U.S. Fish and Wildlife Service
Office of Subsistence Management
Fisheries Resource Monitoring Program

Abundance and Run Timing of Adult Salmon in Tanada Creek in the Wrangell-St. Elias National Park and Preserve, 2010

Annual Report for Project 10-502

David R. Sarafin

Wrangell - St. Elias National Park and Preserve
P.O. Box 439
Mile 106.3 Richardson Hwy.
Copper Center, Alaska 99573

May 2011

TABLE OF CONTENTS

Page

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

ABSTRACT

Tanada Lake salmon are highly susceptible to Federal and State subsistence users as well as commercial harvest. The Batzulnetas Area subsistence fisheries specifically target Tanada Lake salmon stocks. Monitoring Tanada Lake salmon stocks aids in assessing sockeye salmon escapement into the uppermost tributaries of the Copper River and in evaluating the harvest opportunity for subsistence fishers in the Batzulnetas Area fishery and the uppermost portion of the Glennallen Subdistrict. The dynamic nature of the flows in Tanada Creek has prevented a rigid picket weir from functioning successfully. The feasibility of a floating resistance board weir utilizing an underwater video recording system as a monitoring tool were tested in Tanada Creek.

Citation: Citation: Sarafin, D.R., 2011. Abundance and Run Timing of Adult Salmon in Tanada Creek in the Wrangell-St. Elias National Park and Preserve, 2010. USFWS Office of Subsistence Management, Fisheries Resource Monitoring Program, 2010 Annual Report (Project No. 10-502). Wrangell - St. Elias National Park and Preserve, Copper Center, Alaska.

INTRODUCTION

The upper Copper River drainage provides spawning habitat for sockeye *Oncorhynchus nerka* and Chinook *Oncorhynchus tshawytscha* salmon. Large numbers of adult salmon are harvested in commercial drift gillnet operations near the mouth of the Copper River from mid-May to September. Salmon escapement into the upper Copper River system contributes to Federal and State subsistence fishing opportunities through September 30. The monitoring and evaluation of these runs is essential to ensure that Wrangell - St. Elias National Park and Preserve (WRST) maintains natural and healthy populations of fish as required by the Alaska National Interest Lands Conservation Act (ANILCA).

The Copper River system supports over 124 known stocks of sockeye salmon, of which at least 12 occur above the confluence of the Copper and Slana rivers (Roberson 1987). Two of these stocks migrate through Tanada Creek and spawn along the shores of Tanada Lake and in the lake outlet area (Figure 1). Historically, Chinook salmon are present in small numbers in Tanada Creek (Veach and Scotton 2001). Tanada Lake sockeye salmon typically comprise the largest combined stock of spawning sockeye within the boundaries of the Wrangell-St. Elias National Park/Preserve, and is one of the largest stocks which spawn upstream of the Gulkana River. Tanada Creek is an ideal candidate for a weir site since it is one of the only clear water salmon streams that is near a road and accessible within WRST. Accurate, historic escapement data are needed to assess long term management strategies for Copper River fisheries and ensure sustainability of these important sockeye salmon stocks.

During 1997 (Raeder 1997), 1998 (Raeder, et al. 1998) and from 2001 through 2009, a fish weir has been operated by WRST in Tanada Creek to document salmon escapements into this Upper Copper River tributary. Prior to these years, the Alaska Department of Fish and Game (ADFG) operated a weir near the outlet of Tanada Lake in 1975, 1978, and 1979. The counts from 1979 were considered to be the first reliable estimate for sockeye salmon escapement to Tanada Lake (Veach and McCormick 2005)

Tanada Lake sockeye are one of the uppermost runs of sockeye salmon in the Copper River drainage and support subsistence salmon fisheries both in the Copper River and in Tanada Creek. Historically, the native villages of Mentasta and Chistochina harvested salmon in the Batzulnetas Area fishery. Batzulnetas, the Ahtna name for the traditional fishing site on Tanada Creek, has been used by the Ahtna people for over 1,000 years (Kari 1986). From 1985-2000, Katie John, Doris Charles and others attempted to reestablish this traditional subsistence fishery through litigation in Federal courts. The final "Katie John Decision", in which the Ninth U.S. Circuit Court of Appeals affirmed the Ninth U.S. Circuit Court's decision, resulted in expansion of Federal management of fisheries in waters under Federal jurisdiction throughout Alaska.

OBJECTIVES

Specific objectives for this study were to:

1. To count by day, the number of adult sockeye and Chinook salmon migrating past a weir operated in Tanada Creek during the period of early-June through mid-September.
2. To estimate the age, sex, length composition of the Tanada Lake sockeye salmon escapement from otolith interpretation, such that the estimates are within 5% of the true proportion 90% of the time.

METHODS

Study Area

Tanada Creek is a third order perennial stream and a tributary to the upper Copper River in southeast interior Alaska (Figure 1). Originating at Tanada Lake (62°27'N, 143°23'W), Tanada Creek runs 30 km northwest to its confluence with the Copper River (62°37'N, 143°48'W). The creek flows through the Copper River Plateau and encompasses a watershed area of approximately 550 km^2. The terrain ranges from nearly level to gently rolling throughout the creek basin, and the creek gradient is less than 2%. Vegetation is dominated by mosses, sedges, dwarf birch, and willows. Black and white spruces are the primary evergreens, with stands of cottonwoods interspersed. Soils are poorly drained and underlain by shallow permafrost (USDA 1979). Annual precipitation in the area averages 39 cm, and ambient temperature ranges from a high of 32° C to a low of -46° C with an average annual temperature of -2.5° C (NOAA 1995). Tanada Lake usually freezes in September or October, and ice breakup normally occurs in May.

The Tanada Creek weir is located approximately 750 m upstream from the Copper River and 300 m downstream from the Batzulnetas village site. Stream width at the weir is approximately 12 m. The vertical banks are approximately 0.65 m high, and there is no bank undercutting. Maximum water depth at midstream during bank-full conditions is estimated to be 1.5 m, and water velocity is moderate at normal water levels. The creek is prone to flooding during heavy rain. Channel substrate at both sites is predominately cobble, with interstitial sand, silt, and gravel. The stream banks are stabilized by spruce, willow, alder, grasses, and an understory of moss and horsetail ferns. Spruce, cottonwoods, and alder contribute to stream shading.

