Mar 5, 1986

Dear Dr Behnke

Enclosed is a draft copy of a little paper I've been working on - Your comments would be appreciated.

I plan to submit it to the North American Journal of Fishery Management.

I hope all is well with you.

Sincerely

Gat Devoe

North American Journal of Fisheries Management 4:216–221, 1984

Three-year Hatchery and Field Evaluation of Four Strains of Rainbow Trout

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ABSTRACT

The performance of four strains of rainbow trout, (*Salmo gairdneri*) was evaluated under hatchery and field conditions. Growth, conversion, and survival were measured in the hatchery; catchability, growth and longevity data were collected in the field. Fish from each strain were stocked at equal densities into two ponds near Three Forks, Montana, for a replicated field evaluation. The domestic Winthrop and Spring Standard Growth strains grew faster, converted food more efficiently, and were harvested at a faster rate than the wild McConaughy and Fish Lake strains. However, the McConaughy and to some extent the Fish Lake strains remained in the fishery longer—up to 3 years, at which time the project was terminated.

Fish culturists and biologists have been modifying the genetic purity and range of the rainbow trout (*Salmo gairdneri*) since the origin of artificial propagation. According to Behnke (1979), eggs from the McCloud River, California hatcheries (both private and federal) were shipped to many locations in the United States and other countries. These eggs were from anadromous coastal rainbow trout, and the smaller tributary trout of the McCloud River which probably played a minor role.

The genetics of rainbow trout have been studied in the laboratory and growth rates of many strains have been evaluated under hatchery conditions. Many of the more domesticated strains have been developed to meet characteristics desirable to the fish culturist, such as rapid growth, high egg production, and disease resistance (Donaldson and Olson 1955; Gall 1975; Gjedrem 1976). The survival and advisability of stocking "hatchery" fish has been a topic of debate for many years. The effect of genetic selection apparently reduces the ability of the strains to compete and survive in the natural environment (Miller 1954, 1958). Some evidence indicates that it is not usually advisable to stock hatchery fish where a wild trout population is well established (Butler 1975; Vincent 1974). However, there are many situations where it is necessary to stock fish to establish a fishable population. These fish must have characteristics that allow them to survive and grow, and perhaps reproduce, depending on the management goals. In addition, they must be catchable by the fishermen.

Kincaid (1981) assembled basic information about performance characteristics of various strains of trout. He also included a literature review on fish strains by species and pointed out the need for additional research.

There are definite differences in the characteristics of the various wild and domestic populations or "strains" of trout; characteristics of some strains have been defined. Hudy and Berry reviewed the literature in a 1979 unpublished report given at the 109th annual meeting of the American Fisheries Society at West Yellowstone, Montana, and reported information on growth, conversion, catchability, survival, disease resistance, and formalin toxicity under captive and non-captive conditions. Hudy (1980) also evaluated the non-captive performance of six strains of rainbow trout in Utah. In their evaluation of the non-captive performance of fingerlings of four rainbow trout strains, Cordone and Nicola (1970) found that harvest of the fish was influenced by strain.

Rawstron (1977a), who stocked three domestic strains of catchable rainbow trout in California waters, reported that the Coleman strain showed a clear superiority over the Shasta and Whitney strains in total harvest. The Eagle Lake strain performed better than the Coleman strain in another field test, leading to the conclusion

This is not published – yet and no reference are included as you may notice.

Any comments would be appreciated

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– Rosenlund A E A
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– West L.

Differences in Catchability Among Three Strains of Cutthroat Trout

William P. Dwyer USFWS 4050 Bridger Canyon Rd, Bozeman

Three strains or subspecies of cutthroat trout, the Snake River, Salmo clarki subsp., the Yellowstone, Salmo clarki bouvieri, and the Colorado, Salmo clarki pleuriticus were used in this study.

Eggs of the Snake River cutthroat came from the Wyoming Game and Fish Department's Auburn Hatchery. This brood stock has been selected for early spawning for many years. The Yellowstone cutthroat eggs were obtained from the Yellowstone Hatchery in Big Timber, Montana, where the broodstock is periodically fertilized with gametes from McBride Lake in order to maintain the gene pool.The Colorado cutthroat eggs came from Ennis National Fish Hatchery, Montana. The broodstock are F1 progeny of the wild population in Trappers Lake, Colorado.

