U.S. Fish & Wildlife Service

Abundance and Run Timing of Adult Steelhead Trout in Crooked and Nikolai Creeks, Kenai Peninsula, Alaska, 2005

Alaska Fisheries Data Series Number 2006-5

Kenai Fish and Wildlife Field Office
Kenai, Alaska
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Kenneth S. Gates and Douglas E. Palmer

Abstract

Fish weirs with underwater video systems were installed and operated on Crooked and Nikolai creeks during 2005 to collect abundance, run timing, and biological information for immigrating steelhead trout. A combined total of 463 steelhead trout were counted past the Crooked (N=379) and Nikolai (N=84) creek weirs between 29 April and 31 May. Peak weekly passage occurred between 1 and 7 May at Crooked Creek and between 8 and 14 May at Nikolai Creek. Age, sex, and length (ASL) data were collected from 70 steelhead trout at Crooked Creek. Few ASL samples (N=3) were collected at Nikolai Creek because the weir trap was ineffective in capturing and holding fish. Sex was also determined by examining video footage recorded at each weir. Females comprised 86% (ASL) and 77% (video) of the escapement at Crooked Creek and 85% (video) of the escapement at Nikolai Creek. The average length of male and female steelhead trout from Crooked Creek was 608mm and 617mm, respectively. Water temperatures during the operational periods ranged from 5.9°C to 10.9°C at Crooked Creek and 3.3°C to 9.6°C at Nikolai Creek. Project start dates were delayed at both weirs because of high water conditions on Crooked Creek and persistent ice conditions at the outlet of Tustumena Lake. Both weirs were operational prior to peak run timing; however, delays installing the weirs likely resulted in conservative estimates of escapement for both streams during 2005.

Introduction

Crooked and Nikolai creeks are the only two streams in the Kasilof River watershed known to support steelhead trout *Oncorhynchus mykiss* (Johnson et al. 2004). Crooked Creek historically supported a small wild run of steelhead trout estimated to consist of a maximum of several hundred fish (Gamblin et al. 2004). The Alaska Department of Fish and Game (Department) enhanced this run beginning in the 1980's to provide additional angling opportunity. Enhancement efforts created a fishery unique from other steelhead trout fisheries on the Kenai Peninsula because it provided anglers an opportunity to harvest fish. Sport catches of steelhead trout in the Kasilof River and Crooked Creek peaked during the mid-1990s and averaged 5,836 fish between 1993 and 1995 (Mills 1994; Howe et al. 1995, 1996). During the same period, harvest of steelhead trout averaged 1,397 fish annually. Higher catches during this period were a direct result of the enhancement program. The enhancement program was terminated in 1993 after concerns were raised about straying of hatchery steelhead trout into the Kenai River. Since termination of the enhancement program, catch has declined and has averaged 579 fish between 1997 and 2004 (Gamblin et al. 2004; Larry Marsh, Alaska Department of Fish and Game, personal communication). Anticipating a decline in the number of steelhead trout available to anglers, the Alaska Board of Fisheries restricted the fishery within Crooked Creek and the Kasilof River below the Sterling Highway Bridge to catch-and-release beginning in 1996.

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Current fishery regulations limit fishing in Crooked Creek from 1 August through 31 December, and only unbaited, single hook, artificial lures may be used between 15 September and 31 December. In addition, no retention of rainbow or steelhead trout is allowed from Crooked Creek. Regulations pertaining to the Kasilof River from 1 September through 15 May allow fishing with one unbaited, single hook, artificial lure from the mouth to the Sterling Highway Bridge. In this same section of river from 16 May through 30 June, only one single hook may be used. Like Crooked Creek, no retention of rainbow or steelhead trout is allowed in the Kasilof River below the Sterling Highway Bridge. Fishing above the Sterling Highway Bridge and in Nikolai Creek is open year-round for rainbow and steelhead trout with a daily bag limit of 2 per day/2 in possession with only one fish exceeding 20 inches in length. Harvest of steelhead trout above the Sterling Highway Bridge is typically fewer than 50 fish annually.

Information regarding the steelhead trout population in Nikolai Creek is limited. Field technicians with the U.S. Geological Survey (USGS) reported the presence of steelhead trout in Nikolai Creek while monitoring emigrating sockeye salmon fry during the early 1990's (Carol Woody, U.S. Geological Survey, personal communication). Jones and Faurot (1991) also reported capturing one steelhead trout in Tustumena Lake that may have been returning to Nikolai Creek.

Steelhead trout returning to the Kasilof River watershed are considered fall-run fish, entering fresh water in the fall and over-wintering before spawning in tributaries in May and June. Larson and Balland (1989) documented similar behavior in steelhead trout returning to the Anchor River on the lower Kenai Peninsula. Begich (1997) has also described the Karluk River steelhead trout population, the largest steelhead population on Kodiak Island, as a fall-run. More recently, USGS has operated a weir on the Ninilchik River to enumerate emigrating steelhead trout (kelts). The timing of kelts passing downstream through the weir varied considerably between years, starting as early as 19 May in 2000 and as late as 12 June in 2001 (USGS, unpublished data). Median cumulative downstream passage dates have ranged from 9 to 18 June in the Ninilchik River. Kelt information is limited for Crooked and Nikolai creeks, but timing of their downstream migration is likely very similar to that observed for the Ninilchik River.

Harvest and catch information collected by the Department indicate that the steelhead trout over-wintering in the Kasilof River do not enter Crooked Creek until late April or early May (Gamblin et al. 2004). The distribution of over-wintering steelhead trout in the Kasilof River is unknown, but fish probably occur throughout the river, as far upstream as Tustumena Lake. The spring migration of steelhead trout into Crooked Creek is thought to occur when water temperatures reach 6 to 7° C (Bob Och, Alaska Department of Fish and Game, personal communication).

