Fishery Data Series No. 13-62

Hydrologic Investigations in Support of Reservations of Water for the Lost River, Alaska

by

Jason Hass

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Alaska Department of Fish and Game **Divisions of Sport Fish and Commercial Fisheries**

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	cfs
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat or long
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	log_2, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

FISHERY DATA SERIES NO. 13-62

HYDROLOGIC INVESTIGATIONS IN SUPPORT OF RESERVATIONS OF WATER FOR THE LOST RIVER WATERSHED, ALASKA

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Figure **Page**

LIST OF APPENDICES

Appendix **Page**

ABSTRACT

The Lost River watershed, located near the community of Yakutat, supports a number of anadromous and resident fish species. The Alaska Department of Fish and Game (ADF&G), Division of Sport Fish selected the Lost River as a candidate for a reservation of water through a process of scoping regional staff and the local watershed partnership. To support a reservation of water application, hydrologic data was collected for five years within four reaches of the Lost River and its tributaries known to support anadromous fish. The ADF&G installed a streamgage on the Lost River on November 8, 2006 and operated it until October 7, 2011. The streamflow data from this streamgage was analyzed, reduced, and compiled into a continuous streamflow record. ADF&G also established three discharge stations within the Lost River watershed. A positive linear relationship existed between discharge measurements taken at these stations and corresponding discharges at the streamgage. This relationship was used to estimate five years of streamflow data at the discharge stations. The mean annual discharge at the streamgage was 84 cubic feet per second (cfs) and mean monthly discharges ranged from 24 cfs in December to 183 cfs in October.

After five years of hydrologic data were collected, reservation of water applications were prepared and filed with the Alaska Department of Natural Resources (DNR). These applications were accepted by DNR and granted priority dates.

Key words: Lost River, Tawah Creek, streamgage, discharge, reservation of water, instream flow

INTRODUCTION

Alaska’s rivers and lakes support some of North America’s most viable and productive salmon fisheries. Over 18,000 streams, rivers, or lakes have been identified throughout the state as being important for spawning, rearing or migration of anadromous fish (Klein 2012). Fish migration, spawning, rearing, and ultimately production in these water bodies are dependent upon sufficient seasonal quantities of water. Demand for water to support hydroelectric power generation, petroleum production, mining, water supply (including out-of-state export), residential, forestry, agriculture, and other uses have the potential to modify the naturally occurring instream flows to which fish have adapted to and are dependent upon (Poff et al. 1997).

The Fish and Game Act requires the Alaska Department of Fish and Game (ADF&G), to "...manage, protect, maintain, improve, and extend the fishery resources of the state in the interest of the economy and general well-being of the state” (Alaska Statute 16.05.020; AS). One mechanism ADF&G uses to fulfill its mandate is to reserve water in rivers and lakes for fish and wildlife. An appropriation of water that remains within a river is legally defined under Alaskan law (AS 46.15.145) and regulations (11 AAC 93.970) as a reservation of water. To reserve water an application with supporting data and analyses must be submitted to the Alaska Department of Natural Resources (DNR). A minimum of five years of mean daily flow data is recommended by DNR to quantify instream flow requirements within an application.

The State of Alaska Legislature amended the Alaska Water Use Act in 1980 to allow instream flows to be legally reserved by a private individual, group, or government agency in order to maintain specific flow rates in a river or volumes and water levels in a lake during specified time periods for one or a combination of four types of uses:

- protection of fish and wildlife habitat, migration, and propagation;
- recreation and parks purposes;
- navigation and transportation purposes; and
- sanitary and water quality purposes.

Priority dates for reservation of water applications are based on the date that they are accepted by the DNR. Alaska water law is based on the doctrine of prior appropriation, also known as “first in time, first in right”. According to the rules of prior appropriation, the right to the requested amount of water is first given to the appropriator who has the earliest priority date to beneficially use the water. Senior water right holders have a legal standing to assert their right against conflicting uses of water from others who do not have a water right or who are junior in priority.

In 2005, the Lost River was selected as a high priority candidate for a reservation of water through an ADF&G Sport Fish staff scoping process (Klein 2012). The Yakutat Salmon Board, the local watershed partnership, was also queried and agreed with the selection.

The Lost River watershed supports valuable stocks of sockeye (*Oncorhynchus nerka*), coho (*O. kisutch*), and pink (*O. gorbuscha*) salmon, cutthroat (*O. clarki*) and steelhead (*O. mykiss*) trout, Dolly Varden (*Salvelinus malma*), and eulachon (*Thaleichthys pacificus;* G. Woods, Fisheries Technician, Yakutat, ADF&G, 2009, personal communication; B. Marston, Fisheries Biologist, Yakutat, ADF&G, 2009, personal communication). The Lost River has been specified by ADF&G as important to anadromous fish as Anadromous Waters Catalog (AWC) stream number 182-80-10100 (Johnson and Daigneault 2013) and has approximately 40 river miles of documented anadromous fish habitat.

The Lost River is the smallest system, by escapement, in the Yakutat area to have established coho salmon escapement goals (Woods and Zeiser 2013). The total abundance of coho salmon in the Lost River system in 2003 was estimated to have been 23,685 (Clark and Tracy 2006). Commercial harvest of coho salmon is now closed at the mouth of the Lost River to protect the Lost River coho salmon stock. However, coho salmon harvests in the Lost River commercial set gill net fishery averaged about 6,000 fish per year from 1972–1999 (Clark and Tracy 2006). Coho salmon from the Lost River are also harvested in a commercial troll fishery. Clark and Clark (1994) estimated the harvest of Lost River origin coho salmon by the commercial troll fishery at about 6,000 fish per year. Lost River sport caught coho salmon has averaged about 1,000 fish per year over the past 15 years and a small number of coho salmon are also harvested in a subsistence fishery (Clark and Tracy 2006).

Prior to the start of this project, the only known hydrologic data collected within the Lost River watershed was at a United States Geological Survey (USGS) streamgage (15129600) located on Ophir Creek (Figure 1). Ophir Creek flows into Summit Lake which is drained by Tawah Creek, a tributary to the Lost River. The Ophir Creek USGS streamgage operated from 1991 to 2012. In 2010, ADF&G submitted a reservation of water application for one reach of Ophir Creek and was given a priority date of October 25, 2010.

In 2006, ADF&G installed one streamgage and established three discharge stations within the Lost River watershed. This report describes a five year project that collected the hydrologic data necessary to file reservation of water applications for five reaches of the Lost River watershed. This project was funded by the Alaska Sustainable Salmon Fund.

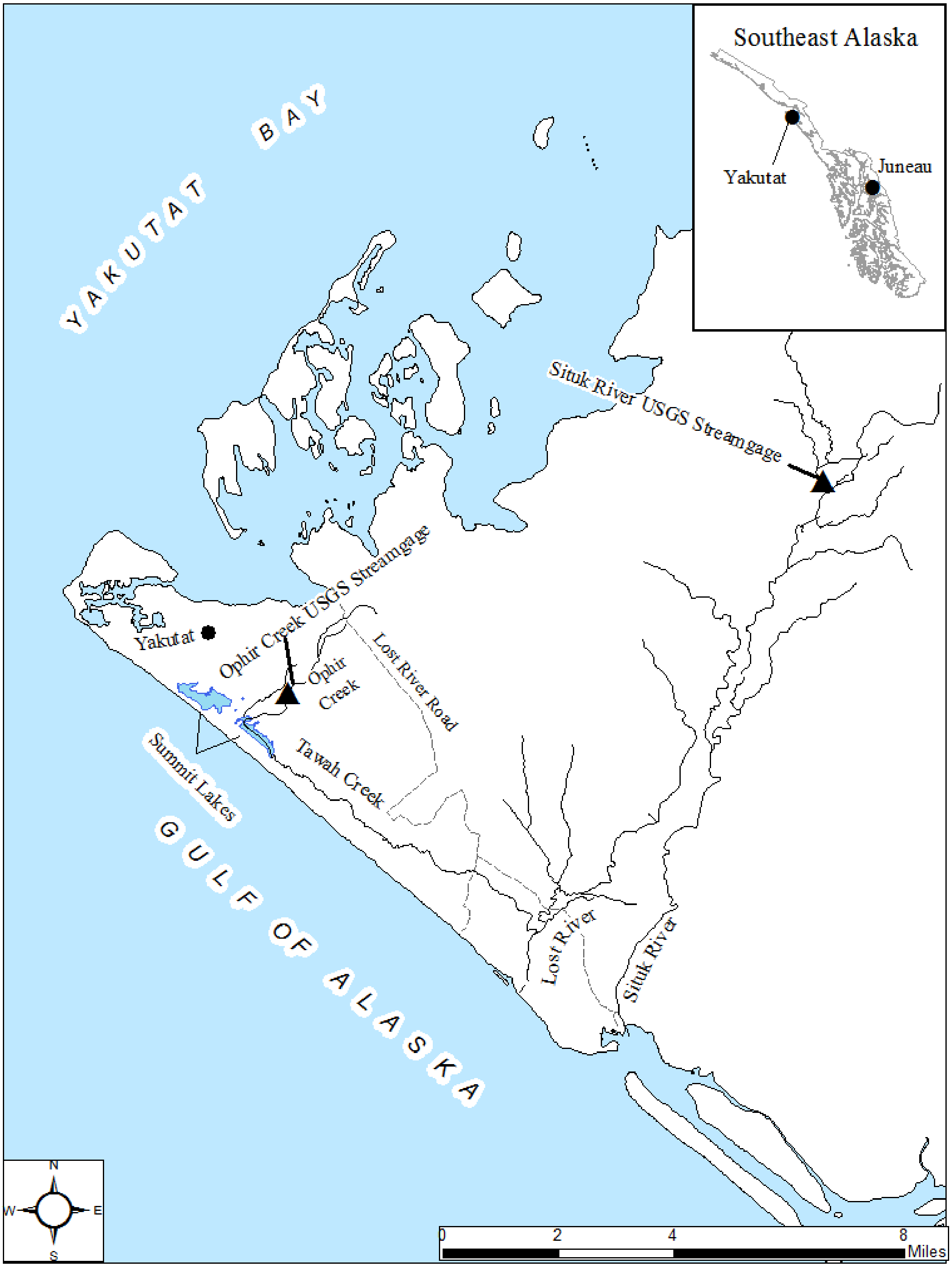

Figure 1.–Location of Lost River watershed in Southeast Alaska.

