Salcha River Chinook and Chum Salmon Counting Tower

R&M# 12-08

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1. Introduction:

Summary:

Management of Yukon River salmon stocks is a complex task, which requires information from a vast area and multiple sources. Accurate escapement estimates made in numerous spawning streams are necessary to successfully manage these stocks. During the 1,553 km migration from the Bering Sea to their spawning grounds, Salcha River salmon pass through six different commercial fishing districts in the Yukon and Tanana Rivers. Subsistence and personal use fishing also occur in these districts. A popular salmon sport fishery is located in the lower 3 km of the Salcha River. Information from all these fisheries combine with sonar estimates nearer the mouth of the Yukon River and escapement data to provide the necessary tools for proper management of stocks.

To perpetuate salmon stocks, fishery managers set harvest levels for the various fisheries such that a desired number of salmon are allowed to reach their spawning grounds (escapement goals). Annual harvest levels are based on estimates of the number of salmon that enter the Yukon River, catch data from relevant fisheries and escapement numbers collected during the current year as well as harvest and escapement numbers from prior years. In-season escapement information gathered from within the spawning rivers provides real-time data for modification to sport fishing harvest levels. Since 1993, tower count escapement estimates have been successful in the Salcha River, with the exception of 1996 when high water required the use of mark-recapture techniques.

The 250 km long Salcha River is located in the middle of the Tanana River drainage approximately 60 km upstream of the Chena River confluence (Figure 1). The Salcha River (drainage basin of 2,170 miles^2) is a surface runoff/tannic river that is clear except after extended heavy rainfall and during spring runoff.

The Salcha River has some of the largest Chinook salmon (*Oncorhynchus tshawytscha*) escapements in the Yukon River drainage (Schultz et al. 1994). Salcha Chinook escapement and composition likely is the best/most documented and has been estimated to be approximately 7-10% of the entire Yukon escapement (Eiler, 2006) (Table 1). In 2001, the Alaska Department of Fish and Game (ADF&G) established a Biological Escapement Goal (BEG) for the Salcha population with an escapement goal range of 3,300 to 6,500 Chinook salmon (Stuby 2001). Prior to 2001, the Salcha minimum escapement goal was 7,100 Chinook salmon. This previous goal was based on a comparison of aerial index area counts (1972-1995) and the then recent (1987-1995) escapement estimates (Evenson 1996). However, data from additional years (1996-

2003) indicated a poor correlation between aerial and ground-based abundance estimates. ADF&G also had established an aerial index area count escapement goal of 2,500 Chinook salmon for the Salcha. Aerial surveys of Chinook salmon from 1972 to the present have been shown to greatly underestimate the escapement numbers and do not correspond well with tower and mark-recapture estimates (Evenson and Stuby 1997, Bernard 1992). Mark-recapture estimates of Chinook salmon escapement made from 1987 through 1992 and in 1996 provided greater accuracy and precision of the total escapement, although sampling technique bias and comparison to tower counts indicates an under estimation of total escapements (Evenson and Stuby 1997).

Estimates of summer chum salmon (*Oncorhynchus keta*) escapement into the Salcha was near 200,000 in 2005, though substantially lower in many other years (Evenson and Stuby 1997, Stark 2006). Chum salmon escapement estimates in all years prior to 1999 have been incomplete estimates because tower counts were suspended at the end of the Chinook salmon run (early August), which ends at least one month before the end of the chum salmon run (Barton 1988; Barton and Conrad 1989; Stuby 2000). From 1999 to present, tower counts have been extended though August, pending weather and funding.

