

FISHERY DATA SERIES NO. 42

SPORT EFFORT, HARVEST, AND ABUNDANCE
OF DOLLY VARDEN CHAR *Salvelinus*
Malma IN THE BUSKIN RIVER, KODIAK
ALASKA 1987¹

By

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ABSTRACT

A creel survey was conducted 23 April through 26 May 1987 to estimate sport effort for and harvest of Dolly Varden *Salvelinus malma* in the Buskin River. Sport anglers fished an estimated 4,619 angler-hours and harvested an estimated 4,766 adult Dolly Varden char. Age 5 and 6 Dolly Varden char were the most abundant age groups in the harvest. The migrations of Dolly Varden char in the Buskin River were monitored through a weir operated from 22 April through 1 October 1987. A total of 29,919 emigrant and 32,848 immigrant Dolly Varden char were counted through the weir.

KEY WORDS: Dolly Varden char, *Salvelinus malma*, effort, harvest, size, age, escapement, Buskin River, Kodiak, Alaska

INTRODUCTION

The Buskin River (Figure 1) is centrally located in the urban area of Kodiak Island and receives more fishing effort by anglers than any other water on Kodiak Island. The river contains steelhead and rainbow trout *Salmo gairdneri*, Dolly Varden char *Salvelinus malma*, and all species of Pacific salmon *Oncorhynchus sp.* except chinook salmon *O. tshawytscha*. Approximately 53% (24,219 angler-days) of the sport fish effort and 49% of the sport harvest (all species) of all Kodiak lakes and streams (Mills 1987) occurs in the Buskin River. Buskin River salmon also support the largest personal use/subsistence fishery on Kodiak Island and a commercial fishery that targets primarily on pink salmon *O. gorbuscha* and coho salmon *O. kisutch* (Manthey et al. 1984). In 1986, approximately 50% of the total Kodiak area Dolly Varden char harvest occurred in the Buskin River (Mills 1987). The sport fishery is directed at anadromous Dolly Varden char during April and May, sockeye salmon *O. nerka* and pink salmon during June through mid-August, and coho salmon during mid-August through mid-October. Immigrant Dolly Varden char are also caught during mid-summer through fall.

The migratory patterns and stock structure of the Dolly Varden char stocks are not well understood. These stocks are anadromous and migrate not only to the Buskin River, but to other marine and freshwater locations as well. As a result, these fish potentially contribute to fisheries other than the Buskin River fishery. The migratory behavior of these fish may be similar to that reported by Armstrong (1965) who found that anadromous Dolly Varden char in southeastern Alaska normally spend the winter in a lake system and migrate to sea in the spring. During the period of summer ocean residency, Dolly Varden char were found to periodically enter systems other than the overwintering site. Buskin Lake (101.5 surface ha) is thought to be the major Dolly Varden char overwintering site for the Chiniak Bay area.

In 1985, the Sport Fish Division of the Alaska Department of Fish and Game (ADF&G) initiated a project to estimate the magnitude and composition of salmon, Dolly Varden char, and steelhead trout returns to the Buskin River (Murray 1986). The project consisted of: (1) enumerating escapements through a weir; (2) estimating angler effort and harvest for the spring Dolly Varden char and fall coho salmon fisheries; (3) estimating the age, sex, and size composition of Dolly Varden char and coho salmon in both the sport harvest and the escapement; and (4) identifying migrational patterns and stock structure of Buskin River Dolly Varden char through a tagging program.

The objective of this report is to present baseline data for the Buskin River Dolly Varden char sport fishery and migrations. Tag returns are still being analyzed and only the tagging effort is reported here. Results of that portion of the project pertaining to coho salmon are reported by Murray (in press).