OBJECTIVE

The objective of this project was to collect the hydrological data necessary to file reservation of water applications to reserve streamflows for anadromous fish habitat within the Lost River and its tributaries. Two tasks were necessary to complete this objective:

1. Install and operate a streamgaging network to quantify streamflows within the Lost River watershed. The network includes a streamgage with semi-permanent discharge measurement stations that can be correlated to the streamgage to obtain five years of streamflow records for each study reach; and
2. Complete and file five reservation of water applications for four reaches of the Lost River and one reach of Tawah Creek to protect fish habitat, migration, and propagation.

STUDY AREA

The Lost River watershed is located approximately five miles southeast of the community of Yakutat in Southeast Alaska (Figure 1). The Lost River lies in the middle of the Yakutat forelands and has a drainage area of approximately 39 square miles. The Yakutat forelands are bordered to the northwest by Yakutat Bay, the Gulf of Alaska to the southwest, the Dangerous River to the east, and Russell Fjord to the northeast. The forelands are a relatively flat area (less than 100 feet in elevation) of deep and permeable coarse glacial deposits and abundant wetlands (Thompson 2005). Isostatic rebound is occurring very rapidly in the Yakutat forelands. The current uplift rate is estimated at over ½ inch annually since the 1979 St. Elias earthquake (Larsen et al. 2003). The forelands weather is typical of maritime climates; cloudy and wet with mild temperatures. Average precipitation and temperature data collected at the Yakutat Airport National Weather Service station from 1949 to 2005 shows that mean annual precipitation is approximately 145 inches, mean annual snowfall is approximately 186 inches, maximum mean monthly temperature is approximately 60° F in August, and the mean minimum temperature is 18° F in January (Table 1; WRCC 2013).

The Lost River is a low gradient, snowmelt, rainfall, and ground water driven system with numerous wetlands. The Lost River has two major tributaries (AWC stream number 182-80-10100-2011, locally known as the West Fork and Tawah Creek (AWC stream number 182-80-101-2005; Figure 2). The Lost River begins in the northeastern section of the watershed and flows southwest until the confluence with the West Fork. The West Fork originates in the northwestern section of the watershed and flows southeast until the confluence with the Lost River. From the West Fork confluence, the Lost River flows southwest for approximately 1.5 miles before intercepting Tawah Creek. The Lost River flows approximately one more mile until it empties into the Lost River Estuary and eventually the Gulf of Alaska. Landownership within the watershed is fragmented between private, state, and federal landowners.

Table 1.–Climate Summary at the Yakutat Airport, 1949 to 2005 (WRCC 2013).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Avg. Max. Temp. (°F)	31.5	35.6	38.5	44.5	50.8	56.5	59.7	60.2	55.4	47.3	38.4	33.8	46.0
Avg. Min. Temp. (°F)	18.6	21.8	23.3	29.2	36.5	43.7	48.0	46.6	41.1	34.4	26.4	22.4	32.7
Avg. Total Precip. (in)	11.2	10.6	10.3	9.0	8.9	6.1	8	12.2	18.3	21.0	15.1	14.7	145.4
Avg. Total Snowfall (in)	34.5	35.9	35.9	15.8	1.1	0	0	0	0	5.0	21.8	36.2	186.1
Avg. Snow Depth (in)	14.0	16.0	19.0	10.0	1.0	0	0	0	0	0	3.0	9.0	6.0

METHODS

REACH DELINEATION

The project was funded by the Alaska Sustainable Salmon Fund, which limits funding to projects that include water bodies that have been identified in the AWC as supporting salmon or steelhead populations. Reservation of water reach boundaries were further refined to minimize the difference in flows (from accretion and reduction) within each reach. USGS topographic maps, ground reconnaissance, drainage basin characteristics, and the AWC were used to aid in the selection of reach boundaries. Stream reaches to be reserved were also limited to those reaches of the stream where site-specific streamflow data could be collected or confidently estimated.

Five reaches were selected for instream flow protection, labeled A to E from the mouth of the Lost River and proceeding upstream (Figure 2). Three of these reaches (A to C) were located on the Lost River. Reach A begins at the mouth of the Lost River at mean lower low water and extends upstream to the confluence with Tawah Creek at river mile 1.4. Reach B extends upstream from Reach A to the confluence with the West Fork at river mile 3.1. Reach C extends upstream from Reach B to approximately 0.8 river miles to the boundary between sections 23 and 24. The final two reaches (D and E) are tributaries to the Lost River. Reach D begins at the mouth of the West Fork and extends upstream approximately 0.5 river miles to the boundary between sections 23 and 14. Reach E begins at the mouth of Tawah Creek and extends upstream approximately 1.8 river miles to the boundary between sections 21 and 22. The location of the stream reach boundaries were selected to minimize differences in streamflow within each reach and to be legally identifiable.

HYDROLOGIC DATA STUDY DESIGN

ADF&G operated a streamgaging network to collect the hydrologic data necessary to reserve streamflows within the five identified reaches. A streamgaging network consists of an index streamgaging station that is operated over a long-period of time (typically many years), and an associated network of semi-permanent stations (e.g. streamgages, staff gages, instantaneous discharge measurements, etc.) which are operated concurrently on nearby reaches, tributaries, and sometimes streams, if hydrologically similar (Klein 2013). The simple linear relationships between the semi-permanent stations and the streamgage were used to obtain five years of streamflow records for each of the study reaches.

On November 8, 2006, streamgage 11701 was installed as an index gage within Reach C, on the Lost River, one-half mile above the confluence with the West Fork (Figure 2). Three semi-permanent instantaneous discharge measurement stations were established later to describe the hydrologic relationship between Reach C and the remaining four reaches (A, B, D, and E). Discharge station 11702 was located within Reach B, on the downstream side of the Lost River Road Bridge. Discharge station 11703 was located within Reach D, on the West Fork, 300 feet above its confluence with the Lost River. Discharge station 11704 was located within Reach E, on Tawah Creek, just above the Tawah Creek Road Bridge (Table 2).