The U.S. Fish and Wildlife Service (Service) conducted a preliminary investigation in Crooked Creek during 2004 to develop an underwater video system for enumerating steelhead trout. Steelhead trout were enumerated during May 2004 at the Crooked Creek Hatchery and concurrently at a weir equipped with an underwater video system 200 m upstream of the hatchery. Daily counts of steelhead trout from both locations were similar, indicating that the underwater video was an accurate and cost effective method to enumerate fish passage. A total of 206 steelhead trout were enumerated during 2004; however, this is likely a conservative estimate of abundance because weir and video counts were not initiated until 4 May (U.S. Fish and Wildlife Service, unpublished data). To gain more information pertaining to the run-size of steelhead trout in Crooked and Nikolai creeks, the Service installed and operated an underwater video system in each creek during 2005. Specific objectives of the two projects were to: 1) enumerate adult steelhead trout entering Crooked and Nikolai creeks; 2) determine the run-

timing of adult steelhead trout entering Crooked and Nikolai creeks; and 3) estimate the age, sex, and length of migrating adult steelhead trout in Cooked and Nikolai creeks.

Study Area

The Kasilof River drains a watershed of 2,150 km^2, making it the second largest watershed on the Kenai National Wildlife Refuge (Refuge). The watershed consists of mountains, glaciers, forests, and the Kenai Peninsula's largest lake, Tustumena Lake. The Kasilof River is only 29 km long and drains Tustumena Lake, which has a surface area of 29,450 hectares, a maximum depth of 287 m, and a mean depth of 124 m. All tributary streams in the watershed which drain refuge lands enter Tustumena Lake except Crooked Creek (Figure 1).

Crooked Creek is a tannin-stained stream approximately 80 km long which intersects the Kasilof River at river-kilometer nine (60° 19.20'N and 151° 16.55'W; NAD83). The headwaters of Crooked Creek are on the Refuge and the watershed drains approximately 75.6 km^2 (Moser 1998). Crooked Creek has a highly sinuous channel and substrates ranging from sand to cobble.

Nikolai Creek enters the south shore of Tustumena Lake approximately 8 km SE of the lake outlet (60° 11.43'N and 151° 0.36'W; NAD83). Its watershed is approximately 95 km^2 and falls within the Refuge boundary and a designated wilderness area (Moser 1998). Nikolai Creek has a relatively steep gradient, low sinuosity, and predominately cobble substrate.

Methods

Weir and Video Operations and Design

The weir located at Crooked Creek Hatchery was installed to monitor the steelhead trout escapement in Crooked Creek. The hatchery weir is a permanent structure with a steel corrugated footer and bulkheads. Metal grates are placed onto the weir framework to divert fish migrating upstream into a hatchery raceway. An underwater video system was installed in the raceway to monitor fish passage. After passing the video system, fish exited the hatchery into Crooked Creek and continued their upstream migration. Fish moving downstream bypassed the hatchery and passed over the weir unharmed.

The Nikolai Creek weir was located approximately 200 meters upstream from the mouth of the creek. The weir was constructed using a combination of floating resistance board panels (Tobin 1994) and flexible pickets (Palmer 2003). Flexible pickets were used in low velocity sections of the stream near each bank and were constructed from 2.5-cm inside diameter Polyvinyl Chloride (PVC) electrical conduit. Each flexible panel measured 3-m long by 1.5-m high with 1.9-cm spacing between pickets. Panels were held together by 3-mm stainless wire rope. Metal tripods were used to support the flexible picket panels. The floating portion of the weir was constructed using specifications outlined by Tobin (1994), with minor modifications to the panel width, picket spacing and resistance board material. The setup and design of the weir allowed upstream movement of fish through a counting chute. Downstream movement of fish occurred over a partially submerged floating weir panel. Except when weir maintenance or biological sampling was required, the Nikolai Creek weir was unmanned and outfitted with a video and microwave system to monitor upstream fish passage.

