

Fishery Data Series No. 09-29

**Coho Salmon Smolt Production, Adult Harvest, and
Escapement in Jordan and Duck Creeks, Southeast
Alaska, 2005–2006**

by

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and

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June 2009

Alaska Department of Fish and Game

Divisions of Sport Fish and Commercial Fisheries



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Weights and measures (metric)		General		Measures (fisheries)	
centimeter	cm	Alaska Department of		fork length	FL
deciliter	dL	Fish and Game	ADF&G	mid-eye-to-fork	MEF
gram	g	Alaska Administrative		mid-eye-to-tail-fork	METF
hectare	ha	Code	AAC	standard length	SL
kilogram	kg	all commonly accepted		total length	TL
kilometer	km	abbreviations	e.g., Mr., Mrs., AM, PM, etc.		
liter	L			Mathematics, statistics	
meter	m	all commonly accepted		<i>all standard mathematical</i>	
milliliter	mL	professional titles	e.g., Dr., Ph.D., R.N., etc.	<i>signs, symbols and</i>	
millimeter	mm			<i>abbreviations</i>	
		at	@	alternate hypothesis	H _A
Weights and measures (English)		compass directions:		base of natural logarithm	<i>e</i>
cubic feet per second	ft ³ /s	east	E	catch per unit effort	CPUE
foot	ft	north	N	coefficient of variation	CV
gallon	gal	south	S	common test statistics	(F, t, χ^2 , etc.)
inch	in	west	W	confidence interval	CI
mile	mi	copyright	©	correlation coefficient	
nautical mile	nmi	corporate suffixes:		(multiple)	R
ounce	oz	Company	Co.	correlation coefficient	
pound	lb	Corporation	Corp.	(simple)	r
quart	qt	Incorporated	Inc.	covariance	cov
yard	yd	Limited	Ltd.	degree (angular)	°
		District of Columbia	D.C.	degrees of freedom	df
Time and temperature		et alii (and others)	et al.	expected value	<i>E</i>
day	d	et cetera (and so forth)	etc.	greater than	>
degrees Celsius	°C	exempli gratia		greater than or equal to	≥
degrees Fahrenheit	°F	(for example)	e.g.	harvest per unit effort	HPUE
degrees kelvin	K	Federal Information		less than	<
hour	h	Code	FIC	less than or equal to	≤
minute	min	id est (that is)	i.e.	logarithm (natural)	ln
second	s	latitude or longitude	lat. or long.	logarithm (base 10)	log
		monetary symbols		logarithm (specify base)	log ₂ , etc.
Physics and chemistry		(U.S.)	\$. ¢	minute (angular)	'
all atomic symbols		months (tables and		not significant	NS
alternating current	AC	figures): first three		null hypothesis	H ₀
ampere	A	letters	Jan,...,Dec	percent	%
calorie	cal	registered trademark	®	probability	P
direct current	DC	trademark	™	probability of a type I error	
hertz	Hz	United States		(rejection of the null	
horsepower	hp	(adjective)	U.S.	hypothesis when true)	α
pH	pH	United States of		probability of a type II error	
(negative log of)		America (noun)	USA	(acceptance of the null	
parts per million	ppm	U.S.C.	United States	hypothesis when false)	β
parts per thousand	ppt, ‰	U.S. state	Code	second (angular)	"
				standard deviation	SD
volts	V		use two-letter	standard error	SE
watts	W		abbreviations	variance	
			(e.g., AK, WA)	population	Var
				sample	var

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ESCAPEMENT IN JORDAN AND DUCK CREEKS, SOUTHEAST
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TABLE OF CONTENTS

	Page
LIST OF TABLES.....	ii
LIST OF FIGURES.....	ii
LIST OF APPENDICES.....	iii
ABSTRACT.....	1
INTRODUCTION.....	1
STUDY SITE.....	3
METHODS.....	3
Smolt Counts and Coded Wire Tagging.....	3
Age Composition, and Mean Length- and Weight-at-Age of Coho Smolt.....	3
Enumeration.....	5
Age and Sex Composition, and Mean Length-at-Age of Coho Adults.....	5
Instream Adult Carcass Sampling.....	6
Escapement Estimation.....	6
Harvest.....	7
Run Size, Exploitation Rate, and Marine Survival.....	7
Other Species.....	7
Physical Data.....	8
RESULTS.....	8
Smolt Tagging, Age, Length, Weight, and Abundance.....	8
Escapement and Carcass Sampling.....	11
Age, Sex, and Length Composition of Adult Returns.....	11
Harvest, Run Size, Exploitation, and Marine Survival in 2006.....	12
Other Species.....	12
Physical Data.....	15
DISCUSSION.....	16
ACKNOWLEDGMENTS.....	22
REFERENCES CITED.....	22

LIST OF TABLES

Table	Page
1. Survey counts of adult coho salmon for Jordan and Duck Creeks from 1966, 1969, 1973, 1976–1978, and 1981–2006.	2
2. Age composition, mean length, and mean weight of coho salmon smolt sampled at Jordan Creek in 2005.	9
3. Age compositions, mean length, and mean weight of coho salmon smolt sampled at Duck Creek in 2005.	9
4. Harvest sampling statistics and estimated harvest of Jordan Creek adult coho salmon in 2006 (terms defined in Bernard and Clark 1996, m_{ij} = tags recovered in fishery, \hat{r}_{ij} = estimated number of fish harvested).	13
5. Smolt to adult survival and exploitation rates for coho salmon returning to Jordan Creek in 2006.	15
6. Emigrants other than coho salmon counted at Jordan Creek in spring 2005.	15
7. Comparison of weir counts and stream survey counts of adult coho salmon at Jordan Creek.	16

LIST OF FIGURES

Figure	Page
1. Map of Mendenhall Valley showing the location of ADF&G weir and fyke net sites on Jordan and Duck Creeks.	4
2. Upstream view of incline-plane trap used to capture emigrant fish in Jordan Creek.	4
3. Downstream view of incline-plane trap used to capture emigrant fish in Jordan Creek.	4
4. Downstream view of fyke net used to capture emigrant fish in Duck Creek.	5
5. Downstream view of bipod and picket weir used to capture immigrant fish in Jordan Creek.	5
6. Cumulative number of tagged coho salmon smolt released in 2005 at Jordan Creek.	9
7. Length distribution of age-1 and age-2 smolt sampled at Jordan Creek in 2005.	10
8. Weight distribution of age-1 and age-2 smolt sampled at Jordan Creek in 2005.	10
9. Cumulative number of tagged coho salmon smolt released in 2005 at Duck Creek.	11
10. Length distribution of age-1 and age-2 smolt sampled at Duck Creek in 2005.	12
11. Weight distribution of age-1 and age-2 smolt sampled at Duck Creek in 2005.	14
12. Cumulative number of adult coho salmon captured at Jordan Creek in 2006.	14
13. Length distribution of adult coho salmon by age class at Jordan Creek in 2006.	15
14. Length distribution of Dolly Varden emigrating from Jordan Creek in 2005.	17
15. Length distribution of Dolly Varden emigrating from Duck Creek in 2005.	17
16. Water temperature at Jordan Creek and Duck Creek during spring 2005.	18
17. Water temperature at Jordan Creek and Duck Creek during fall 2006.	18
18. Total daily precipitation (mm) at Jordan Creek (weir site) in fall 2006.	19
19. Average daily stream discharge rates (ft ³ /s) and total daily precipitation (mm) at Jordan Creek (USGS site) in spring 2005.	19
20. Marine survival of coho salmon from Jordan Creek, Macaulay Hatchery, Taku River, Berners River, and Auke Creek for return years 2006.	20

LIST OF APPENDICES

Appendix	Page
A1. Total numbers of emigrating coho salmon captured in Jordan Creek, 2005.	26
A2. Random recoveries of coded wire tagged coho salmon bound for Jordan Creek or recovered during the carcass survey at the stream location by date sample in 2006.	27
A3. Random recoveries of coded wire tagged coho salmon bound for Duck Creek by date sampled in 2006.	27
A4. Length, sex, and PIT tag numbers of cutthroat trout captured at Jordan Creek in 2005.	28
A5. List of computer data files archived from this study.	28

ABSTRACT

We enumerated smolt production and estimated marine survival, exploitation rates, and harvest of coho salmon *Oncorhynchus kisutch* in Jordan and Duck Creek near Juneau, Alaska in 2005–2006. These streams are located in an urban area and have been monitored continuously since 1966. Future airport expansion could impact the production of coho salmon in these streams, therefore at the request of the Federal Aviation Administration, the Alaska Department of Fish and Game and the National Marine Fisheries Service conducted studies in both creeks beginning in 2003. This report summarizes the coho salmon smolt and adult production data gathered from 2005 to 2006. In 2005, a total of 6,057 coho salmon smolt were tagged at Jordan Creek, and 293 smolt were tagged at Duck Creek. Low or no stream flows in Duck Creek precluded normal smolt emigration in 2005. In 2006, an escapement count of 164 adult coho salmon was obtained at Jordan Creek, and an estimated minimum 74 (SE = 21.6) to an estimated maximum 149 (SE = 14.9) of these were attributed to the Jordan Creek coho stock. The remaining balance of fish was attributed to fish of unknown origin. The estimated contribution of Jordan Creek coho salmon to the marine fisheries was 68 (SE = 15) in 2006. The estimated smolt-to-adult survival of Jordan Creek coho salmon was between 2.3% (SE = 0.03%) and 3.6% (SE = 0.05%) in 2006, lower than other nearby coho salmon stocks. In 2006, 7 adult coho salmon were counted at Duck Creek. In 2006, 2 Duck Creek coho salmon were sampled in marine fisheries. The total number of coho salmon harvested in marine fisheries, marine survival, and exploitation rates could not be estimated for Duck Creek because of the unknown proportion of smolt tagged.

Key words: coded wire tag, production, abundance, harvest, contribution, marine survival, exploitation rate, troll fishery, gillnet fishery, seine fishery, recreational fishery, age composition, size composition, sex composition, length-at-age, smolt, PIT tag, coho salmon, *Oncorhynchus kisutch*, escapement, Jordan Creek, Duck Creek, Southeast Alaska, inclined-screen trap, picket weir, fyke net, Dolly Varden, *Salvelinus malma*, cutthroat trout, *Oncorhynchus clarki*, steelhead trout, *Oncorhynchus mykiss*, pink salmon, *Oncorhynchus gorbuscha*, chum salmon, *Oncorhynchus keta*, sockeye salmon, *Oncorhynchus nerka*, reclamation, environmental impact, environmental analysis, citizens advisory group, rehabilitation.

INTRODUCTION

Coho salmon *Oncorhynchus kisutch* are the target of many recreational marine anglers in the Juneau area. An estimated 26,273 coho salmon were harvested in the 2002 Juneau marine boat sport fishery (Hubartt and Jaenicke 2004). The Taku River, Berners River, and Macaulay Salmon Hatchery (operated by Douglas Island Pink and Chum, Inc., DIPAC) produce many of the coho salmon caught in this fishery. Many small systems contribute to this fishery as well (Jones III and McPherson 1997). Monitoring the escapement into these small systems, located along the Juneau roadside, is a management tool used by Alaska Department of Fish and Game (ADF&G). Jordan and Duck creeks are two small systems that contribute to the Juneau marine sport fishery and to northern Southeast Alaska commercial fisheries.

Prior to 2001, the only counts of coho salmon escapement into Jordan Creek were indices of partial escapement obtained through foot surveys

(Table 1). These indices have been used annually since 1981, along with the indices of partial coho salmon escapement into four other creeks, to assess whether coho salmon escapement goals are achieved in the Juneau area (Jones III and McPherson 1997; DerHovanisian and Geiger 2005). The minimum escapement goal for Jordan Creek coho salmon was not met for 5 consecutive years (1996–2000), leading to concern about smolt production (DerHovanisian and Geiger 2005; note that the goal was eliminated in 2005, see Clark 2005). Thus, ADF&G operated a smolt weir in 2001 to determine coho salmon smolt production during the spring emigration. A large number of coho salmon smolt (25,990) were counted, indicating the importance of Jordan Creek as a rearing and overwintering site for juvenile coho salmon (B. Glynn, Juneau Area Management Biologist, ADF&G Sport Fish Division, Douglas; personal communication). ADF&G also assessed the total smolt production in Jordan Creek in 2002 (8,171) and total adult return in 2003 (389, Lum and Glynn 2007).

Table 1.–Survey counts of adult coho salmon for Jordan and Duck Creeks from 1966, 1969, 1973, 1976–1978, and 1981–2006.

Survey year	Jordan Creek	Survey type ^a	Duck Creek	Survey type ^a
1966	na	na	500	F
1969	na	na	1	F
1973	na	na	120	F
1976	na	na	na	na
1977	na	na	na	na
1978	na	na	2	F
1981	482	F	na	na
1982	368	F	na	na
1983	184	F	13	F
1984	251	F	na	na
1985	72	F	na	na
1986	163	F	18	F
1987	250	F	17	F
1988	215	F	na	na
1989	133	F	3	F
1990	216	F	13	F
1991	322	F	na	na
1992	785	F	80	F
1993	322	F	21	F
1994	371	F	na	na
1995	77	F	na	na
1996	54	F	na	na
1997	24	F	na	na
1998	63	F	na	na
1999	47	F	na	na
2000	30	F	na	na
2001	119/525 ^b	F/W	23 ^b	W
2002	1,396	F	na	na
2003	78/389	F/W	na	na
2004	38/227	F/W	na	na
2005	94/562	F/W	na	na
2006	76/164	F/W	7	W

^a F = foot survey, W = weir survey, na = no survey

^b Weir numbers collected for the Federal Aviation Administration (SWCA and RTG 2001).