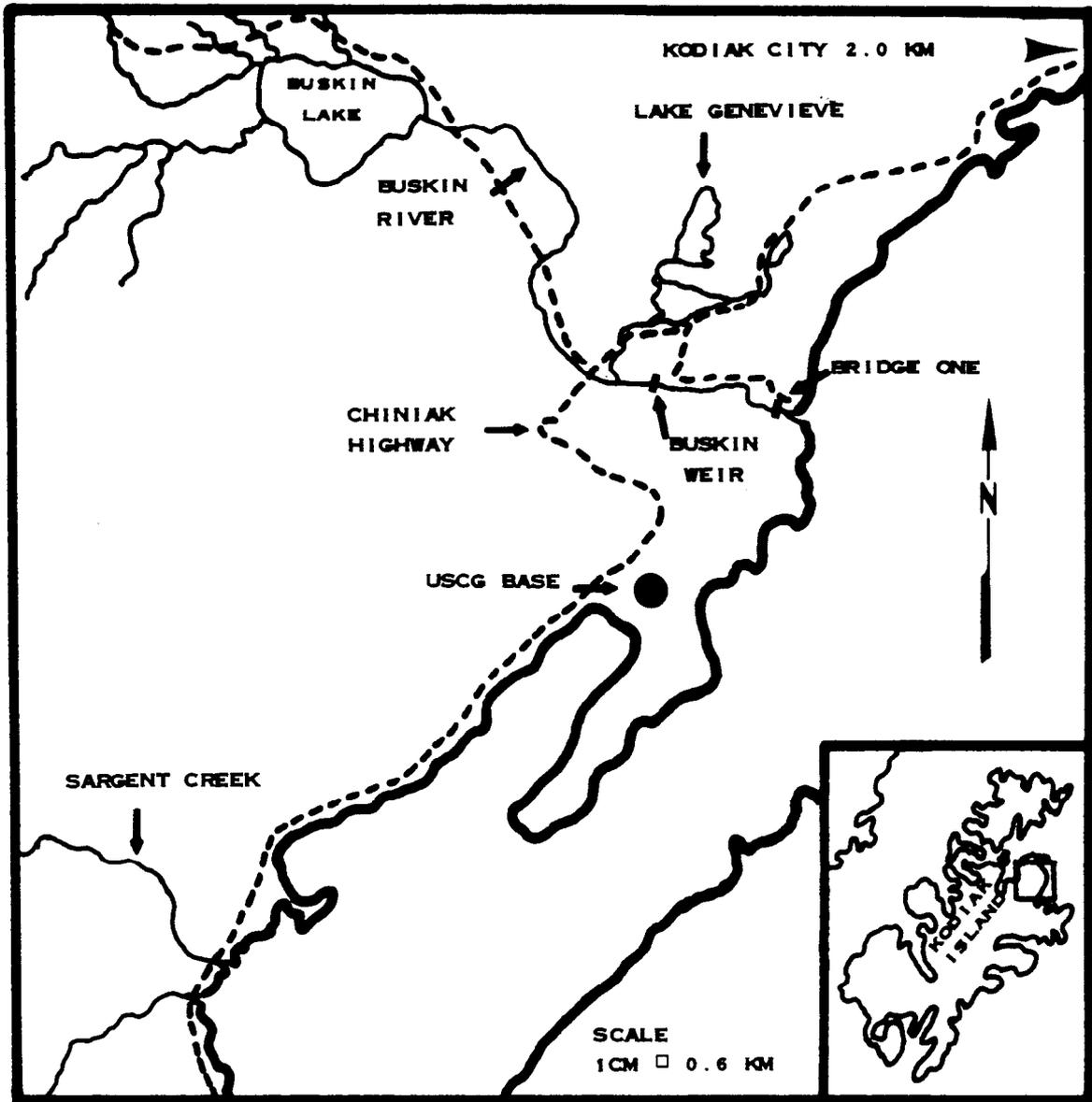


Figure 1. Location of Buskin River, Kodiak Island, Alaska.

METHODS

Sport Fishery

Anglers were permitted a daily bag limit of 10 Dolly Varden char (no size limit) with a possession limit of 20 fish in 1987 (ADF&G 1987). Sport fishing was not permitted within 100 m of the weir by regulation and this closure was extended an additional 210 m upstream of the weir to encompass a large holding area. The extended closure was accomplished by emergency order and was in effect during the period 6 May to 9 June 1987.

Study Area:

Dolly Varden char usually commence emigration from Buskin Lake during mid-April and continue through May or early June. However, a late spring break-up and heavy ice cover on Buskin Lake are thought to delay the emigration by 2 weeks in some years. Dolly Varden char immigration from salt water begins in July and continues into early winter.

The Buskin River sport fishery for Dolly Varden char occurs throughout the spring emigration and the summer-fall immigration. The sport fishery for both emigrant and immigrant fish generally occurs throughout the river (Figure 1).

Study Design:

A creel survey was conducted on the Buskin River from 23 April through 26 May to estimate sport effort in angler-hours and sport harvest of Dolly Varden char.

Angler counts were conducted following a stratified random sampling design. The creel survey was stratified into weekday and weekend/holiday strata. Approximately 60% of the sampling effort was allocated to weekdays and 40% to weekend/holidays. For the creel survey, the fishing day was considered to be 17 hours in duration (0600-2300 hours). The fishing day was stratified into four time periods: A, 0600-0759 hours; B, 0800-1159 hours; C, 1200-1659 hours; and D, 1700-2300 hours. Sampling effort was allocated approximately proportional to the number of hours in each period.