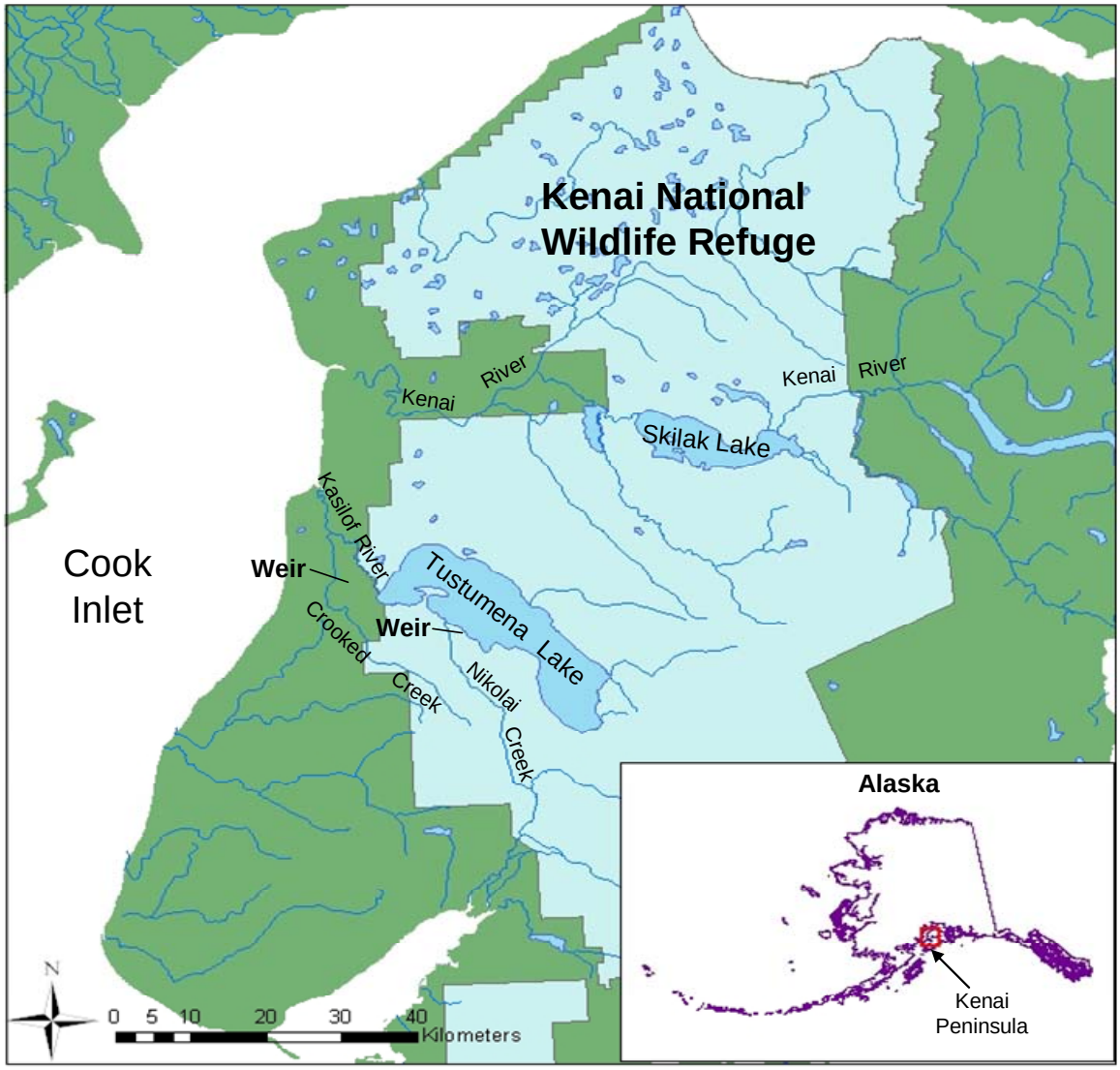

FIGURE 1. —Map of the Kasilof River watershed showing weir locations on Crooked and Nikolai creeks.

Setup and design of each video system was similar to that used by Hetrick et al. (2004) on the Ongivinuk River during 2001 and 2002 and more recently on Big Creek in 2003 (Anderson et al. 2004). One underwater video camera was located inside a sealed video box attached to the fish passage chute. The video box was constructed of 3.2-mm aluminum sheeting and was filled with filtered water. Safety glass was installed on the front of the video box to allow for a scratch-free, clear surface through which images were captured. The passage chute was constructed from aluminum angle and was enclosed in plywood isolating it from exterior light. Video images from Nikolai Creek were transmitted via a 2.4 MHz microwave frequency to a digital video recorder (DVR) located at a private residence near the Sterling Highway. Microwave transmission of the video signal minimized power requirements needed at the remote site and allowed the crew to remotely monitor fish passage. The underwater camera, microwave transmitter, and underwater lights at Nikolai Creek were powered by three 80-watt solar panels. Two solar panels wired in parallel supplied power to two 360Ah 6-volt batteries wired in series which powered the underwater lights. The remaining solar panel maintained the charge on one 12-volt battery which powered the underwater camera and microwave transmitter. All video images from each project were recorded on a removable 120 gigabyte hard drive at 20 frames-per-second using a computer-based DVR. Fish passage was recorded 24 hours per day seven

days each week. Stored video files were retrieved and reviewed weekly. The video box and fish passage chute at each weir were artificially lit using a pair of 12-volt underwater pond lights. Pond lights at Crooked Creek were equipped with 20-watt bulbs which provided a quality image. The same bulbs were initially used at Nikolai Creek but were eventually switched to 10-watt bulbs to conserve battery power. The lights provided a consistent source of lighting during day and night hours. Each DVR was equipped with motion detection to minimize the amount of blank video footage and review time. Appendix 1 contains a complete list of video and microwave equipment.

Biological Sampling

Data on fish age, sex, and length (ASL) were collected using a temporally stratified sample design (Cochran 1977). Samples from Crooked Creek were collected in the raceways from immigrating steelhead trout. A sampling trap was installed upstream of the fish passage chute at Nikolai Creek to collect ASL samples. Sampling effort was divided into strata and was based upon in-season run strength. Each stratum was a calendar week consisting of seven days.

Sampling consisted of sex determination, length measurements, and scale and tissue collections. Sex was determined by observing external characteristics. Length measurements were taken from the mid-eye to fork-length to the nearest 5 mm. Scales were removed from the preferred area using methods described by Mosher (1968) and Koo (1962). The preferred area is located on the left side of the fish, two scale rows above the lateral line on a diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin. Four scales were taken from each steelhead trout, mounted on gummed cards, and pressed on acetate to make an impression. Scale impressions have been forwarded to Department biologists in Southeast Alaska for age determination. Results from the scale analysis will be reported in a subsequent report.

In addition to age, sex, and length, a small fin clip, less than 20 mm in length, was taken from the right pelvic fin of each steelhead trout sampled and placed in 90% ethanol alcohol. Tissue samples will be archived for future analysis at the Service's Conservation Genetics Laboratory in Anchorage.

