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Hydrologic Investigations in Support of Reservations of Water for Peterson Creek, Alaska

by

Jarrod J. Sowa

August 2012

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	ft^3/s
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

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HYDROLOGIC INVESTIGATIONS IN SUPPORT OF RESERVATIONS OF WATER FOR PETERSON CREEK, ALASKA

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ABSTRACT

The Peterson Creek watershed located on Douglas Island near Juneau supports a number of anadromous fish species. The Alaska Department of Fish and Game, Division of Sport Fish selected Peterson Creek, through a process of regional staff scoping in 1997, as a candidate water body for a reservation of water. Nine anadromous reaches of the creek were selected for protection of instream flows. In order to collect the data necessary to file a reservation of water application, stream discharge was measured by the U.S. Geological Survey and the Alaska Department of Fish and Game at six locations within the watershed. The U.S. Geological Survey operated a streamgage from November 1, 1998 to September 30, 2004 on the mainstem of Peterson Creek. The Alaska Department of Fish and Game successfully operated one streamgage and collected discharge measurements at four other stations within the Peterson Creek watershed from June 13, 2001 to October 6, 2005. The mean annual discharge of the creek averaged 12 cubic feet per second. The mean monthly discharge ranged from eight cubic feet per second in July to 20 cubic feet per second in October. Stream discharge was lowest in winter and increased from these lows in the spring mainly from snowmelt. Flows decreased into the summer as snowmelt lessened before rising again due to rainfall through the fall and early winter. Stream discharge measured on the mainstem indicated that there was a gain in discharge between stations along the length of the creek during all seasons. Streamflow data collected at the stations and the relationship in discharge between them was used to prepare a reservation of water application requesting to reserve instream flows in nine reaches of Peterson Creek. The application was accepted by the Alaska Department of Natural Resources and given a priority date of March 17, 2008. A reservation certificate has not been granted at this time but the application was listed as a priority for adjudication in fiscal year 2013.

Key words: Peterson 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 17,000 streams, rivers, or lakes have been identified throughout the state as being important for spawning, rearing or migration of anadromous fish (Johnson and Blanche 2011). 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 projects 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 full volume of water is first given to the appropriator who has the earliest priority date to beneficially use the water. This senior water right holder has a legal standing to assert that right against conflicting uses of water from others who do not have water rights or who are junior in priority.

In 1997, Peterson Creek was selected through a process of scoping by ADF&G Sport Fish Southeast staff as a candidate for a reservation of water. At this time, no hydrologic data existed that could be used to support an application. To address this data need, the stream was chosen in 1997 by ADF&G staff as their highest priority for the measurement of streamflows. In 2004, the creek was again selected by regional staff through an updated regional scoping process as a candidate for a reservation of water[1].

Developers of a proposed golf course filed for water permits in 1997 to appropriate 50,000 gallons/day from shallow groundwater wells within the watershed. Several private residences, which exist near the downstream end of Peterson Creek, also have water rights to appropriate water. Potential future development within the watershed includes extension of the North Douglas Highway and associated housing development.

Approximately three stream miles of Peterson Creek's mainstem (Anadromous Waters Catalog stream number 111-50-10750) and seven miles of the tributaries are catalogued as important to anadromous fish. Coho salmon (*Oncorhynchus kisutch*), chum salmon (*O. keta*), pink salmon (*O. gorbuscha*), cutthroat trout (*O. clarki*), and Dolly Varden (*Salvelinus malma*), utilize this creek for a portion of, or all of their spawning, incubation, rearing, and passage life phases (Johnson and Blanche 2011; B. Glynn, Fishery Biologist, Douglas, ADF&G, 2006 personal communication). These species contribute to sport and commercial fishing in the area (M. Schwan, Fishery Biologist, Douglas, ADF&G, 2000 personal communication). The stream also provides spawning and rearing habitat for coastal cutthroat trout and anadromous and resident Dolly Varden char. Sitka black tailed deer (*Odocoileus hemionus sitkensis*), black bear (*Ursus americanus*), river otters (*Lutra canadensis*), porcupines (*Erethizon dorsatum*), bald eagles (*Haliaeetus leucocephalus*), northern goshawks (*Accipiter gentilis*), red squirrels (*Tamiasciurus hudsonicus*), and great grey owls (*Strix nebulosa*) are found within the watershed. The watershed is used extensively by Juneau residents to hunt deer, collect berries and mushrooms, and observe wildlife.

In 2001, ADF&G began a multi-year project funded by the Alaska Sustainable Salmon Fund to collect the hydrologic data necessary to file a reservation of water application to protect instream flows within the Peterson Creek watershed. This report describes a five year project that collected the hydrologic data necessary to file a reservation of water application for nine reaches of Peterson Creek.

[1] Memorandum from K. Brownlee, ADF&G Southeast Instream Flow Coordinator to Kelly Hepler, ADF&G Director Division of Sportfish, December 17, 2004.

OBJECTIVE

The objective of this project was to collect the hydrological data necessary to file a reservation of water application to reserve instream flows within Peterson Creek. Two tasks were necessary to complete this objective and include:

1. Install and operate a network of streamgages to characterize hydrologic conditions within the Peterson Creek watershed.
2. Complete and file a reservation of water application for reaches of Peterson Creek to protect fish habitat, migration, and propagation.

STUDY AREA

The Peterson Creek watershed is located in Southeast Alaska on Douglas Island near Juneau (Figure 1). The watershed is approximately four square miles and drains the western slope of 3,130-foot Mount Meek. Eight major tributaries enter the mainstem floodplain through a section of broad alluvial fans before continuing on to an estuary in Fritz Cove. The dominant channel substrate ranges from sand to gravel in size and large woody debris is found throughout the mainstem and its tributaries. Channel bed widths in the mainstem range from 15 to 30 ft. The forest community along the riparian corridor is dominated by Sitka spruce (*Picea sitchensis*) and Western hemlock (*Tsuga heterophylla*). The watershed is in near pristine condition with the only development being several private residences located near the mouth of the creek. Land ownership within the watershed is fragmented between Sealaska Corporation, City and Borough of Juneau, United States Forest Service, and private landowners.

Peterson Creek is located within the northern temperate rainforest that dominates the Pacific Northwest coast of North America, including Southeast Alaska. This area's weather is characterized by a cool maritime climate with abundant year round precipitation (Nowacki et al. 2001). Average precipitation and temperature data collected at the nearby Juneau Airport National Weather Service station from 1971 to 2000 shows that mean annual precipitation is approximately 58 inches, mean annual snowfall is approximately 84 inches, mean annual temperature is approximately 42° F, the maximum mean temperature is approximately 60° F in August, and the mean minimum temperature is 11° F in February (see National Oceanic and Atmospheric Administration database of U. S. Climate Normals; http://hurricane.ncdc.noaa.gov/cgi-bin/climatenormals/climatenormals.pl accessed June 2012).

METHODS

REACH DELINEATION

The funding for the project which was through an Alaska Sustainable Salmon Fund grant limited the scope of the instream flows to be reserved to those reaches that had been identified in the ADF&G Anadromous Waters Catalog (AWC) (ADF&G 1998) as supporting anadromous fish. Reservation of water reach boundaries were further refined so as to minimize the difference in flows (from accretion and reduction) within each reach. United States Geologic Survey (USGS) topographic maps, ground reconnaissance, drainage basin characteristics, and the AWC were used to aid in the selection of reach boundaries.

During initial reconnaissance, it was observed that USGS topographic maps inaccurately represented the true hydrography in the watershed. In order to develop a better hydrographic

representation, ADF&G staff intensively surveyed and mapped the stream channels within the watershed. In concert with the stream mapping effort, Sport Fish and Habitat Division staff conducted fish habitat surveys to update the AWC.

Nine reaches (Reaches A to I) of Peterson Creek watershed were selected for instream flow protection. Four of these reaches (A to D) were located on the mainstem (Figure 2) and five (E to I) were located on tributaries to the mainstem (Figure 3). The mainstem reaches begin at the downstream end of the creek at mean lower low water and extend upstream three miles to the upper extent of anadromous waters as depicted in the AWC. To minimize the difference in flows within the mainstem reaches, upper boundaries were located immediately upstream of where a major tributary entered the creek while lower boundaries were located immediately upstream of the next major tributary. Each reach located on a tributary starts at the confluence with the mainstem and extends upstream to the upper extent of anadromous water as identified in the AWC.

HYDROLOGIC DATA STUDY DESIGN

To collect the hydrologic data necessary to reserve instream flows within the nine reaches a network of streamgages was operated within the watershed. ADF&G contracted the USGS to operate a streamgage (index gage) within Reach A for five years. This gage (USGS streamgage 15109048) was located on the mainstem of Peterson Creek below tributary one near the upstream boundary of Reach A (Figure 2). ADF&G concurrently operated four semi-permanent streamgages and one discharge measurement station within the watershed. ADF&G streamgage 10101 was located within Reach F on tributary one, ADF&G streamgage 10104 was located within Reach C on the mainstem above tributary three, ADF&G discharge measurement station 10102 was located within Reach G on tributary three, ADF&G streamgage 10103 was located within Reach D on the mainstem above tributary four, and ADF&G streamgage 10105 was located within Reach E on the mainstem above tributary eight (Table 1; Figures 2, 3).

GAGING STATION

The objective of operating a streamgage is to obtain a continuous record of discharge at the site (Carter and Davidian 1968). The collection of stage 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 (staff gages 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 USGS streamgage operation protocols and procedures described in Rantz and others (1982).

Table 1.–USGS and ADF&G streamgage and discharge measurement station locations, associated drainage areas, and periods of operation within the Peterson Creek watershed, Southeast Alaska.

