captured above the confluence with the Cheekye River

Note: A buffer zone to Moodys side-channel could be instigated to avoid handling Brohm creek fish which spend considerable time resident in the pool above the Cheekye river confluence

Introduction

The objective of this supplementation work is to increase the numbers of steelhead returning to the river for a period of three years during a period of likely poor wild fish returns due to the CN caustic soda spill and resultant fish kill on August 5th 2005 (McCubbing et al 2006). It is hoped that this supplementation will improve steelhead adults numerically and reduce the time of recovery from the spill related fish mortality by increasing spawner numbers. No harvest will be allowed on returning hatchery origin adults to maximize escapement. At the time of commencement of this work, ocean conditions remain poor (McCubbing and Ward 2005) and return rates of smolts (hatchery or wild origin) will likely remain low.

Based on radio tracking data collected during recent population enumeration studies (1999-2006) three or more possibly discrete spawning areas are utilized by adult steelhead in the Cheakamus watershed. These can be generally classified as Brohm Creek (a tributary of the Cheekye River), the Cheakamus river upstream of Culliton Creek and the Cheakamus river downstream of the Bailey Bridge (RK 5). Due to glacial sediments emanating from Culliton Creek, few fish have been observed spawning downstream of Culliton Creek for several kilometres.

Juvenile steelhead rear throughout the Cheakamus rivers anadromous reach although survey data indicates higher densities are observed in the mid and upper river areas above the Cheekye River confluence, Figure 1. An estimated 90% or greater of these fish died during the spill event (McCubbing et al 2006). Fish rearing at the time of the incident in Brohm Creek, a productive lower river tributary would not have been directly affected by the spill. Brohm Creek while providing a small area of rearing habitat, has been observed to be one of the most productive steelhead producers in British Columbia (Van Dishoeck, 2002a & b). There is also likely some rearing of Brohm Creek fish in the Cheekye River although perhaps low numbers during summer freshet when glacial sediments limit suitable habitat. Fish rearing in the lower Cheakamus River may comprise of fish displaced from Brohm Creek based on observations of parr redistributions at elevated densities as observed both from RST data (Melville and McCubbing 2005) and at the Keogh River (data on file). Any Brohm origin steelhead juveniles which were in the mainstem at the time of the incident would have been detrimentally effected by the spill.

In summary young steelhead (fry and parr) rearing throughout the main river anadromous reach were greatly affected by the spill related fish kill (McCubbing et al 2006). *However fish rearing in Brohm Creek or the Cheekye River at the toime of the incident were unaffected by*

the spill. These fish may have resulted in some recolonisation of the lower main river post spill.

Provincial Broodstock Collection Policy

Provincial policy on broodstock collection is to select wild fish from the watershed into which their progeny will be released. This policy assumes that any population is genetically adapted for the watershed it inhabits and is thus the best choice for establishing successful returns once smolts are released.

Target Broodstock Collection.

A target for collection of 10 pairs of steelhead brood adults (10 male and 10 female) has been derived for the Cheakamus steelhead supplementation program (Labelle 2006). This target is based on two elements: the risk of removing wild fish from the river where they may be more productive than normal due to reduced competition and predation following significant losses of other fishes from the ecosystem, and the wish to avoid swamping the returning wild adults which were effected by the spill (>95% loss of juveniles year classes) with a large number of hatchery fish derived from a small parental contribution of unknown genetic diversity.

Key objectives of local protocol.

