Calibration of Chinook and coho salmon escapement estimation methods at three small, clear streams on the West Coast of Vancouver Island

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ABSTRACT

Chinook (*Oncorhynchus tshawytscha*) and coho (*O. kisutch*) salmon are notoriously challenging to enumerate on the West Coast of Vancouver Island (WCVI). Visual counting and river conditions can vary enormously within and among years which limits the methods and rivers where escapements can be estimated reliably. Visual index methods have been applied for several years on the WCVI; however, their accuracy is unknown which makes it challenging to assess changes in spawner abundance and to make comparisons to stock status benchmarks or escapement goals measured in units of total abundance (not indices; Parken et al. 2006) To assess the accuracy of the visual indices and enable one to assess spawning numbers against stock status benchmarks, Chinook salmon and coho salmon escapements to Leiner River, Tahsis River and Tranquil Creek; three small, clear WCVI rivers; were estimated using visual index, mark-recapture, and mark-resight methods in 2005 and 2006. Fluctuating water levels limited mark application and coupled with predator removal severely reduced the number of carcasses available for recovery. For coho salmon, valid mark-recapture and mark-resight escapement estimates were developed for two and three, respectively, of the four river by year combinations (no calibration was performed at Leiner River in 2005 and no tags were applied at Tahsis in 2005). For Chinook salmon, valid mark-recapture and mark-resight escapement estimates were developed for one and four, respectively, of the five river by year combinations. Further, three visual index methods were conducted on each of the five year by river combinations. These estimates were used to develop expansion factors for calibration by comparing visual area-under-the-curve (AUC) estimates based on swim surveys to mark-recapture and resight total escapement estimates. Several, study design issues included variable river conditions, tag loss, timing of tag application, common tag colours applied to adults and jacks in the same or nearby systems, and common tag colours applied to coho and Chinook salmon significantly compromised our confidence in the accuracy of the 2005 and 2006 total escapement estimates and expansion factors. Several critical improvements must occur with future program designs in order to increase the quality and confidence in the visual indices and total escapement estimates and the resultant expansion factors.

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INTRODUCTION

Accurate and precise population escapement estimates are important to the assessment of the status of salmon stocks. Escapement is defined as the number of fish that return to the river to spawn - these mature salmon have escaped the marine and freshwater fisheries and entered the terminal survey area (English *et al*., 1992). Estimates of Pacific salmon escapement can be generated using a variety of techniques including visual surveys, mark-recapture studies, fence counts, sonar, and electronic counters. This calibration study of visual indices of Chinook (*Oncorhynchus tshawytscha*) and coho (*O. kisutch*) salmon abundance was funded by the Southern Boundary Restoration and Enhancement Fund Committee. The vast majority of escapements to small, clear streams on the WCVI are estimated using the area-under-the-curve (AUC) method based on swim surveys, which involves counting fish during multiple visits to a stream. This method is considered to be efficient and robust when used with valid observer efficiency and survey life data (Perrin and Irvine, 1990). Data such as AUC estimates are frequently used as an indicator of production for future generations, and to provide an index of the success of management of the fishery (Neilson and Geen, 1981).

There are significant issues surrounding the quality of many visual escapement estimates; therefore, the Department of Fisheries and Oceans (DFO) and the Pacific Salmon Commission (PSC) are attempting to calibrate these visual estimates against estimates from other more robust methods such as a mark-recapture by developing expansion factors throughout many parts of the Pacific Region. The mark-recapture method is the best calibration option for this study as fences, electronic and sonar technology can not be used due to severe rain events that cause unpredictable, fluctuating water levels throughout the survey period. Marks are applied at entry and then recovered and resighted during swim surveys, allowing generation of escapements using the Petersen method or the resight population estimator; however, fluctuating water levels also make tag application and recovery difficult. Fluctuating water levels limited mark application and coupled with predator removal severely reduced the number of carcasses available for recovery; therefore, valid mark-recapture escapements could only be estimated for Tranquil Creek coho salmon in 2005 and 2006. Due to these environmental conditions, predators, financial and other constraints, visual counting is likely to remain the most efficient method to survey spawner abundance for many WCVI Chinook and coho salmon populations.

Interest in validating Chinook salmon escapement estimates in the Tranquil, Tahsis and Leiner Rivers extends beyond the development of expansion factors for visual methods. Visual escapement estimates in the 1960's and early 1970's varied between 4 and 1,500 Chinook salmon. These systems appear to epitomize the mixed stock problem as two small and apparently weak Chinook salmon populations located between the two large, hatchery-enhanced stocks at Roberston Creek hatchery and Conuma River hatchery. While Tahsis and Leiner Rivers have continued small scale enhancement, Tranquil has had no enhancement since 2002.

The Chinook and coho salmon mark-recapture programs on Tranquil Creek and Tahsis River were conducted in 2005 and 2006, and 2006 was the first year for Leiner River. AUC and mark-resight escapements were also estimated based on multiple visual (swim) surveys. Leiner River flows into the same estuary as Tahsis River and evaluation of mixing was attempted. Very few carcasses were recovered due to fall floods and predators (bears and wolves). In order to compensate for the inability to sample a representative portion of carcasses, the recapture portion of the study also consists of counts of marked and unmarked live fish observed during swim surveys. Typically, the highest swim survey counts occur immediately prior to spawning, when fish are still holding in pools.

Study Area

The majority of Chinook and coho salmon stocks on the WCVI are comprised of a single run, including Tahsis, Leiner and Tranquil Rivers (Appendix 1). These WCVI salmon stocks move into their natal streams in the fall as weather and stream conditions permit.

Tranquil Creek

Tranquil Creek is located in Clayoquot Sound on the WCVI and represents many small, clear streams in the area (Figure 1). Clayoquot Sound is of particular interest to Salmon Stock Assessment as the majority of systems in this sound are un-enhanced and these wild systems have been in a constant state of decline or at low abundance since the early 1990's.

Water levels are approximated using Environment Canada's Water Survey Station information for Tofino Creek, a similar size stream within close proximity (Appendix 2 and 3). If the water level on Tofino Creek was above 1.6 m on a daily basis, crews would not attempt application, recovery or swim surveys for safety purposes. Water temperatures ranged from 3-11°C during the spawning season (September-January).

Four species of Pacific salmon; chum (*O. keta),* sockeye (*O. nerka*), coho and Chinook spawn within a 3.5 km section of Tranquil Creek. Swim surveyors counted fish throughout this section and tags were applied in the holding areas of the lower portion of the system, just upstream of tidal holding areas. A single-run of Chinook salmon spawns between early-September and mid-November and a coho run spawns between late-October and mid-January. Timing of spawn varies annually due to weather (rainfall) and in-river conditions. In 2005, the peak of spawn for Chinook salmon occurred in mid-October and late-November for coho salmon. In 2006, the peak of spawn for Chinook salmon occurred in late-October and late-November for coho salmon.

Tahsis and Leiner Rivers

Tahsis and Leiner Rivers are located in Nootka Sound where they flow into the head of Tahsis Inlet approximately 1 km apart. They both represent small, clear rivers on the WCVI.

Annual and spawning season mean discharge (m^3s^{-1}) is not reported for Tahsis or Leiner Rivers, as the closest Environment Canada Water Survey Station is located at Gold River (Appendix 4 and 5); although, this is a much larger river the fluctuation in flow emulates that in Tahsis and Leiner Rivers. Water temperatures ranged from 5-11°C during the spawning season (September-January).

Tahsis and Leiner Rivers support four species of Pacific salmon: sockeye, chum, coho and Chinook. In Tahsis River, the majority of the Pacific salmon spawn in a 5 km section. Swim surveyors counted fish throughout the spawning area and tags were applied in the holding areas of the lower portion of both systems, just upstream of tidal holding areas. These rivers both support a single-run of Chinook salmon that spawns from early-September to late-November and a single-run of coho salmon that spawns from mid-October to early-January. Peak spawning varies annually due to weather conditions (rainfall).

METHODS

Mark-Recapture

"The Petersen mark-recapture method of population estimation is based on the general principle that the number of individuals in a population of unknown size may be estimated by marking or tagging a representative sample of individuals, releasing these to become distributed throughout the population, then obtaining a second sample at random for examination." (Cousens *et al*., 1982:33). Chinook and coho salmon holding in pools throughout the lower portion of the system were beach seined for tagging in cooperation with local enhancement groups and swim surveys were conducted to recover carcasses. Crews recovered small numbers of carcasses due to high water and predators. Swim surveyors also counted live marked and unmarked fish to determine the mark re-sight escapement estimates.

Marking of Chinook and coho salmon from deep holding pools occurred in the lower portions of each river, just above tidal holding areas to representatively apply tags to fish as they returned to the rivers. Tagging opportunity was limited by water levels, as fish wait for higher flows before moving into the system to spawn – leaving a narrow tagging window annually. Mass entry and subsequent holding of all four species of Pacific salmon made visual observations more challenging – especially when high numbers of chum salmon were present. A seine net was set by skiff or jetboat in a downstream crescent and drawn from the river to enclose a small area of water along the riverbank. Each fish was primary-marked with an individually numbered, Floy T-bar anchor tag applied approximately 2 cm behind the dorsal fin. Operculum punches, as secondary marks, were applied by punching a hole through the operculum on one side with a 6 mm paper punch. Each fish's species, tag number and colour, fork length, sex, and spawning condition were recorded. Operculum tissue samples were also collected from Chinook and coho salmon during mark application to contribute to a DNA baseline and forwarded to the Molecular Genetics Laboratory at the Pacific Biological Station in Nanaimo. After tagging and data collection, the salmon were released over a submerged section of the net - at no time were the fish removed from the water.

Carcass recovery operations were conducted during swim surveys (see section below), and crews conducted surveys every 1-10 days from mid-September to early-January. Species, date, reach number, sex, tag number and colour, post-orbital to hypural plate (POH) length, and secondary mark status were recorded for each carcass recovered. Scales and otoliths were collected from Chinook and coho salmon carcasses. Scales were forwarded to the Fisheries & Oceans Canada, Fish Aging Laboratory at the Pacific Biological Station and otoliths were processed by South Coast Stock Assessment staff. Examined carcasses were cut in half to prevent re-counting.

The adult Chinook salmon population ($\hat{N}$) using carcass recoveries was estimated using the Chapman modification of the Petersen estimator (Ricker, 1975 and Cousens *et al*., 1982):

$$\hat{N}_{i,MR} = \frac{(M+1)(C+1)}{(R+1)}$$

where N is the estimate of adult salmon, M is the number of adult salmon marked, C is the total number of adult carcasses examined for marks and R is the number of marked adult carcasses recovered (Ricker, 1975). This adjusted Petersen estimate is the most commonly used mark-recapture formula and provides a nearly unbiased estimate of N (Cousens *et al*., 1982).

Binomial confidence intervals were used when R/C > 0.10 and Poisson confidence intervals were used when R/C < 0.10 and R < 50 (Krebs 1998).

Tag Loss

Tag loss was calculated by dividing the total number of carcasses with a secondary mark (operculum punch) only by the total marked carcasses recovered for each system annually. Carcasses were only recovered for Tranquil Creek; therefore, no tag loss could be estimated for Tahsis and Leiner Rivers. The weighted mean tag loss by individual system could only be estimated for Tranquil Creek and was determined by dividing the total lost tags for both years by the total tagged carcasses recovered for both years combined.

Swim Survey

Swim surveys were conducted from mid-September to early-January for Tranquil, Tahsis and Leiner Rivers. Occasionally, surveys could not be conducted due to extremely low or high flows and turbidity, and surveys were conducted as soon as water levels became suitable and visibility improved. Two swimmers equipped with snorkeling gear swam designated areas and then combined their individual counts. For each stratum, observers discussed which groups of fish were counted by only one observer and which were counted by both. These counts were recorded for each stratum and summed for the daily total. When schools of fish were encountered, the swimmer would pass over the fish several times and break large groups up allowing individual fish to be counted. In these cases, the "best pass" consisting of the largest number of marked and unmarked salmon counted was used for the final estimate. In some cases, one swimmer would count tagged fish and the other would count untagged fish. The numbers collected during swim surveys were used for both the AUC and the re-sight estimate. Swim surveyors also collected and examined carcasses for the recovery portion of the mark-recapture program.

Mark-Resight

The visual swim survey re-sight procedure involved counting the number of marked and unmarked Chinook and coho salmon; whereas, the AUC estimates utilized total live counts. Total escapement was calculated using the joint hypergeometric maximum-likelihood estimator (JHE) described by White (1996):

$$L(N \mid M, c_k, r_k) = \prod_{i=1}^{k} \frac{\binom{M}{r_k}\binom{N-M}{c_i - r_k}}{\binom{N}{c_k}},$$

where $L(N \mid M, c_k, r_k)$ = Likelihood of N conditional on the observed values of M, c_k, and r_k, and N is the population size, M is the number of tagged fish in the study area (tags applied), c_k is the number of fish inspected for tags on the k^{th} survey, and r_k is the number of tagged fish counted on the k^{th} survey.

Tag loss, which was assumed to occur during competitive interactions among fish actively spawning, was not used to adjust mark-resight observations as sample sizes were too low to detect tag loss over time or to provide a precise estimate of tag loss.

Area-Under-the-Curve

In order to estimate escapement using the AUC method, swimmers counted total live fish by species on several dates throughout the spawning period (see description above).

Trapezoidal Approximation

Total live Chinook and coho salmon counts were plotted for each date to form the fish curve, and the areas of the trapezoids were summed to estimate total fish-day component of the AUC. The total fish-days or the AUC ($\hat{A}_i$) for year *i* was (Irvine et al. 1992):

$$\hat{A}_i = 0.5 \bullet \sum_{j=2}^{n} \left(t_j - t_{j-1}\right) \bullet \left(\hat{p}_j + \hat{p}_{j-1}\right), \qquad (1)$$

where t_j was the number of days since the first fish commenced spawning, $n - 2$ was the number of swim surveys, and $\hat{p}_j$ was the number of salmon counted on day *j* (sum of the fish counts by strata). 100% observer efficiency was assumed in this study, as clear water and low flows provided high visibility for both streams. Surveys were temporally bounded by the day the first fish commenced spawning ($j = 1$, $\hat{p}_j = 0$) and the first day when there were no longer any live spawners (t_n, $\hat{p}_n = 0$). The first and last dates of spawning were estimated from spawning observations made during swim surveys. Note that $t_j = 1$ and $p_j = 0$ for the day when the first fish commenced spawning and t_n was the number of days that live spawners were present; thus $p_n = 0$.

The AUC method for calculating the annual escapement ($\hat{N}_{i,AUC}$) was

$$\hat{N}_{i,AUC} = \frac{\hat{A}_i}{\hat{S}_i}, \qquad (2)$$

where $\hat{S}_i$ was the survey life in year *i* defined as the mean length of time (d) live fish were available for counting. Both the area-under-the-tag-curve and index survey life were used to determine escapement estimates using the AUC method.

Maximum Likelihood Model

This method assumes an underlying statistical distribution model of fish arrival and death from which the number of fish alive in the stream can be predicted on a given day, and the pattern of arrival and death is assumed normally- or beta-distributed (Hilborn et al.1999). Observer counts are used for the number of fish present, as we assumed observers saw 100% of the fish in the stream. The observer counts of fish and index survey life were then used to estimate the number of fish in the stream. This likelihood model was modified to allow for uncertainty in the survey life. The likelihood of different escapements and confidence bounds around the estimates were calculated using the likelihood profile. The probability distribution of the estimate was plotted in funnel graphs to generate confidence intervals (Schnute 1987 in Hilborn et al. 1999).

Survey Life

Survey life is defined as the mean duration of time (days) that individuals of one species were available for counting in the stream or the mean number of days fish were alive in the stream (stream life; Perrin and Irvine 1990).

Swim survey data including condition of fish, abundance of new fish and rate of die off were recorded and used to estimate a minimum and maximum value for the index survey life on an annual basis, the mean of these two values was then used as the index survey life.

The area-under-the-tag-curve (AUTC) survey life was determined by tagging salmon in the lower portion of the stream, prior to the onset of spawning and resighting the tags during

swim surveys. Swim survey counts of tagged fish were not corrected for tag retention due to low sample sizes and resultant poor precisions of tag loss rates. Further, counts were not corrected for observer efficiency (assumed 100%). Swim counts were used to measure the AUTC and the total tag days were divided by the original number of tags applied to estimate survey life in days as described by Irvine et al (1992) and Hetrick and Nemeth (2003):

$$SLp = \sum_{i=1}^{n} (Ci * ti) / d$$

where n equals the number of swim surveys, C_i is the count of tagged fish for the i^{th} survey, t_i is the time elapsed between the i^{th} and the i^{th}-1 survey and d is the total number of tags deployed.

Expansion Factors

Results from the independent mark-recapture, the mark-resight and AUC's using the trapezoidal and maximum likelihood method were used to estimate expansion factors for Chinook and coho salmon.

We estimated visual peak count expansion factors ($\hat{\pi}_i$) from

$$\hat{\pi}_{i,PC} = \frac{\hat{N}_{i,MR}}{\hat{N}_{i,PC}},$$

where the total escapement estimate (mark-recapture and mark-resight) and peak count swim survey estimate were obtained from concurrent sampling programs in year *i*. We estimated visual AUC expansion factors ($\hat{\pi}_i$) from

$$\hat{\pi}_{i,AUC} = \frac{\hat{N}_{i,MR}}{\hat{N}_{i,AUC}},$$

where the total escapement estimate (mark-recapture and mark-resight) and swim survey AUC estimate (MLE and trapezoidal) were obtained from concurrent sampling programs in year *i*.

RESULTS

Coho Salmon

Mark Recapture

In 2005, tagging of coho salmon took place early in the run at Tranquil Creek: 175 adult coho salmon were marked on October 19 and 45 on October 20 (Appendix 6) and spawning activity peaked 6 weeks later (Appendix 11). Five tagged jacks were excluded from the mark-recapture analysis (Appendix 12). The Petersen mark-recapture adult escapement estimate was 706 coho salmon with a binomial 95% confidence interval of 536 - 994 coho salmon. The mark incidence was approximately 30%. Bias testing and sex specific escapement estimates were not conducted as too few marked carcasses were recovered (Table 1 and Appendix 12).

In 2006, the majority of tagging took place late in the run at Tranquil Creek: 37 adult coho salmon were marked on October 17, 15 on October 22, and 116 on October 30, and spawning activity peaked three weeks later (Appendix 7). 25 tagged jacks were excluded from the mark recapture analysis. The Petersen mark-recapture adult escapement estimate was 239 spawners with a binomial 95% confidence interval of 183 - 559 coho salmon. The mark

incidence was approximately 57% (Table 1). Bias testing and sex specific escapement estimates were not conducted as too few marked carcasses were recovered (Table 1 and Appendix 13).

For Tahsis River in 2006, 105 adult coho salmon were marked 1 on September 29, 31 on October 13, and 73 on October 30 (Appendix 9). 15 tagged jacks were excluded from the mark-recapture analysis. The Petersen mark-recapture adult escapement estimate was not valid, as there only two untagged carcasses were examined and no tags were recovered. Recovery was difficult due to fluctuating water levels and predators eating the carcasses.

Mark-recapture escapements could not be developed for Tahsis River in 2005 because no tags were applied. Mark-recapture escapements could not be estimated for Leiner River, as no mark-recapture program was conducted in 2005 and no tagged carcasses were recovered in 2006 (Table 1).

Table 1. The number of coho salmon marked, examined for marks, and recovered with marks, and the mark incidence and the Petersen escapement estimate for Tranquil Creek, Tahsis River and Leiner River in 2005 and 2006.

	Tranquil	**Tahsis**	**Leiner[a]**
	2005		
Number of Fish Marked (M)	220	0	No data
Number of Fish Examined (C)	63	0	No data
Number of Fish Recovered (R)	19	0	No data
Mark Incidence (100 * R/C)	30%	na	No data
Petersen Estimate ($\hat{N}$)	706	na	No data
Confidence Interval (CI) Method	Binomial		
Lower 95% CI	536	na	No data
Upper 95% CI	994	na	No data
	2006		
Number of Fish Marked (M)	143	105	44
Number of Fish Examined (C)	14	2	4
Number of Fish Recovered (R)	8	0	0
Mark Incidence (100 * R/C)	57%	na	na
Petersen Estimate ($\hat{N}$)	239	na	na
Confidence Interval (CI) Method	Binomial		
Lower 95% CI	183	na	na
Upper 95% CI	511	na	na

[a] Leiner MR not conducted in 2005.

