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EVALUATION OF SIX STRAINS OF RAINBOW TROUT (*Salmo gairdneri*) STOCKED AS FINGERLINGS IN PORCUPINE RESERVOIR, UTAH

by

Mark Hudy

A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

in

Wildlife Science

UTAH STATE UNIVERSITY
Logan, Utah

1980

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Mark Hudy

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ABSTRACT

Evaluation of Six Strains of Rainbow Trout (Salmo gairdneri)
Stocked as Fingerlings in Porcupine Reservoir, Utah

by

Mark Hudy, Master of Science

Utah State University, 1980

Major Professor: Dr. Charles R. Berry
Department: Wildlife Science

Different strains of rainbow trout (Salmo gairdneri), Ten Sleep, Sand Creek, Beitey, Shepherd-of-the-Hills, New Zealand, Fish Lake-Desmet, Desmet, were compared for survival to the creel, growth and catchability after being stocked in a fluctuating 80 ha Utah reservoir. Fish were stocked in the spring and fall as fingerlings and monitored by creel censusing, gill netting and electrofishing. Fish were tagged with coded wire snout tags prior to stocking. An angler opinion survey was conducted to determine angler satisfaction with numbers and size of fish caught.

Regardless of strain, spring stocking was superior to fall stocking in survival to the creel. In the spring 78 stocking the Ten Sleep strain had the highest survival to the creel (33.7 percent), followed in order by Shepherd-of-the-Hills (11.0 percent), Beitey (5.5 percent), Sand Creek (5.4 percent), New Zealand (4.1 percent), and Fish Lake-Desmet (2.9 percent). In the spring 79 stocking the Shepherd-of-the-Hills strain had the highest survival to the creel (7.6 percent),

followed in order by the Sand Creek (7.3 percent) and the Ten Sleep (6.5 percent). Similar trends in survival were found in gill netting and electrofishing samples. Migration out of the reservoir was negligible for each strain. There were no strain differences in catchability by different methods (shore, boat) or gear (bait, artificial lure). Differences in growth between the fastest growing strains (Ten Sleep, Sand Creek) and the slowest growing strains (New Zealand, Fish Lake-Desmet) averaged as great as 16 mm in length and 43 g in weight. Differences in growth and survival among strains were great enough to span the range of angler satisfaction with numbers caught and size of fish caught from satisfactory to unsatisfactory. Therefore, strain selection can be a useful tool to improve fingerling stocking programs and manipulate the number of anglers who are satisfied with the angling experience.

(79 pages)

INTRODUCTION

Since the origin of artificial propagation of rainbow trout (Salmo gairdneri) over 100 years ago (Needham and Behnke 1962), the world distribution of rainbow trout has changed dramatically (MacCrimmon 1971, 1972). In the late nineteenth century, eggs from McCloud River rainbow trout were distributed throughout the United States. The McCloud River rainbow are the probable ancestors of many of today's wild and domestic rainbow trout. With the addition of steelhead forms, hybridization with cutthroat trout (Salmo clarki), and natural and artificial selection, the ancestry and original characteristics of the rainbow trout have been either confused, changed or lost (Lewis 1944; Needham and Behnke 1962; MacCrimmon 1971, 1972; Scott et al. 1978; Dollar and Katz 1964). Today wild and domesticated rainbow populations show distinct and often diverse characteristics in their performances in the hatchery, laboratory and field (Hudy and Berry 1979). In the literature these distinct populations are commonly called strains.

Traditionally, rainbow trout have been evaluated and artificially selected for characteristics such as growth, egg production, disease resistance and spawning time which are important to fish culturists (Millenbach 1950). But, little is known of the value of a strain's hatchery performance characteristics to the fish once it's stocked in the wild (Shuck 1948). This is because few attempts have been made to evaluate non-captive performance of rainbow trout strains for characteristics such as growth rate, catchability and survival when stocked in the wild as fingerlings or catchables.

In Utah, 14 million fingerling rainbow trout were stocked by the Utah Division of Wildlife Resources (DWR) between 1974-76 and 10 million between 1976-78 (DWR 1976, 1978). Seven strains of rainbow trout broodstock have been maintained by the DWR. The performances of these strains under captive (hatchery) conditions have been evaluated (Leppink and Starostka 1976; Berry et al. 1978; Dean 1980). Strains are not currently matched to various wild environments due to the lack of information on non-captive performance.

Recreational fisheries managers, trout egg producers, private pond fish producers and others should consider a strain's non-captive performance. Studies have shown that increases in the return to the creel can be accomplished by strain selection (Cordone and Nicola 1970; Rawstron 1973, 1977; Ford 1978; Kincaid 1978; Dolan and Piper 1979). Increases of a few percent return can significantly alter the economics of a trout fishery and reduce production needs of fish culture facilities (Rawstron 1973, 1977; Moring 1978). Selecting a strain of rainbow trout that will grow faster, live longer and have higher creel returns in the wild will provide a better quality fishery that minimizes waste of the hatchery reared fingerling trout.

The specific objective of this study was to evaluate the non-captive performance of the strains of rainbow trout reared by the DWR in their hatchery system. Hypotheses tested were for:

H_1: Survival to the creel is equal for all strains.

H_2: Change in growth is equal for all strains.

H_3: Catchability (by month, method, year) is equal for all strains.

Secondary objectives were to provide information on:

1. migration of rainbow trout strains
2. angler satisfaction
3. harvest and fishing pressure on Porcupine Reservoir.

LITERATURE REVIEW

Studies in California reservoirs and elsewhere have shown the importance of non-captive evaluation of rainbow trout strains. Cordone and Nicola (1970) showed that the return to creel can be greatly influenced by strain selection in a fingerling program. The average return to the creel of the Kamloops strain (14 percent) and Shasta strain (11 percent) was superior to that of the Whitney (3.7 percent) and Virginia (4.2 percent) strains. The Shasta strain had the highest ratio of pounds planted to pounds caught and the lowest cost per pound in the creel. The Kamloops strain was found to be more susceptible to boat fishermen indicating a more limnetic distribution. Rawstron (1973, 1977) demonstrated the importance of strain differences in a catchable program. The Coleman Kamloops strain was consistently superior in repeated tests to the Whitney and Shasta strains. No growth differences were found between the three strains, but the limnetic distribution of Kamloops strain reduced mortality and allowed the strain to reach a larger size. Based on return data and hatchery costs, each kilogram of Kamloops caught was produced for up to $0.55/kg less than the Shasta strain and $0.24/kg less than the Whitney strain. Boles and Borgeson (1961) found higher returns of catchable Mt. Shasta and Hot Creek strains when compared to the Whitney and Virginia strains. The higher catchability in the first year and their consequent reduced (relative) winter mortality were attributed to their success. Wales and Borgeson (1961) found the Kamloops strain more susceptible to fly fishing than the Mt. Shasta strain.

Ayles (1976) evaluated three strains of rainbow trout for aquaculture potential in central Canadian pot hole lakes. A domestic strain was superior in growth and intermediate in survival to two wild strains. Strain differences between lakes indicated a significant lake-strain interaction (Ayles 1976).

Reisenbichler and McIntyre (1977) investigated the survival and growth of rainbow trout of different levels of domestication. In a non-captive environment wild trout had the highest survival and intermediately domesticated trout the highest growth.

In fingerling stockings in two South Dakota reservoirs, Ford (1978) found differences in total percent return. The Growth strain (32.5 percent) was the highest, followed by the Kamloops (27.4 percent), Washington (23.6 percent) and Manchester (15.7 percent).

In two Montana ponds, Dolan and Piper (1979) found a higher catchability of domestic strains (Winthrop and Standard Growth) compared with that of two wild strains (Fish Lake and McConaughy). Similar results were found in a repeat of the study (Dwyer et al. 1980).

