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Evaluation of the Rainbow Trout Stocking Program for Piledriver Slough

by

L. Saree Timmons

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ABSTRACT

In 1987 an experimental stocking program was begun at Piledriver Slough. Between 20,000 and 79,481 rainbow trout *Oncorhynchus mykiss* were stocked annually from 1987 through 1990. Fish were stocked at several locations, and ranged in size from fingerlings to catchables. The stocking program was evaluated using statewide harvest surveys, creel surveys, and field sampling. Statewide harvest surveys showed that after initiation of the rainbow trout stocking program, Piledriver Slough quickly became one of the most popular sport fishing locations in interior Alaska in terms of effort and, a large number of rainbow trout were harvested. Based on creel survey questionnaires, anglers gave the quality of fishing at Piledriver Slough moderate ratings, but overwhelmingly approved of the stocking program. Growth and survival of rainbow trout stocked in Piledriver Slough were generally low. Only rainbow trout stocked as catchables contributed significantly to the fishery. Prior to stocking in 1990, about 16 percent of the rainbow trout harvested were 1988 catchables and about 84 percent were 1989 catchables. Of the rainbow trout captured during field sampling in 1990, about 7 percent were 1988 subcatchables, 14 percent were 1988 catchables, 2 percent were 1989 fingerlings, 6 percent were 1989 subcatchables, and 71 percent were 1989 catchables. In 1990, four percent of the rainbow trout sampled from Piledriver Slough were gravid females, and no rainbow trout were found that were conclusively age 0 rainbow trout resulting from natural reproduction. Movement of rainbow trout out of Piledriver Slough is believed to be negligible. Number of catchable rainbow trout stocked was related positively to fishing effort (days fished) expended at Piledriver Slough. An average angler "success" rate (defined as a catch rate of three or more rainbow trout per completed fishing trip in excess of 1 hour) of about 40 percent was maintained for three to four weeks after stocking.

Key Words: rainbow trout, *Oncorhynchus mykiss*, stocking, evaluation, fingerling, subcatchable, catchable, natural reproduction.

INTRODUCTION

Piledriver Slough, a clear-water stream located near Fairbanks, Alaska, was chosen as the location for an experimental stocking program of rainbow trout *Oncorhynchus mykiss* by the Alaska Department of Fish and Game (ADFG) that took place from 1987 through 1990. The purpose of the program was to determine if a viable sport fishery for rainbow trout could be established in Piledriver Slough and to determine the best strategy for stocking rainbow trout in these flowing waters of interior Alaska. Variable numbers of rainbow trout were stocked at different sizes, times, and locations from 1987 through 1990. Creel surveys, statewide harvest surveys, and test sampling were tools utilized to evaluate the success of the stocking efforts. Specific objectives in 1990, which focused on reproduction, distribution, and composition of the rainbow trout stocked in Piledriver Slough, were to:

1. document the presence or absence of age 0 rainbow trout in Piledriver Slough;

2. estimate the proportion of rainbow trout in Piledriver Slough that were gravid females; and,

3. estimate the stocking cohort, age, and length compositions of the rainbow trout population in Piledriver Slough.

With the expiration in 1991 of the Fish Transport Permit for Piledriver Slough (Appendix A), this report summarizes available data concerning rainbow trout in Piledriver Slough, and will provide information necessary for making decisions about future introductions of rainbow trout in Piledriver Slough.

Public opinion in the 1980's about stocking fish contributed to the decision to begin experimentally stocking rainbow trout in flowing waters of Alaska's interior. As fishing pressure in interior Alaskan waters expanded during the 1980's, stocking became an increasingly popular management option for improving sport fishing. In 1985 and 1988, about 80% of respondents to angler surveys conducted by ADFG approved of stocking fish as a management tool for improving fishing (Holmes 1987; Viavant and Clark 1990). In addition to approving of stocking in general, anglers increasingly requested opportunities to fish for rainbow trout in streams along the road systems close to Fairbanks. In fact, on May 7, 1987, the Fairbanks North Star Borough Assembly passed a resolution requesting the Governor's Office to pursue a rainbow trout stocking program in the Chena River (Resolution No. 87-058, Appendix B), and in a creel survey at Piledriver Slough in 1986, 86% of anglers surveyed supported stocking rainbow trout in Piledriver Slough (Clark and Ridder 1987). Stocking rainbow trout in a riverine environment was also seen as a way of providing alternative fishing opportunities for anglers who were displaced by increasingly restrictive regulations implemented in 1987, 1988, and 1990 intended to reduce Arctic grayling harvest in the Chena and other roadside Interior rivers. In January 1987, a State Fish Transport Permit was approved for stocking rainbow trout in Piledriver Slough, and the first stocking took place that summer.

Piledriver Slough was chosen for the experimental stocking program due to its location, ready access, size, man-made nature, and habitat characteristics. Located near Fairbanks, Alaska, the largest urban area in interior Alaska, Piledriver Slough can be accessed at many locations along the Richardson Highway (Figure 1). Although there are no developed recreational areas along the slough, there are several gravel pull-offs and parking areas along the Richardson Highway and at gravel road crossings. Piledriver Slough is also easily accessed at its upper end from a residential area along the Old Richardson Highway at Stringer Road. Piledriver Slough, as it is now, was the result of human influences. Contrary to its name, Piledriver Slough is not a slough, although it was at one time. In 1976, the slough was blocked off from the Tanana River as part of a flood control project. As a result, Piledriver Slough became a clear-water stream fed primarily from run-off and ground-water instead of the Tanana River. It is still directly influenced by fluctuations of the Tanana River, with occasional flooding of the slough during high water events. The habitat of Piledriver Slough was considered satisfactory for stocked rainbow trout. Numerous riffles and pools characterize the upper reaches, while slower, deeper water are the norm near its confluence with Moose Creek. Substrate of the slough varies from gravel to mud, and in the summer the lower reaches are choked with a variety of aquatic vegetation. After completion of the flood control project, Piledriver Slough was quickly inhabited by most fish species indigenous to interior Alaska, including Arctic grayling *Thymallus arcticus*, round whitefish *Prosopium cylindraceum*, least cisco *Coregonus sardinella*, humpback whitefish *Coregonus pidschian*, northern pike *Esox lucius*, and coho salmon *Oncorhynchus kisutch*. Other fish inhabiting the slough include slimy sculpin *Cottus cognatus* and longnose suckers *Catostomus catostomus*.

Moose Creek, French Creek and Garrison Slough were included in the 1990 sampling because they are interconnected with Piledriver Slough (Figures 1 and 2). Lower Moose Creek, from Eielson Air Force Base to its confluence with the Tanana River, is primarily a meandering stream with steep cut-banks and muddy bottom. Access to Moose Creek can be gained from the Richardson Highway and several bridge crossings on Eielson Air Force Base. French Creek, a tributary to Moose Creek, varies from a small creek with gravel and mud substrate to a small river nearly the size of Moose Creek. Access to French Creek is primarily limited to bridge and pipeline crossings on Eielson Air Force Base. Garrison Slough is also a small tributary to Moose Creek, contained almost entirely on Eielson Air Force Base. Because the Alaska oil pipeline crosses French and Moose creeks at numerous locations, these water bodies were the subjects of habitat and fish surveys conducted by the Division of Habitat, ADFG, prior to construction of the pipeline. Physical characteristics of these streams are presented in Appendix C.

METHODS

Evaluation of the experimental stocking program at Piledriver Slough utilized stocking records of rainbow trout, statewide harvest surveys, on-site creel surveys, and field sampling.

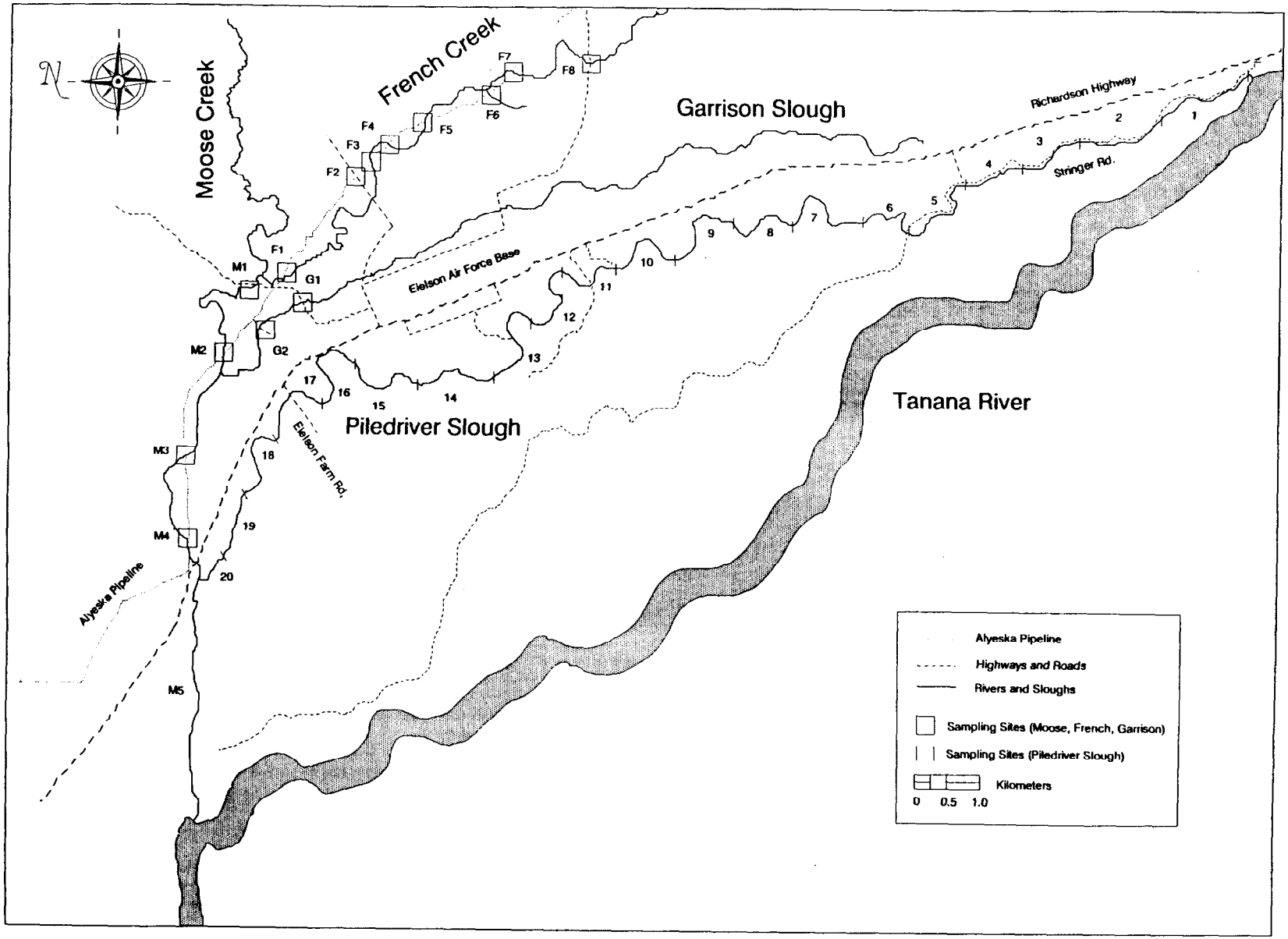


Figure 1. Map of study sites on Piledriver Slough, Moose Creek, French Creek, and Garrison Slough.

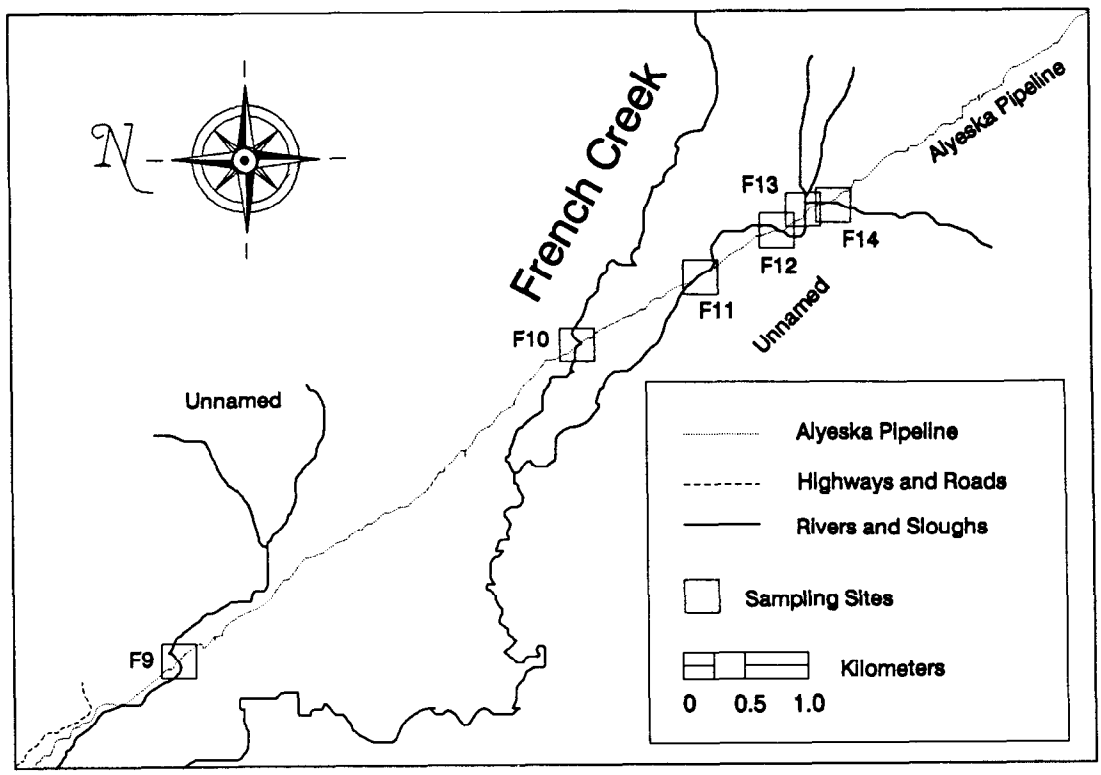


Figure 2. Map of study sites on upper French Creek.

Experimental Stocking Program

Three sizes of rainbow trout were stocked in Piledriver Slough from 1987 through 1989: fingerlings, subcatchables, and catchables. In 1990, only catchable rainbow trout were stocked. Although weight varied between individuals of the same stocking cohort as well as across cohorts, fingerlings are generally defined as fish that were one to two months old and weighed between 1 and 4 g. Subcatchables and catchables were the same age at stocking (about one year old), but subcatchables were about 20 g, whereas catchables were about 100 g (Table 1). All rainbow trout stocked in Piledriver Slough were Swanson River strain, except about one-half the catchables stocked in 1988 were Big Lake strain. All fingerlings and subcatchables were obtained from Clear Hatchery. Catchables stocked in 1987 were obtained from Elmendorf Hatchery. Catchables stocked in 1988, 1989, and 1990 were obtained from Ft. Richardson Hatchery. Stocked rainbow trout were not marked prior to or upon release, except 1990 catchables, which were given adipose fin clips. Numbers of catchable rainbow trout stocked annually varied from 12,495 to 26,554 from 1987-1990. Numbers of subcatchable rainbow trout stocked annually varied from 8,553 to 17,927 from 1987-1989, and 35,000 fingerlings were stocked each year from 1987 through 1989 (Table 1).