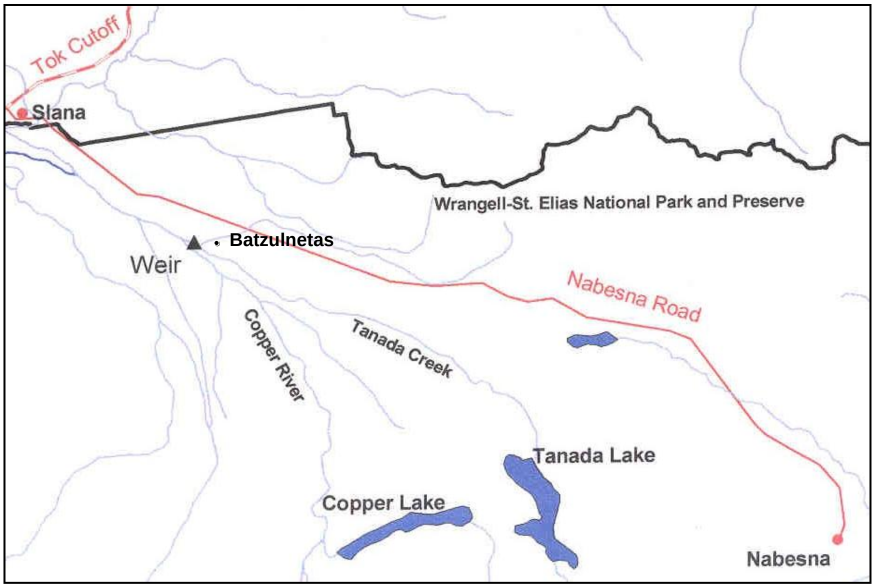

Figure 1. Tanada Creek and vicinity.

Weir Installation and Operation

In 2010, a floating resistance board weir was installed as described by Tobin (1994) (Figure 2). Installation began in Mid-May (Figure 3) and was completed by early June (Figure 4). The weir has been installed at the same general location since 2006, which is approximately 50 meters downstream of its location of prior years. This site featured a wider stream cross section, a relatively shallow, less pronounced channel, and no bank undercutting. This location was selected to reduce the risk of major flooding at the weir site. The weir, with picket spacing of 3.75 cm, was placed across the 12 m stream width. The weir was designed with resistance boards that could be adjusted to raise the downstream end of the weir pickets approximately 75 cm above the water surface. We have found these resistance boards to be unsuccessful in their designed purpose, and have added an overhead cable suspension system to provide a means of adjusting and maintaining the downstream end of the weir pickets at the desired height to block fish passage. Rigid weir pickets were installed from each riverbank connecting to the vertical bulkhead pickets of the floating weir structure. Technicians regularly checked the integrity of the weir to assure that no gaps existed that could permit fish passage.

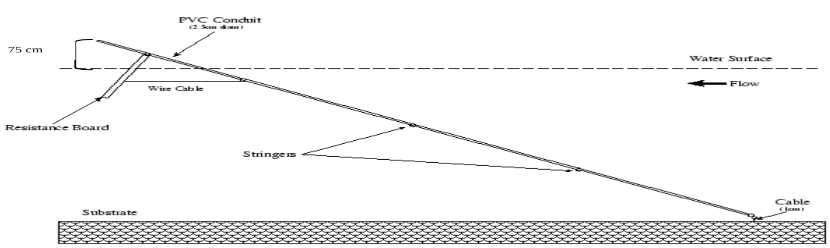

Figure 2. Side-View diagram of weir structure.

Figure 3. Constructing Tanada Creek weir.

Figure 4. Completed Tanada Creek weir structure.

In an effort to establish historic consistency of water depth measurements, a permanent cross section station was established on June 9, 1998 at a location approximately 100 m upstream of the present weir site. Four brass cap reference markers were used to identify the transect. A staff-gauge was placed in the creek near the north bank along the cross section. A staff gauge and water temperature reading were taken at the beginning of each daily weir check.

Escapement Estimation

We utilized an underwater video camera installed directly on a passage chute connected to the weir (Figures 5, 6, and 7). This allowed fish passage throughout the day and night, except when the crew closed the weir gate to review recorded video footage. To obtain useable video images during flooded, murky water conditions, the camera was secured inside a sealed aluminum housing that was filled with clear water. The fish passage chute forced fish passing through the weir to swim within a few inches of the glass surface of the camera housing. This ensured that, even during periods of high turbidity, all fish swimming past the camera were recorded and could be identified.

Figure 5. Video camera housing attached to fish passage chute.

Figure 6. Preparing camera housing for placement in river.

Figure 7. Underwater video and fish passage chute attached to weir.

A 12 volt, underwater LED light was installed in the fish passage chute to illuminate the view area. A photocell switch automatically turned the light on and off in response to changes in the level of ambient light.

A weatherproof case containing both a time-lapse S-VHS recorder and a separate digital video recorder (DVR) were housed on the north bank of the creek (Figure 8). A 12 volt deep cycle battery bank (400 Amp-hours total capacity) provided power to the system. The use of duplicate recording provided a backup in case one of the units malfunctioned or failed to record. Charge was maintained in the battery bank primarily through use of two separate photovoltaic solar panel arrays (580 Watts total rating) and charge controllers. Supplemental charge was also obtained from a gas powered 2000 W generator and 40 Amp, 12 volt charger.

Figure 8. Video recorders and field monitor.

Daily weir checks were performed throughout the season. Upon arrival at the site, staff would close the gate to the fish passage chute, stop video recording, and then review digital video footage from the previous day's video start time to the present day video stop time. All observed salmon passage was recorded by hour (Figure 9). Counts reported were obtained primarily from the DVR, as the control features made it easier for staff to review output from this unit than from the S-VHS recorder. Having duplicate recording units proved useful since there were occasional times when one of the units would fail. The time-lapse recorder was programmed to record in standard play (SP) mode, allowing for 48 hours of viewing on each T-160 tape. Tapes were changed every 48 hours.

