

Fishery Data Series No. 93-49

Origin of Fishing Effort at Piledriver Slough, 1992

by

David Bernard

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November 1993

Alaska Department of Fish and Game

Division of Sport Fish



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ABSTRACT

During June and July, 1992, 209 anglers were interviewed at Piledriver Slough to estimate the source of fishing effort. Responses were used to classify fishing effort as new effort expended because of stocking rainbow trout *Oncorhynchus mykiss* (63%), base effort expended regardless of stocking (6%), or transferred effort from other fisheries (31%). Relative magnitudes of new, base, and transferred effort estimated from anglers interviewed on weekdays, on weekends, or within a day after stocking were not meaningfully different. Transferred effort came from other stocked fisheries and from fisheries on resident species. Almost none of the fishing effort at Piledriver Slough was transferred from other fisheries because of regulations imposed on those other fisheries. Fishing parties with minors were more prevalent on weekends than at other times of the week.

KEY WORDS: Piledriver Slough, diversion of effort, rainbow trout, *Oncorhynchus mykiss*, stocking, evaluation.

INTRODUCTION

Piledriver Slough is a 34 km clear stream that was established in 1976 by blocking the direct flow of the Tanana River through the slough (Figure 1). Piledriver Slough now is fed by water upwelling from the Tanana River aquifer. After the Tanana River was blocked, Arctic grayling *Thymallus arcticus* colonized the slough and a small fishery developed. Capture of tagged fish during studies of Arctic grayling stocks indicate that most of the colonizing Arctic grayling were probably from the adjoining Moose and French Creek system as well as the more distant Chena and Salcha rivers (Timmons and Clark 1991; Fleming 1991). Arctic grayling now are well established in the slough with higher densities than other assessed populations of Arctic grayling in the Tanana River drainage. Unlike other clear streams in the Tanana drainage, Arctic grayling use Piledriver Slough for both spawning and feeding.

Rainbow trout *Oncorhynchus mykiss* were first stocked into Piledriver Slough in 1987. The estimated number of anglers participating in the fishery increased from 470 in 1984 (the only year that an estimate was made prior to 1987) to 4,686 in 1987 and reached a high of 6,313 in 1990 (Mills 1981-1992; Table 1). The fishery at Piledriver Slough probably is popular because it is near major population centers, access is easy, and Arctic grayling and rainbow trout are desired by anglers. To protect the Arctic grayling population from over harvest, bait is not allowed in the fishery and Arctic grayling less than 305 mm (12 inches) cannot be kept. There are no size restrictions for rainbow trout. Catchable size rainbow trout (150 to 400 mm) now are stocked in Piledriver Slough three or four times each year from late May or early June through July. Each year, the time of first stocking depends on when ice has melted from the slough and from the access roads.

The goal of this research was to determine whether stocking rainbow trout in Piledriver Slough increased fishing effort or shifted existing effort away from resident and other stocked populations in other fisheries. The specific objectives of this study were to estimate:

1. the fraction of fishing effort at Piledriver Slough in 1992 that would have been directed on resident fish populations in other fisheries in the absence of stocking rainbow trout in Piledriver Slough (hereafter called transferred fishing effort); and,
2. the fraction of fishing effort at Piledriver Slough in 1992 that would not have been produced in the absence of stocking Piledriver Slough with rainbow trout.

Resident fish populations were defined as any indigenous population in an area that was not augmented or sustained by stocking fish from any hatchery or water body. An angler-day is the unit of fishing effort.