Tag Loss

In 2005 at Tranquil Creek, 3 of the 19 (16%) coho salmon recovered had lost the T-bar anchor tag, but they were identified by secondary marks (Table 2). At Tranquil Creek in 2006, 3 of the 8 (38%) coho salmon recovered had lost their tag, but they were identified by secondary marks (Table 2). There was no need to further adjust the number of recaptured coho salmon because all marked fish had an operculum punch that would not have healed during the study period, and staff closely examined all fish for these marks. At Tahsis and Leiner Rivers, no coho salmon carcasses were recovered to estimate the T-bar anchor tag loss rate. For Tranquil Creek,

the weighted mean tag loss rate was 29% with a total 6 of 21 T-bar anchor tags lost among all the carcasses recovered for both years combined.

Table 2. Coho salmon tag loss by year for Tranquil Creek, Tahsis and Leiner Rivers.

	Tranquil	**Tahsis**	**Leiner[a]**
	2005		
Number of Fish Marked (M)	220	0	No data
Number of Fish Examined (C)	63	0	No data
Number of Fish Recovered (R)	19	0	No data
Number of Fish Recovered with Floy Tag	16	na	No data
Number of Fish Recovered with Secondary Mark Only (Lost Tags)	3	na	No data
Proportion of Lost Tags	0.16	na	No data
Tag Loss	**16%**	na	No data
	2006		
Number of Fish Marked (M)	143	120	44
Number of Fish Examined (C)	14	2	4
Number of Fish Recovered (R)	8	0	0
Number of Fish Recovered with Floy Tag	5	na	na
Number of Fish Recovered with Secondary Mark Only (Lost Tags)	3	na	na
Proportion of Lost Tags	0.38	na	na
Tag Loss	**38%**	na	na
Weighted Mean	**29%**	na	na

Swim Surveys

Coho salmon counts are presented in Appendixes 14-19. Coho salmon peak of spawn by year for Tranquil Creek, Tahsis and Leiner Rivers are presented in Appendix11. No mixing between Leiner and Tahsis Rivers was observed for coho salmon.

Peak of spawn occurred around the same time in both years in late-November for Tranquil Creek and early-December for Leiner River. However, the peak of spawn for Tahsis River was much later in 2006 than 2005. Peak of spawn in Leiner River was one month earlier than in Tahsis River, although the systems are within close proximity (Appendix 11). This may have been due to the behaviour of the fish or possibly a recording error by surveyors.

Mark - Resight

The coho salmon mark-resight estimates of escapement and 95% confidence intervals are presented in Table 3 for Tranquil Creek, Tahsis River and Leiner River in 2005 and 2006. In general, the mark-resight estimates were higher than all other estimates. The exceptionally high estimate for Tahsis River in 2006 may result from tags missed by observers or tag loss over time, which cannot be estimated due to low sample sizes. No mark program was conducted for Leiner

River in 2005. For Tahsis River 2005 and Leiner River 2006, adverse river conditions resulted in infrequent surveys and tag resight counts of coho salmon that were too low to be reliable (Appendixes 16, 18, and 19).

At Tranquil Creek in 2005, the spawning abundance of 808 coho salmon (95% confidence interval; 782 - 835) was estimated with a JHE estimator based on 20 swim surveys following tag application over 46 days (October 21 – December 19; Appendix 14). Surveys after December 19 were excluded because fish began spawning and dying, resulting in too few fish counted on a single survey to use in the analysis (Appendix 14). Over the 20 surveys, mark incidences were similar and 48% the total spawner escapement was observed on the swim survey with the highest count, which produces higher precision in the estimate, and confidence intervals of less than 4% of the estimate.

At Tranquil Creek in 2006, the spawning abundance of 465 coho salmon (95% confidence interval; 447 - 486 was estimated with a JHE estimator based on 10 swim surveys over 65 days (October 18 – December 3; Appendix 15). Surveys after December 3 were excluded because fish began spawning and dying, resulting in too few fish counted on a single survey to use in the analysis (Appendix 15). Over the 10 surveys, mark incidences were similar and 79% the total spawner escapement was observed on the swim survey with the highest count, which produces higher precision in the estimate and confidence intervals of less than 5% of the estimate.

At Tahsis River in 2006, the spawning abundance of1,860 coho salmon (95% confidence interval; 1,659 – 2,108), was estimated with a JHE estimator based on 11 swim surveys over 54 days (September 30 – December 23: Appendix 17). Over the 11 surveys, mark incidences were similar and 40% the total spawner escapement was observed on the swim survey with the highest count, which produces moderate precision in the estimate and confidence intervals of less than 14% of the estimate.

Table 3. Coho salmon mark-resight escapement estimates and 95% confidence intervals for Tranquil Creek, Tahsis River and Leiner River in 2005 and 2006.

	Tranquil	**Tahsis**	**Leiner**
2005			
Resight Escapement	**808**	**na**	**na**
Lower 95% CI	782	na	na
Upper 95% CI	835	na	na
2006			
Resight Escapement	**465**	**1,860**	**na**
Lower 95% CI	447	1,659	na
Upper 95% CI	486	2,108	na

AUC

The AUC escapement estimates, using the index survey life, were consistently lower for coho salmon across all systems in both years because the index survey lives were higher than the AUTDC survey lives. All of the coho salmon MLE AUC estimates were higher than the trapezoidal estimates, except it was lower in Tranquil Creek for 2006 (Table 4). Note that the MLE AUC estimate of escapement incorporates uncertainty around the total fish days and survey

life; therefore, the total estimate is not the total spawner days divided by the survey life (Equation above).

The observer counts, trapezoidal AUC curves and MLE curves can be seen in Appendix 20-25. Typically, the MLE (Beta or normal) curve fits well to the observed data. This was reflected in small differences between the trapezoidal and MLE estimates. The advantage of the MLE AUC estimates is that confidence intervals can be generated.

Table 4. Coho salmon escapements estimated by the AUC trapezoidal and MLE (with 95% CI's) methods, total fish days, and surveys life estimates using the index and AUTC methods for Tranquil Creek, Tahsis River and Leiner River in 2005 and 2006.

	Tranquil	**Tahsis**	**Leiner**
	2005		
AUC Index Method			
Fish Days	20,237	37,951	7,838
Index Survey Life	37.5	37.5	37.5
Escapement Estimate	**540**	**1,012**	**209**
AUC Tag Curve Method			
Fish Days	20,237	37,951	na
AUTC Survey Life	30.0	na	na
Escapement Estimate	**675**	na	na
AUC MLE Method			
Fish Days	21,183	35,220	7,894
Index Survey Life	37.5	37.5	37.5
Escapement Estimate	**808**	**1,182**	**395**
Lower 95% CI	782	916	304
Upper 95% CI	835	1,578	540
	2006		
AUC Index Method			
Fish Days	11,974	35,477	28,117
Index Survey Life	31.5	45.0	37.5
Escapement Estimate	**380**	**788**	**750**
AUC Tag Curve Method			
Fish Days	11,974	35,477	28,117
AUTC Survey Life	22.6	16.8	13.4
Escapement Estimate	**529**	**2,117**	**2,100**
AUC MLE Method			
Fish Days	10,386	32,137	30,603
Index Survey Life	31.5	45.0	37.5
Escapement Estimate	**330**	**714**	**816**
Lower 95% CI	257	587	631
Upper 95% CI	437	899	1,090

Survey Lives

The area-under-the-tag-days-curve, MR-based, index and literature-based coho salmon survey lives for Tranquil Creek, Tahsis and Leiner Rivers for 2005 and 2006 are presented in Table 5. In general, the survey lives vary by year and estimation method. The index surveys lives are considered the best estimate for coho salmon.

The 2006 AUTC survey life estimates for Tahsis and Leiner Rivers indicated the early arrival coho salmon had shorter survey lives than later arriving fish; however, Tranquil Creek data indicates that the survey life of early arrival coho salmon was marginally longer than later arriving fish.

The mean survey lives reported by Bocking et al (1992) for coho salmon on the east coast of Vancouver Island (ECVI) including Black Creek, French Creek and Trent River were 24.5, 16.2, and 27.7 days consecutively with a range of 0-61 days, with a mean of 22.8 days. This was reported as the literature-based survey life for coho salmon in Table 5.

Table 5. The area-under-the-tag-days-curve, independent, index and literature based coho salmon survey lives for Tranquil Creek, Tahsis and Leiner Rivers for 2005 and 2006.

Survey Life	Tranquil	Tahsis	Leiner
	2005		
AUTC (Total tags)	30.0	No MR data	No MR data
MR-based	28.7	No MR data	No MR data
Index (minimum)	30.0	30.0	30.0
Index (minimum)	45.0	45.0	45.0
Index (mean)	37.5	37.5	37.5
2006			
AUTC (Total tags)	22.6	15.0	13.4
AUTC (Early tags)	34.1	13.1	13.8
AUTC (Late tags)	33.6	15.9	22.5
MR-based	50.1	No MR data	No MR data
Index (minimum)	28.0	30.0	30.0
Index (minimum)	35.0	60.0	45.0
Index (mean)	31.5	45.0	37.5
From Literature	22.8	22.8	22.8

Expansion Factors

Visual expansion factors for coho salmon were developed from visual estimates (peak count, trapezoidal AUC and MLE AUC) and total escapement (mark-recapture and mark-resight) by year and river system and varied from 0.65 to 2.60 (Table 6). More than two years of expansion factors are needed to estimate a mean expansion factors.

Table 6. Visual expansion factors for coho salmon developed from visual estimates and total escapement by year and river system.

River System	Year	Visual Index			Total Escapement		Visual Expansion Factors					
		Peak Count (PC)	Trapezoidal AUC (AUC_{trap})	MLE AUC (AUC_{MLE})	Mark-Recapture (MR)	Mark Resight (MRS)	Peak Count (not expanded)		Trapezoidal AUC		MLE AUC	
							(MR/PC)	(MRS/PC)	(MR / AUC_{trap})	(MRS / AUC_{trap})	(MR / AUC_{MLE})	(MRS / AUC_{MLE})
Tranquil Creek	2005	391	540	711	706	808	1.81	2.07	1.31	1.50	0.99	1.14
	2006	369	380	330	239	465	0.65	1.26	0.63	1.22	0.72	1.41
Tahsis River	2005	871	1012	1182	na	na	na	na	na	na	na	na
	2006	751	788	714	na	1860	na	2.48	na	2.36	na	2.60
Leiner River	2005	183	209	395	no study		na	na	na	na	na	na
	2006	603	750	816	na	na	na	na	na	na	na	na

Chinook Salmon

Mark Recapture

In 2005, high river levels in October prevented crews from applying tags on Chinook salmon as they entered Tranquil Creek (Appendix 4). Therefore, fish were tagged very late in the run and after the peak in spawning activity (October 11-18; Appendix 32), with 36 tags applied on October 19 and 51 on October 20 (Appendix 6). As only six tagged carcasses were recovered, the mark recapture estimate is biased and Krebs (1998) recommends that at least seven recaptures are needed to produce a nearly unbiased estimate. The biased Petersen estimate ranged from 426 to 1,631 Chinook salmon (Poisson 95% confidence interval).

For Tranquil Creek in 2006, long periods of dry, warm weather in the early fall maintained low summer flow conditions which prevented most Chinook salmon from entering the creek. Tagging occurred very late in the run, with 16 tags applied on October 17, and 40 tags applied on October 22 and 20 on October 30 (Appendix 7). As only two tagged carcasses were recovered, there was not enough recovery data to apply the mark-recapture method (Table 7).

For Tahsis River in 2005, river levels were low through September and prevented most Chinook salmon from entering the system until October when high river levels occurred, limiting opportunity catch and tag fish (Appendix 5). Therefore, only 31 fish were captured and tags were applied to 25 of them and 6 were taken for brood-stock. As only two carcasses were recovered and no tags, no mark-recapture escapements were estimated. In 2006, only 16 fish were tagged on September 29 and no carcasses were recovered; therefore there was not enough recovery data to apply the mark-recapture method (Table 7).

No mark-recapture program was conducted on Leiner in 2005. In 2006, 29 tags were applied on September 25 and 15 on October 3 (Appendix 10). As only four carcasses were recovered and no tags, there was not enough recovery data to apply the mark-recapture method (Table 7). Carcasses were very difficult to recover due to fluctuating water levels and predators eating carcasses.

Table 7. Numbers of Chinook salmon marked, examined for marks, and recovered with marks, and the mark incidences and Petersen escapement estimates for Tranquil Creek, Tahsis River and Leiner River in 2005 and 2006.

	Tranquil	**Tahsis**	**Leiner[a]**
	2005		
Number of Fish Marked (M)	87	25	No data
Number of Fish Examined (C)	66	2	No data
Number of Fish Recovered (R)	6	0	No data
Mark Incidence (100 * R/C)	8.8%	na	No data
Petersen Estimate ($\hat{N}$)	841	na	No data
Confidence Interval (CI) Method	Binomial	na	
Lower 95% CI	426	na	No data
Upper 95% CI	1631	na	No data
	2006		
Number of Fish Marked (M)	76	16	44
Number of Fish Examined (C)	21	0	4
Number of Fish Recovered (R)	2	0	0
Mark Incidence (100 * R/C)	na	na	na

	Tranquil	Tahsis	Leiner[a]
Petersen Estimate ($\hat{N}$)	na	na	na
Confidence Interval (CI) Method	na	na	na
Lower 95% CI	na	na	na
Upper 95% CI	na	na	na

[a] Leiner MR only conducted in 2006.

Tag Loss

T-bar anchor tag loss rates were calculated for Tranquil Creek only because no Chinook salmon carcasses were recovered from Tahsis or Leiner Rivers. In 2005, 2 of 6 (33%) carcasses had lost their tags and in 2006, one of two carcasses had lost its tag (Table 8). For Tranquil Creek, the weighted mean tag loss was 38% with a total 3 of 8 tags lost among the carcasses recovered in both years combined.

Table 8. Chinook salmon tag loss by year for Tranquil Creek, Tahsis and Leiner Rivers.

	Tranquil	Tahsis	Leiner[a]
	2005		
Number of Fish Marked (M)	87	25	No data
Number of Fish Examined (C)	66	2	No data
Number of Fish Recovered (R)	6	0	No data
Number of Fish Recovered with Floy Tag	4	na	No data
Number of Fish Recovered with Secondary Mark Only (Lost Tags)	2	na	No data
Proportion of Lost Tags	0.33	na	No data
Tag Loss	**33%**	na	No data
Number of Fish Marked (M)	76	16	44
Number of Fish Examined (C)	21	0	4
Number of Fish Recovered (R)	2	0	0
Number of Fish Recovered with Floy Tag	1	na	na
Number of Fish Recovered with Secondary Mark Only (Lost Tags)	1	na	na
Proportion of Lost Tags	0.50	na	na
Tag Loss	**50%**	na	na
Weighted Mean	**38%**	na	na

[a] Leiner MR only conducted in 2006.

Swim Surveys

Chinook salmon counts are presented in Appendixes 26-31, and the peak of spawning activity by year for Tranquil Creek, Tahsis and Leiner Rivers are presented in Appendix 32. Eight Chinook salmon tags applied Leiner River were observed in Tahsis River, 2006, which

indicates mixing and potential immigration to Tahsis and emigration from Leiner. These resighted tags were removed and were not used to estimate survey life or escapement. Further research on emigration and immigration is required to determine rates and correction factors for escapement estimates.

In both years, spawning activity peaked around early October for Tahsis and Leiner Rivers. For Tranquil Creek, spawning activity peaked around mid-October in 2005 and late-October in 2006 (Appendix 32).

Mark – Resight

The Chinook salmon mark-resight estimates of escapement and 95% confidence intervals are presented in Table 9 for Tranquil Creek, Tahsis River and Leiner River in 2005 and 2006. The mark-resight estimates vary compared to the mark-recapture and AUC estimates. No mark program was conducted for Leiner River in 2005. For Leiner River in 2006, adverse river conditions resulted in infrequent surveys and tag resight counts that were too low to be reliable (Appendix 31).

At Tranquil Creek in 2005, the spawning abundance of 624 Chinook salmon (95% confidence interval; 584 - 678), was estimated with a JHE estimator based on 3 swim surveys following tag application over 6 days. Surveys after October 25 were excluded because fish began spawning and dying, resulting in too few fish counted on a single survey to use in the analysis (Appendix 26). Over the 3 surveys, mark incidences were similar and 82% the total spawner escapement was observed on the swim survey with the highest count, which produces high precision in the estimate and confidence intervals of less than 9% of the estimate.

At Tranquil Creek in 2006, the spawning abundance of 964 Chinook salmon (95% confidence interval; 808 - 1180), was estimated with a JHE estimator based on 7 swim surveys over 65 days (October 18 – November 14; Appendix 27). Over the 7 surveys, mark incidences were similar and only 34 % of the total spawner escapement was observed on the swim survey with the highest count, which produces lower precision in the estimate and confidence intervals of less than 23% of the estimate.

At Tahsis River in 2005, the spawning abundance of 203 Chinook salmon (95% confidence interval; 172 - 266) was estimated with a JHE estimator based on 3 swim surveys over 16 days (October 4 – 20; Appendix 28). Over the 3 surveys, mark incidences were similar and 72% of the total spawner escapement was observed on the swim survey with the highest count, which produces lower precision in the estimate and confidence intervals of less than 31% of the estimate.

At Tahsis River in 2006, the spawning abundance of 120 Chinook salmon (95% confidence interval; 100-165) was estimated with a JHE estimator based on 7 swim surveys over 54 days (September 30 – November 2: Appendix 29). Over the 7 surveys, mark incidences were similar and the swim survey with the highest count was actually higher than the mark-resight estimate, as the peak count was observed on the first swim survey and was not included in the mark-resight estimate. Due to extremely low flows (river dry in some areas), swim surveys were conducted too late and may only represent the later portion of the run.

Table 9. Chinook salmon mark-resight escapement estimates for Tranquil Creek, Tahsis River and Leiner River in 2005 and 2006.

	Tranquil	**Tahsis**	**Leiner**
2005			
Resight Escapement	**624**	**203**	No data

	Tranquil	Tahsis	Leiner
Lower 95% CI	584	172	No data
Upper 95% CI	678	266	No data
2006			
Resight Escapement	**964**	**124**	na
Lower 95% CI	808	100	na
Upper 95% CI	1180	165	na

AUC

The AUC escapement estimate using the AUTC survey life was consistently higher than other estimates for Chinook salmon across all systems in both years because the AUTC survey life was lower than the index survey life. All of the coho salmon MLE AUC estimates were higher than AUC estimates in 2005 and lower in 2006 (Table 10). Note that the MLE AUC estimate of escapement incorporates uncertainty around the total fish days and survey life; therefore, the total estimate is not the total spawner days divided by the survey life (Equation above).

The observed counts, trapezoidal AUC curves and MLE curves are reported in Appendixes 33-38. Typically, the MLE (Beta or normal) curve fits well to the observed data. This was reflected in small differences between the trapezoidal and MLE estimates. The advantage of the MLE AUC estimates is that confidence intervals can be generated by considering the precision in the survey life and counts used to estimate the fish curve.

Table 10. Chinook salmon escapements estimated using the AUC trapezoidal and MLE (with 95% CI's) methods including the total fish days and surveys life estimates from the index and AUTC methods for Tranquil Creek, Tahsis River and Leiner River in 2005 and 2006.

	Tranquil	**Tahsis**	**Leiner**
	2005		
AUC Index Method			
Fish Days	10,090	2,381	5,870
Index Survey Life	17.5	20.0	20.0
Escapement Estimate	**577**	**119**	**293**
AUC Tag Curve Method			
Fish Days	10,090	2,381	5,870
AUTC Survey Life	na[a]	13	No data
Escapement Estimate	na	**179**	na
AUC MLE Method			
Fish Days	10,289	2,164	7,098
Index Survey Life	17.5	20.0	20.0
Escapement Estimate	**735**	**201**	**355**
Lower 95% CI	596	159	297
Upper 95% CI	931	256	442
AUC Index Method			
Fish Days	8,288	2,447	3,071
Index Survey Life	20.0	17.5	17.5
Escapement Estimate	**414**	**140**	**175**
AUC Tag Curve Method			
Fish Days	8,288	2,447	3,071
AUTC Survey Life	7.4	10.6	na
Escapement Estimate	**1,120**	**231**	na
AUC MLE Method			
Fish Days	4,580	1,765	2,935
Index Survey Life	20.0	17.5	17.5
Esc Est	**229**	**101**	**168**
Lower 95% CI	168	77	125
Upper 95% CI	332	145	239

[a] Not representative.

