Kateen River Chinook Salmon Escapement Calibration 2010

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CONTENTS

ABSTRACT

Chinook salmon (*Oncorhynchus tshawytscha*) escapement was estimated in the Kateen River in Northern British Columbia in 2010. A run size index from visual peak count surveys was calibrated against an abundance estimate generated using mark re-sight techniques. The escapement index from the peak count survey was 90 large Chinook salmon. The escapement estimate from the mark re-sight program was 218 fish with a standard deviation of 18.3 fish. The coefficient of variation was 8.4% for the mark re-sight escapement estimate.

The expansion factor for the visual survey index was found to be 2.4 in the Kateen River in 2010. The current average expansion factor for escapements to the Kateen River measured from 2005 to 2008 and 2010 was 1.65 with a coefficient of variation of 32%.

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INTRODUCTION

Funding for this project was provided by the Northern Boundary and Transboundary Rivers Restoration and Enhancement Fund for the calibration of visual indices of Chinook salmon (*Oncorhynchus tshawytscha*) abundance. The relationship between visual indices and estimates of total spawners was examined and an expansion factor was developed for the 2010 escapement to the Kateen River. This report presents the expansion factors for the fifth year of study in the Kateen River, a tributary of the Khutzeymateen River.

The primary objective of this study was to generate an expansion factor for a visual escapement index on a clear running coastal stream. A mark re-sight program on the Kateen River was used to provide an escapement estimate with a reasonable level of accuracy to allow for the development of an expansion factor for a visual index of escapement. These results compliment previous work completed on a second coastal stream, the Kwinamass River, where factors were measured over 5 years.

Interest in validating Chinook salmon escapement estimates in the Kwinamass and Khutzeymateen Rivers extends beyond the development of expansion factors for visual methods. These systems didn't respond to Pacific Salmon Treaty initiatives in 1985 as observed in many other systems in the North Coast of British Columbia. Visual escapement estimates in the 1960's and early 1970's varied between 750 and 5000 Chinook salmon in each river. These systems appear to epitomize the mixed stock problem as two small and apparently weak Chinook salmon populations located between the two large and relatively healthy populations of the Nass and Skeena Rivers.

A significant time series of visual escapement indices exist for Chinook salmon stocks the Kwinamass and Khutzeymateen watersheds (Appendix 1). Estimates of Chinook salmon in the Khutzeymateen apply primarily to the Kateen River tributary and the area downstream of the Khutzeymateen – Kateen confluence. The estimates are extrapolations and essentially the same methods have been used for 20 years. They are similar to peak count extrapolations. These systems presented a fortunate scenario where the personnel conducting stream inspections remained static over a decade and the primary individual engaged in estimation of Chinook salmon in these systems was involved since 1985.

Stream inspection logs for the Kwinamass and Khutzeymateen River systems have been prepared since 1985. The logs provide information on live and dead Chinook salmon observed and stream conditions during each inspection. These raw data allow for comparison of the existing indices (commonly referred to as Fishery Officer estimates) to other methods of generating escapement estimates using the same data (e.g. area under the curve or peak count estimates).

Mark-recapture experiments were conducted on the Kwinamass River for 5 years, 2002 to 2006 inclusive. Fishery Officer estimates continued over this time, independent of the mark-recapture estimates. Recoveries of Chinook salmon carcasses from the Kwinamass and Khutzeymateen Rivers were extremely limited due to the predators that inhabit the area (bears and wolves). To make up for the inability to sample a representative portion of the population from carcasses the recapture portion of the study consisted of observations of marked and unmarked live Chinook salmon during swim and boat surveys. The swim surveys have been most effective (i.e. observed the most Chinook salmon) when they were timed just before spawning when the fish were holding in pools. The boat surveys were more effective when the Chinook salmon were spawning and could be observed in the shallow riffles.

METHODS

The total number of large Chinook salmon spawning in the Kateen River was estimated using a mark re-sight procedure. Chinook salmon were caught by angling and marked with Petersen discs. The marked ratio was determined by swimming the river with snorkel gear. The mark re-sight estimate was compared with the abundance index developed from visual counts of spawning Chinook salmon made while floating and walking the river.

