Fishery Data Series No. 08-13

Steelhead Abundance and Composition in the Karta River, 2005

by

Stephen H. Hoffman

March 2008

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 Department of Fish and Game	ADF&G
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)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

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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by

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ABSTRACT

In 2005, a bipod weir was installed on the Karta River in Southeast Alaska to capture and count all migrating steelhead *Oncorhynchus mykiss*. All spring-immigrating adult steelhead were counted, measured, examined to determine sex, and marked prior to release; emigrating adult steelhead were counted, checked for marks, and if unmarked, sampled as previously described. Between March 24 and July 15, 376 immigrant and 352 emigrant steelhead were counted. This system supports a fall run and 105 of the emigrants were unmarked. Thus, the minimum total escapement was 481. Females and age classes 3.2 and 4.2 predominated among spring immigrant fish. The length of immigrant steelhead averaged 739 mm TL and had SD = 71; less than 1% of the fish exceeded 914 mm TL, or 36 in, the regionwide legal size limit.

Key words: Southeast Alaska, Karta River, Prince of Wales Island, steelhead, *Oncorhynchus mykiss*, escapement, weir, age-sex-length, subsistence, management decision

INTRODUCTION

Steelhead trout *Oncorhynchus mykiss* support an important subsistence fishery for rural residents of Prince of Wales Island (POW) in Southeast Alaska. Regulations that established a federally managed subsistence fishery for this species were approved by the Federal Subsistence Board in December 2002. A popular sport fishery also exists, with residents from Alaska, the other 49 states, and around the world participating (Jennings et al. 2007; Schwan 1984). The sport fishery is managed by the State of Alaska and has existed on POW since statehood. Little historical or current information is available to document steelhead population sizes, characteristics, run timing, and spatial distribution in the majority of the 85 POW streams that contain this species. The lack of data on these stocks has hampered efforts to assess the potential effects of directed subsistence harvest and prevents the refinement of federal regulations that, when coupled with conservative State sport fishing regulations, would ensure adequate conservation and allow for expanded subsistence harvest opportunities.

Steelhead are particularly valuable as a food resource because they provide for fresh fish harvest opportunities during a time period when other salmon species are unavailable. Information obtained from recent Alaska Department of Fish and Game (ADF&G) household surveys indicate that approximately 600 steelhead are harvested annually on POW by qualified users (Turek 2005), suggesting that subsistence activities tend to occur in streams adjacent to their communities. Subsistence steelhead fisheries on POW are managed by permit and annual household limits. Prior to the enactment of conservative sport fish regulations in the early 1990s, which restricted steelhead retention through implementation of annual and minimum size limits, the estimated recreational harvest on the island ranged from about 800 to 2,000 steelhead per year from 1987 to 1991 (Mills 1988-1992). In contrast, recreational harvests averaged about 30 steelhead from 1999 to 2004 (Howe et al. 2001; Walker et al. 2003; Jennings et al. 2004, 2006a-b; Jennings et al. 2007).

With the exception of the Situk River near Yakutat, Karta River receives the highest recreational angler effort for steelhead in Southeast Alaska, and averaged about 920 angler-days from 2000 to 2004 (Walker et al. 2003; Jennings et al. 2004, 2006a-b; Jennings et al. 2007). Results from a survey of 2002 users of U.S. Forest Service (USFS) recreational cabins revealed that anglers accounted for 61% of the total steelhead caught and 48% of the total steelhead harvested in the Karta River (Harding et al. 2005). Karta River is also open for subsistence harvest of steelhead.

Karta River is one of 12 streams on POW that contain both fall and spring run steelhead populations. (Hoffman et al. 1990). Adult steelhead weirs were operated in the Karta River in spring 1983 (Jones 1984), 1989 (Hoffman et al. 1990), and 1992 (Harding and Jones 1993). Immigrant/emigrant counts were 375/497, 1,220/842, and 185/347, respectively.

Prior to the 2005 field season, the Organized Village of Kaasan (OVK) initiated plans to construct a weir on the Karta River to count all immigrant adult sockeye salmon and offered to cooperate with ADF&G by installing the weir

earlier to count returning adult steelhead. This presented the department with a cost-effective opportunity to obtain a steelhead count and other information needed to evaluate the conservative sport fishing regulations implemented in the early 1990s.