Survey Lives

The area-under-the-tag-days-curve, MR-based, index- and literature-based Chinook salmon survey lives for Tranquil Creek, Tahsis and Leiner Rivers for 2005 and 2006 are presented in Table 11. In general, the survey lives vary by year and estimation method. The index surveys lives are considered the best estimate of survey life.

The 2006 AUTC survey life estimates for Tahsis and Leiner Rivers indicated the early arrival Chinook salmon had longer survey lives than later arriving fish (Table __); however,

these short survey lives are not considered representative, as the many fish were holding for a period of approximately ten days before tags could be applied.

The average spawning residency of Chinook in the Wannock River was 13 d (ranging from 7-23 d). The average spawning residency of male Chinook was 14 d (ranging from 7-23 d); the average spawning residency for female Chinook was 12 d (ranging from 7-16 d). 12.8 days was determined for Chuckwalla Chinook salmon (Nelson et al. 2000). Therefore, we reported a mean literature-based survey life of 12.9 days to represent fish in these systems (Table 11).

Table 11. The area-under-the-tag-days-curve, MR-based, index and literature based coho salmon survey lives for Tranquil Creek, Tahsis and Leiner Rivers for 2005 and 2006.

Survey Life	Tranquil	Tahsis	Leiner
	2005		
AUTC (Total tags)	4.7	13.3	No data
MR-based	12.0	na	No data
Index (minimum)	14.0	15.0	15.0
Index (minimum)	21.0	25.0	25.0
Index (mean)	17.5	20.0	20.0
2006			
AUTC (Total tags)	7.4	10.6	na
AUTC (Early tags)	4.1	na	na
AUTC (Late tags)	2.7	na	na
MR-based	na	na	na
Index (minimum)	15.0	14.0	15.0
Index (minimum)	25.0	21.0	20.0
Index (mean)	20.0	17.5	17.5
From Literature	12.9	12.9	12.9

Expansion Factors

Visual expansion factors for Chinook salmon were developed from visual estimates (peak count, trapezoidal AUC and MLE AUC) and total escapement (mark-recapture and mark-resight) by year and river system varied from 0.84 to 4.21 (Table 12). More than two years of expansion factors are needed to estimate a mean expansion factors.

Table 12. Visual expansion factors for Chinook salmon developed from visual estimates and total escapement by year and river system.

River System	Year	Visual Index			Total Escapement		Visual Expansion Factor					
		Peak Count (PC)	Trapezoidal AUC (AUC_{trap})	MLE AUC (AUC_{MLE})	Mark-Recapture (MR)	Mark Resight (MRS)	Peak Count		Trapezoidal AUC		MLE AUC	
							(MR/PC)	(MRS/PC)	(MR / AUC_{trap})	(MRS / AUC_{trap})	(MR / AUC_{MLE})	(MRS / AUC_{MLE})
Tranquil Creek	2005	534	577	735	841	624	1.58	1.17	1.46	1.08	1.14	0.85
	2006	327	380	229	na	964	na	2.95	na	2.54	na	4.21
Tahsis River	2005	147	119	201	na	203	na	1.38	na	1.71	na	1.01
	2006	118	414	101	na	124	na	1.05	na	0.30	na	1.23
Leiner River	2005	292	293	355	no study		na	na	na	na	na	na
	2006	114	175	168	na	na	na	na	na	na	na	na

DISCUSSION

Spawner escapement goals and benchmarks are key pieces of information to assess stock status and implement the Pacific Salmon Treaty and the Wild Salmon Policy developed by Fisheries and Oceans Canada. Typically maximum sustained yield escapement goals are calculated from stock-recruitment analyses of several years of spawner escapements and subsequent production. The approach can take several years (15-20) to acquire sufficient data and often requires considerable resources. For these and other reasons, many stocks, such as the small, clear WCVI rivers, do not have sufficient spawner and production data to estimate optimal spawning escapements. Consequently, habitat-based methods have been developed as low-cost, quick alternatives.

Parken et al. (2006) developed a habitat-based approach to estimate the optimal spawning escapements of Chinook salmon based on the size of the watershed used by the stock. The model was developed from stock-recruitment estimates of optimal spawning escapements for stocks ranging from coastal Oregon to the Yukon drainage in Alaska. The model has been verified with independent estimates of optimal spawner escapements and was used to establish escapement goals for data limited stocks in Alaska.

The habitat model predicts the optimal number of spawners required, but most data limited stocks only have indices of abundance and additional information is required to convert the indices to total spawners in order to make comparisons in common units (not indices). The habitat model requires an estimate of the watershed area below migration barriers and knowledge of the life history (see Parken et al. 2006 for details). However, to apply the habitat model to data limited systems, calibration studies are used to generate expansion factors to convert the spawner indices into estimates of total escapement, unless total escapement methods are already in place (e.g. fence, sonar, mark-recapture, etc.). Calibration involves estimating total escapement by mark-recapture or direct count methods while performing the index method over several years in order to develop a sufficiently precise factor to convert indices to total escapements. Visual indices typically provide a cost effective alternative to annual mark-recapture estimates or direct methods of estimating escapement on an ongoing basis.

Chinook and coho salmon are notoriously challenging to enumerate across the West Coast of Vancouver Island. Due to low salmon spawner abundances, variable river conditions and multiple species the other enumeration techniques such as sonar, electronic counters and fences are not logistically or financially feasible on these systems. We found that the visual counting and river conditions varied enormously within and among years for the three streams, which limited the ability of crews to mark and recover adequate numbers of marks. Also, fluctuating water levels limited mark application and coupled with predator removal severely reduced the number of carcasses available for recovery. Application of AUC methods can also be prone to bias because survey lives can vary annually and by system (Perrin and Irvine 1990; Trouton 2004).

In our study for coho salmon, valid mark-recapture and mark-resight escapement estimates were developed for two and three, respectively, of the four river by year combinations (no calibration was performed at Leiner River in 2005 and no tags were applied at Tahsis in 2005). For Chinook salmon, valid mark-recapture and mark-resight escapement estimates were developed for one and four, respectively, of the five river by year combinations. Further, three visual index methods were conducted on each of the five year by river combinations. These estimates were used to develop expansion factors for calibration by comparing visual AUC estimates based on swim surveys to mark-recapture and resight total escapement estimates.

Several, study design limitations including variable river conditions, tag loss, timing of tag application, common tag colors applied to coho and Chinook salmon in the same or nearby systems, and common tag colors applied to adults and jacks significantly compromised our confidence in the accuracy of the 2005 and 2006 total escapement estimates and expansion factors. It also prevented the estimation of spawner abundance by age, sex or within the targeted precision on the total abundance (CV of 20%). These critical improvements are recommended in order to increase the quality and confidence in the visual indices and total escapement estimates and the resultant expansion factors:

a. Initiate tagging and swim surveys sooner (late-September for Tranquil) to enumerate the earlier portion run and for proportional distribution of marks,
b. Use Petersen disk tags to reduce tag loss,
c. One tag colour per system to estimate emigration and immigration between Leiner and Tahsis Rivers,
d. Tag fresh (e.g. green) adults only and do not tag jacks or spawners to ensure representative tagging of the adult population,
e. Sex-specific operculum punches to determine sex correction factors if adequate sample sizes are obtained,
f. Have an additional crew member walk stream banks in conjunction with swim surveys to increase the number of recoveries, and
g. Quantify rates of immigration and emigration using techniques such as radio telemetry.

The PSC Chinook technical committee has considered data standards for factors used to expand escapement indices. The draft recommendations include that expansion factors be based on a minimum of 3 years data and that the coefficient of variation (CV) for the point estimates should not exceed 20% on average across years. Additional years of escapement calibration are required to generate average expansion factors of sufficient quality to yield reliable total abundance estimates and to better understand the accuracy of the current visual index methods.

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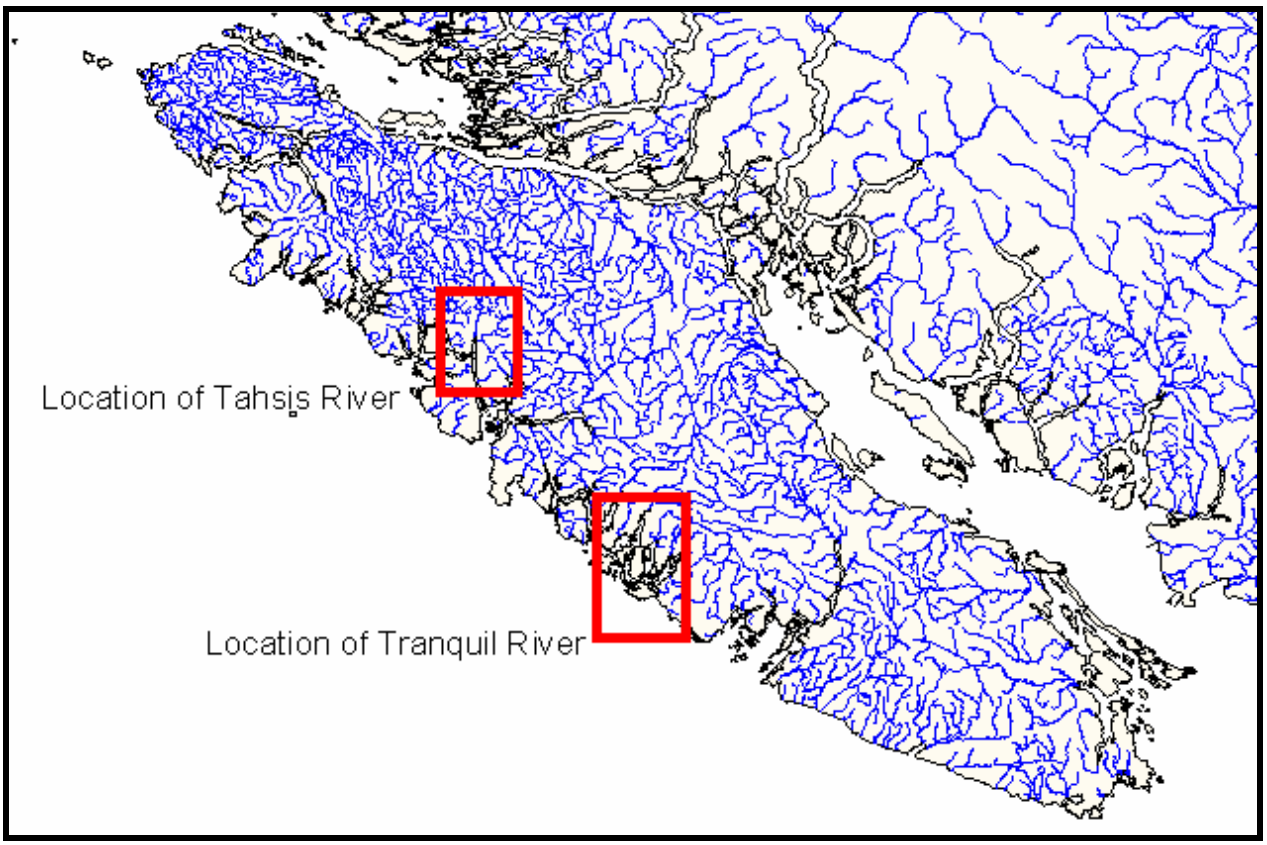
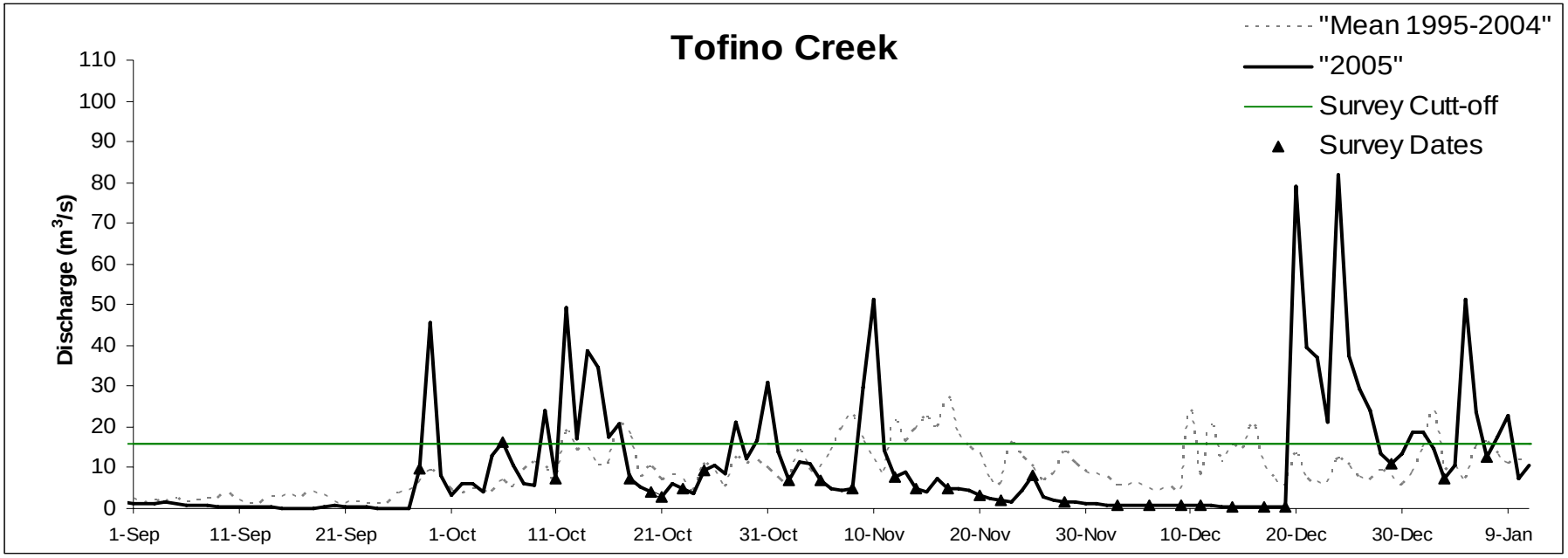
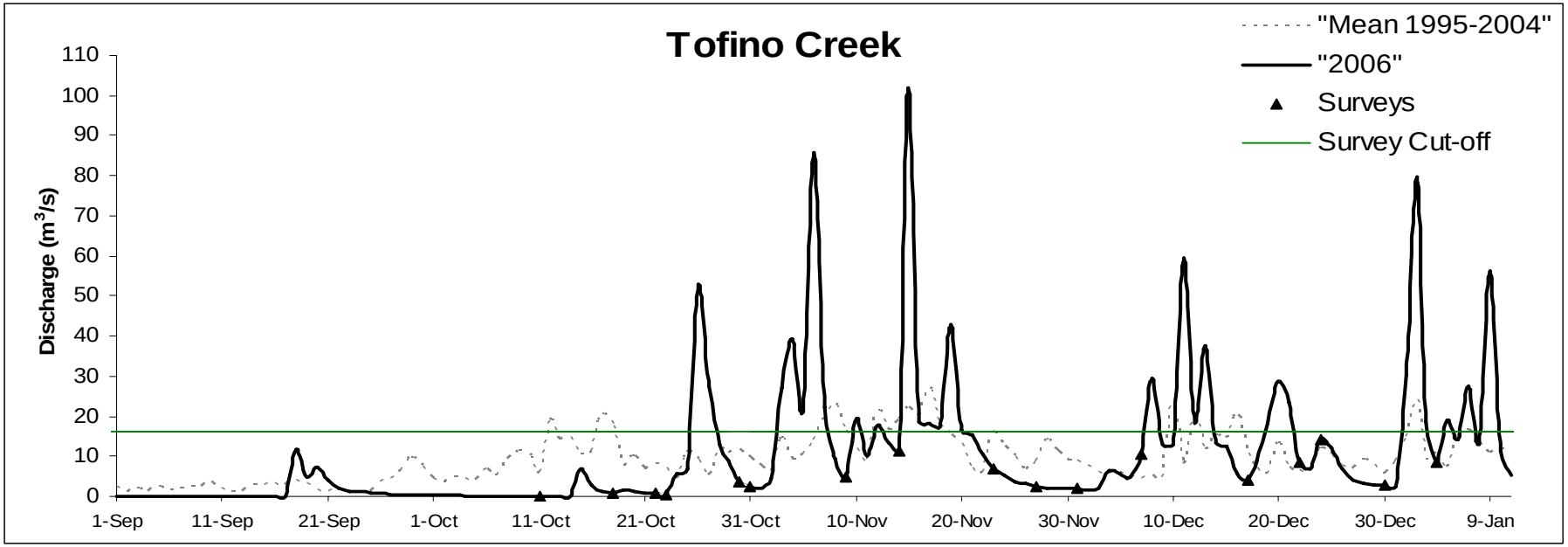
APPENDICES

Appendix 1. Location of Tahsis and Tranquil Rivers, on the West Coast of Vancouver Island.

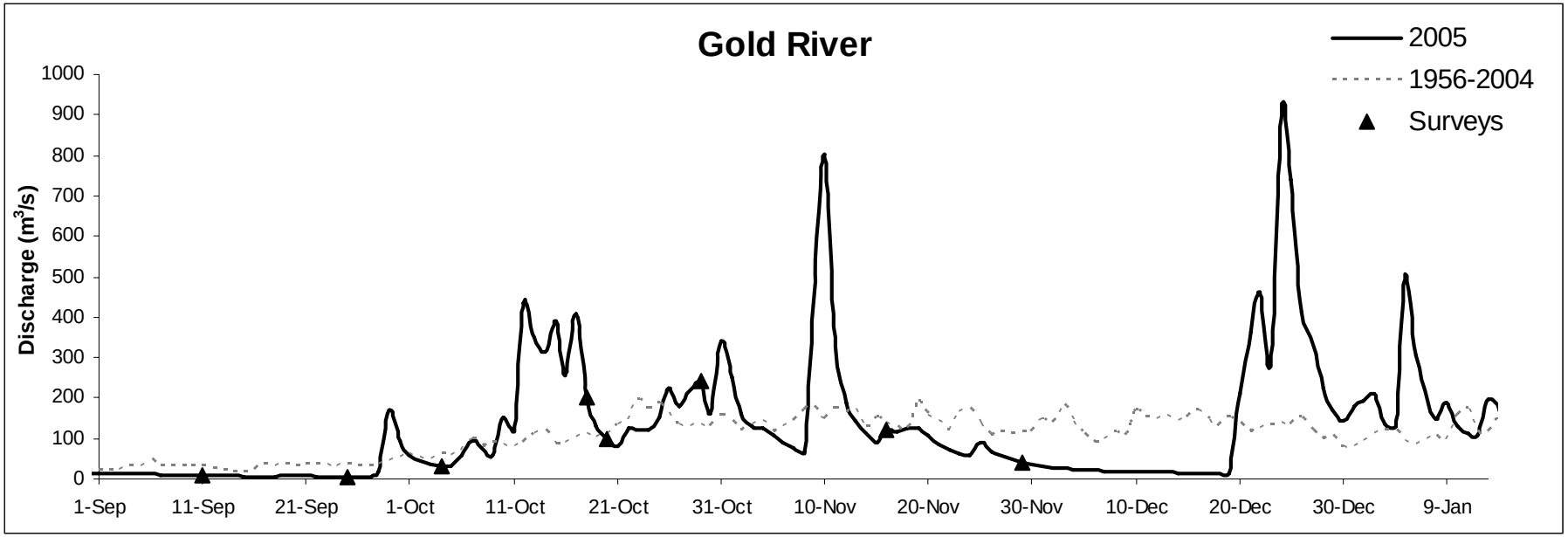




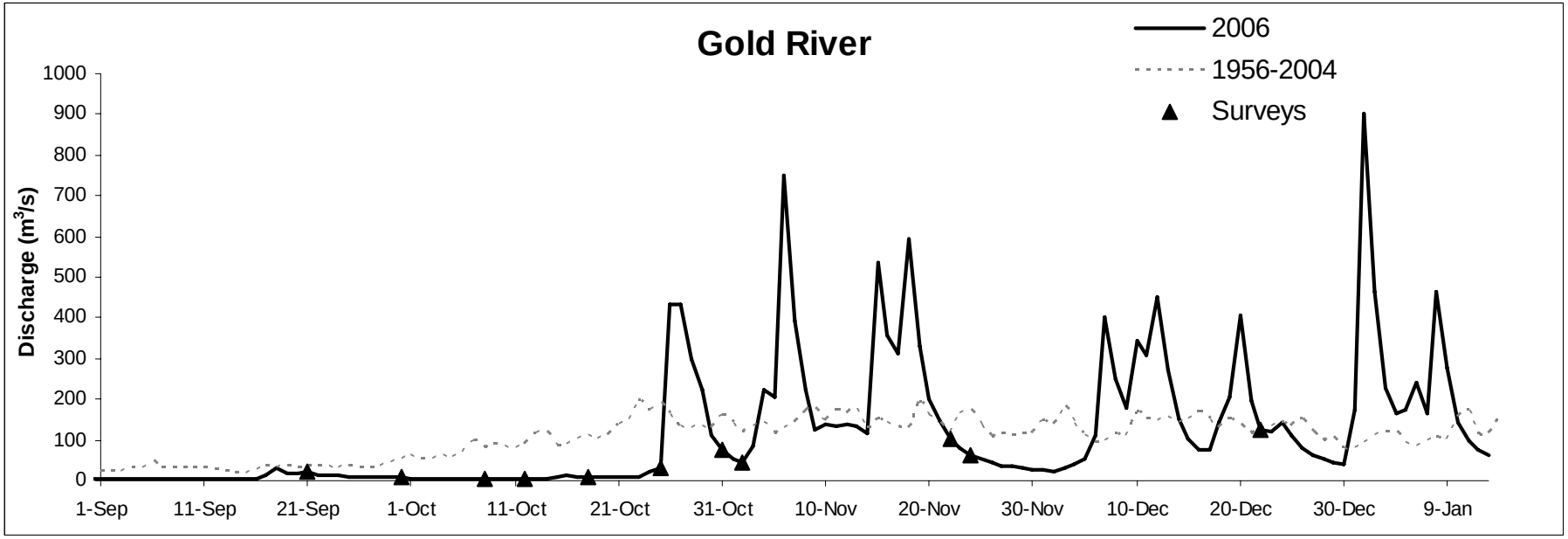
Appendix 2. Daily discharge, survey dates, and survey cutoff discharge for 2005, and the mean daily flows for 1995-2004 are approximated for Tranquil Creek using Environment Canada's Water Survey Station information at Tofino Creek, a similar size stream within close proximity (Lynne Campo, pers. comm., Environment Canada, unpublished data).