Station #	Period of Operation	Latitude	Longitude	Drainage Area (mi^2)
USGS 15109048	11/01/1998 to 09/30/2004	134.6650	58.2833	4.3
ADF&G 10101	06/13/2001 to 03/14/2003	134.6637	58.2829	1.1
ADF&G 10102	08/13/2001 to 08/05/2002	134.6613	58.2801	0.78
ADF&G 10103	06/27/2002 to 05/10/2005	134.6595	58.2807	1.3
ADF&G 10104	07/12/2002 to 10/05/2005	134.6568	58.2785	1.8
ADF&G 10105	07/15/2002 to 03/03/2005	134.6496	58.2743	0.67

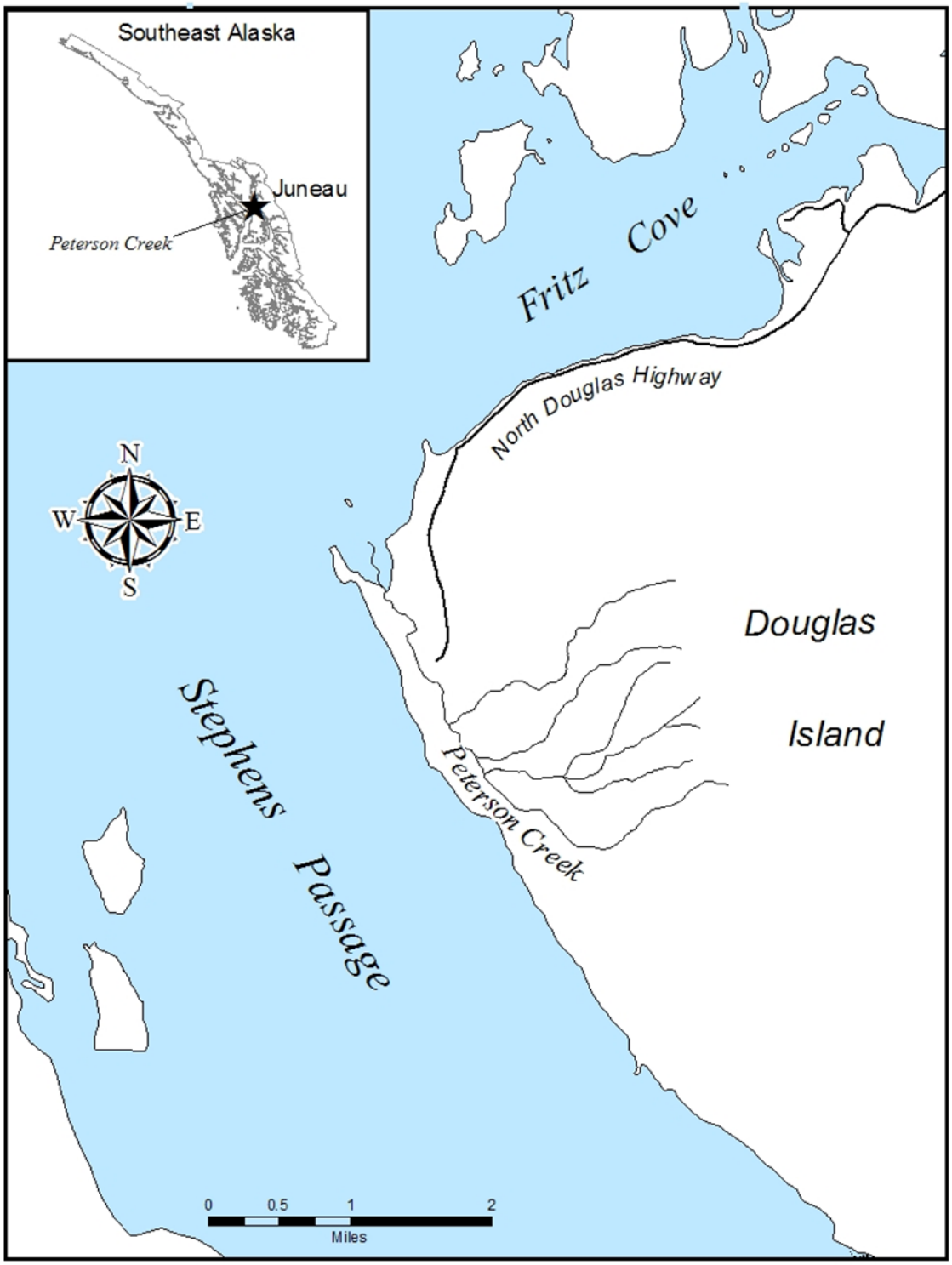

Figure 1.–Location of the Peterson Creek watershed in Southeast Alaska.

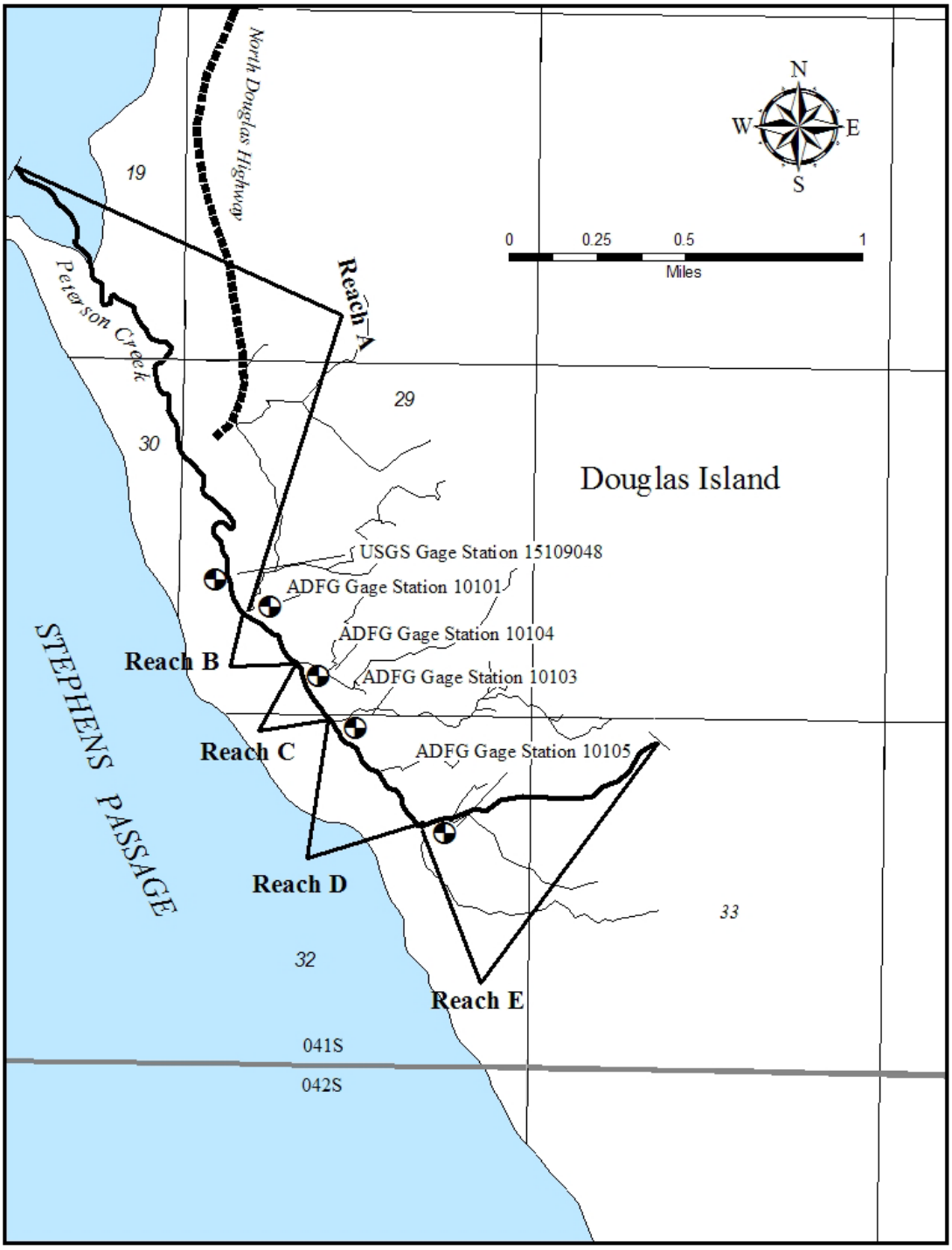

Figure 2.–Location of mainstem reservation of water reach boundaries and streamgages within the Peterson Creek watershed, Southeast Alaska.

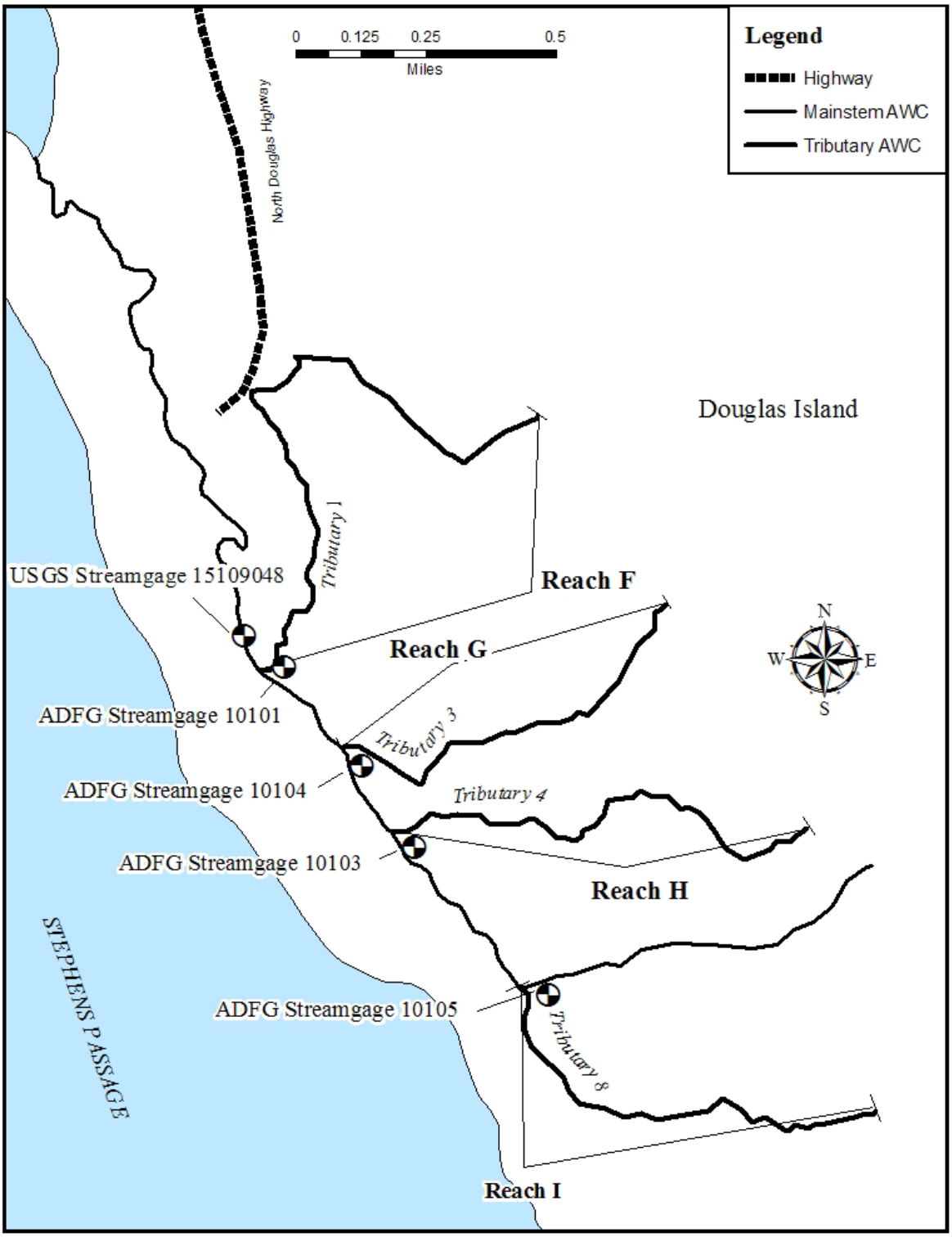

Figure 3.–Location of tributary reservation of water reach boundaries and streamgages within the Peterson Creek watershed, Southeast Alaska.