Run Timing

The proportion of the total escapement passing the weir each day was calculated for each year, and the mean of each day's proportion was used to develop an historical run proportion curve. Only years for which escapement data was obtained for a substantial portion of the run were used to calculate mean daily proportions. We reviewed data from all eleven years with recorded fish counts from the period of 1979 through 2009, and then selected only the years that had recorded fish counts throughout the period of early-June through early-September (2003, 2004, 2006, 2007, and 2009). From these five years, the latest date when at least 90% of that seasons' total estimated run had passed the weir was September 4. This was selected as the date of minimal duration of weir counts for the inclusion in run timing analysis, to presume that a minimum of 90% of the run was documented.

Figure 9. Image of sockeye salmon passing camera.

Biological Data

As a means of estimating the age, sex, and length composition of sockeye salmon in the spawning escapement, we collected otoliths, identified sex, and measured length from carcasses collected in spawning areas of Tanada Lake and its creek outlet area. Three sampling events occurred during September 2010, once carcasses were observed in the lake. Events were separated by one week to allow carcasses to accumulate for sampling. All collected otoliths were analyzed by ADFG Commercial Fisheries Division staff in Cordova to ensure consistency in aging. Based on past work at this site, we anticipated having four age groups and tried to obtain a total of 121 readable otoliths so that age composition estimates would be within 20% of the actual proportion 90% of the time (Bromaghin 1993).

Capacity Building

Owners of the Batzulnetas village site have generously cooperated with WRST by allowing use of their land to conduct this project. We work directly with them regarding any concerns they may have pertaining to the project or impacts from land use. During the Batzulnetas culture camp, which occurs each July, WRST provides a forum for community members to observe the weir project in operation and to ask questions about abundance, timing, and management of the Tanada Creek run. Participation in the Batzulnetas subsistence fishery varies each year. We also hire local residents to work on the weir project, and these employees provide a direct connection between this project and surrounding communities.

RESULTS

Weir Operation

While the floating resistance board weir can be successfully operated over a wide range of flow conditions, Tanada Creek is prone to flooding some years during extended periods of heavy rain. During the eight years this weir has been used (2003-2010), it has been inoperable for extended periods in two years (2008 and 2005): about one out of every four years.

In 2010, the floating resistance board weir was in place for 126 days, from May 25 through September 27. Two high water events required the removal of near-shore rigid pickets to relieve pressure on the weir from the excessive debris load (Figure 10). The downstream picket-end support cables were also detached as another measure of preventing damage. With the pickets removed, the weir was not functional for approximately 48 hours on June 29 through July 1 and for approximately 60 hours on July 23 through July 26. Counts were obtained from the remaining 121 days of the season (Table 1).

Table 1. Dates of weir operation, Tanada Creek, 1979, 1998, and 2000-2010.

Year	Start date	End date	Flood days	Days operational
1979	June 25	August 21	0	57
1998	June 2	August 21	0	80
2000	July 11	July 13	N.A.	2
2001	June 5	August 22	10	68
2002	June 27	August 15	1	48
2003	May 31	September 19	0	111
2004	May 29	September 7	0	101
2005	May 26	September 22	18	101
2006	June 6	September 21	0	107
2007	June 13	September 23	0	103
2008	May 28	July 8	>30	41
2009	June 2	September 26	0	116
2010	May 25	September 27	5	121

Figure 10. Tanada Creek weir at flood stage, June 29, 2010.

For most of the 2010 season, staff gauge readings were above the 2002-2009 average (Figure 11). Staff gauge readings ranged from 0.4 ft on May 29 to 3.6 ft on June 29. In comparison, the highest water levels, since staff gauge readings were started in 2002, were recorded in 2005 when levels reached 4.5 ft (McCormick and Sarafin 2006).

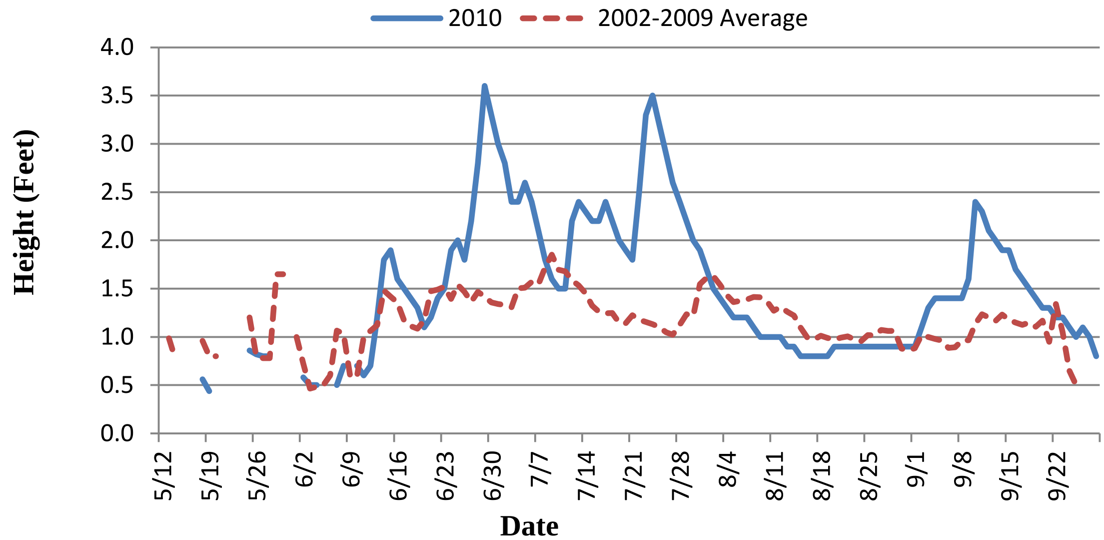

Figure 11. Daily staff gauge readings at Tanada Creek weir site for 2010, along with average of daily readings for the period 2002-2009.

Water temperatures were recorded on each visit to the weir site and ranged from 31ºF to 64ºF (Figure 12). For the majority of the 2010 season, the observed water temperatures were below the 2002-2009 average.