The mark re-sight estimate of large Chinook salmon was generated using Schnabel's method for multiple censuses:

$$N = \frac{\Sigma (C_t M_t)}{(R+1)}$$

where N was the estimate of large Chinook salmon, M was the number of large Chinook salmon marked at time t, C was the total number of large Chinook salmon observed in the snorkel surveys at time t and R was the number of marked large Chinook salmon observed in the snorkel surveys. Approximate confidence limits were obtained by considering R as a Poisson variable (Ricker, 1975). Mark re-sight estimates of population size and confidence limits were also developed using the joint hypergeometric maximum-likelihood estimator described by White (1996).

The process of marking Chinook salmon occurred in the lower portions of the river. Chinook salmon were caught by angling to minimize capture related mortalities (angling mortality was less than 5%). The primary mark consisted of uniquely numbered, vinyl, Petersen discs applied 2 cm below the dorsal fin. The discs were attached with 7 cm stainless steel pins passed through a disc, through the skin, between the dorsal rays, through the skin on the far side of the fish and through a second disc. A loop was twisted into the end of the pin to secure the disc in place. The discs were 26 or 32 mm in diameter and provided a visible mark to the snorkel or float crews. Different colored tags were applied to males less than 65 cm fork length, larger males and females. Secondary marks were applied by punching a hole through the left operculum with a 6 mm paper punch. Fish judged to be unhealthy after capture were sampled for biological attributes and released without marks.

Chinook salmon caught in the mark application procedure were sampled for fork length, sex, and scales. Sex was determined from external appearance. Scale samples were collected on to scale books as described by MacLellan (1999). Scales were forwarded to the Fisheries & Oceans Canada, Fish Ageing Laboratory at the Pacific Biological Station for ageing.

The re-sight procedure was to swim the river with snorkel gear and count the number of marked and unmarked Chinook salmon. When schools of fish were encountered it was often necessary to swim over the school several times in order to break it up such that individual fish could be counted. In these cases the “best pass” consisting of the largest number of marked and unmarked Chinook salmon counted was used for the final estimate.

RESULTS

The 2010 visual index of Chinook salmon escapement for the Kateen River was based on float counts made on 17 August and 8 September and a helicopter count on 28 August (Table 1). The visual index generated from these surveys was 90 large Chinook salmon.

Marking of Kateen River Chinook salmon for the mark re-sight project occurred over 6 days from 16 to 28 July 2010. A total of 124 Chinook salmon were caught, 102 large 22 jacks (males <65 cm as measured from the tip of the nose to the fork of the tail). 90 large Chinook salmon, 55 males and 35 females, were tagged and released. In addition, 15 of the 22 jacks caught were released with tags.

Swims of the Kateen River occurred on 30 July, 4 August and 10 August 2010. The majority of the spawning area from the cataract to the confluence was covered each day. Conditions were good on 30 July with 57 large Chinook salmon and 12 jacks observed. Conditions were poor on 4 August with only 9 large Chinook salmon and 1 jack observed due to reduced visibility from glacial till. Conditions were good on 10 August with 56 large Chinook salmon and 14 jacks observed (Table 2).

No fish were observed to have lost tags; however, half of a tag was recovered from the bottom of the river by divers on 10 August. The recovered disc (half of the Petersen tag) was not numbered.

The Schnabel estimate of large Chinook salmon spawning in the Kateen River was 218 with 95% confidence limits of 176 and 270. The variance was 333 fish, the standard deviation was 18.3 fish and the coefficient of variation was 8.4%. This estimate compared well with the joint hypergeometric estimate of 200 large Chinook salmon with 95% confidence limits of 140 and 370 (Figure 2.).

Jack Chinook salmon could be easily distinguished from the pink salmon (*O. gorbuscha*) present because of the good viewing conditions on 30 July and 10 August and the relatively small run of pink salmon. This allowed for an estimate of jacks. The Schnabel estimate of jack Chinook salmon spawning in the Kateen River was 33 with 95% confidence limits of 20 and 52 (Table 4). The variance was 35 fish, the standard deviation was 5.9 fish and the coefficient of variation was 18.1%. The joint hypergeometric estimate of for jack Chinook salmon was 35 with 95% confidence limits of 26 and 53 (Figure 3.).

The expansion factor for the visual index to the mark re-sight estimate of large Chinook salmon spawning in the Kateen River in 2010 was 2.4 (Table 3).