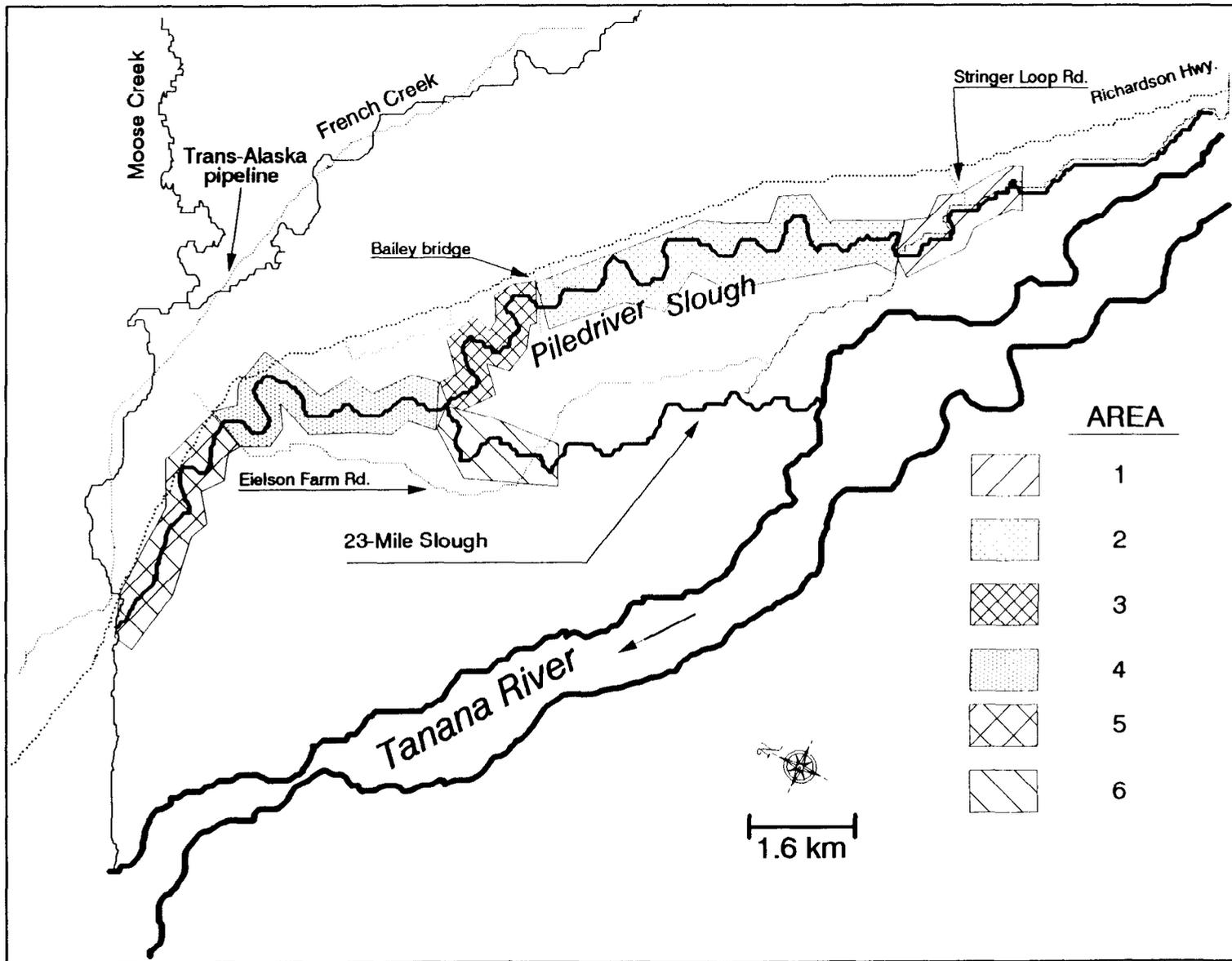


Figure 1. Map of the Piledriver Slough study area.

Table 1. Estimated numbers of anglers, trips, angler-days (days fished), and number of catchable size rainbow trout stocked and harvested in the Piledriver Slough fishery.^a

Year	Number of Anglers	Number of Trips	Days Fished	Number of Catchable Rainbow trout Stocked	Number of Rainbow trout Harvested
1980	NE		NE		
1981	NE		NE		
1982	NE		NE		
1983	NE		4,418		
1984	470	2,334	4,651		
1985	NE	3,019	NE		
1986	NE	1,870	NE		
1987	4,686	15,236	13,257	12,495	4,346
1988	4,981	21,936	24,375	26,544	12,296
1989	5,268	19,512	22,746	25,655	7,689
1990	6,313	23,024	27,705	20,000	8,052
1991	5,308	15,365	17,703	25,143	6,414

^a Mills 1981-1992.