Fish for the study were reared for approximately 14 months and stocked as catchables in early June of 1983 and 1984. Each strain was marked by a fin clip in order to assure identification later. Equal numbers of each strain were releaced into two ponds near Three Forks Montana at a rate of 600 per hectare. The ponds are 5.02 and 8.66 hectares and will be referred to hereafter as the West and Middle ponds, respectively.

The creel census began one day after stocking and continued for 10 weeks. The sampling period was five 14-day periods. "Morning" sampling extended from 0800 to 1500 and "evening" from 1500 to 2200 or earlier if there were no fishermen. Ten of the 14 days were sampled in each stratum. This was broken down to four evenings and three mornings of the ten weekdays,

and two evenings and one morning out of the four weekend days in each stratum.

The population was sampled in Septempber of 1983 to estimate growth and mortality. The Peterson population estimate was used to predict mortality. Seventy five cutthroat of each strain were marked and released into the West and Middle ponds, respectively. Ten days later 125 ft experimental gill nets were used for recapture.

Results

Results of this study demonstrate a difference in susceptability to angling among the three strains of cutthhroat.

Table 1 shows the percentage of each strain harvested for both years of the creel census from the West and Middle ponds. The trends were the same during both years. However, the fishing pressure, based on hourly counts by the creel clerk, was 36% lower in 1984 than 1983. Mean percent harvest of each strain over both years is shown in Figure 1.

Table 1. Percent removal of each strain by angling.

Year	Pond	Snake R.	McBride	Colo R
1983	West	65.6	41.0	16.8
1983	Middle	64.5	35.2	12.5
1984	West	53.4	28.0	10.1
1984	Middle	24.2	8.8	5.5

The catch per unit effort (CPUE) data was analyzed using parametric and non-parametric statistics. Mean CPUE for each strain is shown in Fig.2. There is a significant difference in CPUE among all three strains, with the Snake River being the most and the Colorado River the least susceptable. These data are based on the mean of 16 strata [4 strata in 2 ponds over 2 sampling periods].

The Kruskal-Wallis statistic is a one-way analysis of variance using the ranks rather than the original measurements. Using this the CPUE data was significant with a D value of 23.11 and, P <= 0.0000, with a chi square of 80 . The Mann-Whitney test was then applied to determine significance between each strain. This again was statistically significant.

Fall sampling data for the Middle Pond indicates a higher mortality rate than angling data suggests, however, the sampling for the population estimate was accomplished 60 days after the creel census was terminated. Fishing pressure in August was neglegible, however as water temperatures began to decrease in September pressure increased. This could account for the discrepency. Theoretically CPUE should be directly proportional to abundance of fish in the stock. Therefore if the abundance of the most catchable strain decreases, the CPUE also decreases and a larger portion of the fish caught would be taken form the less catchable populations, even though total numbers harvested may decrease.

Management Implications

Implications for future fishery management are numerous. Potential advantages include: better control of harvest rate, improved survival and growth by using strains best suited for the particular environment, provide more fish by using strains which do not exhibit intra specific competition for food and or space.

Conclusion

Under the conditions of this study the Snake River were the most vulnerable to the the type of angling which occurred in these ponds, (primarily lure and bait) . Stomach samples are being examined to determine if food habits may explain a difference in vulnerability.

This and many other studies have shown that different strains or subspecies of trout possess unique characteristics. The use of particular strains with the desired characteristics to meet specific management objectives will lead to a more creative style of management in the future. These studies also point out the need to maintain and update a strain registry, such as has been developed by Kincaid, in order for the information to be collected and disseminated in an orderly manner.