Appendix 3. Daily discharge, survey dates, and survey cutoff discharge for 2006, and the mean daily flows for 1995-2004 are approximated for Tranquil Creek using Environment Canada's Water Survey Station information at Tofino Creek, a similar size stream within close proximity (Lynne Campo, pers. comm., Environment Canada, unpublished data).



Appendix 4. Daily discharge, survey dates, and survey cutoff discharge for 2005, and the mean daily flows for 1995-2004 are approximated for Tahsis and Leiner Rivers using Environment Canada's Water Survey Station information at Gold River; although, this is a much larger river the fluctuation in flow emulates that in Tahsis and Leiner Rivers (Lynne Campo, pers. comm., Environment Canada, unpublished data).



Appendix 5. Daily discharge, survey dates, and survey cutoff discharge for 2006, and the mean daily flows for 1995-2004 are approximated for Tahsis and Leiner Rivers using Environment Canada's Water Survey Station information at Gold River; although, this is a much larger river the fluctuation in flow emulates that in Tahsis and Leiner Rivers (Lynne Campo, pers. comm., Environment Canada, unpublished data).

Appendix 6. Daily mark application of Chinook and coho salmon by tag number and colour, date, species, sex and spawning condition for Tranquil Creek in 2005.

Tag #	Colour	Date	Species	Sex	Spawning Condition	Length (mm)
676	Orange	19-Oct-05	CN	M	Ripe	660
677	Orange	19-Oct-05	CN	M	Ripe	787
678	Orange	19-Oct-05	CN	M	Ripe	559
679	Orange	19-Oct-05	CN	M	Ripe	559
680	Orange	19-Oct-05	CN	M	Ripe	597
681	Orange	19-Oct-05	CN	M	Ripe	635
682	Orange	19-Oct-05	CN	M	Ripe	648
683	Orange	19-Oct-05	CN	M	Ripe	648
685	Orange	19-Oct-05	CN	M	Ripe	635
686	Orange	19-Oct-05	CN	F	Green	838
687	Orange	19-Oct-05	CN	M	Ripe	838
688	Orange	19-Oct-05	CN	M	Ripe	584
690	Orange	19-Oct-05	CN	M	Ripe	686
691	Orange	19-Oct-05	CN	F	Spawned Out	762
692	Orange	19-Oct-05	CN	M	Ripe	813
694	Orange	19-Oct-05	CN	M	Ripe	864
695	Orange	19-Oct-05	CN	M	Ripe	686
696	Orange	19-Oct-05	CN	F	Green	787
697	Orange	19-Oct-05	CN	F	Green	775
698	Orange	19-Oct-05	CN	F	Green	813
699	Orange	19-Oct-05	CN	M	Ripe	711
700	Orange	19-Oct-05	CN	F	Green	787
701	Orange	19-Oct-05	CN	M	Ripe	584
702	Orange	19-Oct-05	CN	M	Ripe	508
703	Orange	19-Oct-05	CN	M	Ripe	584
704	Orange	19-Oct-05	CN	F	Spawned Out	711
705	Orange	19-Oct-05	CN	M	Ripe	610
706	Orange	19-Oct-05	CN	M	Ripe	559
707	Orange	19-Oct-05	CN	M	Ripe	787
708	Orange	19-Oct-05	CN	M	Ripe	546
709	Orange	19-Oct-05	CN	F	Partial Spawn	724
710	Orange	19-Oct-05	CN	M	Ripe	597
711	Orange	19-Oct-05	CN	M	Ripe	559
712	Orange	19-Oct-05	CN	F	Green	686
713	Orange	19-Oct-05	CN	M	Ripe	660
714	Orange	19-Oct-05	CN	M	Ripe	610
715	Orange	20-Oct-05	CN	M	Ripe	559
716	Orange	20-Oct-05	CN	M	Ripe	610
717	Orange	20-Oct-05	CN	F	Ripe	813
718	Orange	20-Oct-05	CN	M	Ripe	610
719	Orange	20-Oct-05	CN	M	Ripe	737
720	Orange	20-Oct-05	CN	M	Spawned Out	787
721	Orange	20-Oct-05	CN	M	Ripe	559
722	Orange	20-Oct-05	CN	M	Ripe	749
723	Orange	20-Oct-05	CN	M	Ripe	533
724	Orange	20-Oct-05	CN	M	Ripe	864

Tag #	Colour	Date	Species	Sex	Spawning Condition	Length (mm)
725	Orange	20-Oct-05	CN	F	Partial Spawn	838
751	Orange	20-Oct-05	CN	F	Partial Spawn	737
752	Orange	20-Oct-05	CN	M	Ripe	787
753	Orange	20-Oct-05	CN	F	Spawned Out	813
754	Orange	20-Oct-05	CN	F	Spawned Out	787
755	Orange	20-Oct-05	CN	M	Ripe	610
756	Orange	20-Oct-05	CN	M	Ripe	559
757	Orange	20-Oct-05	CN	F	Green	724
758	Orange	20-Oct-05	CN	M	Ripe	635
759	Orange	20-Oct-05	CN	F	Spawned Out	724
760	Orange	20-Oct-05	CN	M	Spawned Out	635
761	Orange	20-Oct-05	CN	M	Spawned Out	610
762	Orange	20-Oct-05	CN	M	Spawned Out	635
763	Orange	20-Oct-05	CN	M	Spawned Out	737
764	Orange	20-Oct-05	CN	F	Spawned Out	787
765	Orange	20-Oct-05	CN	F	Partial Spawn	762
766	Orange	20-Oct-05	CN	M	Spawned Out	648
767	Orange	20-Oct-05	CN	F	Partial Spawn	711
768	Orange	20-Oct-05	CN	M	Green	610
769	Orange	20-Oct-05	CN	F	Spawned Out	724
770	Orange	20-Oct-05	CN	M	Spawned Out	597
771	Orange	20-Oct-05	CN	M	Ripe	813
772	Orange	20-Oct-05	CN	F	Spawned Out	660
773	Orange	20-Oct-05	CN	F	Spawned Out	838
774	Orange	20-Oct-05	CN	M	Ripe	597
775	Orange	20-Oct-05	CN	M	Ripe	673
776	Orange	20-Oct-05	CN	M	Spawned Out	660
777	Orange	20-Oct-05	CN	M	Spawned Out	686
778	Orange	20-Oct-05	CN	M	Ripe	673
779	Orange	20-Oct-05	CN	M	Green	610
780	Orange	20-Oct-05	CN	F	Partial Spawn	838
781	Orange	20-Oct-05	CN	M	Ripe	635
782	Orange	20-Oct-05	CN	M	Ripe	559
783	Orange	20-Oct-05	CN	M	Ripe	610
784	Orange	20-Oct-05	CN	M	Ripe	584
785	Orange	20-Oct-05	CN	M	Ripe	584
786	Orange	20-Oct-05	CN	M	Ripe	6223
787	Orange	20-Oct-05	CN	M	Ripe	635
788	Orange	20-Oct-05	CN	M	Ripe	533
789	Orange	20-Oct-05	CN	F	Green	749
790	Orange	20-Oct-05	CN	M	Green	635
779	Green	19-Oct-05	CO	M	Green	648
780	Green	19-Oct-05	CO	F	Green	622
782	Green	19-Oct-05	CO	F	Green	597
783	Green	19-Oct-05	CO	F	Green	584
784	Green	19-Oct-05	CO	M	Green	533
785	Green	19-Oct-05	CO	M	Green	622
786	Green	19-Oct-05	CO	M	Green	610
788	Green	19-Oct-05	CO	F	Green	610

Tag #	Colour	Date	Species	Sex	Spawning Condition	Length (mm)
789	Green	19-Oct-05	CO	M	Green	483
790	Green	19-Oct-05	CO	F	Green	597
791	Green	19-Oct-05	CO	F	Green	622
792	Green	19-Oct-05	CO	F	Green	572
793	Green	19-Oct-05	CO	M	Green	483
794	Green	19-Oct-05	CO	F	Green	610
795	Green	19-Oct-05	CO	F	Green	673
796	Green	19-Oct-05	CO	F	Green	533
797	Green	19-Oct-05	CO	M	Green	521
798	Green	19-Oct-05	CO	M	Green	457
800	Green	19-Oct-05	CO	F	Green	622
801	Green	19-Oct-05	CO	M	Green	457
802	Green	19-Oct-05	CO	F	Green	584
803	Green	19-Oct-05	CO	F	Green	660
804	Green	19-Oct-05	CO	F	Green	622
805	Green	19-Oct-05	CO	F	Green	610
807	Green	19-Oct-05	CO	F	Green	546
808	Green	19-Oct-05	CO	M	Green	521
811	Green	19-Oct-05	CO	M	Green	635
812	Green	19-Oct-05	CO	F	Green	622
813	Green	19-Oct-05	CO	F	Green	457
814	Green	19-Oct-05	CO	F	Green	572
815	Green	19-Oct-05	CO	F	Green	597
816	Green	19-Oct-05	CO	M	Green	559
817	Green	19-Oct-05	CO	F	Green	584
818	Green	19-Oct-05	CO	M	Green	533
820	Green	19-Oct-05	CO	M	Green	622
821	Green	19-Oct-05	CO	M	Green	610
822	Green	19-Oct-05	CO	M	Green	533
823	Green	19-Oct-05	CO	F	Green	521
824	Green	19-Oct-05	CO	F	Green	572
825	Green	19-Oct-05	CO	M	Green	533
826	Green	19-Oct-05	CO	F	Green	508
827	Green	19-Oct-05	CO	M	Green	597
828	Green	19-Oct-05	CO	F	Green	572
829	Green	19-Oct-05	CO	F	Green	648
831	Green	19-Oct-05	CO	M	Green	610
832	Green	19-Oct-05	CO	F	Green	610
833	Green	19-Oct-05	CO	M	Green	533
834	Green	19-Oct-05	CO	M	Green	610
835	Green	19-Oct-05	CO	M	Green	559
836	Green	19-Oct-05	CO	F	Green	584
837	Green	19-Oct-05	CO	F	Green	648
839	Green	19-Oct-05	CO	M	Green	508
840	Green	19-Oct-05	CO	M	Green	686
842	Green	19-Oct-05	CO	F	Green	508
843	Green	19-Oct-05	CO	F	Green	622
844	Green	19-Oct-05	CO	M	Green	533
845	Green	19-Oct-05	CO	F	Green	533

Tag #	Colour	Date	Species	Sex	Spawning Condition	Length (mm)
846	Green	19-Oct-05	CO	M	Green	673
847	Green	19-Oct-05	CO	F	Green	660
848	Green	19-Oct-05	CO	M	Green	635
849	Green	19-Oct-05	CO	M	Green	660
850	Green	19-Oct-05	CO	F	Green	622
851	Green	19-Oct-05	CO	M	Green	660
852	Green	19-Oct-05	CO	F	Green	533
853	Green	19-Oct-05	CO	F	Green	559
854	Green	19-Oct-05	CO	F	Green	546
855	Green	19-Oct-05	CO	F	Green	546
856	Green	19-Oct-05	CO	M	Green	495
857	Green	19-Oct-05	CO	F	Green	622
858	Green	19-Oct-05	CO	F	Green	559
859	Green	19-Oct-05	CO	F	Green	559
860	Green	19-Oct-05	CO	M	Green	660
861	Green	19-Oct-05	CO	M	Green	559
862	Green	19-Oct-05	CO	M	Green	610
863	Green	19-Oct-05	CO	M	Green	533
864	Green	19-Oct-05	CO	M	Green	686
865	Green	19-Oct-05	CO	M	Green	673
866	Green	19-Oct-05	CO	M	Green	673
867	Green	19-Oct-05	CO	M	Green	660
868	Green	19-Oct-05	CO	F	Green	483
869	Green	19-Oct-05	CO	M	Green	673
870	Green	19-Oct-05	CO	F	Green	610
871	Green	19-Oct-05	CO	F	Green	559
872	Green	19-Oct-05	CO	F	Green	610
873	Green	19-Oct-05	CO	M	Green	635
874	Green	19-Oct-05	CO	M	Green	508
875	Green	19-Oct-05	CO	F	Green	635
876	Green	19-Oct-05	CO	M	Green	635
877	Green	19-Oct-05	CO	M	Green	584
878	Green	19-Oct-05	CO	M	Green	635
879	Green	19-Oct-05	CO	M	Green	610
880	Green	19-Oct-05	CO	F	Green	559
881	Green	19-Oct-05	CO	M	Green	610
882	Green	19-Oct-05	CO	M	Green	635
883	Green	19-Oct-05	CO	M	Green	660
884	Green	19-Oct-05	CO	F	Green	584
885	Green	19-Oct-05	CO	F	Green	559
886	Green	19-Oct-05	CO	F	Green	584
887	Green	19-Oct-05	CO	M	Green	635
888	Green	19-Oct-05	CO	F	Green	622
889	Green	19-Oct-05	CO	M	Green	660
890	Green	19-Oct-05	CO	F	Green	584
891	Green	19-Oct-05	CO	M	Green	711
892	Green	19-Oct-05	CO	F	Green	660
893	Green	19-Oct-05	CO	M	Green	546
894	Green	19-Oct-05	CO	M	Green	584

Tag #	Colour	Date	Species	Sex	Spawning Condition	Length (mm)
895	Green	19-Oct-05	CO	F	Green	508
896	Green	19-Oct-05	CO	F	Green	546
897	Green	19-Oct-05	CO	F	Green	508
898	Green	19-Oct-05	CO	M	Green	495
899	Green	19-Oct-05	CO	M	Green	648
900	Green	19-Oct-05	CO	F	Green	572
902	Green	19-Oct-05	CO	M	Green	419
903	Green	19-Oct-05	CO	F	Green	584
904	Green	19-Oct-05	CO	F	Green	533
905	Green	19-Oct-05	CO	M	Green	508
906	Green	19-Oct-05	CO	M	Green	610
907	Green	19-Oct-05	CO	M	Green	483
908	Green	19-Oct-05	CO	M	Green	622
909	Green	19-Oct-05	CO	M	Green	546
910	Green	19-Oct-05	CO	M	Green	546
911	Green	19-Oct-05	CO	F	Green	546
912	Green	19-Oct-05	CO	F	Green	559
913	Green	19-Oct-05	CO	F	Green	572
914	Green	19-Oct-05	CO	F	Green	559
915	Green	19-Oct-05	CO	M	Green	432
916	Green	19-Oct-05	CO	M	Green	584
917	Green	19-Oct-05	CO	M	Green	495
918	Green	19-Oct-05	CO	M	Green	508
919	Green	19-Oct-05	CO	M	Green	432
920	Green	19-Oct-05	CO	F	Green	572
921	Green	19-Oct-05	CO	F	Green	508
922	Green	19-Oct-05	CO	F	Green	559
923	Green	19-Oct-05	CO	F	Green	508
924	Green	19-Oct-05	CO	M	Green	508
925	Green	19-Oct-05	CO	F	Green	533
926	Green	19-Oct-05	CO	F	Green	495
927	Green	19-Oct-05	CO	F	Green	584
928	Green	19-Oct-05	CO	F	Green	584
929	Green	19-Oct-05	CO	F	Green	584
930	Green	19-Oct-05	CO	M	Green	610
931	Green	19-Oct-05	CO	F	Green	559
932	Green	19-Oct-05	CO	F	Green	559
933	Green	19-Oct-05	CO	M	Green	419
934	Green	19-Oct-05	CO	F	Green	584
935	Green	19-Oct-05	CO	F	Green	635
936	Green	19-Oct-05	CO	F	Green	584
937	Green	19-Oct-05	CO	F	Green	521
938	Green	19-Oct-05	CO	M	Green	660
939	Green	19-Oct-05	CO	M	Green	483
940	Green	19-Oct-05	CO	M	Green	559
941	Green	19-Oct-05	CO	M	Green	584
942	Green	19-Oct-05	CO	M	Green	635
943	Green	19-Oct-05	CO	M	Green	559
944	Green	19-Oct-05	CO	M	Green	559

Tag #	Colour	Date	Species	Sex	Spawning Condition	Length (mm)
945	Green	19-Oct-05	CO	F	Green	635
946	Green	19-Oct-05	CO	F	Green	584
947	Green	19-Oct-05	CO	F	Green	559
948	Green	19-Oct-05	CO	M	Green	610
949	Green	19-Oct-05	CO	F	Green	533
950	Green	19-Oct-05	CO	M	Green	483
951	Green	19-Oct-05	CO	F	Green	584
952	Green	19-Oct-05	CO	F	Green	533
953	Green	19-Oct-05	CO	F	Green	572
954	Green	19-Oct-05	CO	F	Green	610
955	Green	19-Oct-05	CO	F	Green	584
956	Green	19-Oct-05	CO	M	Green	610
957	Green	19-Oct-05	CO	F	Green	559
958	Green	19-Oct-05	CO	M	Green	533
959	Green	19-Oct-05	CO	F	Green	610
960	Green	19-Oct-05	CO	F	Green	559
961	Green	19-Oct-05	CO	F	Green	559
962	Green	19-Oct-05	CO	F	Green	546
963	Green	19-Oct-05	CO	M	Green	546
964	Green	19-Oct-05	CO	F	Green	559
966	Green	20-Oct-05	CO	M	Green	635
967	Green	20-Oct-05	CO	F	Green	584
968	Green	20-Oct-05	CO	F	Green	559
969	Green	20-Oct-05	CO	M	Green	610
970	Green	20-Oct-05	CO	F	Green	610
971	Green	20-Oct-05	CO	F	Green	584
972	Green	20-Oct-05	CO	M	Green	445
974	Green	20-Oct-05	CO	M	Green	457
975	Green	20-Oct-05	CO	F	Green	483
976	Green	20-Oct-05	CO	M	Green	533
977	Green	20-Oct-05	CO	M	Green	597
978	Green	20-Oct-05	CO	M	Green	508
979	Green	20-Oct-05	CO	F	Green	584
980	Green	20-Oct-05	CO	F	Green	584
981	Green	20-Oct-05	CO	F	Green	521
982	Green	20-Oct-05	CO	F	Green	584
984	Green	20-Oct-05	CO	M	Green	419
985	Green	20-Oct-05	CO	M	Green	533
986	Green	20-Oct-05	CO	F	Green	559
987	Green	20-Oct-05	CO	F	Green	546
988	Green	20-Oct-05	CO	M	Green	483
989	Green	20-Oct-05	CO	F	Green	572
990	Green	20-Oct-05	CO	M	Green	559
991	Green	20-Oct-05	CO	M	Green	406
992	Green	20-Oct-05	CO	M	Green	622
993	Green	20-Oct-05	CO	F	Green	495
994	Green	20-Oct-05	CO	F	Green	368
995	Green	20-Oct-05	CO	F	Green	597
996	Green	20-Oct-05	CO	F	Green	584

Tag #	Colour	Date	Species	Sex	Spawning Condition	Length (mm)
997	Green	20-Oct-05	CO	M	Green	495
998	Green	20-Oct-05	CO	M	Green	597
999	Green	20-Oct-05	CO	M	Green	508
1000	Green	20-Oct-05	CO	F	Green	572
1001	Green	20-Oct-05	CO	M	Green	521
1002	Green	20-Oct-05	CO	F	Green	533
1003	Green	20-Oct-05	CO	M	Green	546
1004	Green	20-Oct-05	CO	F	Green	483
1005	Green	20-Oct-05	CO	M	Green	584
1006	Green	20-Oct-05	CO	F	Green	432
1007	Green	20-Oct-05	CO	M	Green	597
1008	Green	20-Oct-05	CO	M	Green	597
1009	Green	20-Oct-05	CO	F	Green	546
1010	Green	20-Oct-05	CO	M	Green	584
1011	Green	20-Oct-05	CO	F	Green	483
1012	Green	20-Oct-05	CO	F	Green	521
1013	Green	20-Oct-05	CO	J	Green	279
973	Green	20-Oct-05	CO	J	Ripe	318
901	Green	19-Oct-05	CO	J	Green	330
983	Green	20-Oct-05	CO	J	Green	305
838	Green	19-Oct-05	CO	J	Green	292

Appendix 7. Daily mark application of Chinook and coho salmon by tag number and colour, date, species, sex and spawning condition for Tranquil Creek in 2006.