Water temperatures were recorded at each weir location using an Optic StowAway Temp logger (ONSET Computer Corporation®). Temperatures were recorded every 30 minutes and averaged for the day. Temp loggers were operated between 15 April and 31 May.

Results

Weir and Video Operations

The weir and video system at Crooked Creek were installed on 29 April 2005 and operated through 31 May. The Department operated the weir and video equipment after 31 May for Chinook salmon enumeration and reported no additional steelhead trout passing the video system. The video system operated smoothly except during 11 and 12 May, when the DVR shut down for unknown reasons. The DVR shut down late in the evening on 11 May and was restarted around mid-day on 12 May. No attempt was made to estimate escapement during this time period.

The weir and video system at Nikolai Creek was installed between 3 and 6 May 2005 and was operated through 31 May. Water levels were not measured during this period, but started to subside almost immediately following the weir installation. No problems were encountered with

the weir and video system. Cloudy weather moved into the area in mid-May and remained in the area through the end of the month. Overcast skies during this period limited the charging capability of the solar panels. Batteries supplying power to the lights were changed out twice to keep the system operational.

Biological Data

A total of 379 steelhead trout were counted passing the video system at Crooked Creek Hatchery between 29 April and 23 May (Figure 2; Appendix 2). Peak weekly passage (*N*=188) occurred between 1 and 7 May and median cumulative passage occurred on 5 May. The highest daily count (*N*=42) occurred on 8 May. The number of steelhead trout counted after 14 May only represented 4% (*N*=15) of the total escapement. Water temperatures ranged between 5.9°C and 8.8°C between 1 and 7 May, the week of peak steelhead trout passage (Figure 2; Appendix 3).

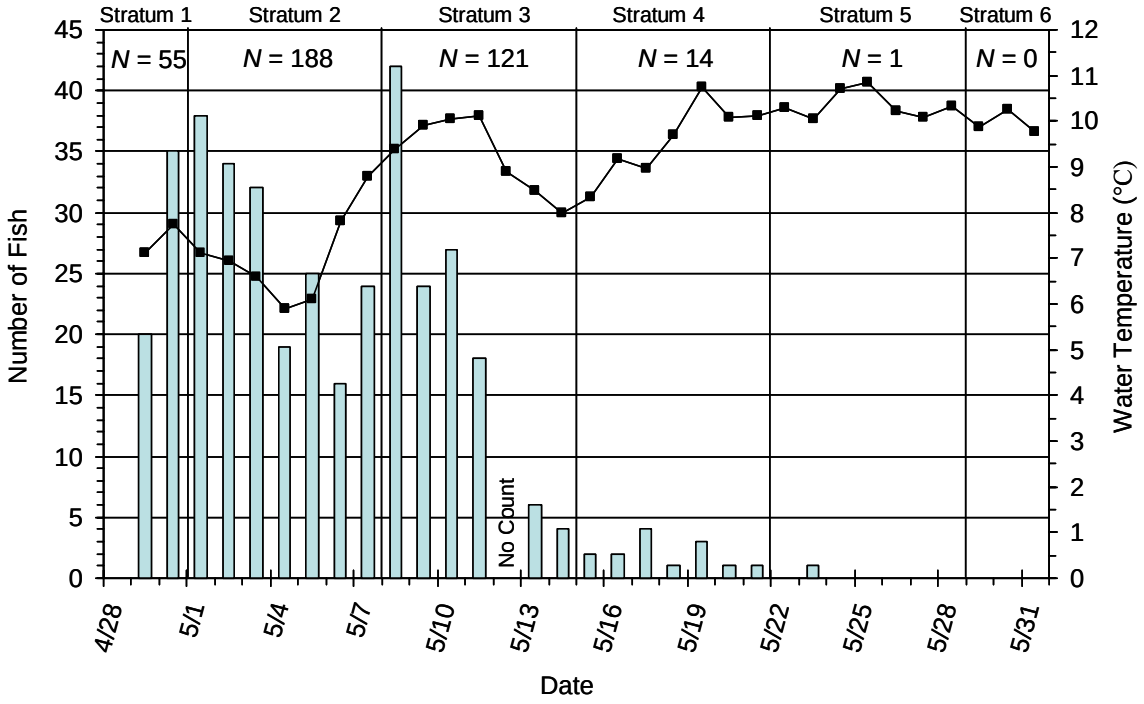

FIGURE 2. —Daily and weekly escapement of steelhead trout and water temperatures in Crooked Creek, Alaska, 2005. Counts did not begin until mid-day on 29 April and no count was observed on 12 May because of problems encountered with the digital video recorder.

ASL samples were collected from 70 steelhead trout at the Crooked Creek Hatchery between 1 and 17 May. Females averaged 617 mm in length and accounted for 86% of the sample. Males averaged 608 mm in length. Sex determination based on examination of video records also favored females (77%). Sex composition for the entire return of steelhead trout, including both ASL and video records, was 79% female (Figure 3). Male and female sex ratios were nearly equal in late April but shifted to a dominant female component during May.