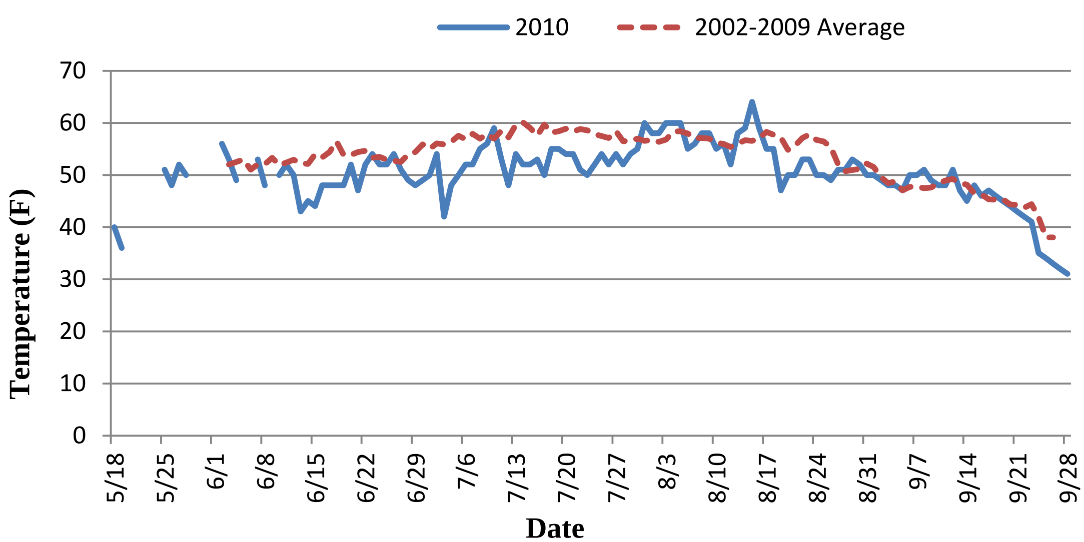

Figure 12. Daily recorded water temperatures at Tanada Creek weir site for 2010, along with the average of daily recorded temperature for the period 2002-2009.

Escapement Estimation

A total of 5,226 sockeye and 16 Chinook salmon were observed migrating past the weir in 2010 (Table 2, Figure 13, and Appendix A). The sockeye salmon count was below the average of counts from previous seasons. The greatest daily sockeye salmon escapement in 2010 occurred on August 25 when 254 sockeye salmon were counted through the weir. The Chinook salmon count of 16 was equal to the average from all previous years with counts. The maximum number of Chinook salmon observed in previous years is 137, which was observed in 2008. For the other 12 years in which counts are available, they have ranged from 0 to 16 Chinook salmon.

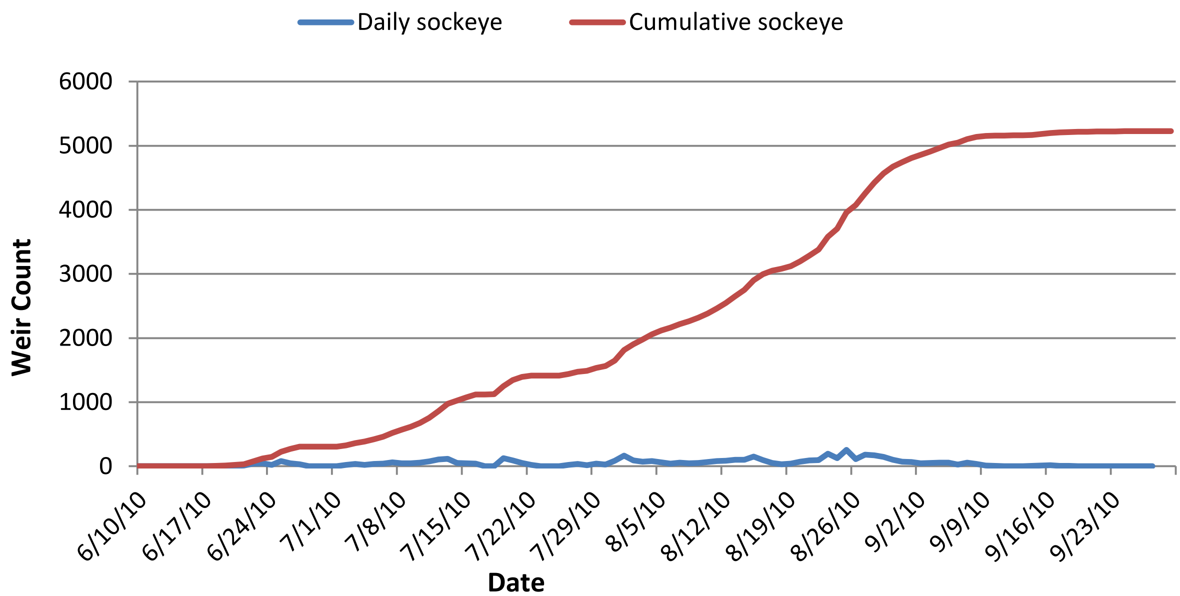

Figure 13. Daily and cumulative counts of sockeye salmon passing the weir, 2010.

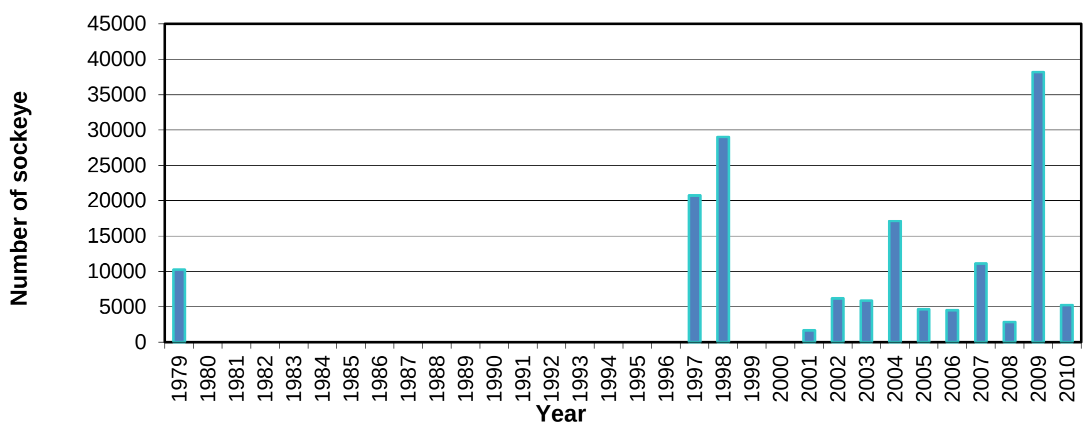

Figure 14. Estimated sockeye salmon escapement by year, 1979-2010.