Local protocol for the collection of adult brood fish should aim to provide a wide genetic representation of fish similar to those lost from this watershed, excepting for the restrictions in sample size created by smolt release targets which were established to reduce the risk of hatchery returns genetically swarming predicted low numbers of wild spawners (Korman 2005). This might be achieved by selecting fish which vary in:

- Age
- Size
- Spawn timing
- Spawning location
- Repeat spawner frequency
- Minimize affects on remaining wild brood
- Avoid potential holding losses in the hatchery

Brohm Creek Spawners

It is proposed that Brohm steelhead adult spawners might be genetically distinct from the populace of Cheakamus spawners. In general biological and life history information collected from known spawners are different in Brohm fish than they are for upper river spawners, with lower river spawners falling somewhere in between. In general terms and despite low annual sample size, Brohm fish exhibit trends towards:

- Smaller adults - dominated by maiden 2 ocean spawners (data on file)
- Skewed early river entry (pre March 15th)
- Outmigrate as younger smolts (mean = 2 year old)
- Low repeat spawner frequency

Studies on microsatellite allele frequency has indicated that variances in these population characteristics may be co-incident with significant variances in genetic fingerprinting (McCubbing and Hartley 1994) and are possibly inherited traits. Brohm creek is a small watershed (average wetted width 5m) accessed through the Cheekye River an unstable glacial stream. Larger spawners are not required to establish redds in the small pools and pocket gravel areas and would be vulnerable to increased predation. Early river entry is probably required as the Cheekye River “blows” out from early April in some years, apparently limiting access to the spawning area in Brohm Creek due to sediment movement and excessively high turbidity (BC Hydro data on file). Young smolts are produced due to high invertebrate/algal production, a result of naturally occurring phosphorous from volcanic rocks in the watershed and despite high fry and parr densities.

Based on these observations and the perceived limited affect of the spill on Brohm derived juveniles it is proposed that while the collection protocol should adhere to the principles of maximizing genetic diversity, the selection of Brohm spawners should be limited as much as possible as these fish may be maladapted for spawning and rearing in the main river.

Fish Size and spawning location.

In general smaller fish <750mm (mostly 2 ocean spawners) are more likely to enter Brohm Creek to spawn while larger fish >750mm (repeat spawners and 3 ocean maiden spawners) are more likely to spawn in the lower and upper mainstem (Table 1). The largest fish

>900mm were represented mainly by upper river spawners, Figure 1. All spawning populations have representation from all size classes and age classes (Appendix 1).

Protocol 1: Fish above 750mm in length should represent >70% of the total broodstock collection to avoid selecting Brohm river and over selection of lower river spawners.

Note: Targeting some fish larger than 900mm would increase the chances of selecting upper river spawners

Behavioural Information of Steelhead and Broodstock Collection

Adult steelhead trout spawning migrations have been the focus of recent detailed studies on the Cheakamus River pre spill. From 1999 through 2005 a total of 135 steelhead adults were radio tagged and tracked from their location of capture (by angling) through to spawning site selection (e.g. McCubbing and Melville 2000) as part of developing an annual visual diver derived population abundance (Korman et al 2005). Steelhead adults returning to spawn in the Cheakamus River in the spring of each year have been observed as spawning in one of three areas:

- Upper Cheakamus, upstream of Culliton Creek confluence
- Lower Cheakamus, 2km above Bailey Bridge to Cheekye confluence
- Brohm Creek

Fish captured during tagging operations prior to March 1st resulted in 50% of sampled and tagged fish subsequently spawning Brohm Creek. This percentage fell sharply in March to just 8%, and 13% in April. The latest capture of a Brohm spawner was April 19th compared with May 1st for upper river spawners and May 7th for lower river spawners. The greatest percentage of upper river spawners were captured in March 15th to April 30th when they represented 65% of the total fish encountered.

Protocol 2: Fish captures should be targeted after March 1st to reduce the Brohm fish being introduced to the broodstock.

Note: Captures post March 15th will favour the capture of Upper River spawners which may form a discrete genetic population.