In 2001, the Federal Aviation Administration (FAA) funded the operation of adult coho salmon weirs on Jordan and Duck creeks as part of their environmental impact analysis for a planned airport expansion (SWCA and RTG 2001¹; Table 1).

¹ SWCA Environmental Consultants and RTG. 2001. Report of year 2001 fishery sampling for the Juneau airport EIS: summer estuary habitats and fall salmon weirs in Duck and Jordan Creeks, Unpublished report Juneau, AK. December 2001.

Mitigation measures such as culvert expansion on Jordan Creek are included in the Environment Impact Statement (FAA 2007). However, a major relocation of the lower portion of Duck Creek during this airport expansion could impact the production of coho salmon from this area.

Prior to 2001, counts of adult coho salmon at Duck Creek were from foot surveys. Foot surveys of adult coho salmon at Duck Creek in 1966 and 1973 documented 500 and 120 adult coho salmon, respectively (Table 1). The status of Duck Creek coho salmon became a concern to resource agencies in the late 1970s and early 1980s when very few coho salmon were observed spawning in Duck Creek. By 1978, the count was down to two adult coho salmon at Duck Creek (Table 1). Five coho salmon smolt emigration counts averaging 3,000 smolt were documented in the early 1990s at Duck Creek (K Koski, Coastal and Marine Ecologist, Alaska Chapter of the Nature Conservancy (TNC), Juneau; personal communication), indicating that juvenile coho salmon used the creek for rearing. Collaborative efforts to restore fish habitat within Duck Creek were initiated by the National Marine Fisheries Service (NMFS) in 1993.

This report includes results of two projects from a multiyear study that began at Jordan and Duck creeks in 2003 as a collaborative effort between NMFS and ADF&G. The first project was designed to investigate coho salmon smolt production in each creek. Smolt production and associated biological data were originally proposed as an indicator of the effectiveness of habitat restoration in Duck Creek, and as an indicator of the current condition of fish habitat within Jordan Creek. This project was funded through the Alaska Sustainable Salmon Fund (AKSSF). ADF&G obtained additional AKSSF funding to collect immigrant fisheries data on both creeks starting in 2004. Jordan Creek foot survey counts were also compared to weir counts to determine the percentage of the immigration observed in foot surveys. This report summarizes results from field work done in spring 2005 and fall 2006. Project objectives were to:

1. Count all coho salmon smolt leaving Duck and Jordan creeks in 2005.

2. Estimate the marine harvest of coho salmon from Duck and Jordan creeks in 2006.
3. Estimate the age composition of coho salmon smolt emigrating from Duck and Jordan creeks in 2005.
4. Estimate the mean length-at-age of coho salmon smolt emigrating from Duck and Jordan creeks in 2005.
5. Estimate the mean weight-at-age of coho salmon smolt emigrating from Duck and Jordan creeks in 2005.
6. Count adult escapements of coho salmon into Duck and Jordan creeks in 2006 and estimate age and sex composition.

STUDY SITE

Jordan and Duck Creeks (ADF&G Catalog Nos. 111-50-10620 and 111-50-10500-2002, respectively; Johnson and Klein 2009) are located approximately 11 km northwest of Juneau, Alaska, on the Juneau road system (Figure 1). Jordan Creek is about 4.8 km long and originates from a ground water source on the east side of the Mendenhall Valley. The upper section of Jordan Creek flows through a forest of spruce and hemlock, while the lower section flows through an industrialized area before draining into Gastineau Channel.

Duck Creek also originates from a ground water source and flows for about 4.8 km through residential and industrial areas in the center of the Mendenhall Valley before emptying into the Mendenhall River. Jordan and Duck creeks have historically produced coho salmon, pink salmon *O. gorbuscha*, chum salmon *O. keta*, sockeye salmon *O. nerka*, cutthroat trout *O. clarkii* and Dolly Varden char *Salvelinus malma*. Chinook salmon *O. tshawytscha* and steelhead trout *O. mykiss*, have also been seen in Jordan Creek.

METHODS

SMOLT COUNTS AND CODED WIRE TAGGING

All emigrant fish at Jordan Creek were diverted into an incline-plane trap (Figures 2 and 3) and then into a holding box downstream. The trap was located about 50 m downstream from Yandukin Drive and was operated from March 25, 2005 through June 30, 2005. In Duck Creek, a fyke net connected to a holding box (Figure 4) was placed

at the upstream entrance of the culvert under the Mendenhall Mall Road to capture emigrant fish. The fyke net was operated from April 7, 2005 through June 30, 2005.

Each coho salmon smolt captured at Jordan and Duck creeks was counted, anesthetized in a water-based solution of MS-222 and sodium bicarbonate, adipose-clipped, and tagged with a coded wire tag (CWT) that had a unique code for the year and stream location. A coho salmon smolt was defined as being ≥ 70 mm FL. Tagged smolt were passed through a quality control device (QCD) to ensure that all fish were tagged. All tagged smolt were placed in a holding box for 24 hrs to evaluate mortality and tag retention. After 24 hrs, a random sample of at least 50 smolt from the holding box was passed through the QCD to assess tag retention. If less than 98% of the sampled smolt possessed a CWT, then all smolt were passed through a QCD and those smolt missing tags were retagged. Smolt were released downstream after confirming tag retention.

AGE COMPOSITION, AND MEAN LENGTH-AND WEIGHT-AT-AGE OF COHO SMOLT

A sample of tagged smolt from each creek was anesthetized, sampled for scales, weighed to the nearest 0.1 g, and measured to the nearest mm FL. Scales were collected from the preferred area (Scarnecchia 1979) above the lateral line and posterior to the dorsal fin on the left side of the fish, pressed between two microscope slides, and aged using a microfiche reader with a 70x magnification lens.

Originally 5% of the total tagged smolt were to be randomly sampled throughout the 2005 emigration at Jordan Creek. From March 25, 2005 through May 31, 2005 every 20th smolt was sampled, but from June 1, 2005 through June 5, 2005, every 5th smolt was sampled, and from June 6, 2005 through the end of the run (June 30, 2005), the sampling rate of every 20th smolt was resumed. While not likely, the possibility existed at Jordan Creek that some smolt were not captured because they left the system before the weir was installed, after the weir was pulled, or during high water events. This could have contributed a small bias in our estimators if the inference is for the entire population of Jordan Creek smolt leaving the system in 2005.

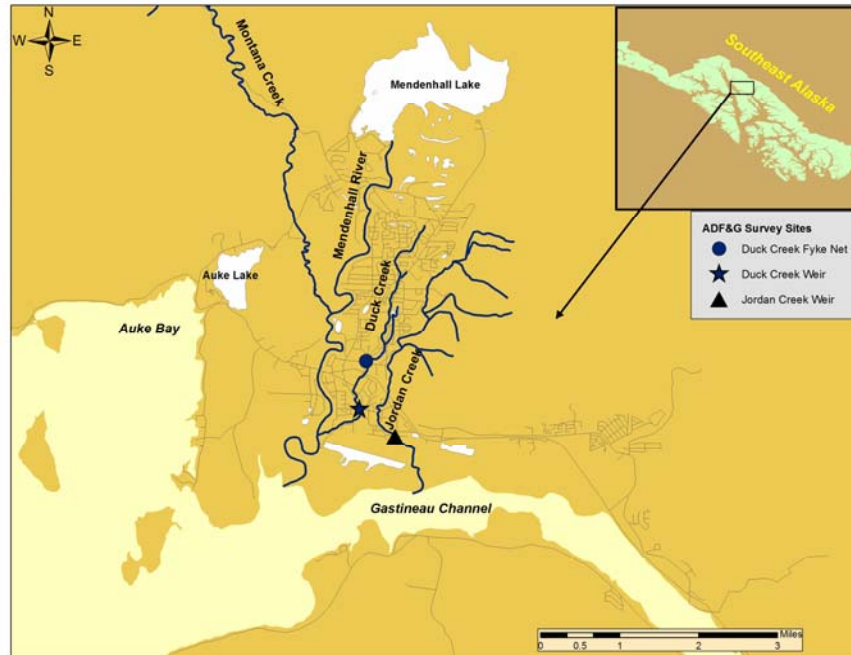


Figure 1.—Map of Mendenhall Valley showing the location of ADF&G weir and fyke net sites on Jordan and Duck Creeks.



Figure 2.—Upstream view of incline-plane trap used to capture emigrant fish in Jordan Creek.



Figure 3.—Downstream view of incline-plane trap used to capture emigrant fish in Jordan Creek.

Every other smolt was to be sampled during the 2005 emigration at Duck Creek. Just as with Jordan Creek, the sampling rate had to be adjusted due to the fluctuations in fish numbers. From April 7, 2005 to May 9, 2005, every other fish was sampled, but from May 10, 2005 through the rest of the emigration, every 4th fish was sampled.

Water levels fluctuated and became extremely low during the 2005 field season at Duck Creek. From

May 26, 2005 through June 14, 2005, when the weir was pulled, the creek in the area of the weir was dry. These extremely dry conditions and the resulting short duration of the fyke operation, compounded by the low sampling rate, gave reason to limit all statistical inference to the captured population only. Inferences drawn from the Duck Creek sample data were relevant only to the tagged population of smolt.



Figure 4.–Downstream view of fyke net used to capture emigrant fish in Duck Creek.

Two sample t-tests were used to determine if the length and weight data needed to be stratified because of the sampling rate changes. Chi-square tests were used to determine if the age data needed to be stratified. Proportions of emigrant coho salmon smolt in a specific age class a by creek and sample year were estimated using:

$$\hat{p}_a = \frac{n_a}{n} \quad (1)$$

$$\text{var}(\hat{p}_a) = \frac{\hat{p}_a(1 - \hat{p}_a)}{n - 1} \quad (2)$$

where:

\hat{p}_a = estimated proportion of smolt in age class a ,

n = number of smolt successfully aged,

n_a = subset of n belonging to class a .

Estimates of mean length- and weight-at-age along with their associated variances were calculated with standard sample summary statistics (Cochran 1977). Length and weight distributions were visually analyzed for apparent trends.

ENUMERATION

An aluminum bipod and picket weir, including a 2.4 m² trap (Figure 5), was installed in Jordan Creek near the smolt trap site upstream of tidal influence to obtain an escapement count of adult coho salmon. A gap of 31 mm between pickets allowed coho salmon jacks, or ocean-age-0 fish,



Figure 5.–Downstream view of bipod and picket weir used to capture immigrant fish in Jordan Creek.

and fish less than 400 mm TL to pass through the weir. Therefore the population inference for this study was the adult population, or ocean-age-1 fish. The bottom and sides of the weir were sealed with sandbags and the weir was monitored daily. The weir was operated from September 2, 2006 through November 8, 2006.

An adult weir was operated from September 7, 2006, through November 7, 2006 at Duck Creek to obtain an estimate of escapement. The weir was located in the cement structure adjacent to the electrical substation inside the airport security fence off of Cessna Drive (Figure 1).

All immigrant coho salmon captured at the weirs were counted, classified as adults or jacks, inspected for missing adipose fins, and if not sampled for age, sex, and length (ASL), immediately released into the stream above the weirs. All fish were examined for other tags or marks. All other salmon species captured at the weir were counted and released.

Foot surveys were also conducted by management staff to obtain index counts of coho salmon escapement in Jordan Creek in 2006. These foot survey counts were compared to weir counts to determine the efficiency of foot surveys for Jordan Creek.

AGE AND SEX COMPOSITION, AND MEAN LENGTH-AT-AGE OF COHO ADULTS

Initially, every other adult coho salmon returning to Jordan Creek was sampled for scales in 2006. The sampling rate was changed to every adult coho salmon beginning October 4, 2006 when it

was obvious that the escapement numbers were low. Every coho salmon captured at Duck Creek in 2006 was sampled for scales. All scales were collected from the preferred area (Scarnecchia 1979) and placed on a gum card. Scales were then pressed onto acetate cards and analyzed for age using a microfiche reader with a lens of 70x magnification. The sex of each coho salmon captured at both creeks was estimated by visually examining morphological differences described by Sandercock in Groot and Margolis 1991. Chi-square tests were used to determine if the age and length data needed to be stratified by date.

The proportions of adult coho salmon in a specific age or sex class a from each creek were estimated as in equation 1. The variance of the age proportions was estimated using equation 2.

Each adult coho salmon was measured to the nearest mm MEF at Jordan Creek during 2006. The mean length-at-age for Jordan Creek adult coho salmon was calculated for the following groups: all adults, age-1.1, age-2.1, females, and males. Length distributions for each age and each sex were visually analyzed for apparent trends.