Rantz and others (1982) provides guidance for selection of a streamgage site. The ideal considerations include a straight section of stream upstream and downstream of the site, all the flow is confined to one channel, and the streamgage site is far enough upstream from the confluence with another stream so as to not be affected by backwater. Each streamgage was located in a pool, with a stable hydraulic control, and far enough upstream of confluences so as not to be affected by backwater. Vented General Electric® Druck PDCR 1830[2] pressure transducers, +-.1% accuracy, were used at all gage sites to measure water level (stage). The transducers were housed within 1-½"perforated wellheads that were driven through an undercut stream bank and into the stream substrate. A vented polyurethane cable ran from the transducer through flexible metal conduit and was wired to a Campbell Scientific® Instruments CR10X data logger housed in a weather-proof box. The data logger was programmed to turn on the sensors and record stage at 15-minute intervals and ambient internal data logger air temperature at four-hour intervals.

A staff gage was installed within each streamgage pool to measure the water surface elevation (WSE) independent of the transducer. At installation, the transducers were programmed to read the corresponding staff gage WSE. At each site visit, the staff gage WSE was compared to the transducer WSE reading to determine if it was being represented correctly by the transducer. To monitor possible changes in the elevation of the staff gage, three reference marks (RMs), consisting of large galvanized lag screws driven into spruce trees, were established near each gage. During the installation of the streamgages, the difference in the elevations of the RMs in relation to the staff gage was measured using standard differential surveying techniques (Kennedy 1990). The RM and staff gage elevations were surveyed at a minimum once a year and also when the streamgages were 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 stream. Discharge measurements were collected using a top set wading rod and either a Price AA or Pygmy velocity meter. Discharge measurements were taken periodically throughout the year and during periods of extreme low and high flows following USGS protocols (Rantz and others 1982). During winter when the creek was covered in ice, the ice was removed approximately three feet upstream and downstream of the transect in order to collect a discharge measurement.

SITE VISITS

Site visits to the streamgages were made about ten times a year. Typically, all ADF&G streamgages were visited in the same day to download data from the data loggers, measure discharge, and perform routine gage maintenance. Data was downloaded from the data loggers using a Palm Pilot ™. 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 typically taken at every visit.

After a site visit, discharge measurement data was transcribed from the field notebooks to MS Excel® to calculate discharge, pictures were downloaded and labeled, and data was downloaded from the Palm Pilot to a desktop computer. Transducer stage, staff gage readings, air temperature, 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

Streamflow records computation is a step by step process in which stream stage is converted to discharge using the stage-discharge relationship (rating curve). Before being converted to discharge, the stage record was corrected for movement of the staff gage, transducer movement and drift, or fill and scour of the hydraulic control. WISKI© was used to develop rating curves, make corrections to the stage record, apply rating curves to corrected stage values in order to calculate 15 minute discharges, and summarize these discharges to mean daily, mean monthly, and average annual flow values. 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). This included comparisons of streamflow records from USGS streamgage 15109048, nearby weather records, trends of the hydrograph, and instantaneous discharge measurements.

Computed discharge values were typically summarized as mean daily, mean monthly, and mean annual flow values for the water year (October 1st-September 30th). The procedures used to compute streamflow records coincide with those described in Rantz and others (1982) and in Kennedy (1983). A description of the methods used to compute the records for ADF&G Streamgage 10101 is provided in Appendix A.

Mean daily flow records computed for each gage were analyzed by a series of Statistical Analysis System® programs to estimate the annual, monthly, and mean daily summaries and flow duration values for specified time periods. Mean annual flow was estimated as a mean of the annual mean daily flow values over all complete water years of record. Mean monthly flows were estimated as the mean of monthly mean daily flows for all complete months over the entire period of record. Duration estimates represent the expected frequency of occurrence of mean daily flows within the specified time periods. The durations of daily mean flows 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

The USGS operated streamgage 15109048 continuously from November 1, 1998 to September 30, 2004. Mean annual flow at the site ranged from 10 to 15 cfs and averaged 12 cfs for water years 2000 to 2004. The highest flow measured at the gage was 364 cfs on December 27, 1999 when six inches of rain fell upon eight inches of snow. The lowest flow recorded at the gage was 0.90 cfs on March 17, 2002. Streamflows typically peaked from October to December in response to rain or rain on snow events (Figure 4). Flows were lowest in March during extended cold air temperatures and increased from these lows as the snow melted from April to June. As snowmelt decreased throughout the summer, flows also decreased until around themiddle of July when flows began to increase due to rainfall events. Water quality samples were taken at the site by the USGS from April 4, 2001 to July 7, 2002. The data collected at the site are available from the USGS National Water Information System website (http://waterdata.usgs.gov/nwis).

ADF&G streamgage 10101 operated continuously from June 14, 2001 to March 14, 2003. Sixteen measurements of instantaneous discharge, ranging from 0.4 to 51 cfs, were taken at the

site between August 13, 2001 and March 8, 2001 (Table 2). The mean annual flow for water year 2002 was 3.6 cfs. The highest flow recorded at the gage was 56 cfs on October 21, 2002 and the lowest flow recorded was 0.37 cfs on September 16, 2002 (Figure 5). Appendix B 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 in this appendix.

At ADF&G discharge measurement station 10102, stream discharge was measured five times from August 3, 2001 to August 5, 2002 at discharges ranging between 0.20 and 0.91 cfs (Table 2). Mean daily flow data could not be accurately calculated for ADF&G streamgages 10103, 10104, and 10105 due to transducer malfunctions, data logger programming errors, and other miscellaneous problems and errors. Stream discharge was measured periodically at each streamgage from July 8, 2002 to October 6, 2005 (Table 2). The lowest discharge measured was 0.51 cfs taken on July 14, 2003 at streamgage 10105 and the highest was 27 cfs taken on October 17, 2002 at streamgage 10104.

HYDROLOGIC RELATIONSHIP BETWEEN STATIONS

Simple linear regression was used to estimate the relationship between discharge at ADF&G streamgages (10101, 10103, 10104, and 10105) and USGS streamgage 15109048. Instantaneous discharge measurements collected at the ADF&G streamgages were regressed against the corresponding mean daily discharge from USGS streamgage. A positive linear relationship, with coefficients of determination (r^2) ranging from 0.938 to 0.996, existed between corresponding discharge at the USGS and ADF&G streamgages (Figures 5 to 8).

Concurrent mean daily discharge measured at the USGS streamgage (located on the mainstem below tributary one) and ADF&G streamgage 10101 (located at the downstream end of tributary one) were similar in timing, frequency, and duration (Figure 9). The difference in concurrent mean daily discharges measured at these two streamgages from June 14, 2001 to March 14, 2003 indicates that on average Peterson Creek-Tributary One contributed 29% of the discharge measured at the mainstem USGS streamgage.

