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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, 2008

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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 underwater video counting as a monitoring tool were tested in Tanada Creek.

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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 (Veatch 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, 1998, and from 2001 through 2008, 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 Tanada Lake outlet in 1979.

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 seasons' study were to:

1. Install and operate a weir from approximately June to mid-August.
2. Compare and assess run timing with historic estimates.
3. Estimate age, sex, and length composition of the escapement.
4. Test video technology as an alternative method of assessing abundance.
5. Conduct outreach about this project through instruction of local students and residents.

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 km². 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.

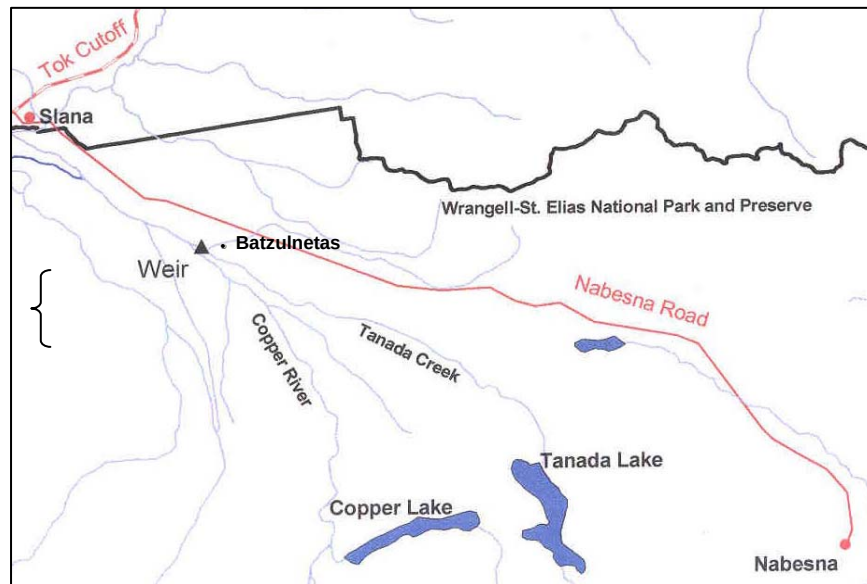


Figure 1. Tanada Creek and vicinity.

Weir Installation and Operation

In 2008, a floating resistance board weir was installed as described by Tobin (1994) (Figure 2). Installation began on May 14 (Figure 3) and was completed May 28 (Figure 4). The weir was installed at the same location as in 2006 and 2007, 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. Rigid weir pickets were installed from each riverbank connecting to the vertical bulkhead pickets of the floating weir structure. A 1.5 m x 2 m fish trap was installed in the weir near the north bank. The trap was constructed of aluminum channel, steel pipes, and PVC with gates that could be raised and lowered at both ends to allow for holding, sampling, and releasing fish. Technicians using dry suits, face masks, and snorkels regularly checked the integrity of the weir and repaired any gaps that could permit fish passage.

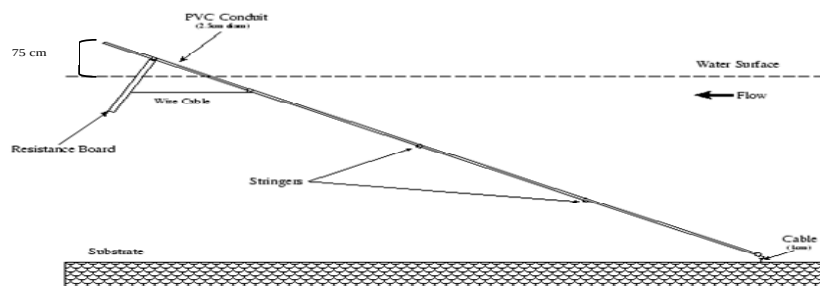


Figure 2. Side-View diagram of weir structure.



Figure 3. Constructing Tanada Creek weir, 2008.



Figure 4. Completed Tanada Creek weir structure, 2008.

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 set along a 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.

One *HOBO*[®] *TEMP* data logger was placed in a submersible case at the base of the staff gauge to collect water temperature data throughout the summer. The data logger recorded temperatures every hour and 30 minutes.