Comparison of Catchability Among Three Strains of Cutthroat Trout

By

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Abstract

In 1983 and 1984 two ponds near Three Forks, Montana were stocked at equal rates with Snake River, Colorado River and the Mc Bride Lake strain of the Yellowstone cutthroat trout. A creel census was conducted to determine susceptibility to angling. The mean percent harvest of each strain for both years during the creel census period was: Snake River cutthroat trout, 51.9%; McBride Lake cutthroat trout 28.2%; Colorado River cutthroat trout, 11.2%. A significant difference in catchability was found between strains; the Snake River strain was the most susceptible to angling, while the Colorado River strain was the least susceptible. A population estimate conducted in the fall of 1983 indicated that the Colorado River cutthroat trout accounted for 47-62% of the remaining fish, followed by the McBride (33-47%), and the Snake River cutthroat trout (5-6%).

Introduction

Biologists have noted differences in trout strains performance for many years. Much work has been done evaluating various characteristics of rainbow trout; less information is available on cutthroat.

Kincaid (1981) assembled basic information about performance characteristics of various strains of trout. He also included a literature review on fish strains by species and pointed out the need for additional research.

There are definite differences in the characteristics of the various wild and domestic strains of trout; characteristics of some strains have been defined. Dwyer and Piper (1984) found that two strains of a domesticated rainbow trout were much more susceptible to angling than wild strains.
Hudy (1980) evaluated the non-captive performance of six strains of rainbow trout in Utah. In their evaluation of the non-captive performance of fingerlings of four rainbow trout strains, Cordone and Nicola (1970) found that harvest of the fish was influenced by strain.

There are two main objectives for utilizing specific strains. One concerns using preadapted strains which have an evolutionary history in which they have developed specializations such as thermotolerance, predatory ability, or potential longevity. Selecting a fish with the particular specializations to meet specific management objectives will lead to greater success (Behnke 1972).

The second aspect concerns stocking two or more strains, subspecies, or species together to achieve greater total biomass than one strain would produce alone. Ecological differences between species are often magnified by interactive segregation (Nilsson 1967). The biological function is to attenuate competition when food or space is the limiting factor. This leads to a more complete utilization of the habitat and greater productivity. Nelson & Platts = Gr. -1987- Environ. Biol. Fishes 20(4).

Glova (1986) described interactive segregation among juvenile coho (Oncorhynchus kisutch) and coastal cutthroat (Salmo clarki clarki); Hume and Northcote (1985) reported on the phenomena with Dolly Varden (Salmo malma) and cutthroat trout. In another example, Trojnar and Behnke (1974), observed differences in habitat use and food habits of two strains of sympatric cutthroat trout.

Catchability or susceptibility to angling is an important aspect of fish behavior which has frequently been overlooked in making management decisions (Behnke 1980). In a put-and-take situation, the ideal goal is to have all fish harvested over a short period of time; therefore, a susceptible strain would be the fish of choice in these situations. A trophy fishery may require a fish that is less susceptible to angling in order to survive to trophy size.

Many strains of cutthroat cutthroat trout have been used for management purposes, but success has varied. There is a need to evaluate specific strains of cutthroat trout under various field conditions in order to enable management biologists to match the fish habitat with the management objective. The understanding of

unique strain characteristics increases the management potential of all strains. Potential advantages of utilizing various genetic strains for specific management purposes include, better control of harvest rate, improved survival and growth by using strains best suited for the particular environment. This may also provide more fish by using strains which do not exhibit intraspecific competition for food and space. The purpose of this study was to compare the field performance of three strains of cutthroat trout.

Methods

Three subspecies of cutthroat trout, the Snake River, (Salmo clarki subsp.), the McBride Lake strain of the Yellowstone, (Salmo clarki bouvieri), and the Colorado, (Salmo clarki pleuriticus) were used in this study. Eggs of the Snake River cutthroat were obtained from the Wyoming Game and Fish Department's Auburn Hatchery. This broodstock has been selected for early spawning for many years. Yellowstone cutthroat eggs were obtained from the Division of Fish, Wildlife and Parks, Yellowstone Hatchery in Big Timber, Montana, where the broodstock gametes are periodically back-crossed with gametes from the McBride Lake fish in order to maintain the gene pool (McMullin and Dotson 1988). Ennis National Fish Hatchery, Montana, supplied the Colorado cutthroat eggs. The broodstock were F1 progeny of the wild population in Trappers Lake, Colorado.