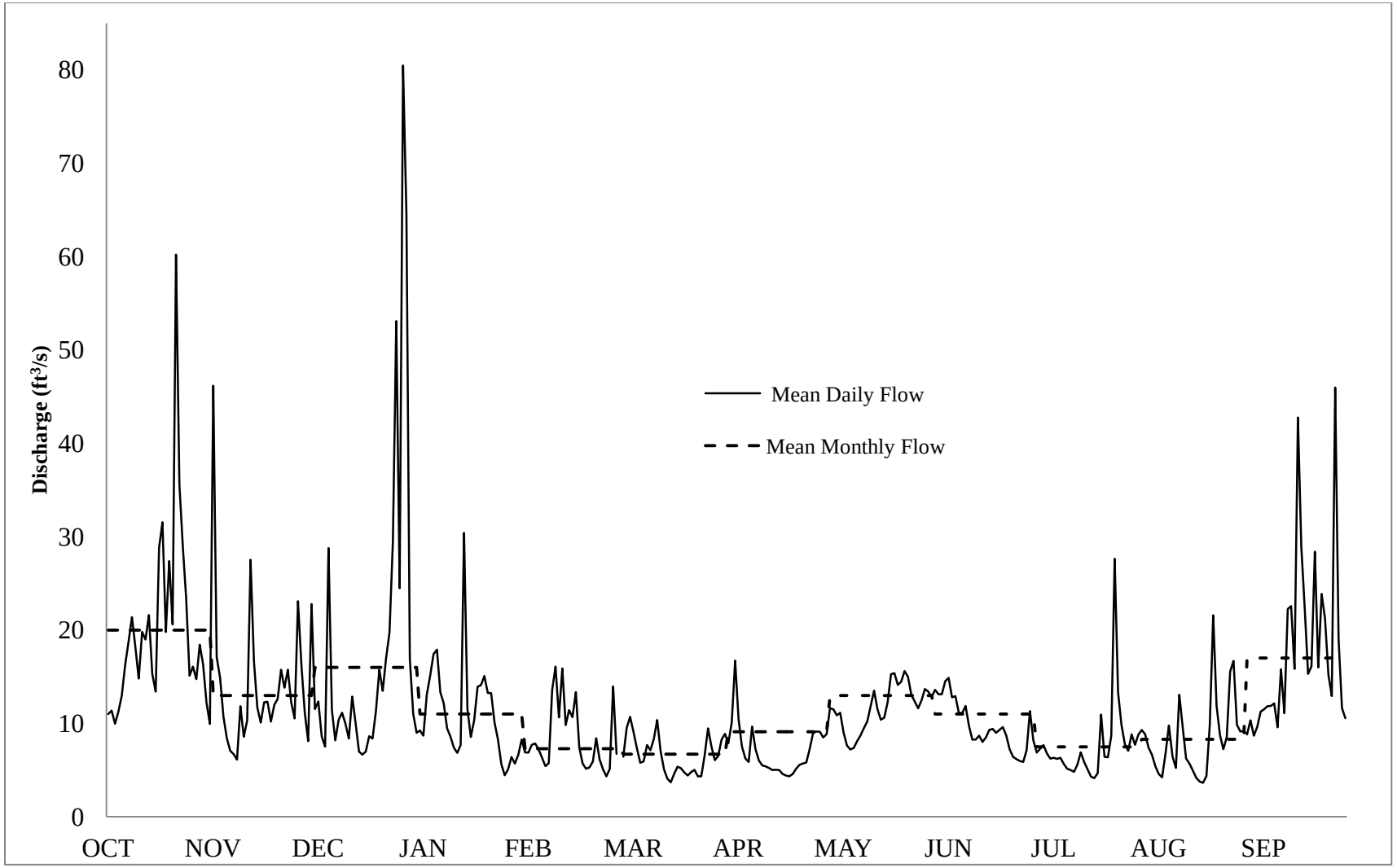

Figure 4.–Mean daily (October 1, 1999 to September 30, 2004) and mean monthly (November 1, 1998 to September 30, 2004) flows for Peterson Creek, Southeast Alaska, based on data from USGS Streamgage 15109048.

Table 2.–USGS streamgage 15109048 mean daily flow and concurrent instantaneous discharge measurements taken at ADF&G stations 10101, 10102, 10103, 10104, and 10105 within the Peterson Creek watershed, Southeast Alaska from 2001 to 2005.

Date	USGS 15109048 Discharge[a] (ft^3/s)	ADF&G 10101 Discharge[b] (ft^3/s)	ADF&G 10102 Discharge[b] (ft^3/s)	ADF&G 10103 Discharge[b] (ft^3/s)	ADF&G 10104 Discharge[b] (ft^3/s)	ADF&G 10105 Discharge[b] (ft^3/s)
08/13/2001	2.5	0.40	0.25	--	--	--
09/17/2001	35	6.5	--	--	--	--
01/31/2002	8.4	0.78	--	--	--	--
04/09/2002	2.4	0.23	--	--	--	--
04/25/2002	3.4	1.0	0.20	--	--	--
06/21/2002	6.4	1.6	0.78	--	--	--
07/08/2002	6.6	1.6	0.91	3.7	--	--
07/19/2002	5.5	--	--	3.1	3.9	1.7
08/05/2002	3.5	--	0.34	1.4	1.4	0.78/1.0[c]
08/06/2002	3.2	0.44	--	1.4	1.5	--
08/12/2002	50	--	--	10	18	4.1
09/26/2002	17	4.9	--	5.5	8.1	3.5
10/17/2002	84	--	--	18	27	13
10/21/2002	225	51	--	--	--	--
11/08/2002	4.9	1.1	--	1.8	2.5	1.2
12/06/2002	8.7	1.9	--	2.4	3.0	1.8
03/14/2003	2.4	0.61	--	--	1.2	--
04/23/2003	6.9	--	--	2.5	2.6	1.7
07/14/2003	1.9	--	--	0.90	1.2	0.51
09/18/2003	10	--	--	3.5	4.1	--
10/17/2003	6.7	--	--	1.5	2.0	0.84
11/04/2003	7.0	--	--	1.9	--	1.1
11/05/2003	6.2	1.2	--	--	2.2	--
11/13/2003	50	--	--	--	23	11
11/14/2003	29	8.7	--	--	15	--
12/17/2003	20	--	--	8.8	12	3.4
03/08/2004	21	9.4	--	12	18	--
03/30/2004	11	--	--	--	--	1.9
09/09/2004	5.2	--	--	4.2	5.5	2.0
03/03/2005	--	--	--	--	--	6.6
08/29/2005	--	--	--	3.7	4.3	1.6
10/03/2005	--	--	--	--	7.3	2.8
10/06/2005	--	--	--	4.5	--	--

Note: --No measurement taken on this day

[a] Mean daily discharge.

[b] Instantaneous discharge measurement.

[c] Two measurements taken this day.

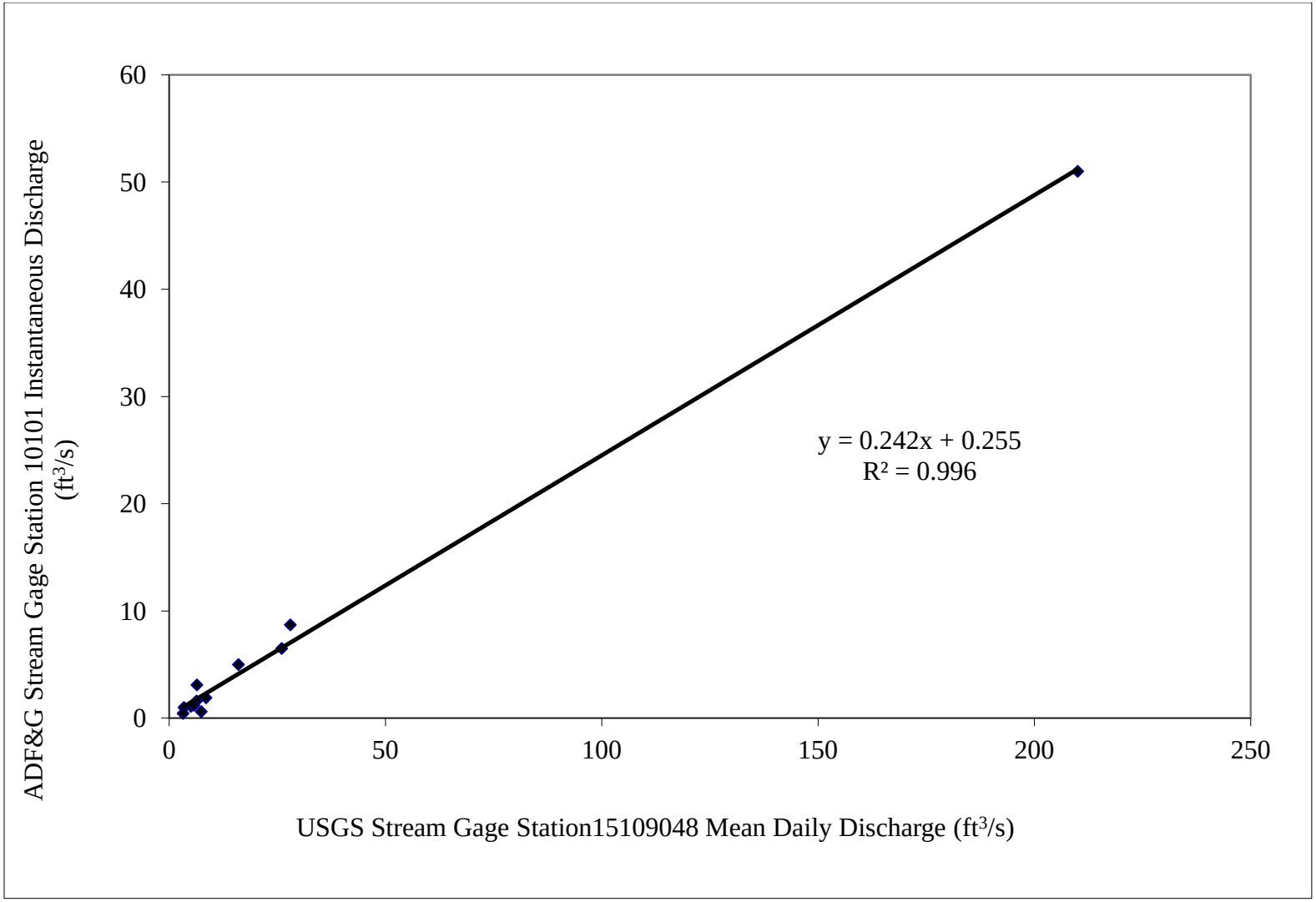

Figure 5.–Simple Linear Regression model used to estimate relationship between ADF&G streamgage 10101 and USGS streamgage 15109048 within the Peterson Creek watershed, Southeast Alaska.

