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Steelhead Usable Habitat Area in Southeast Alaska: Ratz Creek Watershed, 2009–2011

by

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and

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

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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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ABSTRACT

To better understand steelhead (*Oncorhynchus mykiss)* populations and habitat capability in Southeast Alaska, stream habitat and fish use surveys were conducted in Ratz Creek watershed on Prince of Wales Island, Southeast Alaska, from 2009 to 2011. The overall goal of this project was to develop a model to assess the carrying capacity of steelhead in Southeast Alaska streams, based on the relationship between usable habitat area and steelhead production. Ratz Creek was the fourth watershed out of eight to be surveyed for this project. During habitat surveys, the stream network was mapped and individual stream reaches were classified according to fluvial process group and channel type. Several stream reach characteristics were measured, including reach length and channel bed width. Large woody debris and macro-pools were counted to characterize the available habitat. These data have been found to be important indicators of fish habitat in other streams occupied by salmonids, and were used to describe existing conditions of the stream reaches surveyed for this project.

Snorkel surveys and minnow traps were used during fish use surveys to identify stream reaches occupied by steelhead. When steelhead were observed in a reach, the channel bed width and reach length were multiplied together to estimate steelhead usable habitat area for that reach. Adult steelhead occupied a total of 10 stream reaches, including reaches in the mainstem and in a significant tributary stream, resulting in a total adult usable habitat area of 9.46 ha. In addition to the reaches occupied by adults, juvenile steelhead were observed in 10 additional reaches, for a combined total of 12.52 ha of usable habitat area. Existing production data for Ratz Creek were used to calculate an estimated 45 adults/ha and 126 smolts/ha of total usable habitat area.

Key words: Ratz Creek, Southeast Alaska, steelhead, *Oncorhynchus mykiss,* stream habitat survey, large wood accumulations, key wood accumulations, macro-pools, snorkel survey, usable habitat area.

INTRODUCTION

Southeast Alaska (SEAK) is known to anglers for the high quality stream habitat that provides abundant opportunities to catch steelhead *(Oncorhynchus mykiss)*. Steelhead stocks have been managed conservatively since 1994 when the Board of Fisheries adopted restrictive regulations in response to concerns over population declines. However, given recent liberalization of federal subsistence steelhead regulations, there is an imminent need to better understand steelhead populations in SEAK with respect to habitat capability. Small populations of steelhead are common throughout SEAK and are considered particularly vulnerable to overharvest and habitat degradation (Nehlsen et al. 1991). Therefore, a better understanding of how particular habitats contribute to steelhead production and rearing potential is important to the management of this species.

In 2005, the Alaska Department of Fish and Game, Division of Sport Fish (ADF&G-SF) initiated a long-term project (described in this report) to address management and conservation needs by collecting steelhead habitat data in systems where steelhead stock assessment projects were occurring. The overall goal for the project is to integrate these two datasets into a habitat capability model for steelhead in SEAK. Surveys for this project include two components: a characterization of watershed stream habitats (Phase I), followed by a seasonal assessment of habitat use and occurrence by juvenile and adult steelhead (Phase II).

This project explores an alternative stock assessment method (i.e., a habitat-based model) for steelhead in SEAK, similar to efforts conducted by researchers in British Columbia and Oregon (Bocking et al. 2005; Cramer and Ackerman 2009a; Tautz et al. 1992). Tautz et al. (1992) described three categories of information used in developing a steelhead carrying capacity and production model for the Skeena River in British Columbia: distribution, fish use, and production. Distribution referred to the number and extent of streams or tributaries likely to contain steelhead; fish use involved estimating total area and total usable habitat area of potential steelhead bearing streams; and production included the possible number of steelhead smolts produced from a stream's expected usable area. For the ADF&G-SF project, the Tautz model will be refined by calculating total steelhead usable habitat area from stream reaches with verified steelhead use, and by integrating population productivity from each watershed in which usable habitat area is calculated.

In March 2008, ADF&G-SF staff from Region I convened to discuss the process of integrating the steelhead habitat capability project with other steelhead research projects in SEAK. The outcome of this meeting is presented in the Strategic Plan for the Southeast Alaska Steelhead Research and Monitoring Program (unpublished ADF&G, Division of Sport Fish, Strategic Plan for Southeast Alaska Steelhead Research and Monitoring Program; available at the Southeast Regional Office, Douglas, Alaska), referred to herein as the *Steelhead Strategic Plan*. The components necessary to adequately develop this steelhead habitat model require production and habitat data (i.e., usable area) for eight steelhead bearing systems with greater than five years of production data. Four of the systems will provide smolt and adult production estimates, while the other four systems will contribute only adult production data to the model. Habitat data, including usable area, will be collected for all eight systems. The systems selected will be stratified to account for biological and hydrological diversity found in northern and southern SEAK, as well those that provide lake rearing habitat and those that do not (i.e., no lake present or a migration barrier exists that blocks access to the lake).

Because regional steelhead stocks are generally considered stable (Harding 2009), this is an ideal opportunity to pursue system-specific stock assessment information with regards to habitat quality and availability. This project was initiated in the Sitkoh Creek watershed, beginning with Phase I surveys (Crupi et al. 2010), followed by Phase II surveys (Crupi and Nichols 2012b). Peterson Creek and Sashin Creek (Crupi and Nichols 2012a) were the second and third steelhead systems studied in the *Steelhead Strategic Plan* design. Given the limited reference that can be made to other steelhead-bearing systems in SEAK based on results from only three watersheds, it is important to integrate habitat data from other systems with available production data in the development of this habitat-based model. The Ratz Creek watershed on Prince of Wales Island was identified to be the fourth watershed to collect habitat and fish use data on, based on the need for this project to obtain adult and juvenile production data from a lake rearing system in southern SEAK. Results from Phase I and Phase II surveys conducted on Ratz Creek are presented in this report.

DESCRIPTION OF PROJECT AREA

Ratz Creek (ADF&G Anadromous Waters Catalog Stream No. 106-10-10100) is a steelhead system located on Prince of Wales Island, approximately 85 km northwest of Ketchikan, Alaska (Figure 1). The mainstem of Ratz Creek provides approximately 7.44 km of anadromous habitat before emptying into Clarence Strait via Ratz Harbor. Several fish species inhabit the mainstem and associated tributaries as identified in the Anadromous Waters Catalog (AWC) including: chum (*O. keta*), coho (*O. kisutch*), pink (*O. gorbuscha*), and sockeye salmon (*O. nerka*); steelhead and cutthroat trout (*O. clarkii*); and Dolly Varden (*Salvelinus malma*) (Johnson and Daigneault 2008).

Figure 1.–Location of Ratz Creek watershed in Southeast Alaska.

Landownership within the Ratz Creek watershed is held by the United States Forest Service (USFS) Tongass National Forest. The stream is accessible via a small road (USFS Road 30) approximately 20 km north of Thorne Bay. The USFS has managed the watershed for timber harvest with 13.24 km^2 reportedly harvested. The watershed drains an area of 43.34 km^2, and includes three lakes: Big Ratz Lake (0.84 km^2), Trumpeter Lake (0.21 km^2), and Little Lake (0.26 km^2). A USFS fish ladder is located immediately downstream from the outlet of Big Lake (Figure 2). It is believed that the Ratz Creek system supports a fall-run of adult steelhead that overwinters in these lakes (Piazza et al. 2008). Prior to surveys being conducted for this project in the Ratz Creek watershed, the USFS had identified a mapped stream network totaling approximately 97.60 km (Table 1).

Table 1.–Existing mapped hydrography of the Ratz Creek watershed, Southeast Alaska.

Reporting metric	Length[a] (km)	Comments/description
Stream length – AF	1.28	Stream length of alluvial fan (AF) process group
Stream length – FP	3.43	Stream length of flood plain (FP) process group
Stream length – HC	66.47	Stream length of high gradient contained (HC) process group
Stream length – ES	0.04	Stream length of estuarine (ES) process group
Stream length – L	7.49	Stream length of lake (L) process group
Stream length – LC	0.60	Stream length of low gradient contained (LC) process group
Stream length – MC	7.01	Stream length of moderate gradient contained (MC) process group
Stream length – MM	8.71	Stream length of moderate gradient mixed control (MM) process group
Stream length – PA	2.57	Stream length of palustrine (PA) process group

[a] Stream length calculated from existing mapped hydrography in a Geographic Information System (GIS).

In 2005 and 2007, a cooperative steelhead stock assessment project between ADF&G, the Bureau of Indian Affairs, the Organized Village of Kasaan, and the USFS was conducted to count adult steelhead in Ratz Creek through a weir. The minimum spawning escapement of steelhead counted passing upstream through the weir combined with unmarked emigrants totaled 399 in 2005 (Piazza et al. 2008) and 284 in 2007 (Piazza 2009).

In 2010, ADF&G-SF initiated a multi-year project to assess the steelhead population on Ratz Creek. The project included a weir that was installed at the same site (Figure 2) that was used in the 2005 and 2007 steelhead stock assessment project. The multi-year ADF&G-SF project involves collecting a variety of biological and population data on adult and juvenile steelhead in Ratz Creek. Information collected through the project will be used to compare to other steelhead streams in SEAK. The weir was in operation between mid-March and late May in both 2010 and 2011.