Both ocean type and stream type Chinook salmon were evident in the 2010 Kateen River samples. Ocean type fish made up 9% of males and 24% of females caught. The predominant age differed by gender; age 4_2 fish made up 48% of males and age 5_2 fish made up 66% of females (Table 4.). One dead, partially eaten, female Chinook salmon was recovered during the snorkel survey. It was 96 cm in length. Scales revealed 4 marine annuli but the freshwater age could not be determined.

DISCUSSION

The Khutzeymateen Chinook salmon population has been assessed with visual indices between 100 and 750 Chinook since 1985. The index for 2010 was 90 large Chinook salmon. The index applies essentially to the Kateen River tributary of the Khutzeymateen River. The mark re-sight procedure on the Kateen River was successful in estimating the return of large and jack Chinook salmon in 2010. The estimates of large Chinook salmon from the mark-recapture were consistent with the visual indices which only measured large Chinook salmon. An unexpected result was that we were able to estimate jack Chinook salmon in the 2010 population. Typically this estimate would not be available because unmarked jack Chinook salmon cannot always be distinguished from pink salmon during the swims. Although the pink salmon population was significant in 2010 with a visual escapement index of 87,000 spawners, this did not complicate Chinook enumeration because the species separated spatially and the good conditions readily allowed for species identification. The Khutzeymateen and Kateen Rivers have significant pink salmon populations with visual escapement indices up to 230,000. The

Khutzeymateen River also has a significant population of chum salmon; however returns were low in 2010 with a visual index of 2,300.

Water levels, turbidity, light, wind and other conditions greatly affect attempts to enumerate spawning salmon. Thunder storms on 28 July essentially halted tagging as the river rose 30 cm in two hours and fish couldn't be captured as visibility dropped to near zero. Poor results from the swim conducted on 4 August were the result of glacial till clouding the waters. Warm weather had eliminated the snow pack and begun to melt old ice from the glaciers around the Khutzeymateen watershed. Overall, conditions experienced in 2010 were good during mark application and recovery events.

None of the Chinook salmon marked in 2010 were observed to have lost their Petersen disc tags so no corrections were made to account for tag loss. Typically the divers have been able to see tag scars on fish that lost tags in past studies. Low levels of tag loss were evident in previous studies but were not observed in 2010. A single disc recovered by divers on 10 August did not bear a number (i.e. the numbered disc was on the other half of the tag). The poor condition of the tag made it unclear whether it was applied in 2010 or in earlier studies. Viewing conditions were very good for two of the swims so significant tag losses would have been noticed from tag scars on the fish or from the mutilation mark (the opercular punch).

The mark rate for large Chinook salmon in the Kateen River in 2010 was 41%. Mark rates for studies conducted from 2005 to 2008 were 22%, 15%, 25% and 18% respectively. These rates are high considering the amount of angling effort used in applying marks. Half of the Chinook salmon population was encountered by 18 angler days of effort in 2010. An important result from these studies was that Chinook salmon populations in small, clear river systems were exceptionally vulnerable to angling.

The Pacific Salmon Treaty outlined tasks for the Chinook Technical Committee (CTC), which included establishing MSY or other biologically-based escapement goals. Most stocks do not have sufficient spawner and production data to estimate optimal spawning escapements. Most data limited stocks only have indices of abundance and additional information is required to convert the indices to total numbers of spawning fish. This project estimated total escapement by mark re-sight and direct count methods while performing visual index methods to establish the relationship between the indices and the total escapement estimates. Parken et. al. (2006) developed a habitat model that predicts the spawners required for maximum sustainable yield and replacement of Chinook salmon based on the size of the watershed used by the stock. The ultimate objective of this series of studies will be to relate the habitat based escapement goals or targets generated for these stocks with the abundances observed in the visual indices.

The CTC has considered data standards for factors used to expand escapement indices. The draft recommendations include the criteria 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% across years. The CTC guidelines include the criteria that the contrast in escapements (largest escapement / smallest escapement) used to generate factors should exceed 4.

The 2010 Kateen River Chinook salmon escapement was the lowest measured in the mark re-sight projects at this site. The visual index of escapement was also the lowest ever recorded (Appendix 1.). The expansion factor for converting the visual index to total escapement in 2010 was 2.4, the largest in the 5 year time series of observations for the Kateen River (Table 5.). This brings the average expansion factor measured on the Kateen River from 2005 to 2008 and 2010 to 1.65 with a standard deviation of 0.54. The resulting coefficient of variation was 32%. The contrast in the escapements used to generate the expansion factor was 3.9 but comes from testing the lowest end of the escapement range.