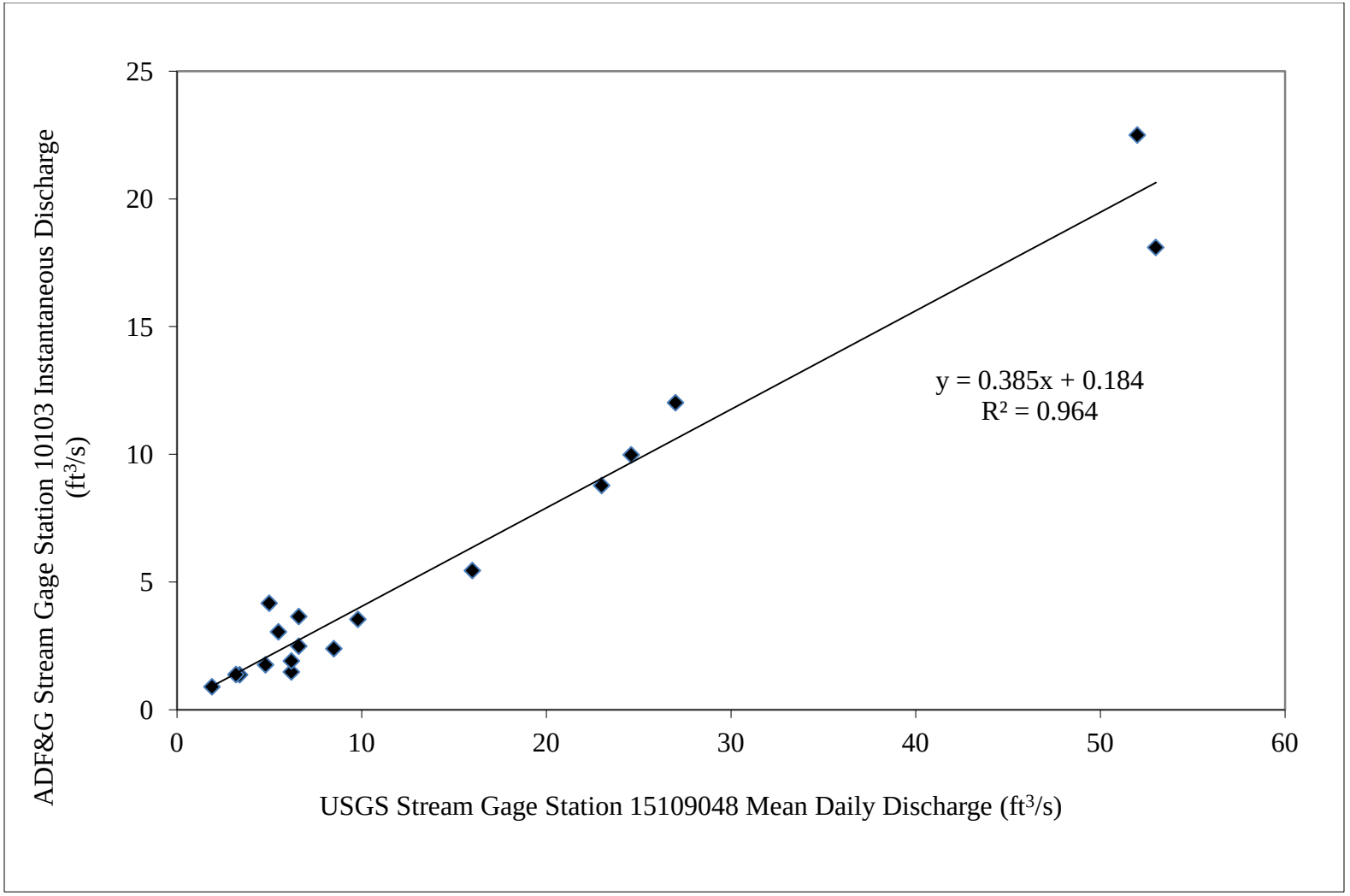

Figure 6.–Simple Linear Regression model used to estimate relationship between ADF&G streamgage 10103 and USGS streamgage 15109048 within the Peterson Creek watershed, Southeast Alaska.

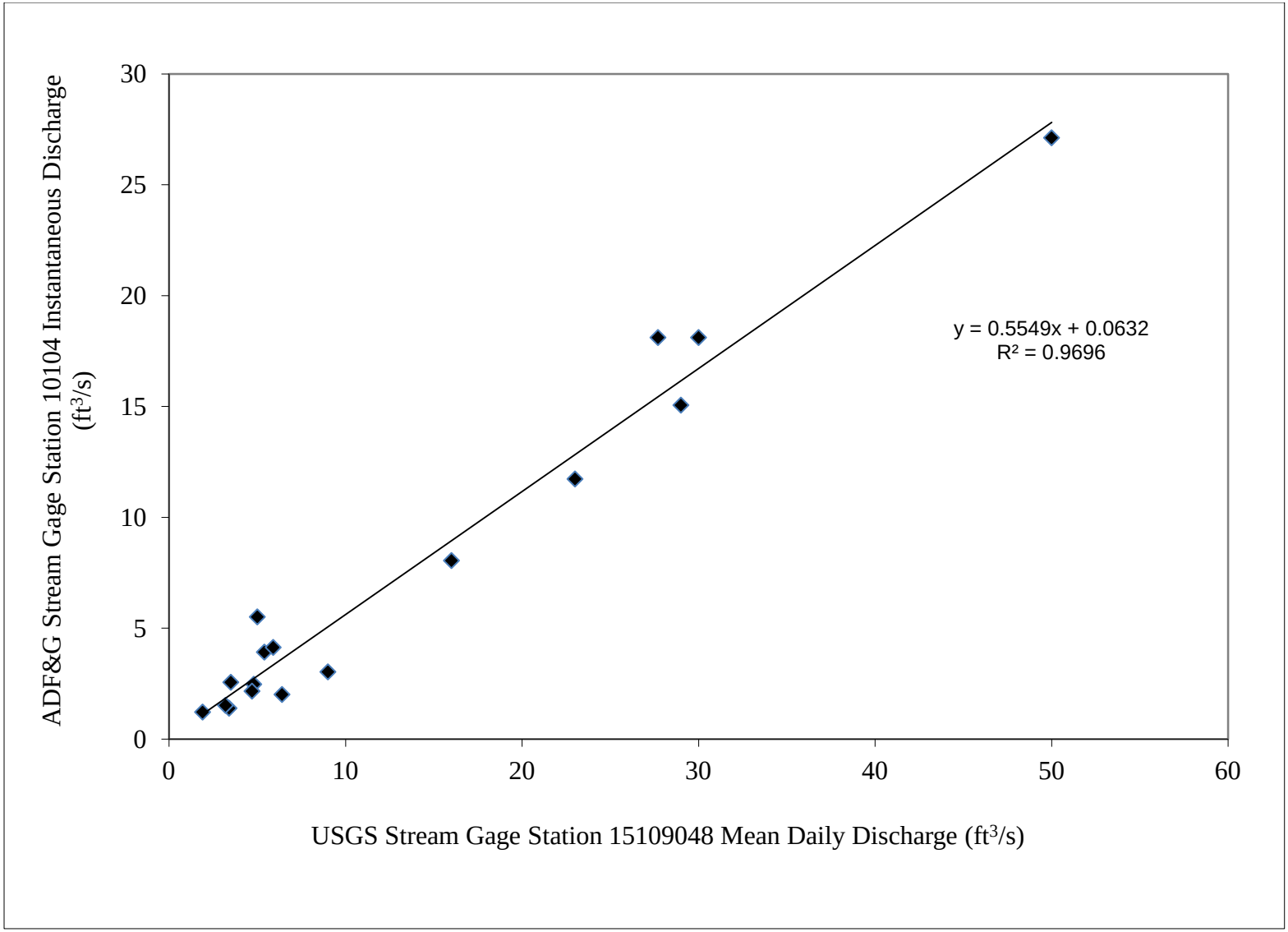

Figure 7.–Simple Linear Regression model used to estimate relationship between ADF&G streamgage 10104 and USGS streamgage 15109048 within the Peterson Creek watershed, Southeast Alaska.

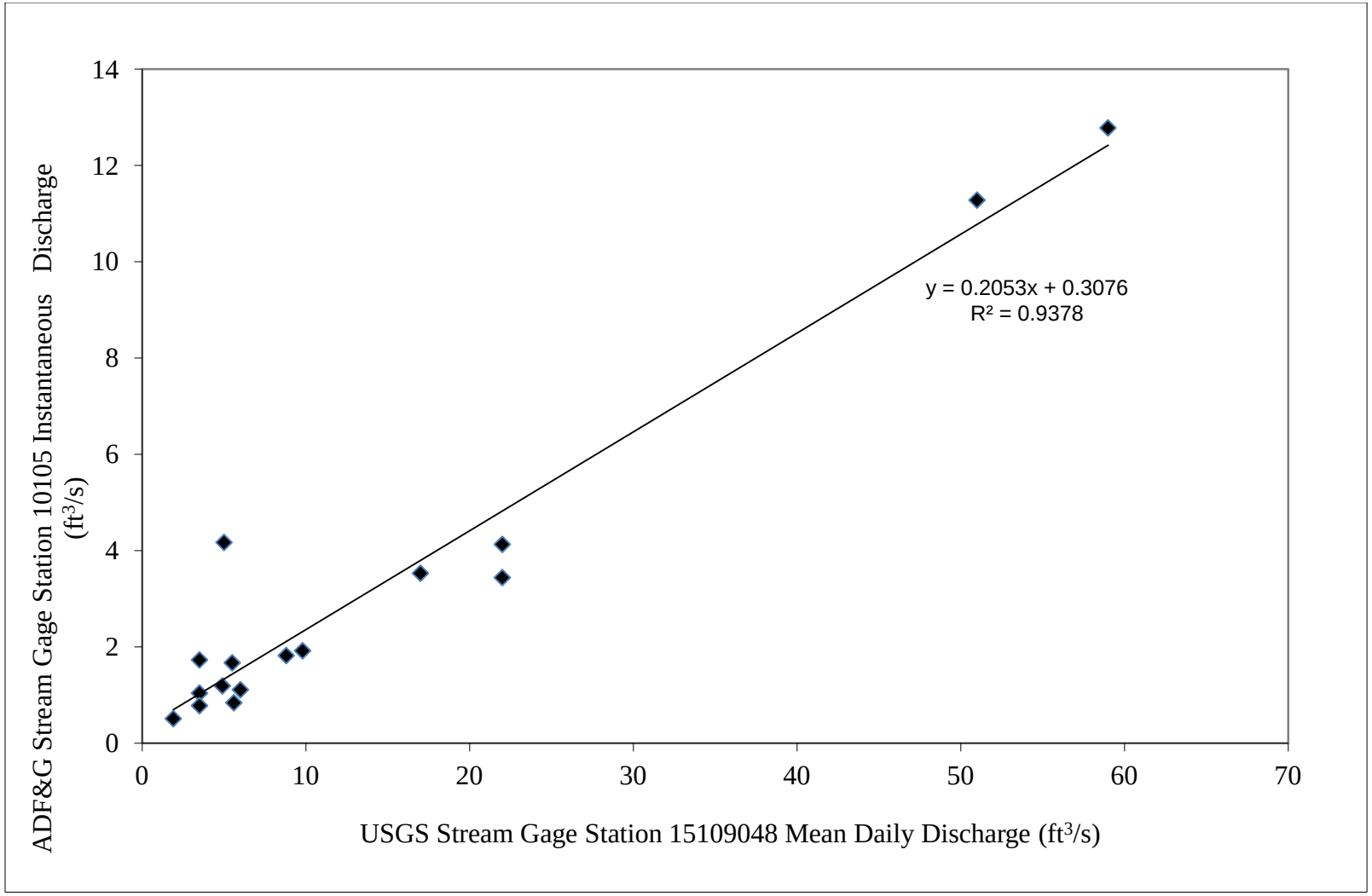

Figure 8.–Simple Linear Regression model used to estimate relationship between ADF&G streamgage 10105 and USGS streamgage 15109048 within the Peterson Creek watershed, Southeast Alaska.