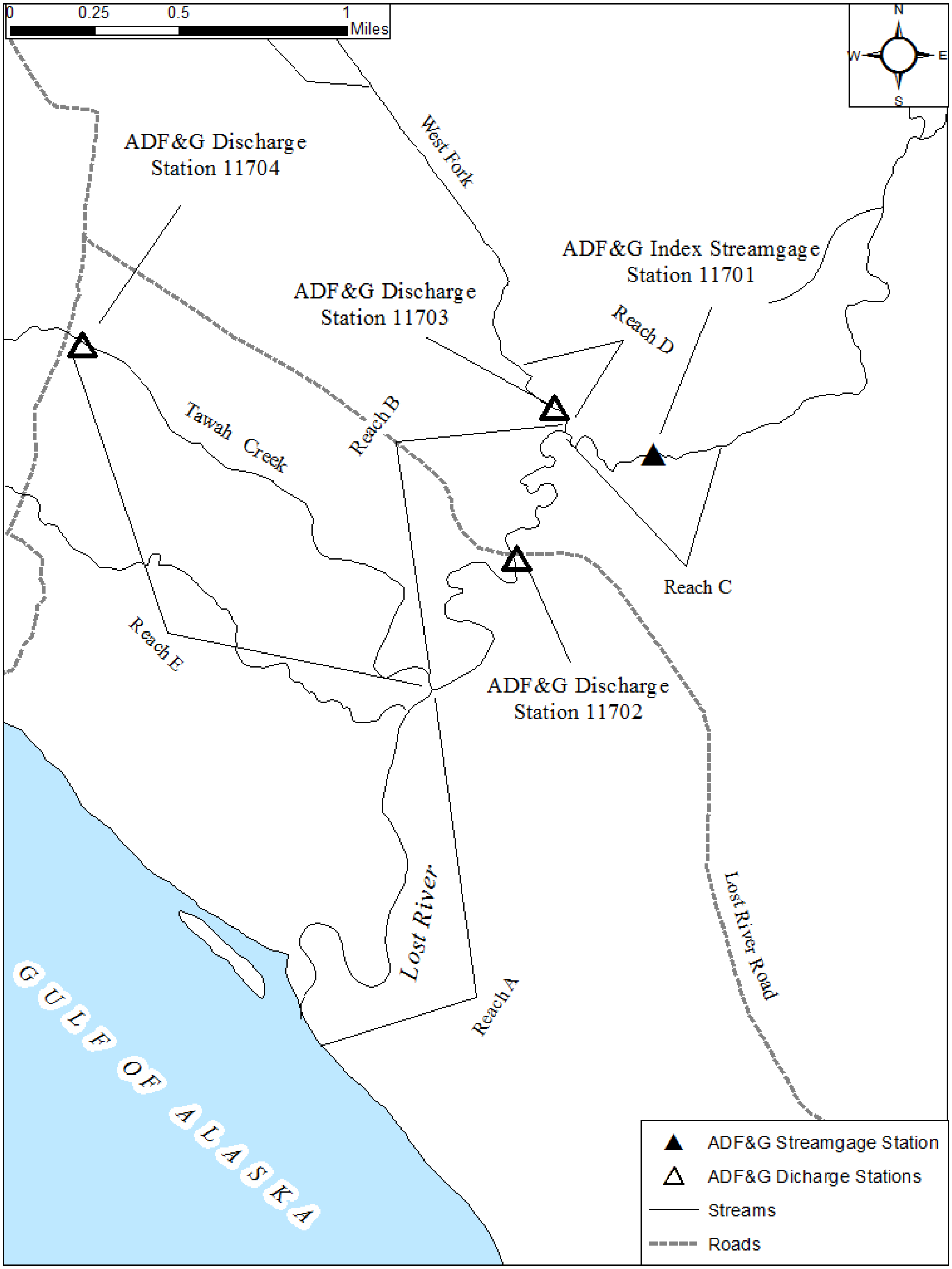

Figure 2.–Location of reservation of water reach boundaries, streamgage, and discharge stations within the Lost River watershed, Southeast Alaska.

Table 2.–Streamgage and discharge measurement station locations and periods of operation within the Lost River watershed, Southeast Alaska.

Station #	Describing Streamflow Within	Period of Operation
Streamgage 11701	Reach C	11/8/2006 to 10/7/2011
Discharge Station 11702	Reach B	12/14/2006 to 10/6/2011
Discharge Station 11703	Reach D	04/25/2007 to 10/6/2011
Discharge Station 11704	Reach E	10/25/2007 to 10/6/2011

Note: Reach A streamflows were calculated by summing streamflows from Reach B and Reach E.

GAGING STATION

The objective of operating a streamgage is to obtain a continuous record of discharge at the streamgage site (Carter and Davidian 1968). The collection of stage (water level) and direct measurements of discharge are essential components in the operation of a streamgage. A continuous record of stage is obtained by installing instruments that sense and record water-surface elevation in the stream relative to an established datum (a staff gage for this project). Direct measurements of discharge are taken at different times of year and with varying flow rates in order to define the stage-discharge relationship (rating curve) and to detect the timing and magnitude of changes to this relationship over time. ADF&G followed methods and protocols establish in the ADF&G Surface-water data manual (Klein 2013) and also relied on USGS streamgage operation protocols and procedures described in Rantz and others (1982) and other USGS reports and technical memos.

Generally, the index streamgage is located near the mouth of the drainage basin. However, during high tide stages (>10 ft) the Lost River watershed can be tidally influenced approximately 3.5 miles upstream from the mouth (near the upper reach boundaries of Reaches C, D, and E). If the index gage were to be located within this tidally affected reach, backwater conditions created at high tide would exist at every high tide and would create a poor record of stage data. A suitable site for the index streamgage (streamgage 11701) upstream of most tidal stages was found near the upper portion of Reach C on the Lost River, approximately half a mile above the confluence with the West Fork. At this location, streamflow is only backed up for a short while during very large tides.

Rantz and others (1982) provides guidance for selection of a streamgage site. The ideal site includes a straight section of stream upstream and downstream of the streamgage site, all the flow is confined to one channel, and the streamgage site is far enough upstream from intertidal zone or the confluence with another stream so as to not be affected by backwater. Streamgage 11701 was located in a pool with a relatively stable hydraulic control and satisfied these criteria. Stage and water temperature were measured (+-.1% accuracy) at the streamgage site using an InSitu Level© Troll 500 pressure transducer. A vented polyurethane cable connected the transducer to a desiccant pack at the end of the cable, located on the stream bank. The transducer, cable, and desiccant were housed within 1 $^{1}/_{4}$ inch schedule 40 galvanized pipe secured to the streambed using custom pipe brackets and $^{5}/_{8}$ inch rebar. The transducer was programmed to measure and record stage and water temperature every 15 minutes on the quarter hour.

A staff gage was installed, using rebar and custom aluminum brackets, within the streamgage pool to measure the stage independent of the transducer. At installation, the transducer was programmed to read the corresponding staff gage stage. At each site visit, the staff gage stage and the transducer stage recording were compared to ensure stage was being accurately recorded by the transducer. To monitor possible changes in the elevation of the staff gage, three reference marks (RMs), consisting of large galvanized lag bolts driven into spruce trees, were established near the gage site. During the installation of the streamgage, the difference in the elevations of the RMs in relation to the staff gage was measured using standard differential surveying techniques (Kenney 2010). The RM and staff gage elevations were surveyed at least once a year and also when the streamgage was removed.

DISCHARGE MEASUREMENTS

Streamflow, or discharge, is defined as the volume rate of flow of water and is typically reported in cubic feet per second (cfs; Buchanan and Somers 1969). Discharge is determined by measuring the average velocity, depth, and width of sub sections across the discharge measurement transect. Ideally each subsection should represent 5% of the total streamflow.

Discharge was most often measured at the streamgage and discharge stations following the USGS midsection method (Rantz and others 1982) using a Price AA or Pygmy vertical axis velocity meter on a top-setting wading rod. A JBS Energy, Inc. AquaCalc® electronic digital counter was used to record the transect parameters, count meter revolutions, and calculate discharge. When high water conditions made the discharge transect unwadeable, a Streampro© Acoustic Doppler Current Profiler (ADCP) was used to measure discharge. One person with a rope would cross the river using the bridge located near the discharge transect and the tethered Streampro© was towed back and forth across the river to take a discharge measurement. Using a Bluetooth connection, data collected by the ADCP was recorded on a ruggedized laptop PC.

SITE VISITS

Site visits to the streamgage were made about six times a year to download data from the transducer, measure discharge, and perform routine gage maintenance. If time, weather conditions, and tide stage allowed, discharge measurements were taken at the three discharge stations. Site visits were timed to measure discharge over a range of flows and throughout the year in order to determine the stage-discharge relationship. During large tide cycles, site visits were also timed to coincide with the low or ebb tide. Discharge was not measured if the discharge transect was tidally affected. Data was downloaded from the transducer data logger using an InSitu Rugged Reader™ handheld PC. The difference between the staff gage and transducer was monitored by reading the staff gage at each site visit. Discharge measurement data, staff gage readings, and other site visit notes were recorded in waterproof field notebooks. Photographs of the staff gage, discharge measurement transect, and of the stream were taken at every visit.

After a site visit, discharge measurement data was downloaded from the AquaCalc® or ADCP laptop to MS Excel®, pictures were downloaded and labeled, and transducer data was downloaded from the Rugged Reader™ to a desktop computer. Transducer stage, water temperature, staff gage readings, and discharge measurement data were imported into the Water Information System Kisters Incorporated© (WISKI©) hydrological software package database for storage and analysis.

STREAMFLOW RECORDS COMPUTATION

The WISKI© software program was used to convert stream stage to discharge using the stage-discharge relationship. Following each site visit, the 15 minute stage records were imported into

WISKI© and reviewed graphically to check for obvious errors or missing data. Over time, pressure transducers have a tendency to drift and can begin to record stage data slightly different from the true stage. At the end of each water year (September 30th) the continuous stage record was corrected within WISKI© to correct this difference. The 15 minute stage data was also corrected to remove the occasional temporary spikes caused by tidal influence at the site.

Using the relationship between stream stage and discharge within the gaging pool, a rating curve was developed to convert the corrected stage data to discharge. To create a rating curve each discharge measurement and corresponding stage value were plotted on the x and y axis respectively and the best fit line was plotted through them. A well-defined rating curve has a wide range of low to high discharge values and a stable hydraulic control. At times the hydraulic control will fill or scour, thus changing the stage for a given discharge. If the changes to the hydraulic control were significant and long term, a new rating curve was developed. If the changes were temporary, the rating curve was temporarily modified or shifted.

The corrected 15 minute stage data were applied to the valid rating curve to determine 15 minute discharge values. WISKI© summarized these 15 minute discharge values into mean daily, mean monthly, and average annual flow values. Any missing or suspect data caused by ice, operator error, or recorder malfunction were estimated by using the hydrographic- and climatic comparison method (Rantz and others 1982, Sauer 2002). This included comparisons of streamflow records from Situk River USGS streamgage 15129500 (Figure 1), nearby weather records, trends of the hydrograph, and instantaneous discharge measurements. A more specific description of the methods used to compute the records for streamgage 11701 is provided in Klein (2013). These procedures used to compute streamflow records were based on procedures described in Rantz and others (1982), Kennedy (1983), Sauer (2002) and Klein (2013).