On average, prior to 2010, the Tanada Lake sockeye salmon stocks have comprised 1.9% of the total inriver Copper River run estimate at the Mile Lake sonar site. However, in 2010 the

Tanada Creek weir count comprised only 0.6% of the estimated total inriver run of 924,010 sockeye salmon into the Copper River.

Table 2. Tanada Creek weir salmon passage estimates obtained since 1979 and total estimated inriver sockeye salmon run estimates from Miles Lake sonar project for the corresponding years.

	Sockeye salmon numbers		Chinook salmon
Year	Tanada Creek (% Miles Lake estimate)	Miles Lake	numbers for Tanada Creek
1979	10,244[1] (4.3)	237,173	5
1997	20,729[2] (1.8)	1,148,079	5
1998	28,992[3] (3.3)	866,957	2
1999	—	848,921	—
2000	—	587,592	—
2001	1,649[4] (0.2)	833,569	16
2002	6,186[5] (0.8)	816,825	5
2003	5,856 (0.8)	695,233	2
2004	17,120 (2.6)	669,646	0
2005	4,659[6] (0.5)	854,268	1
2006	4,514 (0.5)	959,731	4
2007	11,103 (1.2)	926,438	7
2008	2,850[7] (0.4)	717,799	137
2009	38,208 (5.4)	709,330	9
2010	5,226 (0.6)	924,010	16
Averages:			
All previous years with Tanada counts[8]	12,676 (1.6)	786,254	16
Previous Years with reliable Tanada counts[9]	15,360 (1.9)	792,076	4

[1]Partial weir count from June 25 to August 21.
[2]Contains expanded estimates from periods without monitoring; but the season was also shortened due to flooding.
[3]Value contains an estimate of 1,030 fish passing through a breach in weir and weir counts ended on August 21.
[4] Incomplete total count due to short period of weir operation and fish leakage between counting periods.
[5]Estimate based upon mark-recapture sampling; the actual weir count was 2,489.
[6] Weir compromised by flooding, this is a partial count estimate from video review; the actual weir count was 739.
[7]Partial weir count through July 8.
[8]Averages for Tanada Creek sockeye and Chinook salmon and Miles Lake sockeye salmon for 1979-1998 and 2001-2009.
[9]Averages for Tanada Creek sockeye and Chinook salmon and Miles Lake sockeye salmon for 2003, 2004, 2006, 2007, and 2009.

Run Timing

In 2010, the first sockeye salmon was observed at the weir on June 17 and 50% of the total run had passed the weir by August 13 (Figure 15 and Table 3). In prior years, the dates on which the first sockeye salmon was observed passing the weir have ranged between June 5 and July 13, and the median date of the run has ranged from July 2 to August 6.

Table 3. Date first sockeye salmon passed through weir, median run date, and median number migrating past the Tanada Creek weir, 1979, 1998, and 2001-2010.

Year	First Sockeye	Median Date	Median Number
1979	25-June[1]	N.A.[2]	N.A.[2]
1998	13-July	N.A.[2]	N.A.[2]
2001	June 14	N.A.[2]	N.A.[2]
2002	June 28[1]	N.A.[2]	N.A.[2]
2003	June 11	August 6	2,929
2004	June 11	August 2	8,560
2005	June 13	N.A.[2]	N.A.[2]
2006	June 17	July 2	2,257
2007	June 20	July 25	5,552
2008	June 10	N.A.[2]	N.A.[2]
2009	June 5	July 17	19,104
2010	June 17	August 13	2,613

[1] Weir was not operational for the beginning of the run.
[2] Calculations not made since weir was not operated over a substantial portion of the run.

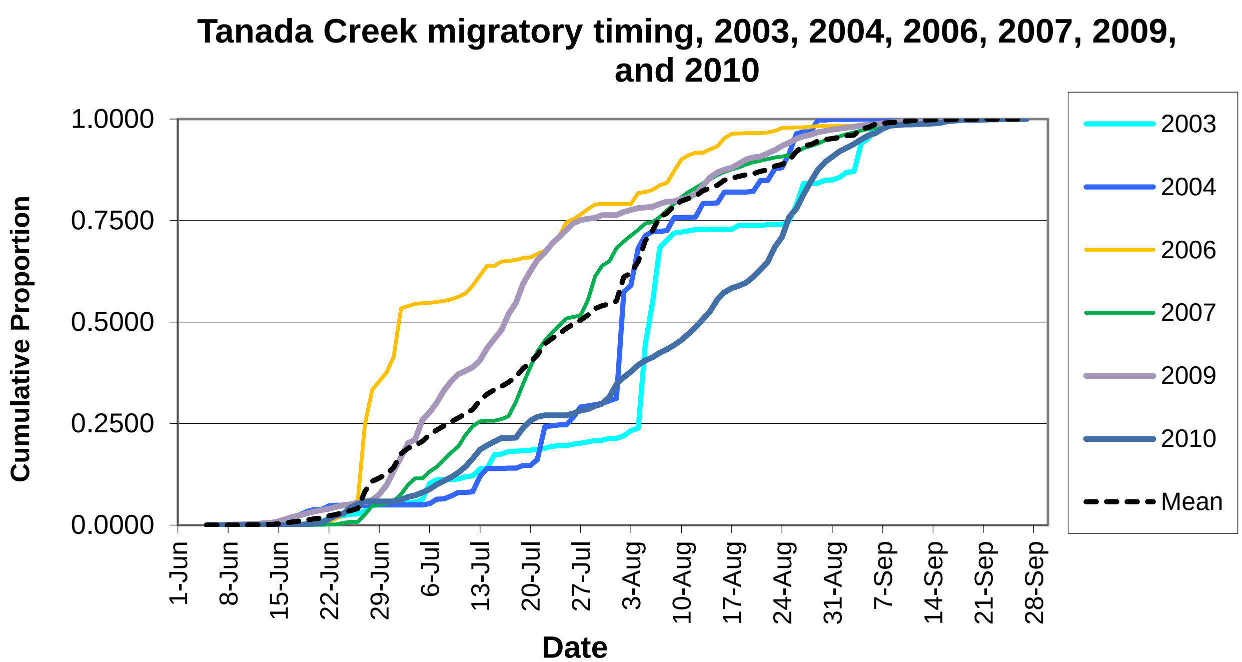

Figure 15. Historical and average migratory run timing for sockeye salmon passing the Tanada Creek weir site.