During previous tagging studies, the location of capture of a fish has been linked to the final spawning destination. In general terms fish captured and tagged above the Bailey Bridge are most likely to be destined to spawn in the upper river area (88%, Figure 3) while those captured below the Cheekye/Cheakamus confluence resulted in increased levels of Brohm spawners being tagged (26%). Fish captured between the Cheekye confluence and Bailey bridge do contain some fish ultimately destined for Brohm Creek (4 of 74 captures) and one Brohm fish was captured upstream of the Bailey bridge. This behaviour of “straying” up the Cheakamus appears linked to fish destined to spawn in the Brohm entering the watershed early and before sufficient flows are present in the Cheekye to allow easy passage over the fluvial fan at the Cheekye/Cheakamus confluence. After initial upstream migrations to the NVOS property area (RK3-6), several tagged individuals were observed over multiple years making downstream migrations to the Cheekye river, under low flow conditions before moving back upstream to holding water in the Cheakamus river (see McCubbing and Melville 2000). Many of these fish eventually entered the Cheekye under higher flows in April or early May. It appears from other fish behaviour that some may have missed the window of opportunity to pass through the Cheekye corridor into the Brohm and as a result, despite multiple migrations to the Cheekye confluence, or even into the lower Cheekye River, eventually spawned in the lower Cheakamus, upstream of the Cheekye and its glacial turbidity and sediment movement.

Protocol 3: Fish for brood stock collection should be captured above the confluence with the Cheekye River

Note: A buffer zone to Moodys side-channel could be instigated to avoid handling Brohm creek fish which spend considerable time resident in the pool above the Cheekye river confluence

Spawning timing based on kelt outmigration and radio telemetry.

An examination of spawning timing was undertaken based on kelt outmigration data or significant downstream passage of fish around the time of spawning followed by a period of prolonged inactivity during freshet. Evidence from the 135 radio tagged fish indicates that spawning commences in both the Brohm creek spawners and the Cheakamus spawners around the same time (Figure 4) and after April 1st. Peak spawning was observed between April 15th and May 15th. Spawning of tagged fish was largely completed by June 1st. It is possible that some fish enter the river after capture of fish becomes difficult under freshet

conditions in late May, but as these fish would be difficult to obtain for broodstock and it might not be possible to collect sufficient pairs consideration should be given to setting an end of season date for collection of June 1st and fish collected prior to May 15th would be preferable.

References

Korman, J. 2006 Risks Benefits and Uncertainties Associated with Using Hatchery Supplementation to Recover the Cheakamus River Steelhead Population and Rules to Assess Recovery Status. Prepared for CERTC 13p.

Labelle M. 2006. Evaluation of Alternative Recovery Strategies for the Cheakamus River. Interim Report to MoE, 23p.

McCubbing, D.J.F and S.E.Hartley. 1994. Management options for a multi-stock salmon resource in a Lake District Catchment. In Proceedings of the Institute of Fisheries Management 25th Annual Study Course Ed > J.Winfiled. p55-80.

McCubbing, D., and Melville, C. 2000. Steelhead trout spawning migration in the Cheakamus River, based on radio tracking observation in the spring of 2000. Report prepared by Instream Fisheries Consultants for B.C. Hydro.

McCubbing, D.J.F., and B.R. Ward. 2005. Adult Steelhead Trout and Salmonid Smolt Migration at the Keogh River, B.C. during Winter and Spring 2005. Habitat Conservation Trust Fund Contract Number: CBIO4051.

McCubbing, D.J.F, C.C.Melville, G.Wilson and M.Foy. 2006. Assessment of the CN Sodium Hydroxide Spill August 5th, 2005 on the Fish Populations of the Cheakamus River. Report to CERTC. 78p.

Melville C and D.J.F McCubbing 2005. Smolt migration trends in the Cheakamus River, 2000 through 2005, using Rotary Traps. BC Hydro WUP Report.

Van Dishoeck, P. 2002 Squamish River system juvenile steelhead sampling program, September 2000, ARL report no 369-1. 50p.

Van Dishoeck, P. 2002 Squamish River system juvenile steelhead sampling program, September 2001, ARL report no 436-1. 47p.