ADF&G experienced budget restrictions in 1999, which necessitated a reduction of salmon counting operations in the interior of Alaska, Region III. Traditionally, ADF&G (Sport fish Division) had operated towers on the Chena, Chatanika and Salcha Rivers. ADF&G continues to operate a tower on the Chena River. The Bering Sea Fishermen's Association (BSFA) has been able to successfully maintain a program to continue the Salcha River tower operation to provide important in-season and annual information for the management of Yukon River salmon stocks since 1999. Due to low chum salmon returns to the Yukon, the paucity of chum information (the Salcha river tower counts are the only Tanana river and middle Yukon summer chum escapement monitoring project) and the importance of chum salmon to many Yukon River fisheries (commercial, subsistence and sport), BSFA has made greater effort to assess Salcha summer chum total run strength, timing and composition.

Objectives:

- estimate the total escapement of chinook salmon in the Salcha River using tower counting techniques such that the estimate is within 15% of the actual value 95% of the time;
- estimate age, sex and length compositions of the escapement of chinook salmon in the Salcha River such that all estimated proportions are within 5% of the actual proportions 95% of the time;
- estimate the total escapement of chum salmon in the Salcha River using tower counting techniques as long as weather conditions and funding permits;
- map and describe located spawning reaches within the Salcha River index area.

2. Methods:

TOWER COUNTS

Counts of Chinook and chum salmon returning to the Salcha River were made as salmon passed by a tower site located approximately 1,000 meters upstream of the Richardson Highway Bridge and in the Salcha River State Park. This site (first occupied in 2004) is 1,500 meters upstream of the site occupied from 1998-2003, which was abandoned due to decreased site suitability (deepening channel and increased sport fishing activity).

Salmon were counted at fixed intervals by experienced technicians from one observation tower located on the south bank adjacent to the river. Counting was done from the 12-foot tall south bank tower (State Park side). Total escapement estimates can be made because little or no spawning occurs downstream of this counting tower site that is located 10 km above the Salcha-Tanana confluence (Stuby 2001). The statistical expansion and analysis for Salcha River Chinook and chum salmon abundance, sex, age and length composition, developed and currently employed by ADF&G, is thoroughly described by Stuby (2000).

These expansion methods were used to estimate the first half of the Chinook salmon run, but because extensive flooding prevented most all counts during the later half of the historic Chinook passage period, historic tower count run data daily portion means from years with near complete records (1993-2000, 2003-2007) were used to estimate daily counts for most of the second half of the Chinook run and summed with the first half seasons data to estimate the total escapement (Table 3). Assuming the first half data represented 50% of the total, simple daily mean historic portions were estimate and summed to estimate the 2008 total Chinook estimate. A Baysian method employed by Dr. Franz Muter in 2002 to generate the Salcha Chinook estimate with confidence estimates is being explored but is yet to be converted to an Excel format for ease of use and standardization. Briefly, Dr. Muter, for the 2002 escapement, estimated the total number of Chinook salmon in the Salcha River based on tower count data. The best estimation method was judged to be a hierarchical model that was fit simultaneously to historical (1993-2001) and the then current (2002) count data (Stark 2003). The model assumes that daily-expanded counts follow a bell-shaped pattern over the course of the season. The number of fish migrating past the counting tower is then estimated by integrating under the bell-shaped curve. Dr. Muter used a multi-year model because peak return dates and the length of the migration period are relatively constant across years, improving estimates within any given year. Several outliers in the 2002 season were removed prior to fitting the model. Model diagnostics suggested a good fit of the model.

Fish were counted as they passed over a 3 meter wide flash panel that lay on the river bottom from bank to bank, a distance of approximately 40-50 meters. Counts were taken hourly, usually 24 hours a day. Technicians were assigned one of three 8-hour shifts (night: 0000-0800, day: 0800-1600, evening: 1600-2400), and they counted 20 minutes of each hour. Counts were generally limited to 20 minutes, although longer and/or sequential counts were occasionally taken to test the validity of the 20-minute count. Count start times were randomly selected from the first 20 minutes of the first hour of the shift and simply repeated for the remaining hours of the shift. On occasion, a second person (chief tower tech, lead PI, ADF&G staff, or techs in training) duplicates counts for quality control or training purposes.