Generating an expansion factor for visual indices of Kateen River Chinook salmon would benefit from the examination of indices and total estimates for larger escapements. The current expansion factor remains outside of the draft standards recommended by the CTC. Additional years of study are suggested to refine the expansion factor used for adjusting visual indices of abundance to total estimates of Chinook salmon escapement on the Kateen River.

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TABLES

Table 1. Visual counts of spawning Chinook salmon in the Kateen River in 2010.

River	Date	Method	Unmarked large Chinook	Marked large Chinook	Total large Chinook
Kateen	17 August	float	18	5	23
Kateen	28 August	helicopter			9
Kateen	8 September	float	14 (2 dead)	1	15 (2 dead)

Table 2. Mark re-sight data summary for the Kateen River.

Date	Observer	Unmarked	Marked (R_t)	Total (C_t)
30-Jul-2010	Diver 1	31	22	53
30-Jul-2010	Diver 2	9	10	19
30-Jul-2010	Boat operator	4	6	10
04-Aug-2010	Diver 1	7	2	9
04-Aug-2010	Diver 2	2	0	2
04-Aug-2010	Boat operator	0	1	1
10-Aug-2010	Diver 1	33	19	52
10-Aug-2010	Diver 2	21	15	36
10-Aug-2010	Boat operator	12	7	19

M = 90, the number of large Chinook salmon marked and released
C_t = the number of large Chinook salmon observed in the surveys (marked & unmarked combined)
R_t = the number of marked large Chinook salmon observed in the surveys

Table 3. Comparisons of visual indices of Chinook salmon escapement with mark re-sight estimates for the Kateen River, 2005 to 2008 and 2010.

Year	River System	Visual Index	Mark re-sight Estimate	Factor
2005	Kateen	350	579	1.65
2006	Kateen	450	847	1.88
2007	Kateen	550	605	1.10
2008	Kateen	250	302	1.21
2010	Kateen	90	218	2.42

Table 4. Age and sex composition of the tag application sample in the Kateen River 2010.

Age	Males	Females	Total
3_1	2		2
4_1	3	4	7
5_1		3	3
3_2	15		15
4_2	28		28
5_2	8	19	27
6_2	2	3	5
1 Marine year	5		5
2 Marine years	8		8
3Marine years	7	4	11
4Marine years	1	5	6
Total	79	38	117
Complete ages	58	29	87
Ocean type	9%	24%	14%
4_2	48%		32%
5_2	14%	66%	31%