The methods by which the different sizes of rainbow trout were stocked varied from one discreet stocking event at one location on one day, to intermittent stockings at various locations in Piledriver Slough (Table 1). For example, from 1987 through 1989, fingerlings were stocked on only one day each summer at Piledriver Slough site 11 (Figure 1), whereas in 1988, catchables were stocked on three different occasions and were carried in ice chests by members of the public to many different locations throughout Piledriver Slough.

Statewide Harvest Surveys and Creel Surveys

Statewide harvest surveys are conducted yearly in Alaska to estimate fishing effort and harvest of sport fish species throughout the state. Purchasers of sport fish licenses who are randomly chosen to participate in the survey receive a questionnaire concerning their sport fishing activities over the past year. Harvest and effort by area, water body, and species are then estimated (see Mills 1983-1990 for detailed methods).

Creel surveys were conducted during the summer months at Piledriver Slough, from 1987 through 1990. Anglers interviewed at Piledriver Slough were questioned concerning time spent fishing, catch, harvest, and opinions regarding the quality of fishing and preferred management options. Demographic information, such as residency, age, and sex, was also recorded. The rainbow trout and Arctic grayling harvests were sampled for age and length characteristics. Data collected during the surveys were used to estimate catch per unit of effort (CPUE - number of rainbow trout caught per hour of fishing), harvest per unit of effort (HPUE - number of rainbow trout harvested per hour of fishing), age and length compositions of the harvest, distribution of the catch and harvest among anglers, angler demographics, and percent response to opinion questions. See Clark and Ridder 1987, Baker 1988 and 1989, Merritt et al. 1990, and Hallberg and Bingham *in press* for complete methods.

Table 1. Numbers, mean weights, and mean lengths of rainbow trout cohorts stocked in Piledriver Slough, 1987-1990.

Stocking Date	Method[a]	Fingerlings Number Stocked	Fingerlings Mean Weight (g)	Fingerlings Mean Length (mm)	Subcatchables Number Stocked	Subcatchables Mean Weight (g)	Subcatchables Mean Length (mm)	Catchables Number Stocked	Catchables Mean Weight (g)	Catchables Mean Length (mm)	Annual Total Stocked All Sizes
5/16/87	A							4,091	110	[b]	
5/22/87	B				4,842	25	134				
5/27/87	B				7,658	25	134				
6/16/87	A							8,404	154	[b]	
8/27/87	C	35,000	2	60							
Total 1987		35,000			12,500			12,495			60,000
6/2/88	D				10,215	22	127				
6/3/88	C				7,712	22	127				
6/10/88	A							9,417	90	213 [c]	
8/8/88	A							11,059	90	213 [c]	
8/11/88	A							3,880	135	213 [c]	
8/11/88	A							2,188	65	213 [c]	
8/16/88	C	35,000	1	45							
Total 1988		35,000			17,927			26,554			79,481
5/31/89	C				8,553	26	130				
6/19/89	A							11,845	96	216	
7/21/89	E							13,810	101	216	
8/7/89	C	35,000	1	47							
Total 1989		35,000			8,553			25,655			69,208
6/27/90	F	0			0			20,000	112	202	
Total 1990		0			0			20,000			20,000

[a] A = distributed from Bailey Bridge to Eielson Farm Rd. with help from public; B = stocked at Bailey Bridge and Eielson Farm Rd. only; C = stocked at Bailey Bridge only; D = stocked at Eielson Farm Road only; E = distributed from Stringer Rd. to Eielson Farm Rd with help from public; F = stocked at Stringer Rd., Bailey Bridge, and Eielson Farm Rd. only.

[b] Not available.

[c] Calculated from creel census data.

Field Sampling

In 1988, Piledriver Slough was sampled with minnow traps and seines in early June. On June 2, three minnow traps were set at Piledriver Slough, site 20, and one minnow trap was set at Moose Creek site 5. The minnow traps were baited with salmon roe and allowed to fish overnight. Also on June 2, 1988, three seine hauls were made just downstream of the confluence of Moose Creek and Piledriver Slough (Moose Creek Site 5), and one seine haul was made at Piledriver Slough site 17. On June 3, 1988, Moose Creek site 5 was sampled with boat mounted electrofishing equipment. In 1989, field sampling was limited to one day. Sites 4 and 16 were sampled with seines on May 19, 1989. In 1990, sampling for rainbow trout occurred throughout Piledriver Slough, in lower Moose Creek, and at bridge and pipeline crossings of Moose Creek, French Creek, and Garrison Slough (Figures 1 and 2). Using a variety of gear types, including backpack and boat mounted electrofishing equipment, hoop traps, minnow traps, and seines, rainbow trout were captured from April 25 through October 5, 1990 (Table 2).

Captured rainbow trout were measured to the nearest mm of fork length (FL), and several scales, taken from an area above the lateral line just posterior to the insertion of the dorsal fin, were removed for determination of age and stocking cohort. Scales were later mounted between glass slides. In 1990, spawning condition and sex were noted by extrusion of eggs or milt when possible, and condition of fins was noted. In 1990, rainbow trout larger than 149 mm were double marked with an individually numbered ADFG Floy tag and an upper caudal fin clip. Tags were inserted on the left side of the fish at the base of the dorsal fin. Sampling for gravid female rainbow trout took place during April and May of 1990 only. During that time, a sample of rainbow trout for which sex could not be determined externally was sacrificed to effectively determine sex and developmental stage of females. A total of 183 rainbow trout larger than 149 mm were examined for sex. Upon autopsy, rainbow trout were categorized as male, female-gravid, female-not gravid, or sex unknown.

Probable stocking cohorts of rainbow trout were determined based upon length at time of sampling, length of cohorts at time of stocking, and scale characteristics (Table 3). Stocking cohort was defined as the year and size group at which a rainbow trout was stocked. Individual stocking cohorts are hereafter referred to by the year of stocking followed by the size at stocking. For example, subcatchables stocked in 1989 will be referred to as 1989 subcatchables. Scales were examined under a microfiche reader at about 40×. As scales were initially examined, characteristics such as circuli counted, presence or absence of three or more closely-spaced circuli termed checks, number of circuli between checks, and length of fish were recorded on data forms. After scales of about 50 rainbow trout had been examined, possible groupings, such as scales with checks versus scales without checks, or scales with many circuli versus scales with few circuli, became evident. Such characteristics, coupled with length at capture, length frequency distributions, and lengths and scale characteristics of cohorts at stocking, were then used to create a preliminary key. As more scales were examined, the key was refined to account for most of the sampled rainbow trout. The key was initially developed for categorizing rainbow trout sampled in 1990, and was

Table 2. Dates and areas sampled, gear used, and numbers of rainbow trout captured during 1990.

Date	Piledriver Slough			French Creek			Moose Creek			Garrison Slough		
	Area[a]	Gear[b]	Number Sampled	Area[a]	Gear[b]	Number Sampled	Area[a]	Gear[b]	Number Sampled	Area[a]	Gear[b]	Number Sampled
4/25	5, 6	HM	40									
4/26	5, 6	HM	4									
4/27	5	HM	10									
4/30	5	HM	24									
5/02	5	HM	27									
5/3	5	ES	23				3- 4	E	2			
5/4	5,11	ES	204									
5/10	16	L	1									
5/11	16	L	1	1-14	H	0	1- 4	H	0	1- 2	H	1
5/14				1-14	H	1	1- 4	H	0	1- 2	H	0
5/16				1-14	H	0	1- 4	H	0	1- 2	H	2
5/17				1- 7	H	1						
5/19	16	L	1									
5/20	16	L	1									
5/21	16	S	1									
5/22				1-14	H	2	1- 4	H	5	1- 2	H	2
5/25				1-14	H	2	2- 4	H	3	1- 2	H	2
5/26	16	L	3									
5/27	16	L	2									
5/28	16	L	1	6	H	1						
5/29				8,12	H	0	1- 4	H	1			
6/1							2- 4	H	4	2	H	0
6/2	16	L	3									
6/5							2- 4	H	17	2	H	0
6/8							2- 4	H	0	2	H	0
6/9	5	L	3									
6/20	5	E	53									
6/21	5	E	22									
6/22	11	E	8	10-14	H	8						
6/25				10-14	H	0						
6/26	11	E	17									

- continued -

Table 2. (Page 2 of 2).

Date	Piledriver Slough			French Creek			Moose Creek			Garrison Slough		
	Area[a]	Gear[b]	Number Sampled	Area[a]	Gear[b]	Number Sampled	Area[a]	Gear[b]	Number Sampled	Area[a]	Gear[b]	Number Sampled
6/27	16	[c]	411	10-14	H	0						
6/28	11	E	9									
6/29	11	E	1	10-14	H	0						
6/30	16	L	54									
7/1	16	L	63									
7/2				10-14	H	0						
7/8	16	L	4									
7/11				10-14	H	3						
7/12							3- 4	E	1			
7/14	16	L	2									
7/15	16	L	2									
7/21	16	L	1									
7/22	5	L	1									
7/24	16	L	1									
8/2	16	L	1									
8/4	16	L	1									
9/10	16-19	E	36				1- 2	E	13			
9/27	5,11,	M	0									
	13,15,	M	0									
	16	M	0									
9/29	5,11,	M	15									
	13,15,	M	0									
	16	M	0									
10/1	11, 5	M	16	1- 7	M	0						
				9-14	M	1						
10/3				1-14	M	0	17-20	M	0	1	M	0
10/5							1	M	0			
							17-20	M	0	1	M	0
Total			1,067			19			46			7

[a] See Figure 1.

[b] H=hoop trap; M=minnow trap; E=electrofishing; S=seine; L=hook and line (creel survey).

[c] Catchable rainbow trout sampled as they were stocked in Piledriver Slough.

Table 3. Key for determining stocking cohort of rainbow trout captured in 1990.

	Characteristic	Next Step	Stocking Cohort
A)	Adipose fin clipped	Stop	1990 catchable
	Adipose fin not clipped	Go to B	
B)	Length <112 mm	Stop	1989 fingerling
	Length 112-145 mm	Stop	1989 subcatchable
	Length 146-174 mm	Stop	1988 subcatchable
	Length 175-207 mm	Go to C	
	Length 208-250 mm	Stop	1989 catchable
	Length >250 mm	Stop	1988 catchable
C)	Has a check on scale	Go to D	
	Does not have a check on scale	Stop	1989 catchable
D)	Number of circuli >=31	Stop	1989 catchable
	Number of circuli <31	Stop	1988 subcatchable

then applied to rainbow trout sampled in 1989 by subtracting one year from the final determination of stocking cohort. Because there were no scale samples of known stocking cohort (other than the 1990 stocking cohort) the error involved in using Table 3 is indeterminate.

Compositions were considered a series of proportions, one for each category, whose sum was one, according to the equations:

$$\hat{p}_i = \frac{y_i}{n}; \text{ and,} \qquad (1)$$

$$\hat{V}[p_i] = \frac{\hat{p}_i(1-\hat{p}_i)}{n-1}; \qquad (2)$$

where:

y_i = the number of rainbow trout in category i in the sample; and,
n = the number of rainbow trout in the sample.

Stocking Level

Fishing effort (days fished) as estimated in statewide harvest surveys were regressed against number of catchable sized rainbow trout stocked each year to determine if there was a significant linear relationship between fishing effort and number of these fish stocked, and if so, to determine estimates of the slope and intercept.

Stocking Frequency

To determine how frequently successive introductions of catchable sized rainbow trout should occur, percent frequency of anglers rating the fishery as excellent or good was graphed against numerical catches. Only data from anglers fishing one or more hours were used for this purpose. Only data from 1990 were used because there were few complete trip interviews in the creel surveys from 1987 through 1989. The point at which percent frequency of angler rating leveled off was chosen as the definition for a "successful" fishing experience. Using this definition of "success", percent frequency of "successful" anglers was graphed against date in one- and two-week intervals. The point at which success dropped off was chosen as the optimal time interval between successive introductions of catchable sized rainbow trout.

Stocking Location

To develop recommendations of where fish should be released, the proportion (p_i) of successful anglers by location (Eielson Farm Rd., Bailey Bridge Rd., and Stringer Rd.) was estimated from creel interviews collected in 1990. Interview data were partitioned by date and location, to reflect the timing of

release and release area. Estimates of p_i and the potential number of samples (m_i) for these groupings were determined.

RESULTS

Statewide Harvest Surveys and Creel Surveys

Sport fishing effort at Piledriver Slough ranged from 13,257 angler days in 1987 to 24,375 in 1988; harvest of rainbow trout ranged from 4,346 fish in 1987 to 12,296 in 1988 (Table 4; Figure 3). These harvests represented 35% (1987), 46% (1988), and 30% (1989) of the catchable sized rainbow trout stocked in Piledriver Slough for those years. The catch and harvest distribution among anglers was similar from 1987 through 1990, with a large portion of anglers catching no rainbow trout (Figures 4 and 5; Table 5). Mean CPUE of rainbow trout at Piledriver Slough was 1.55 fish per hour in 1987, 1.92 in 1988, and 0.68 in 1989 (Table 6). Date strata for estimating mean CPUE were defined differently in all three years.

Creel surveys, in which anglers were asked to rate the fishing as excellent, good, fair, or poor, were conducted at Piledriver Slough from 1986 through 1990. In 1987, the first year rainbow trout were stocked, 61% of the anglers surveyed at Piledriver Slough rated the fishing as excellent or good, compared to 95% in 1986 when anglers only fished for Arctic grayling (Table 7; Figure 6). In the years 1988 through 1990, 58%, 37%, and 42% of anglers, respectively, rated fishing as excellent or good. In the first three years of the experiment, 94-95% of anglers surveyed at Piledriver Slough approved of stocking rainbow trout in Piledriver Slough; in 1990, that statistic was 88% (Table 7; Figure 6). Demographic profiles of anglers fishing at Piledriver Slough remained stable from 1987 through 1990 (Table 8).

Costs of Stocking

Cost of stocking rainbow trout in Piledriver Slough ranged from $1,786 for fingerlings in 1987 to $37,908 for catchables in 1989. Appendix D documents costs of stocking rainbow trout in Piledriver Slough from 1987 through 1990.

Field Sampling

In 1988, no rainbow trout were captured with minnow traps. No rainbow trout were captured with seines in Moose Creek. Many rainbow trout, believed to be subcatchables that had just been stocked, were caught in the seine haul at Piledriver Slough site 17, but those rainbow trout were neither enumerated nor sampled. Two rainbow trout, believed to be 1987 catchables, were caught by electrofishing on June 3, 1988. The lengths of those fish were 295 mm and 310 mm. Scale samples were not taken. A few rainbow trout, believed to be 1988 subcatchables, were also captured with the electrofishing equipment on June 3, 1988, but they were neither enumerated nor sampled.