DISCUSSION

This was ADF&G's first project in Southeast Alaska to collect streamflow data in support of a reservation of water application. Prior to beginning this project, staff had no formal training in the installation, maintenance, and operation of streamgages. Staff received on the ground training and learned from mistakes that were made. Unfortunately, due to incorrectly wired transducers, batteries being insufficiently charged to power the data loggers and transducers, incorrect programs being installed to operate the data loggers, staff not noting changes that were made to programs, and other issues and errors, mean daily flow data could not be accurately calculated for ADF&G streamgages 10103, 10104, and 10105. Instantaneous discharge measurements taken at each of these streamgages were measured correctly according to USGS procedures and were used to estimate the relationship between them and the USGS streamgage.

In general, stream discharge measured at streamgages located on the mainstem showed that there is a gain in discharge along the length of the creek during all seasons (Table 3). However, one measurement, taken on September 9, 2004, indicated a loss in discharge of 0.30 ft^3/s between tributary three and tributary one. Measurements also indicate that Peterson Creek gains significant discharge between streamgage 10104 (located on mainstem downstream of tributary three) and the USGS streamgage 15109048 (located on mainstem downstream of tributary one), due to streamflow contributions from tributary one.

Streamflow data collected at the five streamgages and the relationship in discharge between them was used to prepare a reservation of water application requesting to reserve instream flows in nine reaches of Peterson Creek. The reservation of water application included the following components: 1) maps and legal descriptions describing the reach boundaries and streamgage 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; and 5) the water quantities being requested by time period for each reach. The application was accepted by DNR (Land Administration System number 26817) and given a priority data of March 17, 2008. The accepted reservation of water application has not been adjudicated by DNR nor has a reservation certificate been issued. At the annual DNR-ADF&G Instream Flow meeting in 2011, ADF&G and DNR included the Peterson Creek reservation of water application as a priority for adjudication in the 2013 fiscal year. Klein (2012) provides further information on DNR's water right process.

Requested instream flows attempt to mimic the natural seasonal patterns of streamflows found within the Peterson Creek watershed. All requested flows were near the median flow value and below the respective time periods' mean monthly 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). Changes in the magnitude, frequency, timing, and duration of these flows could directly lead to biologic and geomorphic changes (Whiting 2002).

At this time no major water withdrawals occur within the Peterson Creek watershed. In 2011, Totem Creek Inc. relinquished their four water permits related to development of the proposed golf course. However, three surface water rights totaling withdrawals of 500 gallons gallons/day are permitted for use by private residences located near the mouth of the creek. These water rights are senior in priority to ADF&G's reservation of water. Future water development within the watershed is predicted to increase from the proposed extension of the North Douglas Highway into the watershed and related housing and urban development.

Table 3.–Mean daily discharge measured at USGS streamgage15109048, instantaneous discharge measure at ADF&G streamgages 10103, 10104, and 10105, and the gain in discharge between upstream and downstream stations within the Peterson Creek watershed, Southeast Alaska from 2002 to 2005.

Date	USGS 15109048 Discharge[a] (ft^3/s)	Gain (ft^3/s)	ADF&G 10104 Discharge[b] (ft^3/s)	Gain ft^3/s)	ADF&G 10103 Discharge[b] (ft^3/s)	Gain (ft^3/s)	ADF&G 10105 Discharge[b] (ft^3/s)
07/19/2002	5.5	1.6	3.9	0.9	3.1	1.4	1.7
08/05/2002	3.5	2.1	1.4	0.02	1.4	0.59/0.40[c]	0.78/1.0[c]
08/06/2002	3.2	1.7	1.5	0.14	1.4	--	--
08/12/2002	50	32	18	8.1	10	5.9	4.1
09/26/2002	17	9.0	8.1	2.6	5.5	1.9	3.5
10/17/2002	84	57	27	9.0	18	5.3	13
10/21/2002	225	--	--	--	--	--	--
11/08/2002	4.9	2.4	2.5	0.71	1.8	0.57	1.2
12/06/2002	8.7	5.7	3.0	0.64	2.4	0.57	1.8
03/14/2003	2.4	1.2	1.2	--	--	--	--
04/23/2003	6.9	4.3	2.6	0.06	2.5	0.76	1.7
07/14/2003	1.9	0.7	1.2	0.32	0.90	0.39	0.51
09/18/2003	10	5.9	4.1	0.59	3.5	--	--
10/17/2003	6.7	4.7	2.0	0.53	1.5	0.64	0.84
11/04/2003	7.0	--	--	--	1.9	0.80	1.1
11/05/2003	6.2	4.0	2.2	--	--	--	--
11/13/2003	50	28	23	--	--	--	11
11/14/2003	29	14	15	--	--	--	--
12/17/2003	20	8.3	12	3.0	8.8	5.3	3.4
03/08/2004	21	2.9	18	6.1	12	--	--
03/30/2004	11	--	--	--	--	--	1.9
09/09/2004	5.2	-0.30	5.5	1.3	4.2	2.2	2.0
03/03/2005	--	--	--	--	--	--	6.6
08/29/2005	--	--	4.3	0.7	3.7	2.0	1.6
10/03/2005	--	--	7.3	--	--	--	2.8
10/06/2005	--	--	--	--	4.5	--	--

Note: --No measurement taken on this day

[a] Mean daily discharge.

[b] Instantaneous discharge measurement.

[c] Two measurements taken this day.

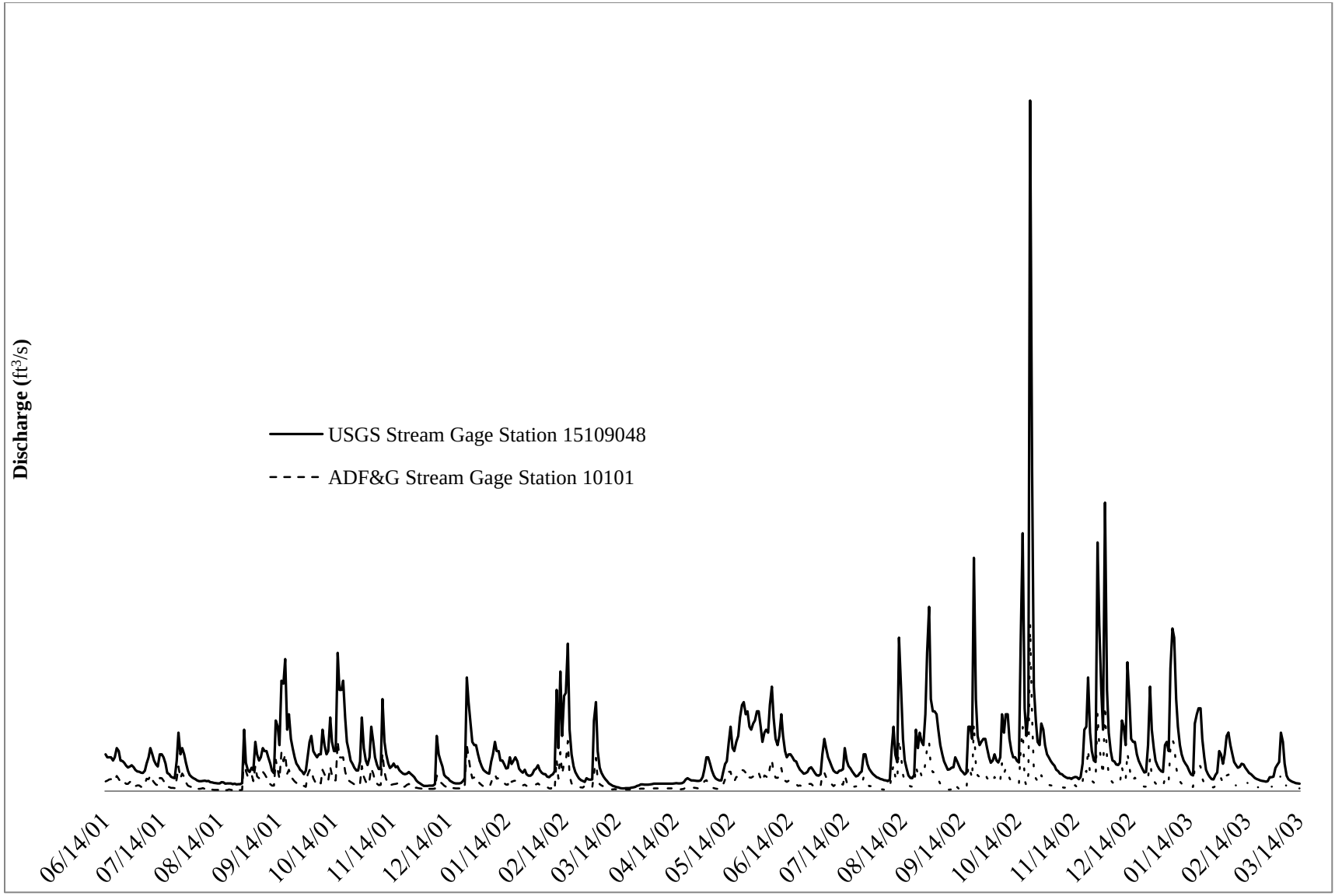

Figure 9.–Mean daily discharge from USGS streamgage 15109048 and ADF&G streamgage 10101 (06/14/2001 to 03/14/2003) within the Peterson Creek watershed, Southeast Alaska.

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APPENDIX A.
ADF&G STREAMGAGE 10101 STATION ANALYSIS FOR WATER YEARS 2001 TO 2003

Appendix A1.–ADF&G streamgage 10101 station analysis for water years 2001 to 2003.

Peterson Creek Trib. No. 1 near Auke Bay, AK

Period: Gage operated from June 13, 2001 through March 14, 2003

Gage: Druck pressure transducer and Campbell Scientific data logger.

Datum: No datum, recorder, or transducer corrections were applied to gage heights. Drift corrections were applied due to difference between recorder and primary reference gage heights (Table 1).