FIGURES

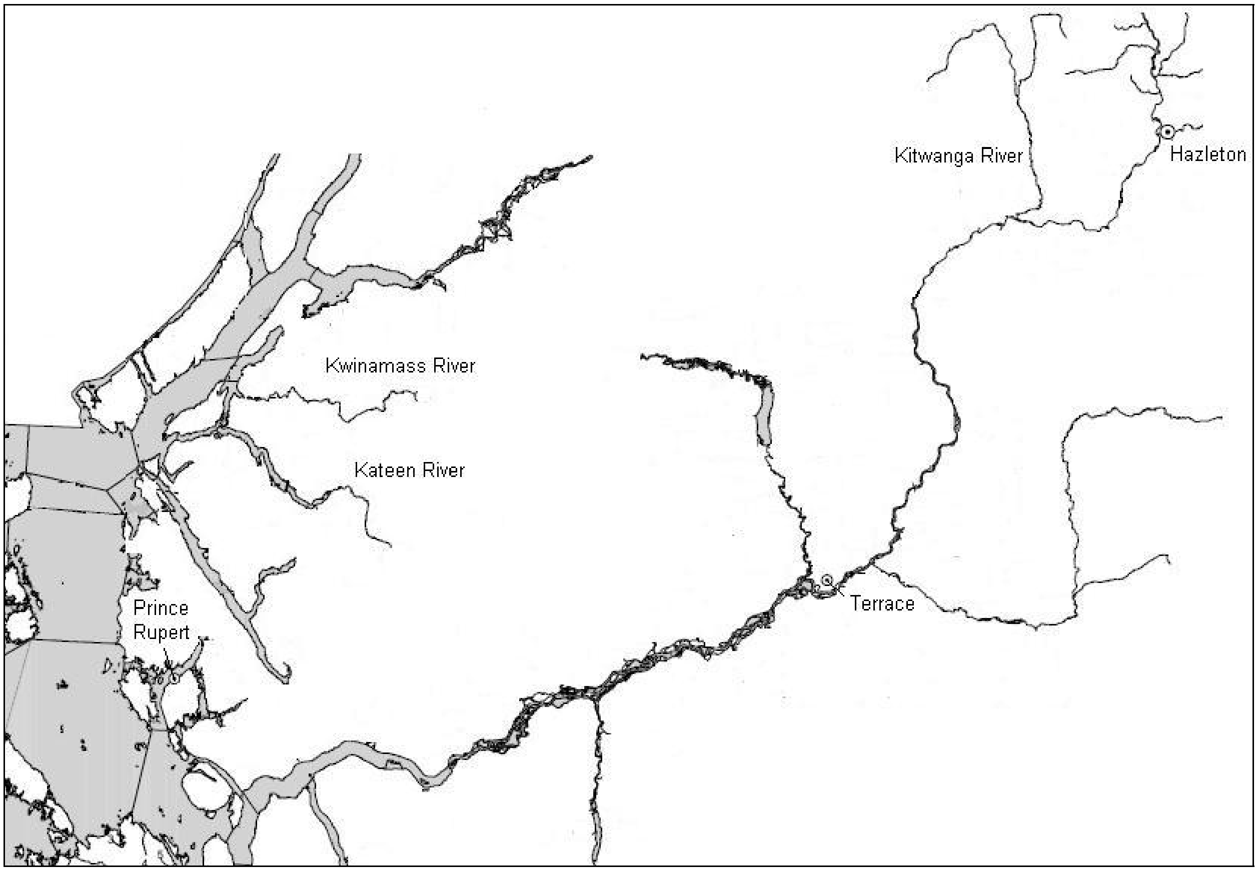

Figure 1. Location of the Kateen River and the Kitwanga River in northern British Columbia.