Mean daily streamflow records computed for streamgage 11701 and for each discharge station were transferred in to a tab-delimited format and analyzed by a series of Statistical Analysis System® programs to estimate mean annual, mean monthly, and mean daily streamflows and streamflow duration values for specified time periods. Mean annual streamflow was estimated as a mean of the annual mean daily streamflow values over all complete water years of record. Mean monthly streamflows were estimated as the mean of monthly mean daily streamflows for all complete months over the entire period of record. Duration estimates represent the expected frequency of occurrence of mean daily streamflows within the specified time periods. The durations of mean daily streamflows were calculated as the percentiles of the empirical distribution of observed values within the specified time periods over the period of record. This provided an estimate of the percentage of time a given mean daily flow was equaled or exceeded within the distribution of mean daily flows for each time period analyzed.

RESULTS

HYDROLOGIC DATA

Streamgage 11701 operated continuously from November 8, 2006 to October 7, 2011. Instantaneous discharge was measured at the streamgage 34 times over the same period and ranged from 6.0 cfs measured on August 8, 2007 to 370 cfs measured on December 3, 2009 (Table 3). The mean annual flow at the streamgage ranged from 68 cfs in water year 2010 to 95 cfs in water year 2008 and averaged 84 cfs from water years 2007 to 2011. The highest flow recorded at the gage was 1,055 cfs on January 18, 2009 when 11 inches of rain fell upon 16 inches of snow. The lowest flow recorded was 4.2 cfs on August 21, 2007 following 22 days of below normal precipitation. Appendix A contains mean daily and mean monthly flows summarized by water year. The durations of mean daily flows calculated as the percentiles of the empirical distribution of observed values within monthly time periods are also presented (Appendix A)

Table 3.–Instantaneous discharges measured at streamgage 11701.

Date	Instantaneous discharge (cfs) measured at 11701
12/13/2006	39
12/14/2006	30
04/24/2007	241
04/25/2007	257
06/25/2007	8.3
08/28/2007	6.0
10/24/2007	79
10/25/2007	60
10/25/2007	66
01/11/2008	15
04/02/2008	34
04/03/2008	80
06/17/2008	14
08/12/2008	13
10/07/2008	298
11/19/2008	30
01/29/2009	35
04/26/2009	104
06/18/2009	11
06/19/2009	12
10/02/2009	133
12/03/2009	370
12/04/2009	118
03/19/2010	68
06/17/2010	32
06/18/2010	22
09/02/2010	60
10/14/2010	54
02/04/2011	119
05/19/2011	17
05/16/2011	16
07/21/2011	6.1
10/06/2011	81
10/07/2011	215

The highest flows within the Lost River watershed tended to occur during late fall and early spring. The high flows in the fall were the result of the high amount of rainfall that the Yakutat area receives during September and October (Table 1; Figure 3). High flows in April and into May were the result of rain falling upon snow which quickly entered the stream. Most of the Lost River watershed is below 100 feet in elevation, and these spring rains quickly melted all the snow within the watershed. Streamflows dropped to their lowest during the summer months when there was no snowpack left to contribute and precipitation was lowest (Table 1).

Twenty two instantaneous discharges were measured at discharge station 11702 between December 14, 2006 and October 6, 2011 and ranged from 12 cfs measured on July 21, 2011 to 473 cfs measured on April 25, 2007 (Table 4). Nineteen instantaneous discharges were measured at discharge station 11703 between April 25, 2007 and October 6, 2011 and ranged from 3.2 cfs measured on July 21, 2011 to 200 cfs measured on February 3, 2011 (Table 5). Fourteen instantaneous discharges were measured at discharge station 11704 between October 25, 2007 and October 6, 2011 and ranged from 17 cfs measured on July 21, 2011 to 292 cfs measured on February 4, 2011 (Table 6).

HYDROLOGIC RELATIONSHIP BETWEEN STATIONS

A simple linear regression model was used to estimate the relationships between the discharge at streamgage 11701 and the corresponding discharges measured at discharge stations 11702, 11703, and 11704. Instantaneous discharge measurements taken at the discharge stations were regressed against the corresponding 15-minute discharge values at streamgage 11701, as described in Klein (2013). The corresponding 15-minute discharge values from streamgage 11701, as opposed to the mean daily discharge values, were used in the regression analyses. This procedure was selected because of the fast rate of change in discharge and it provided the best relationships. Simple linear regression results showed a strong, positive correlation between discharge at the streamgage (11701) and corresponding discharge measured at discharge stations 11702, 11703, and 11704 with coefficients of determination (r^2) values of 0.991, 0.940, and 0.939, respectively (Figures 4–6). Mean daily discharge values, from October 1, 2006 to September 30, 2011, for each discharge station were estimated from the respective regression parameters based on streamflow records from streamgage 11701.

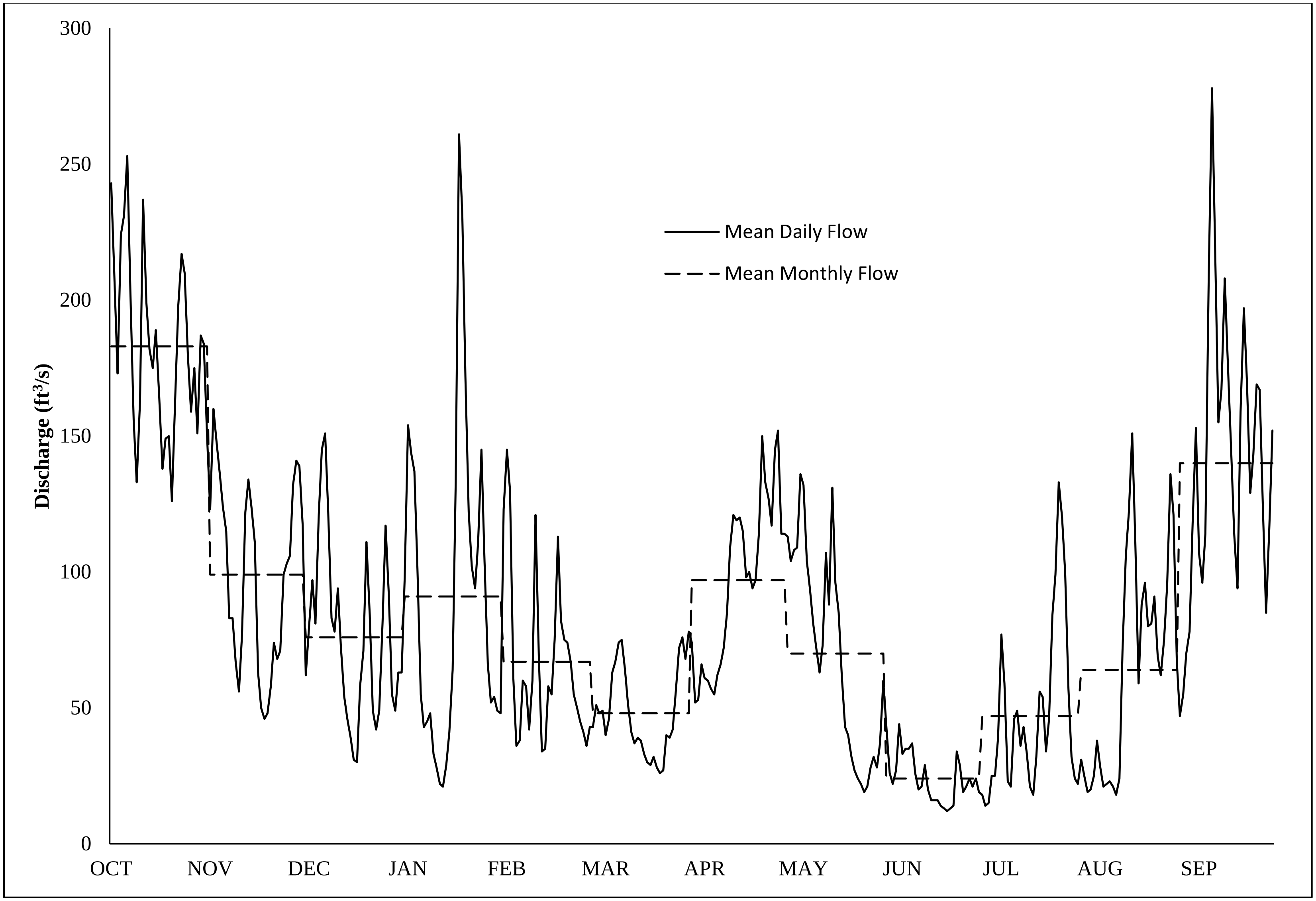

Figure 3.–Mean daily (October 1, 2006 to September 30, 2011) and mean monthly (October 1, 2006 to September 30, 2011) flows for the Lost River, Southeast Alaska, based on data from streamgage 11701.

Table 4.–Instantaneous discharges measured at discharge station 11702 and corresponding discharges from streamgage 11701.