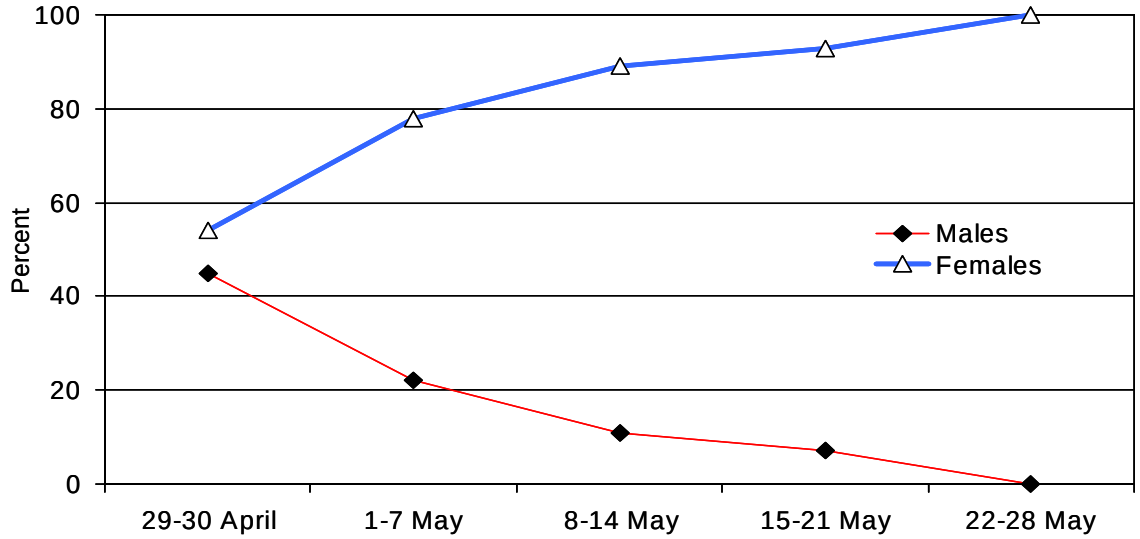

FIGURE 3. —Weekly percent of male and female of steelhead trout observed at Crooked Creek, Alaska, 2005.

A total of 84 steelhead trout were counted passing Nikolai Creek weir between 4 and 20 May 2005 (Figure 4; Appendix 2). Peak weekly passage (*N*=61) occurred between 8 and 14 May. Passage observed during this week accounted for 73% of the total escapement. Median cumulative passage occurred on 9 May. Only seven steelhead trout passed the weir after 14 May. Water temperatures ranged between 6.4°C and 7.9°C between 8 and 14 May, the week of peak steelhead trout passage (Figure 4; Appendix 3). Most of the fish migrated upstream past the weir at water temperatures less than 8°C.

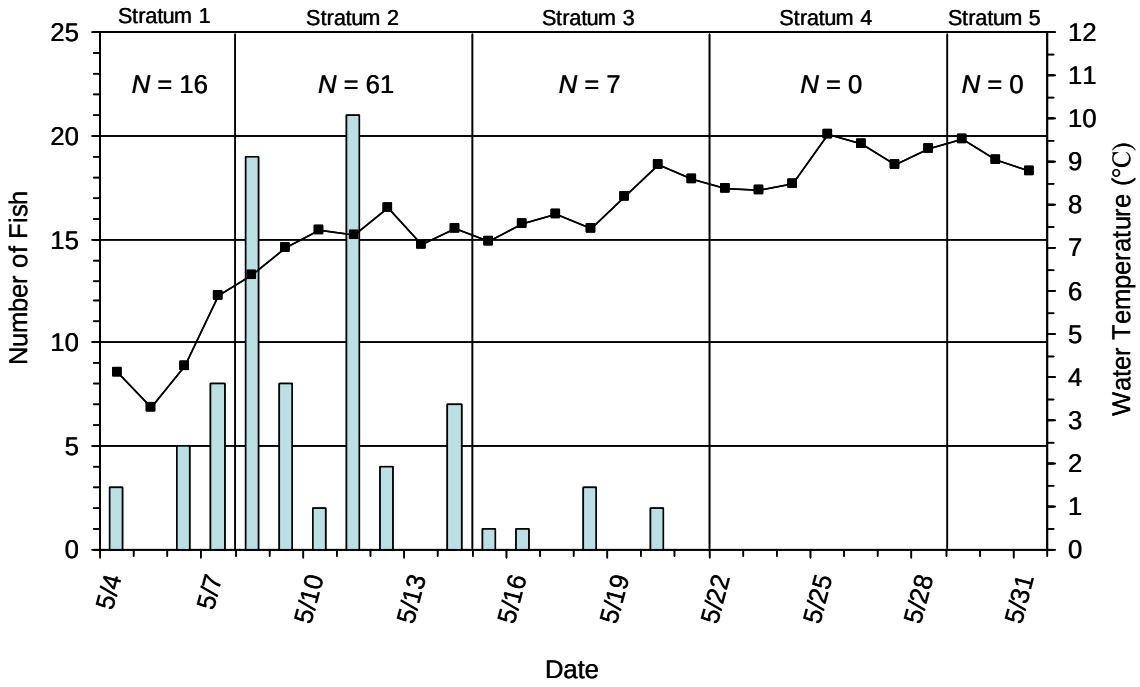

FIGURE 4. —Daily and weekly escapement of steelhead trout and water temperatures in Nikolai Creek, Alaska, 2005. Counts did not begin until mid-day on 4 May.

The weir trap was not effective in capturing and holding fish at Nikolai Creek resulting in a very small ASL sample (*N*=3). Little could be ascertained from such a small ASL sample; however, females comprised 85% of the total escapement based on review of the video records. Sex composition was skewed heavily towards females throughout the entire run (Figure 5).