Biological Data

A total of 77 sockeye salmon were sampled during three sampling events in September 2010. Ages were interpreted from all otoliths collected (Table 4). Age-1.3 sockeye salmon comprised

68.8% of the samples collected and age-1.2 comprised the remaining 31.2%. Observations conducted on the spawning grounds revealed a below average number of spawning salmon and carcasses present.

Table 4. Age-class, brood year, and sex composition of Tanada Lake sockeye salmon sampled, 2010.

		Age-Class[1] (Brood Year)		
		1.2 (2006)	1.3 (2005)	Weir Passage
Female	Percentage of sample	15.6	22.1	37.7
	Number in escapement	814	1,154	1,968
Male	Percentage of sample	15.6	46.8	62.3
	Number in escapement	814	2,443	3,258
Total	Percentage of sample	31.2	68.8	100.0
	Number in escapement	1,629	3,597	5,226
	Standard Error	278	278	

[1]Ages interpreted from otoliths.

Capacity Building

During 2010, this project provided seasonal employment for three local residents who worked as technicians staffing the weir. The weir site was also used as an educational resource for the Batzulnetas culture camp, which takes place July each year (Figure 16). We also gave presentations concerning the weir project at local Subsistence Resource Commission meetings, South Central Resource Advisory Council meetings, government-to-government meetings with Mentasta and Cheesh-na tribes, and to the Ahtna Subsistence Committee.

Figure 16. Batzulnetas culture camp.

DISCUSSION

Escapement Estimation

Escapement monitoring typically relies on video, sonar, or direct visual observation. Video technology provides a means of monitoring without having staff continually on site throughout the field season. Prior to 2007, Tanada Creek weir operations were based on direct visual observations at the weir made one or more times each day, although a video recorder was placed upstream of the weir to determine whether it would be possible to use this technology instead of a weir (McCormick and Sarafin 2006). The gate in the weir was only open to allow fish passage when counting was being done. Despite efforts to make counts and pass fish at various times of the day, salmon would not always pass through the weir while someone was on site and opened the gate. Inevitably, salmon would be observed backed up below the weir and congregated in pools, apparently delayed in their migration due to weir operations. This increases their vulnerability to predation, can cause self-inflicted injuries when salmon repeatedly attempt to pass the weir when the gate is closed, and may also deplete their energy stores. When salmon concentrate behind the weir, the likelihood of human-bear habituation is also increased, particularly as bears begin to associate the weir site with food availability.

An alternative to regulating fish passage by closing and opening a gate within the weir is to keep the gate open at all times. However, this makes it necessary to either continuously observe and record salmon passage or to extrapolate data to cover periods when visual observations are lacking. Since salmon passage rates vary within and among days, direct visual observations would need to be made several times each day to reduce the magnitude of extrapolation errors. We have been able to avoid these problems by using an underwater video recording system in conjunction with a passage chute built into the weir to ensure that all fish passing through the weir travel close to the camera lens. This allows us to keep the weir gate open when staff is not present, and allows salmon to pass the site in a less obstructed manner that should allow them to migrate in a more natural pattern with fewer detrimental effects.

Run Timing

Historical run proportions are commonly used to make inseason estimates of salmon escapements and total run size (for example, Mundy 1982 and Hyun et al. 2005). Unfortunately, run timing of the Tanada Lake sockeye salmon escapement has been highly variable for the five available years of data. For example, the date on which 50% of the escapement passed the weir has varied by 42 days (Table 3). Inseason forecasts of total escapements based on the mean run proportions for these five years would be very inaccurate (Figure 16). While various factors can influence run timing, we think the way in which the weir was operated probably had a large effect. Prior to 2007, when salmon were only allowed to pass through the weir gate during counting, investigators observed delays in salmon migration at the Tanada Creek weir that were thought to be as long as one to two weeks in some years (Veach and McCormick 2003, McCormick and Sarafin 2006). Migration delays seem to have been reduced with the integration of underwater video recording equipment into the weir during 2007-2010, which allows the weir gate to be left open except for a short period each day when recordings are being reviewed (Sarafin 2008, 2009, and 2010). We hope continued use of video recording will reduce the variability of run timing estimates.

Biological Data

With the continuously operating underwater video recording system in place, staffing time at the weir site was greatly reduced. However, as occurred in 2007, having the weir gate continually open except for the 3-5 hours each day when staff was on site greatly reduced the number of salmon available for sampling. Additionally, all salmon sampled at the weir site have extensively resorbed outer scale margins that made their scales unreadable and required ages to be estimated using a length-at-age relationship developed by ADFG. Since this relationship was derived from mixed stock samples collected in the lower Copper River, this technique introduced unknown errors into Tanada Lake age composition estimates. Therefore, we shifted sampling from the weir site to spawning areas, where we have been collecting otoliths from carcasses. While we easily met our sample size goals in 2007 and 2009, we were not able to find enough carcasses to sample in 2008 and 2010, probably due to the low numbers of sockeye salmon in the escapements of those years.

Capacity Building

Each season, three local residents of the Slana area were employed by WRST to staff the weir. Through this employment, they gained experience in biological monitoring, sampling, reporting, and entering data. Through their individual local ties, they each contributed to disseminating information from this, and other projects within the Park. They have had a very positive impact on improving communications and relations between the residents of local communities and WRST.

CONCLUSIONS

Weir Operation

The resistance board weir appears to be a better design for the selected counting site than a rigid picket weir. We had no problems continuously operating the resistance board weir during 2006, 2007, and 2009, although water levels were not extremely high during the counting season. We were not able to operate the weir during the flood conditions experienced during 2008. During similar flood conditions in 2010, near shore rigid pickets were removed and the downstream floating pickets were released from the support cable to relieve pressure. The weir was not substantially damaged and counts resumed soon after each flood event.