A highly domesticated strain (Wytheville) and a wild strain (Fish Lake) were evaluated at the Fish Genetics Laboratory in Beulah, Wyoming. Fish Lake had a higher total recovery but the Wytheville strain was 35.8 percent heavier (Fish Genetics Laboratory data, Ray Simon, unpublished, Leetown, WV). Further work on three fall and five winter spawning strains found significant differences in growth, susceptibility to angling and total return (Kincaid 1978).

Leppink (1977), in Utah, found the Ten Sleep strain (62.8 percent) more catchable than the Sand Creek (54.8 percent) and New Zealand (45.0 percent) when stocked as catchables in a large spring.

Several papers have investigated the migration tendencies of rainbow trout strains. Ratledge and Cornell (1953) found no significant differences in migration between the Manchester strain and control groups (Wytheville heritage) when stocked as catchables in three North Carolina creeks. In a study on four California impoundments (Rawstron 1973), emigration rates of the Whitney strain were greater than the Kamloops and Shasta strains. Cordone and Nicola (1970) found emigration rates of the wild Kamloops strain to be greater than that of domesticated strains. Moring (1978a) investigated downstream loss of two strains stocked as catchables in a small Oregon stream. During high flows in April, up to 37.2 percent of the Roaring River strain migrated downstream and removed themselves from the major fishery. The Cape Cod strain was less migratory (up to 18.2 percent in April) and was caught in higher numbers. Economic analysis (Moring 1978b) determined that by stocking the less migratory strain, the benefit/cost ratio of the stream could increase from 14.1:1 to 18.0:1. The Cape Cod strain is now recommended for stream stocking in Oregon (Kinunen and Moring 1978).

In summary, it is clear that non-captive differences occur between strains of rainbow trout. Depending on the magnitude and type of program, a strain's non-captive performance advantages may greatly outweigh captive performance traits which may be disadvantages in the hatchery.

STRAIN HISTORY

The strains of rainbow trout used in the study were the Fish Lake-Desmet (FLD), Ten Sleep (TS), Sand Creek (SC), Shepherd-of-the-Hills (SH), New Zealand (NZ), Beitey (B), and Desmet (D). All but the B and NZ strains are presently cultured by the DWR.

The B strain came to Utah from Beitey's Resort, Valley, Washington in May 1969. The strain was discontinued in the DWR's hatchery system in 1974. The SH strain was brought to Utah in 1970 from the Shepherd-of-the-Hills Hatchery, Branson, Missouri. Eggs are available from November 1 to January 1. The TS strain was received from Ten Sleep, Wyoming in 1971 and eggs are available from November 15 to January 1. The SC strain came from Sand Creek, Wyoming in 1971 and eggs are available from September 1 to February 1. The NZ strain was received from Beulah, Wyoming in 1971 and eggs are available from September 9 to April 1. The NZ strain was discontinued in the DWR's hatchery system in 1978. The D strain is from wild stock in Desmet Lake, Wyoming. Eggs are available from February 1 to May 1. The FLD strain represents a cross between the D strain and wild Fish Lake, Utah stock. Eggs are available from February 1 to May 1.

STUDY AREA

All fingerlings were stocked in Porcupine Reservoir, a fluctuating, multiple use, cold water reservoir located in Cache County, Utah, near Avon. Porcupine Reservoir is in the Bear River drainage; the main tributary is the East Fork of the Little Bear River. The reservoir is at an elevation of 1,615m and fluctuates in surface area from 80 to 22 hectares. When full, the reservoir has a mean depth of 20.1m, a maximum depth of 42.4m and a volume of $15.419 \times 10^6 m^3$. The DWR owns a conservation pool of $1.2335 \times 10^6 m^3$, or approximately 8 percent of maximum storage.

The limnology of the reservoir was previously studied and reviewed by the Environmental Protection Agency during the national eutrophication survey (EPA 1972). Porcupine is a hard water reservoir and has a total alkalinity ranging from 150-182 mg/l as $CaCO_3$. The mean secchi disc reading ranges from 0.7m in May up to 2.1m in the fall. Phosphorus is the limiting nutrient except in August, when nitrogen is limiting. The reservoir has a growing season of 150-200 days and has had no history of winter kill (Personal communication, D. Pitman, DWR Regional Fish Biologist).

The reservoir was filled and first stocked in 1962. A single dirt road provides access to the reservoir. The reservoir has been stocked annually with 20-60,000 rainbow trout fingerlings. In addition, up to 15,000 cutthroat trout fry have been stocked annually. Rainbow trout averaging 254-279 mm in length make up 94 percent of the catch by numbers (Unpublished data, DWR Regional Office, Ogden,

Utah). Kokanee salmon (Oncorhynchus nerka), cutthroat trout and brown trout (Salmo trutta) make up 3, 2 and 1 percent of the catch respectively. The top predators are cutthroat trout and brown trout.

Porcupine Reservoir experiences very heavy pressure opening day and maintains high fishing pressure throughout June (2,749 Angler Use Days-AUD). Pressure steadily drops through the summer (July, 1,350 AUD; August, 583 AUD) before increasing again in September (1,054 AUD) (Unpublished Porcupine Reservoir data, D. Pitman, DWR Regional Office, Ogden, Utah).

METHODS

Hatchery procedures and stocking

Care and maintenance of rainbow strains in the hatchery was the responsibility of others. Fingerlings stocked in 1978, except the B strain, were reared at the DWR's Glenwood Fish Hatchery and then shipped to the Logan Experimental Fish Hatchery for further rearing on May 11, 1978. Eggs from the B strain were received from the Utah Cooperative Fishery Research Unit and reared at the Logan hatchery. At the Logan hatchery, fish were reared in outdoor raceways (3m x 1.2m x .6m), one strain per raceway. Flows in each raceway were maintained at 37.8 liters/min. Raceway loading densities ranged from 2.79kg/m^3 - 13.3kg/m^3. Periodic monitoring showed that dissolved oxygen values were always above 7.0mg/l at the raceway outfall. Fish were fed Nelson's Silver Cup feed at standard rates and pellet sizes according to methods suggested by Leitritz and Lewis (1976). Fish were sampled weekly to adjust feeding rations. From June 14 till stocking (July 15) the FLD and NZ strains, the smaller fish, received a day's ration in twice daily feedings, while the four other strains received a day's ration in twice daily feedings every other day. The adjustment in feeding protocol was undertaken in an attempt to equalize the size of the fish at stocking time. In 1978, all strains were stocked on July 15 (Table 1). A pilot study to evaluate fall stocking (October 2) was also conducted with surplus fish of the TS, SH, SC, D and NZ strains (Table 1).

Table 1. Rainbow trout stocking data for Porcupine Reservoir (1978-79).