In 1990, no rainbow trout were found in Piledriver Slough that were conclusively age 0 fingerlings resulting from natural reproduction. Four rainbow trout under 100 mm were captured in the fall of 1990, but the

Table 4. Effort and harvest of rainbow trout at Piledriver Slough and in the Tanana drainage, 1983-1990.

	Piledriver Slough				Tanana Drainage		% of Tanana Drainage[f]	
Year	Number of Anglers	Number of Trips	Days Fished	Harvest of Rainbow Trout	Days Fished	Rainbow Trout Harvest	Days Fished	Rainbow Trout Harvest
1983[a]			4,148	0	146,386	20,664	2.8	0
1984[b]	470	2,334	4,651	0	145,752	34,022	3.2	0
1985[b]	648	3,019	2,133	0	136,422	33,432	1.6	0
1986[b]	342	1,870	2,079	0	144,937	31,270	1.4	0
1987[c]	4,686	15,236	13,257	4,346	156,061	31,824	8.5	13.7
1988[d]	4,981	21,936	24,375	12,296	174,554	78,345	14.0	15.7
1989[e]	5,268	19,512	22,746	7,689	186,418	74,675	12.2	10.3

[a] Mills 1984.
[b] Mills, unpublished data.
[c] Mills 1988.
[d] Mills 1989.
[e] Mills 1990.
[f] Percent of Tanana drainage fishery represented by Piledriver Slough.

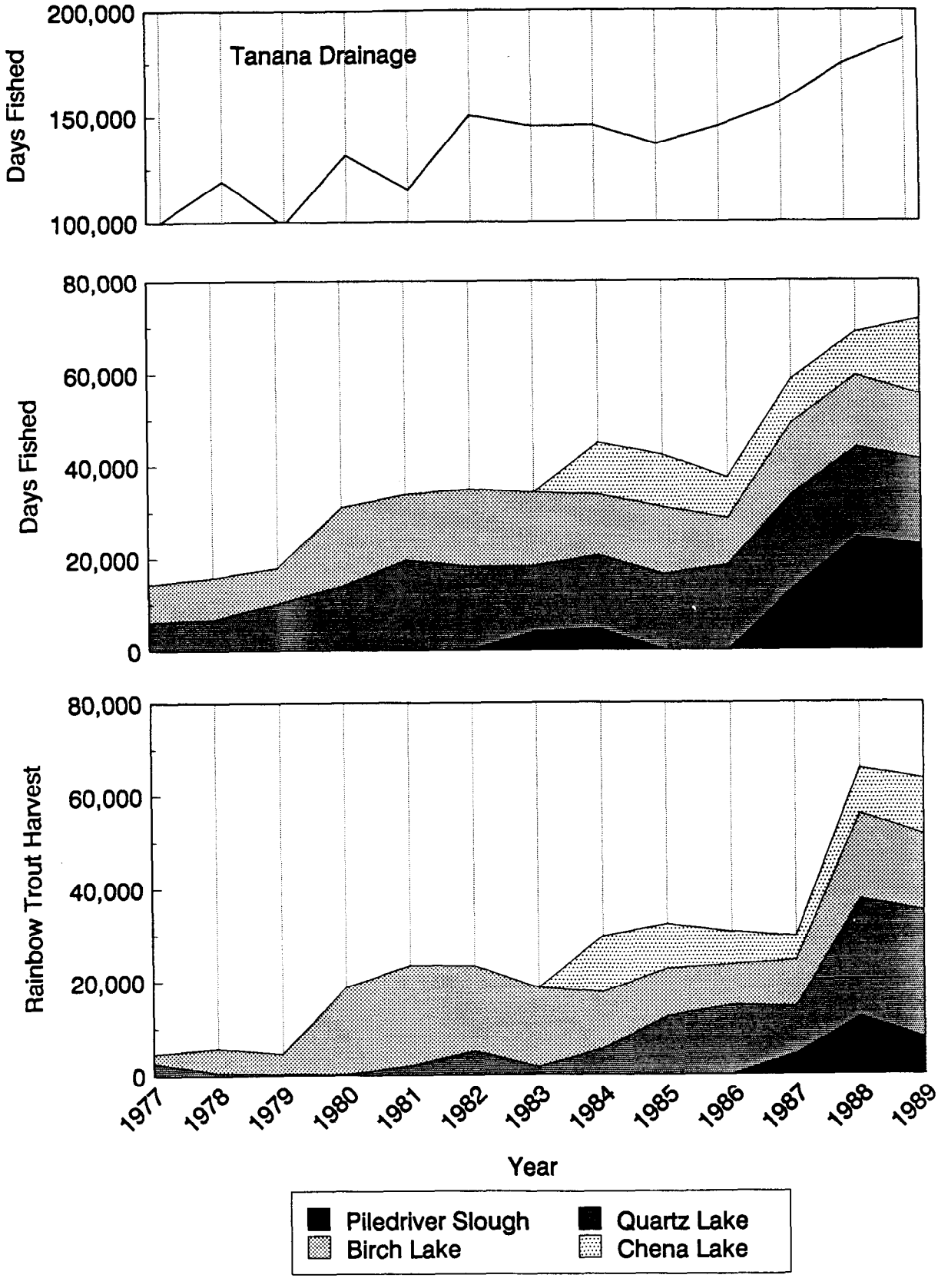


Figure 3. Sport fishing effort in the entire Tanana drainage, and fishing effort and harvest of rainbow trout in four popular Tanana drainage fisheries, 1977-1989.

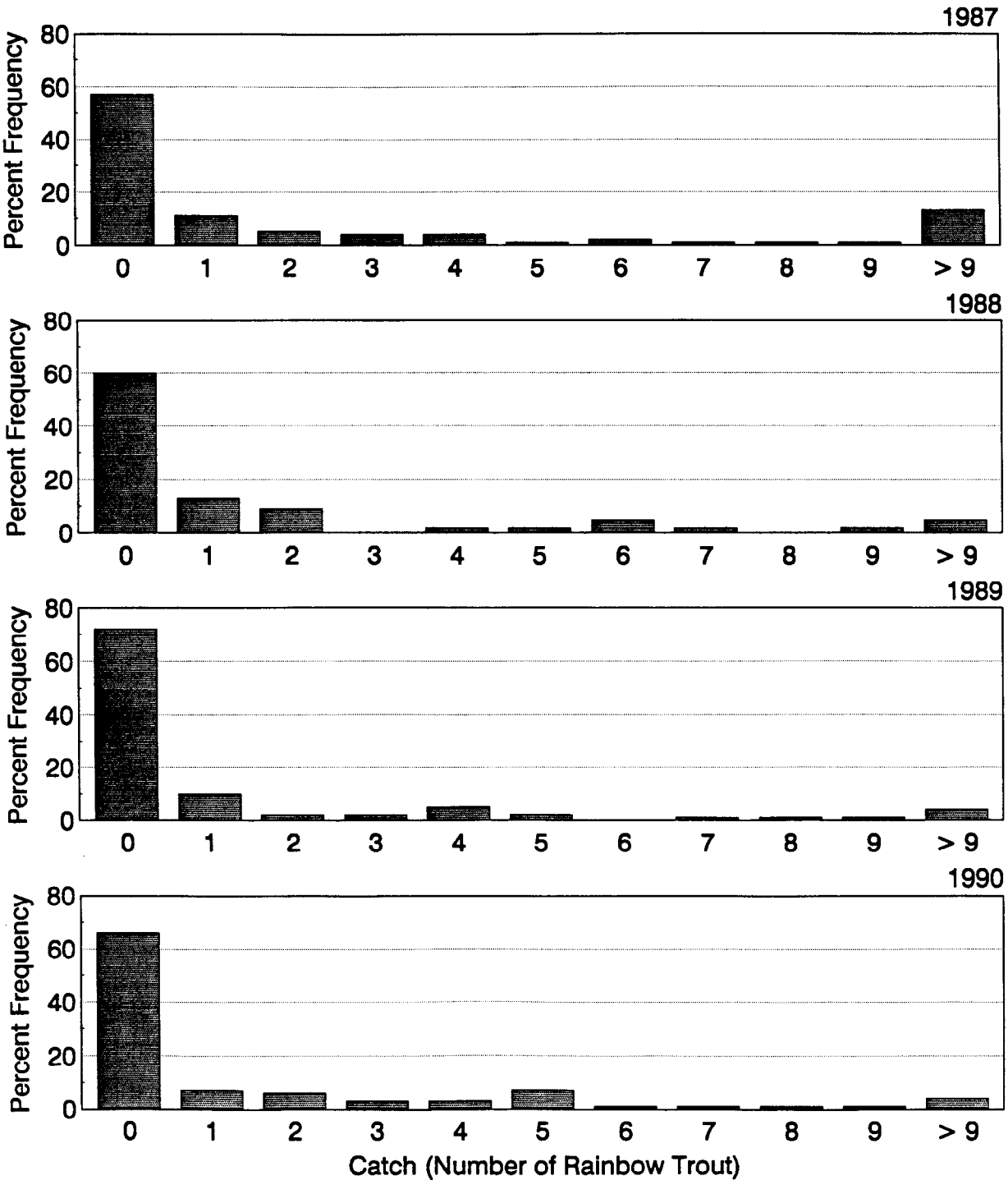


Figure 4. Distribution of angler-trips by catch at Piledriver Slough, 1987-1990.

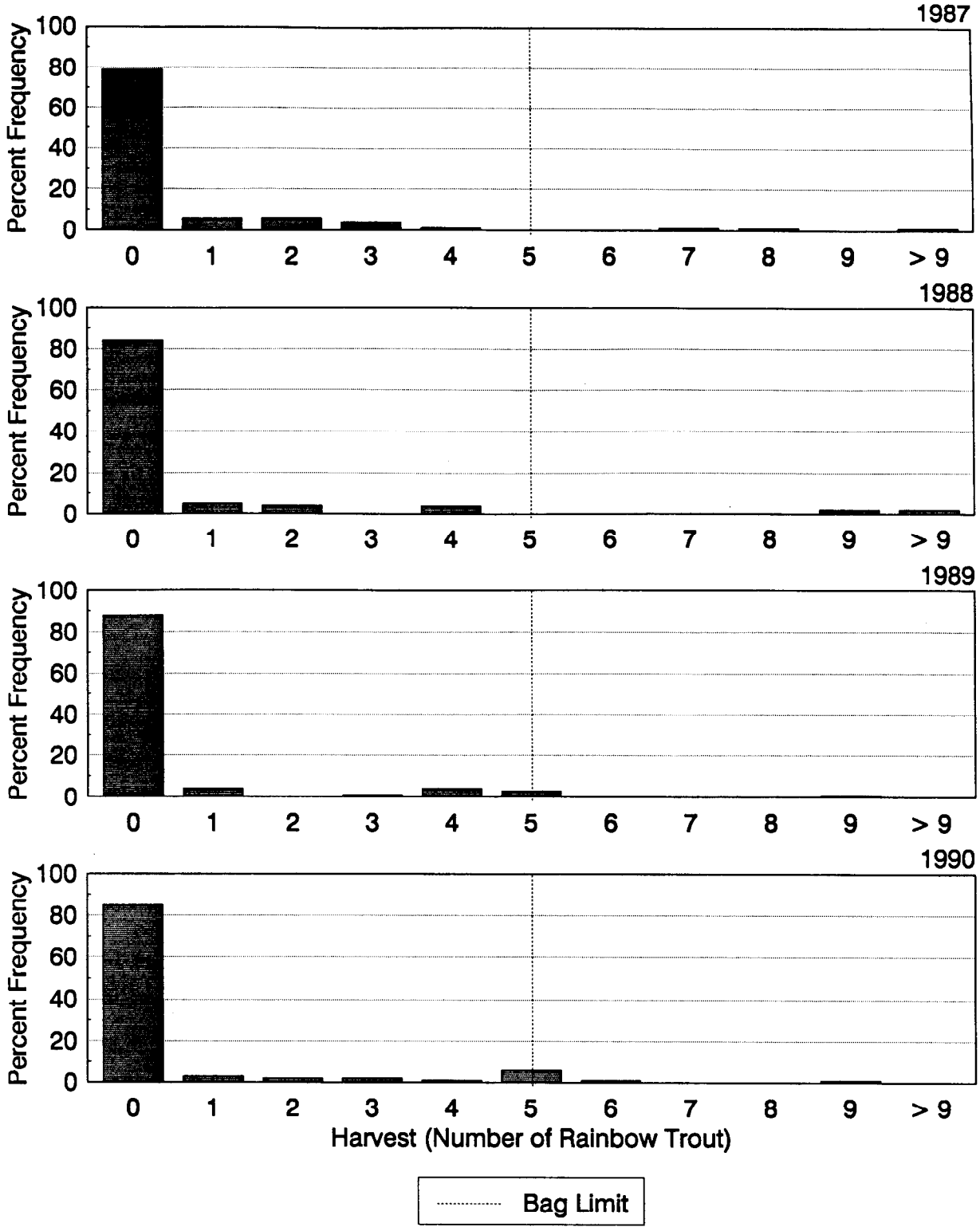


Figure 5. Distribution of angler-trips by harvest at Piledriver Slough, 1987-1990.

Table 5. Distribution of the catch and harvest of rainbow trout among anglers at Piledriver Slough, 1987-1990[a].

	Catch								Harvest							
Number	1987		1988		1989		1990[b]		1987		1988		1989		1990[b]	
of Fish	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
0	47	57	33	60	102	72	554	66	65	79	46	84	125	88	672	85
1	9	11	7	13	14	10	55	7	5	6	3	5	5	4	29	3
2	4	5	5	9	3	2	60	6	5	6	2	4	0	0	33	2
3	3	4	0	0	3	2	25	3	3	4	0	0	2	1	13	2
4	3	4	1	2	7	5	22	3	1	1	2	4	5	4	18	1
5	1	1	1	2	3	2	62	7	0	0	0	0	4	3	47	6
6	2	2	3	5	0	0	4	1	0	0	0	0	0	0	4	1
7	1	1	1	2	2	1	3	1	1	1	0	0	0	0	0	0
8	1	1	0	0	1	1	4	1	1	1	0	0	0	0	0	0
9	1	1	1	2	1	1	3	1	0	0	1	2	1	1	1	1
> 9	10	13	3	6	6	4	25	5	1	1	1	2	0	0	0	0
Total	82		55		142		817		82		55		142			

[a] Data sources: Baker 1988, 1989; Hallberg and Bingham 1991; unpublished data (for 1989), Peggy Merritt, Sport Fish Division, Alaska Department of Fish and Game, 1300 College Road, Fairbanks, AK 99701.

[b] 1990 percentages may not equal n/total because estimates of percentages were weighted by time and area strata.

Table 6. Number of anglers interviewed, and estimates of mean CPUE[a] and mean HPUE[b] for Piledriver Slough, 1987-1989[c].