INSTREAM ADULT CARCASS SAMPLING

Foot surveys were conducted at least once a week during the immigration to collect heads from coho salmon carcasses in and around Jordan Creek. Otoliths were removed from the heads of all coho salmon carcasses having an adipose finclip. Heads from adipose-clipped carcasses were labeled with a cinch tag and sent to the ADF&G Mark, Tag, and Age Laboratory for CWT extraction and analysis. Otoliths were to be extracted from all sampled heads and adult coho salmon carcasses separated into two categories (i): adipose-clipped and -unclipped. These categories were further organized into two subcategories (j): coho salmon originating from Jordan Creek and coho salmon originating from Macaulay Hatchery based on the CWTs. Unfortunately, the otoliths were lost prior to thermal-mark analysis. Coho salmon with an unknown origin were treated as either (a) being from Jordan Creek, leading to an estimate of the maximum escapement that could have returned from smolt produced in Jordan Creek), or (b) being from other sources, leading to a minimum escapement estimate. Proportions of carcasses

within these sub-categories were estimated (by sample year) using:

$$\hat{p}_j = \frac{n_j}{n_i} \quad (3)$$

$$\hat{\text{var}}(\hat{p}_j) = \frac{\hat{p}_j(1 - \hat{p}_j)}{n_i - 1} \quad (4)$$

where

\hat{p}_j = estimated proportion of adipose-clipped or -unclipped adult coho salmon carcasses in subcategory j ,

n_i = number of sampled adult coho salmon carcasses in category i ,

n_j = subset of n_i in subcategory j .

ESCAPEMENT ESTIMATION

The estimated proportions of carcasses in each subcategory were multiplied by the escapement counts of all returning adult coho salmon in each category to estimate the escapement of adult coho salmon in each subcategory that could be attributed to Jordan Creek production. The equation for this estimate was:

$$\hat{N}_{ej} = \hat{p}_j N_{ei} \quad (5)$$

$$\hat{\text{var}}(\hat{N}_{ej}) = N_{ei}^2 \hat{\text{var}}(\hat{p}_j) \quad (6)$$

where

\hat{N}_{ej} = estimated escapement of adult coho salmon in subcategory j ,

N_{ei} = escapement count of adult coho salmon in category i .

An estimate of escapement \hat{N}_e was calculated using the carcass samples (see equations 5 and 6) to determine and estimate the presence of hatchery fish, such that:

$$\hat{N}_e = \hat{N}_m + \hat{N}_u \quad (7)$$

where \hat{N}_m is the estimated number of adipose-clipped fish that could be attributed to Jordan Creek, and \hat{N}_u is the number of unmarked, unclipped fish that were attributed to Jordan Creek. Variance of \hat{N}_e was estimated by:

$$\text{var}[\hat{N}_e] = \text{var}[\hat{N}_m] + \text{var}[\hat{N}_u] \quad (8)$$

where $\text{var}[\hat{N}_m]$ and $\text{var}[\hat{N}_u]$ are the binomial sampling variances calculated in equation 6. Because the samples were non-random, it is assumed that the variance is a minimum variance. Likewise, there is no way to describe the possible bias from sampling carcasses.

HARVEST

The harvest of Jordan and Duck creek coho salmon in 2006 was estimated using samples collected in the creek and from Southeast Alaska commercial and recreational fisheries using the methods in Bernard and Clark (1996). Commercial catch data were summarized and stratified differently for various fisheries. Statistics for the troll fishery were stratified by troll fishing period and by fishery quadrant, the seine and gillnet fisheries by statistical week and fishing district, and the recreational fisheries by port/fishery and fortnight (or biweek). In most cases, CWTs of interest were recovered in only a few of the sport fish sampling strata (e.g., low/high use harbors, morning/evening periods, derby strata, charter/lodge contributions), which defined the fishery biweek. Assuming the harvests of fish with CWTs of interest were independent of sampling strata within fishery biweeks, harvests and sampling information were totaled over the fishery biweek to estimate contributions.

RUN SIZE, EXPLOITATION RATE, AND MARINE SURVIVAL

Estimated total run size \hat{N}_R for each year (harvest plus escapement of coho salmon returning to Jordan and Duck creeks above the weir) was the sum of the estimated harvest \hat{T} and escapement \hat{N}_e (of Jordan Creek origin):

$$\hat{N}_R = \hat{T} + \hat{N}_e \quad (9)$$

$$\text{var}[\hat{N}_R] = \text{var}[\hat{T}] + \text{var}[\hat{N}_e] \quad (10)$$

Estimates of harvest \hat{r}_i were calculated for each stratum, then summed across strata and across fisheries to obtain the estimate of the total harvest \hat{T} :

$$\hat{T} = \sum_i \hat{r}_i \quad (11)$$

$$\text{var}[\hat{T}] = \sum_i \text{var}[\hat{r}_i] \quad (12)$$

The estimated fishery exploitation rate \hat{E} was calculated:

$$\hat{E} = \frac{\hat{T}}{\hat{N}_R} \quad (13)$$

The delta method (Seber 1982) was used to approximate the variance of \hat{E} :

$$\text{var}[\hat{E}] \approx \frac{N_e^2}{\hat{N}_R^4} \text{var}[\hat{T}] \quad (14)$$

Smolt-to-adult survival was estimated by:

$$\hat{S} = \frac{\hat{N}_R}{N_S} \quad (15)$$

where N_S is the total smolt production: the variance of \hat{S} is:

$$\text{var}[\hat{S}] = \frac{\text{var}[\hat{N}_R]}{N_S^2} \quad (16)$$

OTHER SPECIES

All migrant Dolly Varden and every cutthroat trout captured in Jordan Creek were examined for external marks. Approximately every other Dolly Varden captured at Jordan Creek and all Dolly Varden captured at Duck Creek in spring 2005 were measured to the nearest 5 mm FL. All cutthroat trout captured were measured to the nearest 1 mm FL. Untagged, emigrant cutthroat trout were injected with a passive integrated transponder (PIT) tag, adipose-clipped, and released. Previously PIT-tagged trout were

measured and their unique PIT tag number was recorded. All cutthroat trout mortalities were sampled for otoliths, length, scales, and sex; PIT tags, if present, were recovered. Pink salmon and chum salmon fry, sculpin, flounder, and three-spine stickleback were counted and released downstream. Adult immigrating steelhead were counted and measured to the nearest mm before being released upstream. Steelhead kelts were tagged with PIT tags as they emigrated from Jordan Creek. Adult pink, chum, Chinook, and sockeye salmon were counted at all weirs in the fall and released upstream.

PHYSICAL DATA

Water temperature (°C) was recorded almost every day at the Jordan Creek trap and weir site during the spring (May 26, 2005 through June 24, 2005) and fall operations (September 6, 2006 through November 6, 2006). Water temperature was also recorded daily at the Duck Creek adult weir site from April 12, 2005 through June 10, 2005, and at the adult weir site from September 8, 2006 through October 31, 2006. Missing values of temperature were calculated by averaging the two values bracketing the missing value. Daily precipitation (mm) was collected in a rain gauge located at the Jordan Creek weir site from September 14 through November 6, 2006. Additional values of total daily precipitation (mm) for spring 2005 and average water depth (ft) and average discharge (ft³/s) for spring 2005 were recorded at a United States Geological Survey (USGS) gauging station (USGS 15052475) located in Jordan Creek on the downstream end of the Egan Drive culvert ([USGS 2005](#)).

RESULTS

SMOLT TAGGING, AGE, LENGTH, WEIGHT, AND ABUNDANCE

Jordan Creek 2005: The first smolt tagged was released April 3, the last smolt was released on June 24, 2005 and the midpoint of the emigration occurred on May 16 (Figure 6). A total of 6,057 emigrating coho salmon smolt were tagged and released (Appendix A1). An estimated 89.4% (SE = 0.17 %) of the smolt sampled with legible scales were age-1 and 10.6% (SE = 0.17%) were age-2 (Table 2). Because of illegible scales, 24 sampled

smolt could not be aged. A Chi-square test indicated that the proportions of age-1 coho salmon smolt were the same ($P = 0.08$) in all samples collected regardless of the sampling increase that occurred from June 1 to June 5. The mean length and weight for all smolt sampled (Table 2) was 94.6 mm (SE = 0.7 mm) and 8.8 g (SE = 0.2 g), respectively. The mean length and weight of smolt by age (Table 2) was 91.7 mm (SE = 0.6 mm), and 7.9 g (SE = 0.2 mm) for age-1 smolt, and 116.3 mm (SE = 2.4 mm) and 15.4 g (SE = 1.1 g) for age-2 smolt. A t-test indicated that the mean lengths were statistically similar ($P = 0.47$) for smolt sampled from March 25 through May 30 and June 6 through June 30 when the sampling rate was 5%, and from May 31 through June 5 when the sampling rate was increased to 20%. Another t-test, however, indicated that the mean weights ($P = 0.43$) were statistically different in smolt sampled from March 25 through May 30 and June 6 through June 30 when the sampling rate was 5% and from May 31 through June 5 when the sampling rate was increased to 20%. However, these weight data were not stratified because the differences in mean weight (8.8 g vs. 8.5 g) were presumed to be biologically insignificant. Length and weight distributions at age for smolt sampled at Jordan Creek in 2005 are shown in Figures 7 and 8.

Duck Creek 2005: Low or no water limited the capture of fish in Duck Creek. It was unlikely that the entire smolt emigration was tagged and it was impossible to determine the abundance of the actual smolt run from these partial counts. Inferences cannot be attributed to the entire population.

There were 293 coho salmon smolt tagged and released from April 20 through May 25 (Figure 9). An estimated 32.1 % (SE = 4.6 %) of the 106 smolt sampled with legible scales were age-1 (Table 3), and 67.9 % (SE = 4.6 %) were age-2. Eighteen smolt had illegible scales and could not be aged. The sampling rate was 50% for the entire sampling period.

The mean length and weight for all smolt sampled (Table 3) was 121.9 mm (SE = 1.3 mm) and 17.7 g (SE = 0.5 g). The mean length and weight by age was 110.0 mm (SE = 2.1 mm) and 13.3 g (SE = 0.7 g) for age-1 smolt, and 126.5 mm (SE = 1.5 mm)

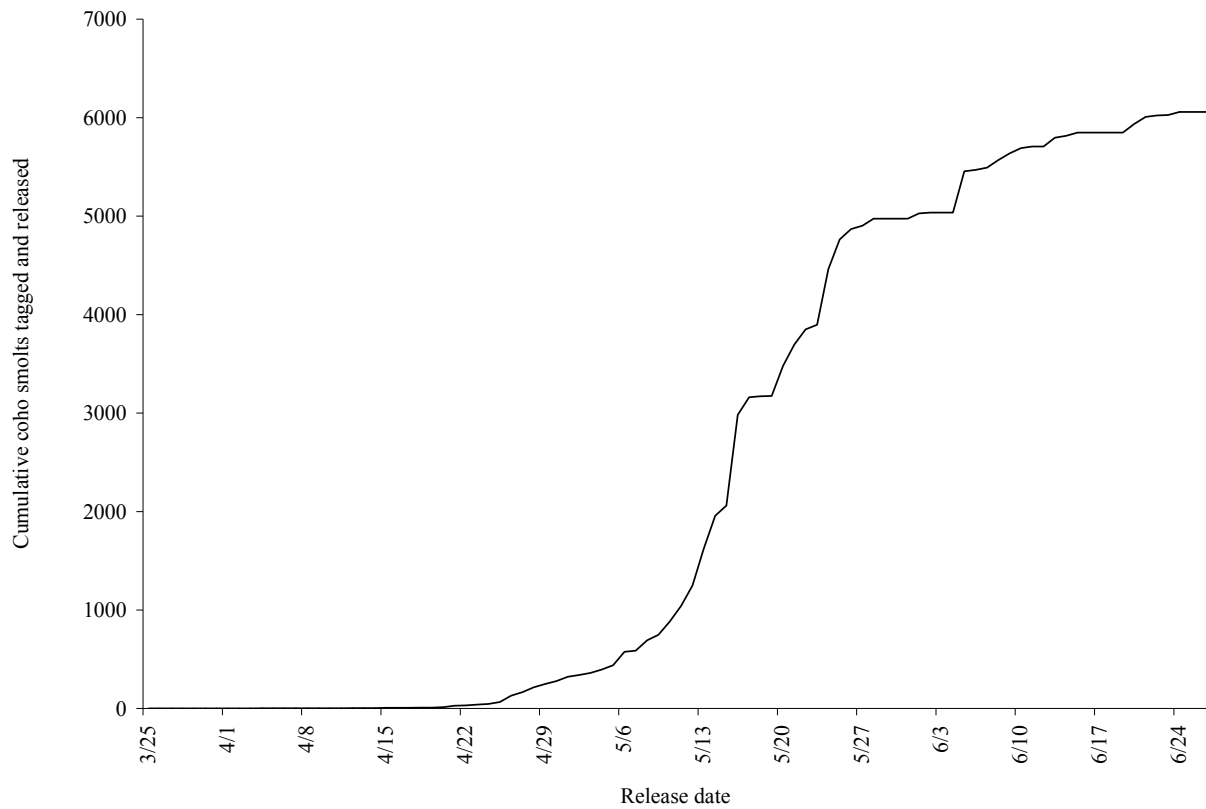


Figure 6.—Cumulative number of tagged coho salmon smolt released in 2005 at Jordan Creek.