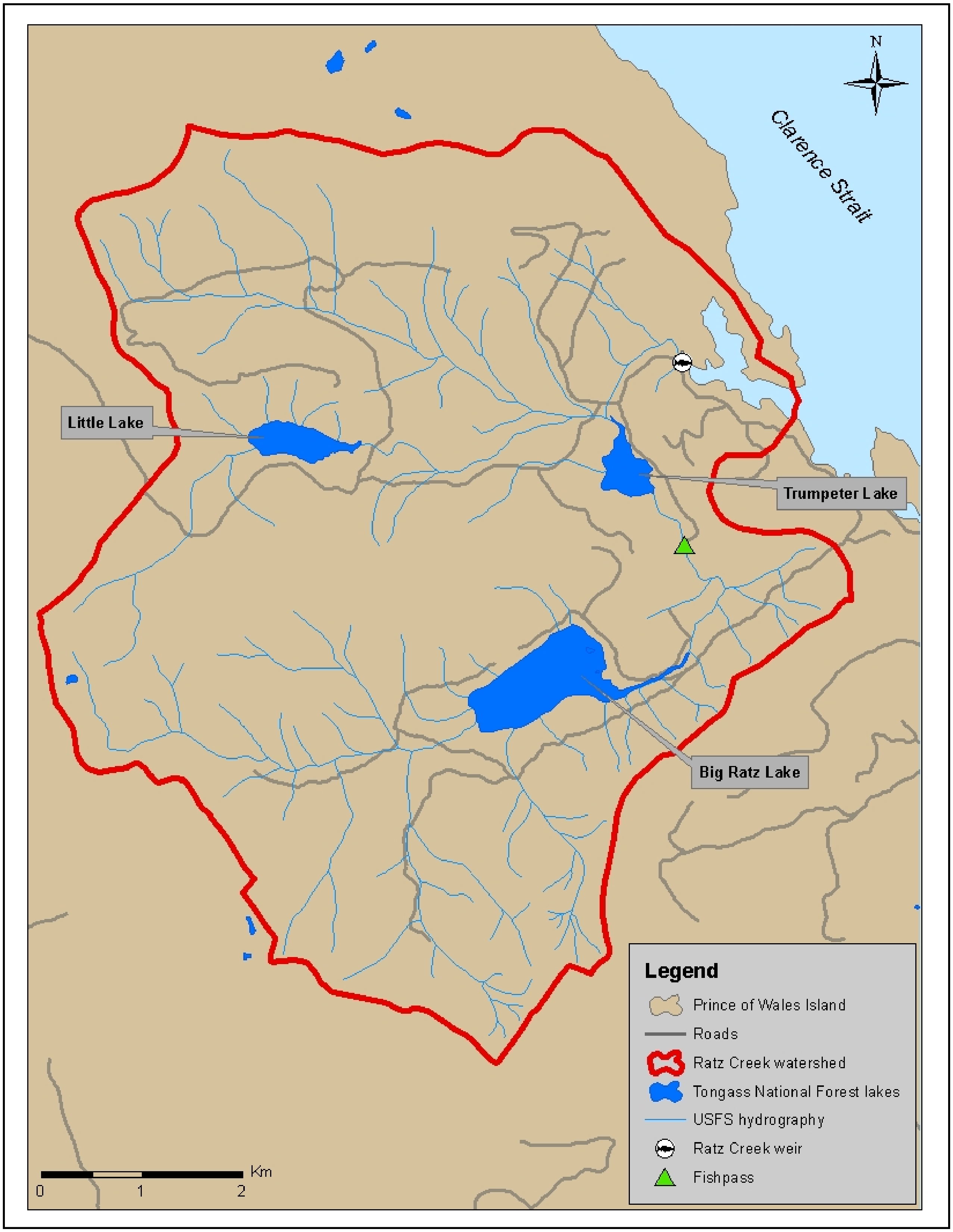

Figure 2.–Map showing USFS hydrography and other predominate features in Ratz Creek watershed, Southeast Alaska.

OBJECTIVES

Phase I (habitat characterization): measure and characterize physical stream habitat in the mainstem and tributaries of the Ratz Creek watershed. Objectives that were addressed:

1. Estimate habitat metrics in each stream reach such that the estimate is within 35% of the actual value 95% of the time. The following metrics will be estimated:

    a. Mean channel bed width ($\overline{cbw}$);

2. Census stream attributes in each stream reach to calculate the following metrics:

    b. Macro pool density (D);

    c. Large wood density (*LWD*);

    d. Key wood density (*KWD*).

Phase II (fish use): measure the amount of steelhead usable habitat. The following objective was addressed:

1. Estimate usable area for juvenile and adult steelhead in the Ratz Creek watershed such that the estimate is within 35% of the actual value 95% of the time.

METHODS

STREAM HABITAT SURVEYS

Following established stream habitat survey protocols described in the ADF&G Stream Habitat Survey User Guide (Frenette et al. *In prep*), mainstem reaches and prioritized tributaries were surveyed on Ratz Creek (August 2009, September 2009, and April 2010). The core components of the stream habitat survey protocol used in the current study were derived from the USFS Region 10 Tier II Aquatic Habitat Survey (USFS 2001), and the USFS Channel Type Users Guide (USFS 1992). The stream habitat survey provided key data necessary for conducting coarse assessments of the habitat that may be important to fish at both the watershed and geomorphic reach scales. The stream habitat survey methodology included the collection of both physical and biological features and events encountered while transiting along the stream network. The locations of these features and events were recorded on Global Positioning System (GPS) receivers, adding the necessary spatial data for full integration within GIS, using ArcGIS™[1] software (version 10.0).

The unit of scale at which physical habitat parameters were aggregated and reported for this project was the geomorphic stream reach (reach, hereafter) level. Geomorphically distinct stream reaches were identified using the "Tongass Channel Type Classification" system (USFS 1992). This classification scheme was based on the geomorphic process groups, which describe the interrelationship between watershed runoff, landform relief, geology, and glacial or tidal influences on fluvial erosion and deposition processes. Individual stream reaches have a minimum mapping unit, or length, of 100 m. Stream reaches are generally homogeneous throughout their length, with regard to macro-habitat and geomorphic characteristics. Therefore,

[1] Product names used in this report are included for scientific completeness, but do not constitute a product endorsement.

individual stream reaches were classified by the physical attributes found within their geomorphic boundaries (Frenette et al. *In prep*).

Data collected during the stream habitat survey included: (1) mapping the stream course, (2) mapping physical habitat features and fish observations, (3) characterizing physical habitat of stream reaches and side channels, and (4) documenting features and events with photos. Physical habitat measures recorded within each reach included: stream gradient, channel bed width (CBW), incision depth, bankfull width, predominant bank composition, channel pattern, dominant substrates (primary, secondary, and tertiary) (Appendix A), length of stream reach, length of side channel(s), length of riparian disturbance (by type), number of barriers (by type), number of large wood accumulations, number of key wood pieces, and counts of macro pools (Appendix B) following protocols discussed in Crupi et al. (2010). All data collected during this project were entered into the division's *Odyssey* database following established protocols (unpublished ADF&G, Division of Sport Fish, Region I Divisional Database [Odyssey] User Guide; available at the Southeast Regional Office, Douglas, Alaska), and handled identically with respect to data processing, quality assurance, and quality control measures.

Field crews acquired CBW measurements using a range finder (>10 m, +/- 0.5 m) or measuring tape (<10 m, rounded to nearest 0.25 m), at intervals of up to 100 m along the reach, with a minimum sample size of 3 measurements per reach. These measurements were used to calculate average CBW ($\overline{cbw}_i$) for each reach, which was necessary to determine total area and total usable area. The importance of this measurement to the model (estimating usable area) warrants the effort necessary to measure CBW with sufficient frequency, within each reach, to estimate the mean according to criteria specified in the objectives. At the end of each reach, crews calculated the sample coefficient of variation (CV) for each reach (CV = sample SD / mean) to determine if additional sampling was required. If reach sampling was not sufficient, the field crew calculated an additional approximate sample CV (CV_a = sample range / 4 / mean). Using the larger of CV or CV_a, we estimated how much additional sampling effort was required for the reach. When additional samples were required, they were distributed roughly uniformly across the reach at locations approximately mid-distance from initial sampling locations as recorded by GPS.

Calculated metrics include mean CBW.

Mean CBW ($\overline{cbw}_i$) for each reach was calculated as:

$$\overline{cbw}_i = \frac{\sum cbw_k}{n_i}, \qquad (1)$$

where:

cbw_k = individual CBW measures taken within reach *i*; and

n_i = number of measures taken within reach *i*.

Censused metrics include: macro pool density, large wood accumulation density, and key wood density.

Macro pool density (D_i) for each reach were calculated as:

$$D_i = \frac{p_i}{a_i}, \tag{2}$$

where:

p_i = number of qualifying macro pools counted in reach *i*; and

a_i = area of reach *i* (length of reach *i* * $\overline{cbw}_i$).

Large wood density (*LWD*) and key wood density (*KWD*) for each reach were calculated the same as in the macro pool density calculation (equation 2).

FISH HABITAT USE ASSESSMENT AND ESTIMATE OF STEELHEAD USABLE HABITAT AREA

To effectively identify steelhead usable area, fish use surveys were conducted on the entire mainstem and all significant tributaries (below geologic barriers) to document the presence of steelhead. Underwater observation has been identified as one of the most functional and cost-effective methods available to acquire information on fish abundance, behavior, and distribution, over long reaches in small streams (Dolloff et al. 1996; Hankin and Reeves 1988).

Snorkel surveys were performed by 2-person crews, and these surveys were supplemented in some stream reaches with minnow trap sampling. When used, minnow traps were baited with salmon roe, placed <100 m apart throughout the reach, and soaked for a minimum of 1 h, following procedures outlined in Magnus et al. (2006). To maximize the potential to observe steelhead within all reaches actually occupied, sampling was repeated in the spring, summer, and fall seasons. When steelhead were observed, the stream reach identifier, spatial location (i.e., GPS waypoint), number of fish in each size class (050 mm, 51–150 mm, 150–200 mm, and >200 mm), and the meso-habitat occupied by these fish were recorded. Meso-habitat was categorized as scour pools, backwater pools, glides, and riffles. The same information was also collected and recorded for all other species of salmonids observed during snorkel surveys or minnow trapping efforts.

To meet project objectives, the individual stream reaches occupied by steelhead were identified, then the total area used by both adult and juvenile steelhead were calculated. In survey reaches where steelhead were observed, the entire area of that reach was considered usable habitat. When steelhead were not observed, the reach was not considered usable habitat. The following calculations were performed to calculate steelhead usable habitat area and total area.

The amount of usable habitat of the i^{th} usable reach (u_i) was calculated as:

$$u_i = l_i \times \overline{cbw}_i, \tag{3}$$

where:

l_i = total length of reach *i*; and

$\overline{cbw}_i$ = average CBW of reach *i*.