Strain	# Stocked	Length (STD)	Weight (STD)	Stocking Date	Tag
Ten Sleep	700[1/]	81.67 ± (7.67)	6.66 ± (1.68)	7/15/78	CWT
Sand Creek	1,200[1/]	83.57 ± (8.30)	6.58 ± (1.86)	7/15/78	CWT
New Zealand	5,127	66.45 ± (5.71)	3.70 ± (0.76)	7/15/78	CWT
Beitey	3,634	84.54 ± (8.69)	6.87 ± (2.09)	7/15/78	CWT
Shepherd-of-the-Hills	5,792	76.99 ± (10.60)	5.63 ± (1.71)	7/15/78	CWT
Fish Lake - Desmet	6,419	68.47 ± (8.04)	4.47 ± (1.61)	7/15/78	CWT
Ten Sleep*	1,600	131.31 ± (21.08)	27.75 ± (13.47)	10/2/78	FC
Shepherd-of-the-Hills*	1,100	117.08 ± (20.68)	21.17 ± (11.13)	10/2/78	FC
Sand Creek*	3,000	104.78 ± (15.93)	15.36 ± (6.71)	10/2/78	FC
Desmet*	5,000	73.20 ± (7.12)	4.55 ± (1.43)	10/2/78	FC
New Zealand*	1,000	78.61 ± (9.13)	5.96 ± (1.91)	10/2/78	FC
Ten Sleep	10,000	81.82 ± (7.90)	6.39 ± (2.05)	5/4/79	CWT
Sand Creek	10,000	79.05 ± (5.88)	5.43 ± (1.28)	5/4/79	CWT
Shepherd-of-the-Hills	10,000	84.50 ± (7.89)	6.79 ± (2.00)	5/4/79	CWT
Desmet	2,500	110.53 ± (12.36)	15.05 ± (5.15)	10/23/79	CWT
Fish Lake - Desmet	2,500	104.16 ± (11.80)	12.69 ± (4.25)	10/23/79	CWT

1/ Low numbers due to accidental mortality during transportation.

* Pilot study--extra fish that were not raised experimentally in the hatchery were fin clipped and stocked.

When the study was duplicated in 1979, fingerlings were reared by personnel of the Logan Experimental Fish Hatchery. Eggs from broodstock were received from the DWR's Egan Hatchery and reared at Logan. Moore Clark trout feed was used throughout the study at standard rates and pellet sizes suggested by Lietritz and Lewis (1976). Flow rates were adjusted to 0.12kg/l/min and each strain's density was adjusted to $8kg/m^3$. Fish were inventoried weekly.

Only the TS, SC and SH strains were stocked in the spring (May 1979, Table 1). Strains stocked in the fall were the D and FLD strains (Table 1). The D and FLD strains suffered an outbreak of myxobacteria before stocking and were treated prior to release.

Prestocking data on egg size, spawning date and broodstock age were determined (Table 2). In the July 1978 stocking, the B, TS and SC strains were statistically equal (α = .01) in length and weight at stocking. The SH strain averaged 6mm and 1g smaller than the B, TS and SC strains. The NZ and FLD strains were statistically equal (α = .01) and averaged 15mm and 2.5g smaller than the B, TS and SC strains (Table 2).

Prior to stocking each strain was sampled for proximal analysis of percent moisture, fat, ash and protein (Horwitz 1975). Protein was found by subtraction (Table 3). The NZ strain had a statistically higher (α = .05) percentage of body fat at stocking (Table 4).

In the May 1979 stocking, the TS, SC and SH were all statistically different (α = .01) in length. The maximum difference was 5.5mm. The SC strain was statistically different (α = .01) from TS and SH in stocking weight. The average difference was 1g (Table 3).

Table 2. Hatchery history of strains of rainbow trout stocked in Porcupine Reservoir (1978-79).

Strain	Date Spawned	# Eggs/Oz.	Broodstock Age (Years)	Date Stocked
Ten Sleep	1/10/78	264	5	7/15/78
Shepherd-of-the-Hills	1/10/78	290	5	7/15/78
Sand Creek	1/10/78	225	6	7/15/78
New Zealand	2/2/78	270	4	7/15/78
Fish Lake - Desmet	1/24/78	290	5	7/15/78
Beitey	1/MS/78	NA	4-6	7/15/78
Sand Creek	11/21/78	264	6	5/4/79
Shepherd-of-the-Hills	11/21/78	253	5	5/4/79
Ten Sleep	11/21/78	238	5	5/4/79
Fish Lake - Desmet	2/8/79	225	5	10/23/79
Desmet	2/10/79	277	4	10/23/79

NA - Not Available

MS - Multiple Spawning Dates

Table 3. Body composition of strains of rainbow trout stocked in Porcupine Reservoir (7/15/78 and 5/04/79).

Strain	Year	% Moisture	% Fat	% Ash	% Protein
Beitey	1978	75.2 ± (2.2)	7.6 ± (1.6)	2.4 ± (0.3)	14.9 ± (1.2)
Sand Creek	1978	73.9 ± (2.2)	8.5 ± (2.0)	2.4 ± (0.3)	15.2 ± (0.7)
Ten Sleep	1978	76.1 ± (1.9)	6.4 ± (1.4)	2.4 ± (0.4)	15.1 ± (0.9)
Shepherd-of-the-Hills	1978	74.8 ± (3.0)	7.8 ± (1.5)	2.7 ± (0.3)	15.2 ± (1.4)
Fish Lake - Desmet	1978	75.9 ± (1.3)	8.0 ± (1.6)	2.1 ± (0.3)	13.8 ± (1.2)
New Zealand	1978	73.7 ± (2.0)	10.2 ± (1.2)	2.0 ± (0.2)	14.0 ± (1.3)
Sand Creek	1979	76.2 ± (0.9)	5.9 ± (0.9)	2.6 ± (0.2)	15.3 ± (0.7)
Ten Sleep	1979	75.2 ± (0.7)	6.5 ± (0.5)	2.8 ± (0.4)	14.9 ± (1.9)
Shepherd-of-the-Hills	1979	75.8 ± (1.2)	5.9 ± (1.1)	2.4 ± (0.1)	15.9 ± (0.5)

n = 12

Table 4. Duncan's multiple range test of the mean % fat of six strains of rainbow trout stocked 7/15/78 in Porcupine Reservoir. $\bar{X}_i$ = means % fat of strain (i).

Strain	$\bar{X}_i$	$\bar{X}_i - \bar{X}_{TS}$	$\bar{X}_i - \bar{X}_B$	$\bar{X}_i - \bar{X}_{SH}$	$\bar{X}_i - \bar{X}_{FLD}$	$\bar{X}_i - \bar{X}_{SC}$
New Zealand (NZ)	10.2	3.8**	2.6**	2.4**	2.2*	1.7*
Sand Creek (SC)	8.5	2.1*	0.9	0.7	0.5	
Fish Lake - Desmet (FLD)	8.0	1.6	0.4	0.2		
Shepherd-of-the-Hills (SH)	7.8	1.4	0.2			
Beitey (B)	7.6	1.2				
Ten Sleep (TS)	6.4					

N = 72

n = 12

* = Significant .05

** = Significant .01

The three strains were statistically equal in the percentage of body fat at stocking.

Tagging methods and tag retention

All strains of rainbow trout were marked with the coded wire snout tag which has been used extensively in Pacific salmon fisheries management (Jefferts et al. 1963; Moberly et al. 1977; USFW 1976; USFW 1978). The coded wire system involves injecting a magnetized type 302 stainless steel wire tag into the snout of an anesthetized fingerling. The tag is permanently etched with a binary code for later identification and is 0.25mm in diameter and 1mm in length. A field sampling detector enables later identification by noting changes in the magnetic field when a tagged fish is passed through the detector. The tag, once detected, must be dissected out to read the binary code and determine the strain.

Tagged fish were held 2 weeks prior to stocking except the 1979 fall group, which was held 3 months. Mortality of each strain was less than one-half of 1 percent, most of which was attributed to anesthetic (MS-222-quinaldine mixture) overdoses. Tag loss after 2 weeks averaged 6 percent for the spring 1978 group with no significant differences between strains. The spring 1979 group averaged 1 percent tag loss again with no significant differences between strains. The fall 1979 group was tagged at 75mm and held 3 months until stocking at 125mm. High tag loss (up to 20 percent) was experienced in two of four raceways of this group of fish. In this case, fish without tags were sorted out prior to stocking and only tagged fish were stocked. In the spring of 1979,

fish known to have tags at 2 weeks were held in captivity to determine tag loss after 2 weeks. No tag loss occurred at 3 months.

Extra fish used in the pilot study (fall 1978) were finclipped. The following clips were used: adipose, left pelvic, right pelvic, both pelvics and anal.