A string of lights with 20 evenly spaced flood lamps (100 wt) was strung 15 to 20 feet above the flash panel from 20-foot tall metal light posts. The lights were turned on at dusk and off after dawn and are powered by a very quiet gas generator.

In an effort to quantify the visibility encountered during the individual counts, a set of standardized descriptions of stream visibility were developed for this site (there are 7 panels) and given numeric values as follows
10 = can clearly see all panels (chance of missing fish is near zero)
9 = can see all panels but harder due to wind, rain, water clarity (chance of missing fish 5%)
8 = can see 6 of 7 panels clearly, barely see panel 7 (chance of missing fish 10%)
7 = can see 5 of 7 panels clearly, barely 6 and poorly on 7 (chance of missing fish 20%)
6 = can see 4 of 7 panels clearly, barely 5 and not on 6/7 (chance of missing fish 40%)
5 = can see 3 of 7 panels clearly, barely 4/5 and not 6/7 (chance of missing fish 60%)
4 = can see 3 of 7 panels clearly, not 4 – 7 (chance of missing fish 80%)
3 = can see 2 of 7 panels clearly, barely 3, not 4-7 (chance of missing fish 100%)
2 = can see little bit of panel 1/2 (chance of missing fish 100%) rescue tower time
1 = flood stage – tow down or removed

Technicians recorded stream conditions as part of their hourly recording routine. This information/data collection was started in 2005, as was an effort to quantify large verses small Chinook salmon (not reported in this document as is still under development). The "chance of missing a fish" percentage was described to the technicians as follows: given what you (the technician) know about where the Chinook generally pass the over the panels, what is the percentage chance that you would not see the average Chinook salmon?" Simply stated, this means that at a 50% chance of missing fish, the technician estimates that he/she is missing, not seeing, or not counting half of the Chinook salmon passing the tower during that count. During years of operations at this site it has been noted that the larger Chinook salmon tended to pass not over panels 7 (outer most) or 1, rarely over 2 or 3 but commonly over panels 4, 5 and 6, panel 5 being the most common. Smaller Chinook salmon tended to pass over panels 2, 3 and 4, but rarely over 1, 5, 6 or 7. Panel 5 spanned the river thalweg (deepest point = 4 feet deep at 2500 ft^3/s, 'normal flow'), panels 4 and 6 were in 3 feet of water while 2, 3 and 4 were in 2 feet of water at normal volume. Panels 1 and 7 were 1/4 out of the water with the deep end of panel 7 in 2 feet of water at normal volume. Salcha river flow volume and historic status information is from a USGS stream gauge station 500 meters downstream of the tower site.

AGE-SEX-LENGTH COMPOSITIONS

Chinook and chum salmon carcasses were collected from a jet boat using a gig spear or on foot from the shore. Carcasses were sampled from the tower site to 75 km upriver to Butte Creek (river km 85); this was the area sampled in previous years and is the same area used for aerial index counts. Carcass samples were collected throughout the sampling area as evenly distributed as practical. Length (mid-eye to fork-of-tail) and sex information were collected from both Chinook and chum salmon in the field. Scales were collected from Chinook salmon and vertebra from chum salmon for age determination in the laboratory. Stuby and Evenson (1998) describe the method used by ADFG to expand carcass data into estimates of total escapement's age-sex-length composition.

3. Results:

All Salcha River abundance and age-sex-length data is archived at and reported in a variety of Alaska Department of Fish and Game publications and presented at several annual fisheries meetings within Alaska. Data in this report is preliminary until reviews and analysis are finalized and reported by ADFG. The final estimate is usually published by ADFG within one or two years.

Tower counts began July 5 and ended for the season August 10 (Table 2). The Salcha tower counting operations start date in 2008, as in most years since 1999, was primarily based on historic passage and current downstream observations of subsistence, sport and commercial fishery catches but was delay by about a day or so due high water. USGS historical water level/volume records indicate that Salcha stream levels were generally well above average for most of 2008 salmon passage period. Local forest fires had no effect on tower operations. Stream visibility hourly data were summarized and presented to ADFG with count data. High murky stream conditions on July 12-13 decreased visibility during some portion of those days, especially during the twilight hours causing counts to be suspended or compromised beyond reliability. July 28 was the only day from July 20 through the rest of the Chinook passage period where visibility was not compromised. When visibility is rated as less than 7, counts are considered marginalized and not used for escapement estimates.