Tag #	Tag Colour	Date	Species	Sex	Spawning Condition	POH Length (mm)
791	Orange	17-Oct-06	CN	F	Green	625
792	Orange	17-Oct-06	CN	M	Ripe	675
793	Orange	17-Oct-06	CN	M	Ripe	605
794	Orange	17-Oct-06	CN	M	Ripe	695
795	Orange	17-Oct-06	CN	M	Ripe	865
796	Orange	17-Oct-06	CN	M	Ripe	670
797	Orange	17-Oct-06	CN	F	Ripe	735
798	Orange	17-Oct-06	CN	M	Ripe	715
799	Orange	17-Oct-06	CN	M	Ripe	700
800	Orange	17-Oct-06	CN	F	Partial Spawn	685
801	Orange	17-Oct-06	CN	M	Ripe	615
802	Orange	17-Oct-06	CN	M	Ripe	760
803	Orange	17-Oct-06	CN	M	Ripe	725
804	Orange	17-Oct-06	CN	M	Ripe	515
805	Orange	17-Oct-06	CN	M	Ripe	580
806	Orange	17-Oct-06	CN	M	Ripe	630
806	Orange	22-Oct-06	CN	F	Partial Spawn	710
807	Orange	22-Oct-06	CN	M	Ripe	760
808	Orange	22-Oct-06	CN	F	Spawned Out	680
809	Orange	22-Oct-06	CN	M	Ripe	690
810	Orange	22-Oct-06	CN	F	Partial Spawn	730
811	Orange	22-Oct-06	CN	M	Ripe	580
812	Orange	22-Oct-06	CN	M	Ripe	740
813	Orange	22-Oct-06	CN	F	Spawned Out	720
814	Orange	22-Oct-06	CN	F	Spawned Out	680
815	Orange	22-Oct-06	CN	M	Ripe	635
816	Orange	22-Oct-06	CN	M	Ripe	710
817	Orange	22-Oct-06	CN	M	Ripe	740
818	Orange	22-Oct-06	CN	M	Ripe	770
819	Orange	22-Oct-06	CN	F	Spawned Out	730
820	Orange	22-Oct-06	CN	M	Ripe	725
821	Orange	22-Oct-06	CN	M	Ripe	800
822	Orange	22-Oct-06	CN	M	Ripe	770
823	Orange	22-Oct-06	CN	F	Spawned Out	875
824	Orange	22-Oct-06	CN	F	Ripe	740
825	Orange	22-Oct-06	CN	M	Spawned Out	710
826	Orange	22-Oct-06	CN	F	Spawned Out	710
827	Orange	22-Oct-06	CN	M	Ripe	770
828	Orange	22-Oct-06	CN	M	Ripe	710
829	Orange	22-Oct-06	CN	F	Ripe	760
830	Orange	22-Oct-06	CN	M	Ripe	680
831	Orange	22-Oct-06	CN	F	Ripe	690
832	Orange	22-Oct-06	CN	M	Ripe	690
833	Orange	22-Oct-06	CN	M	Ripe	660
834	Orange	22-Oct-06	CN	M	Ripe	770

Tag #	Tag Colour	Date	Species	Sex	Spawning Condition	POH Length (mm)
835	Orange	22-Oct-06	CN	F	Spawned Out	680
836	Orange	22-Oct-06	CN	F	Spawned Out	750
837	Orange	22-Oct-06	CN	M	Ripe	630
838	Orange	22-Oct-06	CN	F	Ripe	700
839	Orange	22-Oct-06	CN	M	Ripe	750
840	Orange	22-Oct-06	CN	F	Ripe	600
841	Orange	22-Oct-06	CN	F	Ripe	690
842	Orange	22-Oct-06	CN	F	Ripe	730
843	Orange	22-Oct-06	CN	F	Ripe	680
844	Orange	22-Oct-06	CN	M	Ripe	660
845	Orange	22-Oct-06	CN	F	Ripe	740
57	Green	30-Oct-06	CN	F	Ripe	780
801	Rose	30-Oct-06	CN	F	Partial Spawn	710
802	Rose	30-Oct-06	CN	M	Ripe	700
803	Rose	30-Oct-06	CN	F	Ripe	710
804	Rose	30-Oct-06	CN	M	Ripe	650
805	Rose	30-Oct-06	CN	M	Ripe	650
806	Rose	30-Oct-06	CN	F	Ripe	790
807	Rose	30-Oct-06	CN	F	Spawned Out	730
808	Rose	30-Oct-06	CN	F	Green	650
810	Rose	30-Oct-06	CN	M	Ripe	570
811	Rose	30-Oct-06	CN	M	Spawned Out	655
812	Rose	30-Oct-06	CN	F	Spawned Out	720
813	Rose	30-Oct-06	CN	F	Ripe	750
814	Rose	30-Oct-06	CN	M	Ripe	600
815	Rose	30-Oct-06	CN	F	Ripe	660
816	Rose	30-Oct-06	CN	M	Ripe	740
817	Rose	30-Oct-06	CN	M	Ripe	650
818	Rose	30-Oct-06	CN	M	Ripe	635
819	Rose	30-Oct-06	CN	M	Ripe	675
820	Rose	30-Oct-06	CN	M	Ripe	715
1	Green	17-Oct-06	CO	M	Green	660
2	Green	17-Oct-06	CO	M	Green	625
3	Green	17-Oct-06	CO	F	Green	610
4	Green	17-Oct-06	CO	M	Green	650
5	Green	17-Oct-06	CO	M	Green	530
6	Green	17-Oct-06	CO	M	Green	615
7	Green	17-Oct-06	CO	F	Green	575
8	Green	17-Oct-06	CO	M	Green	630
9	Green	17-Oct-06	CO	M	Green	615
10	Green	17-Oct-06	CO	M	Green	595
11	Green	17-Oct-06	CO	F	Green	590
12	Green	17-Oct-06	CO	F	Green	550
13	Green	17-Oct-06	CO	M	Green	625
14	Green	17-Oct-06	CO	F	Green	625
16	Green	17-Oct-06	CO	F	Green	605
17	Green	17-Oct-06	CO	F	Green	615
20	Green	17-Oct-06	CO	M	Green	650
21	Green	17-Oct-06	CO	F	Green	620

Tag #	Tag Colour	Date	Species	Sex	Spawning Condition	POH Length (mm)
22	Green	17-Oct-06	CO	F	Green	600
23	Green	17-Oct-06	CO	F	Green	520
25	Green	17-Oct-06	CO	F	Green	615
27	Green	17-Oct-06	CO	F	Green	525
28	Green	17-Oct-06	CO	F	Green	615
29	Green	17-Oct-06	CO	F	Green	620
30	Green	17-Oct-06	CO	F	Green	620
31	Green	17-Oct-06	CO	F	Green	520
32	Green	17-Oct-06	CO	F	Green	645
33	Green	17-Oct-06	CO	M	Green	635
34	Green	17-Oct-06	CO	F	Green	610
36	Green	17-Oct-06	CO	M	Green	590
38	Green	17-Oct-06	CO	M	Green	615
39	Green	17-Oct-06	CO	F	Green	605
1014	Green	22-Oct-06	CO	F	Green	585
40	Green	22-Oct-06	CO	F	Green	620
42	Green	22-Oct-06	CO	M	Green	600
43	Green	22-Oct-06	CO	F	Green	580
44	Green	22-Oct-06	CO	F	Green	610
45	Green	22-Oct-06	CO	M	Green	590
48	Green	22-Oct-06	CO	M	Green	530
49	Green	22-Oct-06	CO	M	Green	620
50	Green	22-Oct-06	CO	M	Green	540
52	Green	22-Oct-06	CO	M	Green	610
53	Green	22-Oct-06	CO	M	Green	520
54	Green	22-Oct-06	CO	M	Green	630
56	Green	22-Oct-06	CO	M	Green	480
1	Orange	30-Oct-06	CO	F	Green	615
4	Orange	30-Oct-06	CO	F	Green	565
5	Orange	30-Oct-06	CO	F	Green	610
6	Orange	30-Oct-06	CO	F	Green	595
8	Orange	30-Oct-06	CO	F	Green	590
9	Orange	30-Oct-06	CO	F	Green	660
10	Orange	30-Oct-06	CO	F	Green	605
12	Orange	30-Oct-06	CO	F	Green	620
13	Orange	30-Oct-06	CO	F	Green	610
16	Orange	30-Oct-06	CO	M	Green	565
17	Orange	30-Oct-06	CO	F	Green	605
18	Orange	30-Oct-06	CO	M	Green	600
19	Orange	30-Oct-06	CO	F	Green	695
20	Orange	30-Oct-06	CO	F	Green	650
21	Orange	30-Oct-06	CO	F	Green	625
22	Orange	30-Oct-06	CO	F	Green	600
23	Orange	30-Oct-06	CO	M	Green	630
24	Orange	30-Oct-06	CO	F	Green	555
25	Orange	30-Oct-06	CO	F	Green	635
26	Orange	30-Oct-06	CO	F	Green	610
27	Orange	30-Oct-06	CO	F	Green	595
28	Orange	30-Oct-06	CO	F	Green	585

Tag #	Tag Colour	Date	Species	Sex	Spawning Condition	POH Length (mm)
29	Orange	30-Oct-06	CO	F	Green	595
30	Orange	30-Oct-06	CO	F	Green	565
31	Orange	30-Oct-06	CO	F	Green	580
32	Orange	30-Oct-06	CO	F	Green	635
33	Orange	30-Oct-06	CO	M	Green	470
34	Orange	30-Oct-06	CO	F	Green	585
35	Orange	30-Oct-06	CO	F	Green	600
39	Orange	30-Oct-06	CO	F	Green	655
40	Orange	30-Oct-06	CO	M	Green	590
41	Orange	30-Oct-06	CO	F	Green	610
42	Orange	30-Oct-06	CO	F	Green	595
43	Orange	30-Oct-06	CO	M	Ripe	655
44	Orange	30-Oct-06	CO	M	Green	630
45	Orange	30-Oct-06	CO	F	Green	670
46	Orange	30-Oct-06	CO	M	Ripe	625
47	Orange	30-Oct-06	CO	M	Green	645
48	Orange	30-Oct-06	CO	F	Green	595
49	Orange	30-Oct-06	CO	F	Green	685
50	Orange	30-Oct-06	CO	F	Green	585
51	Orange	30-Oct-06	CO	M	Green	605
52	Orange	30-Oct-06	CO	M	Green	630
54	Orange	30-Oct-06	CO	M	Green	635
55	Orange	30-Oct-06	CO	M	Green	660
56	Orange	30-Oct-06	CO	F	Green	615
57	Orange	30-Oct-06	CO	M	Ripe	590
58	Orange	30-Oct-06	CO	F	Green	615
59	Orange	30-Oct-06	CO	F	Green	625
60	Orange	30-Oct-06	CO	F	Green	580
61	Orange	30-Oct-06	CO	M	Ripe	685
62	Orange	30-Oct-06	CO	F	Green	655
63	Orange	30-Oct-06	CO	M	Green	645
64	Orange	30-Oct-06	CO	F	Green	595
65	Orange	30-Oct-06	CO	M	Green	665
66	Orange	30-Oct-06	CO	M	Green	440
67	Orange	30-Oct-06	CO	M	Green	660
69	Orange	30-Oct-06	CO	M	Green	570
72	Orange	30-Oct-06	CO	F	Green	560
73	Orange	30-Oct-06	CO	M	Green	49.5
75	Orange	30-Oct-06	CO	M	Green	625
76	Orange	30-Oct-06	CO	M	Green	580
77	Orange	30-Oct-06	CO	M	Green	665
78	Orange	30-Oct-06	CO	M	Green	630
79	Orange	30-Oct-06	CO	F	Green	650
80	Orange	30-Oct-06	CO	M	Ripe	575
81	Orange	30-Oct-06	CO	M	Ripe	665
82	Orange	30-Oct-06	CO	M	Green	650
83	Orange	30-Oct-06	CO	M	Green	630
84	Orange	30-Oct-06	CO	M	Green	640
85	Orange	30-Oct-06	CO	M	Green	660

Tag #	Tag Colour	Date	Species	Sex	Spawning Condition	POH Length (mm)
86	Orange	30-Oct-06	CO	M	Green	580
88	Orange	30-Oct-06	CO	M	Green	580
89	Orange	30-Oct-06	CO	M	Ripe	580
90	Orange	30-Oct-06	CO	M	Ripe	630
92	Orange	30-Oct-06	CO	M	Ripe	680
93	Orange	30-Oct-06	CO	F	Ripe	595
94	Orange	30-Oct-06	CO	M	Ripe	510
95	Orange	30-Oct-06	CO	M	Ripe	650
96	Orange	30-Oct-06	CO	M	Green	620
97	Orange	30-Oct-06	CO	M	Green	470
98	Orange	30-Oct-06	CO	M	Green	625
99	Orange	30-Oct-06	CO	M	Green	610
100	Orange	30-Oct-06	CO	F	Green	590
101	Orange	30-Oct-06	CO	M	Green	550
102	Orange	30-Oct-06	CO	M	Green	630
103	Orange	30-Oct-06	CO	F	Green	585
104	Orange	30-Oct-06	CO	F	Green	555
105	Orange	30-Oct-06	CO	M	Green	650
106	Orange	30-Oct-06	CO	F	Green	655
107	Orange	30-Oct-06	CO	M	Green	550
108	Orange	30-Oct-06	CO	M	Ripe	650
112	Orange	30-Oct-06	CO	M	Green	540
113	Orange	30-Oct-06	CO	M	Green	645
116	Orange	30-Oct-06	CO	F	Green	640
117	Orange	30-Oct-06	CO	M	Green	630
118	Orange	30-Oct-06	CO	F	Green	635
120	Orange	30-Oct-06	CO	M	Green	445
15	Green	17-Oct-06	CO	J	Green	310
18	Green	17-Oct-06	CO	J	Green	310
19	Green	17-Oct-06	CO	J	Green	290
24	Green	17-Oct-06	CO	J	Green	310
37	Green	17-Oct-06	CO	J	Green	355
51	Green	22-Oct-06	CO	J	Green	300
55	Green	22-Oct-06	CO	J	Green	280
2	Orange	30-Oct-06	CO	J	Green	275
7	Orange	30-Oct-06	CO	J	Green	345
11	Orange	30-Oct-06	CO	J	Green	375
14	Orange	30-Oct-06	CO	J	Green	325
15	Orange	30-Oct-06	CO	J	Green	285
36	Orange	30-Oct-06	CO	J	Green	325
37	Orange	30-Oct-06	CO	J	Green	305
38	Orange	30-Oct-06	CO	J	Green	305
53	Orange	30-Oct-06	CO	J	Green	320
68	Orange	30-Oct-06	CO	J	Green	275
70	Orange	30-Oct-06	CO	J	Green	265
71	Orange	30-Oct-06	CO	J	Green	285
74	Orange	30-Oct-06	CO	J	Green	295
87	Orange	30-Oct-06	CO	J	Green	285
110	Orange	30-Oct-06	CO	J	Green	300

Tag #	Tag Colour	Date	Species	Sex	Spawning Condition	POH Length (mm)
114	Orange	30-Oct-06	CO	J	Green	355
119	Orange	30-Oct-06	CO	J	Ripe	320
122	Orange	30-Oct-06	CO	J	Green	310

Appendix 8. Daily mark application of Chinook salmon by tag number and colour, date, species, sex and spawning condition for Tahsis River in 2005. No coho salmon were tagged.

Tag #	Tag Colour	Date	Species	Sex	Spawning Condition	POH Length (mm)
UNK	Orange	3-Oct-05	CN	UNK	UNK	UNK
UNK	Orange	3-Oct-05	CN	UNK	UNK	UNK
UNK	Orange	3-Oct-05	CN	UNK	UNK	UNK
UNK	Orange	3-Oct-05	CN	UNK	UNK	UNK
UNK	Orange	3-Oct-05	CN	UNK	UNK	UNK
UNK	Orange	3-Oct-05	CN	UNK	UNK	UNK
UNK	Orange	3-Oct-05	CN	UNK	UNK	UNK
UNK	Orange	3-Oct-05	CN	UNK	UNK	UNK
UNK	Orange	3-Oct-05	CN	UNK	UNK	UNK
UNK	Orange	3-Oct-05	CN	UNK	UNK	UNK
UNK	Orange	3-Oct-05	CN	UNK	UNK	UNK
UNK	Orange	3-Oct-05	CN	UNK	UNK	UNK
UNK	Orange	3-Oct-05	CN	UNK	UNK	UNK
UNK	Orange	3-Oct-05	CN	UNK	UNK	UNK
UNK	Orange	3-Oct-05	CN	UNK	UNK	UNK
UNK	Orange	3-Oct-05	CN	UNK	UNK	UNK
UNK	Orange	3-Oct-05	CN	UNK	UNK	UNK
UNK	Orange	3-Oct-05	CN	UNK	UNK	UNK
UNK	Orange	3-Oct-05	CN	UNK	UNK	UNK
UNK	Orange	3-Oct-05	CN	UNK	UNK	UNK
UNK	Orange	3-Oct-05	CN	UNK	UNK	UNK
UNK	Orange	3-Oct-05	CN	UNK	UNK	UNK
UNK	Orange	3-Oct-05	CN	UNK	UNK	UNK
UNK	Orange	3-Oct-05	CN	UNK	UNK	UNK
UNK	Orange	3-Oct-05	CN	UNK	UNK	UNK
UNK	Orange	3-Oct-05	CN	UNK	UNK	UNK
UNK	Orange	3-Oct-05	CN	UNK	UNK	UNK

Appendix 9. Daily mark application of Chinook salmon by tag number and colour, date, species, sex and spawning condition for Tahsis River in 2006.