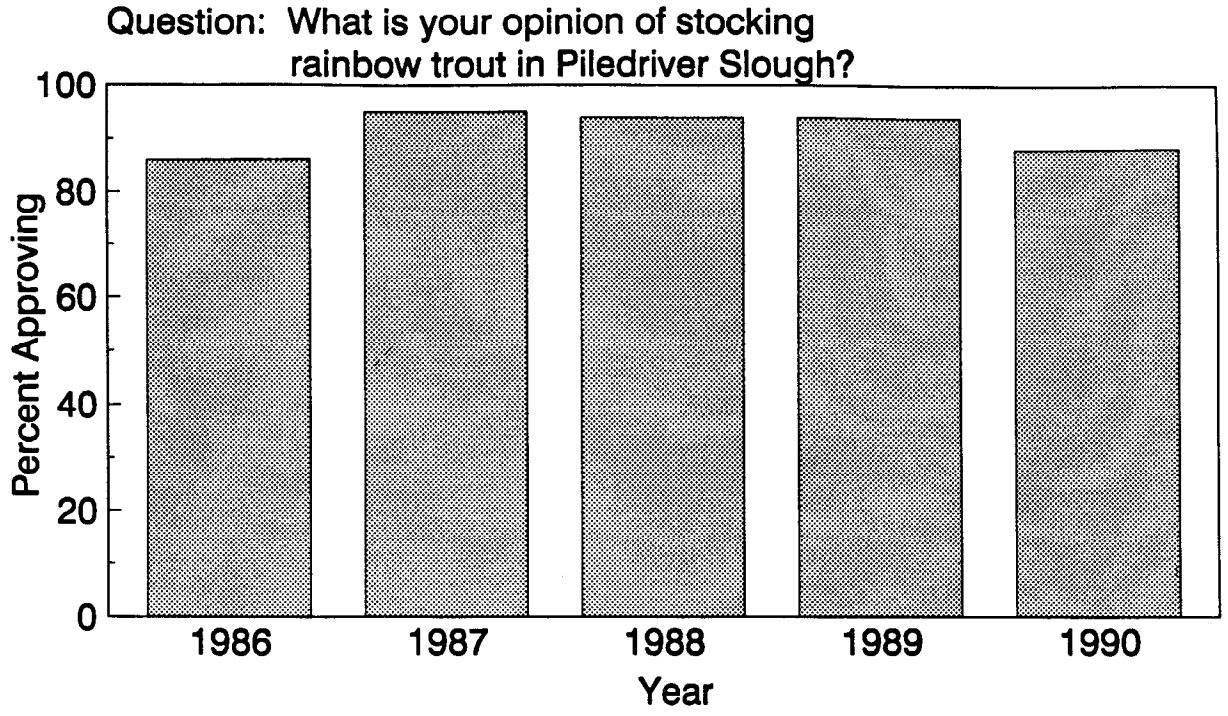
	Angler Interviews			CPUE			HPUE		
Date	C[d]	I[e]	Total	Mean	SE	CV	Mean	SE	CV
4/25-5/31/87	25	404	429	0.54	0.25	-	0.16	0.10	-
6/01-6/30/87	28	249	277	3.36	0.65	-	0.98	0.27	-
7/01-7/31/87	21	85	106	2.62	0.52	-	1.04	0.26	-
8/01-8/31/87	8	39	47	0.34	0.22	-	0.02	0.04	-
Total 1987	82	777	859	1.55	0.43	-	0.49	0.19	-
5/16-6/03/88	4	21	25	0.00	0.00	0	0.00	0.00	0
6/04-7/01/88	27	127	154	2.03	0.74	37	0.32	0.17	53
7/02-7/29/88	9	69	78	0.43	0.37	88	0.06	0.10	171
7/30-9/09/88	15	75	90	3.13	0.69	22	0.84	0.48	57
Total 1988	55	292	347	1.92	0.67	35	0.39	0.28	73
5/89	169	-	169	0.41	0.15	-	0.07	0.04	-
6/89	91	-	91	0.58	0.22	-	0.21	0.09	-
7/89	111	-	111	0.18	0.05	-	0.09	0.03	-
8/89	81	-	81	1.42	1.12	-	0.17	0.15	-
Total 1989	452	-	452	0.68	0.30	-	0.15	0.05	-

[a] Catch per unit of effort (hours).
[b] Harvest per unit of effort (hours).
[c] Baker 1987, 1988; Merritt et al. 1989. Dashes indicate data unavailable.
[d] Number of interviews for completed fishing trips.
[e] Number of interviews for incomplete fishing trips.

Table 7. Responses of anglers at Piledriver Slough, 1986-1990, to three questions concerning sport fishing.

Question	Response	1986[a]		1987[b]		1988[c]		1989[d]		1990[e]	
		%	n	%	n	%	n	%	n	%	n
What is your opinion of stocking rainbow trout in Piledriver Slough?	Approve	86	85	95	560	94	235	94	441	88	717
	Dissapprove	9	9	2	13	3	8	1	7	1	5
	No Opinion	5	5	3	15	3	7	4	21	11	86
How would you rate the fishing here this year?	Excellent	45	10	8	40	16	34	6	26	1	11
	Good	50	11	53	218	42	87	31	139	41	333
	Fair	5	1	22	90	30	63	19	88	33	266
	Poor	0	0	16	65	12	25	15	68	10	80
	No Opinion[g]			-	-	-	-	29	132	15	119
What is your opinion of a no-bait restriction at Piledriver Slough?[f]	Approve			72	423	70	174	74	321	64	522
	Dissapprove			19	114	23	58	19	83	10	85
	No Opinion			9	50	7	18	7	31	25	201

[a] Clark and Ridder 1987.
[b] Baker 1988.
[c] Baker 1989.
[d] Merritt et al. 1990.
[e] Hallberg and Bingham, in press
[f] This question was not included in the 1986 creel survey.
[g] This option was not included in the 1987 and 1988 creel surveys.



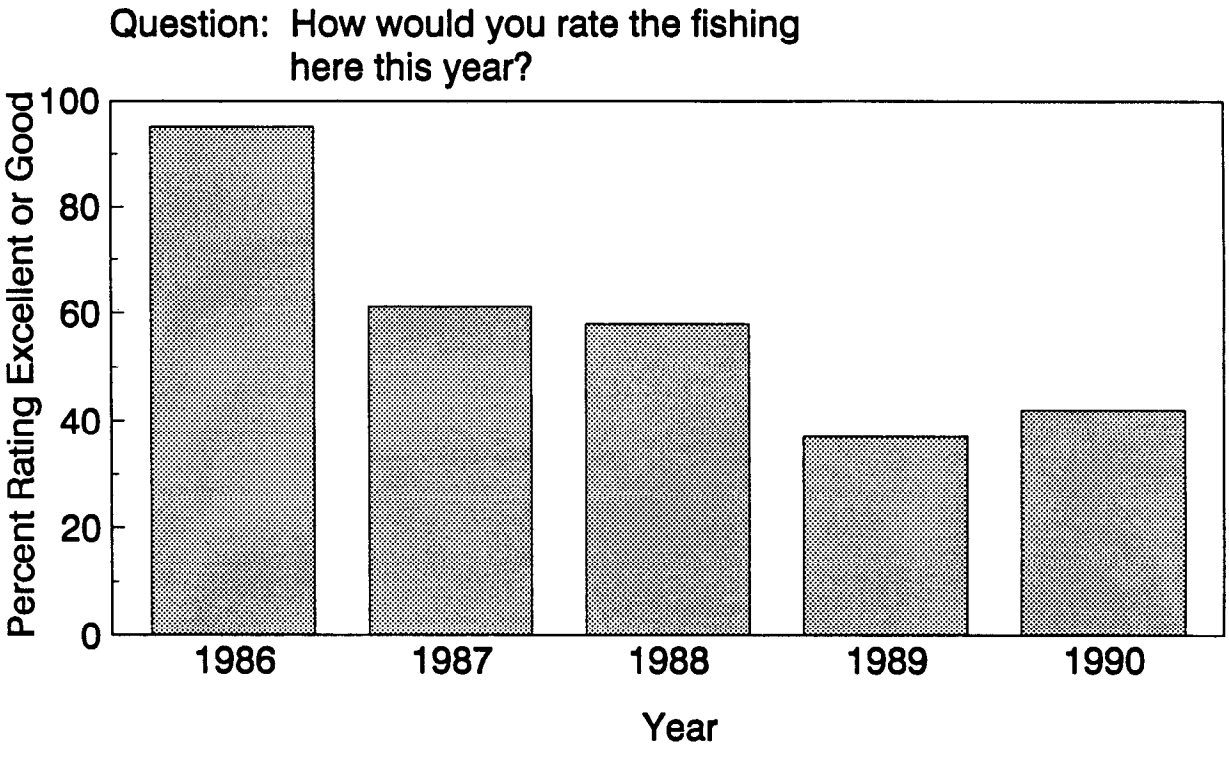


Figure 6. Opinions of anglers concerning stocking rainbow trout in Piledriver Slough, and their ratings of fishing in Piledriver Slough, 1986- 1990.

Table 8. Demographic profiles of anglers interviewed at Piledriver Slough, 1986-1990[a].

	1986[b]		1987[c]		1988[d]		1989[e]		1990[f]	
Category	n	%	n	%	n	%	n	%	n	%
Total Number of Interviews	156		878		347		532		812	
Male	141	90	764	89	302	87	469	88	718	88
Female	15	10	94	11	44	13	63	12	94	12
Adult	144	92	748	88	273	79	432	82	707	87
Youth	12	8	102	12	73	21	96	18	105	13
Resident	92	59	183	94	175	51	267	51	711	88
Non-Resident	0	0	12	6	21	6	32	6	101	12
Military[g]	89	57	428	49	150	43	222	43	396	49
Unknown	64	41	-	-	-	-	-	-	-	-
Local	126	81	399	96	175	100	358	71	-	-
Non-Local	11	7	15	4	0	0	147	29	-	-
Unknown	19	12	-	-	-	-	-	-	-	-
Tourist	2	1	14	1	6	2	50	9	41	5
Neither	65	42	436	50	-	-	-	-	-	-
Other	-	-	-	-	340	98	488	91	-	-
Gear Type:										
Spinners	31	20	390	46	146	42	223	46	-	-
Bait	44	28	30	4	11	3	18	4	-	-
Jigs	1	1	11	1	6	2	6	1	-	-
Flies	78	50	410	49	183	53	235	49	-	-
Unknown	2	1	-	-	-	-	-	-	-	-

[a] Dashes indicate data unavailable.
[b] Clark and Ridder 1987.
[c] Baker 1988.
[d] Baker 1989.
[e] Merritt et al. 1990.
[f] Hallberg and Bingham 1991, *in press*.
[g] In 1986 and 1987, the percent Military was calculated with the sum of Tourist, Military, and Neither.

determination as to whether those fish were age 0 fingerlings resulting from natural reproduction or were age 1 and potentially stocked in 1989 as 1.2 g fingerlings was inconclusive. Of the 183 rainbow trout examined for sexual maturity, 4% were gravid females, 43% were females that were not gravid, 39% were males, and the sex of 14% of the sample was indeterminable (Table 9; Figure 7).

In 1989, length distributions of rainbow trout sampled during test fishing were not significantly different from those sampled from the harvest during creel surveys (Kolmogorov-Smirnov Test; $P = 0.28$; Figure 8). Pre-stocking and post-stocking creel data were combined for that test. For 1990, statistical tests comparing the length distributions of rainbow trout sampled during test fishing to those sampled from the harvest during creel surveys were not conducted because of the small sample size for the creel survey prior to stocking ($n = 14$). However, Figure 9 shows that the minimum length of rainbow trout harvested prior to stocking was about 220 mm, while a large portion of rainbow trout captured in the test fishing was under 220 mm. Length distributions of catchables stocked in 1990 were significantly different (smaller) from the harvest after stocking (Kolmogorov-Smirnov Test; $P < 0.01$; Figure 9).

Lengths of stocking cohorts were compared to lengths in subsequent years with Kruskal-Wallis tests (Conover 1980) when sample sizes of at least 20 fish for each year were available (Table 10; Figure 10). Lengths of 1989 subcatchables were significantly larger in 1990 than in 1989 ($P = 0.02$). Lengths of 1988 catchables at stocking were not significantly different from lengths in 1989 ($P = 0.76$), but were significantly different from lengths in 1990 ($P < 0.01$). Lengths of 1989 catchables were not significantly different in 1989 and 1990 ($P = 0.07$).

In 1989, both the test fishery and the sport fishery prior to the 1989 stocking events were comprised primarily of catchables stocked the previous year (Table 11; Figure 11). In 1990 prior to stocking, 71% of the rainbow trout caught during test fishing were 1989 catchables and 14% were 1988 catchables. About 13% were subcatchables from either 1989 or 1988, and only 2% were 1989 fingerlings. All rainbow trout sampled in the sport fishery prior to the 1990 stocking event were 1988 or 1989 catchables. All rainbow trout sampled in the sport fishery in 1990 after stocking were 1990 catchables.

Fingerlings comprised 46% of the total number of rainbow trout stocked for all four years combined, but none were found in the samples from the sport fishery and very few were caught test fishing (Figure 12). Catchables, which comprised only 37% of the total rainbow trout stocked during the four year period made up almost 100% of the sport fishery, and about 80% of the test fishery.

A total of 14 rainbow trout were tagged and recaptured later (Table 12). Most recaptured rainbow trout moved little between tagging and recapture. One rainbow trout released at site 5 was recaptured almost two months later downstream at site 11. Another rainbow trout was released at Moose Creek site 3 on June 5 and recaptured on June 26 at Piledriver Slough site 11. Mean

Table 9. Sex composition of rainbow trout sampled in Piledriver Slough, 1990.