Fish for the study were reared for approximately 14 months and stocked as catchables in early June of 1983 and 1984 (Table 1). Each strain was marked by a unique fin clip for later

identification. Equal numbers of each strain were released into two ponds near Three Forks, Montana for a total stocking rate of 600 fish per hectare.

The ponds have a surface area of 5.02 and 8.66 hectares, and will be referred to hereafter as the West Pond and Middle Pond, respectively. The West Pond has a maximum depth of 5.46 m, a mean depth of 3.64 m; maximum depth of the Middle Pond is 5.46 m and mean depth is 3.94 m. Shoreline vegetation is comprised mainly of cattails (Typhaceae) in both ponds (Dolan and Piper, 1979).

The creel survey began 1 d after stocking and continued for 10 weeks. Sampling was stratified into five 14-d periods. "Morning" sampling extended from 0800 to 1500 and "evening" from 1500 to 2200. Ten d were sampled in each stratum; this was further divided into 4 evenings and 3 mornings of the 10 weekdays, and 2 evenings and 1 morning out of the 4 weekend days in each stratum. The sampling days were selected by using a random number table (Ostle 1966).

The ponds were sampled in September of 1983 to estimate mortality of stocked trout. Seventy and 80 cutthroat of each strain were marked by a caudal fin punch and released into the West and Middle ponds, respectively. Ten days later, experimental gill nets (each 38.1 m long x 1.8 m wide, in panels of five mesh sizes; 1.9, 3.2, 3.8, 5.1, and 6.4 cm) were used for recapture. Population estimates were based on the Peterson method (Ricker 1975). Separate estimates were made for each strain.

Catch per unit effort data was analyzed using the non-

parametric Kruskal-Wallis statistic (Hollander and Wolfe 1973). The Mann-Whitney test was then applied to determine significant differences among the means.

Results

Susceptibility to angling differed among the three strains of cutthroat trout. Although the percentage of each strain harvested from the West and Middle ponds varied between years, trends were similar during both years (Table 2). Fishing pressure was estimated to be 36% lower in 1984 than 1983. Mean percent harvest was highest for Snake River cutthroat trout (52%), followed by McBride Lake cutthroat trout (29%), and Colorado River cutthroat trout (11%) (Figure 1).

Differences in CPUE among all three cutthroat trout strains (Figure 2) were significant ($P < 0.05$). The Snake River strain had the highest CPUE and the Colorado River strain had the lowest. These data are based on the mean of 16 strata [4 strata in 2 ponds over 2 sampling periods].

Four of the six population estimates obtained in 1983 were statistically biased. Therefore, estimates were made for the entire population in each pond, and the estimated number for each strain was based on the proportion of each captured in the nets. Results indicate that there were 701 fish in the Middle pond, of which 435 were Colorado River cutthroat trout, 231 McBride Lake cutthroat trout, and 35 Snake River cutthroat trout. Estimates for the West pond were greater. There was a total of 1236 with equal numbers (581) of Colorado River and Yellowstone cutthroat trout, and 74 Snake River cutthroat trout (Table 3).

Discussion

Fall populations estimates for the Middle Pond indicate higher mortality than estimated by creel survey; however, sampling occurred 60 days after the creel census was terminated and the estimates had wide confidence intervals. Angler use in August was negligible, but as water temperatures began to decrease in September, use increased. This additional pressure in September could also account for the observed discrepancy.

Estimated numbers of cutthroat trout remaining in the two ponds in September 1983 exhibited trends which support the creel survey data. The Colorado River cutthroat and Yellowstone were the most abundant; few Snake River cutthroat were present (Table 3).