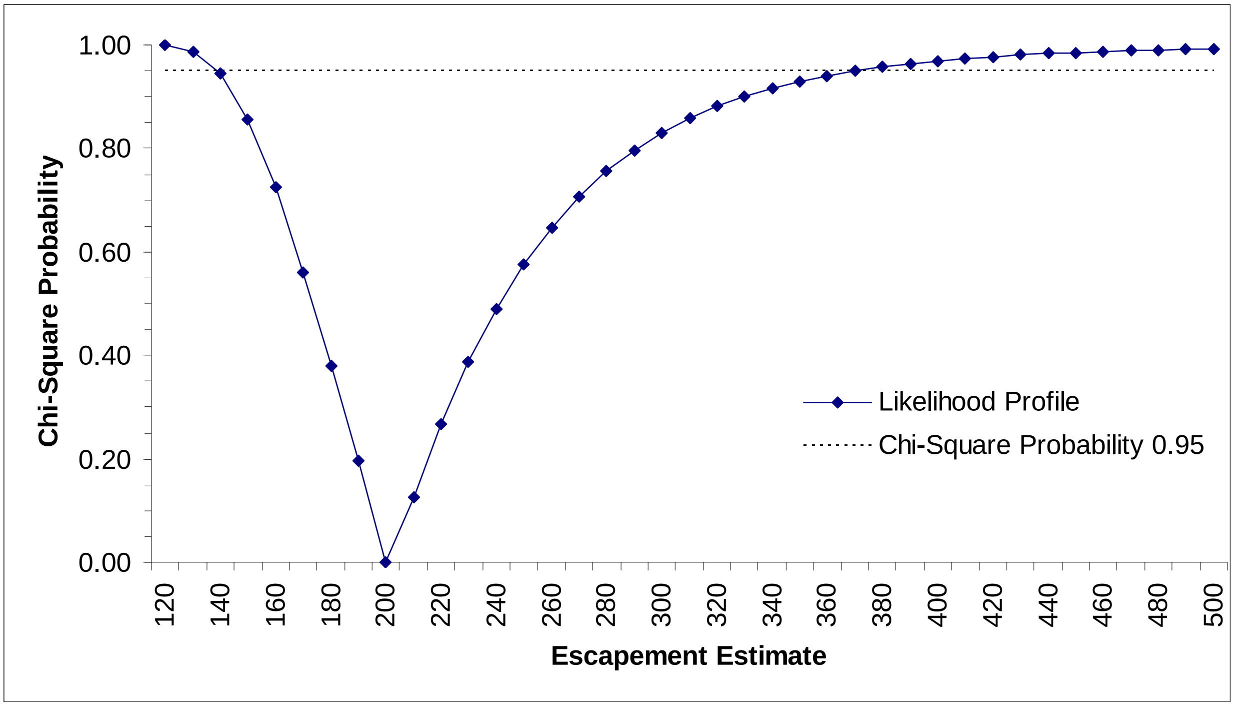

Figure 2. The joint hypergeometric maximum likelihood profile for the estimate of large Chinook salmon spawning in the Kwinamass River 2010.

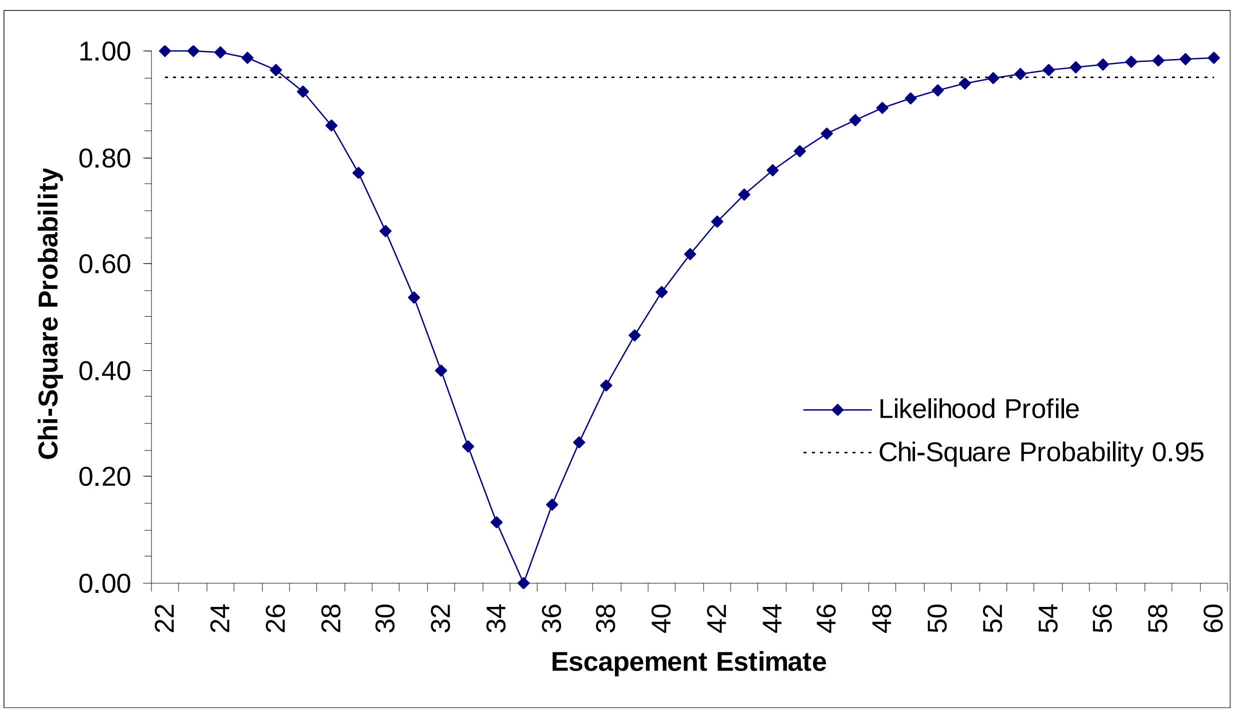

Figure 3. The joint hypergeometric maximum likelihood profile for the estimate of jack Chinook salmon spawning in the Kwinamass River 2010.

APPENDICES

Appendix 1. Chinook salmon escapements to Kwinamass and Khutzeymateen Rivers from Fishery Officer records.