Sexual Characteristic	Percent of Total	n	SE
Unknown	13.66	25	2.55
Male	39.34	72	3.62
Females			
Not Gravid	42.62	78	3.67
Gravid	4.37	8	1.52
All Females	46.99	86	3.70
Total	100.00	183	

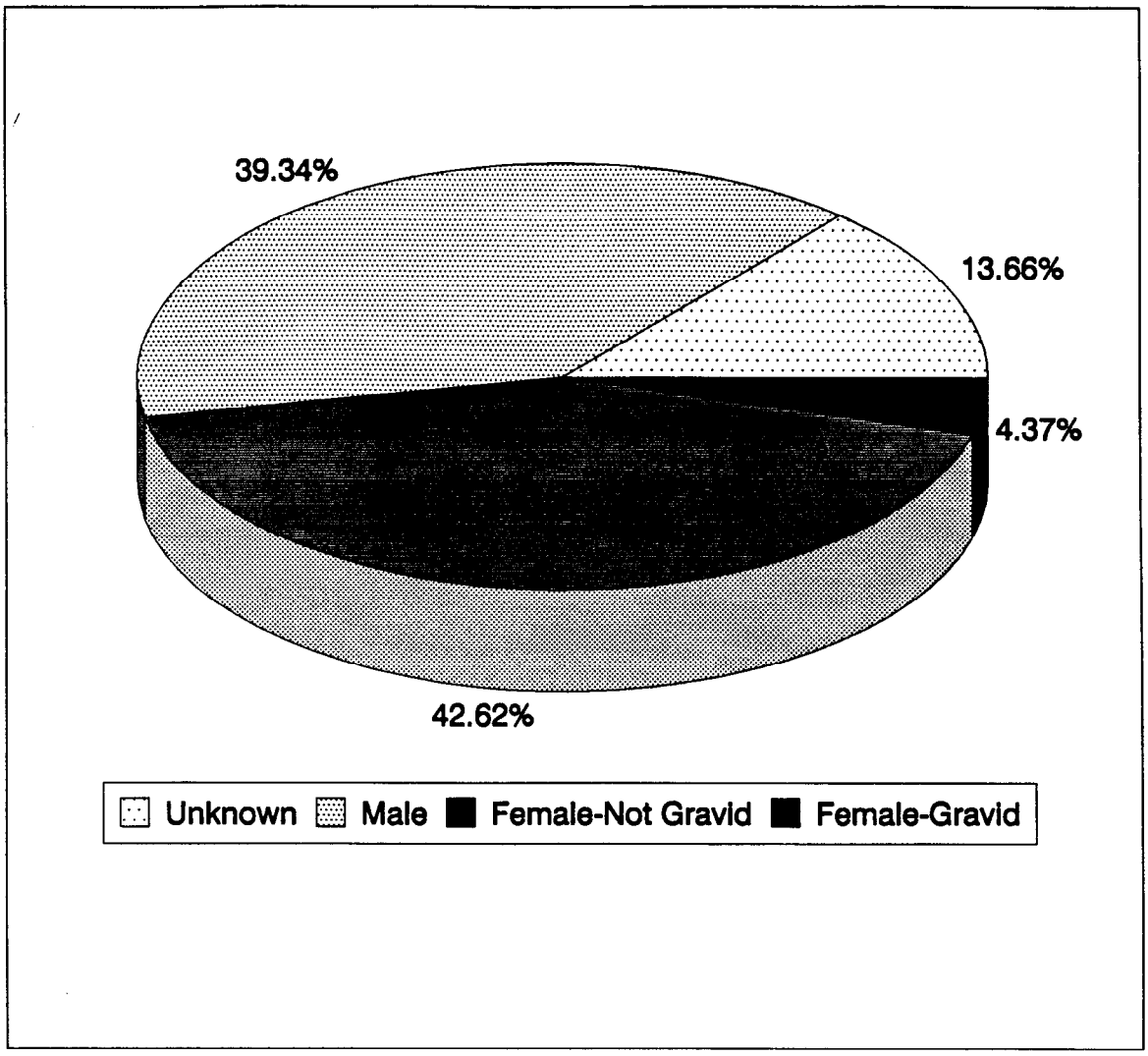


Figure 7. Sex composition of rainbow trout in Piledriver Slough, 1990.

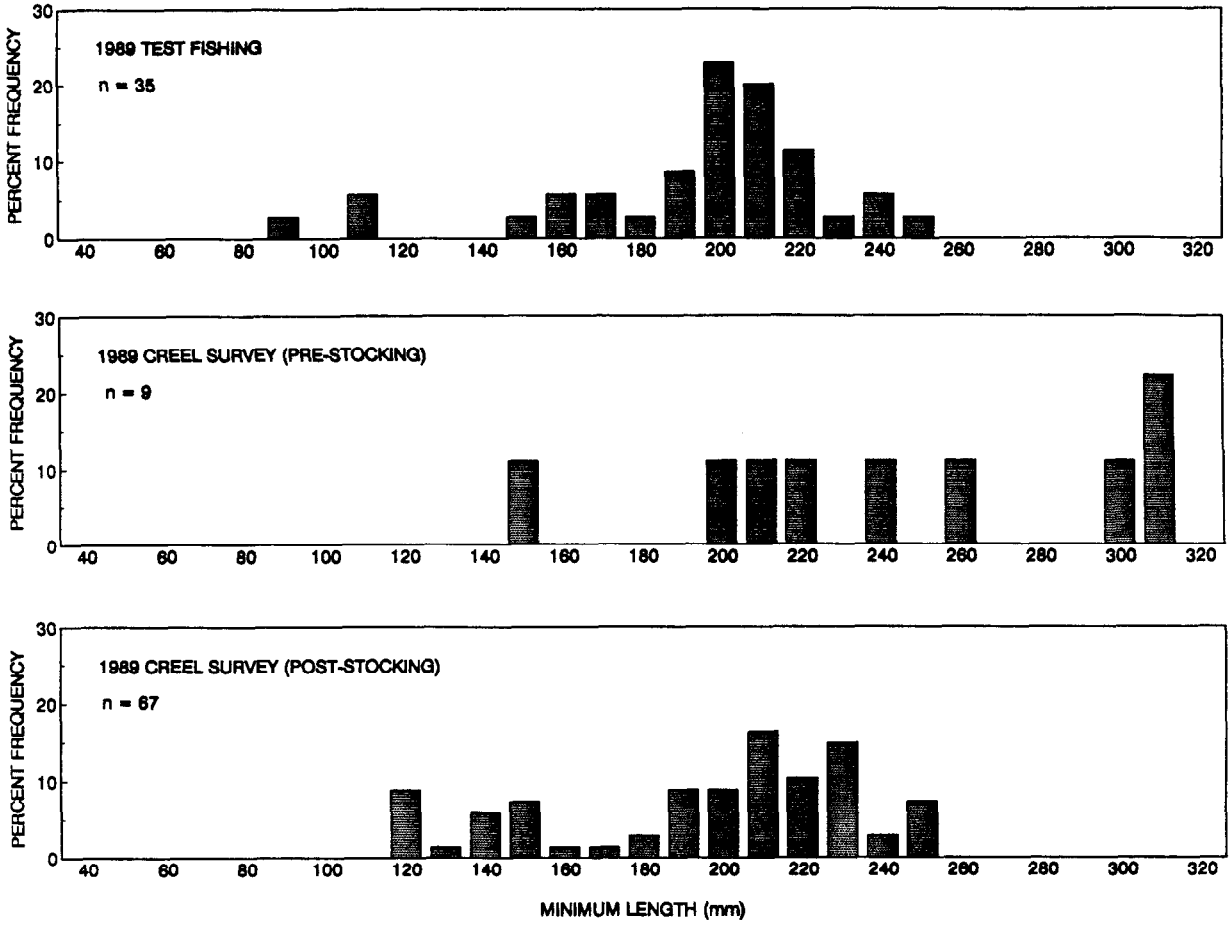


Figure 8. Length distributions of rainbow trout sampled during test fishing and creel surveys in 1989.

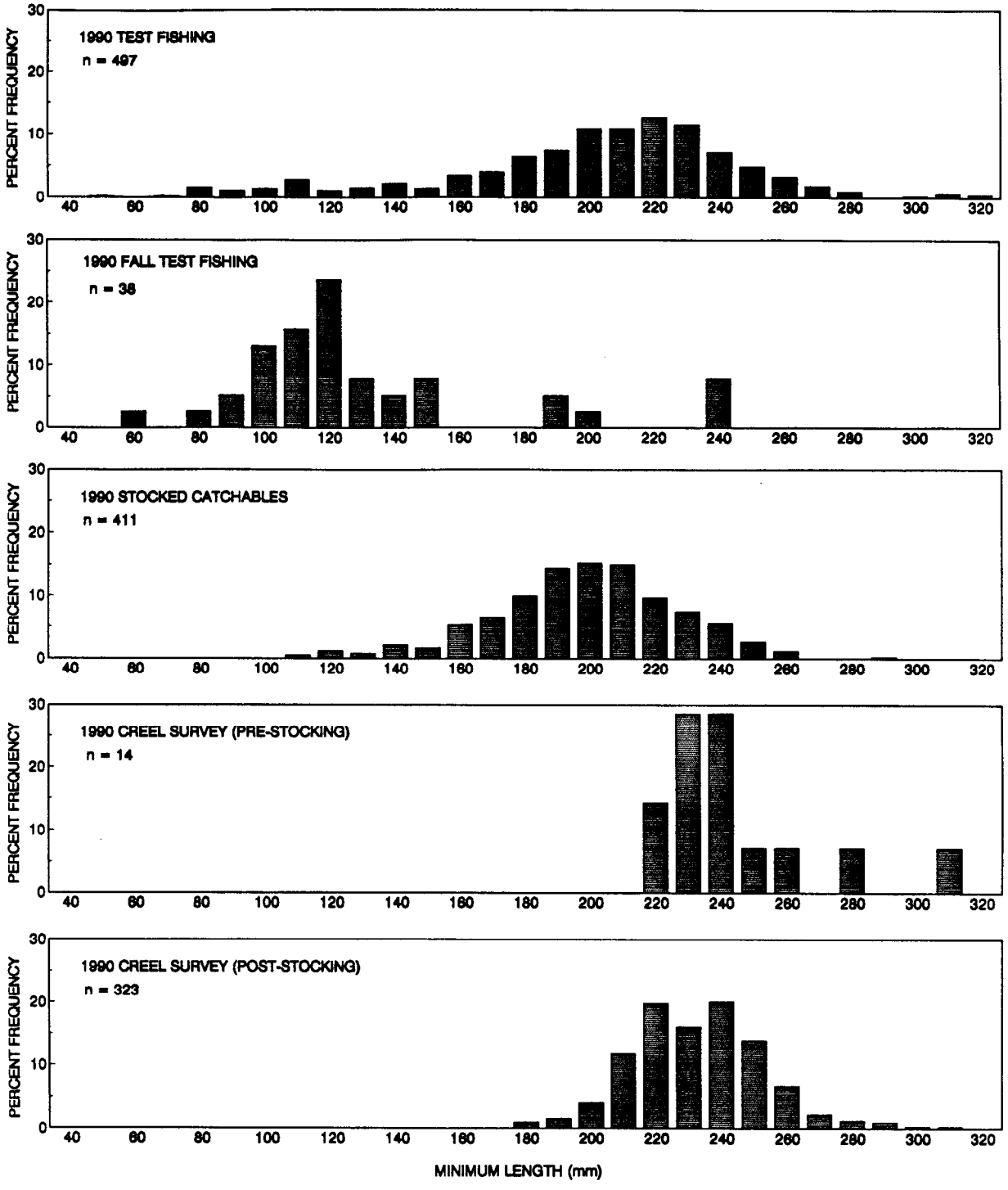


Figure 9. Length distributions of rainbow trout sampled during test fishing and creel surveys in 1990, and length distribution of catchables stocked in 1990.

Table 10. Mean lengths of rainbow trout stocked and sampled in Piledriver Slough, 1987-1990.[a]

Stocking Cohort	1987			1988			1989			1990			Fall 1990		
	Mean Length	n	SE	Mean Length	n	SE	Mean Length	n	SE	Mean Length	n	SE	Mean Length	n	SE
1987 Fingerling	60.36	50	1.21	-	0	-	-	0	-	-	0	-	-	0	-
1988 Fingerling				44.67	51	0.64	107.67	3	8.09	-	0	-	-	0	-
1989 Fingerling							47.08	100	0.42	89.60	5	3.75	100.40	10	5.70
1987 Subcatch	133.94	50	2.94	-	0	-	150.00	1	-	-	0	-	-	0	-
1988 Subcatch				127.06	50	2.74	177.17	6	8.32	173.24	17	4.79	-	0	-
1989 Subcatch							132.18	92	2.04	126.48	31	4.47	-	0	-
1987 Catchable	-	0	-	267.00	6	13.39	-	0	-	-	0	-	-	0	-
1988 Catchable				213.33	45	3.58	217.61	38	4.15	265.22	41	4.17	-	0	-
1989 Catchable							215.53	38	2.82	221.43	207	1.87	-	0	-
1990 Catchable										202.10	411	1.40	-	0	-

[a] Includes all fish with known length and stocking cohort. Catchables stocked and caught in 1988 are questionable and may include some 1988 subcatchables. Catchables stocked in 1990 were sampled at time of stocking.

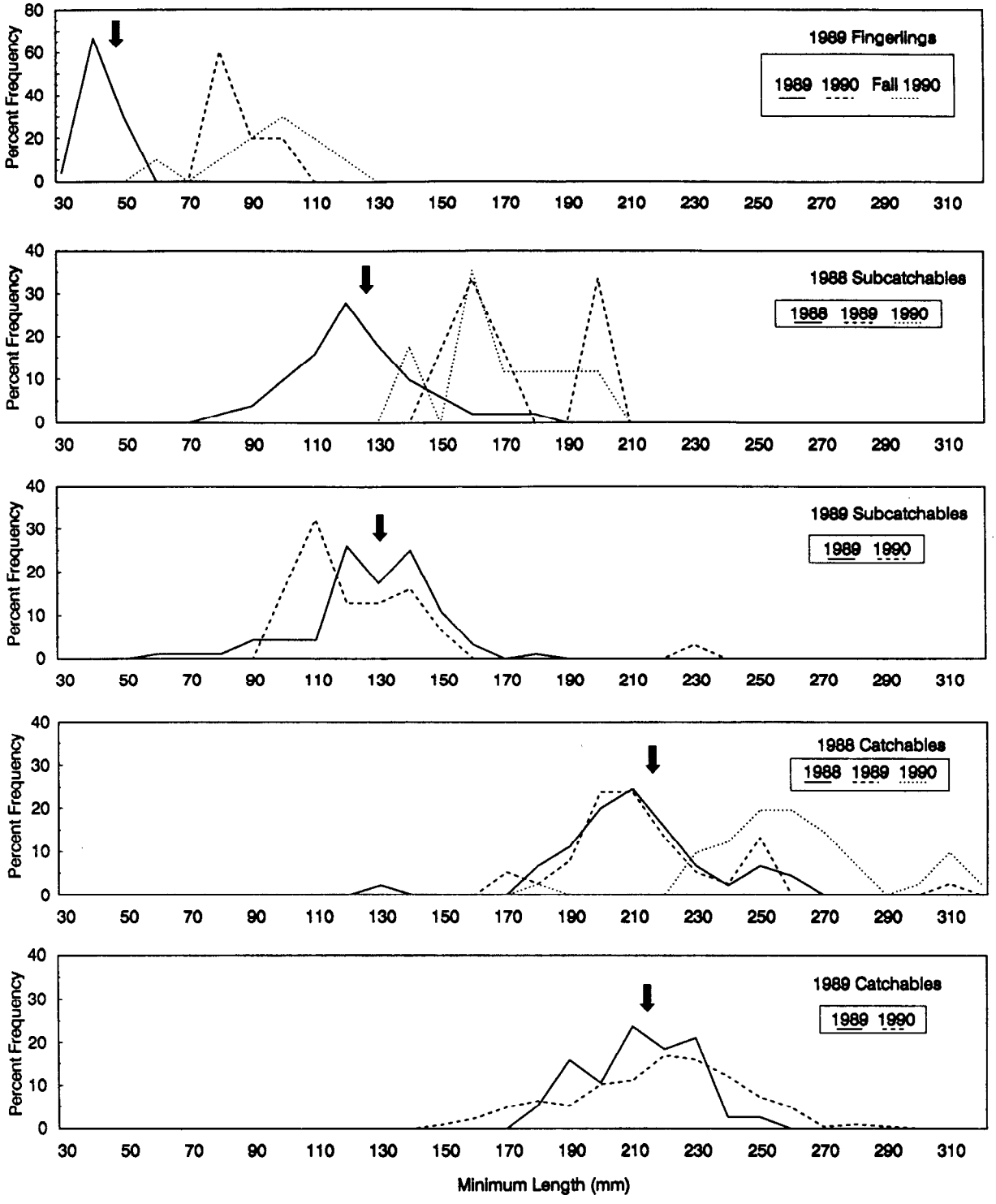


Figure 10. Length distributions of stocking cohorts at time of stocking and one and two years after stocking.