Angler counts took approximately 20 minutes to complete and were considered instantaneous (Neuhold and Lu 1957). Angler interviews were completed trip interviews collected by monitoring the major access points and interviewing anglers as they departed the fishery.

The major assumptions necessary for the creel survey are:

1. Angler counts made during the same day and on consecutive days are independent.

2. No significant fishing effort occurs during the hours 2300-0600.
3. Interviewed anglers are representative of the total angler population.
4. The number of anglers interviewed during a day is proportional to the effort on that day.
5. Fishing effort does not influence catch per unit effort.
6. Angler efforts and catches are normally distributed random variables.

Data Collection:

During a selected sample period, a starting time was randomly selected to count the number of anglers. The remaining time in the sample period was spent conducting angler interviews. Angler counts were conducted by walking and/or driving the length of the fishing area as quickly as possible and counting the number of people actively engaged in fishing. Only anglers who had completed fishing were interviewed. The following information was recorded during each interview: number of fish released by species, number of fish retained by species, and total hours fished (to the nearest 1/4 hour). Demographic information about each angler was also recorded.

Data Analyses:

Angler effort was calculated using a stratified random sample design (Schaeffer et al. 1979). Effort was estimated for the weekday and weekend/holiday components as:

$$(1) \quad \hat{E} = \sum_{j=1}^4 H_j \bar{Y}_j$$

with variance

$$V(\hat{E}) = \sum_{j=1}^4 H_j^2 (s_j^2/n_j)$$

where \bar{Y}_j = the mean number of anglers per count in stratum j ,

H_j = total number of hours of fishing possible in stratum j ,

s_j^2 = the sample variance for angler counts in stratum j , and

n_j = the number of angler counts conducted in stratum j .

The mean effort and mean harvest per angler were calculated for the weekday and weekend/holiday components using a two-stage random sample design with days as the primary sample units and anglers as the secondary sample units (Von Geldern and Tomlinson 1973). Arithmetic means were calculated from all completed-trip anglers interviewed.

The variance of mean effort was estimated as (Sukhatme et al. 1984):

$$(2) \quad V(\bar{f}) = [1-(d/D)] s_B^2 / d + [\sum_{i=1}^d (s_{wi}^2 / m_i)] / dD$$

where,

$$s_{wi}^2 = [\sum_{k=1}^{m_i} (f_{ik} - \bar{f}_i)^2] / (m_i - 1),$$

$$s_B^2 = [\sum_{i=1}^d (\bar{f}_i - \bar{F})^2] / (d - 1)$$

d = number of days on which sampling was conducted,

D = number of possible days in a component,

f_{ik} = effort by angler k interviewed on day i,

m_i = number of anglers interviewed on day i, and

\bar{F} = mean effort per angler during a component.

The variance of mean harvest per angler was estimated by substituting individual harvests for efforts in the above formulae.

Harvest per effort, \bar{h}/\bar{f} , was computed for the weekday and weekend/holiday component. The variance of harvest per effort is approximated by the variance for the quotient of the means of two random variables (Jessen 1978),

$$(3) \quad V(\bar{h}/\bar{f}) = (\bar{h}/\bar{f})^2 [(s_h^2 / \bar{h}^2) + (s_f^2 / \bar{f}^2) - (2rs_h s_f / \bar{h}\bar{f})]$$

where,

\bar{h} = mean number of coho salmon caught per angler,

\bar{f} = as defined previously,

s_h^2 = two-stage variance of \bar{h} ,

s_f^2 = two-stage variance of \bar{f} , and

r = Pearson's correlation coefficient for the h_{ik} and f_{ik} .

Total harvest (T) was computed as:

$$(4) \quad \hat{T} = \hat{E} (\bar{h}\bar{f});$$

and variance (Goodman 1960):

$$V(\hat{T}) = [\hat{E}^2 V(\bar{h}\bar{f})] + [(\bar{h}\bar{f})^2 V(\hat{E})] - [V(\hat{E}) V(\bar{h}\bar{f})].$$

Escapement

The Buskin River weir is located 2 km upstream of the river mouth at an area approximately 40 m wide. Both river banks at the weir site are steep and the river bottom is predominantly small rock substrate. The weir is constructed of 21 mm diameter aluminum pipe spaced 21 mm apart.

Adult fish counted through the weir gates were identified by species and the daily totals recorded. When the coho salmon immigration was nearly completed (1 October) the weir was dismantled and a foot survey was conducted to count fish holding below the weir.