Tag#	Tag Color	Date	Species	Sex	Spawning Condition	POH Length (mm)
1854	green	29-Sep-06	CN	F	spawned	960
1857	green	29-Sep-06	CN	M	M	810
1860	green	29-Sep-06	CN	M	M	860
1861	green	29-Sep-06	CN	M	M	890
1862	green	29-Sep-06	CN	M	M	900
1863	green	29-Sep-06	CN	M	M	1080
1864	green	29-Sep-06	CN	M	T	670
1865	green	29-Sep-06	CN	M	M	840
1855	green	29-Sep-06	CN	F	spawned	910
1867	green	29-Sep-06	CN	M	M	910
1868	green	29-Sep-06	CN	M	M	710
1869	green	29-Sep-06	CN	M	M	720
1873	green	29-Sep-06	CN	M	M	930
1874	green	29-Sep-06	CN	M	M	750
1875	green	29-Sep-06	CN	M	M	900
1876	green	29-Sep-06	CN	M	M	830
N/A	N/A	Oct.13,2006	CN	N/A	N/A	NA
N/A	N/A	Oct.13,2006	CN	N/A	N/A	NA
N/A	N/A	Oct. 18, 2006	CN	N/A	N/A	NA
N/A	N/A	Oct. 18, 2006	CN	N/A	N/A	NA
630	orange	29-Sep-06	CO	F	B	730
651	orange	13-Oct-06	CO	M	B	820
652	orange	13-Oct-06	CO	M	M	820
656	orange	13-Oct-06	CO	M	B	790
657	orange	13-Oct-06	CO	M	T	740
658	orange	13-Oct-06	CO	M	B	740
659	orange	13-Oct-06	CO	F	T	820
661	orange	13-Oct-06	CO	F	B	680
664	orange	13-Oct-06	CO	F	B	780
665	orange	13-Oct-06	CO	F	T	800
666	orange	13-Oct-06	CO	F	B	710
668	orange	13-Oct-06	CO	F	B	800
669	orange	13-Oct-06	CO	M	T	760
670	orange	13-Oct-06	CO	F	T	750
671	orange	13-Oct-06	CO	F	B	770
674	orange	13-Oct-06	CO	M	T	650
675	orange	13-Oct-06	CO	M	B	730
677	orange	13-Oct-06	CO	F	B	690
679	orange	13-Oct-06	CO	F	B	730
680	orange	13-Oct-06	CO	M	B	810
683	orange	13-Oct-06	CO	F	B	730
684	orange	13-Oct-06	CO	F	T	710
685	orange	13-Oct-06	CO	M	B	780
686	orange	13-Oct-06	CO	M	B	820
688	orange	13-Oct-06	CO	F	M	790
689	orange	13-Oct-06	CO	F	T	730

Tag#	Tag Color	Date	Species	Sex	Spawning Condition	POH Length (mm)
690	orange	13-Oct-06	CO	M	T	650
691	orange	13-Oct-06	CO	M	B	760
692	orange	13-Oct-06	CO	M	B	870
693	orange	13-Oct-06	CO	F	T	740
695	orange	13-Oct-06	CO	M	B	470
696	orange	13-Oct-06	CO	M	T	550
1551	green	18-Oct-06	CO	F	T	730
1553	green	18-Oct-06	CO	M	T	750
1554	green	18-Oct-06	CO	M	B	810
1555	green	18-Oct-06	CO	F	T	780
1556	green	18-Oct-06	CO	M	T	770
1557	green	18-Oct-06	CO	F	B	540
1558	green	18-Oct-06	CO	F	B	840
1559	green	18-Oct-06	CO	F	B	690
1560	green	18-Oct-06	CO	F	B	750
1561	green	18-Oct-06	CO	F	T	760
1564	green	18-Oct-06	CO	F	T	760
1566	green	18-Oct-06	CO	M	B	820
1567	green	18-Oct-06	CO	F	T	760
1568	green	18-Oct-06	CO	M	B	890
1569	green	18-Oct-06	CO	F	T	730
1570	green	18-Oct-06	CO	M	T	640
1571	green	18-Oct-06	CO	F	B	770
1572	green	18-Oct-06	CO	F	B	690
1573	green	18-Oct-06	CO	F	T	720
1574	green	18-Oct-06	CO	M	B	880
1576	green	18-Oct-06	CO	F	B	750
1577	green	18-Oct-06	CO	M	T	820
1578	green	18-Oct-06	CO	M	T	610
1579	green	18-Oct-06	CO	F	T	750
1580	green	18-Oct-06	CO	M	B	720
1581	green	18-Oct-06	CO	F	T	750
1582	green	18-Oct-06	CO	F	T	780
1583	green	18-Oct-06	CO	F	B	660
1584	green	18-Oct-06	CO	F	B	670
1585	green	18-Oct-06	CO	M	T	700
1589	green	18-Oct-06	CO	F	M	720
1590	green	18-Oct-06	CO	F	B	830
1591	green	18-Oct-06	CO	M	T	700
1592	green	18-Oct-06	CO	M	T	630
1593	green	18-Oct-06	CO	F	B	730
1599	green	18-Oct-06	CO	M	T	580
1901	green	18-Oct-06	CO	F	B	760
1902	green	18-Oct-06	CO	M	B	870
1903	green	18-Oct-06	CO	M	T	560
1904	green	18-Oct-06	CO	M	B	800
1905	green	18-Oct-06	CO	F	B	750
1906	green	18-Oct-06	CO	M	T	820
1907	green	18-Oct-06	CO	M	T	740

Tag#	Tag Color	Date	Species	Sex	Spawning Condition	POH Length (mm)
1908	green	18-Oct-06	CO	M	B	740
1909	green	18-Oct-06	CO	M	B	720
1910	green	18-Oct-06	CO	F	T	730
1911	green	18-Oct-06	CO	M	T	820
1912	green	18-Oct-06	CO	F	B	810
1913	green	18-Oct-06	CO	F	B	720
1914	green	18-Oct-06	CO	M	T	800
1915	green	18-Oct-06	CO	M	T	800
1916	green	18-Oct-06	CO	F	B	690
1917	green	18-Oct-06	CO	F	B	690
1918	green	18-Oct-06	CO	M	T	660
1919	green	18-Oct-06	CO	M	T	820
1920	green	18-Oct-06	CO	M	B	840
1921	green	18-Oct-06	CO	F	B	770
1922	green	18-Oct-06	CO	F	B	800
1923	green	18-Oct-06	CO	F	B	810
1924	green	18-Oct-06	CO	F	T	690
1925	green	18-Oct-06	CO	F	T	770
1926	green	18-Oct-06	CO	F	B	710
1927	green	18-Oct-06	CO	F	B	670
1928	green	18-Oct-06	CO	F	T	720
1929	green	18-Oct-06	CO	M	B	800
1930	green	18-Oct-06	CO	M	T	850
1932	green	18-Oct-06	CO	F	B	720
1933	green	18-Oct-06	CO	F	B	680
1934	green	18-Oct-06	CO	F	B	790
1951	green	18-Oct-06	CO	M	T	740
1952	green	18-Oct-06	CO	M	T	830
1953	green	18-Oct-06	CO	M	T	620
1954	green	18-Oct-06	CO	M	T	590
673	orange	13-Oct-06	CO	JK	B	340
678	orange	13-Oct-06	CO	JK	B	470
687	orange	13-Oct-06	CO	JK	B	500
694	orange	13-Oct-06	CO	JK	B	430
697	orange	13-Oct-06	CO	JK	B	490
1931	green	18-Oct-06	CO	JK	B	410
1552	green	18-Oct-06	CO	JK	B	320
1575	green	18-Oct-06	CO	JK	T	420
1586	green	18-Oct-06	CO	JK	B	360
1594	green	18-Oct-06	CO	JK	B	460
1595	green	18-Oct-06	CO	JK	T	380
1597	green	18-Oct-06	CO	JK	T	330
1598	green	18-Oct-06	CO	JK	B	380
1600	green	18-Oct-06	CO	JK	B	390
1952	green	18-Oct-06	CO	JK	B	360

Appendix 10.Daily mark application of Chinook salmon by tag number and colour, date, species, sex and spawning condition for Leiner River in 2006.

Tag#	Tag Color	Date	Species	Sex	Spawning Condition	POH Length (mm)
38985	green	25-Sep-06	CO	F	B	740
38985	green	25-Sep-06	CO	M	B	830
38985	green	25-Sep-06	CO	M	T	840
38985	green	25-Sep-06	CO	F	B	700
38985	green	25-Sep-06	CO	M	B	880
38985	green	25-Sep-06	CO	M	B	860
38985	green	25-Sep-06	CO	F	M	830
38985	green	25-Sep-06	CO	M	T	650
38985	green	25-Sep-06	CO	F	B	800
38985	green	25-Sep-06	CO	M	B	880
38985	green	25-Sep-06	CO	M	T	810
38985	green	25-Sep-06	CO	M	T	820
38985	green	25-Sep-06	CO	F	B	690
38985	green	25-Sep-06	CO	M	B	760
38985	green	25-Sep-06	CO	F	B	710
38985	green	25-Sep-06	CO	F	T	720
38985	green	25-Sep-06	CO	M	B	750
38985	green	25-Sep-06	CO	F	T	780
38985	green	25-Sep-06	CO	M	T	810
38985	green	25-Sep-06	CO	F	T	590
38993	orange	3-Oct-06	CO	F	B	790
38993	orange	3-Oct-06	CO	F	T	800
38993	orange	3-Oct-06	CO	F	T	800
38993	orange	3-Oct-06	CO	F	B	770
38993	orange	3-Oct-06	CO	F	B	710
38993	orange	3-Oct-06	CO	M	T	640
38993	orange	3-Oct-06	CO	M	M	920
38993	orange	3-Oct-06	CO	M	T	810
38993	orange	3-Oct-06	CO	F	T	770
38993	orange	3-Oct-06	CO	M	T	730
38993	orange	3-Oct-06	CO	F	B	780
38993	orange	3-Oct-06	CO	F	B	710
38993	orange	3-Oct-06	CO	F	T	760
38993	orange	3-Oct-06	CO	F	T	770
38993	orange	3-Oct-06	CO	M	M	680
38993	orange	3-Oct-06	CO	F	T	760
38993	orange	3-Oct-06	CO	F	T	760
38993	orange	3-Oct-06	CO	F	T	690
38993	orange	3-Oct-06	CO	F	T	720
38993	orange	3-Oct-06	CO	F	B	660
38993	orange	3-Oct-06	CO	M	M	640
38993	orange	3-Oct-06	CO	F	T	790
38993	orange	3-Oct-06	CO	F	B	790
38993	orange	3-Oct-06	CO	F	T	730
38993	orange	3-Oct-06	CO	F	T	780
38993	orange	3-Oct-06	CO	M	T	800
38993	orange	3-Oct-06	CO	M	T	630

Tag#	Tag Color	Date	Species	Sex	Spawning Condition	POH Length (mm)
38993	orange	3-Oct-06	CO	F	B	670
38993	orange	3-Oct-06	CO	M	M	580
38993	orange	3-Oct-06	CO	M	T	870
38993	orange	3-Oct-06	CO	M	M	770
38993	orange	3-Oct-06	CO	M	M	630
38993	orange	3-Oct-06	CO	M	M	830
38993	orange	3-Oct-06	CO	F	B	760
38993	orange	3-Oct-06	CO	M	M	550
38993	orange	3-Oct-06	CO	M	M	610
38993	orange	3-Oct-06	CO	M	M	670
38993	orange	3-Oct-06	CO	F	T	810
38993	orange	3-Oct-06	CO	F	T	650
38993	orange	3-Oct-06	CO	M	M	780
38993	orange	3-Oct-06	CO	M	M	690
UNK	orange	25-Sep-06	CN	UNK	UNK	UNK
UNK	orange	25-Sep-06	CN	UNK	UNK	UNK
UNK	orange	25-Sep-06	CN	UNK	UNK	UNK
UNK	orange	25-Sep-06	CN	UNK	UNK	UNK
UNK	orange	25-Sep-06	CN	UNK	UNK	UNK
UNK	orange	25-Sep-06	CN	UNK	UNK	UNK
UNK	orange	25-Sep-06	CN	UNK	UNK	UNK
UNK	orange	25-Sep-06	CN	UNK	UNK	UNK
UNK	orange	25-Sep-06	CN	UNK	UNK	UNK
UNK	orange	25-Sep-06	CN	UNK	UNK	UNK
UNK	orange	25-Sep-06	CN	UNK	UNK	UNK
UNK	orange	25-Sep-06	CN	UNK	UNK	UNK
UNK	orange	25-Sep-06	CN	UNK	UNK	UNK
UNK	orange	25-Sep-06	CN	UNK	UNK	UNK
UNK	orange	25-Sep-06	CN	UNK	UNK	UNK
UNK	orange	25-Sep-06	CN	UNK	UNK	UNK
UNK	orange	25-Sep-06	CN	UNK	UNK	UNK
UNK	orange	25-Sep-06	CN	UNK	UNK	UNK
UNK	orange	25-Sep-06	CN	UNK	UNK	UNK
UNK	orange	25-Sep-06	CN	UNK	UNK	UNK
UNK	orange	25-Sep-06	CN	UNK	UNK	UNK
UNK	orange	25-Sep-06	CN	UNK	UNK	UNK
UNK	orange	25-Sep-06	CN	UNK	UNK	UNK
UNK	orange	25-Sep-06	CN	UNK	UNK	UNK
1877	green	3-Oct-06	CN	F	spawned	940
1878	green	3-Oct-06	CN	M	M	940
1879	green	3-Oct-06	CN	M	M	900
1880	green	3-Oct-06	CN	M	M	900
1881	green	3-Oct-06	CN	M	M	780
1882	green	3-Oct-06	CN	M	M	870
1883	green	3-Oct-06	CN	M	M	670
1884	green	3-Oct-06	CN	M	M	970
1885	green	3-Oct-06	CN	M	M	940
1886	green	3-Oct-06	CN	M	M	830
1888	green	3-Oct-06	CN	M	M	900
1890	green	3-Oct-06	CN	M	M	580

Tag#	Tag Color	Date	Species	Sex	Spawning Condition	POH Length (mm)
1891	green	3-Oct-06	CN	JK	B	470
1887	green	3-Oct-06	CN	JK	M	450
1889	green	3-Oct-06	CN	JK	M	530

Appendix 11. Coho salmon peak of spawn by year for Tranquil Creek, Tahsis and Leiner Rivers.

Year	Tranquil Creek	Tahsis River	Leiner River
2005	28-Nov	5-Nov	2-Dec
2006	23-Nov	14-Dec	10-Dec

Appendix 12. Daily Chinook and coho salmon carcass recoveries by date for Tranquil Creek in 2005.

Date	# Coho Carcasses	# Coho Tags Recovered	# Chinook Carcasses	# Chinook Tags Recovered
28-Sep-05	0	0	0	0
6-Oct-05	0	0	0	0
11-Oct-05	0	0	0	0
18-Oct-05	0	0	2	0
20-Oct-05	0	0	3	0
21-Oct-05	0	0	5	0
23-Oct-05	0	0	8	0
25-Oct-05	1	0	38	6
2-Nov-05	0	0	8	0
5-Nov-05	0	0	1	0
8-Nov-05	0	0	1	0
12-Nov-05	1	0	0	0
14-Nov-05	3	2	0	0
17-Nov-05	3	0	2	0
20-Nov-05	6	2	0	0
22-Nov-05	3	2	0	0
25-Nov-05	4	0	0	0
28-Nov-05	4	2	0	0
30-Nov-05	8	2	0	0
3-Dec-05	5	2	0	0
6-Dec-05	3	2	0	0
9-Dec-05	3	0	0	0
11-Dec-05	3	1	0	0
14-Dec-05	2	0	0	0
17-Dec-05	6	2	0	0
19-Dec-05	2	0	0	0
29-Dec-05	0	0	0	0
3-Jan-06	4	2	0	0
7-Jan-06	2	0	0	0
Total	63	19	68	6

Appendix 13. Daily Chinook and coho salmon carcass recoveries by date for Tranquil Creek in 2006.

Date	# Coho Carcasses	# Coho Tags Recovered	# Chinook Carcasses	# Chinook Tags Recovered
11-Oct-06	0	0	0	0
18-Oct-06	0	0	5	0
22-Oct-06	0	0	3	0
23-Oct-06	0	0	3	0
30-Oct-06	0	0	0	0
31-Oct-06	0	0	8	1
9-Nov-06	0	0	1	0
14-Nov-06	1	0	1	0
23-Nov-06	0	0	0	0
27-Nov-06	2	1	0	0
1-Dec-06	4	3	0	0
3-Dec-06	2	1	0	0
7-Dec-06	0	0	0	0
17-Dec-06	0	0	0	0
22-Dec-06	0	0	0	0
24-Dec-06	0	0	0	0
30-Dec-06	0	0	0	0
4-Jan-07	0	0	0	0
Total	9	5	21	1

Appendix 14. Swim survey dates and data collected on spawn timing and total number of unmarked, marked and total fish observed; last three columns identify data used to estimate AUC and resight escapements and AUTC survey life for Tranquil Creek coho salmon, 2005. The bold highlighted number indicates the peak count and the bold represents the approximate peak of spawn.

	Swim Survey Observations				Counts Used In:		
Date	Spawn Timing	Unmarked	Marked	Total	AUC Esc Est	Mark-Resight Esc Est	AUDTC SL
28-Sep-05	na	0	0	0	Yes	No	No
6-Oct-05	Pre	11	0	11	Yes	No	No
11-Oct-05	Pre	81	0	81	Yes	No	No
18-Oct-05	Pre	170	0	170	Yes	No	No
20-Oct-05	Pre	353	0	353	Yes	No	Yes
21-Oct-05	Pre	199	164	363	Yes	Yes	Yes
23-Oct-05	Pre	212	160	372	Yes	Yes	Yes
25-Oct-05	Pre	201	149	350	Yes	Yes	Yes
2-Nov-05	Pre	241	122	363	Yes	Yes	Yes
5-Nov-05	Pre	277	114	***391***	Yes	Yes	Yes
8-Nov-05	Start	249	117	366	Yes	Yes	Yes
12-Nov-05	Start	261	87	348	Yes	Yes	Yes
14-Nov-05	na	233	74	307	Yes	No	Yes
17-Nov-05	Before Peak	226	77	303	Yes	Yes	Yes
20-Nov-05	Before Peak	248	67	315	Yes	Yes	Yes
22-Nov-05	Before Peak	263	65	328	Yes	Yes	Yes
25-Nov-05	**Peak**	168	45	**213**	Yes	Yes	Yes
28-Nov-05	**Peak**	215	59	**274**	Yes	Yes	Yes
30-Nov-05	**Peak**	195	46	**241**	Yes	Yes	Yes
3-Dec-05	After Peak	194	41	235	Yes	Yes	Yes
6-Dec-05	After Peak	180	35	215	Yes	Yes	Yes
9-Dec-05	After Peak	167	35	202	Yes	Yes	Yes
11-Dec-05	After Peak	158	32	190	Yes	Yes	Yes
14-Dec-05	After Peak	158	33	191	Yes	Yes	Yes
17-Dec-05	After Peak	151	32	183	Yes	Yes	Yes
19-Dec-05	After Peak	141	27	168	Yes	Yes	Yes
29-Dec-05	End	22	4	26	Yes	No	Yes
3-Jan-06	End	12	3	15	Yes	No	Yes
7-Jan-06	End	2	1	3	Yes	No	Yes

Appendix 15. Swim survey dates and data collected on spawn timing and total number of unmarked, marked and total fish observed; last three columns indicate whether the survey data collected on individual dates was used to estimate AUC and resight escapements and AUTC survey life for Tranquil Creek coho salmon, 2006. The bold highlighted number indicates the peak count and the bold represents the approximate peak of spawn.

	Swim Survey Observations				Counts Used In:		
Date	Spawn Timing	Unmarked	Marked	Total	AUC Esc Est's	Mark-Resight Esc Est	AUDTC Survey Life
11-Oct-06	Pre	122	0	122	Yes	No	No
18-Oct-06	Pre	122	30	152	Yes	Yes	Yes
22-Oct-06	Pre	124	32	156	Yes	Yes	Yes
23-Oct-06	Pre	140	38	178	Yes	Yes	Yes
30-Oct-06	Pre	***309***	36	345	Yes	Yes	Yes
31-Oct-06	Pre	240	129	369	Yes	Yes	Yes
9-Nov-06	Start	158	108	266	Yes	Yes	Yes
14-Nov-06	Start	155	67	222	Yes	Yes	Yes
23-Nov-06	**Peak**	na	na	na	No	No	No
27-Nov-06	Past Peak	10	0	10	Yes	Yes	Yes
1-Dec-06	Past Peak	19	6	25	Yes	Yes	Yes
3-Dec-06	Past Peak	55	18	73	Yes	Yes	No
7-Dec-06	Past Peak	9	1	10	Yes	No	No
17-Dec-06	End	12	0	12	Yes	No	No
22-Dec-06	End	6	1	7	Yes	No	No
24-Dec-06	End	2	0	2	Yes	No	No
30-Dec-06	End	0	0	0	Yes	No	No
4-Jan-07	End	0	0	0	Yes	No	No

Appendix 16. Swim survey dates and data collected on spawn timing and total number of unmarked, marked and total fish observed; last three columns indicate whether the survey data collected on individual dates was used to estimate AUC and resight escapements and AUTC survey life for Tahsis River coho salmon, 2005. The bold highlighted number indicates the peak count and the bold represents the approximate peak of spawn.

	Swim Survey Observations				Counts Used In:		
Date	Spawn Timing	Unmarked	Marked[a]	Total	AUC Esc Est's	Mark-Resight Esc Est[a]	AUDTC Survey Life[a]
11-Sep-05	Pre	18	na	18	Yes	na	na
25-Sep-05	Pre	22	na	22	Yes	na	na
4-Oct-05	Pre	275	na	275	Yes	na	na
18-Oct-05	Pre	434	na	434	Yes	na	na
20-Oct-05	Pre	457	na	457	Yes	na	na
29-Oct-05	**Before Peak**	***871***	na	871	Yes	na	na
16-Nov-05	**After Peak**	496	na	496	Yes	na	na
29-Nov-05	After Peak	395	na	395	Yes	na	na

[a] no marks applied.