Escapement Estimation

For the second year, 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. Thus even during periods of high turbidity, only a few inches of turbid water was between the glass surface of the camera housing and the body of the fish.

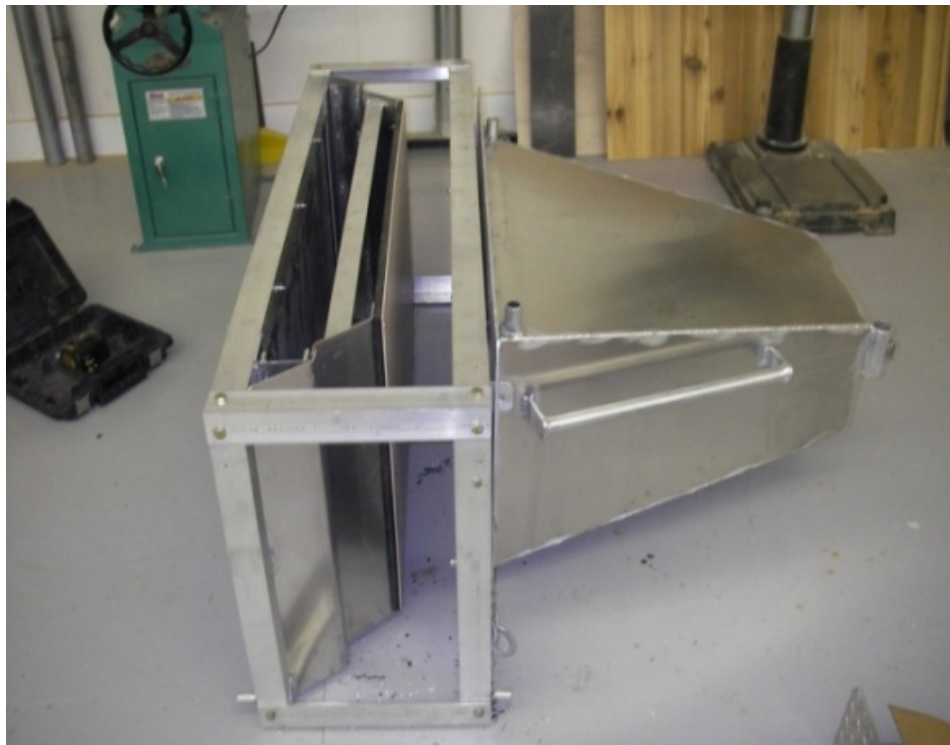


Figure 5. Video camera housing attached to fish passage chute.



Figure 6. Preparing camera housing for placement in river.



Figure 7. Underwater video and fish passage chute attached to weir, 2008.

Two 12 volt LED cluster lights were installed in the fish passage chute to illuminate the view area. A photocell switch automatically turned the lights 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 bank of four 12-volt deep cycle batteries (400 Amp-hours total capacity) provided power to the system. The use of duplicate recording provided a back up in case one of the units malfunctioned or failed to record. Charge was maintained in the battery bank primarily through use of a gas powered 2000 W generator and 40 Amp, 12-volt charger. Supplemental charge was also obtained from a photovoltaic solar panel array of 220 Watts and a charge controller.

Counts reported for 2008 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.



Figure 8. Video recorders and field monitor.

Daily weir checks were performed throughout the season. Upon arrival at the site, staff would close the weir 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). 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.



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. Two sampling events occurred once carcasses were observed in the lake. The first sampling event occurred September 5 to 6 and the second event was September 19 to 20. Events were separated by 12 days to allow for accumulation of carcasses from spawner die-off. Otolith samples 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

The weir was operated 41 days, from May 28 to July 8 (Table 1). It was then rendered inoperable due to damage from the effects of a rapid flood event. Extended periods of heavy rainfall continued throughout July and August. Attempts were made to re-install the weir; however, the water level remained too high for personnel to complete the installation. Although the floating resistance board weir was successfully operated during 2004, 2006, and 2007, it remains prone to periods of inoperability during years with extended periods of heavy rainfall. In 2005, four high water events compromised the weir; the flood level rose above the stream banks and the near-shore rigid pickets were removed due to excessive debris load (Figure 13).