The Snake River cutthroat trout used in this study is a hatchery strain which has been selected for rapid growth and good survival under hatchery conditions. It is an aggressive and hardy strain which has existed under hatchery conditions for many generations. Snake River cutthroat trout evolved in a large river system with other fish species present (Trojnar and Behnke 1974; Behnke 1979). This evolutionary history, as well as the hatchery selection, has produced an aggressive trout which is very susceptible to angling. Under the conditions of this study, the Snake River were the most vulnerable to the type of angling that occurred in these ponds (primarily lure and bait). Rosenlund (USFWS personal communication) found that the Snake River strain performs much better than the strain of rainbows previously used in small impoundment management. Harvest rate of the Snake River cutthroat trout was lower, and he was able to produce a

more stable fishery by reducing the boom or bust situation previously encountered. In a previous study in the Three Forks Ponds, Dwyer and Piper (1984) found that up to 80% of the domesticated rainbow strains were harvested in the same period of time it took to harvest approximately 65% of the Snake River cutthroat trout.

The McBride Lake strain of Yellowstone cutthroat evolved in a 23 acre lake with no other fish species present. The lake is at 6,500 feet, and the abundant invertebrates and high condition factor of trout indicates a biologically productive lake (Arnold and Sharpe 1967). The Yellowstone Cutthroat of McBride Lake have not experienced excessive selection in the hatchery, and are less aggressive than the Snake River cutthroat.

The Trapper's Lake Colorado cutthroat used in this study are reported to be pelagic, feeding mainly on small zooplankton (Behnke, Colorado State University, personal communications). These were the least domesticated stock used. This pelagic "wild" strain would be expected to be less susceptible to the type of angling which occurred in this study.

Genetically pure strains of cutthroat trout should be protected for future generations. Utilizing the unique behavioral and physiological characteristics of these strains will lead to improved fishery management (Varley and Gresswell 1988; Behnke 1972).

Acknowledgments

I thank Dr. Robert Behnke, Dr. Robert White, Mr Bob Gresswell, and Mr Charlie Smith for reviewing this paper, and Mr Bob McFarland for lending his statistical expertise. I also appreciate the cooperation of the Montana Department of Fish, Wildlife and Parks for allowing us to use waters under their jurisdiction. Eggs were provided through the courtesy of MR Butch Bonner of Auburn State Fish Hatchery, Mr Thurston Dotson, Yellowstone State Fish Hatchery, and Mr Wes Orr, Ennis National Fish Hatchery.

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Legends to Figures

Figure 1. Mean cumulative percent harvest of three strains of cutthroat trout over two annual creel censuses, 10 weeks each. Each strata is 14 days.

Figure 2. Mean catch per hour of three cutthroat trout strains. Data collected during two annual creel censuses of 10 weeks each. There is a statistically significant difference between catch rates of each ($P<0.05$).

Table 1. Mean length, weight and condition factor (K) of three cutthroat trout strains at time of stocking into ponds near Three Forks, Montana, 1983 and 1984.