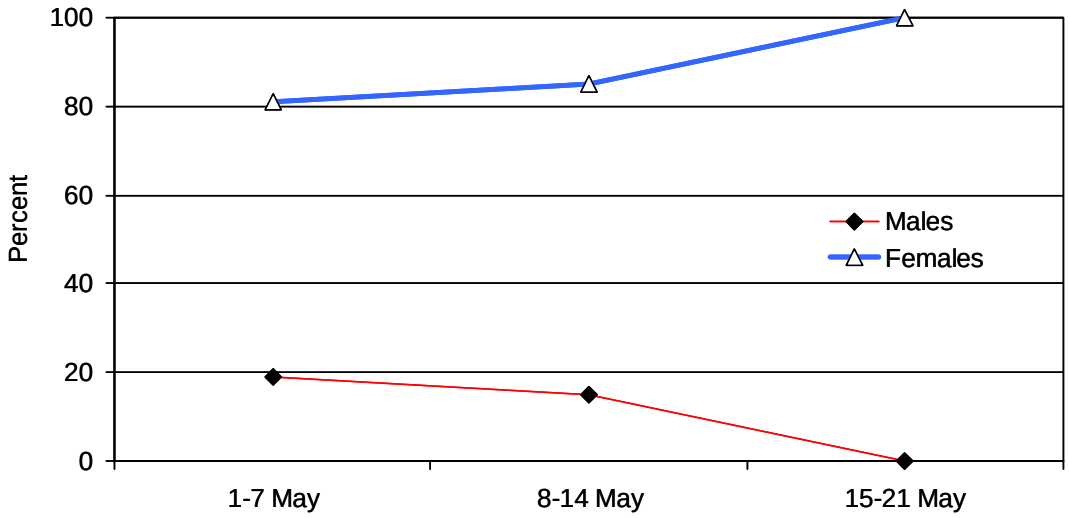

FIGURE 5. —Weekly proportion of male and female steelhead trout sexed during video review, Nikolai Creek, Alaska, 2005.

Discussion

A combined total of 463 steelhead trout were counted past the Crooked (*N*=379) and Nikolai (*N*=84) creek weirs between 29 April and 31 May. We feel that these estimates of abundance accurately represent the relative strength of the steelhead return on each of these streams; however, both estimates are likely conservative because of delays experienced installing both weirs. High water conditions on Crooked Creek and ice that persisted at the outlet of Tustumena Lake delayed installation of both weirs by about 10 days. Steelhead trout were observed passing each weir immediately following installations on 29 April at Crooked Creek and 4 May at Nikolai Creek, suggesting that some early returning fish may have already migrated upstream of the weir locations.

The return of steelhead trout to Crooked Creek during 2005 (*N*=379) was nearly twice that observed by the Service in 2004 (*N*=206; Figure 6). The difference in escapement can largely be attributed to the weir installation date which occurred five days earlier on 29 April during 2005. The number of steelhead trout returning to Crooked Creek during these five days comprised 92% (*N*=159) of the total difference between 2004 and 2005.

Female steelhead trout outnumbered males by more than 3:1 at both Crooked and Nikolai creeks. Highly skewed sex ratios such as these do not occur universally in all steelhead populations; however, female-biased sex ratios have been documented in other locations including the Columbia River Basin (Holubetz 1995), Copper River in Alaska (Wuttig et al. 2004), and Russia's Kamchatka Peninsula (Nick Gayeski, Washington Trout, personal communication). Female-biased sex ratios typically occur in steelhead trout populations that have a high incidence of repeat spawners because females have a higher survival rate than males during and following spawning (Withler 1965). Future examination of the scales collected during 2005 will provide

knowledge of the age composition and the prevalence of repeat spawning in Crooked and Nikolai creeks.

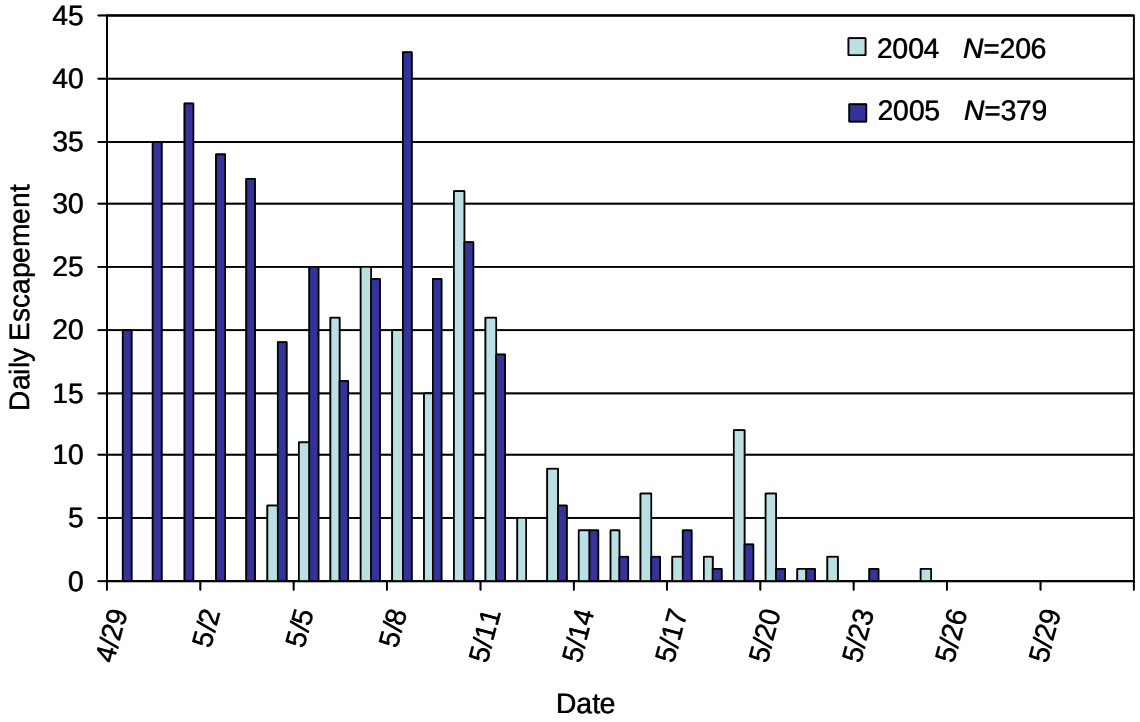

FIGURE 6. —Daily escapement of steelhead trout in Crooked Creek, Alaska, 2004 and 2005. Technical problems were encountered with the DVR on 12 May, 2005 resulting in no count for that day.