Appendix 17. Swim survey dates and data collected on spawn timing and total number of unmarked, marked and total fish observed; last three columns indicate whether the survey data collected on individual dates was used to estimate AUC and resight escapements and AUTC survey life for Tahsis River coho salmon, 2006. The bold highlighted number indicates the peak count and the bold represents the approximate peak of spawn.

	Swim Survey Observations						Counts Used In:				
			Marked					Mark-Resight Esc Est	AUDTC Survey Life		
Date	Spawn Timing	Unmarked	Green Tags	Orange Tags	Total Tags	Total Fish	AUC Esc Est's	Total Tags (all colours combined)	Green Tags	Orange Tags	Total Tags
21-Sep-06	Pre	40				40	Yes	No	No	No	No
30-Sep-06	Pre	52	0	1	1	53	Yes	Yes	Yes	Yes	Yes
8-Oct-06	Pre	36	0	1	1	37	Yes	Yes	Yes	Yes	Yes
12-Oct-06	Pre	78	0	1	1	79	Yes	Yes	Yes	Yes	Yes
18-Oct-06	Pre	94	0	11	11	105	Yes	Yes	Yes	Yes	Yes
25-Oct-06	Start		30	10	40		No	Yes	Yes	Yes	Yes
31-Oct-06	Pre	692	33	13	46	738	Yes	Yes	Yes	Yes	Yes
2-Nov-06	Pre	710	27	14	41	751	Yes	Yes	Yes	Yes	Yes
23-Nov-06	Start	600	24	5	28	628	Yes	Yes	Yes	Yes	Yes
25-Nov-06	Before Peak	521	23	6	29	550	Yes	Yes	Yes	Yes	Yes
5-Dec-06	**Before Peak**		16	2	18		No	Yes	Yes	Yes	Yes
23-Dec-06	**Past Peak**	131	3	2	5	136	Yes	Yes	Yes	Yes	Yes

Appendix 18. Swim survey dates and data collected on spawn timing and total number of unmarked, marked and total fish observed; last three columns indicate whether the survey data collected on individual dates was used to estimate AUC and resight escapements and AUTC survey life for Leiner River coho salmon, 2005. The bold highlighted number indicates the peak count and the bold represents the approximate peak of spawn.

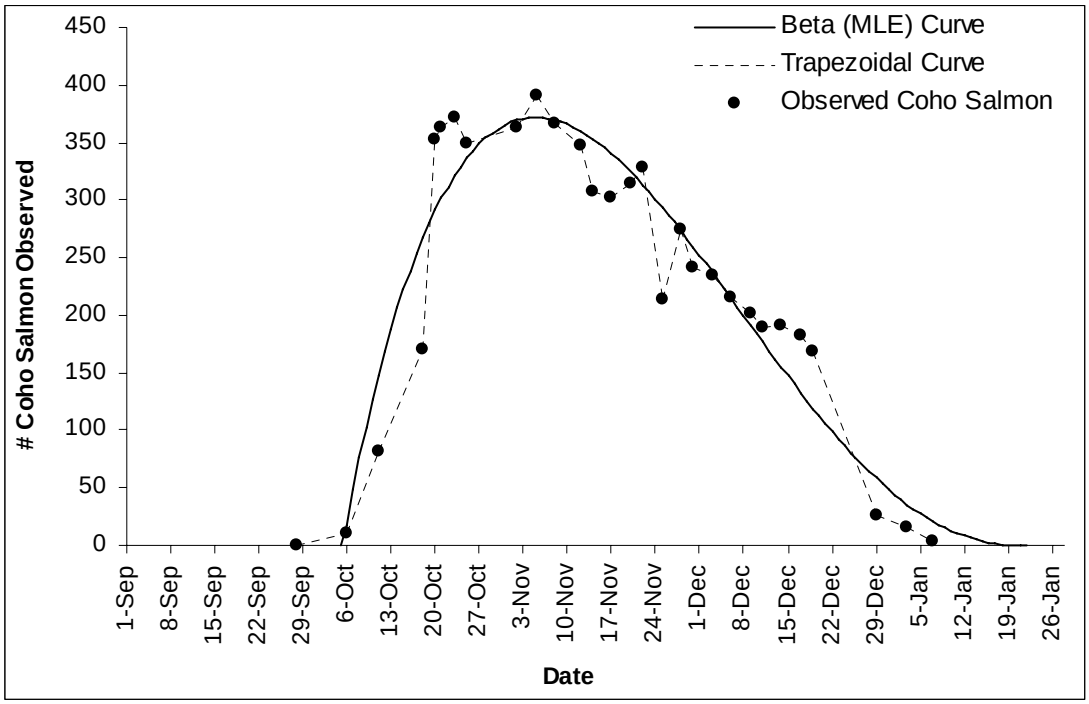
	Swim Survey Observations				Counts Used In:		
Date	Spawn Timing	Unmarked	Marked[a]	Total	AUC Esc Est's	Mark-Resight Esc Est[a]	AUDTC Survey Life[a]
11-Sep-05	Pre	28	na	28	Yes	na	na
2-Oct-05	**Before Peak**	80	na	80	Yes	na	na
17-Oct-05	**End**	***183***	na	183	Yes	na	na
15-Nov-05	na	53	na	53	Yes	na	na
28-Nov-05	End	55	na	55	Yes	na	na

[a] no marks applied

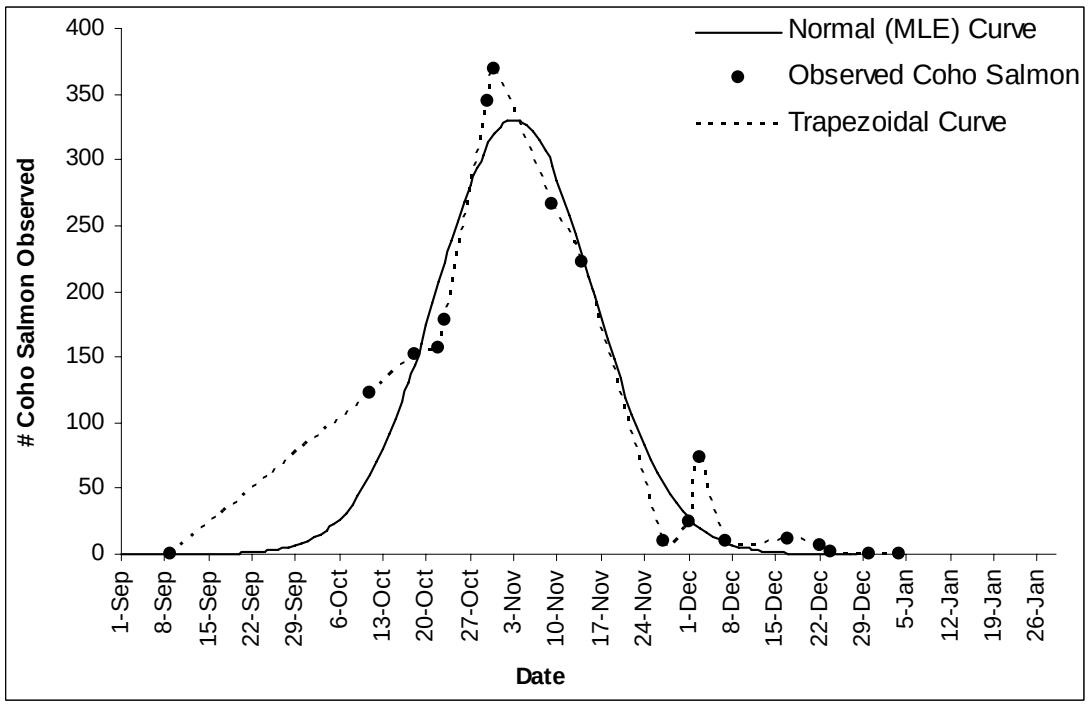
Appendix 19. Swim survey dates were conducted and data collected on spawn timing and total number of unmarked, marked and total fish observed; last three columns indicate whether the survey data collected on individual dates was used to estimate AUC and resight escapements and AUTC survey life for Leiner River coho salmon, 2006. The bold highlighted number indicates the peak count and the bold represents the approximate peak of spawn.

	Swim Survey Observations						Counts Used In:				
			Marked					Mark-Resight Esc Est	AUDTC Survey Lif		
Date	Spawn Timing	Unmarked	Green Tags	Orange Tags	Total Tags	Total Fish	AUC Esc Est's	Total Tags (all colours combined)	Green Tags	Orange Tags	To Ta
20-Sep-06	Pre	72	0	0	0	72	Yes	No	No	No	
26-Sep-06	Pre	334	0	0	0	334	Yes	Yes	No	No	
6-Oct-06	Start	391	0	0	0	391	Yes	Yes	No	No	
11-Oct-06	Pre	452	0	0	0	452	Yes	Yes	No	No	
19-Oct-06	Pre	593	3	7	10	603	Yes	Yes	Yes	Yes	Y
24-Oct-06	Pre	353	5	3	8	361	Yes	Yes	Yes	Yes	Y
30-Oct-06	Pre	384	11	8	19	403	Yes	Yes	Yes	Yes	Y
13-Nov-06	Start	293	12	12	24	317	Yes	Yes	Yes	Yes	Y
24-Nov-06	Before Peak	243	4	10	14	257	Yes	Yes	Yes	Yes	Y
26-Nov-06	**Before Peak**	248	6	4	10	258	Yes	Yes	Yes	Yes	Y
22-Dec-06	**Past Peak**	4	0	0	0	4	Yes	No	Yes	Yes	Y

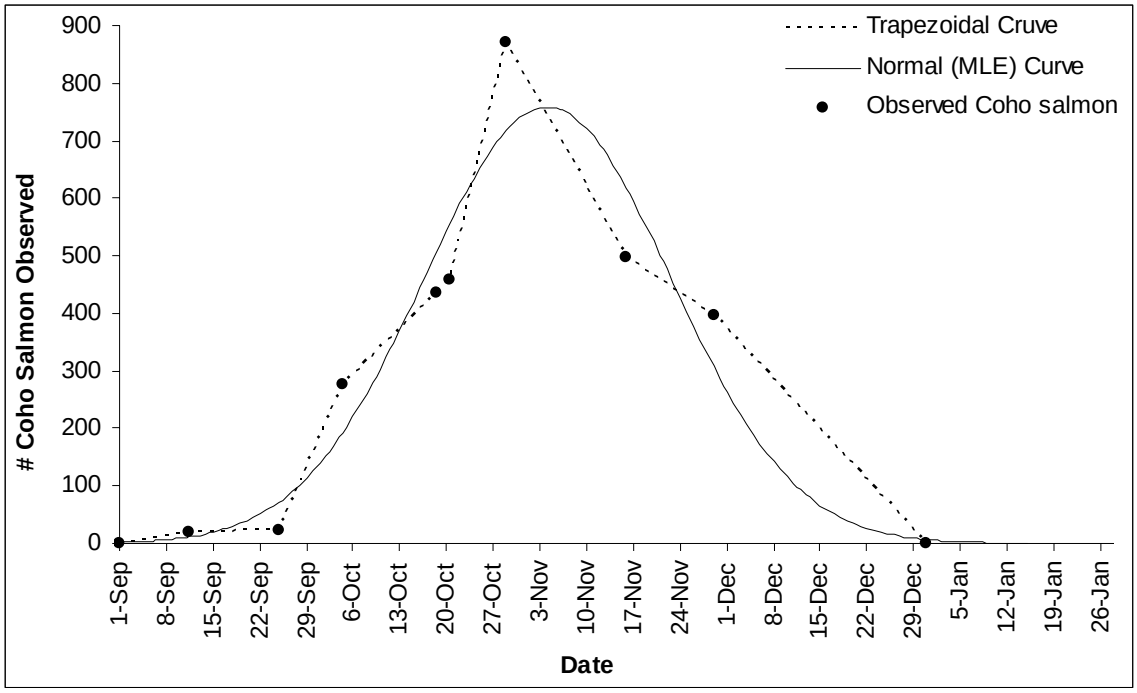
Appendix 20. Beta curve fit to observed coho spawners in Tranquil Creek, 2005.



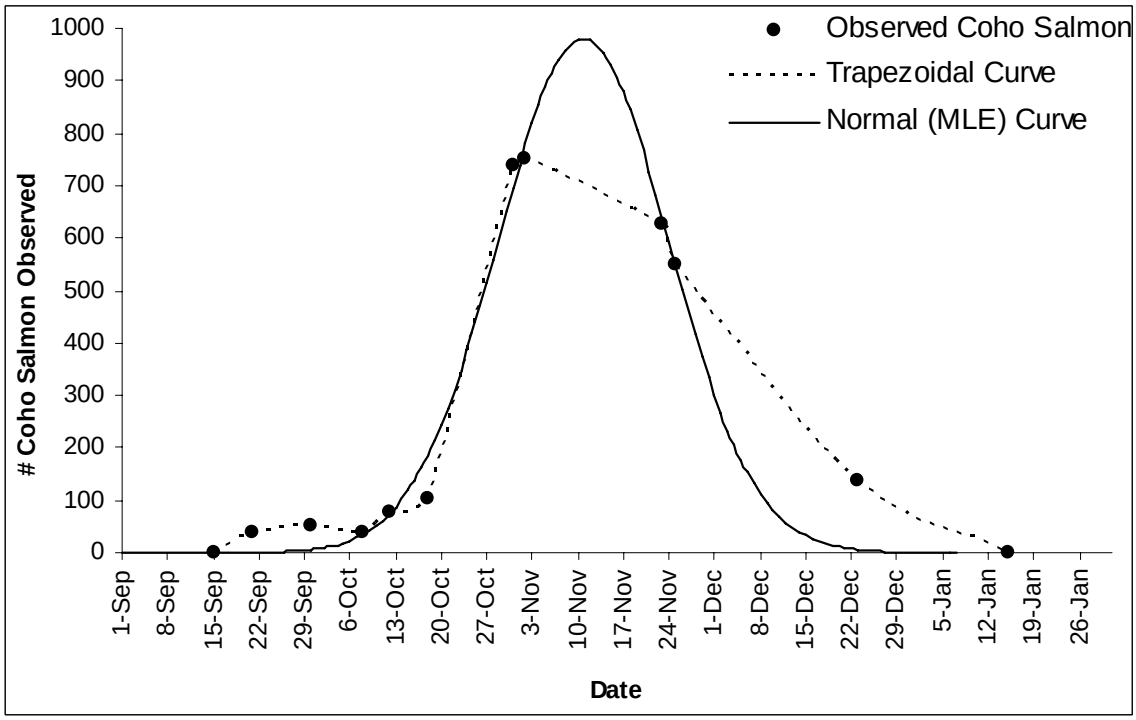
Appendix 21. Normal curve fit to coho spawners observed in Tranquil Creek, 2006.



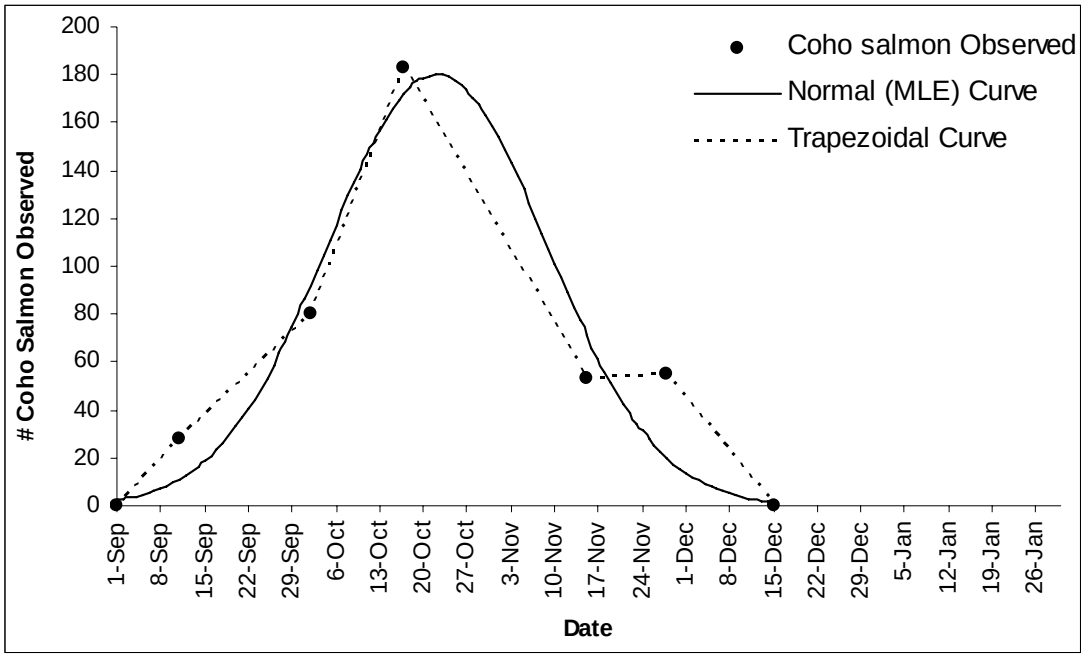
Appendix 22. Normal curve fit to observed coho spawners in Tahsis River, 2005.



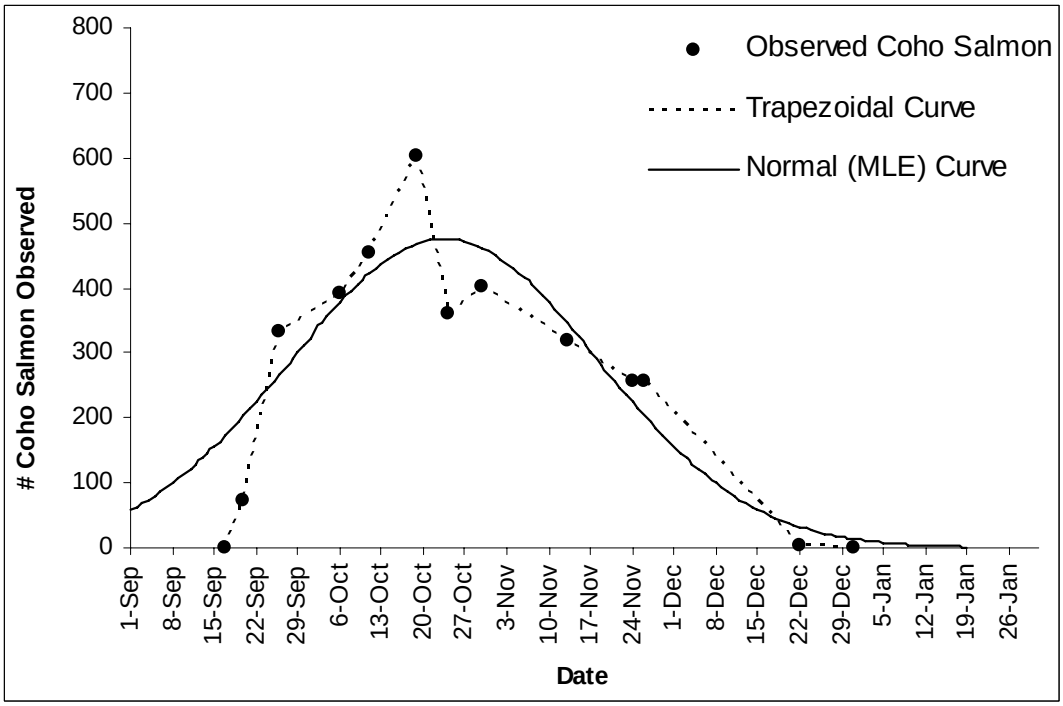
Appendix 23**.** Normal curve fit to coho spawners observed in Tahsis River, 2006.



Appendix 24. Normal curve fit to coho spawners observed in Leiner River, 2005.



Appendix 25. Normal curve fit to coho spawners observed in Leiner River, 2006.



Appendix 26. Swim surveys dates and data collected on spawn timing and total number of unmarked, marked and total fish observed; last three columns indicate whether the survey data collected on individual dates was used to estimate AUC and resight escapements and AUTC survey life for Tranquil Creek Chinook salmon, 2005. Bold highlighted numbers indicate the peak count and bold represents the approximate peak of spawn.