Several times during the season a second technician preformed duplicate counts. While done on occasion over the years, in 2008 extra effort was undertaken due the limited water visibility conditions. Counts were compared and then combined in the field data sheet.

ABUNDANCE ESTIMATES

Chinook salmon

The 2008 Salcha River Chinook salmon escapement estimate is 5,415 (Table 2). Extensive adjustments were made to the total escapement estimates for counts missed because of flooding conditions. The first Chinook salmon was counted passing the tower site during the evening shift July 6 approximately a week later than normal. The estimated Chinook salmon daily passage rate remained between 100-200 through July 14-15, the average 1st quartile passage point. Estimated daily passage of Chinook salmon increase from 200 July 16 to 500 July 19, the average Chinook passage mid-point. The cumulative Chinook salmon count estimate at the historic mid -point was calculated to be 2,678. Because extensive flooding prevented most all counts during the later half of the historic Chinook passage period, historic tower count run data daily portion means from years with near complete records (1993-2000, 2003-2007) were used to estimate daily counts for most of the second half of the Chinook run and summed with the first half seasons data to estimate the total escapement.
Based on readable scales (N=303) from carcass survey data (N= 353), the age-specific proportions of the Chinook run were age-3 (1%), age-4 (10%), age-5 (52%), age-6 (36%) and age-7 (0%) (Table 3). The female proportion of Chinook run was estimated to be 39% and was predominantly (66%) age-6 fish (brood year 2002). Thus while the run was predominately a produced by the 2003 brood year (age-5) the females were mostly a product of the 2002 brood

year. Chinook salmon escapement to the Salcha River was within the BEG range (3,300 to 6,500), but significantly below the 1993-2005 tower count average of 11,797, as well as the 1987-2005 combined mark/recapture and tower count average of 9,787. The 2008 Chinook salmon run began about a week later than the 1993-2006 average, though similar to 2007 and to the Chinook runs throughout the Yukon River drainage and the AYK region in both years. Carcass surveys were a bit of a challenge in 2008. That said the extensive flooding did not seem to have effected the salmon spawning efforts in that few carcasses had the look of un-spawned fish or were still carrying eggs, which is normal. The area surveyed seemed to have similar portions of carcasses as in prior years. The spawning locations noted during carcass surveys are presented in Figure 1 and resemble prior years where that information has been collected, although few larger fish are being found and the numbers spawning in the lower portion of the river seems to be declining.

Chum Salmon

The 2008 escapement of summer chum salmon into the Salcha River was not estimated. The first chum was counted July 16 and chum were still passing when operations ended September 10, both normal events. Chum salmon carcass surveys were successful and survey crews noted seemingly normal numbers on the spawning grounds. Using carcass survey data (N=160), the portion of females was 58% and predominately age-4 fish (51%) with age-5 fish make up most all others (40%) (Table 4). According to USGS historical records, flow volume was well above average in early July, normal from mid-July and well above the norm from July 20 through mid-August.

Table 1. Salcha River Chinook salmon escapement estimates.