Table 2.—Age composition, mean length, and mean weight of coho salmon smolt sampled at Jordan Creek in 2005.

Age class	Age composition (%)	SE (%)	Length (mm FL)	SE (mm)	Weight (g)	SE (g)
Age-1	89.4%	0.17%	91.7	0.6	7.9	0.2
Age-2	10.6%	0.17%	116.3	2.4	15.4	1.1
All ages			94.6	0.7	8.8	0.2

Table 3.—Age compositions, mean length, and mean weight of coho salmon smolt sampled at Duck Creek in 2005.

Smolt year	Age class	Age composition (%)	SE (%)	Length (mm FL)	SE (mm)	Weight (g)	SE (g)
2004	Age-1	32.1	4.6	110.0	2.1	13.3	0.7
	Age-2	67.9	4.6	126.5	1.5	19.6	0.7
	All ages			121.9	1.3	17.7	0.5

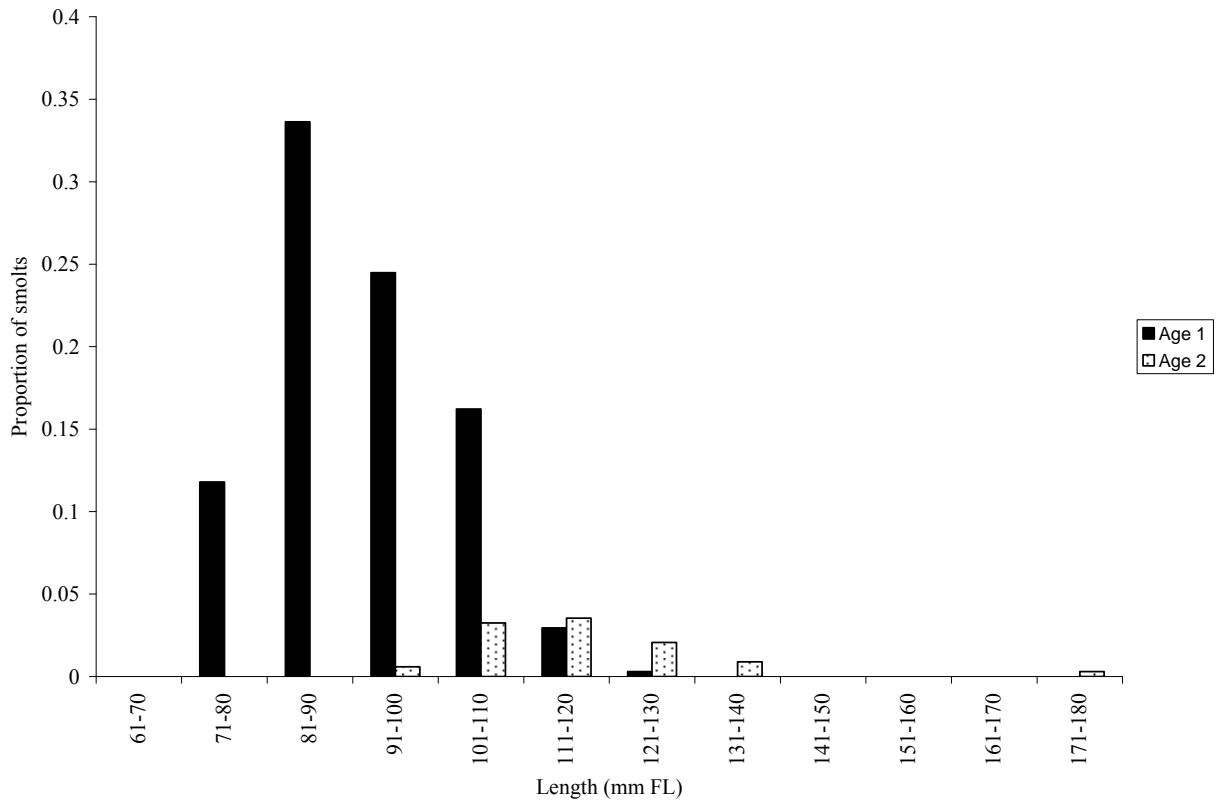


Figure 7.—Length distribution of age-1 and age-2 smolt sampled at Jordan Creek in 2005.

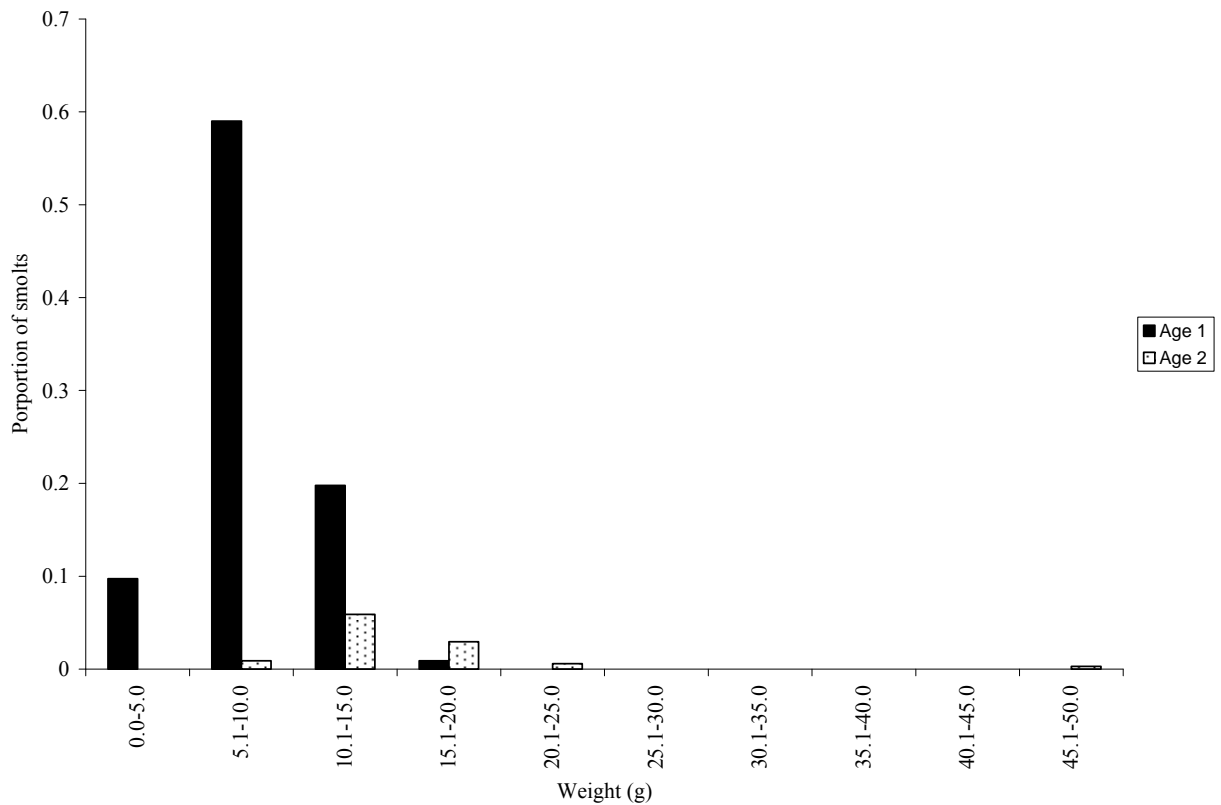


Figure 8.—Weight distribution of age-1 and age-2 smolt sampled at Jordan Creek in 2005.

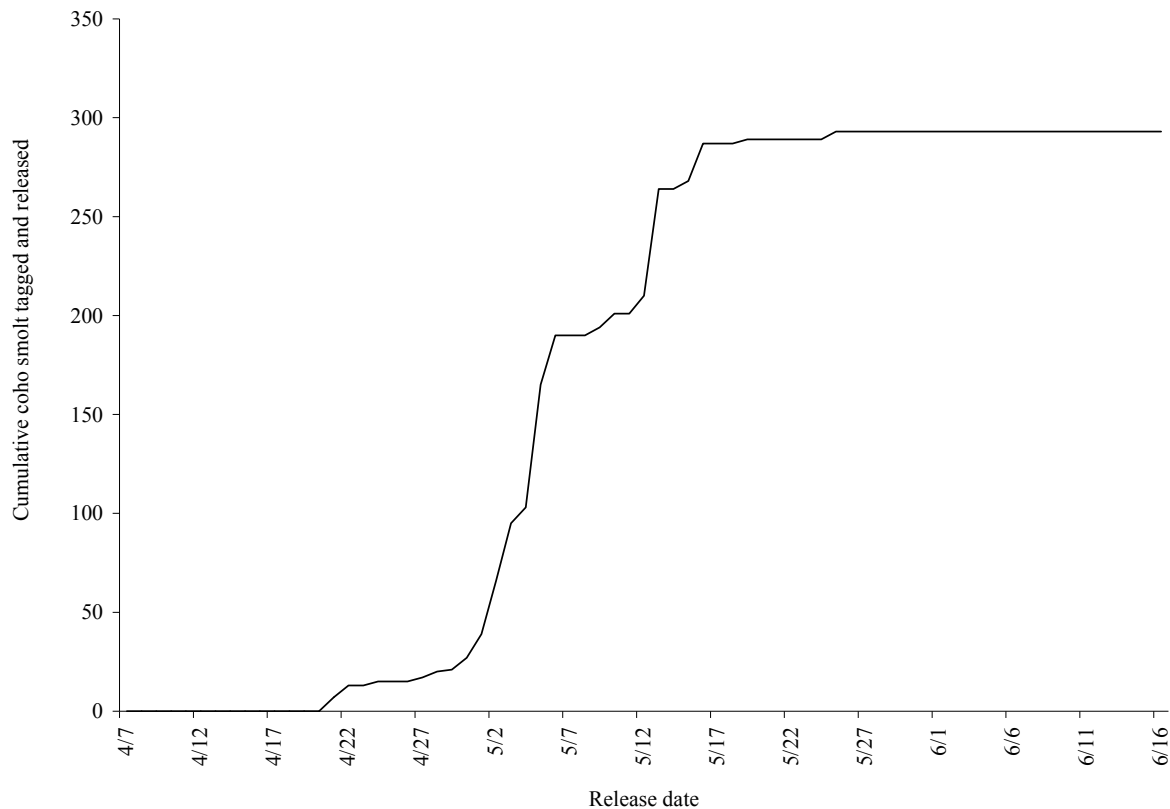


Figure 9.—Cumulative number of tagged coho salmon smolt released in 2005 at Duck Creek.

and 19.6 g (SE = 0.7 g) for age-2 smolt (Table 3). Length and weight distributions at age for smolt sampled at Duck Creek in 2005 are shown in Figures 10 and 11.

ESCAPEMENT AND CARCASS SAMPLING

Jordan Creek 2006: The adult coho salmon immigration began on September 2, ended on November 6 and the midpoint occurred on September 29 (Figure 12). There were 164 adults captured and 118 (72.0%) of the adults were adipose-clipped. Eight heads were collected from adult coho salmon carcasses that had adipose finclips. Two (25%) of the adipose-clipped carcasses contained no CWT, 5 (62.5%) were tagged at Jordan Creek in 2005, and 1 (12.5%) was tagged at Duck Creek in 2005. None of the unclipped fish were looked at for tags. Expanding these CWT data resulted in a minimum escapement of 74 (SE = 21.6) and a maximum escapement of 149 (SE = 14.9) attributed to the Jordan Creek coho stock. Foot surveys counted a peak escapement of 27, about 16% of the total escapement through the weir.

Duck Creek 2006: The first adult coho salmon was caught on September 25, the last on October 8, and a total of seven were captured. Three of these coho salmon were adipose-clipped, and one head was collected (43%, SE = 20%) which did not contain a tag. No otoliths were collected.

AGE, SEX, AND LENGTH COMPOSITION OF ADULT RETURNS

Jordan Creek 2006: The estimated age composition of adult coho salmon was 83.5% (SE = 4.0%) age-1.1 and 16.5 % (SE = 4.0 %) age-2.1. A Chi-square test (P = 0.66) indicated that the proportions of age 1.1 coho salmon were the same in samples prior to September 30 and after October 1. About 13.3 % (n = 98) of the total scales sampled were illegible. An estimated 46.4% (SE = 6.38%) of the adult coho salmon were males and 53.6 % (SE = 6.38%) were females. The average length was 609.8 mm MEF (SE = 3.6 mm) for all adult coho salmon, 612.0 mm (SE = 5.2 mm) for age-1.1, and 616.8 mm (SE = 18.0 mm) for age-2.1 fish. The length distribution at age of adults is shown in Figure 13.