METHODS

The fishery was sampled according to a stratified, systematic design. Each day was considered a sampling period with days grouped into three strata: weekends (Saturdays and Sundays), weekdays (Mondays through Fridays), and the day immediately after the stocking of rainbow trout. Strata were defined based on our assumption that anglers with different motivations fish at different times. For instance, families with children who are lured to Piledriver Slough by the ease of catching rainbow trout would more likely fish on weekends. Anglers who had fished Piledriver Slough prior 1987 may have done so for the solitude and now might fish during the week when participation in the fishery is lower (Hallberg and Bingham 1991). Individuals who exclusively pursue rainbow trout may be more apt to fish after the truck from the hatchery has visited the slough. If inspection of data showed that motivations of anglers did not differ across strata, data could be pooled across strata without regard to the relative amount of fishing effort expended in each stratum. An unusually late thaw and an unusually early freeze in 1992 restricted the fishery to June, July, and August. A single technician interviewed anglers during five days on weekends, four weekdays, and four days immediately after stocking rainbow trout (Tables 2 and 3). Past creel surveys (Hallberg and Bingham 1991) have shown that more anglers fish at Piledriver Slough between 1500 and 2200 h, an angler spent on average of 7 h fishing, and the majority of anglers fished near two access points (Eielson Farm Road and Bailey Bridge). The duration of our sampling period was approximately 7 h, and usually occurred between 1200-2200 h. During a sampling period the technician spent approximately 3.5 h at each access point. A sampling schedule was made using a random number generator to determine which of the two access points would be sampled first during each sampled period. The technician walked upstream and downstream of the access points to find anglers to increase sample size for the exit survey.

During an interview anglers were asked up to seven questions (Appendix A1). Question (1) distinguished individuals in a party that were fishing. Question (2) was used in conjunction with response (a) to question (3) to establish a background of residual fishing effort not affected by the stocking of rainbow trout. Question (3) determined fishing effort produced by stocking¹. Questions (4) and (5) determined fishing effort transferred from other fisheries. Question (6) determined if regulations elsewhere affected the motivation to fish at Piledriver Slough. Responses to questions 5 and 7 were used to determine if anglers would have been fishing on resident or stocked populations (Appendix A5). Not all questions were asked an angler; responses to some questions made other questions irrelevant.

¹ Positive responses to the third question were segregated according to the species that anglers were targeting. If anglers were trying to catch Arctic grayling then effort was categorized as base fishing effort. When anglers were after any other species (whether rainbow trout from stockings in previous years or another species), then effort was categorized as new fishing effort.

Table 2. Rainbow trout stocked in Piledriver Slough in 1992.

Location	Date	Number	Weight (g)
Bailey Bridge	2 June 1992	10,427	87
Bailey Bridge	11 June 1992	751	900
Eielson Farm Road	11 June 1992	260	900
Stringer Road	30 June 1992	5,294	102
Bailey Bridge	30 June 1992	10,089	102
Eielson Farm Road	30 June 1992	3,312	102
Bailey Bridge	30 June 1992	176	900
Bailey Bridge	9 July 1992	10,058	114

Table 3. Dates of sampling periods, by strata,
Piledriver Slough, 1992.

Weekdays	Weekend Days	One Day After Stocking
05-Jun	06-Jun	03-Jun
02 Jul	07 Jun	12-Jun
03-Jul	13 Jun	01-Jul
22-Jul	14-Jun	10-Jul
	05-Jul	

Questions were designed to place responses by the interviewed anglers into one of the following four categories of fishing effort (Appendix A1; Figure 2):

- 1) fishing effort by anglers who fish at Piledriver Slough regardless of the presence of stocked fish (base fishing effort);
- 2) new fishing effort generated by stocking rainbow trout at Piledriver Slough (new fishing effort);
- 3) fishing effort that was pulled away from other fisheries by stocking rainbow trout in Piledriver Slough (transferred fishing effort through opportunity); and,
- 4) fishing effort that was pushed away from other fisheries by regulations at these other fisheries (transferred fishing effort through regulation).

Adults fishing in a party were interviewed separately. Each adult angler that was interviewed represented a single angler-day of fishing effort. If an interviewed adult was responsible for a group of minors in his/her party, the adult represented several angler-days of fishing effort, one for himself (or herself) plus one for every minor in the party. The same angler could be interviewed during different sampled periods but not more than once during a sampled period.

The proportions of parties with minors were calculated by strata using Equations 1 and 2.

$$\hat{p}_k = \frac{\sum_{j=1}^{n_k} y_{kj}}{n_k} \quad (1)$$

$$V[\hat{p}_k] = \frac{\hat{p}_k(1-\hat{p}_k)}{n_k-1} \quad (2)$$

Where:

p_k = the proportion for the stratum;

y_{kj} = the response of angler j interviewed during sampling period k ($y_{kj} = 0$ if no minors in party, $y_{kj} = 1$ if minors in party); and,

n_k = number of anglers interviewed during sampling period k .