Table 11. Stocking cohort compositions for rainbow trout in Piledriver Slough, 1989 and 1990[a].

Cohort	Test Fishery			Creel Census		
	Percent	n	SE	Percent	n	SE
1989						
1987 Subcatchable	0.00	0	-	5.88	1	5.88
1987 Catchable	7.89	3	4.43	17.65	3	9.53
1988 Fingerling	10.53	4	5.05	0.00	0	-
1988 Subcatchable	13.16	5	5.56	5.88	1	5.88
1988 Catchable	68.42	26	7.64	70.59	12	11.39
Total	100.00	38		100.00	17	
1990						
1988 Subcatchable	6.83	17	1.60	0.00	0	-
1988 Catchable	14.06	35	2.21	16.22	6	6.14
1989 Fingerling	2.01	5	0.89	0.00	0	-
1989 Subcatchable	6.02	15	1.51	0.00	0	-
1989 Catchable	71.08	177	2.88	83.78	31	6.14
Total	100.00	249		100.00	37	

[a] Composition estimates are prior to stocking each year. After stocking in 1990, sampled harvest was comprised entirely of 1990 catchables.

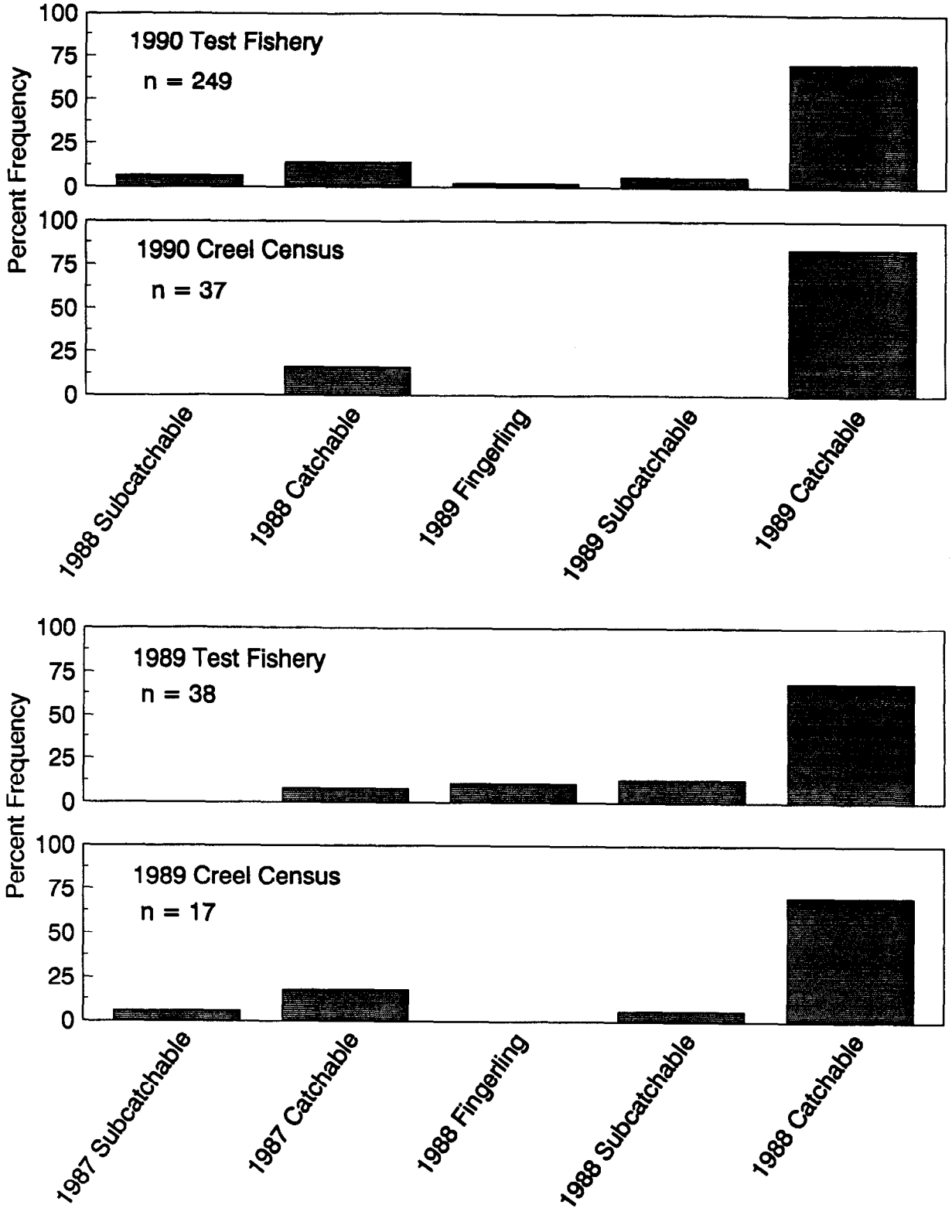


Figure 11. Contribution of stocking cohorts to test fisheries and sport fisheries prior to stocking in 1989 and 1990.

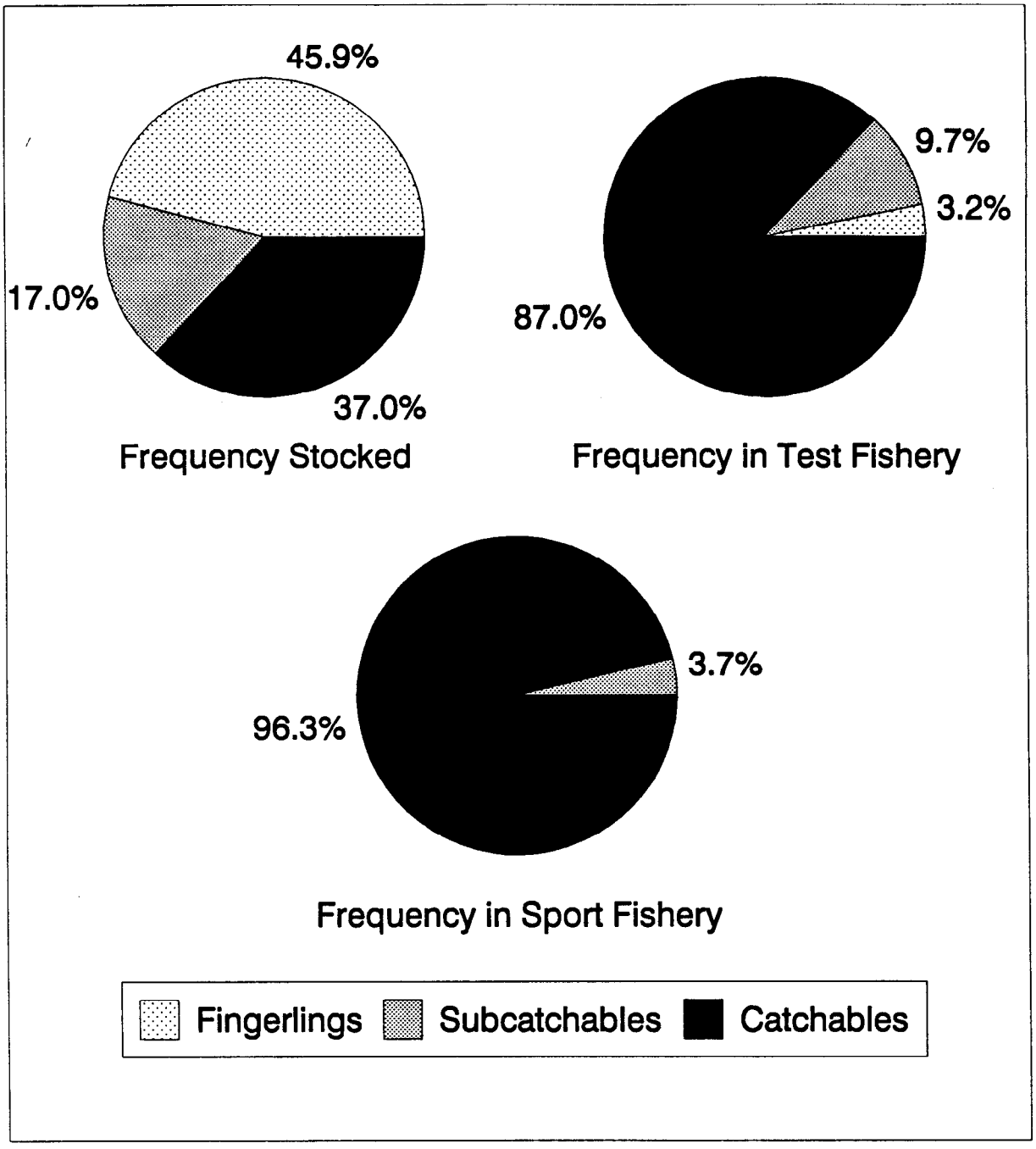


Figure 12. Composition of catches in test and sport fisheries by size group released (1987-1990 combined).

Table 12. Lengths (mm) of rainbow trout tagged and recaptured in Piledriver Slough, 1990[a].

Tag Number	Date Tagged	Area Tagged	Length at Tagging	Date Recaptured	Area of Recapture	Length at Recapture	Change in Length	Days at Large	Change per Day	Outlier[b]
80015	4/25	5	196	6/21	5	215	+19	27	0.70	no
80023	4/25	5	220	5/3	5	224	- 1	9	-0.11	no
80033	4/25	2	220	6/21	5	225	+ 5	27	0.19	no
80034	4/25	2	220	6/20	5	245	+25	26	0.96	no
80035	4/25	2	211	5/3	5	223	+12	9	1.33	yes
80186	5/2	4	175	6/21	5	185	+10	51	0.20	no
80196	5/2	4	217	6/20	5	206	-11	50	-0.22	yes
81291	5/4	5	248	6/21	5	250	+ 2	49	0.04	no
81856	6/5	303-3	212	6/26	11	217	+ 5	22	0.23	no
83724	5/4	5	210	6/20	5	226	+16	48	0.33	no
83905	5/4	5	260	6/21	5	272	+12	49	0.24	no
83935	5/4	5	232	6/26	11	248	+16	54	0.30	no
83979	5/4	5	207	6/20	5	220	+13	48	0.27	no
Mean Growth/Day - with outliers									0.34	
Mean Growth/Day - without outliers									0.30	

[a] All areas were Piledriver Slough sites, except 303-3, which was site 3, Moose Creek.

[b] The largest and smallest changes in growth per day were considered outliers.

growth per day was calculated both with and without outliers. Outliers were defined as the largest and smallest changes in growth. Mean growth per day including outliers was 0.34 mm. Disregarding outliers, mean growth per day was 0.30 mm, so with a total growing season of about 120 days, rainbow trout in Piledriver Slough would likely grow about 36 mm per year.

Water temperatures of the sample areas are documented in Appendix E.

Stocking Level

Fishing effort (days fished) at Piledriver Slough was regressed against numbers of catchable rainbow trout stocked. Estimates of effort expressed as days fished per year were available for six years, from 1984 through 1989. The first three years provided estimates of effort before rainbow trout stocking occurred. Based on a linear regression, there was a significant positive relationship between fishing effort and number of catchable rainbow trout stocked per year ($P < 0.01$; $R^2 = 0.99$; Figure 13). The intercept was estimated to be 3,280 (SE = 527; $P < 0.01$) and the slope was estimated to be 0.78 (SE = 0.03; $P < 0.01$).

Stocking Frequency

Percent frequency of anglers rating the quality of fishing as excellent or good leveled off at a catch of three rainbow trout per completed fishing trip in excess of 0.99 hours. Using a catch of at least three rainbow trout as the definition of a "successful" fishing experience, a success rate averaging about 40% was maintained for three to four weeks after stocking of catchables occurred (Figure 14).

Stocking Location

The proportion of successful anglers (p_i) prior to fish release in 1990 was low (0.00 to 0.02) and did not significantly vary among locations (Eielson Farm Rd., Bailey Bridge Rd., and Stringer Rd.). After stocking (June 26 to July 31), the proportion of successful anglers increased. No significant differences were detected between p_i at Bailey Bridge Rd. (0.68) and the two other locations. There was a significant difference in p_i between Stringer Rd. (0.48) and Eielson Farm Rd. (0.32; two-sample t test, $0.01 < p < 0.05$), attributable to the number of fish released at each location. Large numbers of fish were released in an area of relatively low fishing pressure (Stringer Rd.), so that angler success was improved in that area. The potential number of samples at Stringer Rd. (m_i) was estimated to be only 25 (low fishing pressure) while those at Eielson Farm Rd. were estimated at 259.