The objectives of this project were to:

1) count all immigrant and emigrant adult steelhead; and
2) estimate and/or determine the sex, length and age composition of adult immigrant steelhead.

Genetic tissue samples were also collected from each immigrating adult steelhead for genetic stock identification.

STUDY AREA

Karta River is a large non-road-accessible stream located on the east side of central POW (Figure 1). The drainage is approximately 24 km (15 mi) long and 16,590 ha (41,000 ac) in size. Karta River drains Karta and Salmon lakes and flows into Karta Bay. This stream is accessed via float plane at saltwater or by landing on Karta or Salmon lakes. Additional access occurs via saltwater by small skiffs or anchoring larger vessels in Karta Bay. There are three U.S. Forest Service (USFS) public rental cabins, a highly developed trail in the lower 5 km (3 mi), and a primitive trail that reaches upstream another 6 km (4 mi).

METHODS

A 75-m long aluminum bipod weir was installed on the Karta River to capture all migrating steelhead. The weir contained separate immigrant and emigrant traps (each 2.5 m square) and was located approximately 700 m upstream from tidewater. The department operated the weir from March 24 through May 31 for steelhead, after which time the OVK continued its operation to count sockeye salmon and collect data on emigrant steelhead. Weir integrity was checked at least daily, and fish in both traps were processed whenever necessary (mostly during night time hours) to avoid crowding. Water temperature and level was recorded at about 0800 hours almost every day with a hand-held thermometer and a staff gage installed at the weir site.

All spring-immigrating adult steelhead were counted and measured to the nearest 5 mm FL and TL. If gender could be determined, it was recorded. All fish received an upper caudal lobe finclip prior to release. Four scales were taken from the left side in the preferred location (Alword 1954; Maher and Larkin 1955) from a systematic sample (one in four fish from March 25 to April 9, to one in two from April 10 to April 21, and back to one in four from April 22 to May 31) of steelhead. Scales were mounted on gummed scale cards and aged according to the methods described by Narver and Withler (1977). All emigrating adult steelhead captured at the weir were counted and checked for the presence or absence of an upper caudal lobe finclip, which was recorded. If the fish was not marked, it was measured, but scales were not collected. All steelhead were marked with a punch hole applied to the upper caudal fin lobe to prevent double sampling. All other fish species passed through the weir were identified, counted, and recorded.

Use of the weir produced a census, not a sample, of the spring immigration, so length composition was calculated directly with no variance:

$$p_l = \frac{n_l}{n} \tag{1}$$

where n is the total number of fish measured, and n_l is the subset of n that belonged to length group l.

Because fish were subsampled for scales, the sampling rate was periodically changed throughout the run, and some samples could not be read, the following method was used to estimate age composition:

$$\hat{p}_{a,h} = \frac{n_{a,h}}{n_h} \tag{2}$$

$$\mathrm{var}(\hat{p}_{a,h}) = \left[1 - \frac{n_h}{N_h}\right] \frac{\hat{p}_{a,h}\left(1 - \hat{p}_{a,h}\right)}{n_h - 1} \tag{3}$$

$$\hat{p}_a = \frac{1}{N} \sum_h N_h \hat{p}_{a,h} \tag{4}$$

$$\mathrm{var}(\hat{p}_a) = \sum_h W_h^{\,2}\,\mathrm{var}(\hat{p}_{a,h}) \qquad (5)$$

where $\hat{p}_{a,h}$ is the estimated proportion of the population in age group a and sampling scheme h, n_h is the number of fish successfully aged in strata h, $n_{a,h}$ is the subset of n_h belonging to group a, N_h is the total number of fish passing the weir in sampling stratum h, $W_h = N_h/N$, and $N=\Sigma N_h$.

Genetic samples (axillary appendage) were collected from every previously unsampled steelhead and preserved in ethanol.