Date	*Time*	*Staff Gage (ft.)*	*Recorder Stage (ft)*	*Staff Gage-Recorder Stage*	*Recorder Corrections Stage*	*Transducer Movement/Drift Corrections*	*Net Correction Stage*	Comments
8/13/01	12:00	20.68	20.62	*0.06*	0.00	0.06	0.06	
9/17/01	12:15	21	20.97	*0.03*	0.00	0.03	0.03	
1/31/02	12:45	19.86	20.88	*-1.02*	0.00	0.03	0.03	ice
4/25/02	14:15	20.68	20.66	*0.02*	0.00	0.02	0.02	
6/21/02	10:15	20.72	20.67	*0.05*	0.00	0.05	0.05	
7/8/02	15:00	20.72	20.67	*0.05*	0.00	0.05	0.05	
7/8/02	16:00	20.72	20.67	*0.05*	0.00	0.05	0.05	
8/6/02	11:15	20.6	20.56	*0.04*	0.00	0.04	0.04	
8/6/02	11:50	20.6	20.56	*0.04*	0.00	0.04	0.04	
9/26/02	16:35	20.79	20.79	*0.00*	0.00	0.00	0.00	
9/26/02	17:10	20.79	20.79	*0.00*	0.00	0.00	0.00	
10/21/02	15:00	22.33	22.37	*-0.04*	0.00	0.00	0.00	falling stage
10/21/02	15:32	22.33	22.34	*-0.01*	0.00	0.00	0.00	falling stage
11/8/02	14:37	20.7	20.65	*0.05*	0.00	0.05	0.05	
11/8/02	14:56	20.7	20.65	*0.05*	0.00	0.05	0.05	
12/6/02	13:40	20.77	20.75	*0.02*	0.00	0.02	0.02	
12/6/02	14:20	20.77	20.75	*0.02*	0.00	0.02	0.02	
3/14/03	11:00	20.81	20.72	*0.09*	0.00	0.00	0.00	ice
3/14/03	11:45	20.85	20.72	*0.13*	0.00	0.00	0.00	

Appendix A–Table 1. Gage Height Corrections

Rating Analysis: Rating no. 1 was developed using WISKI and is based on 13 discharge measurements, numbers 1-2, 5-12, and 14-16, a point-of-zero flow of 20.34 (levels of 04/25/03), and a smooth transition of extreme low end. Discharge measurement number 3 was not used since the stage was ice affected. Measurement number 4 was not used since there was no staff gage reading taken during the measurement. Measurement number 13 was not used since the stage was affected by ice. The rating is fairly well defined between 0.4 $ft.^3/s$ and 55 $ft.^3/s$.

-continued-

The following shifts to rating no. 1 were used to compute the record for the period.

Shift Curve # 1 was developed based on discharge measurement number 9 which was 0.1ft. below the rating curve and indicates a slight scour of the control. This shift curve was applied 09/21/2002 at 21:00 until the peak on October 21, 2001 at 04:00 which was assumed to have filled the control.

Shift Curve # 2 is based on discharge measurement 12 which plotted 0.03 feet above the rating curve, indicating material on the control as a result of the 11/30/02 peak. Shift Curve #2 was applied starting on the recession from the 11/30/02 peak at 11:00 and was employed until 12/13/02 at 02:00 when it was assumed a 0.03 ft. scour of the material on the control had occurred.

Shift Curve # 1		Shift Curve # 2			
20.40	0.1	20.40	-0.03		
20.68	0.1	21.00	-0.03		
21.56	0.00	21.56	0.00		

After shifting, all discharge measurements used for the rating analysis plot within the rated measurement accuracy. Rating number one was applied directly during all time periods that a shift was not in affect.

Special Methods:

Stage records were not available from 9/17/2001 to 9/29/2001. Stage records during this time period were estimated using the relationship between flows at ADF&G Gage 10101 and USGS Gage 15109048 (mainstem of Peterson Creek). Ice affected days were determined and estimated by graphing minimum and maximum air temperature, precipitation, snow cover, mean daily discharge from USGS Gage 15109048, and 15 minute and mean daily discharge from ADF&G Gage 10101.

APPENDIX B.
ADF&G STREAMGAGE 10101 DATA SUMMARY

Appendix B1.–ADF&G streamgage 10101 Water Year 2001 mean daily discharge values reported in cubic feet per second.

Mean Daily Discharge (ft^3/s)												
Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	---	---	---	---	---	---	---	---	---	3.0	2.4	3.8
2	---	---	---	---	---	---	---	---	---	3.0	2.1	10
3	---	---	---	---	---	---	---	---	---	2.4	1.8	5.8
4	---	---	---	---	---	---	---	---	---	2.9	2.0	5.0
5	---	---	---	---	---	---	---	---	---	3.8	2.4	6.3
6	---	---	---	---	---	---	---	---	---	5.8	1.9	7.7
7	---	---	---	---	---	---	---	---	---	5.7	1.7	6.8
8	---	---	---	---	---	---	---	---	---	7.0	1.5	5.3
9	---	---	---	---	---	---	---	---	---	5.4	1.4	3.7
10	---	---	---	---	---	---	---	---	---	4.4	1.3	2.6
11	---	---	---	---	---	---	---	---	---	3.6	1.2	1.9
12	---	---	---	---	---	---	---	---	---	3.4	1.1	1.9
13	---	---	---	---	---	---	---	---	---	6.3	1.0	12
14	---	---	---	---	---	---	---	---	4.3	6.2	0.96	8.4
15	---	---	---	---	---	---	---	---	4.5	5.2	0.91	4.7
16	---	---	---	---	---	---	---	---	5.1	3.8	0.86	15
17	---	---	---	---	---	---	---	---	5.1	2.9	0.83	9.7e
18	---	---	---	---	---	---	---	---	4.6	2.5	1.0	12e
19	---	---	---	---	---	---	---	---	5.0	2.3	1.7	5.6e
20	---	---	---	---	---	---	---	---	6.5	2.2	1.1	7.0e
21	---	---	---	---	---	---	---	---	5.3	2.0	0.93	4.8e
22	---	---	---	---	---	---	---	---	4.2	5.9	1.1	4.0e
23	---	---	---	---	---	---	---	---	4.6	11	0.99	3.2e
24	---	---	---	---	---	---	---	---	4.1	6.4	1.1	2.6e
25	---	---	---	---	---	---	---	---	3.6	8.3	0.89	2.4e
26	---	---	---	---	---	---	---	---	3.5	7.0	1.0	2.1e
27	---	---	---	---	---	---	---	---	4.3	4.8	15	1.9e
28	---	---	---	---	---	---	---	---	4.4	3.6	8.1	1.7e
29	---	---	---	---	---	---	---	---	3.3	3.1	5.6	1.4
30	---	---	---	---	---	---	---	---	2.7	2.8	5.6	6.3
31	---	---	---	---	---	---	---	---	---	2.5	6.6	---
Total	---	---	---	---	---	---	---	---	75	139	76	166
Mean	---	---	---	---	---	---	---	---	4.4	4.5	2.5	5.5
Max	---	---	---	---	---	---	---	---	6.5	11	15	15
Min	---	---	---	---	---	---	---	---	2.7	2	0.83	1.4
Acre Feet	---	---	---	---	---	---	---	---	149	276	151	328
Water Year 2001		Total 465		Mean 4.2		Max 15		Min 0.83		Acre Feet 904		

-- No data for this date.

e Estimated data.

Appendix B2.–ADF&G streamgage 10101 Water Year 2002 mean daily discharge values reported in cubic feet per second.

Mean Daily Discharge (ft^3/s)												
Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	8.3	2.4	0.47e	2.1	1.1e	1.0	0.80e	4.0	6.0	1.8	0.79	7.2
2	8.3	4.3	0.62e	1.6	1.1e	6.7	0.83e	2.8	5.6	6.5	0.65	4.5
3	5.0	8.9	0.66e	1.7	1.0e	13	0.85e	1.4	4.8	7.2	0.6	2.9
4	3.6	6.8	0.69e	1.5	1.1e	4.1e	0.85e	1.1	9.2	5.4	0.5	1.3
5	2.7	3.7	0.69e	1.1	1.00e	2.3e	0.85e	0.87	12	4.2	0.42	0.64
6	3.6	2.7	0.69e	3.3	0.84e	1.8e	0.85e	0.7	7.2	4.0	0.4	0.45
7	2.9	2.1	0.83e	5.3	0.79e	1.5e	0.85e	0.64	5.1	2.4	0.91	0.48
8	8.4	2.2	5.1e	6.6	1.7e	1.3e	0.85e	0.61	5.0	1.7	6.7	0.52
9	6.7	15	3.5e	4.8	0.58e	1.1e	0.85e	0.67	5.7	2.4	11	0.59
10	4.7	7.5	2.9e	4.9	12	0.65e	0.85e	2.3	9.0	1.6	5.8	0.98
11	3.9	4.5	2.4e	3.3	4.0e	0.48e	0.85e	4.2	5.5	2.7	4.1	2.8
12	9.5	3.1	1.8e	3.3	15e	0.58e	0.85e	4.4	3.9	2.6	20	1.5
13	6.2	2.1	1.4e	2.9	6.6	0.61e	0.85e	7.4	3.4	2.3	14	0.76
14	4.0	2.3	1.2	2.3	11	0.56e	0.93e	7.4	3.9	6.2	6.7	0.44
15	4.1	2.5	0.93e	2.4	12	0.53e	0.35	3.9	3.9	3.3	3.8	0.41
16	19	2.6	1.0e	4.9	19	0.47e	0.59	3.5	3.4	1.9	2.7	0.37
17	13	2.8	0.94e	3.4	5.8	0.45e	0.49	5.4	2.9	2	2.4	0.72
18	13	2.3	0.88e	3.8	2.8	0.45e	0.53	5.4	2.5	1.9	1.7	10
19	13	1.8	0.88e	3.9	1.8	0.46e	0.64	7.2	1.8	1.5	1.6	8.3
20	7.7	1.3	0.88e	2.9	2.0	0.46e	1.1	8.2	2.0	1.5	1.8	5.0
21	5.1	1.4	1.2e	2.1e	1.5	0.46e	1.3	8.0	1.6	1.7	10	24
22	4.0	2.2	0.86	2.0e	1.3e	0.50e	1.3	7.1	1.3	2.4	6.8	9.2
23	3.4	2.6	2.4	1.8e	1.2e	0.53e	1.0	7.9	1.7	2.1	8.7	5.0
24	2.8	2.0	18	2.1e	1.1e	0.58e	1.0	5.2	1.9	5.4	6.0	4.3
25	2.4	1.5	14	1.7e	1.3e	0.66e	0.94	5.0	2.6	5.6	6.0	4.5
26	1.7	0.94	8.1	1.6e	1.3e	0.72e	0.85	5.5	2.6	3.3	11	5.6
27	2.2	1.1e	5.0	1.6e	1.4e	0.80e	0.71	5.4	1.9	1.8	17	5.6
28	3.0	0.99e	5.3	1.4e	0.99	0.80e	1.1	7.4	1.3	1.8	19	3.9
29	9.9	0.88e	5.2	1.4e	---	0.80e	2.1	7.2	1.2	1.8	9.3	3.3
30	5.6	0.77e	3.7	1.3e	---	0.77e	3.6	4.7	1.1	1.4	7.6	2.2
31	3.5	---	2.8	1.3e	---	0.77e	---	3.5	---	1.3	7.6	---
Total	191	95	95	84	111	46	30	139	120	92	196	117
Mean	6.2	3.2	3.0	2.7	4.0	1.5	0.98	4.5	4.0	3.0	6.3	3.9
Max	19	15	18	6.6	19	13	3.6	8.2	12	7.2	20	24
Min	1.7	0.77	0.47	1.1	0.58	0.45	0.35	0.61	1.1	1.3	0.40	0.37
Acre Feet	379	189	188	167	221	91	59	276	238	182	388	233
Calendar Year 2001			Total 837		Mean 4.2		Max 19		Min 0.47		Acre Feet 1661	
Water Year 2002			Total 1316		Mean 3.6		Max 24		Min 0.35		Acre Feet 2611	