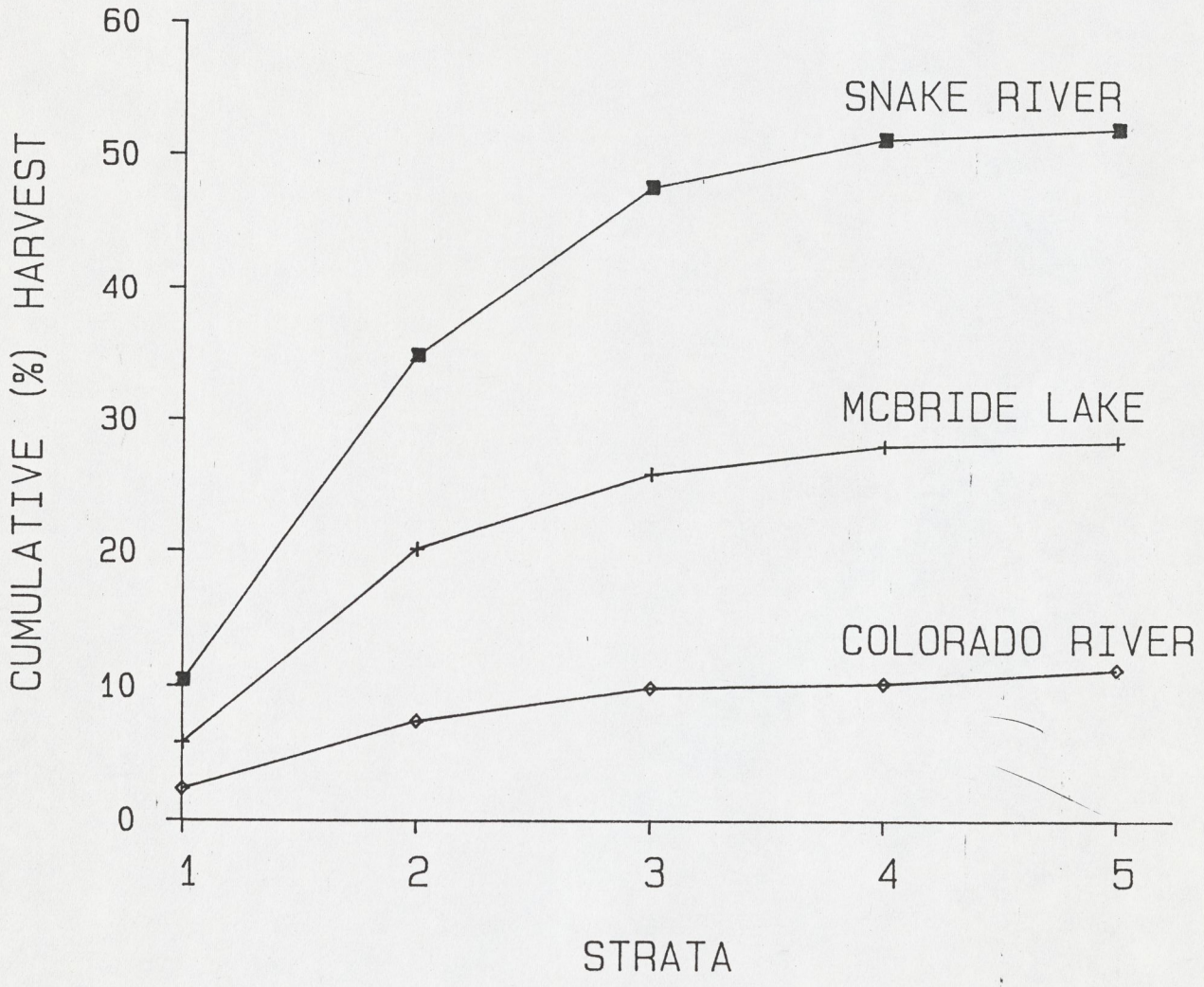
Year 1983	Snake River	McBride	Colorado River
Length(mm)	241	236.5	244
Weight (g)	129	127	158
K factor	0.921	0.960	1.090
Year 1984:			
Length(mm)	216	215	231
Weight (g)	102	93	116
K factor	1.014	9.410	9.410

Table 2. Estimated percent harvest by angling of each cutthroat trout strain during the 1983 and 1984 creel census periods.

Year	Pond	Snake R.	McBride	Colorado R.
1983	West	65.6	41.0	16.8
1983	Middle	64.5	35.2	12.5
1984	West	53.4	28.0	10.1
1984	Middle	24.2	8.8	5.5
	mean	51.9	28.3	11.2
	SD	16.7	12.1	4.1

Table 3. Fall 1983 estimates made on the cutthroat population in the Middle and West ponds near Three Forks, Montana. Confidence internals (CI) for the total pond estimates are at the 95% level and based on the poisson distribution. Number of each strain is based on proportion captured.