Escapement Estimation

Underwater video provides an excellent means of enumerating salmon passage through the weir. We were able to make daily salmon counts during on-site reviews of video recordings, and seem to have reduced interference with natural migratory timing by allowing salmon to pass through the weir gate throughout the day.

Run Timing

Run timing appears to be highly variable in Tanada Creek. Currently, the use of average run proportions based on existing data does not appear to be a useful tool for forecasting total run size during the season. We hope that current counting methods, which appear to have lessened observed effects on salmon migratory behavior, will provide run timing estimates that are less variable. This would eventually allow average run proportions to be useful as an inseason forecasting tool. While such information would have only limited use for managing Copper River fisheries, it could be used to indicate whether sufficient carcasses would be available later in the season for biological sampling.

Biological Data

The sockeye salmon run to Tanada Lake typically consists of a predominant single age class, age-1.3. From 2007-2009, sockeye salmon of this age-class comprised at least 90% of all three annual escapement samples. Otolith interpretation is the preferred ageing method since sockeye salmon have resorbed the outer margins of their scales by the time they arrive at Tanada Creek. We had no problems collecting enough otoliths to meet sampling goals as long as escapements were large (11,103 in 2007 and 38,208 in 2009), but were unable to collect sufficient numbers when escapements were small (2,850 in 2008 and 5,226 in 2010).

Capacity Building

The Tanada Creek weir project provided local residents with employment and experience in biological monitoring, sampling, reporting, and entering data. In turn, seasonal employees have improved communications and relations between local communities and WRST.

RECOMMENDATIONS

Weir Operations

1. Install the weir with a wide span of floating panels and without a sampling trap to make it more capable of withstanding high flows.
2. Continue to operate the underwater video recording system to estimate escapement.

Escapement Estimation and Run Timing

1. Work towards a definition of natural and healthy sockeye salmon escapement for Tanada Lake stocks.
2. Maintain long-term, consistent methods to count salmon through the weir, including use of an underwater video system, to decrease the variability of annual run timing estimates.

Biological Data

1. Continue sampling sockeye salmon carcasses from spawning areas at a level sufficient to collect a minimum of 121 otoliths. Sampling events should be separated by about one week to allow the build-up of enough carcasses to make sampling efforts effective.

ACKNOWLEDGEMENTS

The National Park Service would like to thank the Village of Mentasta Lake, Katie John and Doris Charles for allowing use of their land for the purpose of conducting this project. The U.S. Fish and Wildlife Service (FWS), Office of Subsistence Management, provided funding support for this project through the Fisheries Resource Monitoring Program, under agreement number FIS10-502. Stephen Fried, FWS, provided editorial review and statistical support.

LITERATURE CITED

Bromaghin, J.F. 1993. Sample size determination for interval estimation of multinomial probabilities. The American Statistician 47: 203-206.

Hyun, S., R. Hilborn, J.J. Anderson, and B. Ernst. 2005. A statistical model for in-season forecasts of sockeye salmon (*Oncorhynchus nerka*) returns to the Bristol Bay districts of Alaska. Canadian Journal of Fisheries and Aquatic Sciences 62: 1665–1680.

Kari, J. 1986. Tatl'ahwt'aenn Nenn', The Headwaters People's Country: Narratives of the Upper Ahtna Athabaskans. Alaska Native Language Center, University of Alaska, Fairbanks, Alaska.

McCormick, M.B. and D. Sarafin. 2006. Abundance and Run Timing of Adult Salmon in Tanada Creek in the Wrangell-St. Elias National Park and Preserve. USFWS Office of Subsistence Management, Fisheries Resource Monitoring Program, Final Report No. FIS06-502-1, Anchorage, Alaska.

Mundy, P. R. 1982. Computation of migratory timing statistics for adult chinook salmon in the Yukon River, Alaska, and their relevance to fisheries management. North American Journal of Fisheries Management 4: 359-370.

National Oceanic and Atmospheric Administration, 1995. Annual Climatological Summary, Slana, Alaska. National Climatic Data Center, Asheville, North Carolina.

Raeder, R. 1997. Abundance and Run Timing of Adult Salmon in Tanada Creek, Wrangell-St. Elias National Park and Preserve, Alaska, 1997. National Park Service, Copper Center, Alaska.

Raeder, R., V. Rood, and B. Gavitt. 1998. Abundance and Run Timing of Adult Salmon in Tanada Creek, Wrangell-St. Elias National Park and Preserve, Alaska, 1998. National Park Service, Copper Center, Alaska.

Roberson, K. 1987. Copper River subsistence and personal use salmon fishery management and research - 1987, Report to the Alaska Board of Fisheries (Prince William Sound Data Report#1987-9). Alaska Department of Fish and Game, Division of Commercial Fisheries, Glennallen, Alaska.

Sarafin, D.R. 2008. Abundance and Run Timing of Adult Salmon in Tanada Creek in the Wrangell-St. Elias National Park and Preserve, 2007. USFWS Office of Subsistence Management, Fisheries Resource Monitoring Program, Annual Report No. FIS07-502-1, Anchorage, Alaska.

Sarafin, D.R. 2009. Abundance and Run Timing of Adult Salmon in Tanada Creek in the Wrangell-St. Elias National Park and Preserve, 2008. USFWS Office of Subsistence Management, Fisheries Resource Monitoring Program, Annual Report No. FIS07-502-2009, Anchorage, Alaska.

Tobin, J. H. 1994. Construction and performance of a portable resistance board weir for counting migrating adult salmon in rivers. U.S. Fish and Wildlife Service, Kenai Fishery Resource Office.

United States Department of Agriculture, Soil Conservation Service, 1979. Exploratory Soil Survey of Alaska, National Cooperative Soil Survey.

Veach, E.R. and S. Scotton. 2001. Abundance and Run Timing of Adult Salmon in Tanada Creek in the Wrangell-St. Elias National Park and Preserve. Wrangell - St. Elias National Park and Preserve, Annual Report No. FIS00-013-3, Copper Center, Alaska.