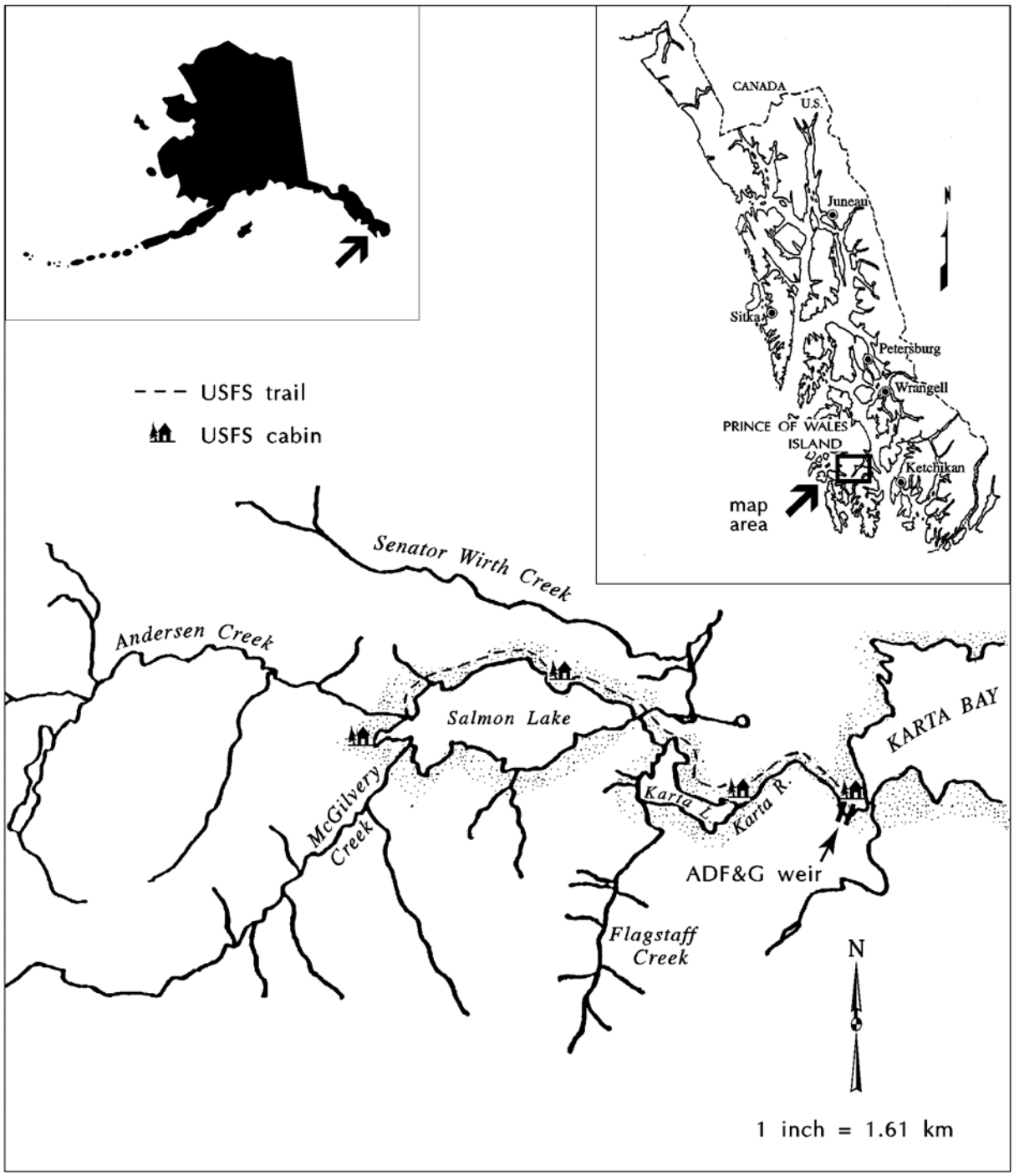

Figure 1.–Study area location on Karta River, 2005.

RESULTS

The weir was operated from March 24 to July 15, 2005 and remained intact the entire season. During this period, 376 steelhead were passed upstream and 352 post-spawn fish, or kelts, were passed downstream; 105 of the emigrants, presumably fall run fish, did not have upper caudal lobe finclips (Appendix A1). Thus, the minimum total escapement was 481.