	Middle Pond	West Pond
Estimate	701	1236
CI	419≤ N≤ 1641	660≤ N≤ 3932
STRAIN:		
Colorado River %	62%	47%
Estimate	435	581
Yellowstone %	33%	47%
Estimate	231	581
Snake River %	5%	6%
Estimate	35	74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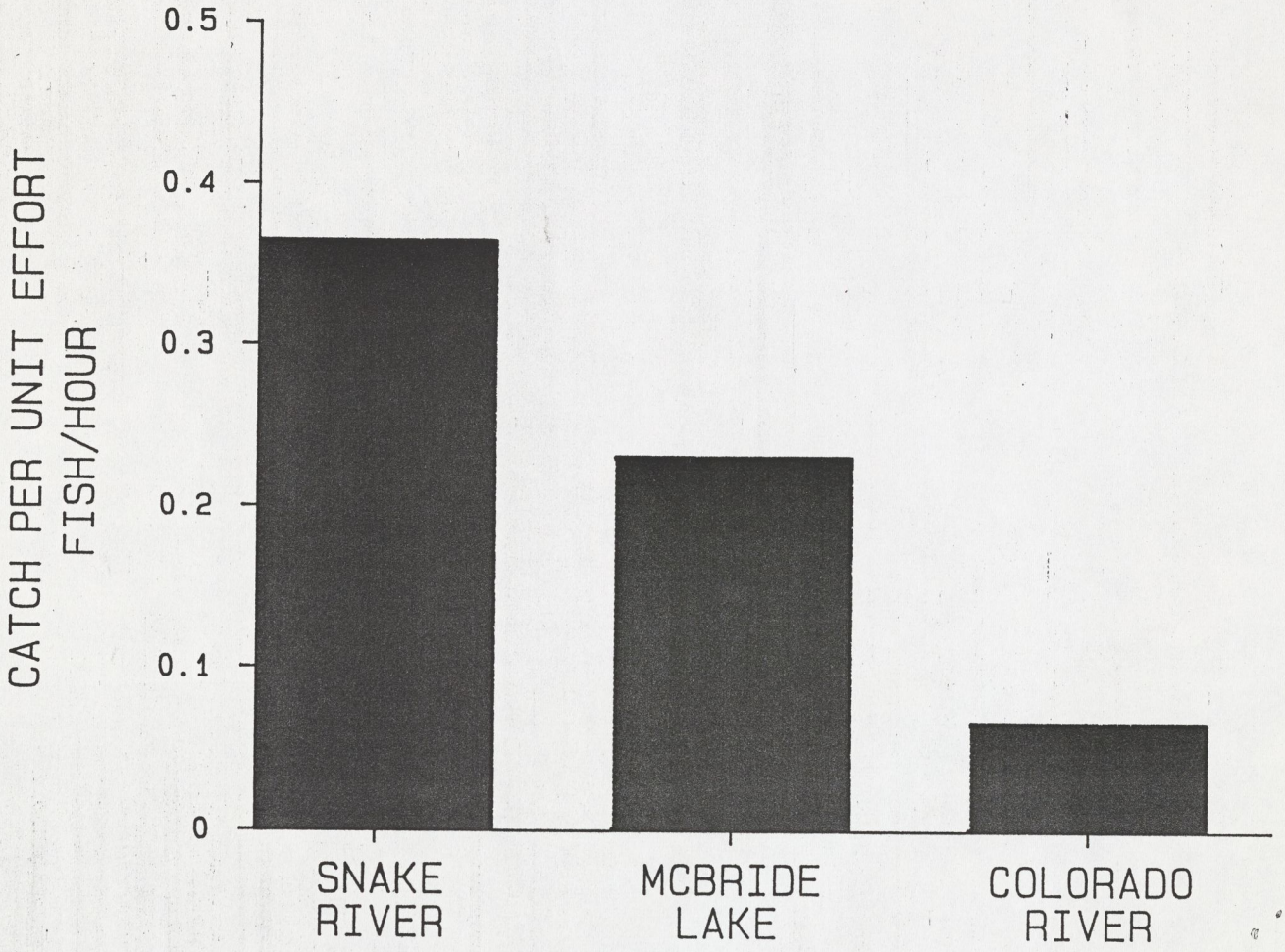
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SNAKE RIVER
MCBRIDE LAKE
COLORADO RIVER

United States Department of the Interior

FISH AND WILDLIFE SERVICE
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BOZEMAN, MONTANA 59715

April 14, 1988

Dr. Robert J. Behnke
Dept. Fish and Wildlife Biology
Colorado State University
Ft. Collins, CO 80523

Dear Bob:

I have enclosed a revised version of the paper which you reviewed for me several years ago. This has been submitted to the North American Journal of Fisheries Management to be considered for publication.

If you have any comments, please let me know.

Sincerely,

Pat

William P. Dwyer
Fishery Biologist

WPD:kp
Enc-as stated.

— 30 yr — ago Bob Butler

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