Creel census and angler opinion survey

A single access road to Porcupine Reservoir facilitated the creel census. No creel census was conducted during the spring and summer of the 1978 fishing season. Tagged fish were collected from fishermen four times a week from September through November. Tagged fish first started returning to the creel in late September 1978. During the 1979 fishing season and June of 1980 a complete census was conducted on all weekends and holidays. A census was conducted on 40 percent of the weekdays in June and 20 percent of the weekdays from July through November.

Census station protocol was as follows: heads were removed from tagged fish and the head was placed in a sample bag along with a data tag showing the date, fish length and weight and method of capture. In the laboratory, the tag was removed from the head, placed under a dissecting microscope, and the strain was determined.

An angler opinion survey was also conducted at the census station. Angler groups were interviewed to determine harvest, hours fished and angler satisfaction. Fishermen were asked the following questions: When did you begin fishing? When did you stop fishing? Were you satisfied with: (1) overall fishing, (2) numbers of fish caught, and (3) size of fish? Total numbers of each fish species caught

and their lengths were recorded on a questionnaire data form. The experience of the fishermen as well as the method (boat or shore) and gear (artificial lures or bait) used was determined. Information that was confusing or uncertain due to a mixture of methods, gear or experience was not recorded.

Other fish collection

Vertical and horizontal gill nets (floating and contour sets) were used to collect fish each fall and spring from Porcupine Reservoir. Horizontal nets were 38m long and 1.8m high and consisted of four panels of the following mesh sizes: 3.2, 2.5, 1.9, 1.3 cm. The vertical nets were 3m wide and set in depths up to 35m. Single mesh sizes of 2.5cm and 1.9cm were used.

Electrofishing from a boat equipped with a boomshocker was used to collect fish in May 1980. A three phase 230 volt A.C. generator was used.

The East Fork of the Little Bear River above and below Porcupine Reservoir was sampled to determine an index of each strain's emigration. Standard backpack electrofishing equipment was used to periodically collect fish from several sections of the stream above and below the reservoir. Tagged emigrants caught by fishermen fishing in the East Fork of the Little Bear River above the reservoir were also identified at the creel census station.

Statistical analysis

Null hypotheses for all statistical tests were tested at both the .05 and .01 levels of significance. Levels of significance greater than .05 were considered not significant. Levels of

significance lower than .01 were given if found in the statistical tables used by Ott (1977) or Ostle and Mensing (1975). Confidence intervals (95 percent) were determined where applicable. All strain data were recorded on computer cards and analyzed on the Burroughs 6700 Computer using the SPSS statistical programs (SPSS 1975). Programs utilized were: ANOVA, REGRESSION, CROSSTABS, SCATTERGRAM and CONDESCRIPTIVE.

Binomial Chi-square analysis was used to analyze survival to the creel, catchability and migration data between strains. ANOVA tests (SPSS 1975) were run on all body composition and length and weight data to determine differences between strains. When the null hypothesis was rejected, multiple comparisons were run. For equal or near equal sample sizes a Duncan's Multiple Range Test was used (Duncan 1955; Ott 1977). For unequal sample sizes a Fisher's Multiple Comparison Test (LSD) was used (Ott 1977).

Total harvest and fishing pressure for all weekends and holidays involved no statistics, as these periods were completely censused for the entire fishing season. Weekday data were expanded by taking the average weekday value and multiplying it by the number of weekdays in that month. Weekend and holiday data was added directly to weekday data with no increase in confidence intervals. Confidence intervals (95 percent) for weekday harvest and fishing pressure data were determined by the following formula:

$$N\bar{x} \pm (t\ \alpha/2)\ \frac{Ns}{\sqrt{n}} \sqrt{\frac{N - n}{N}}$$

where:

N = number of weekdays in the month

n = number of weekdays sampled in the month

$\bar{x}$ = mean weekday value of component (x) for the month

s = standard deviation of component (x) for the month.

Estimates of the number of tagged rainbow trout returned for each month were determined. The average number of tagged fish for each weekday was multiplied by the number of weekdays in that month. The observed strain ratio of that month was then expanded to reach the estimated weekday total. The strains collected on the weekends and holidays of each month were then added to this total. The yearly estimate was the summation of each monthly estimate.

RESULTS

The study was designed to determine if strain differences occurred in survival to the creel, growth or catchability over 24 months. A duplicate study was conducted in part. The first spring group was stocked on 7/15/78 (July 78 group) and consisted of six strains (B, NZ, FLD, SH, SC, TS). The second spring group was stocked on 5/04/79 (May 79 group) and consisted of three strains (SH, SC, TS). Two groups were stocked in the fall of 1978 and 1979. The October 78 group (10/02/78) consisted of the TS, SH, SC, D and NZ strains. The October 79 group (10/23/79) consisted of the D and FLD strains.

Survival to the creel

The objective of this phase of the study was to determine if strains of rainbow trout had differences in their ability to survive to the creel when stocked as fingerlings in Porcupine Reservoir.

July 78 group. The July 78 group (stocked on 7/15/78) was analyzed for strain differences in survival to the creel over 24 months. After 24 months this group had an estimated survival to the creel of 6.7 percent. A total of 1,357 tagged fish were checked at the creel census station over the study period. Only 47 fish were returned the first fall; the first appeared in anglers' creels in early October. During the following June 1,173 fish were recovered; only 146 were recovered from July 1979 through June 1980. In May-June 1980, after the July 78 group had overwintered twice, 18 fish were

returned by gillnetting, electrofishing and angling. Four strains were represented (SH = 9, NZ = 6, FLD = 2, TS = 1).

After almost 2 years in the reservoir, the TS strain had 33.7 percent survival to the creel, while SH had 11.0 percent. The remaining strains had less than 6 percent survival to the creel (Table 5).

May 79 group. The May 79 group (stocked on 5/04/79) was analyzed for strain differences in survival to the creel over 14 months. After 14 months this group had an estimated survival to the creel of 7.1 percent. These fish first appeared in the anglers' creels in late June 1979. A total of 1,457 tagged fish were checked at the creel census station over the study period. The first summer and fall 1,119 were recovered, while 338 were recovered the following June. The SH strain was significantly (α = .05) higher than TS in survival to the creel during the first 7 months in the reservoir; however, no strain significantly (α = .05) differed from others in survival to the creel after more than 1 year in the reservoir (Table 6). There were no significant (α = .05) strain differences between angler returns and gillnetting and electrofishing returns.

Strains common to July 78 and May 79 groups. The three strains (SH, SC, TS) common to both the July 78 and May 79 groups differed in survival to the creel relative to each other from year to year (Table 7). In the July 78 group, TS, SH and SC were significantly different (α = .01) in survival to the creel. The TS strain performed the best (33.7 percent), followed by SH (11.0 percent) and SC (5.4 percent). In the May 79 group, the three strains were equal (α = .05)

Table 5. Cumulative survival to the creel of the July 78 strains, 12 and 24 months after stocking in Porcupine Reservoir.

		Cumulative Survival to the Creel							
		12 Months				24 Months			
Strain	#Stocked	#Observed	%Observed	%Expanded[1]	Statistics[2]	#Observed	%Observed	%Expanded[1]	Statistics[2]
TS	700	196	27.1	29.5		212	30.3	33.7	
SH	5,792	508	8.5	9.7		564	9.7	11.0	
B	3,634	172	4.6	4.8		178	4.9	5.5	
SC	1,200	54	3.9	4.5		57	4.8	5.4	
NZ	5,127	144	2.9	3.5		180	3.5	4.1	
FLD	6,419	146	2.3	2.6		166	2.6	2.9	

[1]Expanded from the creel census program.

[2]Strains connected by the vertical lines not statistically different (α = .01).