Table 1. Dates of weir operation, Tanada Creek, 2000-2008.

Year	Start date	End date	Flood days	Days operational
2000	July 11	July 13		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	102
2008	May 28	July 8	>30	41



Figure 10. Tanada Creek weir at flood stage, July 8-9, 2008.

Staff gauge readings in 2008 ranged from 0.5 ft to 3.8 ft and were well above the 2002-2007 average for much of the season (Figure 11 and 12). In comparison, the highest water levels, since staff gauge readings were started in 2002, were recorded in 2005 when levels ranged from 1.3 ft to 4.5 ft (McCormick and Sarafin 2006).

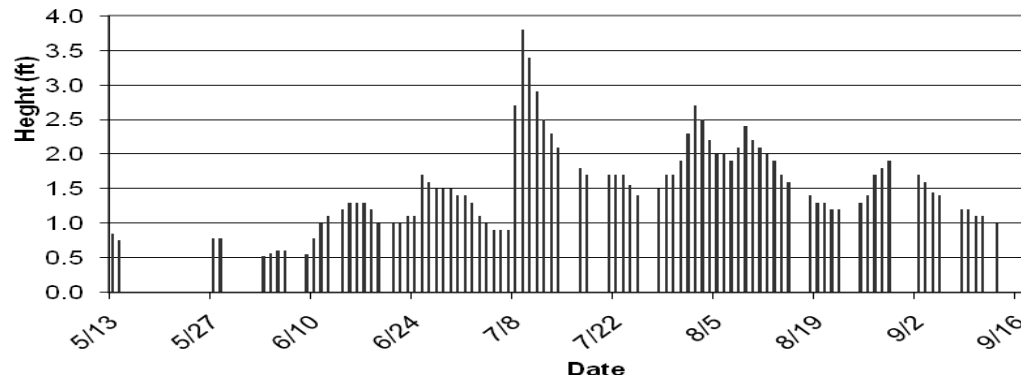


Figure 11. Staff gauge readings at Tanada Creek weir site, 2008.

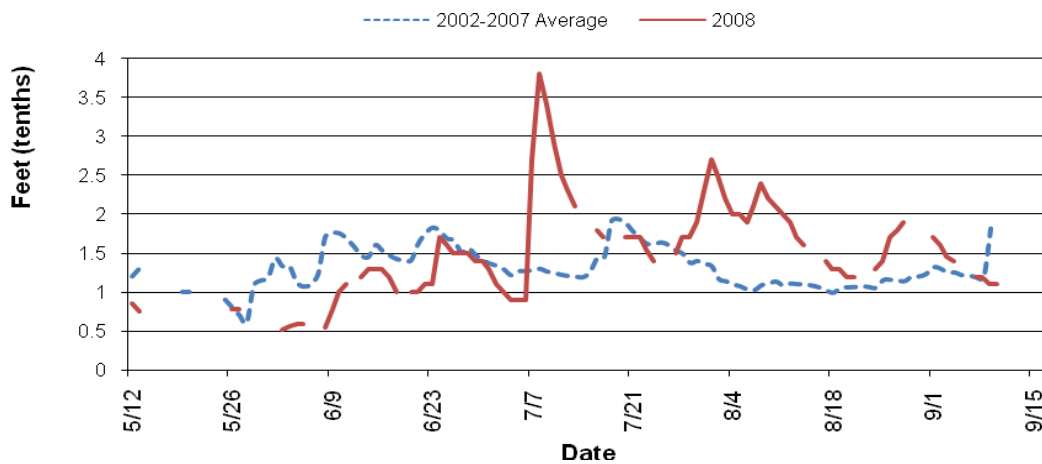


Figure 12. Staff gauge readings at Tanada Creek weir site, 2008 and 2002-2007 average.

Water temperatures in 2008 were recorded on each visit to the weir site, until the flood dislodged the weir structure. Temperatures ranged from 48°F to 60°. Generally, water temperatures were below the 2002-2007 average for this period of the season (Figure 13).