Year	Estimated Escapement	Method	% Female	Estimated No. Females
1987	4,771	Mark-recapture	63	2,996
1988	4,562	Mark-recapture	40	1,807
1989	3,294	Mark-recapture	62	2,049
1990	10,728	Mark-recapture	49	5,246
1991	5,608	Mark-recapture	47	2,647
1992	7,862	Mark-recapture	34	2,705
1993	10,007	Tower	28	2,762
1994	18,399	Tower	45	8,188
1995	13,643	Tower	56	7,640
1996	7,570	Mark-recapture	51	3,846
1997	18,514	Tower	48	8,887
1998	5,027	Tower	30	1,508
1999	9,198	Tower	55	5,031
2000	4,595	Tower	44	2,017
2001	13,328	Tower	38	4,998
2002	8,850	Tower	34	3,009
2003	18,000	Tower	42	7,632
2004	16,000	Tower	63	10,064
2005	6,000	Tower	54	3,240
2006	10,697	Tower	43	4,600
2007	5,631	Tower	35	1971
2008	5,415	Tower	39	1895

Table 2. Salcha River Chinook salmon select historic percent and 2008 estimates of daily and cumulative passage. Yellow denotes days in 2008 for which historic data are used in place of limited or no 2008 data.

	Daily mean	Daily mean	Daily mean	Cumulative total passage			Daily	Cum.
	1993-2000	1993-2007	2004-2007	1993-2000	1993-2007	2004-2007	2008	2008
26-Jun	0.0	0.0	0.0	0.0	0.0	0.0		
27-Jun	0.0	0.0	0.0	0.0	0.0	0.0		
28-Jun	0.0	0.0	0.0	0.1	0.1	0.1		
29-Jun	0.0	0.0	0.0	0.1	0.1	0.1		
30-Jun	0.0	0.0	0.1	0.1	0.1	0.1		
1-Jul	0.2	0.1	0.1	0.2	0.2	0.2		
2-Jul	0.4	0.3	0.1	0.6	0.5	0.3		
3-Jul	0.3	0.2	0.2	0.9	0.7	0.5		
4-Jul	0.4	0.3	0.2	1.3	1.1	0.7		
5-Jul	0.1	0.2	0.2	1.4	1.2	1.0	0	0
6-Jul	0.9	0.8	0.5	2.3	2.0	1.5	111	111
7-Jul	1.2	1.0	0.8	3.5	3.0	2.3	108	219
8-Jul	1.9	1.7	1.4	5.4	4.8	3.7	141	360
9-Jul	2.6	1.9	0.8	8.0	6.7	4.4	168	528
10-Jul	2.4	2.0	1.2	10.4	8.7	5.6	192	720
11-Jul	3.4	2.9	2.0	13.8	11.6	7.6	135	855
12-Jul	4.5	3.7	2.3	18.3	15.3	9.9	156	1011
13-Jul	6.3	5.3	3.6	24.6	20.6	13.5	107	1118
14-Jul	5.1	4.2	2.8	29.6	24.8	16.3	141	1259
15-Jul	4.9	5.1	5.4	34.5	29.9	21.7	45	1304
16-Jul	5.7	5.6	5.4	40.3	35.5	27.1	318	1622
17-Jul	4.6	4.5	4.2	44.9	40.0	31.4	207	1829
18-Jul	4.9	5.9	7.8	49.7	45.9	39.2	528	2357
19-Jul	4.6	6.2	9.0	54.4	52.1	48.2	321	2678
20-Jul	4.7	4.9	5.3	59.1	57.0	53.4	282	2960
21-Jul	5.8	5.7	5.5	64.9	62.7	58.9	293	3253
22-Jul	4.7	5.5	7.1	69.6	68.3	66.0	379	3632
23-Jul	4.4	4.9	5.7	74.0	73.1	71.7	304	3936
24-Jul	5.1	5.1	5.2	79.1	78.2	76.8	277	4213
25-Jul	4.4	4.9	5.8	83.5	83.2	82.6	310	4523
26-Jul	3.1	3.5	4.4	86.6	86.7	87.0	235	4758
27-Jul	3.1	2.7	2.0	89.7	89.4	89.0	107	4865
28-Jul	2.7	2.4	1.7	92.4	91.8	90.7	53	4918
29-Jul	2.0	1.8	1.4	94.4	93.6	92.1	73	4991
30-Jul	1.3	1.3	1.4	95.7	94.9	93.4	73	5064
31-Jul	1.2	1.3	1.5	96.9	96.2	94.9	81	5144
1-Aug	0.8	1.0	1.2	97.8	97.2	96.2	66	5210
2-Aug	0.7	0.8	1.1	98.4	98.0	97.2	57	5268
3-Aug	0.5	0.6	0.6	99.0	98.6	97.8	31	5299
4-Aug	0.2	0.4	0.6	99.2	98.9	98.5	35	5334
5-Aug	0.3	0.4	0.6	99.4	99.3	99.1	32	5366
6-Aug	0.1	0.2	0.5	99.5	99.6	99.6	26	5392
7-Aug	0.1	0.1	0.1	99.7	99.7	99.7	8	5400
8-Aug	0.1	0.1	0.1	99.8	99.8	99.8	4	5404
9-Aug	0.1	0.1	0.0	99.9	99.9	99.8	2	5406
10-Aug	0.0	0.1	0.1	99.9	99.9	99.9	6	5412
11-Aug	0.0	0.0	0.0	100.0	100.0	100.0	1	5413
12-Aug	0.0	0.0	0.0	100.0	100.0	100.0	0	5413
13-Aug	0.0	0.0	0.0	100.0	100.0	100.0	1	5415