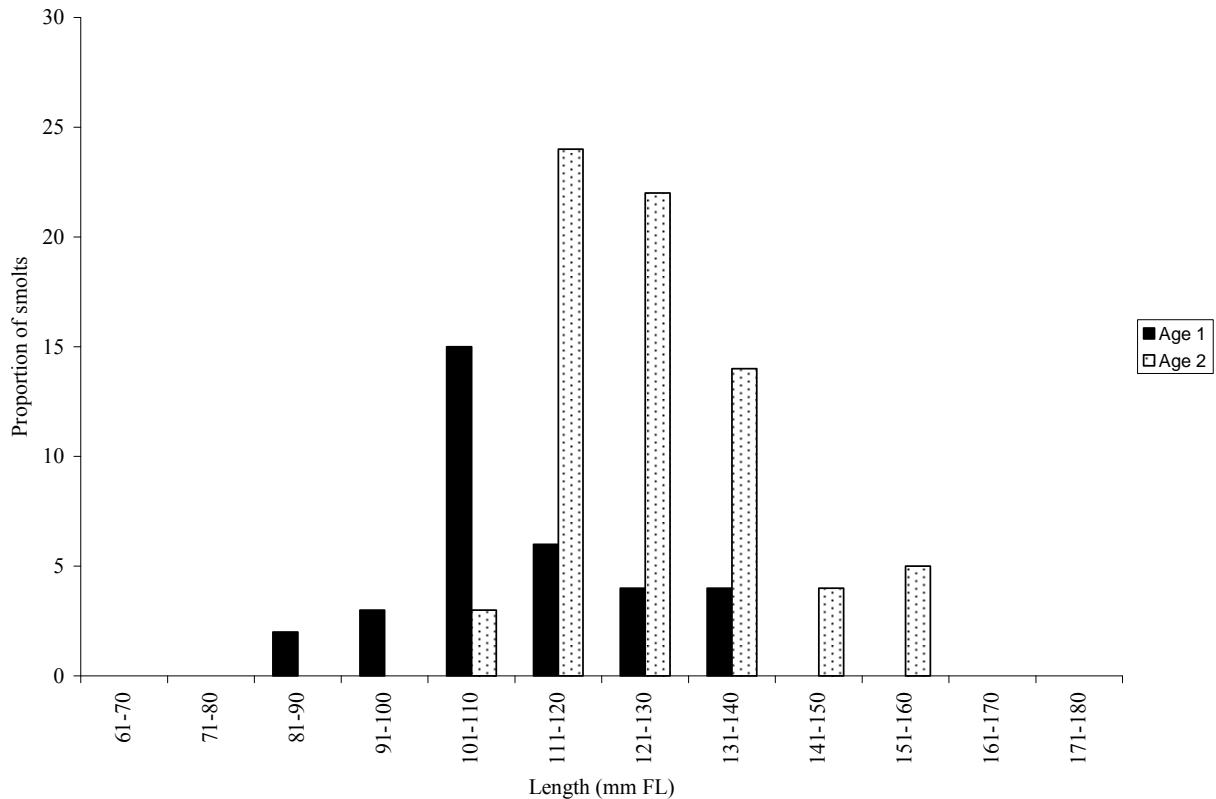


Figure 10.—Length distribution of age-1 and age-2 smolt sampled at Duck Creek in 2005.

Females averaged 617.9 mm MEF (SE = 4.3 mm) and males averaged 600.9 mm (SE = 6.0 mm).

Duck Creek 2006: Two of the 7 coho salmon captured were age-1.1, four were age-2.1, and one could not be aged. Two of the coho salmon captured were females while five were males. The length of adult coho salmon ranged from 435 mm to 580 mm MEF.

HARVEST, RUN SIZE, EXPLOITATION, AND MARINE SURVIVAL IN 2006

Jordan Creek: Fourteen Jordan Creek coho salmon CWTs were recovered in the 2006 commercial fisheries (Table 4, Appendix A2). Two Jordan Creek CWTs were recovered from coho salmon harvested in the 2006 sport fisheries. An estimated 68 (SE = 29) Jordan Creek coho salmon were harvested in 2006 (Table 4). An estimated minimum of 142 (SE = 36.6) and maximum of 217 (SE = 29.8) Jordan Creek adult coho salmon returned in 2006. The minimum exploitation rate of Jordan Creek coho salmon was estimated to be 31.3 % (SE = 0.5 %) and the maximum exploitation rate of Jordan Creek coho

salmon was estimated to be 47.9% (SE = 0.6%) in 2006 marine fisheries (Table 5). Coho salmon smolt-to-adult marine survival at Jordan Creek was estimated to be between 2.3 (SE = 0.06%) and 3.6 % (SE = 0.05 %) for the 2005 smolt year (Table 5).

Duck Creek: In 2006, one tagged Duck Creek coho salmon was recovered in commercial fisheries and one was recovered in sport fisheries (Appendix A3). Only one fish was recovered during escapement counts on Duck Creek in 2006. This fish was adipose-clipped but did not have a CWT, so the total return from the 2006 smolt emigration could not be estimated because information on the ratio of marked to unmarked adult fish was not obtained.

OTHER SPECIES

Jordan Creek has historically contained species other than coho salmon including Dolly Varden, cutthroat trout, steelhead trout, pink salmon, chum salmon, sockeye salmon, sculpin, and three spine stickleback (Briscoe et al. 2008; Lum and Glynn 2007).

Table 4.—Harvest sampling statistics and estimated harvest of Jordan Creek adult coho salmon in 2006 (terms defined in Bernard and Clark 1996, m_{ij} = tags recovered in fishery, \hat{r}_{ij} = estimated number of fish harvested).

TROLL FISHERY (stratified by quadrant and period)										
<i>Period</i>	<i>Quadrant</i>	N_i	n_i	a_i	a'_i	t_i	t'_i	m_{ij}	r_{ij}	$SE(r_{ij})$
3	NW	469,807	134,965	328	327	318	318	3	11	5.3
4	NW	405,761	96,590	1,568	1,519	1,270	1,269	10	43	11.9
GILLNET FISHERY (stratified by week and fishing district)										
<i>Stat. week</i>	<i>District</i>	N_i	n_i	a_i	a'_i	t_i	t'_i	m_{ij}	r_{ij}	$SE(r_{ij})$
38	115	20,270	5,886	328	327	318	318	1	3	2.9
RECREATIONAL FISHERY (stratified by biweek period)										
<i>Biweek</i>	<i>Area</i>	N_i	n_i	a_i	a'_i	t_i	t'_i	m_{ij}	r_{ij}	$SE(r_{ij})$
17	Juneau-marine boat	3,836	1,288	22	16	15	15	1	4	3
18	Juneau-marine boat	3,268	493	19	19	16	16	1	7	6.1
TOTALS		902,942	239,222	2,265	2,208	1,937	1,936	16	68	29

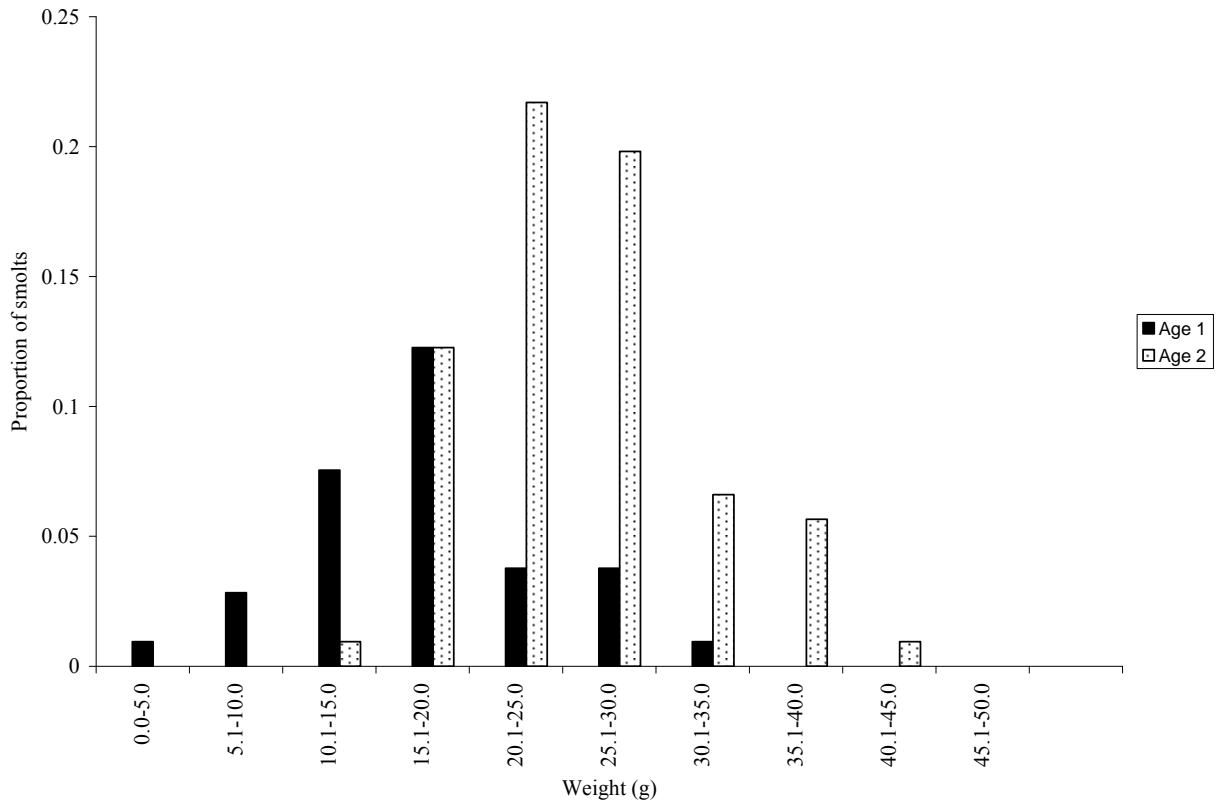


Figure 11.—Weight distribution of age-1 and age-2 smolt sampled at Duck Creek in 2005.

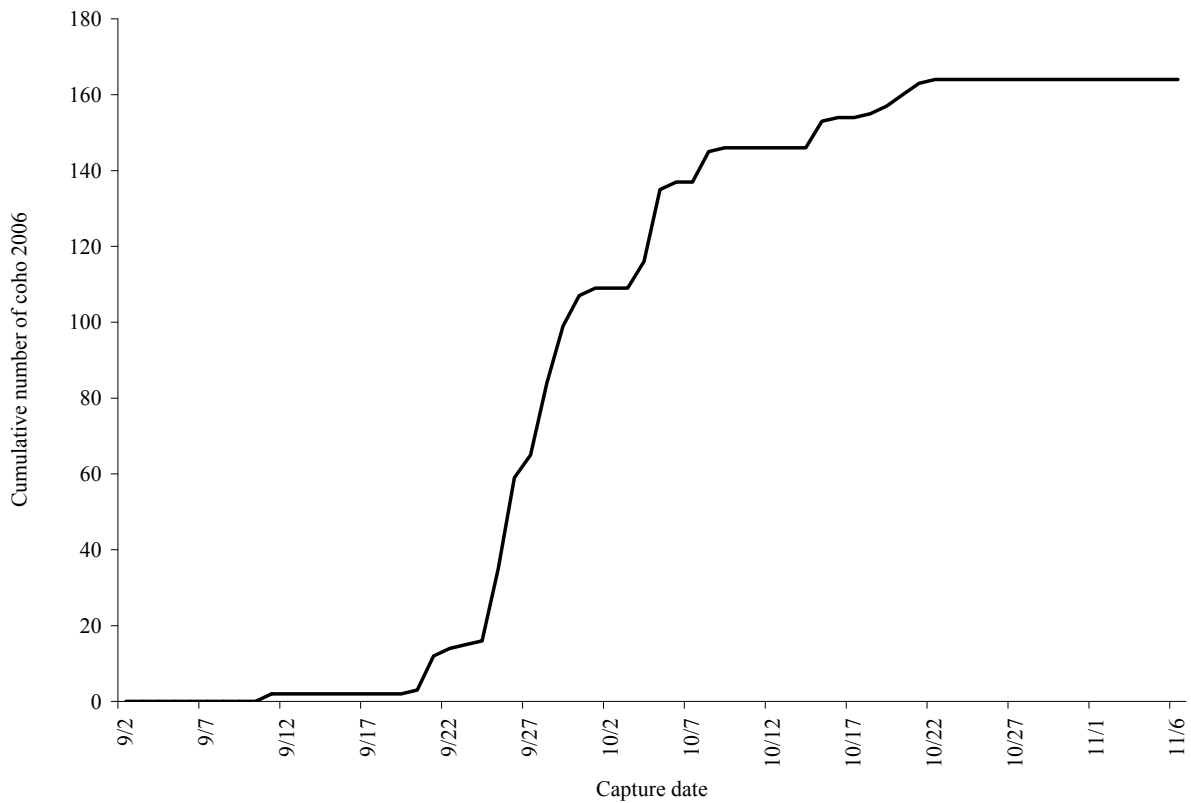


Figure 12.—Cumulative number of adult coho salmon captured at Jordan Creek in 2006.