Table 6. Cumulative survival to the creel of the May 79 strains, 7 and 14 months after stocking in Porcupine Reservoir.

		Cumulative Survival to the Creel							
		7 Months (Summer & Fall)				14 Months			
Strain	#Stocked	#Observed	%Observed	%Expanded[1]	Statistics[2]	#Observed	%Observed	%Expanded[1]	Statistics[2]
SH	10,000	402	4.0	6.4		515	5.2	7.6	
SC	10,000	378	3.8	6.1		493	4.9	7.3	
TS	10,000	339	3.4	5.3		449	4.5	6.5	

[1]Expanded from the creel census program.

[2]Strains connected by the vertical lines not statistically different (α = .05).

Table 7. Combined survival to the creel at 14 months of the strains common to both the July 78 and May 79 groups.

	Survival to the Creel at 14 Months[1]							
	1978 Group		1979 Group		Combined 1978 & 1979			
Strain	#Stocked	#Observed	#Stocked	#Observed	#Stocked	#Observed	%Observed	Statistics[2]
TS	700	203	10,000	449	10,700	652	6.1	
SH	5,792	546	10,000	493	15,792	1,039	6.6	
SC	1,200	56	10,000	515	11,200	571	5.1	

[1]The 1978 group was studied for 24 months but for comparison, data for only 14 months was used.

[2]Strains connected by the vertical lines not statistically different (α = .05).

in survival to the creel. When data from the duplicate stockings were combined it was found that the TS and SH strains had statistically greater (α = .05) survival to the creel than the SC strain (Table 7).

Fall groups. Only 17 fish stocked in October 78 survived to the creel or were returned in gillnetting or electrofishing samples throughout the 21 months of the study. No fish stocked in October 79 were collected the following June.

Growth

The objective of this phase of the study was to evaluate growth differences between strains of rainbow trout stocked as fingerlings in Porcupine Reservoir.

July 78 group. Fish collected by gillnetting (n = 26) 2 months after stocking had an average growth rate of 32mm in length and 18g in weight per month. Statistical analysis for strain differences could not be conducted because of the small sample size. However, using specimens creeled on opening weekend (6/1/79), significant (ANOVA, α = .01) strain differences were found in the change in length and weight. When pairwise comparisons were made using Fisher's Least Significant Difference test (OTT 1979), the TS, SC and FLD strains had significantly (α = .01) greater mean changes in length than the B and NZ strains. Mean differences between the fastest growing strains (TS, SC, FLD) and the slowest (B, NZ) were as much as 15mm in length (Table 8). Using the same analysis, the TS, SC and B strains had significantly greater mean changes in weight than the FLD and NZ strains. Mean differences as much as 43g separated the fastest growing strains (TS, SC, B) from the slowest (FLD, NZ) (Table 9).

Table 8. Fisher's multiple comparison test of the mean change in length ($\bar{X}_i$) of six strains of rainbow trout stocked as fingerlings on 7/15/78 and creeled on 6/02/79 in Porcupine Reservoir.

Strain	$\bar{X}_i$	$\bar{X}_i - \bar{X}_{NZ}$	$\bar{X}_i - \bar{X}_B$	$\bar{X}_i - \bar{X}_{SH}$	$\bar{X}_i - \bar{X}_{FLD}$	$\bar{X}_i - \bar{X}_{SC}$
Ten Sleep (TS)	157.45	15.55*	12.65*	6.86*	5.02	2.52
Sand Creek (SC)	154.93	13.04*	10.13*	4.36	2.50	
Fish Lake - Desmet (FLD)	152.43	10.54*	7.63*	1.84		
Shepherd-of-the-Hills (SH)	150.59	8.69*	5.79*			
Beitey (B)	144.80	2.90				
New Zealand (NZ)	141.89					

N = 828

* = Statistically significant (α = .01)

Table 9. Fisher's multiple comparison test of the mean change in weight ($\bar{X}_i$) of six strains of rainbow trout stocked as fingerlings on 7/15/78 and creeled on 6/02/79 in Porcupine Reservoir.

Strain	$\bar{X}_i$	$\bar{X}_i - \bar{X}_{NZ}$	$\bar{X}_i - \bar{X}_{FLD}$	$\bar{X}_i - \bar{X}_{SH}$	$\bar{X}_i - \bar{X}_B$	$\bar{X}_i - \bar{X}_{SC}$
Ten Sleep (TS)	129.15	43.56*	25.72*	19.84*	11.63	1.25
Sand Creek (SC)	127.89	42.31*	24.46*	18.59*	10.38	
Beitey (B)	117.52	31.93*	14.09*	8.21		
Shepherd-of-the-Hills (SH)	109.31	23.72*	5.87			
Fish Lake - Desmet (FLD)	103.43	17.84*				
New Zealand (NZ)	85.59					

N = 465

* = Statistically significant (α = .01)

Too few fish were obtained by gillnetting to determine if size selectivity occurred between angler returns and those fish returned by gillnetting. When the strains were ranked according to weight gain in the reservoir, and then compared with an analogous ranking for weight at stocking, the rank order was similar (Table 10). The B strain was an exception.

Only 18 fish of the July 78 group were collected by gillnetting, electrofishing or angling in May and June 1980. The four strains (SH, FLD, NZ, TS) represented had a combined mean length of 298mm ±33 and a mean weight of 280g ±82. These 2-year-old fish could not be visually distinguished by length from the 1-year-old fish stocked in May 1979.

May 79 group. Fish collected by gillnetting and angling (n=1,220) 1 to 5 months after stocking had an average growth rate of 32mm in length and 21g in weight per month. Statistical differences (α = .05) were not detected. There were no strain differences (ANOVA, α = .05) in the change in length and weight of fish sampled by gillnetting and electrofishing before opening day on 5/5-9/80 (n=140). There were strain differences in the change in length (ANOVA, α = .05) but not in the change in weight (ANOVA, α = .05) of fish caught by anglers on opening day (5/31/80). When pairwise comparisons were made using Fisher's Least Significant Difference test (α = .01), the SC and TS were the fastest growing strains with mean differences in the change in length as much as 11mm more than the slower growing SH strain (Table 11). Fish collected by gillnetting and electrofishing had the same strain rank according to growth in the reservoir as fish creeled on opening weekend.

Table 10. Comparison of the rank of the July 78 strains in weight at stocking, with rank according to the change in weight after 10 months in Porcupine Reservoir (7/15/78 - 6/01/79).

Strain Rank			
At Stocking		After 10 Months	
Strain	Mean Weight(g)	Strain	Mean Change in Weight (g)
1. Beitey	6.87	1. Ten Sleep	129
2. Ten Sleep	6.66	2. Sand Creek	128
3. Sand Creek	6.58	3. Beitey	118
4. Shepherd-of-the-Hills	5.63	4. Shepherd-of-the-Hills	109
5. Fish Lake - Desmet	4.47	5. Fish Lake - Desmet	103
6. New Zealand	3.70	6. New Zealand	86

Table 11. Duncan's multiple range test of the mean change in length ($\bar{X}_i$) of three strains of rainbow trout stocked as fingerlings on 5/04/79 and creeled on 5/31/80 in Porcupine Reservoir.

Strain	$\bar{X}_i$	$\bar{X}_i - \bar{X}_{SH}$	$\bar{X}_i - \bar{X}_{TS}$
Sand Creek (SC)	194.13	11.16**	5.08
Ten Sleep (TS)	189.05	6.08*	
Shepherd-of-the-Hills (SH)	182.97		

N = 286

* = Statistically significant (α = .05).

** = Statistically significant (α = .01).

When the strains were ranked according to weight at stocking and the ranking compared to a ranking according to weight gain in Porcupine Reservoir, the rankings did not coincide. The SC strain was ranked third in weight at stocking, but had the greatest change in weight after 1 year in the reservoir (Table 12) compared to other strains.