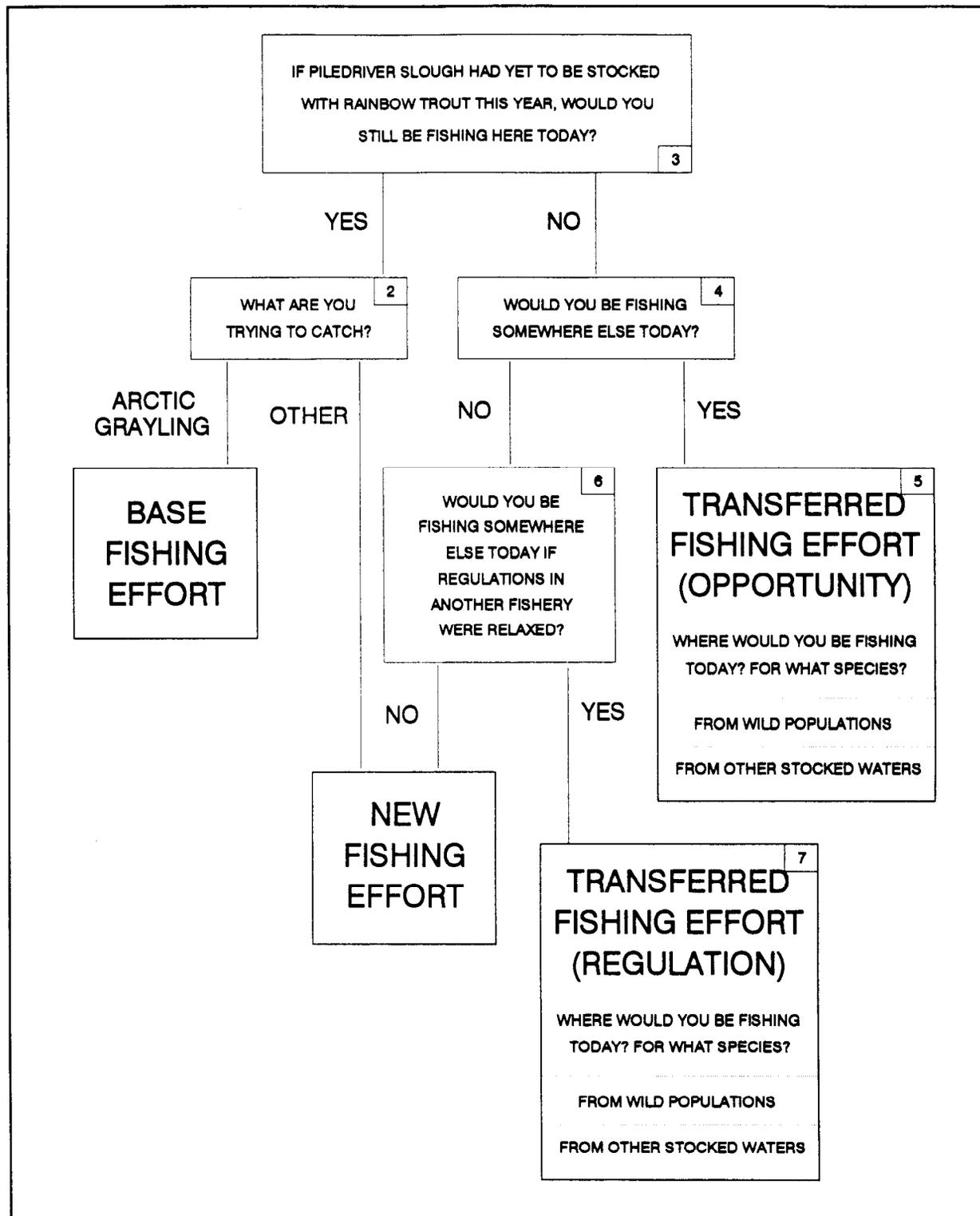


Figure 2. Flow chart describing classification of fishing effort at Piledriver Slough during June and July, 1992, into one of four categories.

Responses were tabulated by category and strata. Relative proportions of fishing effort by motivation (\hat{q}) were estimated without regard to strata as follows:

$$\hat{q}_i = \frac{\sum_h \sum_j (w_{hj} + 1) y_{hj}}{\sum_h \sum_j (w_{hj} + 1)} \quad (3)$$

Where:

y_{hi} = 1 if angler j in stratum h has motivation i ,

y_{hi} = 0 otherwise; and,

w_{hi} = the number of minors under the supervision of angler j in stratum h .