Date	Instantaneous discharge (cfs) measured at discharge station 11702	Corresponding discharge (cfs) at streamgage 11701	Comment
12/14/2006	49	27	
04/24/2007	467	270	
04/25/2007	473	271	
06/25/2007	16	8.6	
10/24/2007	123	80	
04/02/2008	65	40	
06/17/2008	27	14	
08/12/2008	56	13	Poor measurement not used in regression analysis
10/07/2008	452	161	Poor measurement not used in regression analysis
01/29/2009	63	38	
04/26/2009	188	99	
06/18/2009	21	12	
10/01/2009	409	275	Poor measurement not used in regression analysis
12/04/2009	190	130	
03/19/2010	106	64	
06/17/2010	49	25	
09/02/2010	101	57	
10/14/2010	92	55	
02/04/2011	185	127	
07/21/2011	12	7.0	
10/06/2011	149	94	

Table 5.–Instantaneous discharges measured at discharge station 11703 and corresponding discharges from streamgage 11701.

Date	Instantaneous discharge (cfs) measured at discharge station 11703	Corresponding discharge (cfs) at streamgage 11701	Comment
04/25/2007	166	270	
06/25/2007	5.6	8.6	
08/28/2007	3.7	5.9	
10/24/2007	43	81	
04/02/2008	24	37	
06/17/2008	8.2	14	
10/07/2008	181	183	Poor measurement not used in regression analysis
01/29/2009	19	39	
04/26/2009	80	107	
06/18/2009	6.6	12	
10/02/2009	62	141	
12/04/2009	47	112	
03/19/2010	43	67	
06/18/2010	13	21	
09/02/2010	36	59	
10/14/2010	36	56	
02/03/2011	200	469	
07/21/2011	3.2	6.8	
10/06/2011	60	83	

Table 6.–Instantaneous discharges measured at discharge station 11704 and corresponding discharges from streamgage 11701.

Date	Instantaneous discharge (cfs) measured at discharge station 11704	Corresponding discharge (cfs) at streamgage 11701	Comment
10/25/2007	104	63	
10/25/2007	120	63	
04/02/2008	59	43	
06/17/2008	40	14	
01/29/2009	110	39	Poor measurement not used in regression analysis
06/18/2009	27	13	
10/01/2009	249	272	
03/19/2010	94	65	
06/18/2010	40	20	
09/02/2010	64	58	
10/14/2010	120	55	Poor measurement not used in regression analysis
02/04/2011	292	136	Poor measurement not used in regression analysis
07/21/2011	17	6.9	
10/06/2011	118	89	

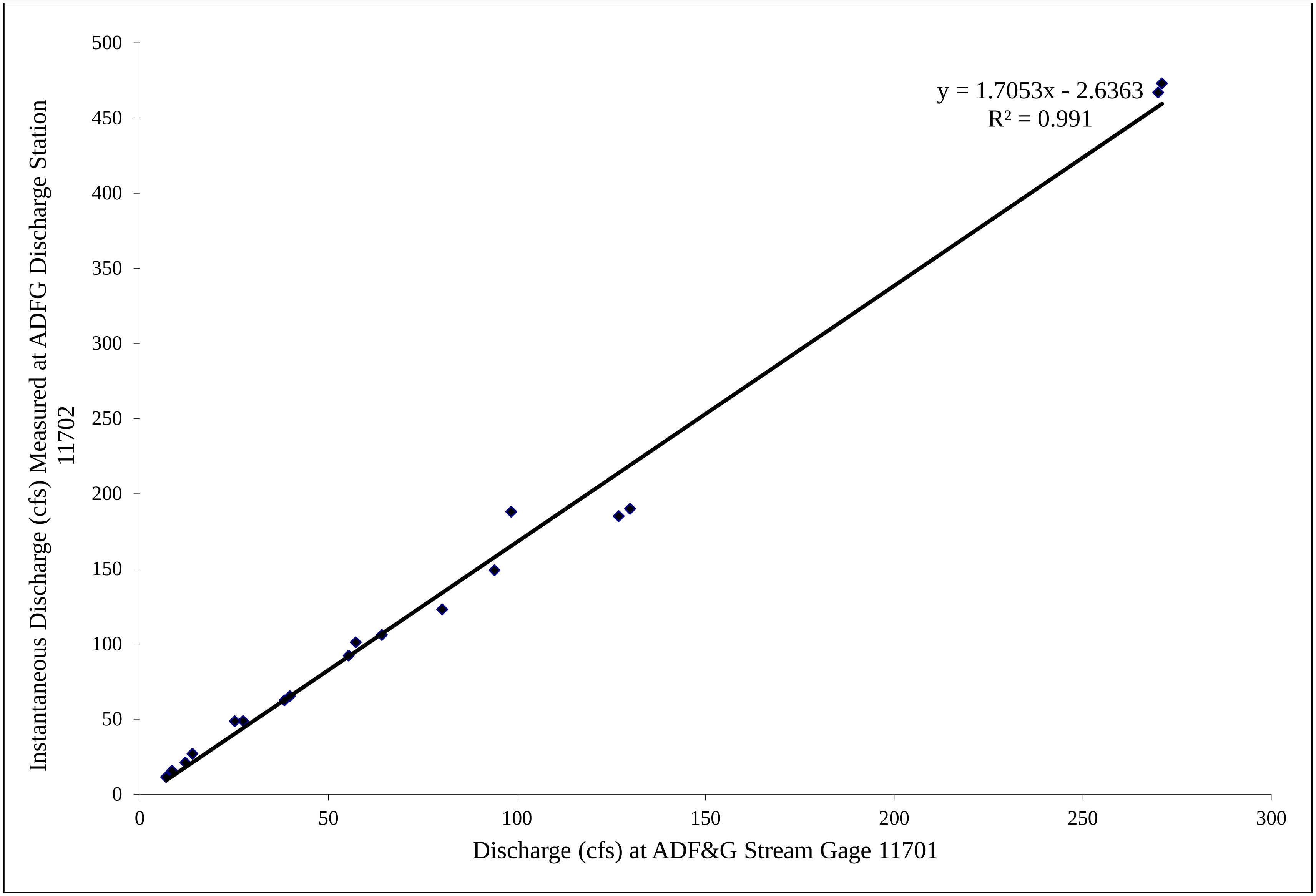

Figure 4.–Simple Linear Regression model used to estimate relationship between discharge station 11702 and streamgage 11701.

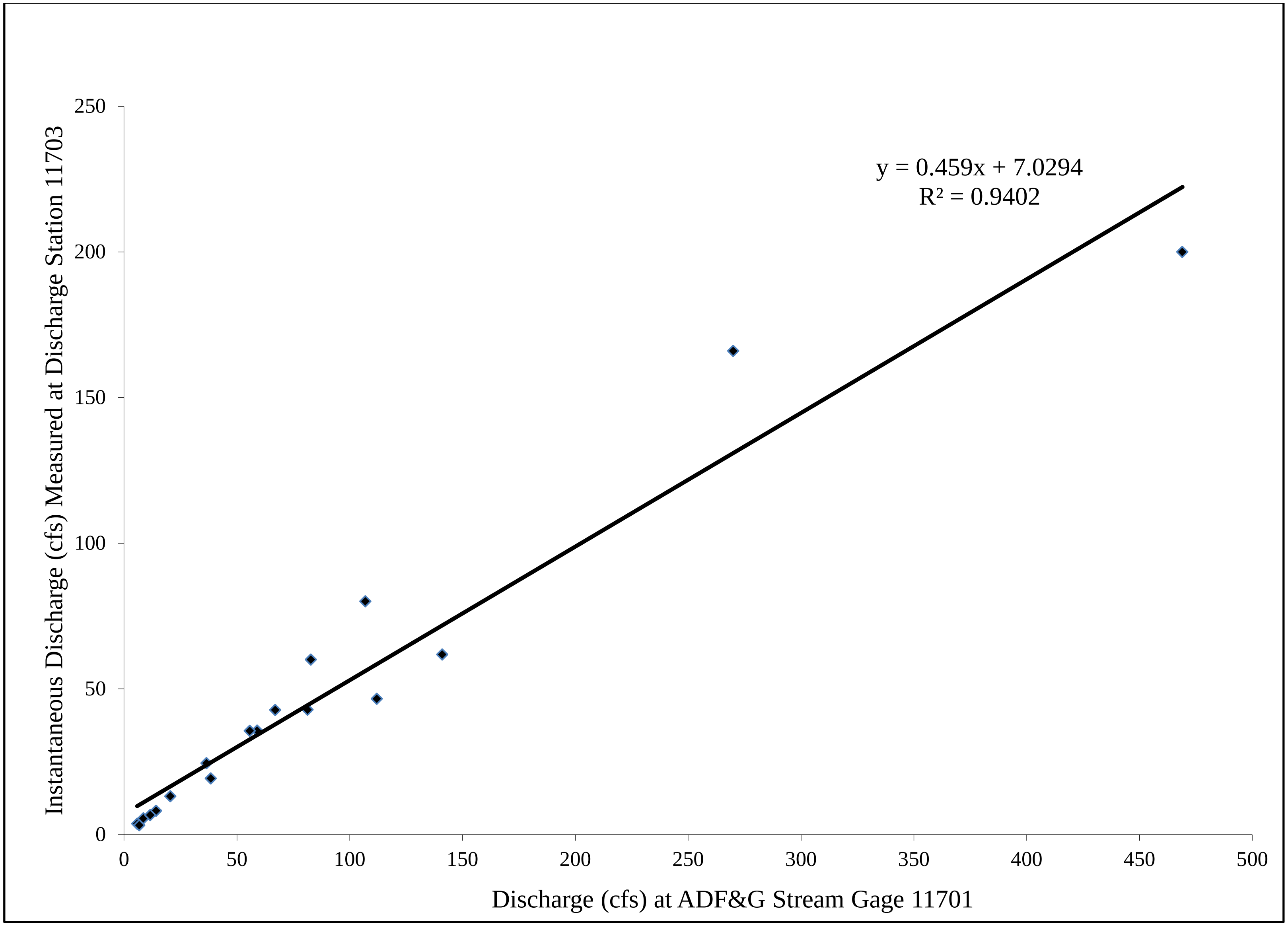

Figure 5.–Simple Linear Regression model used to estimate relationship between discharge station 11703 and streamgage 11701.