Totals	100.00	100.00	100.00	100.00	100.00	100.00	5415

Table 3. Salcha River Chinook salmon carcass survey ASL, 2008 (N=303).

Age (freshwater + marine years)	3	4	5	6	7	8	
Brood Year	2005	2004	2003	2002	2001	2000	Total
Percent Males	0.7	9.9	39.9	10.2	0	0	61
Mean Fork Length (mm)*	395	543	718	853		0	
Percent Females	0.0	0	11.9	25.7	1.7	0	39
Mean Fork Length (mm)*			779	851	878	0	
Percent Total	0.7	9.9	51.8	36	1.7	0	100

*Fork Length is mid-eye to caudal fork.

Table 4. Salcha River Chum salmon carcass survey ASL, 2008 (N=160).

Age	3	4	5	6	7	
Brood Year	2005	2004	2003	2002	2001	Total
Percent Males	1	19	17	3	2	42
Mean Fork Length (mm)*		545	585	598		
Percent Females		32	23	3	1	58
Mean Fork Length (mm)*		531	548	544		
Percent Total	1	51	40	6	3	100

*Fork Length is mid-eye to caudal fork.

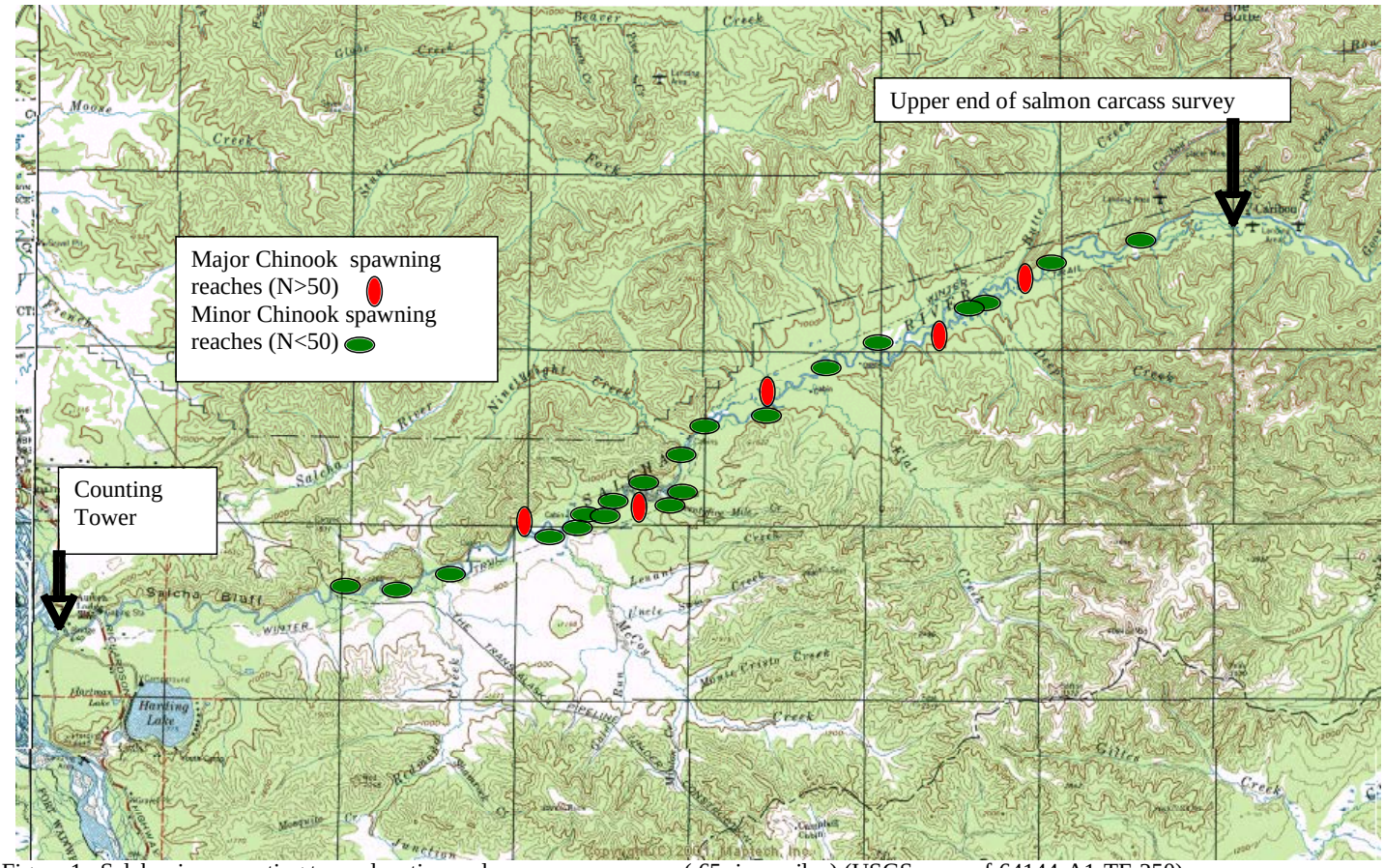

Figure 1. Salcha river counting tower location and carcass survey area (65 river miles) (USGS map ref:64144-A1-TF-250).

4. Discussion:

Salcha River 2008 Chinook salmon escapement of (5,415) was within the current BEG range (3,300 to 6,500). The Salcha River chum salmon escapement estimate was not made due the extensive flooding condition. Chinook salmon run timing was a week later than normal, similar to 2007 and throughout the AYK region in both 2007 and 2008. The 2008 Chinook salmon escapement was well below the 1993-2005 tower count average of 11,797 and below the 1987-2005 combined mark/recapture and tower count average of 9,787. The escapement compositon (age-3 (1%), age-4 (10%), age-5 (52%), age-6 (36%) and age-7 (0%) indicates a continued decline in older age fish. The female proportion of Chinook run was estimated to be 39% and was predominantly (66%) age-6 fish (brood year 2002). While the 2008 run was predominately a produced of the 2003 brood year (age-5), the females were mostly a product of the 2002 brood year which could be interpreted as the run getting younger, selective fisheries removing the larger/older fish and/or the 2003 year class being stronger. The apparent lack of age-7 and fewer age-6 fish is of concern and may explain the decline of fish spawning in the lower portion of the river if there is a relationship between fish size and stream size. According to recent studies of sockeye salmon in the Bristol Bay region and the general life history of salmon species, there is evidence to suggest this is so (Quinn 2005, Groot and Margolis 1999).

According to USGS historical records, flow volume was above average in early July, near average from early to mid-July and very high in the late portion of July through late August. During 2008 operations flooding events affected operations significantly.

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