Ward, B.R. 2006. The Case for Wild Steelhead Recovery Without Artificial Fish Culture Intervention. MoE Report, 9p

Table 1. Length Frequency of steelhead spawners on the Cheakamus River 2000-2006, based on subsequent spawning location.

Length (mm)	Upper	%	Lower	%	Brohm	%
550	0	0%	0	0%	0	0%
600	0	0%	0	0%	1	5%
650	3	4%	4	11%	5	26%
700	11	14%	5	14%	5	26%
750	18	23%	7	19%	4	21%
800	15	19%	4	11%	1	5%
850	10	13%	9	25%	1	5%
900	11	14%	5	14%	1	5%
950	10	13%	1	3%	1	5%
1000	1	1%	1	3%	0	0%
1050	1	1%	0	0%	0	0%
Total	80		36		19	

Table 2. Age of steelhead sampled for radio telemetry studies (2000-2006)

2 ocean maiden							
Spawn Location	2.2	Avg length	R.2	Avg length	Total		
Upper	17	732	11	708	28	51%	
Lower	10	702	5	700	15	27%	
Brohm	10	668	2	650	12	22%	
					Total	55	
3 ocean maiden							
Spawn Location	2.3	Avg length	R.3	Avg length	3.3	Avg length	
Upper	12	840	9	817	2	930	23 70%
Lower	4	874	1	830	1	850	6 18%
Brohm	2	782	2	802	0		4 12%
					Total	33	
Repeat Spawner							
Spawn Location		Avg length					
Upper	17	864	71%				
Lower	6	830	25%				
Brohm	1	810	4%				
Total	24						

Table 3 Stratified Broodstock capture protocol

	Time Period						
	March 1-15	March 16-31	April 1-15	April 16-30	May 1-15	Total	%
Fish <750	1	1	2	1	1	6	30
Fish >750	1	3	5	3	2	14	70
						Total	20