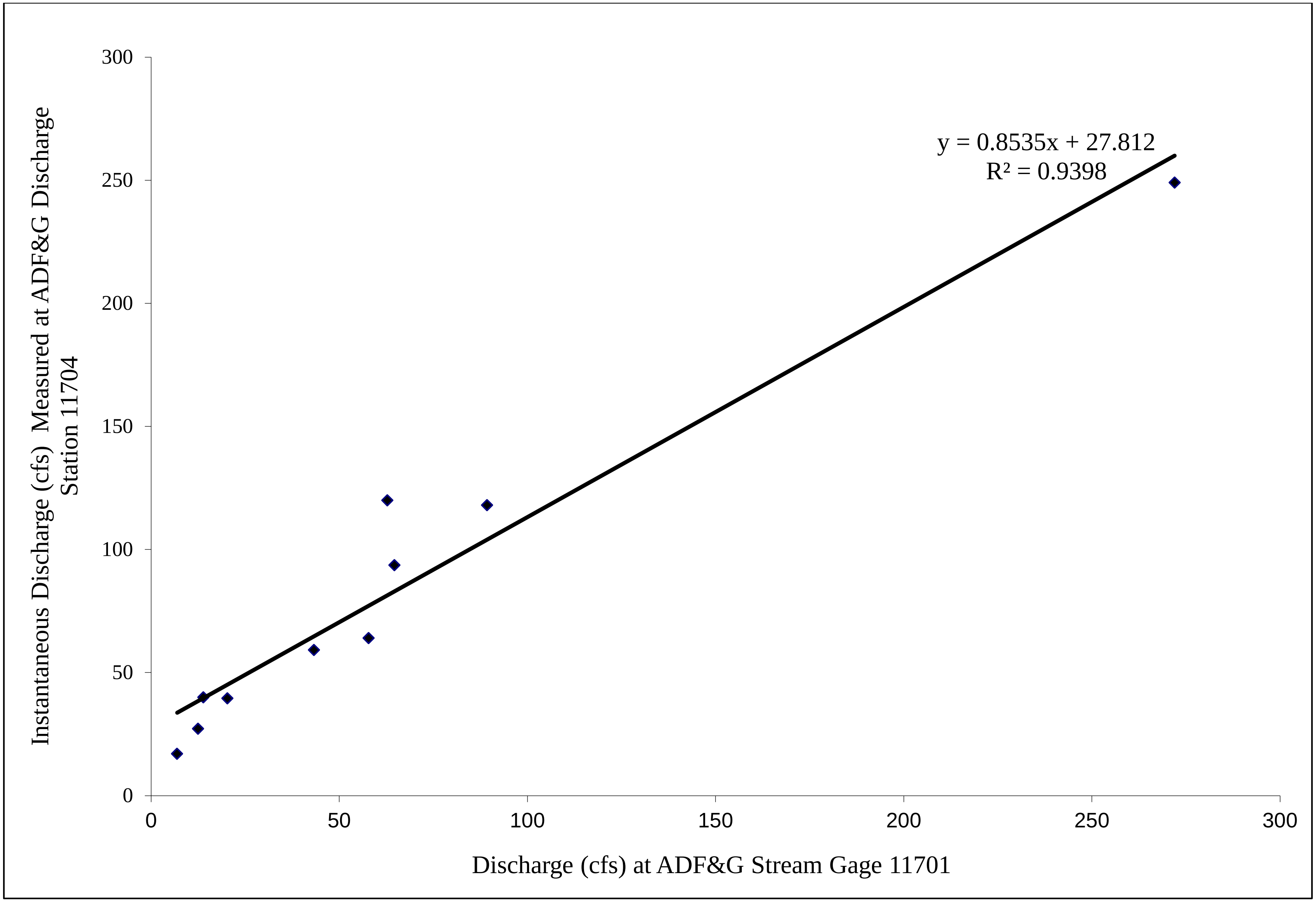

Figure 6.–Simple Linear Regression model used to estimate relationship between discharge station 11704 and streamgage 11701.

DISCUSSION

The Lost River is an integral watershed within the unique Yakutat forelands landscape. The Lost River and its tributaries provide habitat for many fish species at various life stages. Prior to the start of this project, there was little protection to maintain the streamflows in the Lost River that these fish require. This lack of protection was due largely to the absence of hydrologic data. This project collected the hydrologic data necessary to file reservations of water applications for the protection of streamflows within the Lost River watershed.

The estimated streamflow from discharge station 11704 indicated that Tawah Creek contributed the most streamflow to the Lost River. During summer, as streamflows drop during periods of below normal precipitation, the lakes within the Tawah Creek drainage basin contribute an even greater proportion of streamflow to the Lost River. Reach C of the Lost River, contributes less streamflow than Tawah Creek but more than the West Fork of the Lost River.

The Lost River and its tributaries likely receive significant streamflow contributions from groundwater as well. Neil (1998) reports that streamflows in Ophir Creek (a tributary to Tawah Creek) are primarily sustained through groundwater discharge. The Yakutat Foreland aquifer water level fluctuated up to 12 feet during Neil’s study (July 1995 to September 1996). Streamflow contributions or losses in relation to groundwater were not quantified as part of this project.

A sub-task of this project was to collect six discharge measurements at each discharge station per year. The low elevation of the Lost River watershed and the large tides in the Yakutat area prevented this sub-task from always being met. All three discharge measurement stations were located within lower portions of the watershed that are tidally influenced during high tide stages. At these tide stages, the incoming tide backs up the streamflow causing an inaccurate discharge measurement. Hence, site visits to the Lost River had to be timed to coincide with low tide stages.

Streamgage 11701 was originally installed with a perforated sand point wellhead at the terminal end. Three years after installation, the wellhead perforations became plugged with silt, causing erroneous stage recordings. To solve this problem, the wellhead was replaced with a piece of galvanized pipe capped with plastic screen. The large openings in the screen at the end of the pipe allowed the silt to flush out of the housing before accumulating around the pressure transducer.

Preliminary streamflow data were used to prepare a reservation of water application for four reaches of the Lost River and one reach of Tawah Creek. The reservation of water applications were based on three years of preliminary data and included the following components: 1) maps and legal descriptions describing the reach boundaries, streamgage location, and discharge station locations; 2) hydrologic data collected within the watershed; 3) description and justification of the method used to quantify instream flow needs; 4) fish species periodicity chart developed by Yakutat area ADF&G management staff; and 5) the water quantities being requested by time period for each reach. Requested instream flows mimicked natural seasonal patterns of streamflows observed within the Lost River watershed. Requested flows were near the monthly median flow. Although not requested, research has shown that flows near bankfull are needed to maintain the channels sediment, riparian vegetation, and floodplain habitat (Leopold et al. 1964, Reiser et al. 1985, Schmidt and Potyondy 2004).

The application was accepted by DNR (Land Administration System number 27486) and given a priority date of December 11, 2009. DNR later requested that this single application, which contained five reaches, be resubmitted as separate applications for each reach. Reach C was retained by DNR with the December 11, 2009 priority date. Following five years of data collection, reservation of water applications were submitted for the four other reaches (A, B, D, and E) using streamflow data for the entire period of record. These applications were accepted by DNR (Land Administration System numbers 29092, 29093, 29094, 29095) and given a priority date of April, 26, 2013. Reach C was updated at this time, using streamflow data for the entire period of record. A total of 6.2 river miles of fish habitat will be protected through these five reservations of water. The applications have not yet been adjudicated by DNR and therefore no Certificates of Reservation have been issued. Klein (2012) provides further information on DNR's water right process.

At this time, there are no major surface water withdrawals from the Lost River or its tributaries. Hydrologic data collection on the Lost River has been completed and streamgage 11701 has been removed.

ACKNOWLEDGEMENTS

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APPENDIX A.
STREAMGAGE 11701 DATA SUMMARY

Appendix A1.–Streamgage 11701 Water Year 2007 mean daily discharge values in cubic feet per second.