The peak of the spring immigration occurred on April 21 when 46 fish were passed upstream, and the 50% point in the run was reached on April 24; the 50% point of the emigration was reached on May 17, and the peak occurred on May14 when 87 fish were passed downstream (Figures 2 and 3, Appendix A1). Water temperatures were not recorded from May 27 to June 8, nor were stream depths from May 27 to June 17. During the days that data were collected, water temperature ranged from approximately 7°C during late March to about 20°C in late June. Water temperature was above 6°C during the period of peak immigration. Stream depths taken at the weir gaging station varied from about 55 cm in late March to about 180 cm in late April (Figure 2, Appendix A1).

A total of 116 of the 376 immigrant steelhead passed through the weir were sampled for scales. Of these, only 63 were successfully aged. To determine if the aged sample was representative of unaged fish, the lengths of each group were arbitrarily split into two categories at the median length of all immigrant fish (730 mm TL) to permit comparison of the aged fractions:

	<730 mm	≥730 mm
Aged	31	32
Unaged	151	162
Aged fraction	0.170	0.165

The aged fractions were not significantly different (χ^2 = 0.02, df = 1, P = 0.89). Length distributions of aged and unaged fish were also similar (Kolmogorov-Smirnov: d_{max} = 0.087; n = 313, 63; P = 0.745; Figure 4). Thus, the aged sample appeared to be representative of immigrant steelhead.

Females (66%, SE = 7%) and age classes 3.2 (31%, SE = 6%) and 4.2 (42%, SE = 7%) predominated the sample (Table 1). All of the

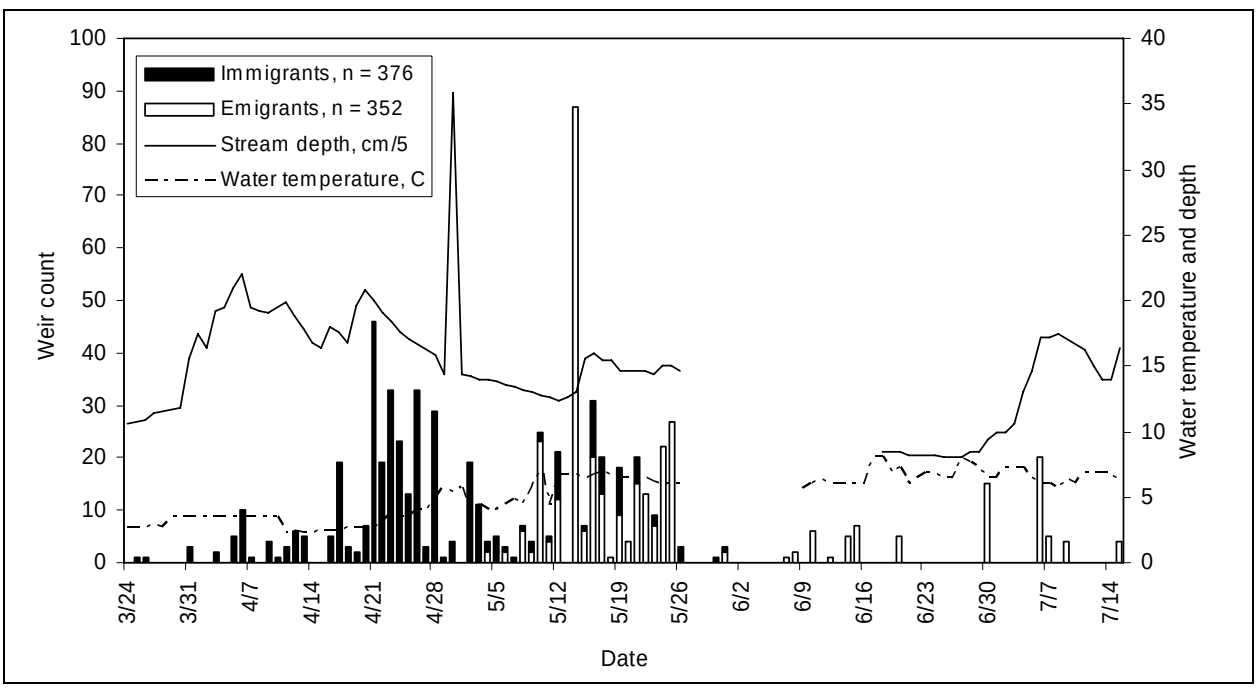

Figure 2.–Steelhead immigration and emigration, water temperature, and stream depth in the Karta River, 2005.