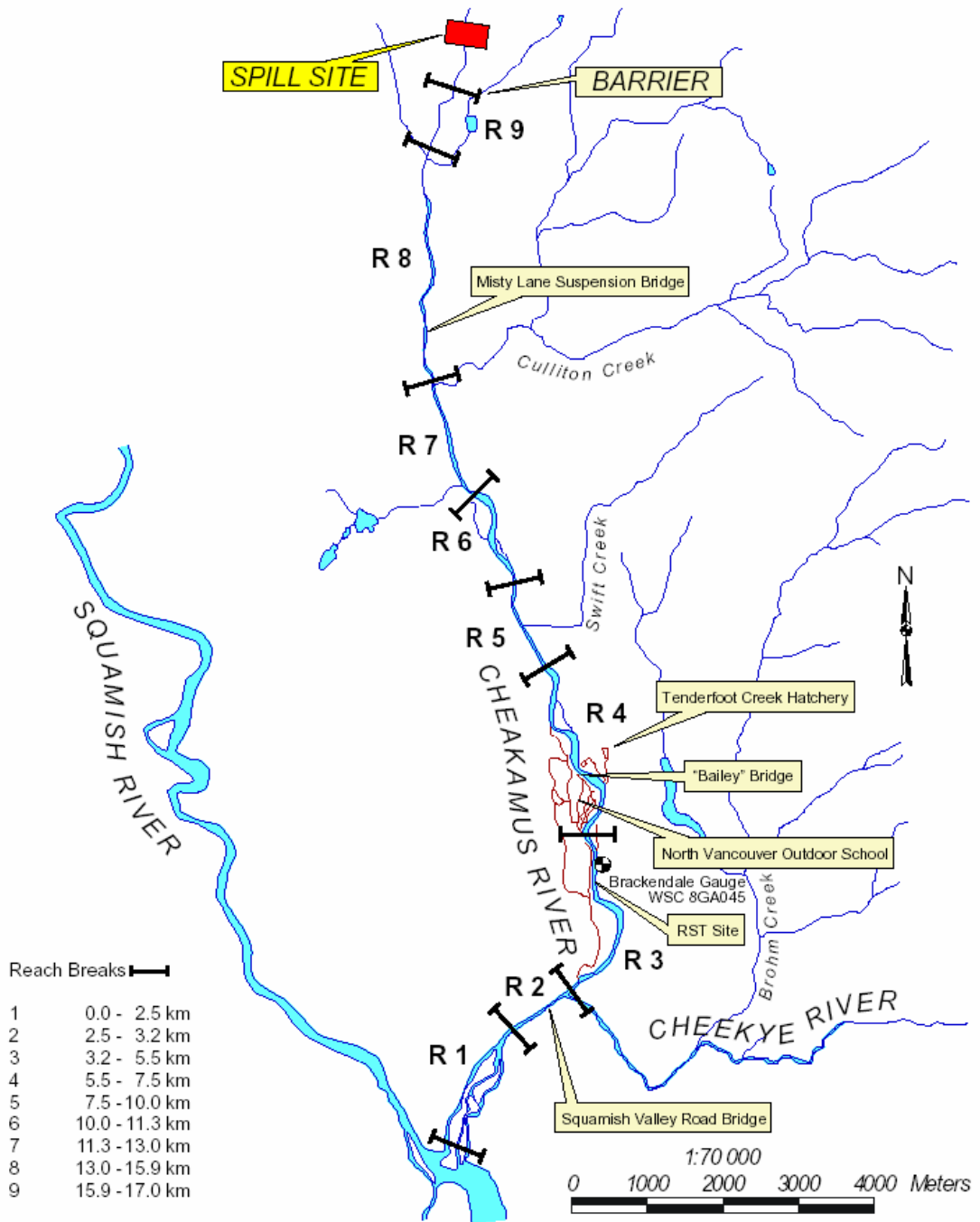


Figure 1. Map of Cheakamus River showing reach breaks, Brohm Creek and location of train derailment.

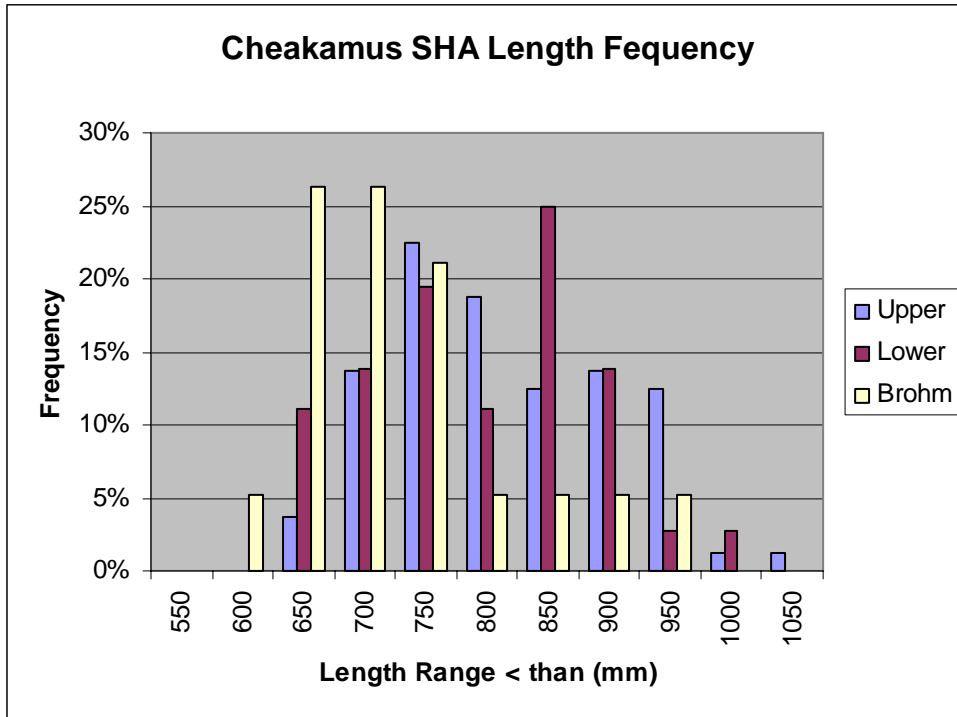


Figure 2. Length Frequency of Cheakamus watershed steelhead spawners from 2000-2006 based on radio telemetry data.