Year	Kwinamass	Khutzeymateen
1962	1500	
1963	3500	
1964	1500	3500
1965	3000	800
1966	5000	1000
1967	3500	800
1968	5000	5000
1969	1000	750
1970	1200	750
1971	2500	750
1972	1000	2000
1973	300	
1974	1200	
1975	1000	
1976	500	500
1977	600	1000
1978	700	700
1979	300	800
1980	300	300
1981	300	300
1982	500	500
1983	150	200
1984	300	300
1985	200	300
1986	600	500
1987	300	750
1988	300	300
1989	200	200
1990	350	325
1991	300	300
1992	295	275
1993	200	200
1994	100	100
1995	100	100
1996	300	
1997	300	150
1998	400	100
1999	200	100
2000	300	300
2001	700	600
2002	600	300
2003	450	150
2004	400	
2005	400	350
2006	500	450
2007	925	550
2008	120	250
2009	260	AP
2010	240	90

AP = adults present but no estimate available

Appendix 2. Comparisons of visual indices of Chinook salmon escapement with mark re-sight estimates for the Kwinamass River, 2002 to 2006.

Year	River System	Visual Index	MR or fence Estimate	Factor
2002	Kwinamass	600	1176	1.96
2003	Kwinamass	450	771	1.71
2004	Kwinamass	400	813	2.03
2005	Kwinamass	400	957	2.39
2006	Kwinamass	500	1512	3.02

Appendix 3. Biological data for fish captured on the Kateen River 2010.

Fish#	Date	Length (cm)	Sex	Tag	GR-age
1	16-Jul-10	48	M	W1	32
2	16-Jul-10	74	M		42
3	16-Jul-10	72	M	G1	42
4	16-Jul-10	50	M	W2	32
5	16-Jul-10	69	M	G2	42
6	16-Jul-10	76	M		2M
7	16-Jul-10	73	M	G3	2M
8	16-Jul-10	66	M	G4	42
9	16-Jul-10	100	F	R1	52
10	16-Jul-10	101	F	R2	4M
11	16-Jul-10	82	M	G5	3M
12	16-Jul-10	98	F	R3	52
13	16-Jul-10	71	M	G6	42
14	16-Jul-10	49	M	W3	32
15	16-Jul-10	90	M	G7	S1
16	16-Jul-10	45	M	W4	32
17	16-Jul-10	51	M	W5	32
18	16-Jul-10	50	M	W6	1M
19	16-Jul-10	47	M		1M
20	16-Jul-10	111	M	G8	4M
21	16-Jul-10	106	M	G9	52
22	16-Jul-10	71	M	G10	42
23	16-Jul-10	97	M	G11	62
24	16-Jul-10	97	F	R4	52
25	16-Jul-10	88	M	G12	52
26	16-Jul-10	42	M		1M
27	16-Jul-10	67	M	G13	42
28	16-Jul-10	68	M		S2
29	16-Jul-10	47	M	W7	32
30	16-Jul-10	96	F	R5	3M
31	16-Jul-10	70	M	G14	42
32	16-Jul-10	76	M	G15	2M
33	16-Jul-10	76	M		42
34	16-Jul-10	95	F	R6	
35	16-Jul-10	82	M		3M
36	16-Jul-10	73	M	G16	42
37	16-Jul-10	116	M	G17	52
38	16-Jul-10	89	F		52
39	16-Jul-10	92	M	G18	52
40	16-Jul-10	75	M	G19	42
41	16-Jul-10	47	M	W8	32
42	16-Jul-10	50	M	W9	32
43	19-Jul-10	68	M	G20	42
44	19-Jul-10	100	F	R7	62
45	19-Jul-10	45	M		32
46	19-Jul-10	75	M	G21	42
47	19-Jul-10	69	M	G22	42
48	19-Jul-10	86	M	G23	42
49	19-Jul-10	42	M	W10	1M
50	19-Jul-10	97	F	R8	4M
51	19-Jul-10	80	M	G24	3M
52	19-Jul-10	78	M	G25	
53	19-Jul-10	101	M	G26	
54	19-Jul-10	90	M	G27	41
55	19-Jul-10	86	F	R9	52
56	19-Jul-10	75	M	G28	42
57	19-Jul-10	76	M	G29	42
58	19-Jul-10	84	F	R10	52
59	19-Jul-10	99	F	R11	51
60	19-Jul-10	101	F	R12	52
61	21-Jul-10	76	M	G30	3M
62	21-Jul-10	71	M	G31	42
63	21-Jul-10	88	F		52
64	21-Jul-10	100	F		52
65	21-Jul-10	99	F	R13	4M
66	21-Jul-10	76	M	G32	42
67	21-Jul-10	60	M	W11	2M
68	21-Jul-10	87	F	R14	52
69	21-Jul-10	45	M		32
70	21-Jul-10	39	M	W12	32
71	21-Jul-10	95	F	R15	52
72	21-Jul-10	92	F	R16	3M
73	21-Jul-10	106	F	R17	62
74	21-Jul-10	46	M	W13	32
75	21-Jul-10	99	F	R18	51
76	21-Jul-10	82	M		3M
77	21-Jul-10	95	F	R19	52
78	21-Jul-10	95	F	R20	52
79	21-Jul-10	91	F	R21	52
80	21-Jul-10	101	M	G33	52
81	21-Jul-10	98	F	R22	52
82	23-Jul-10	93	F	R23	41
83	23-Jul-10	65	M	G34	2M
84	23-Jul-10	81	M	G35	2M
85	23-Jul-10	107	F	R24	3M
86	23-Jul-10	93	F	R25	51
87	23-Jul-10	93	F	R26	41
88	23-Jul-10	71	M	G36	52
89	23-Jul-10	104	F	R27	52
90	23-Jul-10	103	F	R28	52
91	23-Jul-10	76	M	G37	42
92	23-Jul-10	79	M	G38	42
93	23-Jul-10	103	F	R29	4M
94	23-Jul-10	94	F	R30	52
95	23-Jul-10	73	M	G39	42
96	26-Jul-10	78	M	G40	42
97	26-Jul-10	49	M		32
98	26-Jul-10	71	M	G41	2M
99	26-Jul-10	70	M	G42	42
100	26-Jul-10	67	M	G43	31
101	26-Jul-10	66	M	G44	42
102	26-Jul-10	81	M	G45	52