Strains common to July 78 and May 79 groups. The three strains (SH, SC, TS) common to both groups performed similarly, relative to each other, in both years. In most comparisons between strains for weight and length attained in the reservoir, the SH strain had statistically (α = .05) poorer growth than either the TS or SC strains (Table 13).

Fall groups. Only 17 fish of the October 78 fish were returned from gillnetting, electrofishing or angling. Those fish that were captured could not be visually distinguished by length or weight from fish of the May 79 group, even though they had been in the reservoir 7 months longer.

Catchability (by month, method, year)

The objective of this phase of the study was to compare strains of rainbow trout for catchability in different months, and vulnerability to different fishing methods (boat or shore fishing) or gear (bait or artificial lures) used by recreational anglers in Porcupine Reservoir.

July 78 group. The strains had the same relative catchability each month (α = .05). Only 3.5 percent of those creeled were caught during the summer and fall immediately after stocking. Most fish (85.5 percent) were caught the following June, while 11 percent were caught during the next 12 months. Less than 2 percent were caught

Table 12. Comparison of the rank of the May 79 strains in weight at stocking, with rank according to the change in weight after 1 year in Porcupine Reservoir (5/04/79 - 5/31/80).

Strain Rank			
At Stocking		After One Year	
Strain	Mean Weight (g)	Strain	Mean Change in Weight (g)
1. Ten Sleep	7.90	1. Sand Creek	217
2. Shepherd-of-the-Hills	7.89	2. Ten Sleep	206
3. Sand Creek	5.88	3. Shepherd-of-the-Hills	198

Table 13. Mean change in length and weight from 7/15/78 - 6/01/79 and 5/04/79 - 5/31/80 in Porcupine Reservoir of the strains (TS, SC, SH) common to the July 78 and May 79 groups.

	July 78 Group	Statistics[1]	May 79 Group	Statistics[1]
Length	1. Ten Sleep (157mm)		1. Sand Creek (194mm)	
	2. Sand Creek (155mm)		2. Ten Sleep (189mm)	
	3. Shepherd-of-the-Hills (150mm)		3. Shepherd-of-the-Hills (182mm)	
Weight	1. Ten Sleep (129g)		1. Sand Creek (218g)	
	2. Sand Creek (128g)		2. Ten Sleep (208g)	
	3. Shepherd-of-the-Hills (109g)		3. Shepherd-of-the-Hills (199g)	

[1]Strains connected by the vertical lines not statistically different (α = .05).

in June 1980 (Table 14). No differences (α = .05) between strains were found in vulnerability to different methods (boat or shore fishing) or gear (bait or artificial lures) (Table 15). The majority of fish were caught by shore fishermen (83.2 percent) and fishermen using bait (97.4 percent).

May 79 group. The relative catchability among strains varied little each month except during July and August of 1979, when the SC strain was caught significantly less (α = .05) than the SH or TS strains. The majority (76.8 percent) of those creeled from the May 79 group were caught during the summer and fall immediately after stocking (Table 16). No differences (α = .05) between strains were found in vulnerability to different fishing methods or gear (Table 17). The majority of fish were caught by shore fishermen (91.8 percent) and fishermen using bait (96.3 percent).

Fall groups. Too few fish of the October 78 and 79 groups were creeled for statistical analysis. Only 17 fish from the October 78 group and 0 fish from the October 79 group were caught by angling during the study.

Migration

The objective of this phase of the study was to determine if stocked fish migrated out of Porcupine Reservoir into the East Fork of the Little Bear River. In addition, if migration occurred, were strain differences apparent which could explain lower survival to the creel of respective strains in the reservoir?

The number of tagged fish migrating upstream and downstream out of Porcupine Reservoir was small in proportion to the number stocked.

Table 14. The cumulative percent survival to the creel by month and strain of the July 78 group (7/15/78 - 6/30/80).

Strain	1978	1979						1980
	Jul - Nov	Jun	Jul	Aug	Sep	Oct	Nov	Jun
Beitey	3.3	94.9	98.9	98.9	100.0	--	--	--
New Zealand	1.6	80.0	93.9	93.9	95.5	97.7	97.7	100.0
Fish Lake - Desmet	3.6	87.9	89.7	89.7	89.7	95.8	95.8	100.0
Shepherd-of-the-Hills	2.7	88.6	95.3	95.3	97.2	98.1	98.9	100.0
Sand Creek	14.0	94.7	98.2	98.2	98.2	100.0	--	--
Ten Sleep	3.7	92.3	95.6	95.6	97.2	98.1	99.5	100.0
Total All Strains	3.5	89.9	96.2	96.4	97.8	98.3	98.6	100.0

Table 15. Number of each strain of the July 78 group caught by different methods (boat or shore fishermen) or gear (artificial lures or bait).[1]

Strain	Angling Approach					
	Method			Gear		
	Boat	Shore	Total	Artificial	Bait	Total
B	19	133	152	3	148	151
NZ	17	133	150	2	148	150
FLD	25	112	137	9	128	137
SH	95	372	467	11	454	465
SC	5	32	37	0	37	37
TS	28	154	182	5	177	182

[1]No statistical differences (α = .05) by strain.

Table 16. The cumulative percent survival to the creel by month and strain of the May 79 group (5/04/79 - 6/30/80).

Strain	1979						1980
	Jun	Jul	Aug	Sep	Oct	Nov	Jun
Shepherd-of-the-Hills	1.9	6.4	16.8	61.9	72.6	78.1	100.0
Sand Creek	0.2	3.0	6.9	52.1	69.2	76.7	100.0
Ten Sleep	0.4	5.1	15.4	55.2	70.2	75.5	100.0
Total All Strains	.9	4.9	13.0	56.6	70.7	76.8	100.0

Table 17. Number of each strain of the May 79 group caught by different methods (boat or shore fishermen) or gear (artificial lures or bait).[1]

Strain	Angling Approach					
	Method			Gear		
	Boat	Shore	Total	Artificial	Bait	Total
SH	34	441	475	14	461	475
SC	36	423	459	14	443	457
TS	40	369	409	21	386	407

[1]No statistical differences (α = .05) by strain.

Below the reservoir only five tagged fish were collected in qualitative electrofishing samples taken in October and November 1978 and April, May, June and November 1979. Movement upstream was more common, as 51 tagged fish were collected by qualitative electrofishing within 100 to 300m of the confluence with the reservoir (samples taken: Oct. 78, Nov. 78, April 79, May 79, June 79, Nov. 79). Few tagged fish were collected greater than 300m upstream from the confluence. Anglers caught 17 tagged fish upstream and zero tagged fish downstream from the reservoir in 1979. No tagged fish were collected from stream anglers in June 1980. The majority (66 percent) of tagged fish collected upstream by electrofishing or angling were B strain individuals indicating that the B strain may have a greater rheotropic tendency than other strains.

Angler satisfaction

The objective of this phase of the study was to determine the satisfaction of fishermen with: (1) overall fishing, (2) numbers of fish caught, and (3) size of fish caught in Porcupine Reservoir.

1979 fishing season. During the 1979 fishing season, 35.2 percent of the anglers were satisfied with the overall fishing, 31.4 percent with the numbers of fish caught, and 26.4 percent with the size of fish caught. The percentage of anglers satisfied with overall fishing varied by month from a high of 62.1 percent in September to a low of 22.6 percent in July. The anglers satisfied with the numbers of fish caught ranged from 21.5 percent in July to 57.1 percent in September. The percentage satisfied with fish size was similar with a low of 17.0 percent in July and a high of 45.5 percent in September (Table 18).