Variances were calculated with a two-stage bootstrap procedure designed after the original sampling scheme. The complete set of data were duplicated 1,000 times by drawing data at random and with replacement from the original set. The first stage in drawing each bootstrap sample was to randomly select four weekdays, five weekend days, and four of those days following stocking, as was done in the sampling at Piledriver Slough. Days within a stratum were selected with replacement. In the second stage, interviews were drawn randomly and with replacement to equal the number of interviews originally taken on that day. Responses in the bootstrap sample were summed across the 13 days of sampling and divided by the number of angler-days tallied in the bootstrap sample (Equation 3). Averages of the bootstrap samples for each category of response were within a percent of the original proportions, which indicates little bias in the original statistics (Efron 1982). Variance for each original statistic was calculated as the sums of squared deviations between individual bootstrap samples from the bootstrap mean for each category divided by 999. In all categories of response, the empirical bootstrap distribution of proportions was symmetrical about the mean, indicating near normal distributions.

RESULTS

There were 216 interviews with adult anglers during the study. Of these, seven interviews were completed improperly and were not used in further analysis. The remaining 209 interviews represented 311 angler-days and minors accompanied 63 of the 209 adults (Table 4). The proportion of parties with minors was greatest on weekends (0.40, SE = 0.05), less so during the week (0.25, SE = 0.05), and least immediately after stocking (0.17, SE = 0.06). The proportion of parties with minors were significantly different across strata ($\chi^2 = 8.46$, df = 2, P = 0.015), but not between weekdays and days immediately after stocking ($\chi^2 = 1.16$, df = 1, P = 0.28). Most anglers were

Table 4. The number of interviews, categorized by parties producing fishing effort (with minors, or no minors) and by strata, Piledriver Slough, 1992.

Strata	Number of Interviews with Adults			Proportion of Interviews	
	Total	No Minors	With Minors	No Minors	With Minors
Weekdays	71	53	18	0.75	0.25
Saturdays/Sundays	96	58	38	0.60	0.40
One Day After Stocking	42	35	7	0.83	0.17
All Strata	209	146	63		

targeting both rainbow trout and Arctic grayling (Table 5). Of those anglers that were targeting a single species, most were after rainbow trout.

Responses to the questions during the interview showed about 0.06 (SE = 0.02) of total fishing effort was base effort, 0.63 (SE = 0.05) was new effort, and 0.31 (SE = 0.06) was effort transferred from other fisheries (Figure 3; Table 6). The proportion of fishing effort estimated to be new effort ranged from 0.61 to 0.68 across strata (Table 6); the proportion of base effort ranged from 0.04 to 0.08; and the proportion of transferred fishing effort ranged from 0.25 to 0.33. Distributions of the four types of fishing effort were virtually identical for anglers interviewed on weekends and just after the stocking of rainbow trout. Since differences in these distributions across all three strata were nil, interviews were pooled to estimate proportions for the fishery as a whole.

Of fishing effort that had been transferred from other fisheries to Piledriver Slough through the opportunity provided by stocking rainbow trout, significant portions were probably transferred from both stocked and resident populations (Table 7). Most of the transferred fishing effort from anglers interviewed on weekends was estimated to have been transferred from stocked populations other than Piledriver Slough (81%). In contrast, a much lower portion of transferred fishing effort on weekdays and just after the stocking was estimated to have come from other stocked populations (32 and 27%, respectively). Since the distributions of transferred fishing effort were quite different across strata, information could not be pooled to estimate a single distribution for the fishery. Almost none of the fishing effort at Piledriver Slough was transferred from other fisheries because of regulations at those other fisheries (Table 7).

DISCUSSION

A positive response to the third question was originally thought to correspond to base fishing effort. However, almost two-thirds of all responses to this question were positive. Under this scenario only one party with minors responded such as to be categorized as being new fishing effort (*i.e.* fishing for something other than Arctic grayling if rainbow trout had not yet been stocked). Prior to 1987, the year Piledriver Slough was stocked with rainbow trout for the first time, estimates of fishing effort or participation in the fishery for resident species at Piledriver Slough were available only for 1983 and 1984. Statistics are reported in the Statewide Harvest Survey only when 12 or more anglers respond as having fished at a location. Estimated fishing effort in 1983 and 1984 are 4,418 and 4,651 days, respectively. An estimated 470 anglers participated in the fishery in 1984; no estimate of participation is available for 1983. In contrast, estimated fishing effort for 1987 is 13,257 days, and estimated fishing effort for that year is 4,686 anglers. Considering that statistics on participation are the most precise coming from the Statewide Harvest Survey (Mike Mills, personal communication), the statistics from the Survey indicate a jump of an order of magnitude in the

Table 5. The number of positive responses to question 3, regarding base fishing effort, categorized by target species and strata, Piledriver Slough, 1992. Proportions are in parenthesis.