The total usable area in the system (*U*) was calculated as:

$$U = \sum u_i \quad . \tag{4}$$

When the reach was identified as not being used by steelhead, the area of that reach was considered non-usable. The non-usable area of the j^{th} non-usable reach (v_j) and total non-usable area (*V*) were calculated in the same manner as usable area (equations 3 and 4).

The total area (*T*) was calculated as:

$$T = U + V \quad . \tag{5}$$

To help develop the steelhead habitat model for SEAK, it was important to provide metrics of usable area in terms of production. To calculate an average adult escapement estimate for Ratz Creek, weir counts from the 2005 (Piazza et al. 2008), 2007 (Piazza 2009), 2010, and 2011 (D.C. Love, Fishery Biologist, ADF&G-SF, Douglas, personal communication) weir activities were used. In 2005 and 2007, the weir was not in operation for as long as it was in 2010 and 2011, so those numbers were considered to be minimum escapement estimates. In 2007, the weir was not completely fish tight for a period of time due to a major flood event (Piazza 2009); however, the escapement estimate was used to calculate a mean adult steelhead escapement for Ratz Creek, knowing that it would be a minimum escapement. For 2010 and 2011, Chapman's modification to the Peterson estimator (Seber 1982) was used to estimate the adult escapement into Ratz Creek. Details related to calculating the Peterson estimate using weir observations are described in Love and Harding (2009).

Adult steelhead density (A_j) for the watershed was calculated as:

$$A_i = \frac{\bar{a}_j}{U_j} \quad , \tag{6}$$

where:

$\bar{a}_j$ = mean adult steelhead escapement counted in watershed $_j$; and

U_j = total usable area (equation 4) in watershed $_j$.

Production data for juvenile steelhead on Ratz Creek was limited; the 2010 and 2011 steelhead smolt counts were used to determine a juvenile production estimate. Juvenile steelhead density was calculated similarly with equation 6, which provide an estimate of smolt production per hectare of usable habitat area.

When the identification of a potential steelhead was uncertain, the stream reach was not considered occupied by steelhead. Juvenile steelhead smaller than 50 mm were particularly difficult to distinguish from cutthroat trout; on occasions when the species of trout could not be determined, the fish were simply identified as trout instead of differentiating between the species. Through repeated seasonal surveys at previous survey locations (i.e., Sitkoh Creek and Peterson Creek) we improved our likelihood of observing steelhead within these reaches, but acknowledge that it was possible we did not detect or identify all steelhead present. Therefore, the total usable area (*U*) is considered a minimum.

RESULTS

STREAM HABITAT SURVEYS

Table 2 identifies the trips during which stream habitat surveys were conducted in the Ratz Creek watershed. A total of 1,067 stream habitat features at 713 individual waypoints were recorded to precisely map the stream network and document current stream habitat conditions. A total of 21.58 km of stream habitat were surveyed, and reaches were characterized into fluvial process groups and channel types (Table 3). The length of stream surveyed represents approximately 22% of the entire stream network identified in the watershed by the existing, mapped hydrography.

Table 2.–Field survey trips, timing, and distances sampled in Ratz Creek watershed, Southeast Alaska.

Season- year	Survey type	Survey dates	# reaches surveyed	Distance snorkeled (km)
Summer-2009	Habitat	8/18–8/22/2009	50	0.0
Fall-2009	Habitat, fish use	9/29–10/4/2009	43	17.3
Spring-2010	Habitat, fish use	4/27–5/3/2010	36	15.3
Summer-2010	Fish use	6/26–6/29/2010	26	12.1
Spring-2011	Fish use	5/11/2011	9	4.7

Table 3.–Stream hydrography mapped by ADF&G-SF during Phase I habitat surveys in Ratz Creek watershed, Southeast Alaska.

Reporting metric	No. of reaches	Total length surveyed (km)	% Composition of area surveyed	Comments/description
Stream length – AF	1	0.63	2.9	Stream length of alluvial fan (AF) process group
Stream length – FP	5	3.09	14.3	Stream length of flood plain (FP) process group
Stream length – HC	11	3.56	16.5	Stream length of high gradient contained (HC) process group
Stream length – LC	1	0.47	2.2	Stream length of low gradient contained (LC) process group
Stream length – MC	4	3.93	18.2	Stream length of moderate gradient contained (MC) process group
Stream length – MM	14	4.55	21.1	Stream length of moderate gradient mixed control (MM) process group
Stream length – PA	9	3.38	15.7	Stream length of palustrine (P) process group
Stream length – SCH	15	1.97	9.1	Stream length of side channels (SCH)

A total of 45 distinct stream reaches and 15 side channels were identified and mapped, which included approximately 3.5 km more stream habitat than was identified in the existing mapped stream hydrography for the area surveyed. Tables 3 and 4 include habitat-related summary statistics for the different process groups and individual reaches identified throughout the area surveyed. Table 4 is an abbreviated table including only reaches where steelhead were observed; Appendix C contains a table that includes habitat-related summary statistics for all reaches surveyed. The average CBW, density of large and key wood accumulations, and density of macro pools was calculated. The highest densities of large wood accumulation and macro pool habitat were observed in high gradient contained (HC) and moderate gradient mixed control (MM) process groups. The greatest density of key wood was found in HC habitats.

The stream habitat survey on the mainstem of Ratz Creek resulted in the classification of 5 distinct fluvial process groups, including: flood plain (FP), low gradient contained (LC), palustrine (PA), moderate gradient contained (MC), and moderate gradient mixed control (MM) process groups (Table 4; Figure 3; Appendix C). Immediately downstream of Big Ratz Lake was a stretch of PA habitat with substrates ranging from organic to very fine gravel (≤3.9 mm).

Below the PA was an MC channel that included substrate dominated by small cobbles, large cobbles, and large/medium boulders (64 mm to ≥512 mm), followed by an MM with substrates ranging between very course gravel and large cobbles (32–255.9 mm). The MM was followed by another MC reach that included the fish pass and had substrate ranging from small cobble to small boulder (64–512 mm), and an FP reach with medium gravel to small cobble (8–127.9 mm) substrate that drained into Trumpeter Lake.

Downstream of Trumpeter Lake was a short PA section that included 1 long pool within the reach. This PA flowed into an FP reach that ran through a clearcut, followed by an LC reach with substrate ranging from medium gravel to bedrock (8 mm–bedrock). The lowest reach in the system was a long, relatively wide stretch of FP habitat that emptied into Ratz Harbor. This FP (FP5-1) reach contained the highest large wood and macro pool counts, and was the longest of any reach surveyed during Phase II of the project (Table 4; Appendix C).

FISH HABITAT USE ASSESSMENT

Between September 2009 and April 2011, four fish use surveys were conducted on Ratz Creek to assess the distribution patterns of adult and juvenile steelhead, necessary to estimate steelhead usable habitat area. Fish use surveys were repeated seasonally on the majority of stream reaches identified as containing potential steelhead habitat, for a combined total of 49.4 km surveyed during the four trips. Juvenile steelhead were observed during each fish use survey.

Adult steelhead were observed in the fall (2009), spring (2010), and spring (2011) fish use surveys, but were not observed during the summer (2010) event. Juvenile steelhead were observed during all four fish use surveys. Fish species observed in each reach are documented in Appendix C.

A combined total of 2,179 steelhead were observed in 20 different stream reaches during fish use surveys (Table 5). Adult steelhead were observed in eight of the nine mainstem reaches and in two reaches in the largest tributary stream located in the lower portion of the watershed. The only mainstem reach where adult steelhead were not observed was in the short PA stretch that drained out of Trumpeter Lake (Figure 3). In addition to the ten reaches where adults were observed, juvenile steelhead occupied nine other tributary streams throughout the survey area and in the mainstem PA reach where adults were not observed (Table 5; Figure 4).

Table 4.–Habitat characteristics in steelhead occupied stream reaches of Ratz Creek watershed, Southeast Alaska ("*" denotes mainstem stream reaches).

Reach ID	Reach length (m)	Mean channel bed width (m)	Total area (ha)	Stream gradient (%)	Large wood count	Key wood count	Macro pool count	Large wood density (#/ha)	Key wood density (#/ha)	Macro pool density (#/ha)
AF1-1	634.68	6.00	0.38	5.60	92	11	42	241.48	28.87	110.24
FP4-1*	669.23	13.02	0.87	3.40	83	7	37	95.29	8.04	42.48
FP4-2	678.14	13.55	0.92	3.10	318	4	33	346.13	4.35	35.92
FP5-1*	1174.38	19.65	2.31	0.90	334	30	28	144.72	13.00	12.13
FP5-2*	447.64	16.12	0.72	2.10	57	3	16	79.01	4.16	22.18
HC2-3	137.68	10.25	0.14	7.50	6	1	6	42.52	7.09	42.52
LC1-1*	467.12	18.50	0.86	1.40	38	2	7	43.97	2.31	8.10
MC1-2*	790.30	10.95	0.87	7.00	78	21	62	90.13	24.27	71.65
MC1-3	101.52	6.75	0.07	–[a]	–[a]	–[a]	–[a]	–[b]	–[b]	–[b]
MC2-1*	498.89	12.55	0.63	3.80	99	9	53	158.18	14.38	84.68
MM1-1	697.84	3.88	0.27	2.70	70	17	37	258.86	62.87	136.83
MM1-2	217.35	2.44	0.05	1.70	25	5	7	470.55	94.11	131.75
MM1-3	222.88	6.37	0.14	6.00	37	4	13	260.75	28.19	91.61
MM1-4	246.34	6.83	0.17	3.40	7	4	4	41.58	23.76	23.76
MM1-5	224.25	1.73	0.04	2.30	6	17	22	154.36	437.35	565.99
MM2-1	348.93	13.14	0.46	5.50	33	6	19	71.96	13.08	41.43
MM2-2	374.17	10.30	0.39	6.40	242	20	27	627.93	51.89	70.06
MM2-3*	896.08	12.65	1.13	3.00	191	19	67	168.47	16.76	59.10
PA2-1*	214.85	29.64	0.64	0.20	43	1	1	67.52	1.57	1.57
PA2-2*	558.21	26.35	1.47	1.90	144	11	4	97.89	7.48	2.72

[a] No data.

[b] No data, could not be calculated.