-- No data for this date.

e Estimated data.

Appendix B3.–ADF&G streamgage 10101 Water Year 2003 mean daily discharge values reported in cubic feet per second.

Mean Daily Discharge (ft^3/s)												
Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	2.6	2.4	13	5.3	5.9e	2.2e	---	---	---	---	---	---
2	4.4	2.2	5.9	6.1	7.1e	3.3e	---	---	---	---	---	---
3	2.7	1.9	4.0	4.2	11e	4.2e	---	---	---	---	---	---
4	2.1	1.5	3.0	17	9.0e	8.9e	---	---	---	---	---	---
5	3.2	1.3	2.4	20	6.7e	6.7e	---	---	---	---	---	---
6	10	1.4	1.9	18	4.5e	5.4e	---	---	---	---	---	---
7	5.9	1.5	2.0	9.7	3.3	3.6e	---	---	---	---	---	---
8	8.0	1.2	2.7	5.6	1.9	2.7e	---	---	---	---	---	---
9	7.5	1.2	7.8e	3.9	2.4	1.9e	---	---	---	---	---	---
10	4.1	1.7	5.7e	2.9	2.5	0.84e	---	---	---	---	---	---
11	2.9	1.6	4.1e	2.4	3.3	0.65e	---	---	---	---	---	---
12	2.9	0.98	15	2.1	3.7	0.52e	---	---	---	---	---	---
13	2.9	1.5	10	1.9	3.2e	0.67e	---	---	---	---	---	---
14	2.3	2.2	4.5	1.6	3.2e	0.85e	---	---	---	---	---	---
15	2.1	1.4	4.8	1.5	2.5e	---	---	---	---	---	---	---
16	15	1.0	5.6	1.5	2.7e	---	---	---	---	---	---	---
17	24	1.2	4.6	10	2.3e	---	---	---	---	---	---	---
18	6.6	3.7	3.4	11	2.2e	---	---	---	---	---	---	---
19	4.2	8.6	2.6	11	1.4e	---	---	---	---	---	---	---
20	8.5	7.7	2.1	9.8	1.6e	---	---	---	---	---	---	---
21	56	16	1.7	5.0	1.6e	---	---	---	---	---	---	---
22	28	6.4	1.7	2.9	1.9e	---	---	---	---	---	---	---
23	8.9	4.1	5.3	2.6e	2.0e	---	---	---	---	---	---	---
24	5.4	3.3	13	2.5e	2.2e	---	---	---	---	---	---	---
25	4.3	3.7	6.2	2.2e	2.1e	---	---	---	---	---	---	---
26	3.5	28	4.2	1.4e	2.5e	---	---	---	---	---	---	---
27	6.8	18	3.1	1.3e	2.4e	---	---	---	---	---	---	---
28	4.9	11	2.5	1.4e	2.5e	---	---	---	---	---	---	---
29	3.8	6.5	2.2	2.0e	---	---	---	---	---	---	---	---
30	3.1	30	1.5	4.6e	---	---	---	---	---	---	---	---
31	2.6	---	1.6	5.3e	---	---	---	---	---	---	---	---
Total	249	173	148	177	98	42	---	---	---	---	---	---
Mean	8.0	5.8	4.8	5.7	3.5	3.0	---	---	---	---	---	---
Max	56	30	15	20	11	8.9	---	---	---	---	---	---
Min	2.1	0.98	1.5	1.3	1.4	0.52	---	---	---	---	---	---
Acre Feet	494	343	294	350	194	84	---	---	---	---	---	---
Calendar Year 2002			Total 1505		Mean 4.1		Max 56		Min 0.35		Acre Feet 2986	
Water Year 2003			Total 887		Mean 5.4		Max 56		Min 0.52		Acre Feet 1760	

--No data for this date.

e Estimated data.

Appendix B4.–ADF&G streamgage 10101 monthly exceedance flows reported in cubic feet per second.

Percent Exceedence	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
0	20	19	13	3.6	8.2	12	11	20	24	56	30	18
5	11	12	6.7	2.1	8.0	9.2	7.0	15	12	19	17	13
10	9.8	11	2.3	1.3	7.4	8.1	6.4	11	9.8	13	10	8.1
15	6.1	6.7	1.8	1.1	7.4	6.0	6.2	8.7	8.4	9.9	7.6	6.0
20	5.3	5.8	1.3	1.1	7.2	5.7	5.7	7.6	7.1	8.6	6.5	5.3
25	5.0	3.9	1.1	1.00	7.2	5.5	5.4	6.7	6.3	8.3	4.2	5.1
30	4.6	3.3	0.80	0.93	5.6	5.0	4.8	6.0	5.6	7.5	3.7	4.6
35	3.9	2.8	0.80	0.85	5.4	4.9	4.0	5.6	5.2	6.6	2.9	4.1
40	3.3	2.5	0.77	0.85	5.4	3.9	3.6	2.7	4.9	5.6	2.6	3.5
45	2.9	2.5	0.77	0.85	5.2	3.9	3.3	2.4	4.5	5.0	2.4	3.0
50	2.8	2.3	0.66	0.85	4.7	3.4	3.0	1.9	4.0	4.3	2.3	2.6
55	2.4	2.1	0.61	0.85	4.3	2.9	2.8	1.7	3.5	4.1	2.2	2.4
60	2.1	2.0	0.58	0.85	4.0	2.6	2.5	1.5	2.9	4.0	2.0	2.1
65	2.1	1.7	0.56	0.85	3.5	2.5	2.4	1.2	2.5	3.6	1.8	1.8
70	1.9	1.5	0.53	0.85	3.5	2.0	2.3	1.1	2.0	3.4	1.5	1.6
75	1.7	1.4	0.50	0.83	2.3	1.9	2.1	1.0	1.8	3.0	1.4	1.2
80	1.6	1.3	0.48	0.75	1.4	1.8	1.9	0.96	1.3	2.9	1.4	0.94
85	1.5	1.1	0.46	0.64	0.87	1.6	1.8	0.91	0.74	2.7	1.2	0.88
90	1.4	1.0	0.46	0.56	0.70	1.3	1.7	0.83	0.56	2.6	1.1	0.83
95	1.3	0.85	0.45	0.49	0.64	1.2	1.6	0.60	0.45	2.2	0.96	0.69
100	1.1	0.58	0.45	0.35	0.61	1.1	1.3	0.41	0.37	1.7	0.77	0.47

APPENDIX C. ADF&G STREAMGAGE AND DISCHARGE STATION AVAILABLE DATA

Appendix C1.–The following data used for this report are stored in the WISKI database and are available upon request

Database Reference	Description
Streamgage 10101	
PtrCr_Tr_1.Q.DayMean.E	Mean daily flows from 06/14/2001 to 03/14/2003
PtrCr_Tr_1.Q.Obs.Q	Instantaneous discharge measurements from 06/13/2001 to 03/14/2003
Discharge Station 10102	Instantaneous discharge measurements from 08/13/2001 to 08/05/2002
Streamgage 10103	
P_ab_Trib4.Q.Obs.Q	Instantaneous discharge measurements from 07/08/2002 to 09/08/2004
Streamgage10104	
P_ab_Trib4.Q.Obs.Q	Instantaneous discharge measurements from 07/19/2002 to 08/29/2005
Streamgage 10105	
P_ab_Trib4.Q.Obs.Q	Instantaneous discharge measurements from 07/19/2002 to 11/04/2004

Note: Contact Jarrod Sowa, Fishery Biologist III, ADF&G Division of Sport Fish, Research and Technical Services, 802 3rd St. Douglas, AK 99824.

APPENDIX D. PHOTOGRAPHS OF DISCHARGE MEASUREMENT TRANSECTS

Appendix D1.–Photographs of discharge measurement transects.

Figure 1.–Peterson Creek tributary 1 looking upstream at ADF&G streamgage 10101on November 11, 2003 at a discharge of 1.2 cubic feet per second.

Figure 2.–Peterson Creek mainstem upstream of tributary 3 looking upstream from ADF&G streamgage 10104 on September18, 2003 at a discharge of 4.1 cubic feet per second.

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Figure 3.–Peterson Creek mainstem upstream of tributary 4 looking downstream from ADF&G streamgage 10103 on July 07, 2003 at a discharge of 0.90 cubic feet per second.

Figure 4.–Peterson Creek mainstem upstream of tributary 8 looking upstream from ADF&G streamgage 10105 on July 07, 2003 at a discharge of 0.58 cubic feet per second.