Water temperature and flow regime are probably the two factors which have the most influence on run-timing of steelhead trout in Crooked and Nikolai creeks. During 2005, water temperatures in Crooked Creek increased rapidly from 2.0°C on 23 April to 7.0°C on 28 April (Appendix 3). This rapid increase in water temperature coupled with higher discharges associated with spring snow melt likely triggered the upstream migration of fish. We observed relatively large numbers of steelhead trout moving upstream past the weir during the first day of operation on 29 April. The water temperature regime on Nikolai Creek was slightly different with colder temperatures persisting through late April followed by a rapid 3° increase in temperature between 6 and 9 May (Appendix 3). Similar to Crooked Creek, steelhead trout were observed passing the weir immediately after installation on 4 May. Other studies have also noted that water temperature and discharge are important environmental factors influencing the upstream movement of steelhead trout (Shapovalov and Taft 1954; Kesner and Barnhart 1972; Jones 1972).

In conclusion, the use of underwater video has proven to be a relatively inexpensive tool to monitor the abundance and run-timing of steelhead trout in Crooked and Nikolai creeks. We plan to monitor steelhead escapement in both streams during 2006. Weather conditions permitting, both weirs will be installed and operational by 20 April to provide a more accurate assessment of run-timing, abundance, and composition of the return. This assessment information will be useful in formulating future management strategies for steelhead trout in the Kasilof River watershed.

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The Service would also like to thank the Department for allowing us to use their facilities at the Crooked Creek Hatchery. Utilizing the hatchery as a platform to operate the video system was instrumental in creating a smooth operating project. In addition, special appreciation is extended to Michael and Linda Sipes for providing us access to their property to operate the microwave equipment and DVR for Nikolai Creek.

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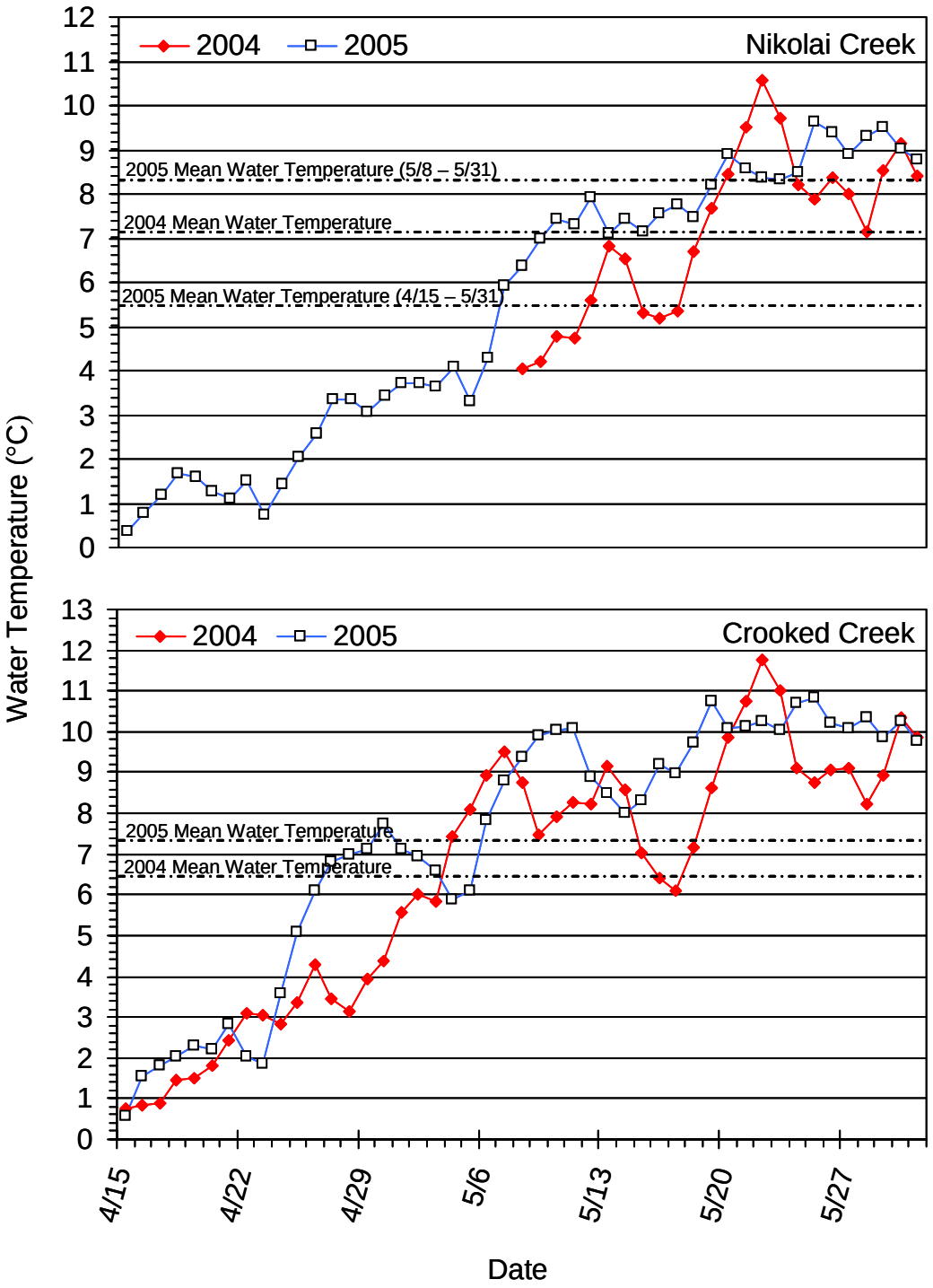
APPENDIX 1. —List of video and microwave equipment used to monitor steelhead trout abundance at Crooked and Nikolai creeks, Alaska, 2005.