Table 5.–Stream reaches where adult and juvenile steelhead were observed in Ratz Creek watershed, Southeast Alaska ("*" denotes mainstem stream reaches).

Reach ID	No. of adult steelhead observed	No. of juvenile steelhead observed
AF1-1	0	18
FP4-1*	16	197
FP4-2	0	5
FP5-1*	97	392
FP5-2*	1	19
HC2-3	2	25
LC1-1*	54	166
MC1-2*	15	521
MC1-3	0	3
MC2-1*	6	184
MM1-1	0	9
MM1-2	0	1
MM1-3	0	13
MM1-4	0	3
MM1-5	0	1
MM2-1	16	136
MM2-2	0	13
MM2-3*	14	241
PA2-1*	0	1
PA2-2*	1	9

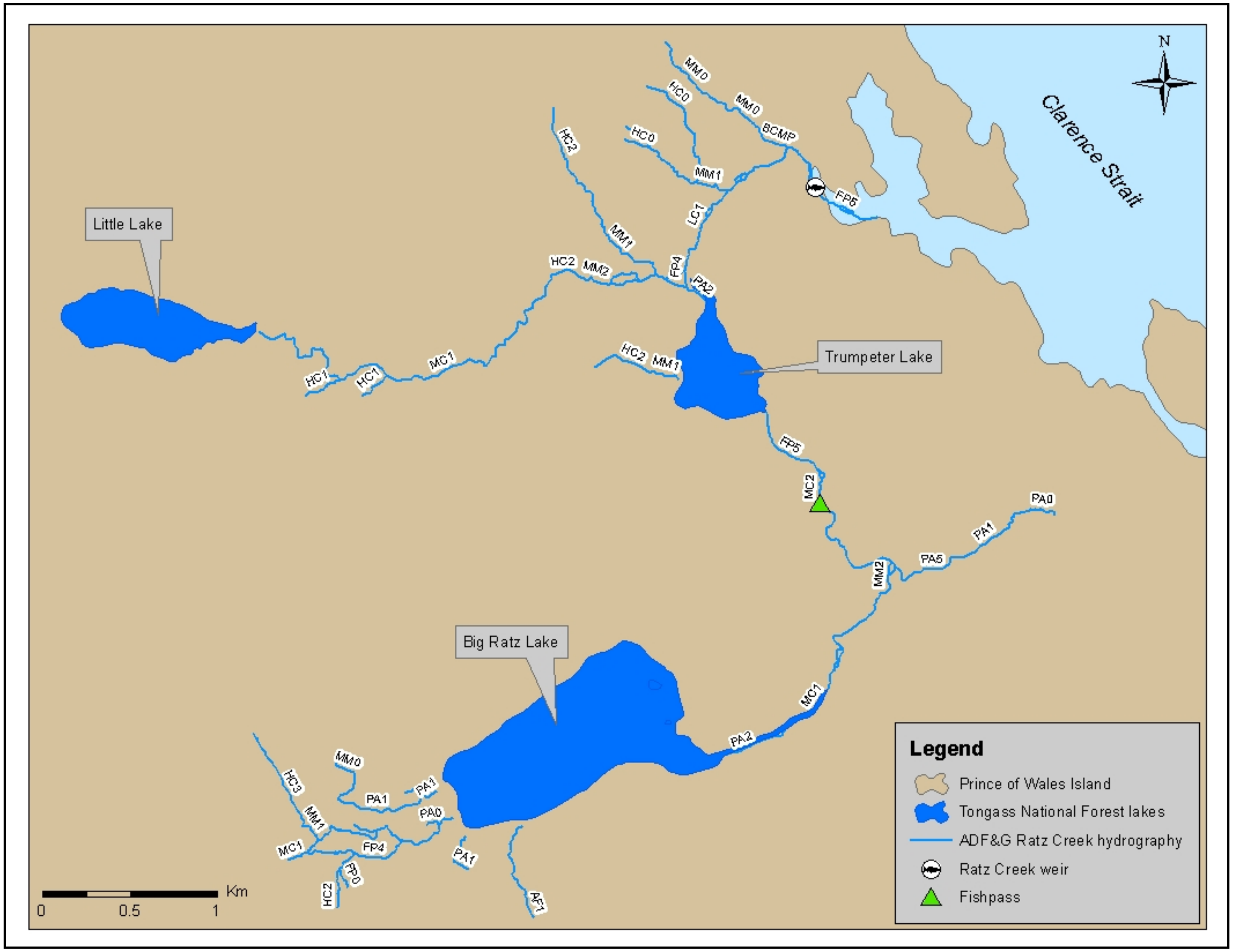

Figure 3.–Stream hydrography, including channel types, mapped by ADF&G during Phase I habitat surveys in the Ratz Creek watershed, Southeast Alaska.

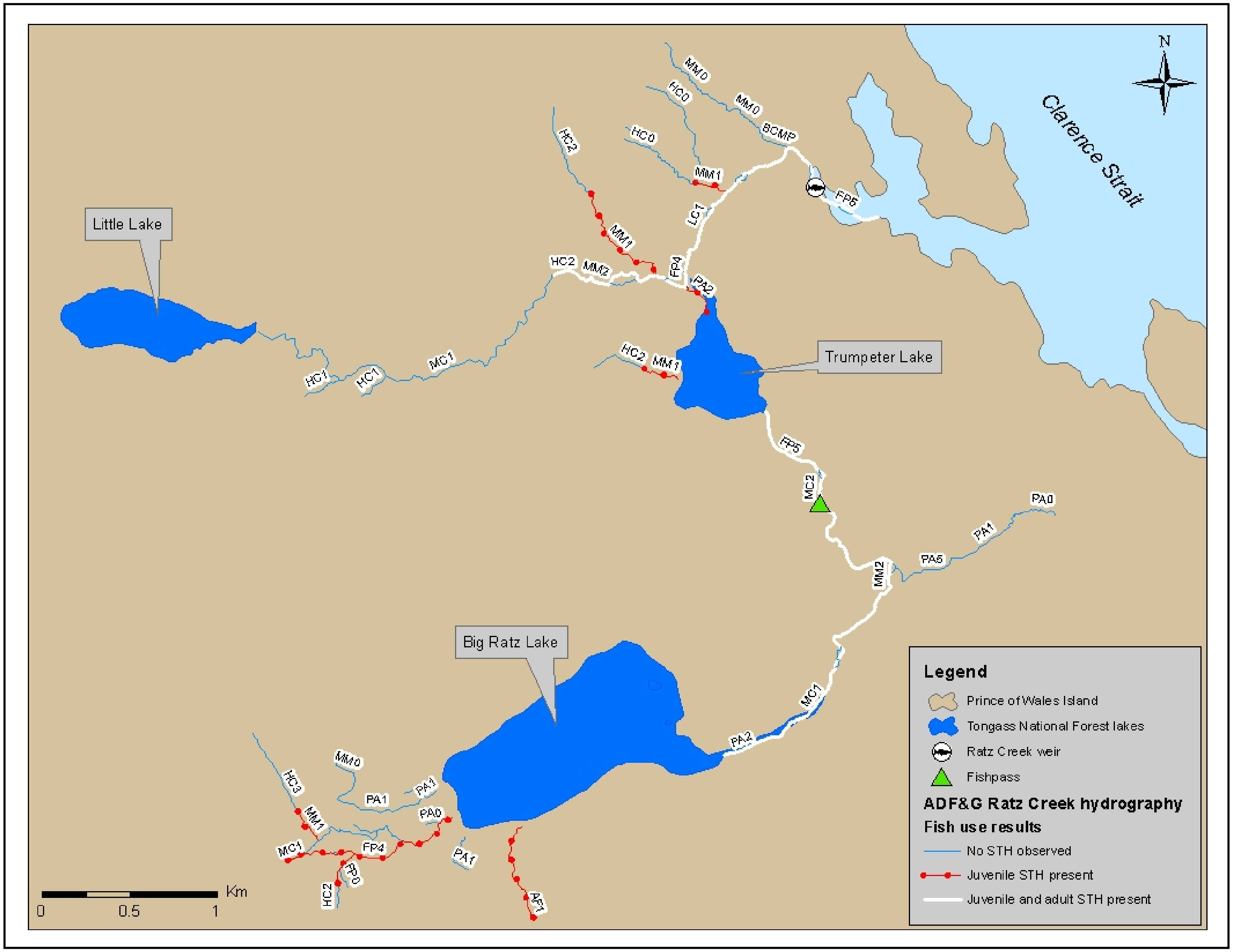

Figure 4.–Fish use survey results for steelhead presence in Ratz Creek watershed, Southeast Alaska.

Of the 222 adult steelhead observed during fish use surveys, 68% occurred in the two lowest stream reaches in Ratz Creek (i.e., the lowest 1.64 km of the mainstem). Over 50% of all adult steelhead observations occurred in FP channel types (Figure 5). Of the 1,957 juvenile steelhead observed during fish use surveys, the highest number (36.2%) were associated with MC channel types (Figure 5). The occurrence of steelhead was also characterized with respect to meso-habitat, independent of channel type or stream reach. Adult (61.7%) and juvenile steelhead (52.1%) were observed most frequently in scour pool meso-habitats (Figure 6).

Individual locations of steelhead show that the highest concentrations of adults occurred in the lower portion of the mainstem (Figure 7). The highest concentrations of juvenile steelhead were observed in mainstem reaches and in the largest tributary stream located in the lower portion of the watershed (Figure 8).

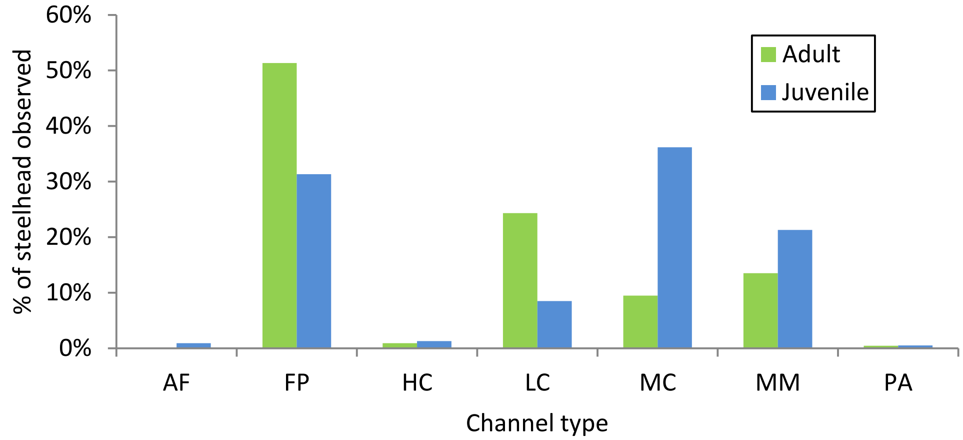

Figure 5.–Channel types occupied by adult and juvenile steelhead in Ratz Creek watershed, Southeast Alaska.