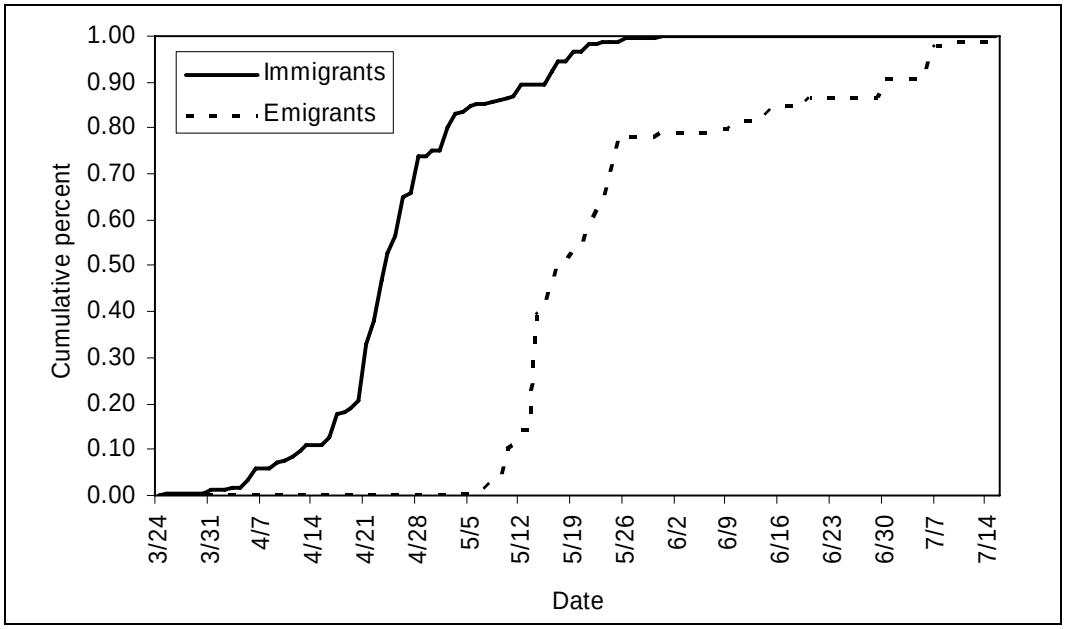

Figure 3.–Run timing of steelhead in the Karta River, 2005.