DISCUSSION

Fish stockings have been evaluated using factors such as harvest, survival, growth, movement, natural reproduction (Fay and Pardue 1986; McMullin and Dotson 1988), and impact on indigenous species (Fausch 1988), but few studies in the literature have evaluated the overall success of stocking programs. In this study, a number of complex and inter-related indicators such as rainbow

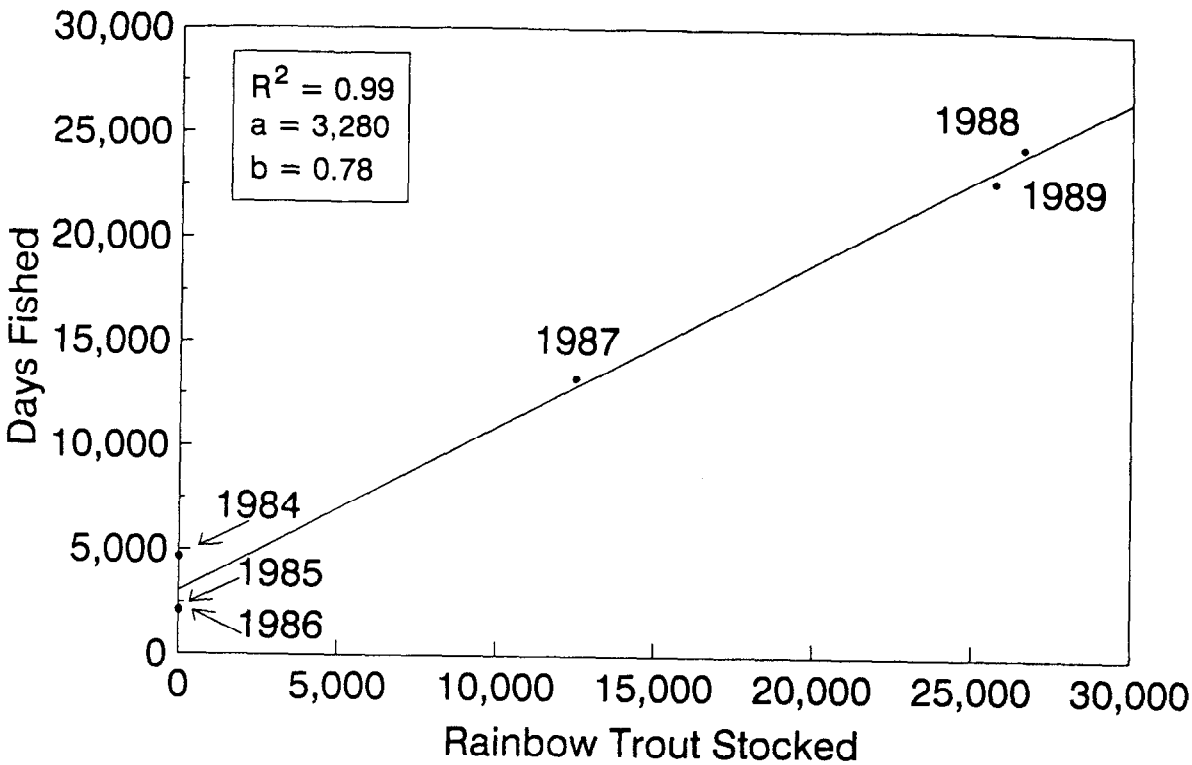


Figure 13. Relationship between number of catchable sized rainbow trout stocked, and number of angler days of fishing effort at Piledriver Slough, 1984-1989.

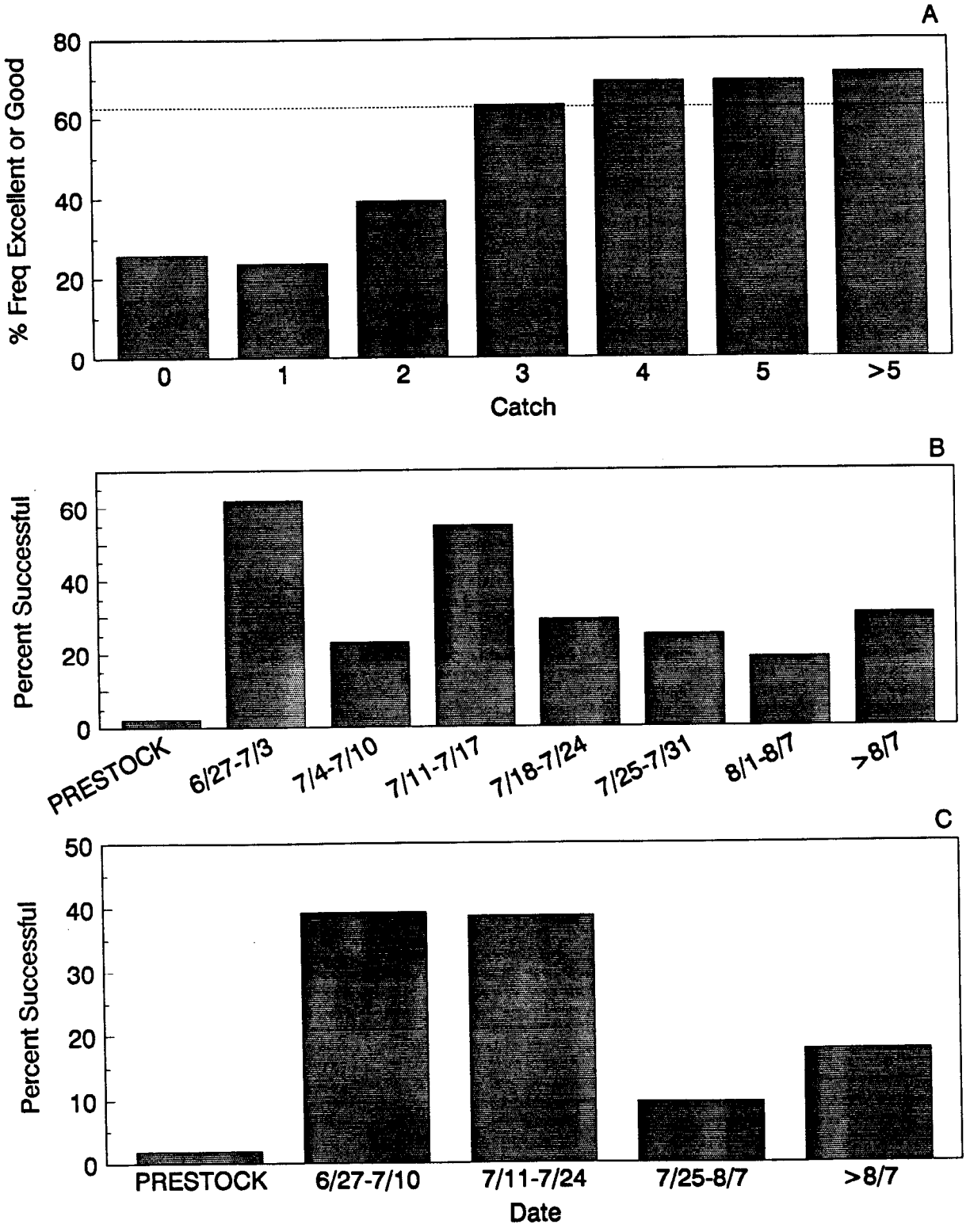


Figure 14. Determination of optimal stocking frequency at Piledriver Slough from data collected in 1990. A. Percent of anglers catching various numbers of rainbow trout who rate the fishing as excellent or good. Dotted line indicates cut-off point for "successful" anglers. B. Percent of anglers who were "successful" before stocking and during weekly intervals after stocking C. Percent of anglers who were "successful" before stocking and during 14 day intervals after stocking.

trout harvest and angler effort, angler satisfaction, angler approval, costs of stockings, growth and survival, movement, natural reproduction, and impact on indigenous species were examined individually, although the inter-relationship of these factors was beyond the scope of this study. Some of these indicators are directly measurable for the Piledriver Slough rainbow trout stocking program, others can be inferred, and for some, conclusive data are not yet available. Because interpretation of these indicators depends on the type of sport fishery that is desired, final conclusions and judgements as to success or failure of the stocking program will vary depending on the goals of the Piledriver Slough stocking program.

Harvest and Effort

For Piledriver Slough, the most readily available indicators of success are consumptive harvest and fishing effort. A fishery was created almost overnight by stocking rainbow trout in Piledriver Slough. Prior to the stocking program, fishing effort and harvest of fish at Piledriver Slough were relatively negligible. Days fished at Piledriver Slough increased twelve-fold with the initiation of the stocking program, ranging from 2,079 in 1986 to 24,375 in 1988. Despite its small size (only about 32 km long), by 1988 Piledriver Slough absorbed almost 16% of the consumptive harvest of rainbow trout and 14% of the fishing effort expended in the Tanana River drainage, making it the most popular stocked water in interior Alaska in terms of angler days of fishing. Harvests and harvest rate of rainbow trout do provide a minimum indication of the total benefits derived from the stocking of rainbow trout. Catch rate is typically 3 to 5 fold harvest rate because of the high level of self imposed catch and release fishing for rainbow trout that occurs at Piledriver Slough.

Estimates of CPUE for Piledriver Slough compare favorably to CPUEs of 0.30 and 0.28 for Quartz Lake in 1986 and 1987, 0.93 for Chena Lake in 1986, and 0.16 for Birch Lake in 1986 (Table 13; Clark and Ridder 1987; Baker 1988). Decreases in effort, harvest, and CPUE at Piledriver Slough in 1989 were due perhaps to differences in the method of stocking or to differences in the number of rainbow trout stocked.

Angler Satisfaction and Approval

Angler satisfaction and approval can also be used to gauge success of the stocking program at Piledriver Slough. Percent of anglers rating the fishing as excellent or good decreased from the year before the program began, when 95% of the respondents rated the fishing as excellent or good. Perhaps as the popularity of the Piledriver Slough fishery increased, anglers became dissatisfied with other non-consumptive aspects of this fishery. Viavant and Clark (1990) reported that motivations not directly involving the catching of fish, such as enjoying nature and enjoying family and friends, accounted for almost 70% of anglers' primary motivation for fishing in the Tanana River drainage. Compared to other fisheries close to Fairbanks, anglers were moderately satisfied with the fishing at Piledriver Slough. In creel surveys in 1986, 48%, 73%, and 26% of anglers surveyed at Quartz, Chena, and Birch Lakes, respectively, rated the fishing as excellent or good (Table 13; Clark and Ridder 1987).

Table 13. Percent of anglers rating fishing as excellent or good, and estimates of CPUE and HPUE, for Piledriver Slough, Quartz Lake, Chena Lake, and Birch Lake[a].

Water Body	Quality of Fishing (Excellent or Good)	Rainbow Trout CPUE[b]	Rainbow Trout HPUE[c]
Piledriver Slough			
1986	95%	-	-
1987	63%	1.55	0.49
1988	58%	1.91	0.39
1989	37%	0.68	0.15
Quartz Lake			
1986	48%	0.30	-
1987	49%	0.28	0.16
Chena Lake			
1986	73%	0.93	-
Birch Lake			
1986	26%	0.16	-

[a] Clark and Ridder 1987; Baker 1988, 1989; Merritt et. al 1990.
[b] Catch per unit of effort (hours fished).
[c] Harvest per unit of effort (hours fished).

Use of angler satisfaction as a measure of success for the rainbow trout stocking program is not totally adequate. Angler satisfaction as a measure of success is confounded because significant numbers of Arctic grayling are taken simultaneously with rainbow trout. In the creel survey, anglers were not asked to distinguish between their ratings of the rainbow trout aspect of the fishery and their ratings of the Arctic grayling aspect of the fishery. In addition, anglers were asked to rate fishing for the entire year at Piledriver Slough, rather than for each fishing trip.

A high level of approval for stocking rainbow trout in Piledriver Slough has been maintained throughout the four years of the experiment. Even before the experiment began, anglers approved of stocking rainbow trout in Piledriver Slough, and anglers in the interior have historically supported stocking programs in general, and rainbow trout stocking in particular.

Costs of Stocking

Rainbow trout stocked as fingerlings and subcatchables did not contribute significantly to the sport fishery at Piledriver Slough. Therefore, stocking these sizes is not cost effective, even though cost per individual is cheaper for fingerlings and subcatchables than for catchables. Benefits of the stockings included harvest of rainbow trout and increased effort (days fished) at Piledriver Slough.

Growth and Survival of Stocked Rainbow Trout

Growth demonstrated by rainbow trout stocked in Piledriver Slough has generally been meager. Mean growth of tagged rainbow trout was only 0.30 mm per day (about 36 mm per year), compared to a minimum estimate of 0.6 mm per day (about 72 mm per year) for subcatchable rainbow trout stocked in Birch Lake in 1988 (Doxey 1989). Lengths of catchable cohorts at stocking in Piledriver Slough were not significantly different from lengths one year later, although the insignificance could be attributed to size-selectivity of the harvest.

Few holdover rainbow trout from previous years were found in Piledriver Slough during spring sampling in 1990, probably due to high fishing mortality, direct and indirect mortality caused by catch and release, or high natural mortality. Direct fishing mortality has removed a large portion of the rainbow trout stocked each year in Piledriver Slough. In the first three years of the program, anglers directly harvested 30-46% of the catchable rainbow trout stocked in the slough. Incidental mortality due to catch and release practices is unknown but is probably significant. High natural mortality during the winter probably occurred to the population of rainbow trout remaining in the slough following the open water fishery. Open water can be found in parts of the slough during the winter, but the slough probably becomes intermittent in areas, creating unfavorable conditions such as crowding and low dissolved oxygen.

Natural Reproduction and Impact on Indigenous Species

Data collected to date do not indicate that successful spawning of rainbow trout in Piledriver Slough has occurred, but neither can it be entirely dismissed at this time. In areas where rainbow trout have been stocked for many years, naturally reproducing populations have become well-established (Vincent 1987; Larson and Moore 1985; Dumont et al. 1988). Rose (1986) found a significant decline in sub-yearling brook trout after the emergence of rainbow trout larvae in early summer, which he felt could be a mechanism by which brook trout are excluded by rainbow trout. Therefore, monitoring of Piledriver Slough for evidence of successful spawning by rainbow trout should continue.

Concerns about the stocking program at Piledriver Slough have centered primarily around competition with indigenous species, especially Arctic grayling. Data concerning direct competition between rainbow trout and Arctic grayling for space, food, and other necessities in Piledriver Slough are unavailable. However, riverine stocking of rainbow trout was shown to have profound negative effects on populations of wild brown trout *Salmo trutta* and wild rainbow trout in Montana (Vincent 1987). Both biomass and abundance of the wild brown trout increased dramatically after cessation of a stocking program, and decreased with the initiation of a stocking program. In another study, Moore et al. (1983) attempted to eradicate exotic rainbow trout from selected streams in the Great Smokey Mountains National Park (Tennessee). Although the rainbow trout were not entirely eliminated from the study streams, the standing crop of native brook trout *Salvelinus fontinalis* increased after major reductions of the rainbow trout populations.

The potential spread of stocked rainbow trout from Piledriver Slough into other Yukon drainage river systems is another legitimate concern, because historically productive systems, such as the Chena River, containing wild stocks of Arctic grayling, chinook salmon, and other species are nearby. In this study, 46 rainbow trout were captured in Moose Creek, French Creek, and Garrison Slough, although those fish could have been transported there by the public during stocking. Larson and Moore (1985) concluded that their study supported the hypothesis that the decline of native brook trout in the Appalachian Mountains was caused by the encroachment of exotic rainbow trout into brook trout range. Dumont et al. (1988) reviewed the spread of introduced rainbow trout in watersheds of the Saint-Laurent River, Quebec, and urged the implementation of an international code of practice for regulating the introduction of fishes into river systems. Although there have been no documented cases of Piledriver Slough rainbow trout being caught in other systems, the movement of rainbow trout out of Piledriver Slough is a potential problem, especially if stockings continue for many years.

The stocking program at Piledriver Slough has impacted the Arctic grayling population because of the massive increase in fishing effort with its resultant increase in the harvest of Arctic grayling since 1987. In 1987, the first year of the stocking program, the harvest of Arctic grayling was 4,907, more than double the harvest of 2,312 for the preceding year (Mills 1988; Mills unpublished data). In 1988, the harvest of Arctic grayling nearly doubled again to a level of 8,095 fish (Mills 1989).