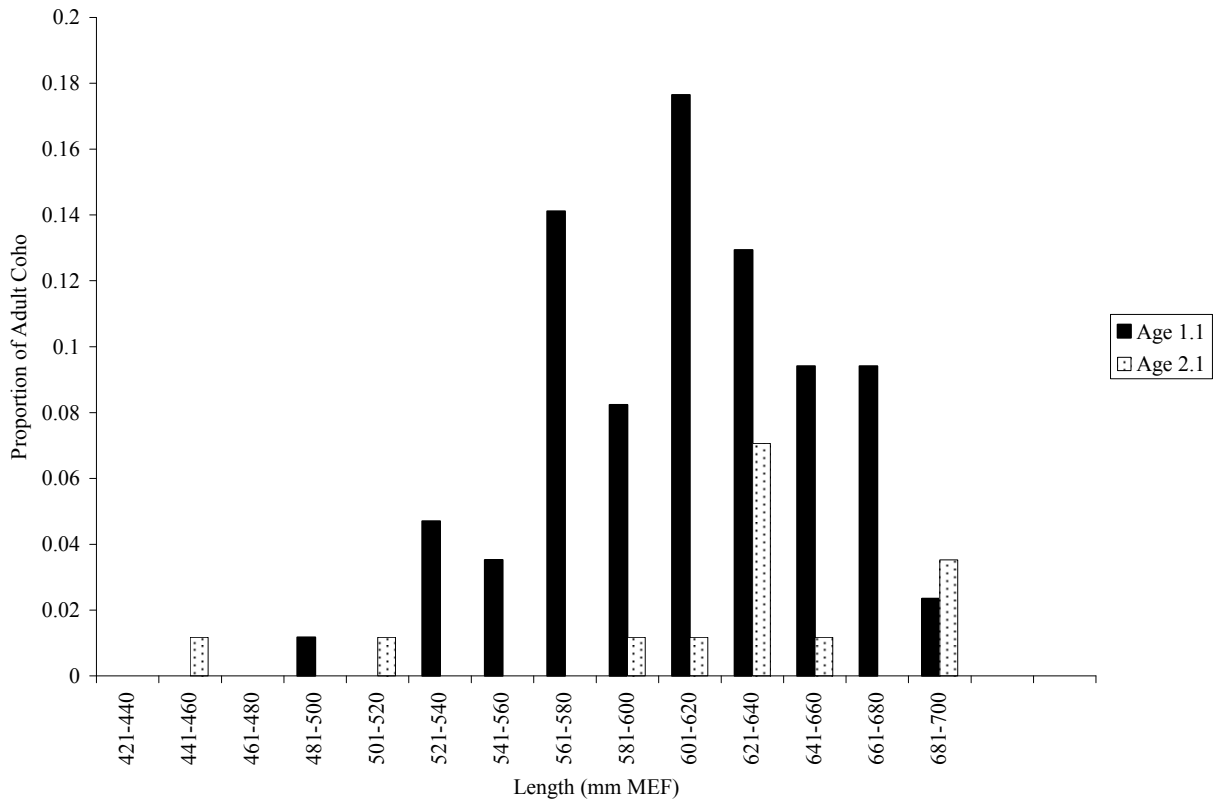


Figure 13.—Length distribution of adult coho salmon by age class at Jordan Creek in 2006.

Table 5.—Smolt to adult survival and exploitation rates for coho salmon returning to Jordan Creek in 2006.

Smolt-to-adult survival (min, max %)	2.3–3.6
SE (min, max %)	0.06–0.05
Exploitation rate (min, max %)	31.3–47.9
SE (min, max %)	0.5–0.6

Table 6.—Emigrants other than coho salmon counted at Jordan Creek in spring 2005.

Pink salmon fry	1
Chum salmon fry	61
Dolly Varden	159
Adult cutthroat	1
Starry flounder	13
Sculpin (Cottidae)	441
Three spine stickleback	104

Jordan Creek: During spring 2005, Dolly Varden, pink and chum salmon fry, cutthroat trout, sculpin, three-spine stickleback, and starry flounder also emigrated past the Jordan Creek

weir (Table 6). Only one adult cutthroat trout was captured in 2005 and was tagged with a new PIT tag. (Appendix A4). The Dolly Varden ranged from 70 mm to 200 mm FL (mean = 129.1 mm, n = 159, SE = 1.46 mm) in 2005 (Figure 14). Thirty-six adult pink salmon and 21 chum salmon passed through the adult weir in Jordan Creek during the fall of 2006.

Duck Creek: In 2005, 13 Dolly Varden were captured in a fyke net and counted. Dolly Varden ranged from 175 mm to 285 mm FL (mean = 222.5 mm, n = 12, SE = 9.9 mm) in 2005 (Figure 15). Three chum salmon passed through the adult weir in Duck Creek during the fall of 2006. Two sockeye passed through the adult weir in Duck Creek during the fall of 2006, but were released below the weir.

PHYSICAL DATA

Water temperatures at the Jordan Creek weir ranged from 2.0 °C to 16.5 °C in spring 2005 (Figure 16), and, from 2.0 °C to 9.0 °C in fall 2006

(Figure 17). Water temperatures in Duck Creek ranged from 5 °C to 11 °C in spring 2005 (Figure 16), and from 3.5 °C to 10 °C in fall 2005 (Figure 17).

Total daily precipitation measured at the Jordan Creek weir site in fall 2006 ranged from zero to 398 mm (Figure 18). Total daily precipitation measured at the USGS site ranged from zero to 0.40 mm in spring 2005 (Figure 19).

The average daily discharge rate at Jordan Creek ranged from 0.15 ft³/s to 20.0 ft³/s in spring 2005 (Figure 19). Discharge rates during the fall were not calculated as the USGS gage was not in place during this time period.

Average daily stream depth measured at Jordan Creek ranged from 2.60 ft to 4.49 ft in spring 2005, and 3.85 ft to 5.42 ft in fall 2006.

DISCUSSION

Major points of discussion for Jordan and Duck Creek coho surround their production in light of their habitat. We will discuss how Jordan and Duck creek stocks compare to each other, other systems in and around Juneau, and how Jordan and Duck creeks are used by local coho stocks.

Escapement numbers counted at the weir can be compared to foot counts in Jordan Creek for four return years (2001, 2003–2006), to show that actual escapement was on average 4.70 (SD =1.57) times the observer stream count (Table 7). This is similar to the expansion factor of 5 assumed by Clark (1995) for Jordan Creek and several other streams on the Juneau road system. Although foot surveys for coho salmon can be unreliable for many reasons (Jones III et al. 1998), an expansion factor near 5 is appropriate when counting conditions are good. While the 2006 foot survey count falls below previous years, no atypical conditions existed in comparison to other years and it appears to be normal variation (B. Glynn, Juneau Area Management Biologist, ADF&G Sport Fish Division, Douglas; personal communication). Thus foot surveys continue to be a rough, but useful method to estimate coho escapement at Jordan Creek when a weir is not feasible.

Jordan Creek coho salmon contributed an estimated 68 fish in 2006 to the commercial and

sport fish harvests in northern Southeast Alaska, and specifically Juneau. In comparison, nearby Auke Creek contributed more coho salmon to the fisheries (an estimated 288 in 2006 (Taylor 2007) even though it produced less smolt than Jordan Creek. Jordan Creek coho salmon also had a lower estimated marine survival (3.6% in 2006) compared to that of neighboring coho salmon stocks (Figure 20). Estimated marine survival was considerably higher for coho salmon returning to Auke Creek, Macaulay Hatchery, Berners River, and the Taku River.

Unusually low productivity of adult coho salmon in Jordan Creek is likely due to low marine survival. Some Jordan Creek smolt may have been predisposed to estuarine mortality if they were stressed by conditions (i.e. low dissolved oxygen, handling and tagging, high water temperatures, pollution, etc.) encountered prior to smolting. McCormick et al. (1998) discusses some of the negative impacts that pollution has on smoltification. Low water flows experienced once again at Jordan Creek resulted in some fry and smolt mortality and could have exacerbated some of these stressful conditions. Previous authors have noted poor water quality in Jordan Creek as another stressor, but we have no new information. Jordan Creek, however, does flow through an industrialized section of suburban Juneau.

High water temperatures coinciding with low water flows during the 2005 smolt emigration could have exacerbated stressful conditions. The preferred temperature range for coho juveniles reported by Brett (1952) is 12–14°C. While this range was reported in a controlled laboratory study and coho juveniles in Jordan Creek may be adapted to a slightly different temperature regime, from June 3 on, Jordan Creek exceeded this

Table 7.—Comparison of weir counts and stream survey counts of adult coho salmon at Jordan Creek.

Spawner year	Weir count	Stream count	Expansion
2001	525	119	4.41
2003	389	78	4.99
2004	227	38	5.97
2005	562	94	5.98
2006	164	76	2.16
		Mean =	4.70
		SD =	1.57

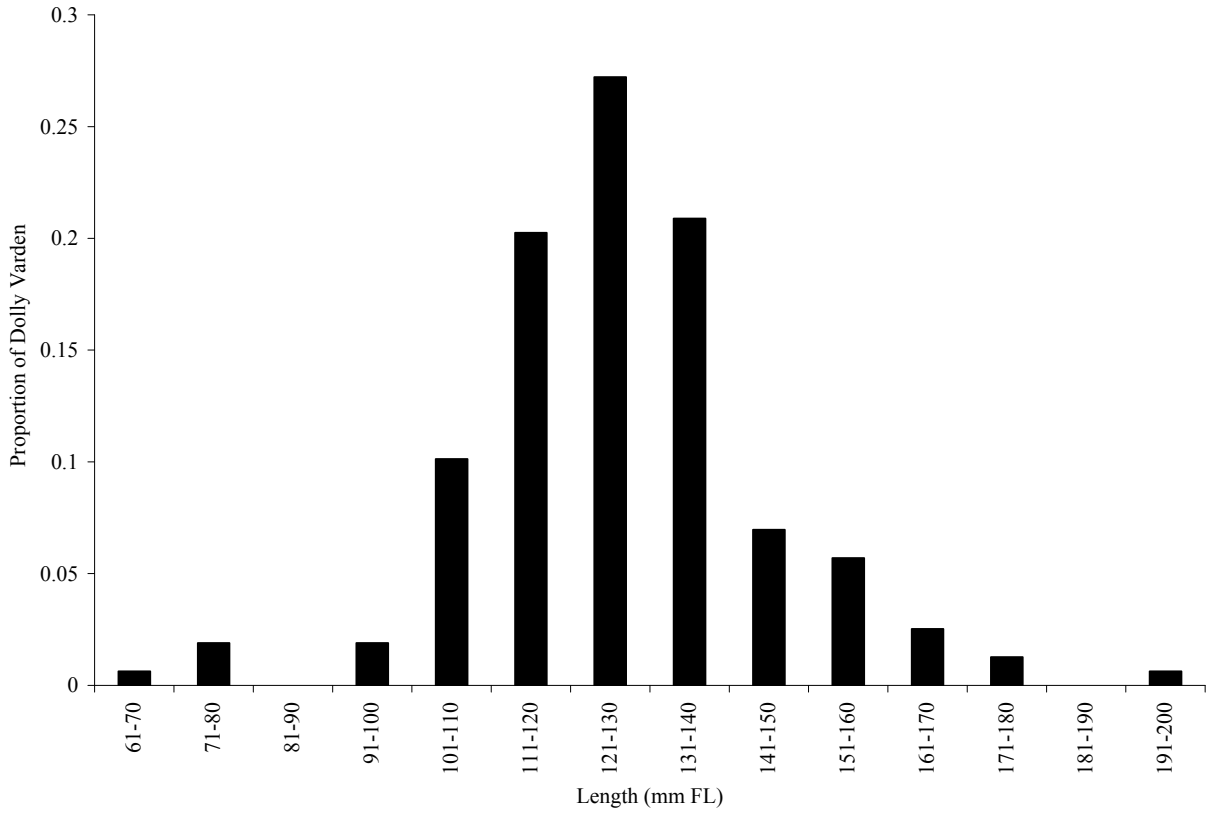


Figure 14.—Length distribution of Dolly Varden emigrating from Jordan Creek in 2005.