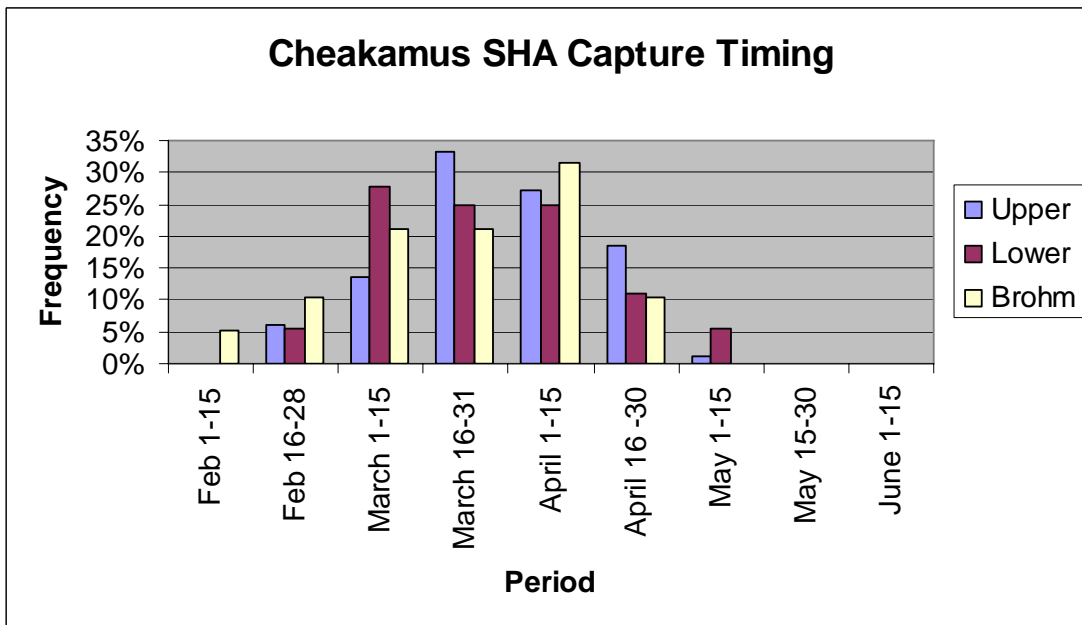


Figure 3. Capture timing versus subsequent spawning location Cheakamus watershed steelhead spawners from 2000-2006 based on radio telemetry data.