	Totals ^a	Target Species		
		Rainbow Trout	Arctic Grayling	Either Species
Weekdays	61	22 (0.36)	8 (0.13)	31 (0.51)
Saturdays/Sundays	99	24 (0.24)	7 (0.07)	68 (0.69)
One Day After Stocking	42	8 (0.19)	4 (0.10)	30 (0.71)
All Strata	202	54 (0.27)	19 (0.09)	129 (0.64)

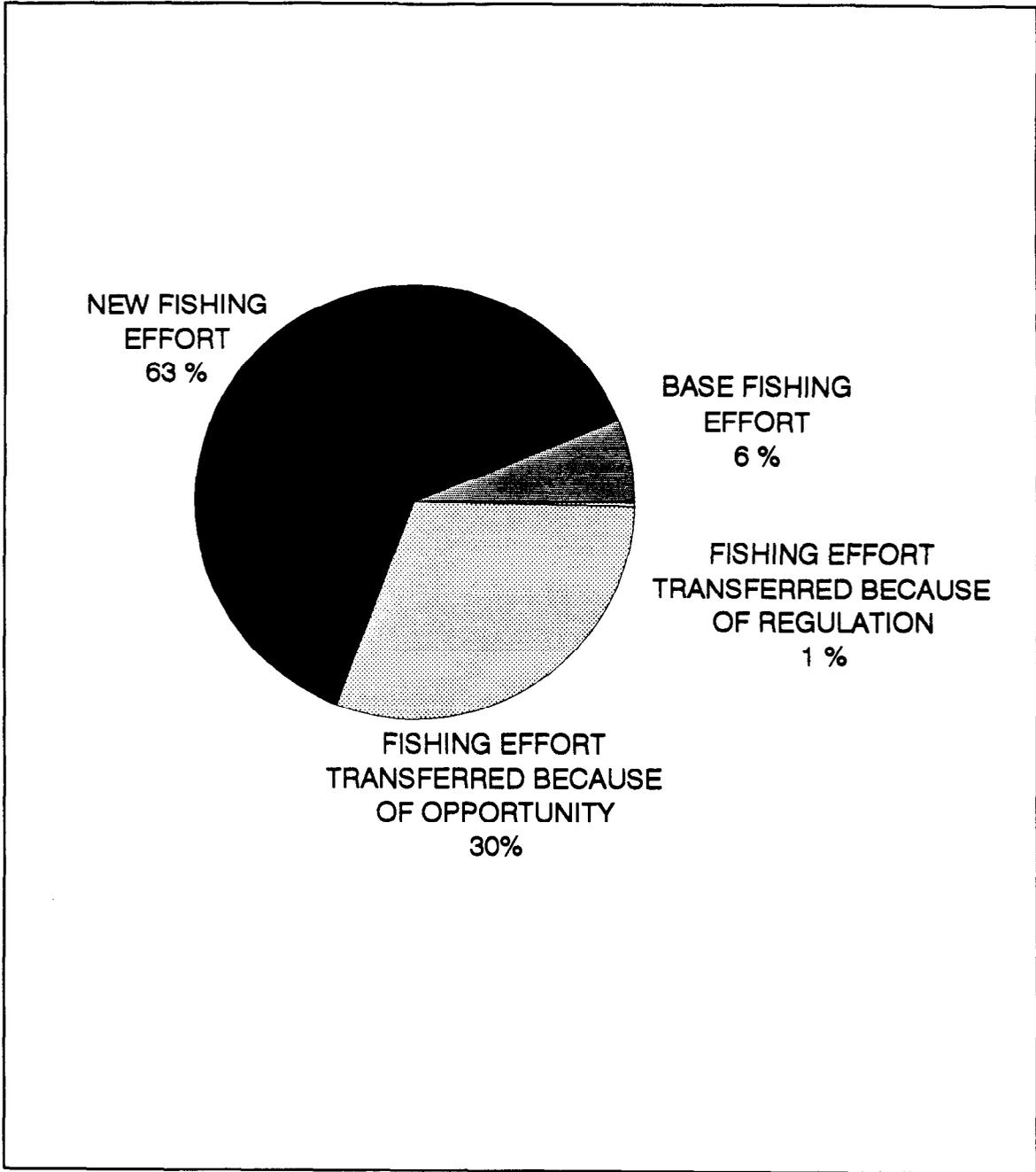


Figure 3. The percentage of sampled angler effort at Piledriver Slough during June and July 1992, segregated into four classification categories.