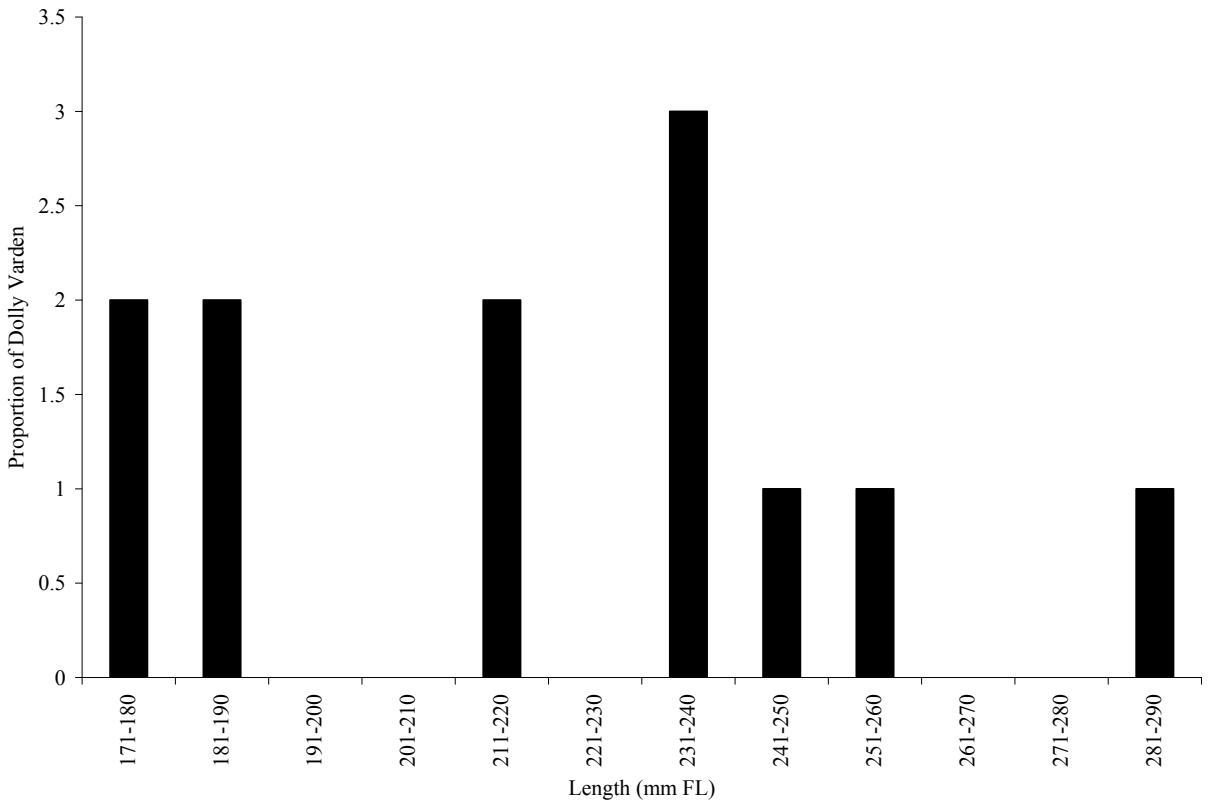


Figure 15.—Length distribution of Dolly Varden emigrating from Duck Creek in 2005.

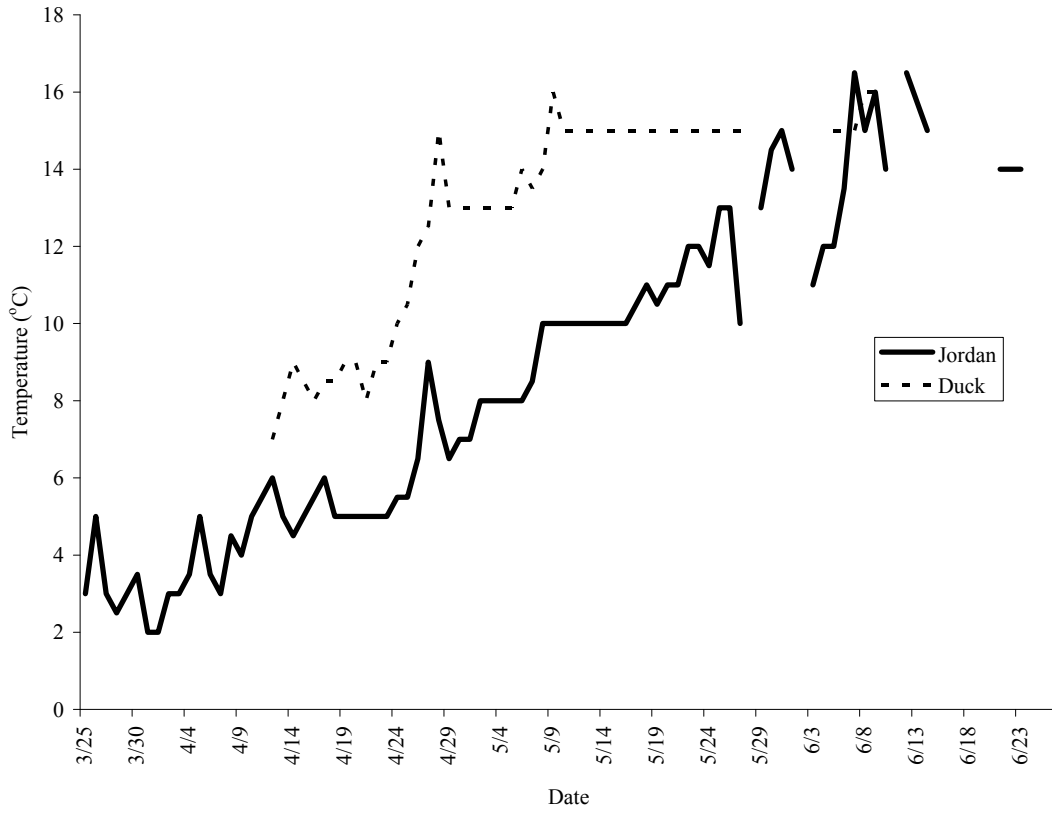


Figure 16.—Water temperature at Jordan Creek and Duck Creek during spring 2005.

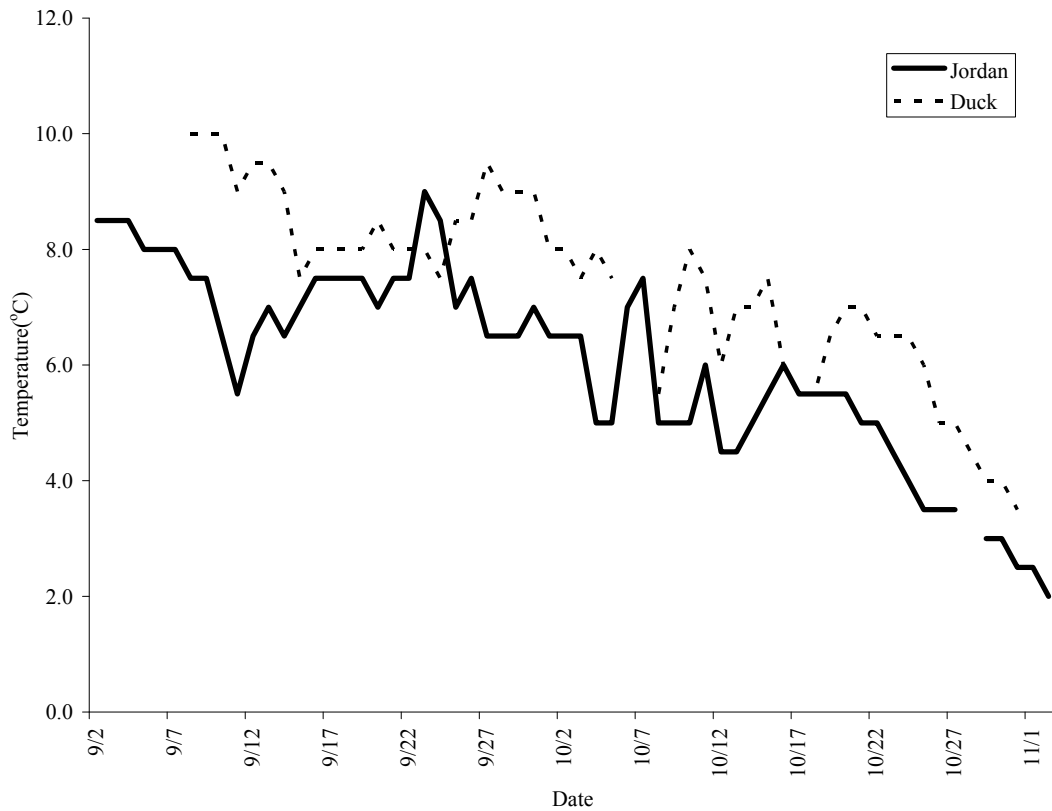


Figure 17.—Water temperature at Jordan Creek and Duck Creek during fall 2006.

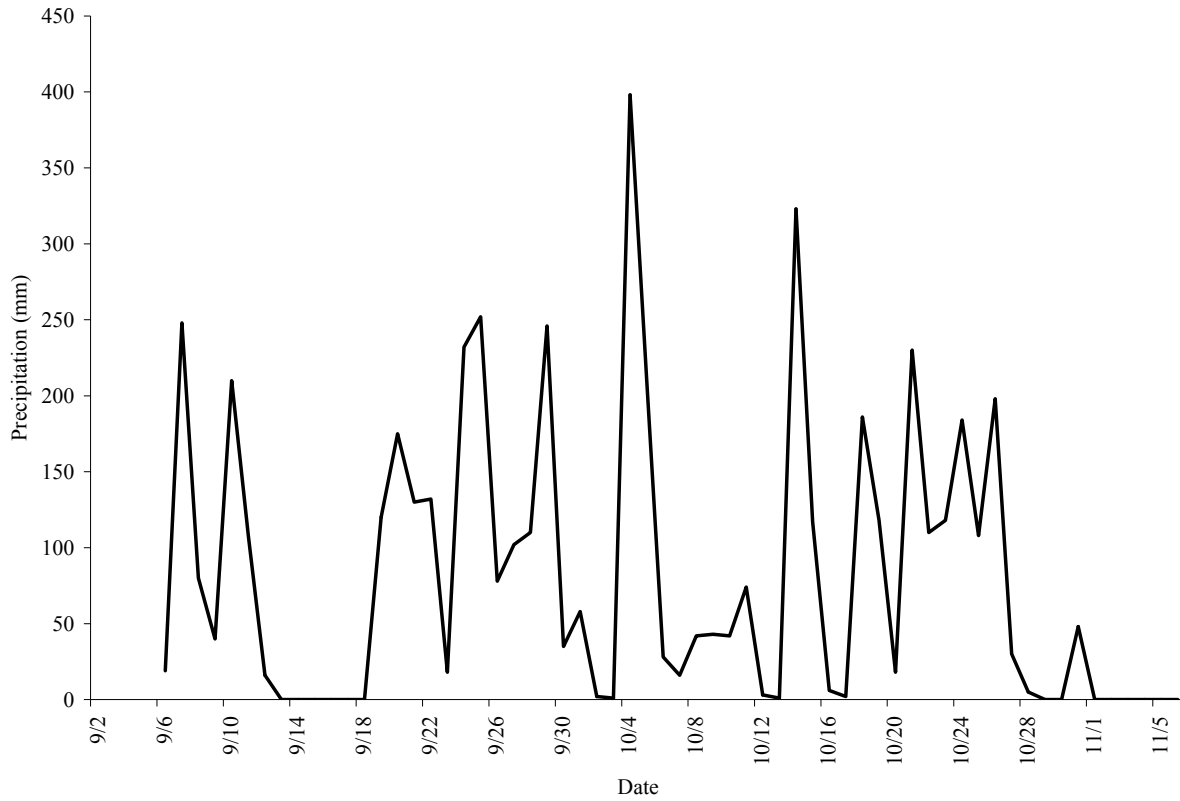


Figure 18.—Total daily precipitation (mm) at Jordan Creek (weir site) in fall 2006.

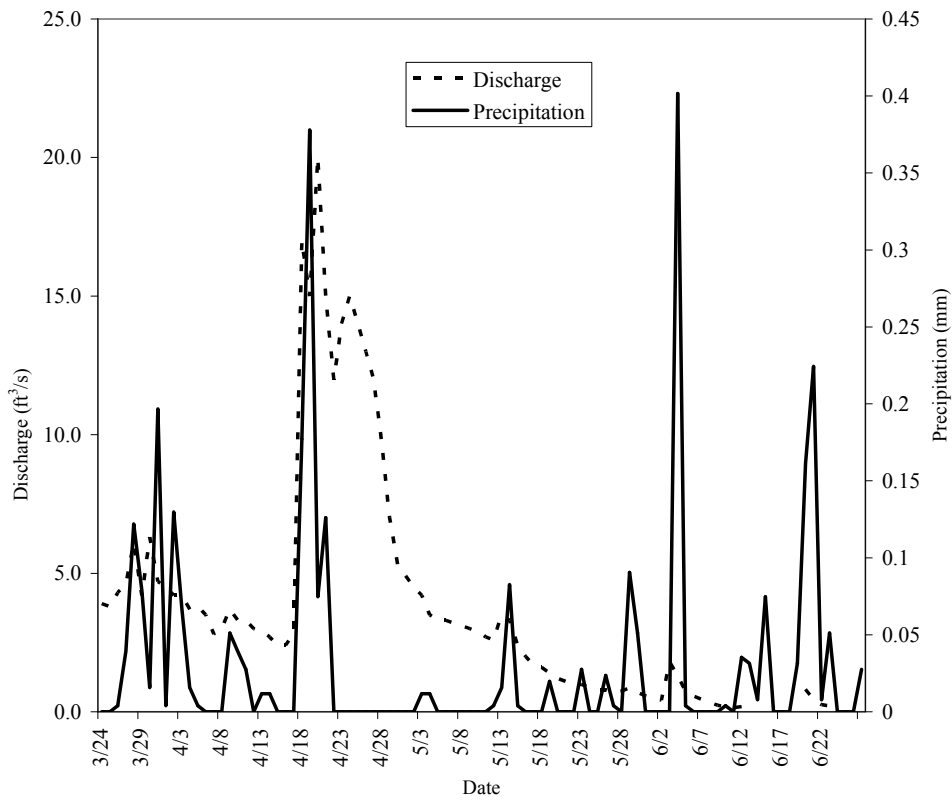


Figure 19.—Average daily stream discharge rates (ft^3/s) and total daily precipitation (mm) at Jordan Creek (USGS site) in spring 2005.

preferred temperature range. In response to increased water temperatures from logging, Holtby (1988) reports that coho salmon smolt in the Carnation River, British Columbia emigrated over a week earlier. While it is unlikely that we have a complete picture of the Duck Creek smolt emigration, the water temperature warmed earlier, and smolt emigrated from the creek earlier than in Jordan Creek during the spring of 2005. Fifty percent of the sampled run had emigrated by May 5 in Duck Creek whereas in Jordan Creek, 50% of the run had emigrated by May 15. This difference could be attributed to the warmer temperature regime, and if temperature trends increase, fish could emigrate earlier potentially arriving in the estuary when food availability is low.