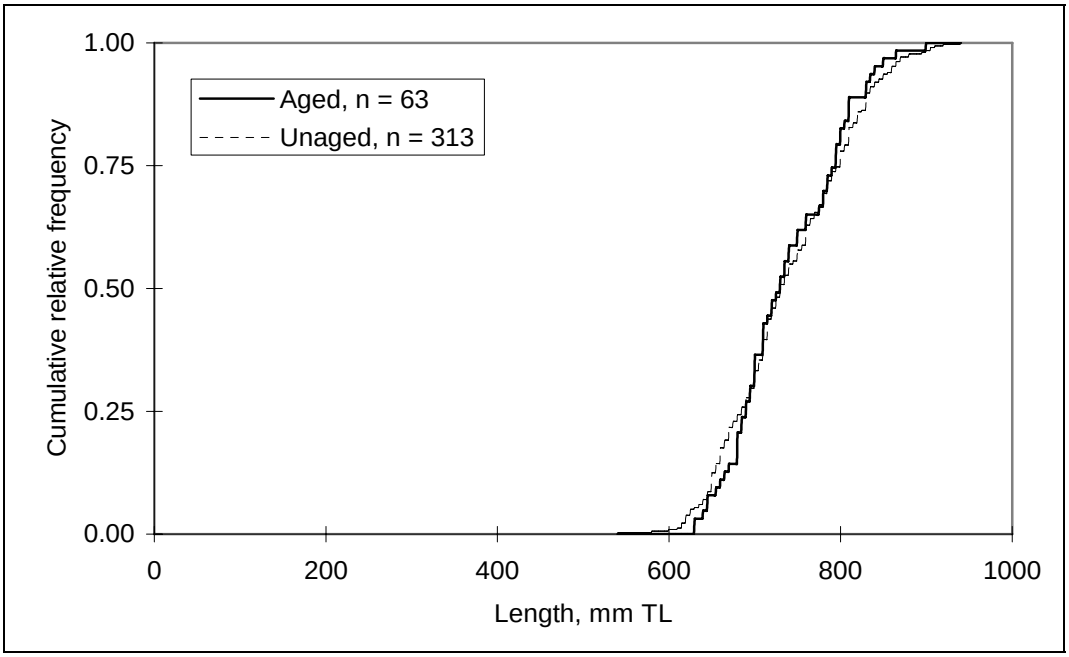

Figure 4.–Cumulative relative frequency of aged and unaged immigrant steelhead in the Karta River, 2005.

spring immigrants captured at the weir were measured. Length averaged 739 mm TL and had SD = 71; less than 1% of the fish exceeded 914 mm TL, or 36 in, the regionwide legal size limit (Table 2).

DISCUSSION

The Karta River system represents one of 85 documented steelhead streams on Prince of Wales Island (PWI). The importance and popularity of

Table 1.–Age and sex composition of spring immigrant steelhead sampled at the weir in the Karta River, 2005.

		Brood year and age class						
		2000	1999	1999	1998	1998	1997	
		3.2	3.3	4.2	4.3	5.2	5.3	Total
Females	n_a	9	6	15	5	2	1	38
	$\hat{p}_a$,%	13.4	9.5	25.9	10.1	4.6	2.3	65.8
	SE [$\hat{p}_a$], %	4.9	4.3	6.6	4.9	3.6	2.6	6.6
Males	n_a	14		10		1		25
	$\hat{p}_a$,%	17.6		15.8		0.8		34.2
	SE [$\hat{p}_a$], %	4.0		4.2		0.7		5.3
Combined	n_a	23	6	25	5	3	1	63
	$\hat{p}_a$,%	31.0	9.5	41.6	10.1	5.5	2.3	
	SE [$\hat{p}_a$], %	5.6	3.4	6.6	3.7	2.7	1.9	

this stream is fairly well documented, as indicated by reported subsistence usage, other anecdotal public comments, and departmental information that indicated the population size for this stream historically approached over 1,000 fish annually. This study verified that the population of steelhead in 2005 was considerably smaller than historic levels**.** The immigrant count of 376 and the count of 105 unmarked emigrants provided a minimum total escapement of 481, which is about 40% of the 1,220 immigrants counted in 1992 (Harding and Jones 1993).

Table 2.–Length composition of spring immigrant steelhead in the Karta River, 2005.

Length *l*, mm TL	n_l	p_l
535–554	1	0.003
555–574	0	0.000
575–594	1	0.003
595–614	5	0.013
615–634	14	0.037
635–654	30	0.080
655–674	30	0.080
675–694	31	0.082
695–714	53	0.141
715–734	35	0.093
735–754	23	0.061
755–774	29	0.077
775–794	32	0.085
795–814	34	0.090
815–834	26	0.069
835–854	11	0.029
855–874	11	0.029
875–894	3	0.008
895–914	5	0.013
≥915	2	0.005
	n =376	

The ratio of spring immigrant females to males (approximately 2:1, Table 1) was similar to that previously seen in the Karta River (Harding and Jones 1993; Hoffman et al. 1990; Jones 1984) and other Southeast Alaska systems (Harding and Jones 1994; Hoffman 2007; Johnson and Jones 2001, 2003; Jones et al. 1991; Yanusz 1997), reflecting a higher survival rate for female steelhead. In 2005, spring immigrant steelhead were dominated by fish that spent 3 to 4 years in freshwater and 2 years in saltwater. This pattern was also observed in 1983, 1989, and 1992 (Harding and Jones 1993; Hoffman et al. 1990; Jones 1984).