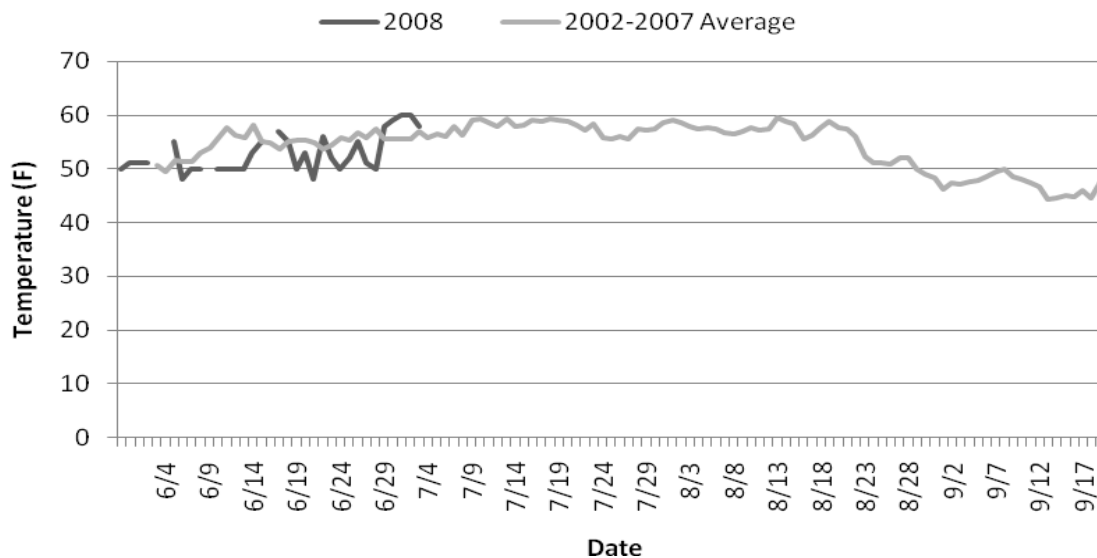


Figure 13. Water temperature at Tanada Creek weir site, 2008 and 2002-2007 average.

Escapement Estimation

A total of 2,850 sockeye and 137 Chinook salmon were observed migrating past the weir in 2008 (Figure 14 and Appendix A). The greatest daily escapement was recorded on July 4 when 291 sockeye salmon were counted through the weir. The 2008 weir passage count of sockeye salmon was below to the historical average of 11,106 (Figure 15 and Table 2). The 2008 weir passage count of 137 Chinook salmon was much greater than the historical average of 5.

On average, the Tanada Lake sockeye salmon stock comprises only 1.7% of the total Copper River run (Table 3). In 2008, the Tanada Creek weir count, which could not be obtained during the entire duration of the run, comprised about 0.4% of the estimated total escapement of 717,799 sockeye salmon into the Copper River.

Run Timing

In 2008, the first sockeye salmon was observed at the weir on June 10, which is the earliest they have been recorded passing the weir. In part years, the first sockeye salmon have been observed at the weir between June 11 and July 13, and the median date of the run has ranged from July 2 to August 23 (Figure 16 and Table 3). Neither the median point nor run timing curve for 2008 could be calculated since the weir was operational for only the early portion of the historical run period.