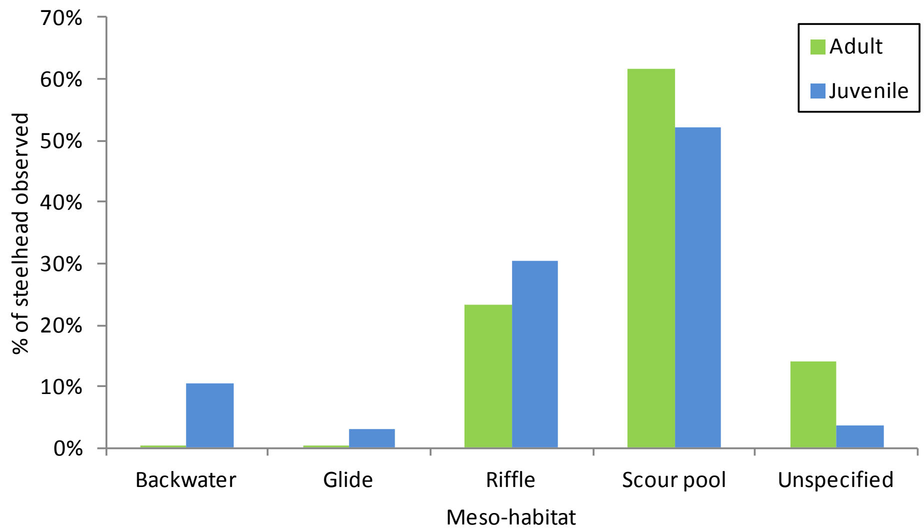

Figure 6.–Meso-habitats occupied by adult and juvenile steelhead in Ratz Creek watershed, Southeast Alaska.

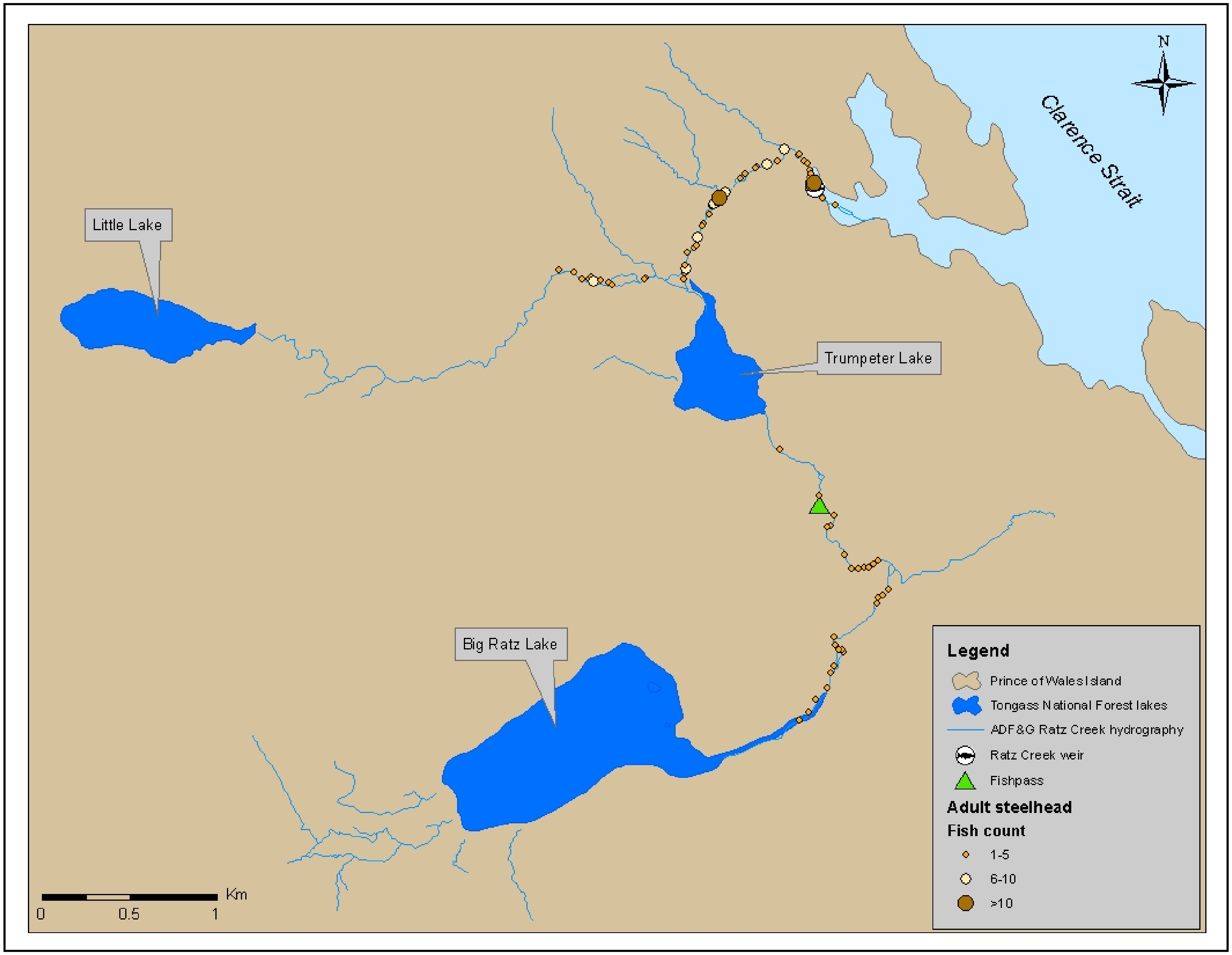

Figure 7.–Locations of adult steelhead observed in Ratz Creek watershed, Southeast Alaska.

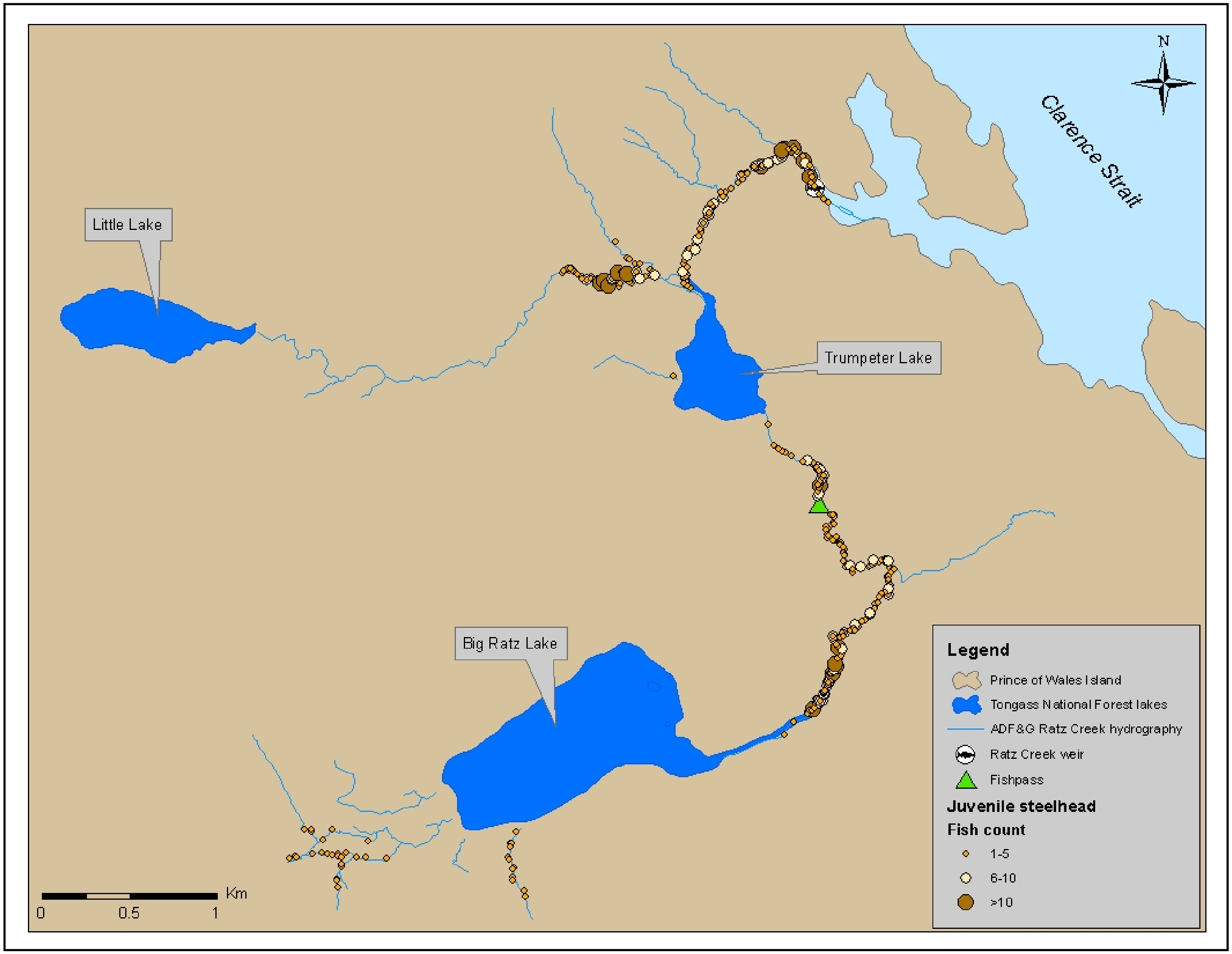

Figure 8.–Locations of juvenile steelhead observed in Ratz Creek watershed, Southeast Alaska.