	Mean Daily Discharge (cfs)											
Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	338	65	9.2	295	93	15	23	275	161	8.4	10	13
2	248	57	10	452	81	14	21	220	78	8.2	9.6	10
3	236	53	20	301	70	13	20	174	53	7.6	8.4	8.2
4	476	41	94	173	60	13	19	167	43	7.7	7.5	12
5	336	33	102	120	51	13	19	172	42	10	7	98
6	254	31	137	83	44	12	23	146	33	9.2	8.3	158
7	201	26	308	63	38	15	48	150	43	8.7	9	92
8	180	15	303	50	33	16	59	129	69	8.8	7.8	94
9	194	15	142	43	29	16	73	103	53	8.6	7.2	236
10	289	15	72	36	27	16	93	125	33	21	7.2	483
11	460	15	48	32	24	16	116	110	25	59	6.4	449
12	323	14	40	29	22	15	126	83	21	68	5.9	164
13	213	14	39	26	23	15	135	77	19	83	5.4	65
14	169	12	30	40	25	15	145	142	17	77	5.1	46
15	132	13	24	68	24	14	167	380	16	47	4.9	235
16	122	11	21	74	27	14	190	249	15	28	4.6	382
17	118	11	20	77	33	13	193	128	14	27	4.5	189
18	116	11	127	81	37	13	185	88	13	23	4.4	72
19	111	11	203	102	36	12	171	63	12	18	4.4	104
20	104	11	422	104	31	12	157	49	10	14	4.3	165
21	372	11	265	135	27	13	146	41	9.6	15	4.5	140
22	485	10	118	152	24	18	137	35	9.3	16	6.3	77
23	375	9.7	68	147	23	24	175	33	9.1	13	7.2	70
24	274	9	57	158	21	27	251	33	8.8	11	10	218
25	272	8.6	47	144	20	28	281	30	8.6	10	10	213
26	229	8.3	53	127	18	28	258	45	8.4	9.4	8.3	199
27	176	8.3	50	118	17	27	261	55	7.7	9	7.1	155
28	136	8.1	45	105	16	26	237	51	7.1	8.1	6.1	79
29	109	8.5	114	106	-	25	239	52	6.8	8.8	5.4	55
30	82	8.5	232	104	-	24	287	114	7.2	13	5.2	40
31	76	-	217	101	-	24	-	243	-	12	5.8	-
Total	7,206	564	3,437.2	3,646	974	546	4,255	3,762	852.6	667.5	207.8	4,321.2
Mean	232.4	18.8	110.9	117.7	34.8	17.6	141.8	121.4	28.4	21.6	6.7	144
Max	485	65	422	452	93	28	287	380	161	83	10	483
Min	76	8.1	9.2	26	16	12	19	30	6.8	7.6	4.3	8.2
Acre feet	14,290	1,119	6,818	7,232	1,932	1,083	8,440	7,462	1,691	1,324	412	8,571

Calendar Year 2006	Total 11,207	Mean 122	Max 485	Min 8.1	Acre Feet 22,230
Water Year 2007	Total 30,439	Mean 83	Max 485	Min 4.3	Acre Feet 60,380

\- No data for this date.

Appendix A2.–Streamgage 11701 Water Year 2008 mean daily discharge values in cubic feet per second.

	Mean Daily Discharge (cfs)											
Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	111	270	37	17	14	73	17	91	12	21	36	42
2	180	431	29	16	13	66	34	103	12	17	28	83
3	120	367	21	21	13	65	91	137	17	13	23	89
4	61	193	17	28	12	63	144	128	46	12	20	81
5	170	104	17	23	12	65	141	237	134	11	19	80
6	330	74	17	19	11	124	131	217	94	10	23	71
7	252	61	17	18	11	219	99	104	98	15	21	76
8	110	61	32	17	10	249	67	77	74	16	18	184
9	59	52	101	15	9.9	248	57	63	101	15	16	150
10	39	44	121	16	10	231	45	51	68	13	15	201
11	44	72	219	15	11	192	44	44	45	14	13	330
12	85	74	181	14	23	146	113	94	33	12	13	206
13	170	57	129	13	31	109	199	228	25	10	55	141
14	243	116	121	13	52	78	182	149	21	9.4	290	264
15	268	112	111	13	91	59	167	136	18	9.6	418	384
16	167	75	80	49	91	47	199	104	16	9.4	229	237
17	79	91	55	81	113	39	185	207	14	10	87	282
18	52	109	39	105	189	37	122	145	13	95	49	247
19	62	149	31	104	202	39	88	77	13	225	52	174
20	61	205	26	92	236	34	73	52	14	214	40	300
21	127	295	27	76	263	29	78	39	12	103	29	309
22	131	266	52	64	240	30	93	32	13	109	37	175
23	128	258	44	53	194	36	113	28	12	242	73	148
24	90	342	37	41	178	45	127	24	10	343	80	127
25	63	222	41	33	155	39	143	21	11	523	101	84
26	156	186	46	27	132	33	132	18	12	434	99	59
27	269	162	35	22	111	27	287	17	12	201	62	46
28	179	111	27	20	94	24	351	15	32	86	43	63
29	199	78	23	18	85	21	164	14	56	50	83	92
30	294	48	20	17	-	19	108	13	30	35	70	126
31	343	-	18	15	-	17	-	12	-	35	37	-
Total	4,642	4,685	1,771	1,075	2,606.9	2,503	3,794	2,677	1,068	2,912.4	2,179	4,851
Mean	149.7	156.1	57.1	34.7	89.9	80.8	126.4	86.3	35.5	94	70.3	161.7
Max	343	431	219	105	263	249	351	237	134	523	418	384
Min	39	44	17	13	9.9	17	17	12	10	9.4	13	42
Acre Feet	9,207	9,293	3,513	2,132	5,171	4,965	7,525	5,310	2,118	5,777	4,322	9,622

Calendar Year 2007	Total 30,330	Mean 83	Max 483	Min 4.3	Acre Feet 60,160
Water Year 2008	Total 34,764	Mean 95	Max 523	Min 9.4	Acre Feet 68,950

\- No data for this date.

Appendix A3.–Streamgage 11701 Water Year 2009 mean daily discharge values in cubic feet per second.

	Mean Daily Discharge (cfs)											
Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	209	99	117	14	46	13	19	128	21	14	17	85
2	214	95	64	14	53	12	18	130	18	12	14	56
3	255	84	51	14	52	12	17	148	15	10	11	41
4	296	105	64	13	47	12	17	183	12	8.9	9.5	32
5	140	105	120	14	42	11	19	169	11	7.9	8.2	26
6	101	82	127	13	37	12	23	177	9.6	7.1	10	22
7	246	88	160	13	33	12	26	166	9.2	6.3	11	19
8	303	104	144	14	30	12	31	197	9	5.9	9.3	17
9	257	79	90	15	27	11	34	180	8.4	5.5	8.4	17
10	318	65	139	14	25	11	39	125	8	5.3	8.4	73
11	535	60	157	14	23	11	64	103	7.7	5.2	11	349
12	468	70	99	19	22	12	88	82	7.6	5.1	17	606
13	434	73	66	32	20	14	91	68	8.6	5	16	464
14	374	85	45	60	19	15	89	55	8.9	4.8	13	253
15	427	98	31	88	18	14	81	52	7.9	4.7	45	101
16	391	88	27	135	18	13	78	51	9.9	4.6	283	87
17	277	62	24	349	18	12	83	42	13	4.5	587	152
18	166	46	21	956	19	12	88	34	12	4.4	377	153
19	195	31	19	844	18	11	107	29	11	4.7	132	101
20	231	27	18	594	17	11	111	24	9.1	12	102	100
21	189	26	16	343	16	11	103	21	13	20	89	245
22	189	27	14	161	15	11	97	19	25	67	98	298
23	289	53	14	99	15	11	92	16	93	133	76	163
24	381	48	15	75	14	11	101	15	60	107	67	156
25	331	97	14	59	14	12	109	13	28	72	50	358
26	182	174	15	49	14	13	105	13	48	76	77	427
27	154	257	15	42	13	17	101	43	70	212	114	242
28	188	329	16	38	13	19	110	68	34	134	247	107
29	157	357	14	39	-	20	116	49	22	54	469	70
30	111	272	14	46	-	20	122	38	17	30	447	135
31	82	-	14	43	-	19	-	27	-	21	229	-
Total	8,090	3,186	1,744	4,223	698	407	2,179	2,465	626.9	1,063.9	3,652.8	4,955
Mean	261	106.2	56.3	136.2	24.8	13.2	72.6	79.4	20.9	34.3	117.9	165.1
Max	535	357	160	956	53	20	122	197	93	212	587	606
Min	82	26	14	13	13	11	17	13	7.6	4.4	8.2	17
Acre Feet	16,050	6,319	3,459	8,376	1,384	807	4,322	4,889	1,243	2,110	7,245	9,828

Calendar Year 2008	Total 36,686	Mean 100	Max 535	Min 9.4	Acre Feet 72,770
Water Year 2009	Total 33,291	Mean 91	Max 956	Min 4.4	Acre Feet 66,030

\- No data for this date.

Appendix A4.–Streamgage 11701 Water Year 2010 mean daily discharge values in cubic feet per second.