Biological Data

Dolly Varden char from the sport harvest were sampled for age and length data. Sampled fish were measured for tip-of-snout to fork-of-tail length to the nearest millimeter. Otoliths were collected for age analysis and were placed in a black watch glass filled with water and read with a binocular microscope (10X) using reflected light. Proportional age composition of the harvest was estimated. Letting p_h equal the estimated proportion of age class h , the variance of p_h was estimated using the normal approximation to the binomial (Schaeffer et al. 1979):

$$(5) \quad V(\hat{p}_h) = \hat{p}_h(1 - \hat{p}_h)/(n_T - 1),$$

where n_T is the number of otoliths read.

Tagging

Emigrant Dolly Varden char were tagged during the spring in the Buskin River prior to passage through the weir. Fish were seined in the closed waters upstream from the weir. Emigrant fish were also tagged in Saltery Lake. Immigrant fish were tagged during the summer in Olds River, American River, Afognak Lake in the Afognak River drainage, and Lake Rose Tead in the Pasagshak River drainage. Immigrant fish were also tagged in Buskin River during the fall.

Fish were tagged with a numbered Floy FD 68B anchor tag, measured from tip-of-snout to fork-of-tail, and released. Tag return data are currently being analyzed and will be reported at a later date.

RESULTS AND DISCUSSION

Sport Fishery

Mean angler counts (Table 1 and Figure 2) progressively increased from the early morning stratum (period A) to the late evening stratum (period D) in the weekday fishery. A similar increase occurred in the weekend fishery, however, mean angler counts peaked in period C and decreased in period D. More of the effort (2,675 angler-hours or 58%) occurred during the weekday fishery than during weekends (1,944 angler-hours). Angler counts by date and daily time period are presented in Appendix Table 1.

Harvest rates for the weekend and weekday fishery were 0.799 and 1.201 fish per hour, respectively (Table 2). Daily summaries of angler interviews are presented in Appendix Table 2.

An estimated 4,766 Dolly Varden char were harvested during 4,619 angler-hours of effort (Table 3). Most of the harvest occurred during the weekday fishery (3,213 fish or 67%).

A comparison of relative precision for the estimates of harvest and effort (Table 3) shows that most of the imprecision occurred in the estimate of harvest for the weekday fishery. The high degree of variability is attributed to the sporadic nature of the Dolly Varden char fishery; no consistent pattern was obvious for fishing effort.

Characteristics of the sport fishery, based on 458 completed-trip angler interviews (Table 4), indicated 83.4% of the anglers were males, 84.9% were adults, 37.8% were military and only 2.6% were tourists. Approximately one-half of the anglers were unsuccessful in catching one or more Dolly Varden. Only one-half of the fish caught were retained. Most anglers (97.8%) used a single gear type and flies (67.1%) were the most popular bait.

Table 1. Estimated effort in angler-hours during the Buskin River sport fishery for Dolly Varden char, 23 April through 26 May, 1987.

Fishery	Counts				Effort (hours)	
	Period ¹	Mean	SE ²	SS ³	Total	SE ²
Weekend	A	0.4	0.40	5	9	8.77
	B	10.2	3.51	5	449	154.56
	C	16.5	3.97	8	908	218.28
	D	8.8	2.73	8	578	180.21
	TOTAL				1,944	322.63
Weekday	A	1.4	0.57	7	66	26.29
	B	2.8	1.19	6	261	109.93
	C	8.3	1.52	10	955	174.87
	D	10.1	3.77	11	1,393	520.17
	TOTAL				2,675	560.30
TOTAL FISHERY					4,619	646.55

¹ Period A: 0600-0759 hrs, Period B: 0800-1159 hrs
 Period C: 1200-1659 hrs, Period D: 1700-2300 hrs

² Standard error.

³ Sample size.