	Swim Survey Observations				Counts Used In:		
Date	Spawn Timing	Unmarked	Marked	Total	AUC Esc Est	Mark-Resight Esc Est	AUDTC SL
28-Sep-05	Pre	2	0	2	Yes	No	Yes
6-Oct-05	Pre	154	0	154	Yes	No	Yes
11-Oct-05	**Start**	534	0	***534***	Yes	No	Yes
18-Oct-05	**After Peak**	468	0	468	Yes	No	Yes
20-Oct-05	After Peak	478	0	478	Yes	No	Yes
21-Oct-05	After Peak	438	71	509	Yes	Yes	Yes
23-Oct-05	End	326	55	381	Yes	Yes	Yes
25-Oct-05	End	246	38	284	Yes	Yes	Yes
2-Nov-05	End	10	0	10	Yes	No	Yes
5-Nov-05	End	5	0	5	Yes	No	Yes
8-Nov-05	End	2	0	2	Yes	No	Yes
12-Nov-05	End	1	0	1	Yes	No	Yes
14-Nov-05	End				No	No	No
17-Nov-05	End	0	0	0	No	No	No
20-Nov-05	End	0	0	0	No	No	No
22-Nov-05	End	0	0	0	No	No	No
25-Nov-05	End	0	0	0	No	No	No
28-Nov-05	End	0	0	0	No	No	No
30-Nov-05	End	0	0	0	No	No	No
3-Dec-05	End	0	0	0	No	No	No
6-Dec-05	End	0	0	0	No	No	No
9-Dec-05	End	0	0	0	No	No	No
11-Dec-05	End	0	0	0	No	No	No
14-Dec-05	End	0	0	0	No	No	No
17-Dec-05	End	0	0	0	No	No	No
19-Dec-05	End	0	0	0	No	No	No
29-Dec-05	End	0	0	0	No	No	No
3-Jan-06	End	0	0	0	No	No	No
7-Jan-06	End	0	0	0	No	No	No

Appendix 27. Swim surveys dates and data collected on spawn timing and total number of unmarked, marked and total fish observed; last three columns indicate whether the survey data collected on individual dates was used to estimate AUC and resight escapements and AUTC survey life for Tranquil Creek Chinook salmon, 2006. Bold highlighted numbers indicate the peak count and bold represents the approximate peak of spawn.

	Swim Survey Observations						Counts Used In:					
			Marked					Mark-Resight Esc Est	AUDTC Survey Life			
Date	Spawn Timing	Unmarked	Green Tags	Orange Tags	Red tags	Total Fish	AUC Esc Est's	Total Tags (all colours combined)	Green Tags[a]	Orange Tags	Red Tags	Total Tags
11-Oct-06	Pre	154	0	0	0	154	Yes	No	No	No	No	No
18-Oct-06	Start	136	0	10	0	146	Yes	Yes	No	Yes	Yes	Yes
22-Oct-06	Before Peak	122	0	9	0	131	Yes	Yes	No	Yes	Yes	Yes
23-Oct-06	**Before Peak**	84	0	29	0	113	Yes	Yes	No	Yes	Yes	Yes
30-Oct-06	**Past Peak**	322	0	5	0	327	Yes	Yes	No	Yes	Yes	Yes
31-Oct-06	Peak	303	0	2	9	***314***	Yes	Yes	No	Yes	Yes	Yes
9-Nov-06	End	27	1	1	1	30	Yes	Yes	No	Yes	Yes	Yes
14-Nov-06	End	3	1	0	0	4	Yes	Yes	No	No	No	Yes
23-Nov-06	End	0	na	na	na	na	Yes	No	No	No	No	No
27-Nov-06	End	0	0	0	0	0	No	No	No	No	No	No
1-Dec-06	End	0	0	0	0	0	No	No	No	No	No	No
3-Dec-06	End	0	0	0	0	0	No	No	No	No	No	No
7-Dec-06	End	0	0	0	0	0	No	No	No	No	No	No
17-Dec-06	End	0	0	0	0	0	No	No	No	No	No	No
22-Dec-06	End	0	0	0	0	0	No	No	No	No	No	No
24-Dec-06	End	0	0	0	0	0	No	No	No	No	No	No
30-Dec-06	End	0	0	0	0	0	No	No	No	No	No	No
4-Jan-07	End	0	0	0	0	0	No	No	No	No	No	No

[a] Too few resights to estimate survey life.

Appendix 28. Swim surveys dates and data collected on spawn timing and total number of unmarked, marked and total fish observed; last three columns indicate whether the survey data collected on individual dates was used to estimate AUC and resight escapements and AUTC survey life for Tahsis River Chinook salmon, 2005. Bold highlighted numbers indicate the peak count and bold represents the approximate peak of spawn.

	Swim Survey Observations				Counts Used In:		
Date	Spawn Timing	Unmarked	Marked	Total	AUC Esc Est	Mark-Resight Esc Est	AUDTC SL
11-Sep-05	Pre	2	0	2	Yes	Yes	No
25-Sep-05	Pre	31	0	31	Yes	Yes	Yes
4-Oct-05	**Peak**	129	18	***147***	Yes	Yes	Yes
18-Oct-05	End	12	2	14	Yes	Yes	Yes
20-Oct-05	End	14	3	17	Yes	Yes	Yes
29-Oct-05	End	8	0	8	Yes	Yes	Yes
16-Nov-05	End	0	0	0	No	Yes	Yes
29-Nov-05	End	0	0	0	No	Yes	Yes

Appendix 29. Swim surveys dates and data collected on spawn timing and total number of unmarked, marked and total fish observed; last three columns indicate whether the survey data collected on individual dates was used to estimate AUC and resight escapements and AUTC survey life for Tahsis River Chinook salmon, 2006. Bold highlighted numbers indicate the peak count and bold represents the approximate peak of spawn.

	Swim Survey Observations				Counts Used In:		
Date	Spawn Timing	Unmarked	Marked	Total	AUC Esc Est	Mark-Resight Esc Est	AUDTC SL
21-Sep-06	Pre	118	0	***118***	Yes	No	No
30-Sep-06	**Peak**	51	9	60	Yes	Yes	Yes
8-Oct-06	**Peak**	55	10	65	Yes	Yes	Yes
12-Oct-06	**Peak**	52	7	59	Yes	Yes	Yes
18-Oct-06	Past Peak	24	2	26	Yes	Yes	Yes
25-Oct-06	End	11	0	11	Yes	Yes	Yes
31-Oct-06	End	8	1	9	Yes	Yes	Yes
2-Nov-06	End	3	2	5	Yes	Yes	Yes
23-Nov-06	End	0	0	0	Yes	No	No
25-Nov-06	End	0	0	0	No	No	No
5-Dec-06	End	0	0	0	No	No	No
23-Dec-06	End	0	0	0	No	No	No

Appendix 30. Swim surveys dates and data collected on spawn timing and total number of unmarked, marked and total fish observed; last three columns indicate whether the survey data collected on individual dates was used to estimate AUC and resight escapements and AUTC survey life for Leiner River Chinook salmon, 2005. Bold highlighted numbers indicate the peak count and bold represents the approximate peak of spawn.

	Swim Survey Observations				Counts Used In:		
Date	Spawn Timing	Unmarked	Marked[a]	Total	AUC Esc Est's	Mark-Resight Esc Est[a]	AUDTC Survey Life[a]
11-Sep-05	Pre	33	na	33	Yes	na	na
2-Oct-05	Pre	***292***	na	292	Yes	na	na
17-Oct-05	Pre	4	na	4	Yes	na	na
15-Nov-05	na	0	na	0	Yes	na	na
28-Nov-05	**Before Peak**	2	na	2	Yes	na	na

[a] No tags applied on Leiner in 2005.

Appendix 31. Swim surveys dates and data collected on spawn timing and total number of unmarked, marked and total fish observed; last three columns indicate whether the survey data collected on individual dates was used to estimate AUC and resight escapements and AUTC survey life for Leiner River Chinook salmon, 2006. Bold highlighted numbers indicate the peak count and bold represents the approximate peak of spawn.

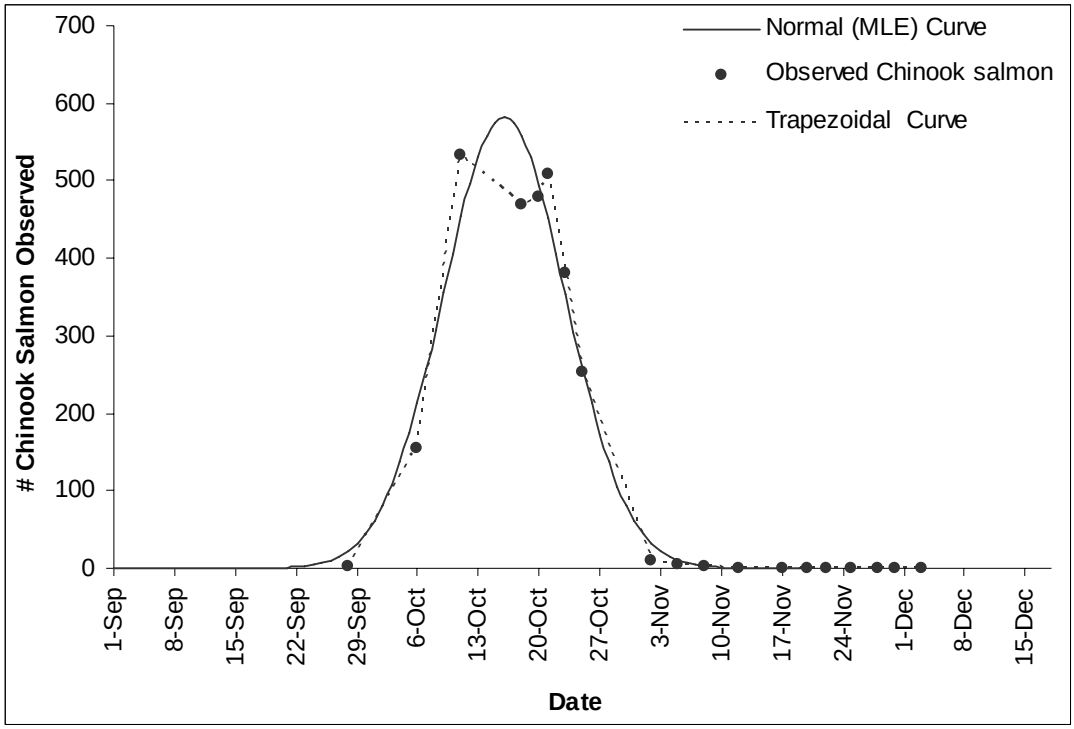
	Swim Survey Observations				Counts Used In:		
Date	Spawn Timing	Unmarked	Marked	Total	AUC Esc Est's	Mark-Resight Esc Est[a]	AUDTC Survey Life[a]
20-Sep-06	Pre	82	0	82	Yes	na	na
26-Sep-06	Before Peak	114	0	114	Yes	na	na
6-Oct-06	**Peak**	77	0	***77***	Yes	na	na
11-Oct-06	Peak	24	0	24	Yes	na	na
19-Oct-06	Past Peak	34	1	35	Yes	na	na
24-Oct-06	Past Peak	20	0	20	Yes	na	na
30-Oct-06	End	5	0	5	Yes	na	na
13-Nov-06	End	1	0	1	Yes	na	na

[a] Too few resight to calculate estimates.

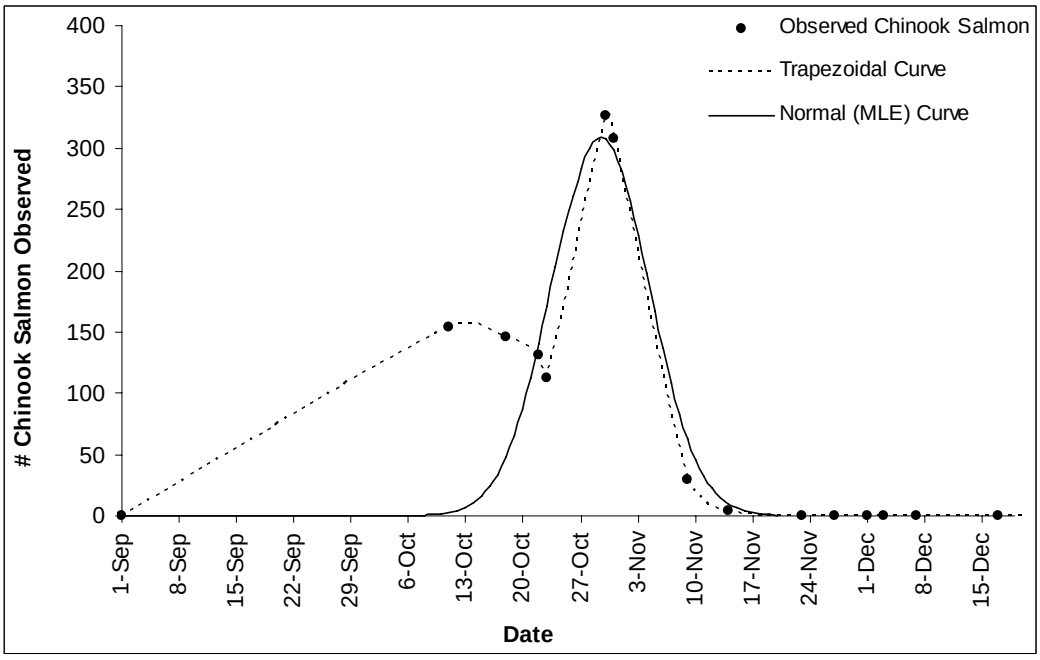
Appendix 32. Chinook salmon peak of spawn by year for Tranquil Creek, Tahsis and Leiner Rivers.

Year	Tranquil	Tahsis	Leiner
2005	14-Oct	4-Oct	7-Oct
2006	27-Oct	8-Oct	11-Oct

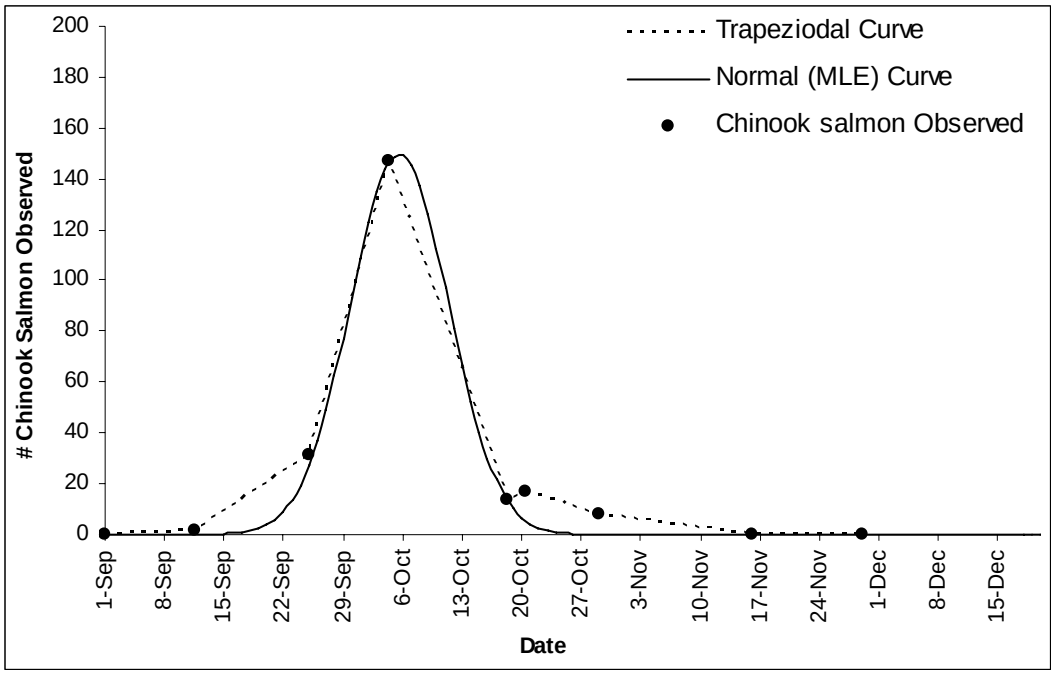
Appendix 33. Normal curve fit to Chinook salmon spawners observed in Tranquil Creek, 2005.



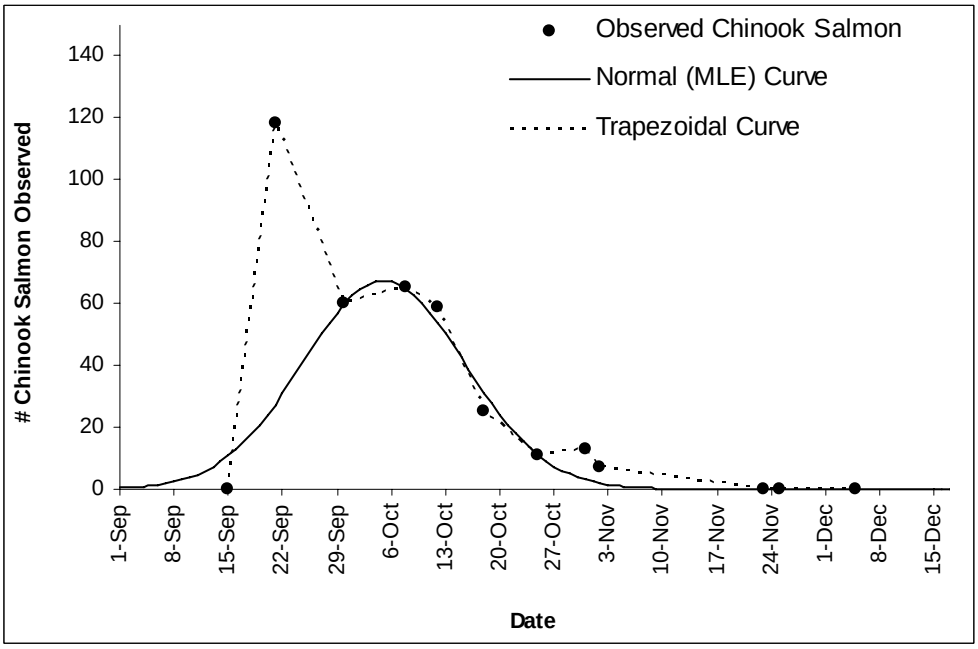
Appendix 34. Normal curve fit to Chinook salmon spawners observed in Tranquil Creek, 2006.



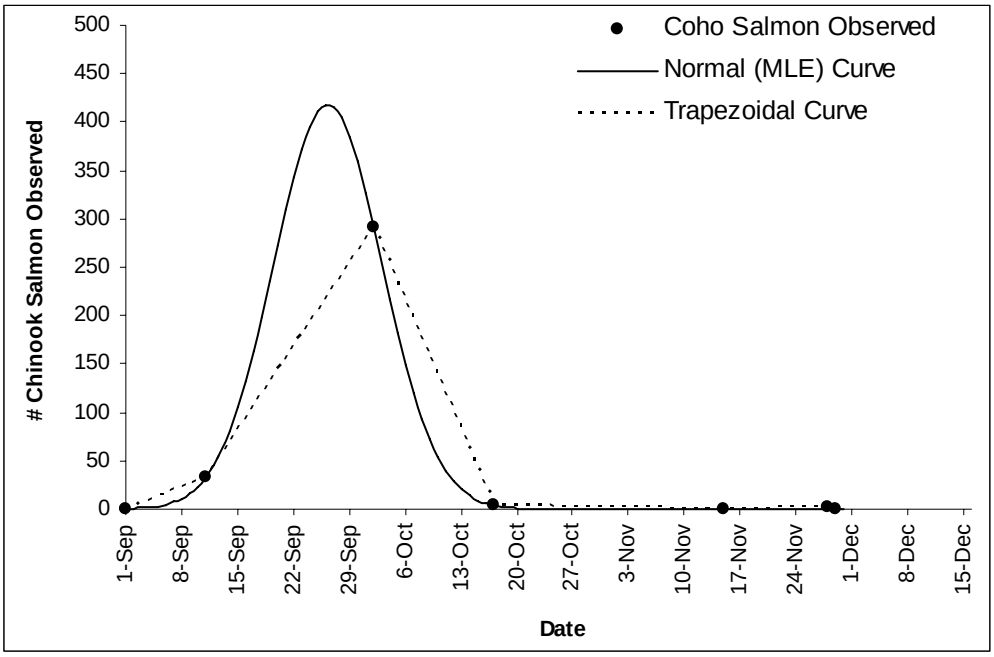
Appendix 35. Normal curve fit to Chinook salmon spawners observed in Tahsis River, 2005.



Appendix 36. Normal curve fit to Chinook salmon spawners observed in Tahsis River, 2006.



Appendix 37. Normal curve fit to Chinook salmon spawners observed in Leiner River, 2005.



Appendix 38. Normal curve fit to Chinook salmon spawners observed in Leiner River, 2006.