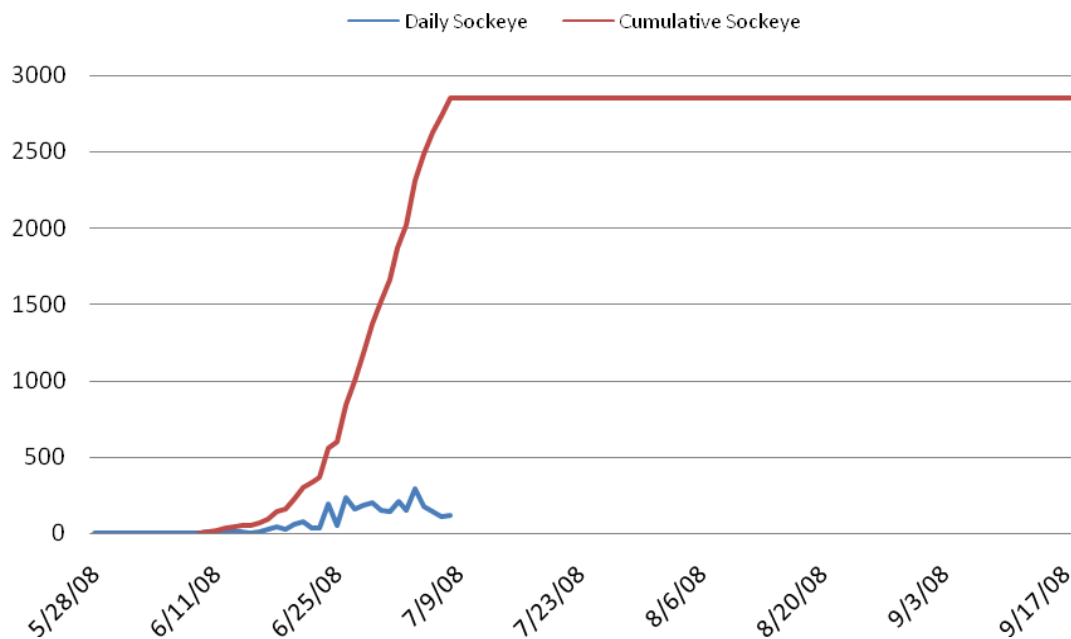


Figure 14. Daily and cumulative counts of sockeye salmon passing the weir, 2008. (The lower line represents daily counts, while the upper line represents cumulative counts.)

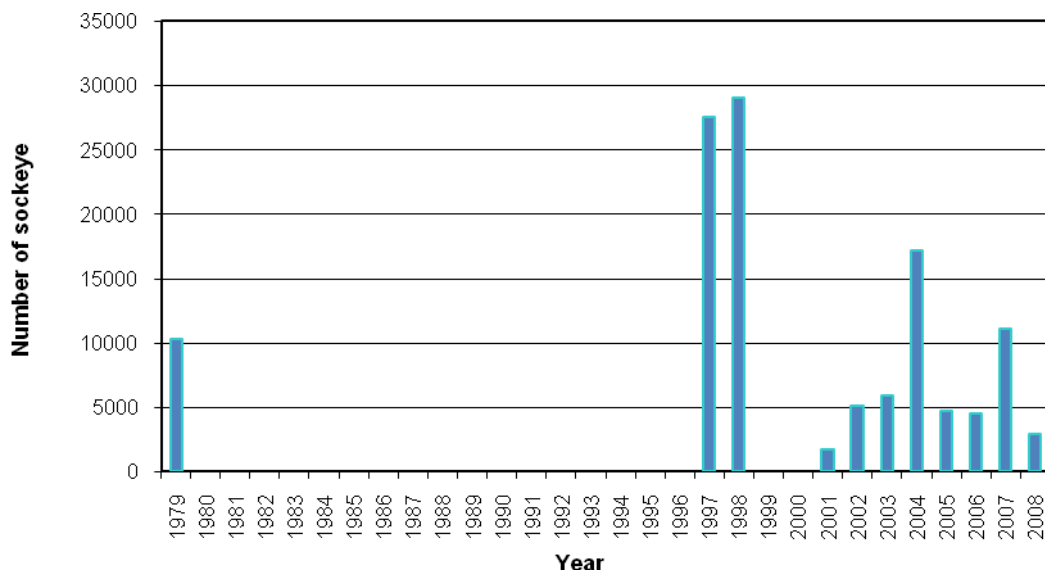


Figure 15. Estimated sockeye salmon escapement by year, 1979-2008.

Table 2. Tanada Creek weir salmon passage estimates and total estimated inriver sockeye salmon run estimates from Miles Lake sonar project, 1979-2008.