STEELHEAD USABLE HABITAT AREA

To calculate usable habitat area for steelhead in Ratz Creek watershed, a total of 451 CBW measurements were measured in 41 stream reaches (Table 6; Appendix D1). The total area (*T)* of stream reaches identified for potential steelhead distribution equaled 15.67 ha. Adult steelhead were observed in the previously mentioned eight mainstem reaches and two tributary reaches, which resulted in an adult usable habitat area totaling 9.46 ha. In addition to the reaches occupied by adults, juvenile steelhead were observed in 10 other reaches, for a combined total of 12.52 ha of usable habitat area (*U*).

As we develop the steelhead habitat model for SEAK it will be important to provide the metrics of usable area in terms of production. In this model, the Ratz Creek watershed will represent one of two lake systems in southern SEAK. Using adult production data from the 2005 (n = 399) and 2007 (n = 284) weir counts, and the 2010 (n = 439; SE = 12.6) and 2011 (n = 579; SE = 6.6) Peterson estimates, the four-year minimum average number of adult steelhead in Ratz Creek was 425 (Love et al. *In prep*). The adult steelhead density (A_i) (i.e., the average number of adults per hectare of total usable habitat) equaled 44.9. Using 2010 (n = 1,820) and 2011 (n = 1,328) weir counts, the two-year minimum average number of juvenile steelhead in Ratz Creek was 1,574 (Love et al. *In prep*). Juvenile steelhead density was calculated by using the average smolt production, divided by the total usable habitat area, which equaled 125.7 per ha.

DISCUSSION

The development of a steelhead habitat capability model for SEAK will be a useful tool for fisheries managers, as it will help improve understanding of steelhead production in terms of available habitat. This is especially true for the numerous steelhead systems where weir programs that identify juvenile production and adult escapement are lacking, recognizing that >90% of all steelhead systems in SEAK have no estimates for these parameters. The main contribution of this study is the calculation of steelhead usable habitat area from direct observation of occupied habitats. The amount of usable habitat area is important as it relates to concurrent stock assessment work, which is necessary to generate an estimate of the number of adult and juvenile steelhead per unit usable area. While the goal is similar to Tautz et al.'s (1992) study, this approach of verifying fish use and physically measuring usable habitat area is empirically based and represents an improvement in the applicability of information that may be used for management decisions. As this relationship is developed for eight steelhead watersheds throughout SEAK, it is important to recognize there is currently only data to represent two lake systems and one nonlake system in the northern portion of SEAK, and one lake system in the southern portion. The full utility of this model will be realized once long-term production and habitat data are incorporated from a variety of steelhead systems throughout SEAK. Short-term achievements of this project include: mapped stream hydrography; additional length and species compositions for AWC nominations; and improved knowledge of salmonid species distribution patterns and habitat relationships, especially for juvenile and adult steelhead.

Table 6.–Stream reach measurements used in the calculation of steelhead usable habitat area in Ratz Creek watershed, Southeast Alaska ("*" denotes mainstem stream reaches).

Reach ID	Reach length (m)	# of channel bed width measurements (n)	Mean channel bed width (m)	SD (+/-)	CV	Total area (ha)	Steelhead present	Usable area (ha)
AF1-1	634.68	18	6.00	1.81	0.30	0.38	Yes	0.38[a]
FP4-1*	669.23	25	13.02	4.64	0.36	0.87	Yes	0.87
FP4-2	678.14	21	13.55	3.96	0.29	0.92	Yes	0.92[a]
FP5-1*	1174.38	23	19.65	5.26	0.27	2.31	Yes	2.31
FP5-2*	447.64	13	16.12	3.45	0.21	0.72	Yes	0.72
HC2-3	137.68	2	10.25	0.35	0.03	0.14	Yes	0.14
LC1-1*	467.12	12	18.50	4.00	0.22	0.86	Yes	0.86
MC1-2*	790.30	20	10.95	1.93	0.18	0.87	Yes	0.87
MC1-3	101.52	1	6.75	–[b]	–[b]	0.07	Yes	0.07[a]
MC2-1*	498.89	11	12.55	4.94	0.39	0.63	Yes	0.63
MM1-1	697.84	16	3.88	0.69	0.18	0.27	Yes	0.27[a]
MM1-2	217.35	9	2.44	0.27	0.11	0.05	Yes	0.05[a]
MM1-3	222.88	6	6.37	1.12	0.18	0.14	Yes	0.14[a]
MM1-4	246.34	6	6.83	2.54	0.37	0.17	Yes	0.17[a]
MM1-5	224.25	12	1.73	0.61	0.35	0.04	Yes	0.04[a]
MM2-1	348.93	7	13.14	4.78	0.36	0.46	Yes	0.46
MM2-2	374.17	5	10.30	0.57	0.06	0.39	Yes	0.39[a]
MM2-3*	896.08	23	12.65	3.35	0.26	1.13	Yes	1.13
PA2-1*	214.85	7	29.64	2.73	0.09	0.64	Yes	0.64[a]
PA2-2*	558.21	17	26.35	11.12	0.42	1.47	Yes	1.47
Total	19,608.00	451				15.67[c]		12.52

[a] Only juvenile steelhead were observed in these reaches; usable area for these reaches were not included in the adult usable habitat area total mentioned above.

[b] n = 1.

[c] Total includes total usable area (*U*) and total non-usable area (*V*). Reaches with non-usable area are not included in this table, but are provided in Appendix D.

Comparison of the carrying capacity results from this study to predictions of other authors working on similar models is challenging due to the differences in model parameters. Tautz et al. (1992) indicated that the Keogh River produced 0.058 smolt/m^2, or 580 smolt/ha of usable area, and Snow Creek in Washington produced 0.039 smolt/m^2, or 390 smolt/ha. Production in both of these systems was substantially more than the 158 smolt/ha at Sitkoh Creek (Crupi and Nichols 2012b*)*, 141 smolt/ha produced at Sashin Creek (Crupi and Nichols 2012a*)*, and the 126 smolt/ha produced at Ratz Creek. Tautz et al. (1992) calculated usable area as the product of stream reach length and estimated wetted width during low summer flows, and found 1,140 ha of usable habitat area with this approach. This estimate of usable habitat area (which incorporated only minimum wetted width) could explain some of the elevated production, but likely not all considering that the derived carrying capacities were two to four times higher than current run size estimates. The authors therefore included numerous adjustments to generate adult estimates for the Skeena River drainage resulting in 92,500 adults, or 81 adults/ha usable area, still substantially greater than any of the systems studied for the SEAK model: Sitkoh Creek, 35 adults/ha; Peterson Creek, 39 adults/ha; Sashin Creek, 14 adults/ha; and Ratz Creek, 45 adults/ha. Cramer and Ackerman (2009b) presented data from six steelhead creeks in Oregon, and included several habitat quality parameters in their carrying capacity predictions that ranged from 0.01 to 0.06 smolt/m^2, or 100 to 600 smolt/ha. Ratz Creek smolt production was within the lower end of this range at 0.012 smolt/m^2, or 126 smolt/ha. If the results from these studies are comparable to this study, then the Ratz Creek stock produces fewer fish per unit of habitat area. One possible explanation is that southern stocks are more productive given longer growing seasons and primary production of available prey (Withler 1966). Although comparisons between different models may assist in providing some corroboration, the various parameters used in these models are likely not similar enough to afford meaningful interpretation.

FISH HABITAT USE ASSESSMENT

Repeated seasonal assessment of fish use in Ratz Creek allowed for documentation of steelhead in several stream reaches that would not have been verified from just one survey. For example, adult steelhead were most abundant and widely distributed during spring surveys, occurring in eight mainstem reaches. However, juvenile steelhead were not as numerous or widely distributed in the spring as they were during the summer and fall surveys. In the spring, adult and juvenile steelhead were only observed in a combined total of 12 stream reaches, resulting in 10.58 ha of usable habitat area (*U*), which was approximately 15% less usable habitat area than was identified through the repeated seasonal surveys. The largest distribution of juvenile steelhead was documented during the fall survey, when steelhead were observed in a total of 19 stream reaches. Two adult steelhead were observed in the fall, which supports the belief that Ratz Creek supports a fall-run of adult steelhead. It is strongly recommended that a seasonal approach should be used when verifying fish habitat utilization to account for seasonal variation in species distribution.

During surveys conducted for this project on Sitkoh Creek and Peterson Creek, seasonal migration of juvenile steelhead from the mainstem into tributaries was not observed. However, observations made on Ratz Creek indicate that there might be some seasonal migration occurring, similar to results presented by Bramblett et al. (2002) for Staney Creek on Prince of Wales Island, SEAK. Because the highest numbers and largest distribution of juvenile steelhead occurred in the fall, and the lowest numbers in the spring, it is possible that they entered tributaries during the fall freshets as water temperatures declined, and then moved out of the tributaries in the spring, as was suggested by Bramblett et al. (2002).

In previous surveys for this project, temperature appeared to influence the movement of juvenile steelhead. Fish observations were uncommon when water temperatures were below 4º C, a threshold temperature also reported by Bryant et al. (2009). Considering this documented temperature threshold, it is recommended that the timing of seasonal surveys occur in the spring after temperatures increase above 4º C, and before late fall when temperatures decrease.

In Ratz Creek, adult steelhead were observed in two reaches of a significant tributary to the mainstem. The stream discharge of the tributary appeared to be comparable to the discharge observed in the mainstem. No adult steelhead were observed in smaller tributary reaches, although there were some reaches where observations of adults seemed possible. To ensure complete assessment of the total usable area of other watersheds, it is recommended that surveys continue to include tributary streams for potential distribution of steelhead.

CONCLUSIONS

IDEAS FROM STEELHEAD STRATEGIC PLAN

Through this study, the habitat-based modeling approach has been refined by directly identifying the types and quantities of freshwater habitat important to spawning adults and rearing juvenile steelhead. Future work should continue to identify the level of production data that is necessary to find a significant relationship between habitat carrying capacity and sustainable production.