Seventy five percent of the spring escapement occurred between April 16 and May 12, and the peak occurred on April 21. This information corroborates the general public perception that in Southeast Alaska, the peak escapement time for spring-run steelhead spans from mid-April to mid-May. Although physical data were not continuously collected during operation of the weir, the available data did reveal migration activity increased once water temperatures exceeded 5°C (Figure 2) and the bulk of the immigration occurred when the water level exceeded 75 cm.

In extremely popular streams such as the Karta River, consideration of conservative management strategies such as catch and release regulations, size restrictions, or small seasonal bag limits may

be appropriate to ensure continuation of an ongoing subsistence and/or sport fishery.

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APPENDIX A

Appendix A1.–Upstream and downstream weir counts of steelhead, water temperature, and stream depth at Karta River, 2005.

Date	Upstream count	Cumulative proportion upstream count	Downstream count	Previously marked	Cumulative proportion downstream count	Water temperature, °C	Stream depth, cm
3/24	0	0.00	0	0	0.00	7	53
3/25	1	0.00	0	0	0.00	7	54
3/26	1	0.01	0	0	0.00	7	55
3/27	0	0.01	0	0	0.00	7	57
3/28	0	0.01	0	0	0.00	7	58
3/29	0	0.01	0	0	0.00	9	59
3/30	0	0.01	0	0	0.00	9	59
3/31	3	0.01	0	0	0.00	9	78
4/1	0	0.01	0	0	0.00	9	87
4/2	0	0.01	0	0	0.00	9	82
4/3	2	0.02	0	0	0.00	9	96
4/4	0	0.02	0	0	0.00	9	97
4/5	5	0.03	0	0	0.00	9	105
4/6	10	0.06	0	0	0.00	9	110
4/7	1	0.06	0	0	0.00	9	97
4/8	0	0.06	0	0	0.00	9	96
4/9	4	0.07	0	0	0.00	9	95
4/10	1	0.07	0	0	0.00	9	97
4/11	3	0.08	0	0	0.00	6	99
4/12	6	0.10	0	0	0.00	6	94
4/13	5	0.11	0	0	0.00	6	89
4/14	0	0.11	0	0	0.00	6	84
4/15	0	0.11	0	0	0.00	6	82
4/16	5	0.13	0	0	0.00	6	90
4/17	19	0.18	0	0	0.00	6	88
4/18	3	0.18	0	0	0.00	7	84
4/19	2	0.19	0	0	0.00	7	98
4/20	7	0.21	0	0	0.00	7	104
4/21	46	0.33	0	0	0.00	7	100
4/22	19	0.38	0	0	0.00	8	95
4/23	33	0.47	0	0	0.00	9	92
4/24	23	0.53	0	0	0.00	9	88
4/25	13	0.56	0	0	0.00	9	85
4/26	33	0.65	0	0	0.00	10	83
4/27	3	0.66	0	0	0.00	10	81
4/28	29	0.74	0	0	0.00	12	79
4/29	1	0.74	0	0	0.00	14	72
4/30	4	0.75	0	0	0.00	13	179
5/1	0	0.75	0	0	0.00	14	72
5/2	19	0.80	0	0	0.00	10	71
5/3	11	0.83	0	0	0.00	11	70
5/4	2	0.84	2	0	0.01	10	70
5/5	5	0.85	0	0	0.01	10	69
5/6	1	0.85	2	1	0.01	11	68
5/7	1	0.85	0	0	0.01	12	67
5/8	1	0.86	6	2	0.03	11	66
5/9	2	0.86	2	2	0.03	14	65
5/10	2	0.87	23	7	0.10	18	64
5/11	1	0.87	4	2	0.11	11	63