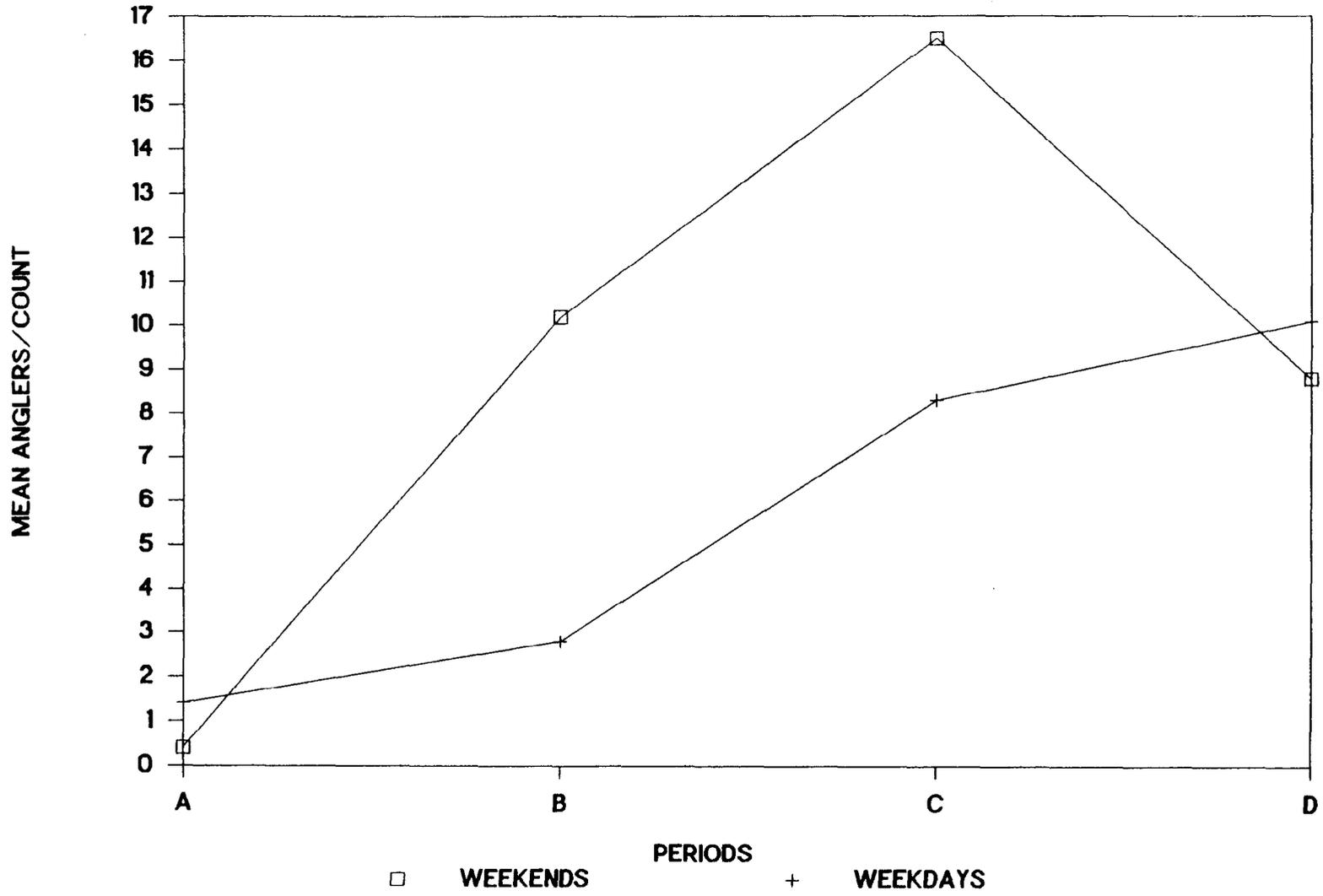


Figure 2. Buskin River mean angler counts by daily period for the weekday fishery and weekend fishery, 1987.

Table 2. Effort and catch summary statistics for anglers interviewed during the Buskin River sport fishery for Dolly Varden char, 23 April through 26 May, 1987.

Fishery	No.			Effort (hours)		Harvest				
	Int. ¹	D ²	d ³	Mean	SE ⁴	Mean	SE	r ⁵	CPUE ⁶	SE
Weekday	215	23	15	1.53	0.092	1.883	0.285	0.380	1.201	0.030
Weekend	242	11	10	1.37	0.081	1.091	0.178	0.236	0.799	0.016

¹ Number of anglers interviewed.

² Number of days possible for sampling.

³ Number of days sampled.

⁴ Standard error.

⁵ Correlation coefficient between angler effort and harvest.

⁶ Number of fish retained per hour fished.

Table 3. Estimated effort and harvest during the Buskin River sport fishery for Dolly Varden char, 23 April through 26 May, 1987.

Fishery	Effort Total	Rel. Pre. ¹	CPUE ²	Rel. Pre.	Harvest Total	SE ³	Rel. Pre.
Weekday	2,675	41.0%	1.201	4.9%	3,213	677.5	41.3
Weekend	1,944	32.6%	0.799	2.4%	1,553	259.6	32.8
TOTAL	4,619	27.4%			4,766	725.5	29.8

¹ Relative precision for 95% confidence interval.