Currently, there are several systems in SEAK with one or more annual weir counts, and this project should strive to utilize data from these systems. To expedite the process of completing the experimental design (two replicates for four treatments: northern vs. southern and lake vs. non-lake), it is imperative that these existing data be utilized to the extent practical and possible. Identifying the timing priority for the four remaining systems to be assessed (one northern and two southern systems without lake rearing access, and one southern system with a lake) will be influenced by management needs and funding. The design itself may be modified in the future as data are collected and analyzed over several years, and as identified management priorities change. For example, if southern SEAK non-lake systems are thought to be at risk of overexploitation, and accumulated data indicate large variation between the two systems initially assessed for this design, additional assessments in these types of systems (i.e., larger sample size) may become a higher priority than the two replicates in the other treatment systems necessary to complete the design. Future steelhead projects should take into consideration the initial design, current management priorities, and relevant data on spawning steelhead abundance. Development of a steelhead model to estimate the annual escapement necessary for sustainable steelhead production in exploited systems based on steelhead spawning and rearing habitat in these systems is the ultimate long-term goal of this research program.

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APPENDIX A: SUBSTRATE SIZE CLASSES

Appendix A1.–Size classes and codes used for identification of dominant substrates.

Substrate	Code	Size class
Organic	ORG	Organic
Sand/silt	SS	< 2mm
Very fine gravel	VFG	2–3.9mm
Fine gravel	FGR	4–7.9mm
Medium gravel	MGR	8–15.9mm
Coarse gravel	CGR	16–31.9mm
Very coarse gravel	VCG	32–63.9mm
Small cobble	SC	64–127.9mm
Large cobble	LC	128–255.9mm
Small boulder	SB	256–512mm
Large/med boulder	LMB	>512mm
Bedrock	BR	Bedrock

APPENDIX B: STREAM HABITAT SURVEY METHOD

At a representative section of each stream reach, termed a Channel Type Verification (CTV) point, pertinent habitat features necessary for characterizing channel-type were recorded. To classify the stream reach according to fluvial process group and channel type, we recorded stream gradients, channel bed widths, incision depth, bankfull width, bank composition, channel pattern, dominant substrates, and surrounding riparian vegetation types. Stream gradient measurements were taken at the extents of the reach, as well as at the CTV point, and the mean gradient ($\bar{g}$) for reach *i* was calculated as:

$$\bar{g} = \frac{\sum g_i}{n}, \tag{1}$$

where:

g_i = individual gradient measures taken within reach *i*; and

n = number of measures taken within reach *i*.

Incision depth, to the nearest 0.5 m, was measured as the vertical distance (m) between the first major slope break above bankfull stage and the channel bottom at the thalweg. Bankfull width was measured from the lateral extent of the water surface at bankfull depth, where bankfull depth is the water surface elevation required to completely fill the channel to a point above which water would spill onto the floodplain. Bankfull width, similar to channel bed width, is also independent of the current flow regime, although past high-flow events ultimately control the extent of this parameter and its effect on the floodplain. Bank composition refers to the dominant geologic material composing the stream bank. Channel pattern indicates the connectivity of the mainstream channel, i.e., single or multiple. We visually identified and measured the three most dominant substrate size classes, with the exception of bedrock. Distance of the stream reach was calculated using ArcGIS™ extension X Tools Pro (version 2.0.0) based on the waypoints attributed to the top and bottom stream reach break (BRK) points. Side channels and disturbance feature lengths were measured in the field using a hand-held laser range finder.

When surveyors encountered accumulations of woody debris, the number of pieces of large wood and key wood were counted. Large wood is defined simply as all pieces of wood (including rootwads) within the bankfull width that are greater than 10 cm diameter, and longer than 1 m in length. Wood pieces that were large relative to the channel size and appeared to contribute to important geomorphic functions (including the formation of pools and cover) are termed key pieces. The qualifying dimensions of key pieces are scaled to the average channel bed width (Appendix Table B1). The density of large wood and key wood were calculated similarly using equation 2.

Large wood density (D_i) for each reach was calculated as:

$$D_i = \frac{\sum w_i}{l_i}, \tag{2}$$

-continued-

where:

w_i = number of large (or key) wood pieces counted in reach *i*; and

l_i = length of reach *i*.

As we surveyed each stream reach, macro-pools were counted. A detailed definition of macro-pools is included in Frenette et al. (*in prep*), but in general they were defined by surrounding characteristics, such as average channel bed width, residual pool depth and the length of the macro-pools themselves. Macro-pool density for each reach was calculated similarly using equation 2.

Appendix Table B1.–Qualifying dimensions of key wood pieces based on average channel bed width.

Average channel bed width (m)	Key piece diameter (m)	Key piece stem length (m)	Rootwad diameter (m)
0–4.9	0.3	>3	>1
5–0.9	0.3	>7.6	>3
10–19.9	0.6	>7.6	>3
≥20	0.6	>15	>3

APPENDIX C: HABITAT CHARACTERISTICS AND SPECIES PRESENT BY REACH

Appendix C1.–Stream reach habitat characteristics and fish species observed in Ratz Creek watershed, Southeast Alaska ("*" denotes mainstem stream reaches).

Reach ID	Reach length (m)	Mean channel bed width (m)	Total area (ha)	Stream gradient (%)	Large wood count	Key wood count	Macro pool count	Large wood density (#/ha)	Key wood density (#/ha)	Macro pool density (#/ha)	Species present[a]
AF1-1	634.68	6.00	0.38	5.60	92	11	42	241.48	28.87	110.24	CDV, SCO, STH, TCT, TRT
FP0-1	116.79	1.02	0.01	4.00	9	2	5	755.48	167.88	419.71	CDV, IDA, SCO, TCT, TRT
FP4-1*	669.23	13.02	0.87	3.40	83	7	37	95.29	8.04	42.48	CDV, KSB, SCM, SCO, SPI, SSE, STH, TCT, TRB, TRT, ULP
FP4-2	678.14	13.55	0.92	3.10	318	4	33	346.13	4.35	35.92	CDV, IDA, SCO, SSE, STH, TCT, TRB, TRT
FP5-1*	1174.38	19.65	2.31	0.90	334	30	28	144.72	13.00	12.13	CDV, SCM, SCO, SPI, SSE, STH, TCT, TRB, TRT, ULP
FP5-2*	447.64	16.12	0.72	2.10	57	3	16	79.01	4.16	22.18	CDV, KSB, SCM, SCO, SPI, SSE, STH, TCT, TRB, TRT, ULP
HC0-1	403.28	1.09	0.04	11.75	8	0	26	181.99	0	591.48	IDA, SCO, TCT
HC0-2	196.61	0.96	0.02	15.40	18	4	11	953.66	211.92	582.79	None
HC0-3	152.89	1.42	0.02	9.40	22	5	11	1013.34	230.31	506.67	TCT
HC0-4	615.28	0.60	0.04	10.00	33	23	22	893.91	623.03	595.94	CDV, IDA, TCT
HC1-1[b]	232.45	2.33	0.05	7.00	29	5	23	535.44	92.32	424.66	IDA, TCT
HC1-2[b]	200.02	1.79	0.04	15.90	35	17	16	977.54	474.80	446.87	None
HC2-1	613.36	2.50	0.15	9.00	9	6	3	58.69	39.13	19.56	CDV, IDA, SCO, TCT, TRT
HC2-2	152.34	2.80	0.04	8.4	–[c]	–[c]	–[c]	–[d]	–[d]	–[d]	CDV, IDA, TCT
HC2-3	137.68	10.25	0.14	7.50	6	1	6	42.52	7.09	42.52	CDV, SCO, SPI, SSE, STH, TCT, TRB, TRT
HC2-4	338.51	–[c]	–[d]	–[c]	–[c]	–[c]	–[c]	–[d]	–[d]	–[d]	CDV, IDA, SCO, TCT

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Reach ID	Reach length (m)	Mean channel bed width (m)	Total area (ha)	Stream gradient (%)	Large wood count	Key wood count	Macro pool count	Large wood density (#/ha)	Key wood density (#/ha)	Macro pool density (#/ha)	Species present[a]
HC3-1	514.74	4.34	0.22	8.10	51	23	21	228.30	102.96	94.00	CDV, IDA, SCO, TCT, TRT
LC1-1*	467.12	18.50	0.86	1.40	38	2	7	43.97	2.31	8.10	CDV, IDA, SCM, SCO, SSE, STH, TCT, TRB, TRT, ULP
MC1-1 [b]	2543.57	4.98	1.27	2.80	413	49	105	326.04	38.68	82.89	IDA
MC1-2*	790.30	10.95	0.87	7.00	78	21	62	90.13	24.27	71.65	CDV, SCO, SSE, STH, TCT, TRB, TRT
MC1-3	101.52	6.75	0.07	–[c]	–[c]	–[c]	–[c]	–[d]	–[d]	–[d]	CDV, IDA, SCO, STH, TCT, TRT
MC2-1*	498.89	12.55	0.63	3.80	99	9	53	158.18	14.38	84.68	CDV, IDA, SCM, SCO, SPI, SSE, STH, TCT, TRB, TRT, ULP
MM0-1	156.64	1.43	0.02	3.70	20	3	10	892.90	133.93	446.45	CDV, IDA, SCO, TCT, TRT, UNK
MM0-2	420.35	1.13	0.05	4.30	22	2	51	463.16	42.11	1073.70	None
MM0-3	257.54	1.44	0.04	6.90	38	3	14	1024.66	80.89	377.51	IDA, TCT, TRT
MM0-3-2	227.81	–[c]	–[d]	ND	ND	ND	ND	–[d]	–[d]	–[d]	SCO, TCT
MM0-4	115.49	1.13	0.01	5.50	ND	ND	ND	–[d]	–[d]	–[d]	CDV, IDA, SCO, TCT, TRT
MM0-5	145.76	1.80	0.03	2.30	ND	ND	ND	–[d]	–[d]	–[d]	CDV, TCT
MM1-1	697.84	3.88	0.27	2.70	70	17	37	258.86	62.87	136.83	CDV, IDA, SCO, SPI, STH, TCT, TRT
MM1-2	217.35	2.44	0.05	1.70	25	5	7	470.55	94.11	131.75	CDV, IDA, SCO, SPI, STH, TCT, TRT
MM1-3	222.88	6.37	0.14	6.00	37	4	13	260.75	28.19	91.61	CDV, IDA, SCO, STH, TCT
MM1-4	246.34	6.83	0.17	3.40	7	4	4	41.58	23.76	23.76	CDV, SCO, STH, TCT, TRT