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Date	Upstream count	Cumulative proportion upstream count	Downstream count	Previously marked	Cumulative proportion downstream count	Water temperature, °C	Stream depth, cm
5/12	9	0.89	12	9	0.14	17	62
5/13	0	0.89	0	0	0.14	17	63
5/14	0	0.89	87	52	0.39	17	65
5/15	1	0.90	6	3	0.41	16	78
5/16	11	0.93	20	16	0.47	17	80
5/17	7	0.94	13	8	0.50	17	77
5/18	0	0.94	1	0	0.51	17	77
5/19	9	0.97	9	5	0.53	16	73
5/20	0	0.97	4	3	0.54	16	73
5/21	5	0.98	15	13	0.59	16	73
5/22	0	0.98	13	11	0.62	16	73
5/23	2	0.99	7	6	0.64	16	72
5/24	0	0.99	22	15	0.70	15	75
5/25	0	0.99	27	20	0.78	15	75
5/26	3	0.99	0	0	0.78	15	73
5/27	0	0.99	0	0	0.78		
5/28	0	0.99	0	0	0.78		
5/29	0	0.99	0	0	0.78		
5/30	1	1.00	0	0	0.78		
5/31	1	1.00	2	2	0.79		
6/1	0	1.00	0	0	0.79		
6/2	0	1.00	0	0	0.79		
6/3	0	1.00	0	0	0.79		
6/4	0	1.00	0	0	0.79		
6/5	0	1.00	0	0	0.79		
6/6	0	1.00	0	0	0.79		
6/7	0	1.00	1	1	0.79		
6/8	0	1.00	2	2	0.80		
6/9	0	1.00	0	0	0.80	14	
6/10	0	1.00	6	4	0.81	15	
6/11	0	1.00	0	0	0.81	16	
6/12	0	1.00	1	1	0.82	15	
6/13	0	1.00	0	0	0.82	15	
6/14	0	1.00	5	5	0.83	15	
6/15	0	1.00	7	4	0.85	15	
6/16	0	1.00	0	0	0.85	15	
6/17	0	1.00	0	0	0.85	20	
6/18	0	1.00	0	0	0.85	20	42
6/19	0	1.00	0	0	0.85	17	42
6/20	0	1.00	5	5	0.86	18	42
6/21	0	1.00	0	0	0.86	15	41
6/22	0	1.00	0	0	0.86	16	41
6/23	0	1.00	0	0	0.86	17	41
6/24	0	1.00	0	0	0.86	17	41
6/25	0	1.00	0	0	0.86	16	40
6/26	0	1.00	0	0	0.86	16	40
6/27	0	1.00	0	0	0.86	20	40
6/28	0	1.00	0	0	0.86	19	42
6/29	0	1.00	0	0	0.86	18	42

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Date	Upstream count	Cumulative proportion upstream count	Downstream count	Previously marked	Cumulative proportion downstream count	Water temperature, °C	Stream depth, cm
6/30	0	1.00	15	15	0.91	16	47
7/1	0	1.00	0	0	0.91	16	50
7/2	0	1.00	0	0	0.91	18	50
7/3	0	1.00	0	0	0.91	18	53
7/4	0	1.00	0	0	0.91	18	65
7/5	0	1.00	0	0	0.91	16	73
7/6	0	1.00	20	20	0.96	15	86
7/7	0	1.00	5	5	0.98	15	86
7/8	0	1.00	0	0	0.98	14	87
7/9	0	1.00	4	4	0.99	16	85
7/10	0	1.00	0	0	0.99	15	83
7/11	0	1.00	0	0	0.99	17	81
7/12	0	1.00	0	0	0.99	17	75
7/13	0	1.00	0	0	0.99	17	70
7/14	0	1.00	0	0	0.99	17	70
7/15	0	1.00	4	4	1.00	15	82
Total	376		352[a]	247[a]			

[a] There were 105 unmarked emigrants (352 emigrants – 247 marked emigrants = 105 unmarked emigrants).

APPENDIX B

Appendix B1.–Computer file containing raw data and analyses for assessment of the Karta River steelhead stock in 2005.

Computer file	Description
Karta steelhead 05.xls	Excel file containing physical data, weir counts, age-sex-length estimates, χ^2 and KS tests, and charts