Table 6. Summary of fishing effort sampled at Piledriver Slough during June and July, 1992, apportioned by strata and category.

	Angler-days of Fishing Effort				
	Total	Base	New	Transferred (opportunity)	Transferred (regulation)
Weekdays	97	8 (0.08)	59 (0.61)	30 (0.31)	0 (0)
Saturdays/Sundays	158	7 (0.04)	98 (0.62)	52 (0.33)	1 (0.01)
One Day After Stocking	56	4 (0.07)	38 (0.68)	14 (0.25)	0 (0)
All Strata	311	19 (0.06)	195 (0.63)	96 (0.31)	1 (<0.01)

Table 7. Sampled fishing effort transferred to Piledriver Slough from other fisheries during June and July, 1992.

	Transferred Effort from:			
	Totals	Stocked Populations	Resident Populations	Did Not Know
Weekdays	22	7 (0.32)	11 (0.50)	4 (0.18)
Saturdays/Sundays	52	42 (0.81)	3 (0.06)	7 (0.13)
One Day After Stocking	22	6 (0.27)	13 (0.59)	3 (0.14)
All Strata	96	55	27	14

size of the fishery at Piledriver Slough between 1986 and 1987. Obviously, base effort was not two-thirds of effort expended during the stocking program. After further thought, positive responses to the third question were segregated by target species. Fishing effort of only those anglers fishing for Arctic grayling, the only resident game fish, was considered as base effort. This fishing effort represents 6% of all effort which is consistent with the changes in participation in the fishery observed when rainbow trout were stocked initially in 1987.

These proportions can be used to directly apportion estimates of angler-days of fishing effort from the Statewide Harvest Survey into base effort, new effort and transferred effort. The estimated fishing effort in 1992 expended at Piledriver Slough is 13,607 (SE = 1,417; Mills 1993). Using the formula to calculate an exact variance for a product of independent variates in Goodman (1960), there are an estimated 816 (SE = 349) days of base effort; 8,572 (SE = 1,137) days of new effort; 4,219 (SE = 900) days of transferred fishing effort. However, because the distribution of transferred effort varied so widely across strata, averages across strata should be weighted by the portion of effort expended in each stratum. Because we do not know the actual amount of fishing effort expended in each stratum, only gross comparisons can be made as to the motivation of anglers who transferred their effort from other fisheries. Since historically about half of fishing effort occurred during weekends and half during the week (Hallberg and Bingham 1991), substantial amounts of fishing effort obviously were transferred from both resident and stocked populations.

The labeling of base fishing effort at Piledriver Slough in 1992 should be considered an approximation of the situation in 1986 to 1987. That approximation would be an exact labeling if the expenditure of base effort in 1986 remained the same from 1987 onward to be measured in 1992. However, the crush of new fishing effort could have affected the persistence of base effort to 1992. Without a precise estimate of fishing effort in 1986 and 1987, no rigorous comparison of changes in the sources of fishing effort is possible across this threshold. Yet, the 10-fold rise in the participation in the fishery in 1987 over 1986 is indicative of a relative base fishing effort of about 10%, which is consistent with our relative estimate in 1992 (6%). No qualifiers are needed in comparing relative fishing effort from other sources, because data taken in 1992 are germane to 1992.

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APPENDIX A

Appendix A1. Questions asked during interviews with anglers.

Questions and Actions:

1. "How many are in your party?" "Are there any minors?" "How many of the children are under your supervision?"
2. "What are you trying to catch? Rainbow trout? Arctic grayling? Does it matter?"
3. "If Piledriver Slough had yet to be stocked with rainbow trout this year, would you still be fishing here today?"
 - 3a. If they say YES, this fishing trip will be considered as effort that would have been EXPENDED HERE REGARDLESS OF OUR STOCKING PROGRAM"{stop}.
 - 3b. If they say NO, ask: "Would you be fishing somewhere else today?"
 - 4a. If they say NO, ask: "Would you be fishing somewhere else today if regulations in another fishery were relaxed?"
 - 5a. If they say NO, this fishing trip will be considered fishing effort that is "PRODUCED BY THE STOCKING OF RAINBOW TROUT IN PILEDRIVER SLOUGH"{stop}.
 - 5b. If they say YES, ask "Where would you be fishing and for what species?"
 - 6a. If they respond with a stocked population, this fishing trip will be considered to have been effort that was "SHIFTED AWAY FROM OTHER STOCKED POPULATIONS"{stop}.
 - 6b. If they respond with a resident population, this fishing trip will be considered to have been effort that was "SHIFTED AWAY FROM RESIDENT POPULATIONS"{stop}.
 - 4b. If they say YES, ask: "Where would you be fishing and for what species?" (Go to 7).
 - 7a. If they respond with a stocked population, this fishing trip will be considered to have been effort that was "SHIFTED AWAY FROM OTHER STOCKED POPULATIONS"{stop}.
 - 7b. If they respond with a resident population, this fishing trip will be considered to have been effort that was "SHIFTED AWAY FROM RESIDENT POPULATIONS"{stop}.

Appendix A2. Frequency of answers for question 2 by those who answered "yes" to question 3.

	Totals	Rainbow Trout	Arctic Grayling	Either Species
Weekdays	61	22	8	31
05-Jun	21	5	4	12
02-Jul	10	5	0	5
03-Jul	23	10	3	10
22-Jul	7	2	1	4
Saturdays	99	24	7	68
Sundays				
06-Jun	4	3	0	1
07-Jun	35	8	7	20
13-Jun	19	2	0	17
14-Jun	12	2	0	10
05-Jul	29	9	0	20
One Day After Stocking	42	8	4	30
03-Jun	19	5	2	12
12-Jun	2	0	2	0
01-Jul	8	1	0	7
10-Jul	13	2	0	11
All Strata	202	54	19	129

Appendix A3. Frequency of answers for question 2 by those who answered "no" to question 3 and "yes" to question 4.

	Totals	Rainbow Trout	Arctic Grayling	Either Species
Weekdays	30	11	0	19
05-Jun	5	3	0	2
02-Jul	14	3	0	11
03-Jul	10	4	0	6
22-Jul	1	1	0	0
Saturdays	52	22	0	30
Sundays				
06-Jun	5	5	0	0
07-Jun	8	6	0	2
13-Jun	23	9	0	14
14-Jun	5	0	0	5
05-Jul	11	2	0	9
One Day After Stocking	14	8	0	6
03-Jun	5	1	0	4
12-Jun	5	3	0	2
01-Jul	3	3	0	0
10-Jul	1	1	0	0
All Strata	96	41	0	55

Appendix A4. Frequency of answers for question 2 by those who answered "no" to question 3, "no" to question 4, and "no" to question 6.

	Totals	Rainbow Trout	Arctic Grayling	Either Species
Weekdays	6	5	0	1
05-Jun	1	1	0	0
02-Jul	3	3	0	0
03-Jul	0	0	0	0
22-Jul	2	1	0	1
Saturdays	6	5	0	1
Sundays				
06-Jun	0	0	0	0
07-Jun	2	1	0	1
13-Jun	2	2	0	0
14-Jun	2	2	0	0
05-Jul	0	0	0	0
One Day After Stocking	0	0	0	0
03-Jun	0	0	0	0
12-Jun	0	0	0	0
01-Jul	0	0	0	0
10-Jul	0	0	0	0
All Strata	12	10	0	2

Appendix A5.

Designations as resident, stocked, or conditional for species and populations listed as responses to questions 5 and 7. Conditional species or populations could be either resident or stocked, depending on the circumstances. For instance, a response of "Harding Lake" coupled with "northern pike" indicates that the angler would have been fishing on a resident population had he/she not been fishing at Piledriver Slough. Responses of "Harding Lake" and "Arctic char" indicates that the angler would have been fishing on a stocked population.

Resident Species:

Arctic grayling
Northern pike
Burbot

Stocked Species:

Rainbow trout
Arctic char

Conditional Species:

Salmon
Lake Trout

Resident Populations:

Gulkana River
Chatanika River
Badger Slough
Along Denali Highway
Southcentral Alaska
Talkeetna River
Chena River
Sheep Creek
Montana Creek
Hidden Lake
Donnelly Lake
Near Nenana
Hidden Lake

Stocked Populations:

Birch Lake
Stocked lakes and ponds
Quartz Lake
Bathing Beauty Pond
Chena lakes
Rainbow Lake

Conditional Populations:

Harding Lake
Moose Creek