² Catch per angler-hour.

³ Standard error.

Table 4. Characteristics of Buskin River sport fishery for Dolly Varden char, 23 April through 26 May 1987.

Angler Demographics		Fishing Gear	
Females	- 16.6%	Residents	- 87.1%
Males	- 83.4%	Tourists	- 2.6%
Adults	- 84.9%	Non-local	- 2.6%
Youth	- 15.1%	Military	- 37.8%
Nonresidents	- 12.9%	Unguided	- 100.0%
Angler Success and Harvest Data		Type of Lure	
Successful anglers	- 49.8%	Bait	- 3.1%
Unsuccessful anglers	- 50.2%	Spinners	- 29.9%
Anglers that retained fish	- 34.1%	Flies	- 67.1%
Anglers that released fish	- 24.9%		
Fish retained	- 49.8%		
Fish released	- 50.2%		

Escapement

The Dolly Varden char count through Buskin River weir from 22 April through 1 October 1987 totaled 29,919 emigrant and 32,848 immigrant Dolly Varden char (Appendix Table 3). The migrant fish counts are incomplete as the weir was not operable prior to the commencement of emigration or for the duration of immigration. However, it appears that relatively few fish emigrated prior to the time that the weir became operable (22 April). The peak of emigration (Figure 3) took place from 5 May through 20 May, nearly 2 weeks after the weir was made operable. Although peak immigration also occurred well before the weir was removed on 1 October (Figure 3), I believe that significant numbers of fish immigrated into the system after the weir was removed.

Biological Data

Age classes 4 through 10 were present in the sport fishery sample (Table 5). The sample was dominated by age 5 (53.8%) and age 6 (26.8%) fish. Mean lengths range from a mean of 250 mm for age 4 fish to 485 mm for the single age 10 fish measured (Table 6).

Tagging

Numbers of Dolly Varden char tagged by location are as follows: Buskin River (5,051); Olds River (1,498); American River (1,500); Lake Rose Tead (1,000); Afognak Lake (1,000); and Saltery Lake (2,000).

ACKNOWLEDGEMENTS

The assistance of the Kodiak Commercial Fisheries Division staff and Ms. Linda Harrington in operating the weir and collecting field data is gratefully acknowledged.