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Reach ID	Reach length (m)	Mean channel bed width (m)	Total area (ha)	Stream gradient (%)	Large wood count	Key wood count	Macro pool count	Large wood density (#/ha)	Key wood density (#/ha)	Macro pool density (#/ha)	Species present[a]
MM1-5	224.25	1.73	0.04	2.30	6	17	22	154.36	437.35	565.99	CDV, IDA, SCO, STH, TCT, TRT
MM2-1	348.93	13.14	0.46	5.50	33	6	19	71.96	13.08	41.43	CDV, IDA, SCO, SPI, STH, TCT, TRB, TRT
MM2-2	374.17	10.30	0.39	6.40	242	20	27	627.93	51.89	70.06	CDV, SCO, STH, TCT, TRT
MM2-3*	896.08	12.65	1.13	3.00	191	19	67	168.47	16.76	59.10	CDV, SCO, SPI, SSE, STH, TCT, TRB, TRT
PA0-1	82.03	2.00	0.02	0.40	–[c]	–[c]	–[c]	–[d]	–[d]	–[d]	CDV, SCO
PA0-2	382.55	0.97	0.04	0.30	5	0	–[c]	134.74	0	–	CDV, SCO, TCT
PA1-1	306.25	2.79	0.09	0.50	3	0	5	35.11	0	58.52	CDV, SCO, TCT
PA1-2	231.12	–[c]	–[d]	0.30	–[c]	–[c]	–[c]	–[d]	–[d]	–[d]	CDV, SCO, TCT
PA1-3	357.16	3.07	0.11	0.30	15	9	–[c]	136.80	82.08	–[d]	CDV, SCO, TCT
PA1-4	750.71	–[c]	–[d]	–[c]	–[c]	–[c]	–[c]	–[d]	–[d]	–[d]	CDV, SCO, TCT
PA2-1*	214.85	29.64	0.64	0.20	43	1	1	67.52	1.57	1.57	CDV, IDA, KSB, SCO, SPI, STH, TCT, ULP
PA2-2*	558.21	26.35	1.47	1.90	144	11	4	97.89	7.48	2.72	CDV, SCO, SSE, STH, TCT, TRB
PA5-1	494.30	17.00	0.84	0.30	52	28	0	61.88	33.32	0	CDV, SCO, TCT

[a] Species codes: CDV–Dolly Varden; IDA–unspecified salmonid; KSB–unspecified stickleback; SCM–chum salmon; SCO–coho salmon; SPI–pink salmon; SSE–sockeye salmon; STH–steelhead; TCT–cutthroat trout; TRB–rainbow trout; TRT–unspecified trout; ULP–unspecified sculpin; UNK–general fish observation, no species information.

[b] Reaches surveyed during Phase I stream habitat surveys, but not during Phase II fish use surveys because they were located above what was believed to be an impassable barrier (height ~4 m); adult pink salmon were observed below the barrier, but none were observed above the barrier.

[c] No data.

[d] No data, could not be calculated.

APPENDIX D: STEELHEAD USABLE HABITAT AREA

Appendix D1.–Stream reach measurements used in the calculation of steelhead usable habitat area in Ratz Creek watershed, Southeast Alaska ("*" denotes mainstem stream reaches).

Reach ID	Reach length (m)	# of channel bed width measurements (n)	Mean channel bed width (m)	SD (+/-)	CV	Total area (ha)	Steelhead present	Usable area (ha)
AF1-1	634.68	18	6.00	1.81	0.30	0.38	Yes	0.38[a]
FP0-1	116.79	5	1.02	0.67	0.66	0.01	No	0.00
FP4-1*	669.23	25	13.02	4.64	0.36	0.87	Yes	0.87
FP4-2	678.14	21	13.55	3.96	0.29	0.92	Yes	0.92[a]
FP5-1*	1174.38	23	19.65	5.26	0.27	2.31	Yes	2.31
FP5-2*	447.64	13	16.12	3.45	0.21	0.72	Yes	0.72
HC0-1	403.28	20	1.09	0.12	0.11	0.04	No	0.00
HC0-2	196.61	7	0.96	0.17	0.18	0.02	No	0.00
HC0-3	152.89	6	1.42	0.20	0.14	0.02	No	0.00
HC0-4	615.28	12	0.60	0.23	0.37	0.04	No	0.00
HC1-1	232.45	10	2.33	0.35	0.15	0.05	No	0.00
HC1-2	200.02	6	1.79	0.19	0.11	0.04	No	0.00
HC2-1	613.36	4	2.50	0	0	0.15	No	0.00
HC2-2	152.34	1	2.80	–[b]	–[b]	0.04	No	0.00
HC2-3	137.68	2	10.25	0.35	0.03	0.14	Yes	0.14
HC2-4	338.51	0	–[c]	–[d]	–[d]	–[c]	No	0.00
HC3-1	514.74	11	4.34	0.67	0.16	0.22	No	0.00
LC1-1*	467.12	12	18.50	4.00	0.22	0.86	Yes	0.86
MC1-1	2543.57	45	4.98	0.96	0.19	1.27	No	0.00
MC1-2*	790.30	20	10.95	1.93	0.18	0.87	Yes	0.87
MC1-3	101.52	1	6.75	–[b]	–[b]	0.07	Yes	0.07[a]
MC2-1*	498.89	11	12.55	4.94	0.39	0.63	Yes	0.63

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Reach ID	Reach length (m)	# of channel bed width measurements (n)	Mean channel bed width (m)	SD (+/-)	CV	Total area (ha)	Steelhead present	Usable area (ha)
MM0-1	156.64	7	1.43	0.37	0.26	0.02	No	0.00
MM0-2	420.35	12	1.13	0.13	0.12	0.05	No	0.00
MM0-3	257.54	8	1.44	0.29	0.20	0.04	No	0.00
MM0-3-2	227.81	0	–[c]	–[d]	–[d]	–[d]	No	0.00
MM0-4	115.49	4	1.13	0.14	0.13	0.01	No	0.00
MM0-5	145.76	1	1.80	–[b]	–[b]	0.03	No	0.00
MM1-1	697.84	16	3.88	0.69	0.18	0.27	Yes	0.27[a]
MM1-2	217.35	9	2.44	0.27	0.11	0.05	Yes	0.05[a]
MM1-3	222.88	6	6.37	1.12	0.18	0.14	Yes	0.14[a]
MM1-4	246.34	6	6.83	2.54	0.37	0.17	Yes	0.17[a]
MM1-5	224.25	12	1.73	0.61	0.35	0.04	Yes	0.04[a]
MM2-1	348.93	7	13.14	4.78	0.36	0.46	Yes	0.46
MM2-2	374.17	5	10.30	0.57	0.06	0.39	Yes	0.39[a]
MM2-3*	896.08	23	12.65	3.35	0.26	1.13	Yes	1.13
PA0-1	82.03	1	2.00	–[b]	–[b]	0.02	No	0.00
PA0-2	382.55	11	0.97	0.36	0.37	0.04	No	0.00
PA1-1	306.25	8	2.79	0.41	0.15	0.09	No	0.00
PA1-2	231.12	0	–[c]	–[d]	–[d]	–[d]	No	0.00
PA1-3	357.16	7	3.07	2.79	0.91	0.11	No	0.00
PA1-4	750.71	0	ND	–[c]	–[c]	–[c]	No	0.00
PA2-1*	214.85	7	29.64	2.73	0.09	0.64	Yes	0.64[a]
PA2-2*	558.21	17	26.35	11.12	0.42	1.47	Yes	1.47
PA5-1	494.30	11	17.00	15.07	0.89	0.84	No	0.00
Total	19,608.00	451				15.67[e]		12.52

[a] Only juvenile steelhead were observed in these reaches; usable area for these reaches was not included in the adult usable habitat area total mentioned above.

[b] n = 1.

[c] No data.

[d] No data, could not be calculated.

[e] Includes total usable area (U) for reaches where steelhead were observed and total non-usable area (V) for reaches where steelhead were not observed.

APPENDIX E: DATA FILES

Appendix E1.–Electronic computer files submitted with this report.

Data file	Description
RatzCreekWatershed.shp	GIS shapefile (State Plane, NAD83, FIPS 5001 projection) containing the border of Ratz Creek watershed.
Ratz_Creek_orig_hydro_NAD83.shp	GIS shapefile (State Plane, NAD83, FIPS 5001 projection) containing USFS stream hydrography for Ratz Creek watershed.
Ratz Creek Weir.shp	GIS shapefile (State Plane, NAD83, FIPS 5001 projection) containing the location of the weir on Ratz Creek.
RTZ_simple.shp	GIS shapefile (State Plane, NAD83, FIPS 5001 projection) containing updated stream hydrography for Ratz Creek watershed based on waypoints taken during ADF&G-SF habitat and fish use surveys.
Fishpass.shp	GIS shapefile (State Plane, NAD83, FIPS 5001 projection) containing the location of the fish pass on Ratz Creek.
OdysseyDB_FEATS_Updated_2012_Ratz.shp	GIS shapefile (State Plane, NAD83 FIPS 5001 projection) containing all mapping features encountered during stream habitat surveys within the Ratz Creek watershed.
OdysseyDB_FOP_Updated_2012_Ratz_2.shp	GIS shapefile (State Plane, NAD83 FIPS 5001 projection) containing all Fish Observation Points (FOP's) observed during fish use surveys within the Ratz Creek watershed.
RatzCreek_KLS	ArcMap project that was used to create maps for the FDS report.
RatzCreek_FOP.xlsx	Excel spreadsheet containing fish observation data that was used to create tables and graphs for the FDS report.
RatzCreekHydro_AttributeTable_Updates_xlsx	Excel spreadsheet containing data that was used to create tables for the FDS report and to calculate usable habitat area for Ratz Creek watershed.
FDS_Tables_Figures.xlsx	Excel file containing only the tables and figures included in the FDS report.