Fish#	Date	Length (cm)	Sex	Tag	GR-age
103	26-Jul-10	77	M	G46	
104	26-Jul-10	92	M	G47	41
105	26-Jul-10	71	M	G48	31
106	26-Jul-10	72	M		2M
107	26-Jul-10	98	M	G49	41
108	26-Jul-10	75	M	G50	42
109	28-Jul-10	47	M	W14	
110	28-Jul-10	97	F	R31	62
111	28-Jul-10	47	M	W15	32
112	28-Jul-10	84	M	G51	3M
113	28-Jul-10	91	F	R32	4M
114	28-Jul-10	71	M	G52	42

Fish#	Date	Length (cm)	Sex	Tag	GR-age
115	28-Jul-10	105	M	G53	3M
116	28-Jul-10	90	F		3M
117	28-Jul-10	43	M		32
118	28-Jul-10	91	F	R33	41
119	28-Jul-10	88	M	G54	52
120	28-Jul-10	41	M		1M
121	28-Jul-10	86	F	R34	52
122	28-Jul-10	113	M		62
123	28-Jul-10	81	M	G55	42
124	28-Jul-10	101	F	R35	41

Appendix 4. Comparison of 2010 project results with the objectives identified in the proposal to the Pacific Salmon Commission's Northern Boundary and Transboundary Rivers Restoration and Enhancement Fund.

1. Estimate the 2010 Chinook salmon escapement to the Kateen River with an estimated coefficient of variation (CV) of 15% or less.

   The mark re-sight program met this data standard for large Chinook salmon and was able to estimate the jack population but not to the data standard. The proposal was designed to meet the data standard for large Chinook only.

2. Improve the expansion factor developed for the Kateen River to convert visual survey spawner indices into estimates of total spawning escapement. Bring the factor within the draft Chinook Technical Committee (CTC) data standards of a CV of 20% or less.

   The 2010 program tested the lowest Chinook salmon escapement ever measured for the Kateen River but since the relationship between the visual index and the mark re-sight estimate had the highest expansion factor in the 5 year time series the average expansion factor remains outside the data standard.

3. Broaden the contrast (highest escapement sampled / lowest escapement sampled) of escapements used to generate the expansion factor.

   The project met this objective but the contrast is still slightly below the data standard of 4.

4. Provide the data required to implement habitat-based escapement goal methods.

   Developing the expansion factor is germane to this goal.

5. Sample all Chinook salmon captured for the biological attributes of length, sex and age. Collect ancillary biological data, such as DNA baseline samples, to improve stock identification.

   This was done (Appendix 3.) and the sampling objective for the genetic baseline (i.e. >200 fish) is complete for this population.