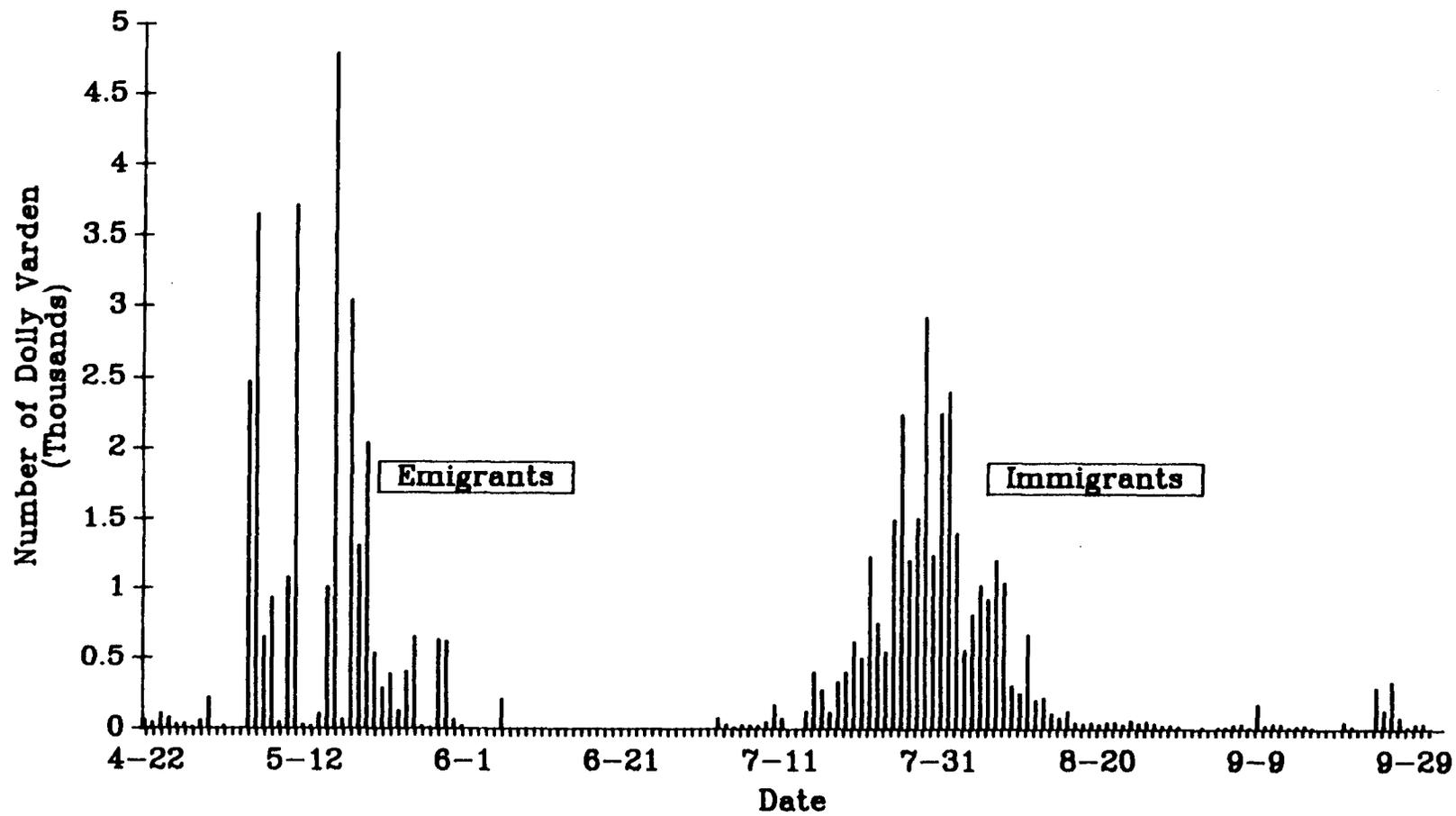


Figure 3. Counts of emigrant and immigrant Dolly Varden char through the Buskin River weir, 1987.

Table 5. Age composition of Dolly Varden char in the Buskin River sport harvest, 1987.

	Age Class							Total
	4	5	6	7	8	9	10	
Sample Size	24	207	103	37	11	2	1	385
Percent	6.2	53.8	26.8	9.6	2.9	0.5	0.3	
Standard Error	1.28	2.54	2.26	1.50	0.85	0.36	0.28	

Table 6. Mean length (mm) of Dolly Varden char in the Buskin River sport harvest, 1987.¹

	Age Class						
	4	5	6	7	8	9	10
Mean Size	250	290	335	374	389	446	485
Standard Error	5.89	2.30	3.65	7.02	10.78	29.5	0
Sample Size	24	207	103	37	11	2	1

¹ Tip-of-snout to fork-of-tail length.

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APPENDIX TABLES

Appendix Table 1. Angler counts in the Buskin River
Dolly Varden char sport fishery, 23 April
through 26 May 1987.

Date	WD/ WE ¹	Count by Period ²			
		A	B	C	D
4/23	WD			8	7
4/24	WD	1		6	4
4/25	WE	2		8	5
4/26	WE		3		6
4/27	WD				
4/28	WD	3	7	2	
4/29	WD		1		4
4/30	WD				
5/01	WD	0		11	12
5/02	WE		19	26	5
5/03	WE	0		34	
5/04	WD			5	
5/05	WD				
5/06	WD	1			14
5/07	WD		6	13	36
5/08	WD				
5/09	WE			13	5
5/10	WE		18	28	21
5/11	WD				
5/12	WD		1	12	31
5/13	WD	0		6	
5/14	WD	4		17	
5/15	WD				
5/16	WE		8		21
5/17	WE	0		11	6
5/18	WD				
5/19	WD				0
5/20	WD				
5/21	WD		0		0
5/22	WD	1	2	3	1
5/23	WE	0			
5/24	WE			9	1
5/25	WE	0	3	3	
5/26	WD				2

¹ WD = Weekday; WE = Weekend/Holiday

² Period A: 0600-0759 hrs, Period B: 0800-1159 hrs,
Period C: 1200-1659 hrs, Period D: 1700-2300 hrs.

Appendix Table 2. Angler effort and harvest data for the
 Buskin River Dolly Varden sport fishery,
 23 April through 26 May 1987.