Year	Sockeye salmon numbers		Chinook salmon numbers in Tanada Creek
	Tanada Creek (% Miles Lake Count)	Miles Lake	
1979	10,244 (4.3)	237,173	5
1997	20,729 ¹ (1.8)	1,148,079	5
1998	28,992 ² (3.3)	866,957	2
1999	—	848,921	—
2000	—	587,592	—
2001	1,649 (0.2)	833,569	16
2002	6,186 ³ (0.8)	816,825	5
2003	5,856 (0.8)	695,233	2
2004	17,120 (2.6)	669,646	0
2005	4,659 ⁴ (0.5)	854,268	1
2006	4,514 (0.5)	959,731	4
2007	11,103 (1.2)	926,438	7
2008	2,850 ⁵ (0.4)	717,799	137
1979-2007 Average	11,106 (1.7)	659,172	5

¹ Contains expanded estimates from periods without monitoring; but the season was also shortened due to flooding.

² Value contains an estimate of 1,030 fish passed through a breach in weir.

³ Estimate based upon mark-recapture sampling; the actual weir count was 2,489.

⁴ Weir compromised by flooding, estimate from video count; the actual weir count was 739.

⁵ Partial weir count through July 8.

Table 3. Annual arrival date of first sockeye salmon and median point of migration past the Tanada Creek weir, 1998, 2001-2008.

Year	First Sockeye	Median Date	Median Number
1998	13-July	19-July	14,496
2001	14-June	14-July	825
2002	28-June	12-July	3,094 ¹
2003	11-June	5-August	2,929
2004	11-June	2-August	8,560
2005	13-June	23-August	2,539 ²
2006	17-June	2-July	2,257
2007	20-June	25-July	5,552
2008	10-June	N.A. ³	N.A. ⁴

¹ Extrapolated based upon total run size estimate.

² Based on overhead video count.

^{3,4} Medians were not calculated since weir was only operated for a portion of the run.