	Mean Daily Discharge (cfs)											
Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	247	32	97	22	53	104	97	20	10	24	71	31
2	139	48	264	17	51	152	79	20	11	20	44	58
3	76	80	363	15	44	141	69	20	13	27	26	44
4	85	100	136	14	34	145	87	17	13	80	20	30
5	155	158	49	13	29	101	78	15	12	84	42	58
6	223	166	32	13	69	72	83	15	12	149	99	106
7	126	93	26	34	197	58	75	14	11	337	61	50
8	96	100	21	94	197	46	58	15	10	246	40	34
9	67	93	19	139	100	84	48	14	9.9	73	38	38
10	52	93	17	79	61	107	37	13	9.7	58	50	38
11	43	127	15	64	51	92	31	15	9.9	141	47	27
12	36	147	13	32	41	73	29	68	32	153	32	22
13	33	134	12	23	38	58	48	133	83	74	28	19
14	29	213	12	24	40	67	110	66	44	118	28	17
15	26	255	12	27	123	98	99	65	28	94	22	15
16	41	90	12	55	113	106	63	54	28	57	18	14
17	104	46	37	149	191	91	63	33	26	40	32	13
18	141	35	93	152	301	77	60	24	21	30	100	13
19	90	27	92	98	127	75	109	31	18	24	59	12
20	57	24	82	63	55	93	105	36	16	21	32	12
21	44	21	104	44	36	75	126	23	15	24	25	12
22	129	19	55	30	29	60	146	19	14	31	22	12
23	236	19	74	21	24	54	89	17	46	28	37	11
24	232	31	127	18	21	106	52	15	59	29	40	12
25	183	50	294	16	21	105	38	14	39	25	27	29
26	188	98	465	14	28	85	34	13	29	21	21	64
27	236	198	346	16	26	99	30	12	23	24	18	108
28	143	227	180	39	41	191	25	11	23	22	19	83
29	72	200	86	79	-	217	24	11	26	19	31	135
30	49	186	42	59	-	145	23	10	24	16	29	217
31	37	-	29	62	-	115	-	10	-	21	23	-
Total	3,415	3,110	3,206	1,525	2,141	3,092	2,015	843	715.5	2,110	1,181	1,334
Mean	110.1	103.7	103.4	49.2	76.5	99.8	67.2	27.2	23.8	68.2	38.1	44.5
Max	247	255	465	152	301	217	146	133	83	337	100	217
Min	26	19	12	13	21	46	23	10	9.7	16	18	11
Acre Feet	6,774	6,169	6,359	3,025	4,247	6,133	3,997	1,672	1,419	4,185	2,342	2,646

Calendar Year 2009	Total 30,002	Mean 82	Max 956.0	Min 4.4	Acre Feet 59,510
Water Year 2010	Total 24,688	Mean 67	Max 465.0	Min 9.7	Acre Feet 48,970

\- No data for this date.

Appendix A5.–Streamgage 11701 Water Year 2011 mean daily discharge values in cubic feet per second.

	Mean Daily Discharge (cfs)											
Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	312	151	51	141	407	11	212	51	9.7	21	19	63
2	253	170	35	269	525	11	108	47	9.2	15	26	66
3	176	155	29	368	469	10	69	63	9.2	17	27	166
4	204	240	94	456	152	10	62	51	19	14	45	237
5	355	222	318	334	49	10	48	86	19	13	49	326
6	355	222	411	146	27	9.9	38	103	17	20	52	406
7	196	147	241	89	22	9.8	36	87	13	20	37	297
8	93	137	110	49	18	9.6	59	51	12	16	30	152
9	86	97	62	29	45	9.4	100	44	11	12	39	128
10	117	61	41	21	174	9.3	115	46	9.9	10	34	246
11	104	111	32	17	495	9.3	104	44	10	8.6	28	237
12	80	307	27	14	235	9.6	68	35	13	7.7	22	102
13	62	390	23	11	58	9.4	73	30	11	7.3	18	83
14	62	190	20	10	41	9.3	79	26	10	7	17	253
15	94	79	18	9.3	32	9.1	79	23	12	6.9	41	307
16	106	52	15	8.9	26	9.1	71	20	11	6.6	73	167
17	112	37	13	8.5	21	9.6	50	18	11	6.3	45	90
18	271	28	12	8.5	18	11	35	17	10	6.9	28	83
19	291	24	9.7	8.6	25	10	27	17	9.2	8.4	47	81
20	179	22	9.1	8.5	33	9.7	24	39	10	8	263	219
21	87	19	8.8	12	29	9.5	31	37	15	7	331	279
22	55	17	8	102	25	9.1	99	30	11	6.4	235	286
23	59	17	7.6	149	21	8.9	281	25	9.1	6	213	252
24	73	67	7.4	264	16	10	136	21	8.1	6.5	257	201
25	47	138	7.2	474	15	12	63	18	7.7	35	157	159
26	42	67	7.3	304	14	53	54	15	7.4	59	105	87
27	38	34	7.4	133	13	114	48	14	7	56	173	60
28	108	29	7.4	56	11	98	36	13	6.8	35	160	91
29	399	54	7.3	29	-	97	29	12	7.1	31	93	232
30	383	71	8.3	20	-	130	28	11	18	26	56	243
31	209	-	35	18	-	217	-	10	-	20	42	-
Total	5,008	3,355	1,682.5	3,567.3	3,016	954.6	2,262	1,104	333.4	519.6	2,762	5,599
Mean	161.6	111.8	54.3	115.1	107.7	30.9	75.4	35.5	11.1	16.8	89.2	186.7
Max	399	390	411	474	525	217	281	103	19	59	331	406
Min	38	17	7.2	8.5	11	8.9	24	10	6.8	6	17	60
Acre Feet	9,933	6,655	3,337	7,076	5,982	1,893	4,487	2,190	661	1,031	5,478	11,110

Calendar Year 2010	Total 25,002	Mean 68	Max 411	Min 7.2	Acre Feet 49,590
Water Year 2011	Total 30,163	Mean 82	Max 525	Min 6.0	Acre Feet 59,830

\- No data for this date.

Appendix A6.–Monthly exceedance flows in cubic feet per second for streamgage 11701, based on complete months of record (October 1, 2006 to September 30, 2011).

Percent Exceedance	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
0	956	525	249	351	380	161	523	587	606	535	431	465
5	349	236	191	251	217	78	214	283	382	399	295	303
10	173	189	115	188	169	55	118	173	299	355	234	203
15	146	123	101	164	142	43	83	100	253	312	198	137
20	124	91	88	139	128	33	68	82	237	276	164	121
25	104	60	73	126	103	26	50	67	217	254	138	102
30	89	51	59	112	86	22	31	50	180	236	110	91
35	76	44	39	107	68	19	26	45	159	209	99	64
40	63	38	30	100	54	17	22	40	149	192	93	52
45	51	34	25	92	51	15	20	36	126	180	82	45
50	42	30	19	88	44	13	17	29	101	167	74	39
55	33	27	16	78	38	13	15	26	89	140	65	32
60	29	25	15	70	33	12	13	22	83	127	55	28
65	22	23	13	63	28	11	12	19	73	111	48	24
70	19	21	12	53	23	11	10	17	63	104	35	20
75	17	19	12	45	19	10	9.0	11	55	87	28	17
80	15	18	11	35	17	9.7	8.0	9.5	39	78	23	15
85	14	16	11	30	15	9.0	7.3	8.0	27	62	15	14
90	14	14	9.9	24	14	8.1	6.4	6.0	17	52	12	12
95	12	12	9.4	19	12	7.8	5.0	5.0	12	41	10	8.0
100	8.5	10	8.9	17	10	6.8	4.0	4.0	8.0	26	8.0	7.2

APPENDIX B. AVAILABLE DATA FOR STREAMGAGE 11701 AND DISCHARGE STATIONS 11702, 11703, AND 11704

Appendix B1.–The following streamflow data used for this report are stored in the WISKI database and are available upon request.

Database Reference	Description
Streamgage 11701	
Lost River.Q.DayMean.E	Mean daily flows from 10/01/2006 to 10/07/2011
Lost River.Q.Day.MonthMean	Mean monthly flows from10/2006 to 09/2011
Lost River.Q.YearMean	Mean annual flows from 2006 to 2011
Lost River.Q.Obs.Q	Instantaneous discharge measurements from 12/13/2006 to 10/07/2011
Discharge Station 11702	
Lost River bl Rd.Q.Obs.Q	Instantaneous discharge measurements from 12/14/2006 to 10/06/2011
Discharge Station 11703	
Lost R WF.Q.Obs.Q	Instantaneous discharge measurements from 04/27/2007 to 10/06/2011
Discharge Station 11704	
Tawah Cr.Q.Obs.Q	Instantaneous discharge measurements from 10/25/2007 to 10/06/2011

Note: Contact ADF&G Division of Sport Fish, Research and Technical Services, SARCU Surface-water Data Coordinator, 802 3rd St. Douglas, AK 99824.

APPENDIX C. PHOTOGRAPHS OF STREAMGAGE AND DISCHARGE STATIONS

Appendix C1.–Looking across at streamgage 11701 on November 19, 2008 at a discharge of 30 cfs. The gage housing is located on the streambank. The wellhead (with an orange tip) contains the transducer and is shown extending from the bank underwater. The staff gage is shown just upstream of the tagline

Appendix C2.–Looking upstream at the Lost River Road Bridge from discharge station 11702 on December 14, 2006 at a discharge of 49 cfs.

Appendix C3.–Looking upstream at discharge station 11703 on August 28, 2007 at a discharge of 3.7 cfs.

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Appendix C4.–Looking downstream from discharge station 11704, Tawah Creek, on June 17, 2008 at a discharge of 40 cfs.