Table 18. Angler satisfaction with the overall fishing and numbers and size of creeled fish at Porcupine Reservoir during the 1979 fishing season.

Month	Percent of Anglers Satisfied With:			Mean Catch Rate		Mean Fish Size (mm)	
	Overall Fishing	Numbers Caught	Fish Size	Satisfied Anglers	Unsatisfied Anglers	Satisfied Anglers	Unsatisfied Anglers
June	31.9	27.2	24.8	.60	.20	260	238
July	22.6	21.5	17.0	.59	.08	304	160
August	38.3	36.5	26.5	.99	.11	232	207
September	62.1	57.1	45.5	.87	.16	217	198

The minimum catch rate of anglers satisfied with the numbers of fish was .59 fish/hr. (Table 19). The average size fish caught by anglers satisfied with fish size varied from 217mm in September to 304mm in July. The average size of fish caught by the dissatisfied angler was never greater than 242mm (Table 19).

During the 1979 fishing season, the satisfaction rating for anglers who caught at least one fish was: 53.7 percent satisfied with overall fishing, 48.0 percent satisfied with numbers of fish, 41.6 percent satisfied with size of fish. Four percent of the anglers who did not catch any fish were satisfied with the overall fishing.

Opening weekend 1980. The anglers were more satisfied in all aspects of the fishery during opening weekend of the 1980 fishing season than during the opening weekend of 1979. Angler satisfaction increased from 34.6 percent to 65.6 percent with the overall fishing, 28.1 percent to 58.9 percent with the numbers of fish caught, and 25.2 percent to 50.0 percent with the size of fish caught (Table 19).

The mean catch rate of satisfied anglers was .95 fish/hr. and that of dissatisfied anglers .36 fish/hr. (Table 19). The satisfaction rating of anglers who had caught at least one fish was: 74.9 percent satisfied with overall fishing, 61.2 percent satisfied with numbers of fish, and 57.7 percent with size of fish.

Fishing pressure and harvest

The objective of this phase of the study was to estimate the fishing pressure and harvest of fish in Porcupine Reservoir during the 1979 fishing season and in June of the 1980 fishing season.

1979 fishing season. An estimated 4,492 fishermen spent 14,659 hours fishing at Porcupine Reservoir during the 1979 fishing season

Table 19. Angler satisfaction with the overall fishing, numbers of fish, and the size of fish at Porcupine Reservoir during opening weekend of the 1979 and 1980 fishing season.

	Percent Satisfied With			Avg. Catch Rate (#/hr.) of Those Satisfied with Numbers (Avg. of Dissatisfied Anglers)	Avg. Fish Size of Those Satisfied with Fish Size (Avg. of Dissatisfied Anglers)
	Overall	Numbers	Size		
Opening Weekend 1979	34.6	28.1	25.2	.69 (.26)	260 (242)
Opening Weekend 1980	65.6	58.9	50.0	.95 (.36)	@

@ = not available

(Table 20). An estimated 6,530 fish were caught (65.1 percent rainbow trout, 6.3 percent cutthroat trout, 4.4 percent brown trout, 24.2 percent kokanee salmon) (Table 20). Boat fishermen (28.6 percent by number) caught 39.4 percent of the fish. Fish that had not been stocked comprised 36.5 percent of the total harvest. The majority of fishing pressure (49.2 percent) and harvest (36.5 percent) was in June. The percentage of fishing pressure in the remaining months was: July 17.0 percent, August 9.7 percent, September 12.9 percent, October 7.2 percent, November 4.0 percent. The percentage of harvest in the remaining months was: July 11.3 percent, August 11.8 percent, September 26.2 percent, October 9.1 percent, November 5.1 percent (Table 21). The catch rate of all species of fish combined ranged from .30 fish/hr. in July to .90 fish/hr. in September. The catch rate for the year was .45 fish/hr. (Table 21).

June 1980. An estimated 3,798 fishermen spent 14,137 hours fishing Porcupine Reservoir during the month of June in 1980 (Table 22). An estimated 7,161 fish were caught (6.9 percent rainbow trout, 2.7 percent cutthroat trout, 2.4 percent brown trout, 88 percent kokanee salmon) (Table 22). Boat fishermen (25 percent by number) caught 31.6 percent of the fish. Fish that had not been stocked comprised 93.1 percent of the June harvest. The catch rate for the month was .51 fish/hr. When these data were compared with similar data for the previous June, differences were apparent.

The hours spent fishing increased from 7,207 in 1979 to 14,137 in 1980 (Table 22). There were 5,964 more kokanee salmon and 1,180

Table 20. Expanded fishing pressure and harvest with 95 percent confidence intervals on Porcupine Reservoir for the 1979 fishing season.

	Method	Number of Fishermen	Hours Fished	Number of Fish Caught[1]			
				RBT	CTT	BRW	KOK
June	Boat	619 ± 60	2,211 ± 261	323 ± 72	71 ± 15	57 ± 10	318 ± 75
	Shore	1,637 ± 126	4,996 ± 352	1,350 ± 134	148 ± 36	96 ± 16	25 ± 5
July	Boat	232 ± 39	1,053 ± 230	49 ± 39	10 ± 0	10 ± 0	372 ± 143
	Shore	457 ± 40	1,444 ± 376	259 ± 118	21 ± 20	6 ± 0	10 ± 0
August	Boat	185 ± 112	606 ± 225	35 ± 66	8 ± 0	11 ± 16	470 ± 450
	Shore	338 ± 89	818 ± 260	191 ± 66	13 ± 16	8 ± 16	34 ± 18
September	Boat	140 ± 52	673 ± 243	345 ± 91	31 ± 41	3 ± 0	305 ± 183
	Shore	407 ± 155	1,219 ± 450	964 ± 552	30 ± 35	7 ± 12	17 ± 12
October	Boat	44 ± 109	147 ± 269	36 ± 51	12 ± 0	18 ± 31	0 ± 0
	Shore	282 ± 274	908 ± 873	450 ± 654	46 ± 67	32 ± 67	6 ± 5
November	Boat	65 ± 74	285 ± 450	55 ± 157	19 ± 31	11 ± 16	6 ± 15
	Shore	86 ± 64	299 ± 272	197 ± 388	2 ± 0	26 ± 47	17 ± 47
Total	Boat	1,285 ± 158	4,475 ± 711	843 ± 216	151 ± 54	110 ± 40	1,471 ± 512
	Shore	3,207 ± 358	9,684 ± 1,171	3,411 ± 959	260 ± 124	175 ± 86	109 ± 52
Grand Total		4,492 ± 391	14,659 ± 1,370	4,254 ± 983	411 ± 135	285 ± 95	1,580 ± 515

[1]RBT = rainbow trout; CTT = cutthroat trout; BRW = brown trout; KOK = kokanee salmon

Table 21. Monthly distribution of fishing pressure, fish harvest and the catch rate on Porcupine Reservoir during the 1979 fishing season.

Month	Percent of Fishermen	Percent of Hours Fished	Percent of Harvest	Catch Rate (number/hour)
June	50.2	49.2	36.5	.33
July	15.3	17.0	11.3	.30
August	11.6	9.7	11.8	.54
September	12.2	12.9	26.2	.90
October	7.3	7.2	9.1	.57
November	3.4	4.0	5.1	.57

Table 22. Comparison of fishing pressure and species harvest on Porcupine Reservoir for June 1979 and June 1980.

	Number of Fishermen	Hours Fished	Number of Fish Caught[1]			
			RBT	CTT	BRW	KOK
June 1979	2,256 ± 140	7,207 ± 266	1,673 ± 152	219 ± 39	153 ± 19	343 ± 75
June 1980	3,798 ± 173	14,137 ± 637	493 ± 40	187 ± 19	174 ± 26	6,307 ± 543

[1]RBT = rainbow trout; CTT = cutthroat trout; BRW = brown trout; KOK = kokanee salmon

fewer rainbow trout caught in June 1980 than in June 1979 (Table 22). More fish were caught in June 1980 (7,161) than were caught during the entire 1979 fishing season (6,530).