Some of the 426 coho salmon juveniles that were below the minimum size threshold for tagging in 2005 may have smolted after they were released downstream of the Jordan Creek weir. If so, a small (maximum 7%) bias could exist in our estimated marine survival. There are also some tagged fish that may have not have completed smoltification and subsequently returned upstream

to freshwater only to leave the system the following year.

Unclipped fish represented 28% of the coho returning to Jordan Creek in 2006. These fish could have come from a variety of sources including Jordan Creek, Duck Creek, other area streams and Macaulay Hatchery. Other studies have documented coho salmon fry emigrating from freshwater, residing in estuarine waters during the first summer, and then emigrating to sea in the first fall (Tschaplinski 1982; Murphy et al. 1984). Unclipped coho salmon could have also emigrated as smolt when the weir was not in place or strayed as adults from neighboring coho salmon systems. If smolt emigrated while the weir was not operating, they would have probably emigrated between September and April during periods of higher water flow. This timing would be abnormal with regard to normal smolt timing, limited availability of food, and the prevalence of predators.

Past research has indicated that adult coho salmon do stray into Jordan Creek from nearby Switzer

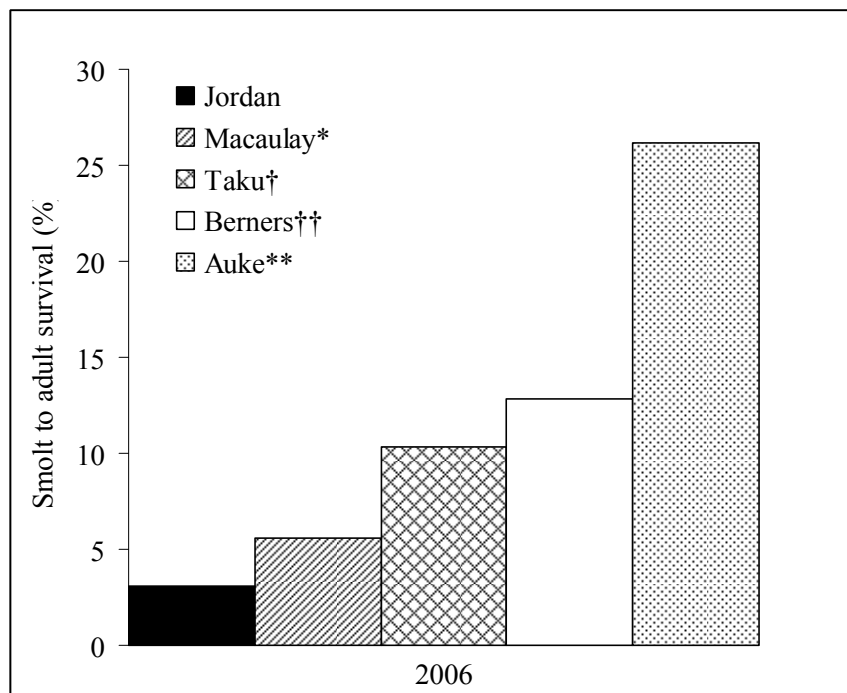


Figure 20.—Marine survival of coho salmon from Jordan Creek, Macaulay Hatchery, Taku River, Berners River, and Auke Creek for return years 2006. *Data from R. Focht, Director of Operations, Douglas Island Pink and Chum, Juneau; personal communication. †Data from E. Jones, Sport Fish Biologist, ADF&G, Douglas; personal communication. ††Data from L. Shaul, Commercial Fish Biologist, ADF&G, Douglas; personal communication. **Data from Taylor 2007.

Creek and Macaulay Hatchery (Lum and Glynn 2007). When the Jordan Creek weir was operated in 2004 and 2005, otoliths and CWTs from carcasses indicated that Macaulay Hatchery coho salmon strayed into Jordan Creek (Briscoe et al. 2008). As no otolith samples were examined from the 2006 carcass samples, we cannot determine the origin of the unclipped coho adults crossing the weir. None of the decoded CWTs from escapement sampling in 2006 at Jordan Creek were from Macaulay hatchery, but tag ratios at the hatchery in 2005 were low (7.41%), so we would not expect to see clipped hatchery fish in our sample of eight carcasses. Interestingly, a Duck Creek CWT was recovered during 2006 further documenting the straying of local stocks into Jordan Creek.

Information from previously tagged coho salmon also indicates that smolt tagged in other systems relocate to Duck Creek to overwinter. This nomadic behavior was previously documented for a coho salmon smolt emigrating from Jordan Creek (Lum and Glynn 2007), two coho salmon smolt emigrating from Berners River (R. Ericksen, Sport Fish Biologist, ADF&G, Haines; personal communication) and one coho salmon smolt immigrating to Auke Creek (C. Hoover, Sport Fish Biologist, ADF&G, Douglas; personal communication).

Duck Creek produces a much higher proportion of age-2 smolt than Jordan Creek ($P < 0.001$), and the average size of Duck Creek smolt is larger than that of Jordan Creek smolt for each age class. One explanation for the age difference could be that a significant portion of coho salmon emigrating from Duck Creek are nomads which traveled as age-1 smolt/presmolt from other systems in the previous year and then reinvaded Duck Creek to overwinter after spending a summer in the estuary. If estuarine waters produce more available food than freshwater, this nomadic scenario could explain the larger average size of Duck Creek smolt. Another explanation is that Duck Creek coho salmon juveniles that would typically smolt at age-1 are trapped in Duck Creek by low water flows until they can migrate a year later as an age-2 smolt. It is also interesting to note that the Dolly Varden were larger in Duck Creek than they were in Jordan Creek (Figures 14 and 15).

Some adult coho salmon escaped into Duck Creek in 2006, but it is not certain they successfully spawned. If they did spawn, it has been suggested that the eggs might not survive due to poor water quality (Koski and Lorenz 1999). Duck and Jordan creeks are both listed as impaired water bodies under section 303(d) of the Clean Water Act (1972, 33 U.S.C. s/s 1251 et. seq.) as a result of poor water quality (i.e., deposits of silt and debris and low dissolved oxygen). Adequate stream flow is necessary to regulate the amount of sediment that settles in the gravel (Meyer et al. 2005) and guarantees the flushing of fine sediments from the creeks. Excessive accumulation of fine sediments in spawning gravel can be detrimental to egg survival, blocking the flow of dissolved oxygen required for egg development (Tagart 1984) and confining fry in redds longer than their yolk can sustain them (Koski 1966). Coho fry were observed in Duck Creek in October of 2007 (Hoferkamp 2008), indicating that some successful spawning might have occurred in 2006, but whether these fish survived to the smolt stage is hard to say. It is difficult to assess the effectiveness of restoration efforts on Duck Creek using coho smolt yields as the measurement of effectiveness, when the beneficial effects of restoration are probably masked by the negative impact of low water flows.

Land surface uplift may also be contributing to the chronic low water flows in both Jordan and Duck creeks. Both of these systems are fed by ground water from an aquifer system in the Mendenhall Valley. Land surface uplift, or glacial rebound, caused by the rebound of the land as deglaciation occurs, could be disconnecting the surface streams from their subsurface aquifer. The Mendenhall Valley land surface was estimated to be rebounding at a rate of about 1.9 cm/yr during the period 1939–1959 (Hicks and Shofnos 1965) and 1.3 cm/yr for the period 1959–1979 (Hudson et al. 1982).

Even with low water flows, Jordan and Duck creeks have continued to provide important habitat for coho salmon. Results of this study emphasize how critical it is to understand the dynamics of many of the smaller coho salmon streams in the Juneau area because of the cumulative contribution of coho salmon from these streams to both the recreational and commercial fisheries.

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APPENDIX A

Appendix A1.—Total numbers of emigrating coho salmon captured in Jordan Creek, 2005.

Alive	
Tagged and released	6,057
Juveniles and Fry released	426
Mortalities	
Recaptured (previously tagged)	8
Pre-Tagging	566
Post-Tagging	34
Tagged with wrong code	5

Appendix A2.--Random recoveries of coded wire tagged coho salmon bound for Jordan Creek or recovered during the carcass survey at the stream location by date sample in 2006.

Head number	Tag code	Gear class	Recovery date	Stat. week	Quadrant	District	Length	Survey site	Sample number
2006 RANDOM RECOVERIES									
522417	40972	DRIFT	9/19/2006	38	NE	115	655	JUNEAU	6046212
94463	40974	TROLL	7/25/2006	30	NW	116	510	PELICAN	6010079
94659	40974	TROLL	8/8/2006	32	NW	114	610	PELICAN	6010110
94679	40974	TROLL	8/8/2006	32	NW		590	PELICAN	6010116
27761	40974	TROLL	8/18/2006	33	NW	114	550	ELFIN COVE	6020110
27791	40974	TROLL	8/31/2006	35	NW	114	605	ELFIN COVE	6020138
94990	40974	TROLL	9/10/200	37	NW	114	585	PELICAN	6010176
94981	40974	TROLL	9/19/2006	37	NW	114	595	PELICAN	6010176
96332	40974	TROLL	9/14/2006	37	NW	114	613	HOONAH	6110319
96286	40974	TROLL	9/14/2006	37	NW	114	617	HOONAH	6110313
315650	40974	TROLL	9/15/2006	37	NW		590	SITKA	6037093
95659	40974	TROLL	9/19/2006	38	NW		630	PELICAN	6010200
316805	40974	TROLL	9/23/2006	38			610	SITKA	6037130
94909	40974	TROLL	9/2/2006	35			525	PELICAN	6010157
265657	40974	SPORT	8/27/2006	35	NE	111	565	JUNEAU	6045325
265663	40974	SPORT	9/3/2006	36	NE	112	550	JUNEAU	6045339
255254	40974	ESCAPE	9/11/2006	37	NE	111	640	JUNEAU MISC.	06AJ2001
255263	40974	ESCAPE	9/19/2006	38	NE	111	680	JUNEAU MISC.	06AJ2008
255255	40974	ESCAPE	9/22/2006	38	NE	111	650	JUNEAU MISC.	06AJ2002
255256	40974	ESCAPE	9/23/2006	38	NE	111	575	JUNEAU MISC.	06AJ2003
255260	40974	ESCAPE	10/6/2006	40	NE	111	535	JUNEAU MISC.	06AJ2006

27

Appendix A3.--Random recoveries of coded wire tagged coho salmon bound for Duck Creek by date sampled in 2006.

Head Number	Tag Code	Gear Class	Recovery Date	Stat. Week	Quad.	District	Length	Survey Site	Sample Number
2006 RANDOM RECOVERIES									
96221	40795	TROLL	9/7/2006	36	NE	112	581	HOONAH	6110293
265651	40795	SPORT	8/14/2006	33	NE	111	800	JUNEAU	6045298
255257	40795	ESCAPE	9/30/2006	39	NE	111	630	JUNEAU MISC.	06AJ2004

Appendix A4.–Length, sex, and PIT tag numbers of cutthroat trout captured at Jordan Creek in 2005.

Date	Length (mm)	Sex	New PIT tag number.
4/19/2005	333	-	134 51296A

Appendix A5.–List of computer data files archived from this study.

FILE NAME	DESCRIPTION
AWL05_Jordan.xls	Age, weight, and length of coho salmon smolt sampled in 2005.
Cutthroat05_Jordan.xls	Length, sex, and PIT tag codes of cutthroat trout captured in 2005.
Dollies05_Jordan.xls	Lengths of Dolly Varden captured in 2005.
Daily05_Jordan2.xls	Master data file that includes stream depth, stream temperature, counts for all species, numbers of coho salmon tagged, mortalities, and comments.
ASL06_Jordan.xls	Age, sex, and length data for adult coho salmon captured in 2006.
Master Data06_Jordan.xls	Daily and cumulative counts for all species, stream temperature, stream depth, precipitation, and number of adipose fin clipped coho salmon captured in 2006.
HarvestEstimate2006jordan_duck.xls	Tag Lab CWT recovery data, harvest expansion report and marine harvest calculations for fish caught in commercial and recreational fisheries in 2006.
ASL06_Duck.xls	Age, sex, and length data for adult coho salmon captured in 2006.
Master Data06_Duck.xls	Daily and cumulative counts for all species, stream temperature, stream depth, precipitation, and number of adipose fin clipped coho salmon captured in 2006.