Item	Model #	Manufacturer	Contact
Digital Video Recorder	DVSM 4-120	Veltek International, Inc.	http://www.veltekcctv.com/
Underwater Camera	Model 10	Applied Micro Video	http://www.appliedmicrovideo.com/
Underwater Lights	Lunaqua 2 12-v	OASE	http://www.pondusa.com
External Harddrive	One Touch 250 GB	Maxtor.com	http://www.maxstore.com
Microwave Transmitter	BE-530T	Premier Wireless, Inc	http://www.premierwirelessinc.com/
Microwave Recievers	BE-322R	Premier Wireless, Inc	http://www.premierwirelessinc.com/
Parabolic Antennas	130135	California Amplifier	http://www.calamp.com

APPENDIX 2. —Daily counts and cumulative proportion of steelhead trout and water temperatures from Crooked Creek during 2004 and 2005 and Nikolai Creek during 2005. Boxed areas represent the second and third quartile and median passage dates.

	Crooked Creek						Nikolai Creek		
	2004			2005			2005		
Date	Daily	Cumulative Proportion	Water Temperature	Daily	Cumulative Proportion	Water Temperature	Daily	Cumulative Proportion	Water Temperature
4/15			0.76			0.57			0.38
4/16			0.86			1.55			0.78
4/17			0.89			1.82			1.18
4/18			1.44			2.02			1.67
4/19			1.51			2.29			1.61
4/20			1.80			2.19			1.25
4/21			2.41			2.85			1.12
4/22			3.10			2.05			1.51
4/23			3.06			1.87			0.74
4/24			2.83			3.60			1.42
4/25			3.37			5.08			2.04
4/26			4.30			6.09			2.58
4/27			3.46			6.83			3.35
4/28			3.16			7.00			3.35
4/29			3.94	20	0.0528	7.10			3.05
4/30			4.39	35	0.1451	7.73			3.43
5/1			5.56	38	0.2454	7.11			3.73
5/2			6.01	34	0.3351	6.95			3.71
5/3			5.85	32	0.4195	6.59			3.62
5/4	6	0.0291	7.43	19	0.4697	5.90	3	0.0357	4.10
5/5	11	0.0825	8.09	25	0.5356	6.10	0	0.0357	3.29
5/6	21	0.1845	8.93	16	0.5778	7.81	5	0.0952	4.27
5/7	25	0.3058	9.51	24	0.6412	8.80	8	0.1905	5.90
5/8	20	0.4029	8.75	42	0.7520	9.39	19	0.4167	6.38
5/9	15	0.4757	7.46	24	0.8153	9.92	8	0.5119	6.99
5/10	31	0.6262	7.90	27	0.8865	10.04	2	0.5357	7.41
5/11	21	0.7282	8.29	18	0.9340	10.10	21	0.7857	7.30
5/12	5	0.7524	8.24	0	0.9340	8.89	4	0.8333	7.92
5/13	9	0.7961	9.14	6	0.9499	8.47	0	0.8333	7.09
5/14	4	0.8155	8.58	4	0.9604	7.99	7	0.9167	7.43
5/15	4	0.8350	7.02	2	0.9657	8.33	1	0.9286	7.14
5/16	7	0.8689	6.41	2	0.9710	9.18	1	0.9405	7.55
5/17	2	0.8786	6.11	4	0.9815	8.97	0	0.9405	7.76
5/18	2	0.8883	7.18	1	0.9842	9.71	3	0.9762	7.45
5/19	12	0.9466	8.61	3	0.9921	10.75	0	0.9762	8.20
5/20	7	0.9806	9.86	1	0.9947	10.08	2	1.0000	8.91
5/21	1	0.9854	10.74	1	0.9974	10.13	0	1.0000	8.59
5/22	2	0.9951	11.78	0	0.9974	10.28	0	1.0000	8.37
5/23	0	0.9951	11.00	1	1.0000	10.05	0	1.0000	8.32
5/24	0	0.9951	9.11	0	1.0000	10.71	0	1.0000	8.47
5/25	1	1.0000	8.78	0	1.0000	10.85	0	1.0000	9.63
5/26	0	1.0000	9.05	0	1.0000	10.22	0	1.0000	9.40
5/27	0	1.0000	9.10	0	1.0000	10.07	0	1.0000	8.91
5/28	0	1.0000	8.21	0	1.0000	10.33	0	1.0000	9.29
5/29	0	1.0000	8.93	0	1.0000	9.86	0	1.0000	9.51
5/30	0	1.0000	10.37	0	1.0000	10.26	0	1.0000	9.03
5/31	0	1.0000	9.86	0	1.0000	9.76	0	1.0000	8.77



APPENDIX 3. —Daily water temperatures for Crooked and Nikolai creeks during 2004 and 2005. Mean water temperature for Nikolai Creek was calculated twice; once for the time period between 14 April and 31 May and once for the time period between 8 May and 31 May.