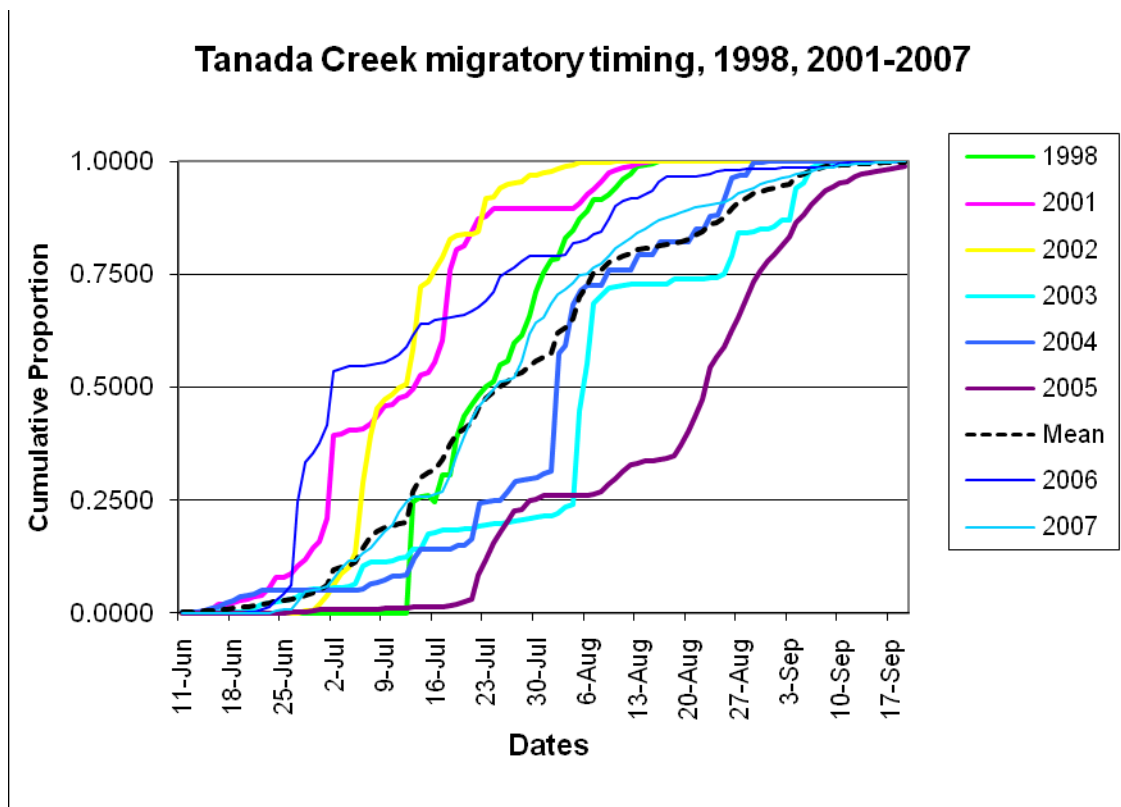


Figure 16. Historical and average migratory run timing for sockeye salmon passing the Tanada Creek weir site.

Biological Data

A total of 113 sockeye salmon were sampled for age, sex, and length information during the two sampling events in September. Ages were obtained from all otoliths collected.

Age-1.3 sockeye salmon from the 2003 brood year were estimated to comprise 90.3% of the escapement sample, while age-1.2 sockeye salmon from the 2004 brood year was estimated to comprise 8.0% of the sample (Table 4). The remaining portion of the sample was comprised of 0.9% age-1.4 and 0.9% age-2.3 sockeye salmon from the 2002 brood year.

Table 4. Age-class, brood year, and sex composition of Tanada Lake sockeye salmon sampled during September, 2008.

		Age-Class ¹ (Brood Year)				Weir Passage
		1.2 (2004)	1.3 (2003)	1.4 (2002)	2.3 (2002)	
Female	Percentage of sample	8.0	36.3	0.9	0.0	45.1
	Number in escapement	227	1,034	25	0	1,286
Male	Percentage of sample	0.0	54.0	0.0	0.9	54.9
	Number in escapement	0	1,538	0	25	1,564
Total	Percentage of sample	8.0	90.3	0.9	0.9	100.0
	Number in escapement	227	2,573	25	25	2,850
	Standard Error	73	80	25	25	

¹Ages interpreted from otoliths.

Capacity Building

In 2008, this weir project provided employment for three local residents who worked as technicians staffing the weir. The Batzulnetas culture camp took place during July (Figure 17), but the weir was not operational during this event. Reports concerning the weir project were given at local Subsistence Resource Commission meetings, South Central Resource Advisory Council meetings, government-to-government meetings with Mentasta and Chistochina, and to the Ahtna Subsistence Committee.

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 a weir made one or more times each day. The gate in the weir was only open to allow fish passage when counts were 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, congregated in pools, and delayed in their migratory attempts. This increases their vulnerability to predation and can eventually lead to self-inflicted bodily damage as fish repeatedly attempt to push through or past the weir when the gate is closed. Also, when salmon are concentrated behind the weir, the likelihood of attracting bears to the weir is increased. One alternative to



Figure 17. Batzulnetas culture camp.

regulating fish passage by closing and opening a gate within the weir is to keep the gate open at all times. If salmon were counted by direct visual observations, keeping the weir open at all times would make it necessary to extrapolate data to cover periods when visual observations were not being made. Since salmon migration rates are not uniform either within or among days, visual observations would need to be made several times each day to reduce the magnitude of extrapolation errors. By using an underwater video camera in conjunction with a passage chute to ensure that all fish passing through the weir travel close to the camera lens, the gate can remain open even when staff is not present, and salmon can pass the site in a less obstructed manner that hopefully allows a more natural migratory pattern and has fewer detrimental effects.

Run Timing

Determining a mean or median run date that could be used to forecast the total run size in-season would be useful to managers, but run timing of the Tanada Creek sockeye salmon stock has been highly variable and forecasts would be very inaccurate (Table 3 and Figure 16). Many factors probably affect run timing each year, including fishing patterns, water discharge, and water temperature. Weir operations may also delay migration under certain conditions.

Biological Data

With the continuously operating underwater video camera in place this year, 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 at the site has reduced the number of salmon available for sampling. Collecting scales from trapped fish is no longer practical with the

new schedule for operating the underwater video system. Additionally, all of the scales collected at the weir site have extensively resorbed outer margins, which has made it necessary to age them 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 introduces unknown errors into Tanada Creek age composition estimates. Therefore, we have been shifting sampling efforts away from the weir site and have been collecting otoliths from carcasses found near spawning areas. While we did not achieve our sample size goal of 121 readable otoliths, we came very close (113), and will need to reexamine our sampling design for future years.