In 1991, triploid (sterile) rainbow trout will be available for stocking in interior Alaska for the first time. Because stocking sterile rainbow trout will address some of the concerns associated with the Piledriver Slough stocking program, only triploid rainbow trout will be stocked in Piledriver Slough in 1991.

Stocking Strategy

If the rainbow trout stocking program at Piledriver Slough is continued, the size, density, and frequency, and locations at which rainbow trout are to be stocked must be determined.

Size:

Results of this evaluation clearly indicate that only catchable rainbow trout should be stocked in Piledriver Slough in the future. Growth and survival of stocked rainbow trout is inadequate to assure that stocked fingerling or subcatchable rainbow trout will contribute significantly to the fishery.

Stocking Level:

If managers decide to continue the rainbow trout stocking program at Piledriver Slough, they may wish to predict the level of fishing effort that will be generated for a given level of stocking. The statistical relationship between angler days of effort and number of catchable rainbow trout stocked annually in Piledriver Slough was very good. However, only three non-zero levels of stocking were available. Increasing stocking level corresponded to a time trend and also to increasing effort over the whole Tanana drainage, confounding the relationship between effort and number of catchable rainbow trout stocked. However, the decrease in effort in 1989, which corresponded to a decrease in number of catchable rainbow trout stocked, is encouraging for the use of this relationship.

Although the linear regression fit very well for the available stocking levels, at some stocking level effort will level off, and increasing the number of fish stocked would result in a negligible increase in effort. Thus, the relationship between effort and number of fish stocked is likely asymptotic rather than linear. To fully describe the relationship, more data are necessary. In 1990, 20,000 catchable rainbow trout were stocked, providing valuable data between the 1987 stocking level and the 1989 stocking level. Although the stocking level is already set at 20,000 for 1991, a higher level in 1992 would provide valuable information on the true shape of the regression line.

Frequency:

Total fishing effort for the year may be satisfactory to gauge the overall success of the Piledriver Slough stocking program, but managers may wish to exert some control over the nature of the fishery that results at Piledriver Slough. For example, the rainbow trout available for stocking at Piledriver Slough each year can be stocked all at one time in one location, at several

times at one location, one time at several locations, or several times at several locations. Stocking the rainbow trout at one time results in a "boom-and-bust" fishery, with most of the effort being expended in a short period of time. Based on the analysis of angler ratings of the fishery, catch, and date, a single stocking maintained a high level of "successful" anglers for three to four weeks. This information was derived from lumping data collected among locations, and sampling was not proportional among locations. Because sampling was not proportional, and all data were lumped, bias may have influenced the percent of angler success, as presented in Figure 13. The dip in angler success during the second week after stocking may be due to bias, and if so, the argument for sustained angler success after stocking is strengthened.

By spreading the stocking program out over the summer, managers will avoid a "boom-and-bust" fishery. Stocking rainbow trout in May or early June would also help to lengthen the fishery, but could increase harvest rate on spawning Arctic grayling. Rewording the creel survey question on rating of the quality of the fishing to specify the rainbow trout aspect of the fishery and the specific fishing trip could improve the analysis.

Locations:

Releasing large numbers of fish in areas of relatively low fishing pressure will improve the success of the few anglers in that area. In contrast, releasing fish in proportion to the number of angler-trips will maximize the chance that at least 40% of the angler-trips have successful anglers. Proportional release of rainbow trout among areas would also minimize any bias encountered by sampling at only one location along Piledriver Slough.

RECOMMENDATIONS

Fausch (1988) criticized fisheries biologists for the lack of rigorous experiments to determine conclusively the effects of stocking exotic fish species into streams inhabited by native salmonoids. He stressed the importance of manipulative experiments, replicates, and the choice of an appropriate response variable. His comments are especially apropos because one of his case studies involved the introduction of rainbow trout into streams similar to Piledriver Slough. The Piledriver Slough program offers a unique opportunity to evaluate the effects of stocking rainbow trout, both on the fishery and on the indigenous Arctic grayling population.

Based on the results of this study and needs for future studies, below are specific recommendations for the stocking program at Piledriver Slough.

Stocking

1. Stock only catchables.
2. Stock several times during the summer.
3. Stock at several locations.
4. Stock triploids.

Evaluation

1. Minnow trap in spring 1991 to determine if fingerlings from natural reproduction are present.
2. Stock at a higher level in 1992 to provide better estimates of the relationship between stocking level and fishing effort.
3. Estimate survival of 1990 catchables (from stocking to spring 1991).
4. Continue monitoring the stock status of Arctic grayling in Piledriver Slough.
5. Following recommendations of Fausch (1988), design a long-term, controlled experiment to study the effects of stocking rainbow trout on Arctic grayling.

ACKNOWLEDGEMENTS

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APPENDIX A

State Fish Transport Permit for stocking rainbow trout in Piledriver Slough.

Applicant name	Organization
Ak Dept. Fish & Game/Sport Fish Div	
Mailing Address	**Phone** / **Species**
1300 College Road	456-8819 / Rainbow Trout
Stock Origin	**Proposed Stocking Location**
	Piledriver Slough

Project summary - Summary statement of precisely what is being proposed.

Stock rainbow trout in Piledriver Slough on an experimental basis.

For Department Use Only

X State Fish Transport Permit — FTP Number 86A1053

Consistent with facility/project plans — Yes____ No____

____ Private Nonprofit Hatchery Fish Transport Permit

Consistent with PNP permit — Yes____ No____

Requires Permit Alteration prior to review — Yes____ No____

Continuation of project — Yes____ No____

New Project — Yes____ No____

____ Other - Shellfish, Plants — Yes____ No____

Status

Forms Complete — Yes____ No____ Date _____

Disease History Complete — Yes✓ No____ Date 12/22/86

In review process — DATE 12/15/86

Returned to applicant — DATE 1/21/87

5 AAC 41.005. PERMIT REQUIRED. (a) No person may transport, possess, export from the state, or release into the waters of the state, any live fish unless the person holds a fish transport permit issued by the Commissioner or his authorized designee.

The Fish Transport Permit (FTP) is the single document, approved by the Commissioner of Alaska Department of Fish and Game (ADF&G), that allows for movements of fish and eggs on an interstate and intrastate basis.

STAFF RECOMMENDATIONS

SIGNATURE PAGE PERMIT No. 86A1053

	Agree	Disagree	Date	Comments Provided Yes	No
1. Regional Program Manager - FRED					
Signature [signature]	X		12-15-86		X
Incomplete:					
2. Fish Health Services Pathologist - FRED					
[signature]	✓		12/22/86	✓	
Incomplete:					
3. Principal Geneticist - FRED					
[signature]	✓		12/29/86		a
4. Regional Supervisor - Comm Fish					
[signature]	X		1-7-87	✓	
5. Regional Supervisor - Sport Fish					
[signature] 11/24/86	X				X
6. Principal Biologist - FRED					
[signature]	✓		1-7-87		
7. Chief-Technology and Development - FRED					
[signature]	✓		1/13/87		
8. Director - FRED					
[signature]	✓		1-16-87		✓

	Approval	Disapproval	Date
9. Commissioner			
[signature]	✓		1/20/87

COMMENT SHEET PERMIT NO. 86A1053

2. Fish Health Services Pathologist - FRED

Comments

Agree

The Swanson River rainbow trout stock has had a colorful disease history involving both IHN and A sal at Elmendorf and A sal at Fort Rich. However, since the redesign of Fort Rich and return to the original wild broodsource, the stock at this facility has not had any major pathogens detected.

Signature Theodore R Meyers

Date 12/22/86

Phone 465-4160

COMMENT SHEET PERMIT NO. 86AD53

4. **Regional Supervisor - Comm Fish**

Comments

Small numbers of chinook and chum salmon have been observed spawning in Piledriver Slough. There exists the possibility that interspecific competition, predation or disease transmission between wild salmon stocks and introduced rainbow trout. There was no mention of other native salmon species utilization of this slough or evaluation of potential impacts of an introduction of a nonindigenous species into the Yukon R. drainag

Signature Richard C. Randall

Date 1-7-87

Phone 344-0541

COMMENT SHEET PERMIT NO. 86A1053

5. **Regional Supervisor** - Sport Fish

Comments

Signature QL + el

Date 11/24/86

Phone 456-7817

FISH TRANSPORT PERMIT

Permit No. 86A1053

Applicant/Organization: ADF&G/Sport Fish Date: 8/26/86

Project Leader: John Clark Telephone No. 456-8819

Effective Period: 1987-1992 Species: RT

Transport Date(s): 1987

Stock Origin: Swanson R. (FT Rich broodstock)

Maximal Number Allowed: 300,000

Incubation & Rearing Location(s): FRED Division Hatcheries

Release Location: Piledriver Slough

Purpose and Benefits: To provide a more diverse sport fishing opportunity in a stream accessible from the road system near populated areas.

Evaluation Plans: Evaluation will be ongoing using standard Sport Fish Division techniques.

Is release site landlocked? No

Native Stocks present, their status, and effects of the proposed action on them: Grayling, whitefish, suckers. Piledriver Slough used to be a slough of the glacial Tanana River. When the Chena River Flood Control structure was built, the slough was blocked off from the Tanana River by the Corps. of Engineers (approx. 19). The slough is now fed by groundwater and is a clearwater stream. Fish have gradual made their way into the slough the past few years and now has a fishable population grayling. No detrimental effects are expected by stocking RT in the slough. This an experiment and we will monitor it closely.

History of previous transports of this stock: 86A1053

Disease history of stock to be transported: On file in Pathology Section

Description of proposed egg take methods: Standard

Isolation measures planned to control disease during transport, including description of container, water source, and method and plan for transport:

Standard

Source of water for rearing and proposed effluent discharge location:

FT Richardson

86A1053

PURPOSE & BENEFITS

There is a rapidly growing public demand for diversified recreational fishing opportunities in the Tanana River drainage in interior Alaska. In recent years, the responsibilities of the Alaska Department of Fish and Game, to maintain and protect the fishery resources, have become increasingly complex. The magnitude of current angling demand is illustrated by the Alaska Statewide Sport Fish Harvest Studies, which indicates that 335,608 anglers fished 1,866,837 days in 1984. In the Arctic-Yukon-Kuskokwim area of the state, 26,845 anglers fished 199,041 days. Approximately 73% of this fishing pressure occurred in the Tanana River drainage. The Statewide Harvest Study has further shown that both Alaskan and nonresident anglers prefer rainbow trout over other resident species. Approximately 182,300 rainbow trout were harvested from Alaskan waters in 1984 with Tanana River drainage stocked lakes producing nearly 34,000 of these fish. The 1984 rainbow trout harvest for Tanana River drainage represented a 500% increase from the 1977 harvest. It is important to note that hatchery produced fish comprised the harvest. There are currently no resident rainbow trout in streams in the Tanana River drainage. Anglers fishing Piledriver Slough were asked if they would favor stocking rainbow trout in Piledriver and out of 99 asked 85 said yes. During the 1986 summer creel census of the upper Chena River, 216 anglers were asked if they would support stocking rainbow trout in the upper Chena and 81% (174) said yes. To date, we have received public support for stocking rainbow trout in streams from J.D. Pett, Goodpaster River property owner's assoc., Fbks chapter of Trout Unlimited, Tanana Valley Sportsmen's Assoc. and the Borealis Kiwanis Club, as well as a number of private individuals who have expressed support for stocking rainbows in streams over the past 10 years. The Salcha River property owners assoc. had mixed feelings about the idea.

Table 1. Rainbow Trout Sport Harvest from the Statewide Harvest Studies for interior Alaska, 1977-1984.

Location	Year							
	1977	1978	1979	1980	1981	1982	1983	1984
Arctic-Yukon-Kuskokwim								
Tanana River Drainage	5,992	6,406	5,186	19,584	24,571	26,186	20,664	34,022
Interior Alaska	223	362	401	835	982	796	1,783	1,442
Seward Peninsula-Norton Sound	0	0	0	0	0	0	0	0
Northwest Alaska	0	0	0	0	0	0	0	0
South Slope Brooks Range	0	0	0	0	0	0	0	0
North Slope Brooks Range	0	0	0	0	0	0	0	13
Total	6,215	6,768	5,587	20,419	25,553	26,982	22,447	35,477

APPENDIX B.

Fairbanks North Star Borough Resolution No. 87-058.

By: Ed Shellinger
Howard "Buzz" Otis
Introduced: 05/07/87
Amended: 05/07/87
Adopted: 05/07/87

RESOLUTION NO. 87-058

A RESOLUTION REQUESTING THE GOVERNORS OFFICE TO PURSUE A RAINBOW TROUT STOCKING PROGRAM IN THE FAIRBANKS AREA

WHEREAS, the State Department of Fish and Game recently has planted rainbow trout in the Piledriver Slough; and

WHEREAS, the state's annual replant at Cambell Creek which runs through downtown Anchorage, has provided a popular, accessible, recreational fishery; and

WHEREAS, the Chena River, which runs through downtown Fairbanks, offers the potential of becoming a popular recreational rainbow trout fishery for visitors and residents alike.

NOW, THEREFORE, BE IT RESOLVED that the Fairbanks North Star Borough Assembly requested the Governors Office to pursue and experimental rainbow trout stocking programs in the Chena River.

PASSED AND APPROVED THIS 7TH DAY OF MAY, 1987

Presiding Officer

ATTEST:

Clerk of the Assembly

APPENDIX C

Appendix C. Physical characteristics of Moose Creek and French Creek measured during Alyeska Pipeline surveys, 1979-1980[a].

Date	Site	DO mg/ℓ	Temp °C	Conductivity μmhos/cm	pH	Discharge m^3/s	Substrate
Moose Creek							
3/26/79	3	3.6	0.8	220	7.5	0.10	mud
6/27/79	2	7.8	10.0	145	7.7	-	mud
6/27/79	3	8.4	13.0	155	7.5	-	mud
6/28/79	1	7.2	10.0	120	7.5	-	mud
9/20/80	0	14.0	2.5	45	7.5	0.45	mud
9/24/79	1	9.2	4.5	85	7.2	-	mud
9/24/79	2	8.6	4.5	75	7.4	-	mud
9/24/79	3	8.2	4.5	125	7.5	-	mud
12/3/79	1	0.8	0.5	110	6.8	-	mud
12/3/79	3	1.0	0.0	135	6.9	0.82	mud
French Creek							
3/25/79	1	3.0	0.5	270	7.7	0	mud
3/27/79	5	3.4	0.0	435	7.5	0.02	mud
9/24/79	5	7.8	3.5	105	7.5	1.0	sand/mud
12/3/79	3	0.2	0.0	-	7.5	<0.01	mud
12/3/79	5	0.2-0.4	0.0	30	6.9	0.32	gravel/mud
12/5/79	1	0.2	0.2	-	6.8	0.27	sand/gravel

[a] Unpublished data, Division of Habitat, Alaska Department of Fish and Game 1300 College Road, Fairbanks, AK 99701.

APPENDIX D