Date	Wd/ We ¹	No. Int. ²	Hours		Dolly Varden Harvest		
			Mean	SE ³	Mean	SE	CPUE
23-Apr	Wd	15	1.6	0.35	0.53	0.291	0.343
24-Apr	Wd	13	1.4	0.21	1.54	0.748	1.067
25-Apr	We	21	1.2	0.13	0.10	0.095	0.078
26-Apr	We	15	1.4	0.22	1.80	0.857	1.302
28-Apr	Wd	19	0.8	0.11	0.74	0.470	0.949
29-Apr	Wd	4	1.8	0.14	2.75	1.250	1.571
01-May	Wd	31	1.6	0.16	3.58	0.736	2.265
02-May	We	43	1.8	0.18	1.05	0.317	0.581
03-May	We	23	1.8	0.19	2.91	0.656	1.665
04-May	Wd	5	1.5	0.32	5.00	2.236	3.333
06-May	Wd	13	1.4	0.19	2.23	0.778	1.547
07-May	Wd	35	1.7	0.18	2.37	0.485	1.419
09-May	We	14	1.9	0.21	2.29	0.946	1.231
10-May	We	48	1.4	0.16	1.44	0.347	1.018
12-May	Wd	33	1.9	0.19	1.85	0.530	0.988
13-May	Wd	17	1.3	0.17	1.06	0.369	0.837
14-May	Wd	16	1.9	0.28	0.88	0.569	0.471
16-May	We	28	1.0	0.14	0.64	0.287	0.632
17-May	We	25	0.9	0.13	0.16	0.111	0.176
19-May	Wd	2	0.5	0.00	0.00	0.000	0.000
21-May	Wd	5	1.2	0.20	0.00	0.000	0.000
22-May	Wd	5	1.2	0.44	0.00	0.000	0.000
24-May	We	17	0.5	0.05	0.00	0.000	0.000
25-May	We	8	1.5	0.56	0.00	0.000	0.000
26-May	Wd	2	2.3	0.75	0.00	0.000	0.000

1 Wd= Weekday; We= Weekend/Holiday

2 Number of anglers interviewed

3 Standard error

Appendix Table 3. Counts of emigrant and immigrant Dolly Varden char through the Buskin River weir, 1987.

Date	Emigrant	Immigrant										
4/22	69		6/02	15		7/13		16	8/23		41	
4/23	49		6/03	12		7/14		130	8/24		65	
4/24	113		6/04	5		7/15		409	8/25		51	
4/25	81		6/05	10		7/16		282	8/26		62	
4/26	33		6/06	213		7/17		123	8/27		49	
4/27	40		6/07	3		7/18		339	8/28		36	
4/28	20		6/08	7		7/19		412	8/29		38	
4/29	62		6/09	0		7/20		631	8/30		27	
4/30	221		6/10	10		7/21		507	8/31		9	
5/01	14		6/11			7/22		1,244	9/01		11	
5/02	27		6/12			7/23		759	9/02		24	
5/03	8		6/13			7/24		550	9/03		12	
5/04	6		6/14			7/25		1,506	9/04		21	
5/05	2,482		6/15			7/26		2,256	9/05		23	
5/06	3,660		6/16			7/27		1,218	9/06		40	
5/07	659		6/17			7/28		1,520	9/07		45	
5/08	939		6/18			7/29		2,942	9/08		18	
5/09	50		6/19		1	7/30		1,252	9/09		180	
5/10	1,081		6/20		0	7/31		2,268	9/10		38	
5/11	3,721		6/21		0	8/01		2,416	9/11		47	
5/12	35		6/22		0	8/02		1,414	9/12		44	
5/13	30		6/23		0	8/03		566	9/13		20	
5/14	109		6/24		0	8/04		821	9/14		30	
5/15	1,014		6/25		0	8/05		1,036	9/15		35	
5/16	4,803		6/26		0	8/06		937	9/16		18	
5/17	71		6/27		0	8/07		1,217	9/17		16	
5/18	3,050		6/28		0	8/08		1,051	9/18		10	
5/19	1,318		6/29		0	8/09		313	9/19		11	
5/20	2,046		6/30		0	8/10		258	9/20		56	
5/21	541		7/01		8	8/11		683	9/21		28	
5/22	292		7/02		10	8/12		208	9/22		0	
5/23	391		7/03		83	8/13		224	9/23		0	
5/24	130		7/04		41	8/14		116	9/24		301	
5/25	409		7/05		21	8/15		88	9/25		141	
5/26	658		7/06		36	8/16		133	9/26		345	
5/27	25		7/07		34	8/17		53	9/27		90	
5/28	19		7/08		32	8/18		46	9/28		23	
5/29	641		7/09		56	8/19		53	9/29		46	
5/30	628		7/10		172	8/20		43	9/30		48	
5/31	69		7/11		83	8/21		55	10/1		9	
6/01	30		7/12		12	8/22		56				
										TOTAL	29,919	32,848