Capacity Building

In 2008, 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 had a positive impact on improving relations between the residents of local communities and WRST.

CONCLUSIONS

Weir Operation

The present weir site worked well in 2006 and 2007 when water levels were not extremely high, but we were not able to operate the weir during the flood conditions experienced during 2008.

Escapement Estimation

Underwater video provides an excellent means of enumerating salmon passage at the weir. Salmon are counted daily during on-site video review. Interference to natural migratory timing is minimized. Run timing appears to be highly variable in Tanada Creek. The average median run date does not appear to be a useful tool for projecting total run size using the existing data.

Biological Data

Otoliths can provide saltwater adult life-stage information that cannot be obtained from the resorbed scales typically collected at Tanada Creek. It appears feasible to collect otoliths as a means of gaining stock-specific age-class data for the Tanada Lake escapement. The predominant age-class (1.3) of the sockeye salmon escapement to Tanada Lake was similar to past years of this project.

Capacity Building

The Tanada Creek weir project supports positive relations between the WRST, fisheries managers, and the residents of local communities.

RECOMMENDATIONS

Weir Operations

1. Modify the weir to reduce resistance to high flows by including a wider span of floating panels and eliminating the sampling trap.
2. Survey Tanada Creek for potential weir sites that may be more resistant to impacts from floods resulting from heavy seasonal rains. For example, a location farther downstream with a broader cross-section and less pronounced channel.
3. Continue to operate the underwater video camera system to estimate escapement.
4. To decrease reliance on a gas powered generator, improve the performance of the photovoltaic power supply by increasing the array wattage, relocating the array, or installing a more efficient charge controller (MPPT, utilizing maximum power point tracking technology).

Escapement Estimation and Biological Data

1. Work towards a definition of natural and healthy sockeye salmon escapement for Tanada Lake stocks.
2. Increase efforts on sampling post-spawning sockeye salmon carcasses so that 121 otoliths are obtained.

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 \$188,000 in funding support for this project FY07 through the Fisheries Resource Monitoring Program, under agreement number FIS07-502. Stephen Fried and Karen Hyer, FWS, provided editorial review and statistical support.

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Appendix A. Tanada Creek daily salmon counts, 2008.

Tanada Creek Weir Salmon Counts, 2008				
Date	Daily sockeye	Cumulative sockeye	Daily Chinook	Cumulative Chinook
5/28/08	0	0	0	0
5/29/08	0	0	0	0
5/30/08	0	0	0	0
5/31/08	0	0	0	0
6/1/08	0	0	0	0
6/2/08	0	0	0	0
6/3/08	0	0	0	0
6/4/08	0	0	0	0
6/5/08	0	0	0	0
6/6/08	0	0	0	0
6/7/08	0	0	0	0
6/8/08	0	0	0	0
6/9/08	0	0	0	0
6/10/08	7	7	0	0
6/11/08	12	19	0	0
6/12/08	12	31	0	0
6/13/08	11	42	0	0
6/14/08	11	53	0	0
6/15/08	0	53	0	0
6/16/08	11	64	1	1
6/17/08	29	93	0	1
6/18/08	45	138	0	1
6/19/08	24	162	3	4
6/20/08	60	222	0	4
6/21/08	75	297	1	5
6/22/08	37	334	2	7
6/23/08	33	367	0	7
6/24/08	188	555	1	8
6/25/08	47	602	1	9
6/26/08	234	836	7	16
6/27/08	158	994	19	35
6/28/08	182	1,176	14	49
6/29/08	198	1,374	12	61
6/30/08	148	1,522	11	72
7/1/08	138	1,660	15	87
7/2/08	207	1,867	10	97
7/3/08	152	2,019	6	103
7/4/08	291	2,310	11	114
7/5/08	176	2,486	7	121
7/6/08	138	2,624	6	127
7/7/08	108	2,732	6	133
7/8/08	118	2,850	4	137

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