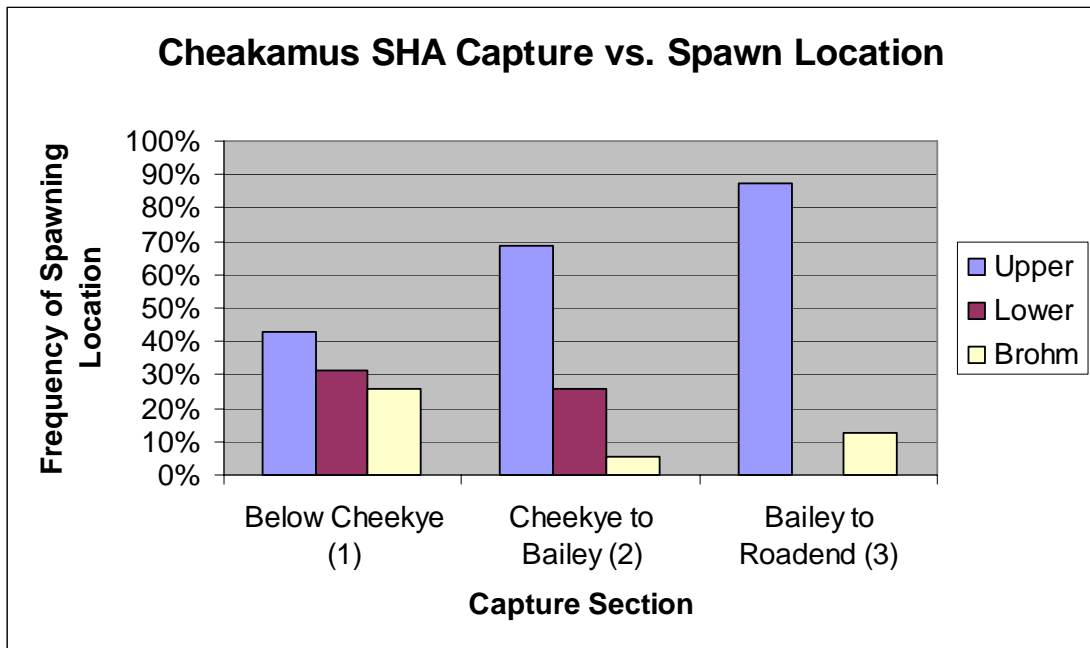


Figure 4. Capture location versus subsequent spawning location Cheakamus watershed steelhead spawners from 2000-2006 based on radio telemetry data.

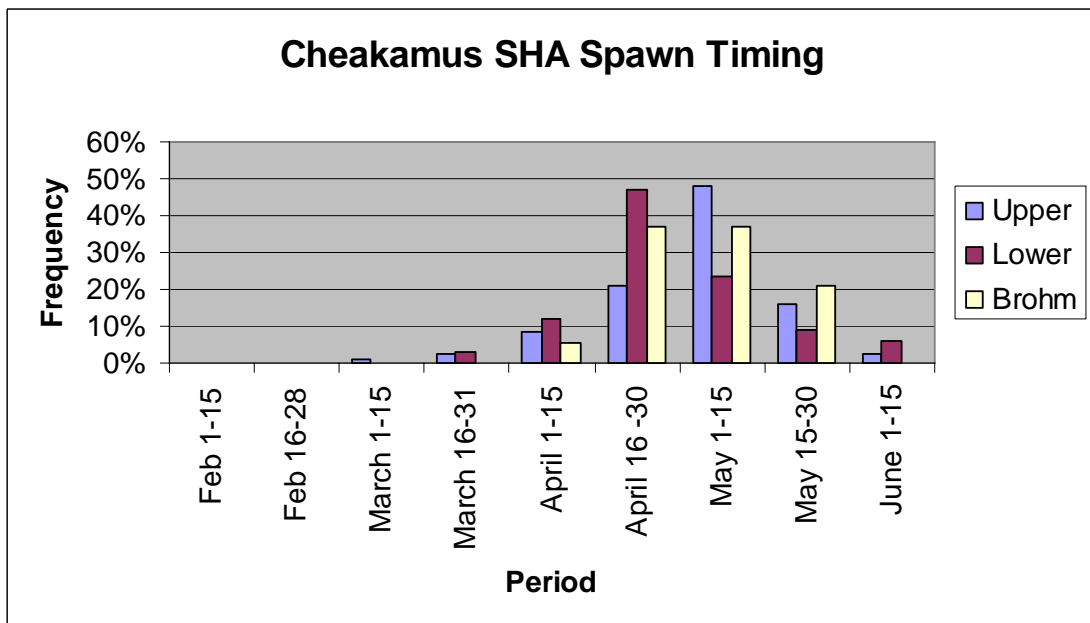


Figure 5. Estimated spawn timing versus spawning location, Cheakamus watershed steelhead spawners from 2000-2006 based on radio telemetry data.