Veach, E.R. and M.B. McCormick. 2005. Abundance and Run Timing of Adult Salmon in Tanada Creek, Wrangell-St. Elias National Park and Preserve: 2003 Annual Report and 2000-2003 Final Report. USFWS Office of Subsistence Management, Fisheries Resource Monitoring Program, Annual Report No. FIS00-03-3, Anchorage, Alaska.

Appendix A. Tanada Creek daily salmon counts, 2010.

	Sockeye Numbers		Chinook Numbers	
Date	Daily	Cumulative	Daily	Cumulative
5/25/10	0	0	0	0
5/26/10	0	0	0	0
5/27/10	0	0	0	0
5/28/10	0	0	0	0
5/29/10	0	0	0	0
5/30/10	0	0	0	0
5/31/10	0	0	0	0
6/1/10	0	0	0	0
6/2/10	0	0	0	0
6/3/10	0	0	0	0
6/4/10	0	0	0	0
6/5/10	0	0	0	0
6/6/10	0	0	0	0
6/7/10	0	0	0	0
6/8/10	0	0	0	0
6/9/10	0	0	0	0
6/10/10	0	0	0	0
6/11/10	0	0	0	0
6/12/10	0	0	0	0
6/13/10	0	0	0	0
6/14/10	0	0	0	0
6/15/10	0	0	0	0
6/16/10	0	0	0	0
6/17/10	3	3	0	0
6/18/10	2	5	0	0
6/19/10	7	12	0	0
6/20/10	9	21	1	1
6/21/10	13	34	2	3
6/22/10	44	78	6	9
6/23/10	45	123	2	11
6/24/10	23	146	2	13
6/25/10	81	227	0	13
6/26/10	45	272	0	13
6/27/10	34	306	0	13
6/28/10	0	306	0	13
6/29/10	0	306	0	13
6/30/10	0	306	0	13
7/1/10	0	306	0	13
7/2/10	21	327	0	13
7/3/10	35	362	0	13
7/4/10	22	384	0	13
7/5/10	35	419	0	13
7/6/10	41	460	0	13
7/7/10	62	522	0	13

-continued-

Appendix A. Continued.

	Sockeye Numbers		Chinook Numbers	
Date	Daily	Cumulative	Daily	Cumulative
7/8/10	48	570	1	14
7/9/10	47	617	0	14
7/10/10	57	674	0	14
7/11/10	79	753	0	14
7/12/10	106	859	2	16
7/13/10	115	974	0	16
7/14/10	53	1,027	0	16
7/15/10	48	1,075	0	16
7/16/10	44	1,119	0	16
7/17/10	0	1,119	0	16
7/18/10	4	1,123	0	16
7/19/10	127	1,250	0	16
7/20/10	92	1,342	0	16
7/21/10	51	1,393	0	16
7/22/10	21	1,414	0	16
7/23/10	0	1,414	0	16
7/24/10	0	1,414	0	16
7/25/10	0	1,414	0	16
7/26/10	23	1,437	0	16
7/27/10	38	1,475	0	16
7/28/10	16	1,491	0	16
7/29/10	44	1,535	0	16
7/30/10	28	1,563	0	16
7/31/10	85	1,648	0	16
8/1/10	164	1,812	0	16
8/2/10	91	1,903	0	16
8/3/10	73	1,976	0	16
8/4/10	83	2,059	0	16
8/5/10	60	2,119	0	16
8/6/10	42	2,161	0	16
8/7/10	55	2,216	0	16
8/8/10	49	2,265	0	16
8/9/10	51	2,316	0	16
8/10/10	65	2,381	0	16
8/11/10	80	2,461	0	16
8/12/10	88	2,549	0	16
8/13/10	102	2,651	0	16
8/14/10	100	2,751	0	16
8/15/10	151	2,902	0	16
8/16/10	96	2,998	0	16
8/17/10	51	3,049	0	16
8/18/10	30	3,079	0	16
8/19/10	43	3,122	0	16

-continued-

Appendix A. Tanada Creek daily salmon counts, 2010.

	Sockeye Numbers		Chinook Numbers	
Date	Daily	Cumulative	Daily	Cumulative
8/20/10	73	3,195	0	16
8/21/10	93	3,288	0	16
8/22/10	95	3,383	0	16
8/23/10	198	3,581	0	16
8/24/10	126	3,707	0	16
8/25/10	254	3,961	0	16
8/26/10	112	4,073	0	16
8/27/10	180	4,253	0	16
8/28/10	170	4,423	0	16
8/29/10	147	4,570	0	16
8/30/10	103	4,673	0	16
8/31/10	70	4,743	0	16
9/1/10	66	4,809	0	16
9/2/10	47	4,856	0	16
9/3/10	50	4,906	0	16
9/4/10	56	4,962	0	16
9/5/10	55	5,017	0	16
9/6/10	29	5,046	0	16
9/7/10	57	5,103	0	16
9/8/10	36	5,139	0	16
9/9/10	12	5,151	0	16
9/10/10	7	5,158	0	16
9/11/10	0	5,158	0	16
9/12/10	2	5,160	0	16
9/13/10	4	5,164	0	16
9/14/10	5	5,169	0	16
9/15/10	11	5,180	0	16
9/16/10	19	5,199	0	16
9/17/10	8	5,207	0	16
9/18/10	7	5,214	0	16
9/19/10	2	5,216	0	16
9/20/10	0	5,216	0	16
9/21/10	4	5,220	0	16
9/22/10	2	5,222	0	16
9/23/10	2	5,224	0	16
9/24/10	2	5,226	0	16
9/25/10	0	5,226	0	16
9/26/10	0	5,226	0	16
9/27/10	0	5,226	0	16

The U.S. Fish and Wildlife Service, Office of Subsistence Management conducts all programs and activities free from discrimination on the basis of sex, color, race, religion, national origin, age, marital status, pregnancy, parenthood, or disability. For information on alternative formats available for this publication please contact the Office of Subsistence Management to make necessary arrangements. Any person who believes she or he has been discriminated against should write to: Office of Subsistence Management, 3601 C Street, Suite 1030, Anchorage, AK 99503; or O.E.O., U.S. Department of Interior, Washington, D.C. 20240.