DISCUSSION

Survival to the creel

I found that the strains of rainbow trout used in this study had differences in survival to the creel when stocked as fingerlings in Porcupine Reservoir. The TS (33.7 percent) and the SH (11.0 percent) strains had the greatest survival to the creel of the July 78 group. The three strains (SH, SC, TS) in the May 79 group were not different (α = .05) in survival to the creel. Before factors affecting survival can be examined, a distinction should be made between survival and catchability.

In my study survival to the creel results indicate a strain's ability to survive long enough to be caught. However, it is possible that strain differences in catchability could bias survival to the creel results. To resolve the issue, I captured fish with gillnetting and electrofishing to determine survival, and compared this data with angler returns to determine whether survival to the creel was affected by catchability. Electrofishing with a boat shocker, used only in May 1980, was a more effective sampling method for rainbow trout than gillnetting. Neither method yielded statistically adequate sample sizes of the July 78 group because of 1) the large number (six) of strains tested in this group, and 2) the low initial numbers stocked of the TS and SC strains. However, trends were apparent, as those strains which had low survival to the creel also had low returns in gillnetting and/or electrofishing samples (Sept. 78, May 79, Oct. 79, Apr. 80, May 80). The effects of catchability on survival to the

creel for the July 78 group could not be evaluated after 2 years in the reservoir, since only 18 fish were captured by angling (14,137 hrs.), gillnetting and electrofishing (244 hrs.) in May and June 1980. On the other hand, adequate numbers of the May 79 strains were obtained by gillnetting and electrofishing to compare survival with catchability. There were no differences (α = .05) between the relative catch of each strain when angler caught fish were compared to fish caught by gillnetting and electrofishing. Although the possibility exists that some strains avoided both gillnetting and electrofishing, I feel this possibility is remote because brown trout, which are difficult to catch (4.4 percent of creel), were easily caught in gillnetting and electrofishing samples (14 percent of gillnet catch). I feel that low survival and not catchability was the main reason for poor survival to the creel of some strains. I feel survival to the creel was unaffected by catchability and is therefore a good index of overall survival; however, differences in hatchery and stocking characteristics could affect survival to the creel.

Variations in characteristics such as broodstock age, egg size, body composition, length and weight have been shown to affect hatchery and poststocking performance (Millenbach 1950, Burrows 1969, Fowler 1972, Gall 1975, Hosmer et al. 1979, Pitman 1979). Fish stocked in Porcupine Reservoir had slight differences in egg size and broodstock age, which might affect the size of fish at stocking and consequently the ability to compete and survive. There was no correlation (α = .05) between egg size and survival to the creel when a Spearman's Rank Correlation test (Ostle and Mensing 1979) was used. Although no statistical test was appropriate to examine the relationship between

broodstock age and survival to the creel, no relationship was apparent by visual examination of the data. Body composition at the time of stocking was different among strains of rainbow trout in the July 78 group, but not among the May 79 group. Differences in body composition among strains of other rainbow trout have been documented after 24 weeks under hatchery conditions (Reinitz et al. 1979). They did not, however, investigate noncaptive performance. Burrows (1969) found that experimentally increasing the body fat of coho salmon (O. kisutch) fingerlings at stocking led to a higher survival. In my study, there was no correlation (α = .05, Spearman's Rank Correlation) between the percent body fat at stocking and survival to the creel. The mean lengths and weights at stocking of strains in the July 78 group were different by as much as 15mm in length and 2.5g in weight. Differences in length and weight may affect the ability of a fish to compete for food and avoid predation. However, the mean lengths and weights of the strains at stocking were not correlated (α = .05, Spearman's Rank Correlation) with survival to the creel. Strains in the May 79 group had mean differences of 5mm in length and 1g in weight at stocking. Although no statistical test for correlation could be applied because of the few strains (three) in the group, no relationship between stocking length and weight and survival to the creel was indicated by visual examination of the data. Although differences in several hatchery and stocking characteristics existed in both the July 78 and May 79 groups, these differences were not correlated with survival to the creel. Therefore I conclude that the loss of 67-97 percent of the stocked fish was because of stress factors within the reservoir.

I feel that the three main factors affecting natural mortality of rainbow trout in Porcupine Reservoir are 1) low water levels in the fall and winter, 2) predation, and 3) competition. The conservation pool in Porcupine Reservoir is small (8 percent of maximum storage) and low water levels usually exist from September through April. These low water conditions allow increased predation and intensify competition (Bennett 1971). Predation by brown trout and cutthroat trout is also high after stocking. When gillnets were set 1 week after stocking, the stomachs of 50 percent of the brown trout caught in the nets contained at least one recently stocked rainbow trout (n = 29). Two 107mm rainbow trout were found in the stomach of one 308mm brown trout. Competition from kokanee salmon has been shown to severely limit rainbow trout fisheries in small impoundments, regardless of productivity type (Calhoun 1966). Kokanee salmon year class strengths varied in Porcupine Reservoir but populations levels were as high as 95 percent of the gillnet catches and 88 percent of the creel in June 1980.

Hooking mortality might also affect survival to the creel as small rainbow trout (150mm) were sometimes caught and released by Porcupine Reservoir anglers. If the released fish are caught by bait, the favorite gear used by anglers in Porcupine Reservoir, the majority may die because of hook inflicted injuries (Stringer 1967, Gresswell 1976). I have no information on the relative numbers of each strain that were caught and released or strain susceptibility to hook inflicted injuries. However, I believe that hooking mortality is minor to overall survival, since the number of hooked and released fish was relatively small compared to the number caught and kept. In addition, I doubt that

there would be strain differences in susceptibility to physical injury, such as hooking.

While mortality factors are important year round, they are most important in the fall. Fish stocked in the fall in Porcupine Reservoir faced the worst of seasonal conditions in terms of low water, competition and predation. I believe these severe conditions are the reason for less than 0.2 percent survival to the creel of the fish stocked in the fall. Too few fall stocked fish were returned for statistical analysis of strain differences in survival to the creel. However, based on this poor return of fall stocked fish, I conclude that spring stocking was superior to fall stocking in Porcupine Reservoir. Although spring stocking was superior, the same strain stocked each spring may perform quite differently from year to year.

The strains (SH, SC, TS) common to both test groups performed differently relative to each other in survival to the creel from year to year. The SH, SC, TS strains in the July 78 group were different in survival to the creel, while the same three strains (May 79 group) stocked the following year were equal in survival to the creel (α = .05). However, the two groups were evaluated under different sets of conditions, such as stocking time, stocking of different strain combinations, environmental conditions, and kokanee salmon population levels, which could affect strain performance. The May 79 group included only three strains and was stocked nearly 2.5 months earlier in the year than the July 78 group, which contained six different strains. In Porcupine Reservoir, year to year differences such as water level and food abundance undoubtedly occurred, but it is difficult to quantify the effects of these differences. Kokanee population

levels also varied (1,580 caught 1979, 6,307 caught June 1980), but it is equally hard to quantify the effects of competition. Perhaps the high kokanee population in 1979 and 1980 was the reason only 493 rainbow trout were caught in June 1980 compared to the 1,673 that were caught in June 1979. Environmental conditions, stocking time, fish population levels and intrastrain competition have all been suggested as factors affecting competition and survival and the subsequent performance of a strain from one year to the next (Rawstron 1973, 1977; Ayles 1976; Dolan and Piper 1979; Dwyer et al. 1980). In studies in California (Rawstron 1972, 1973, 1977), the Kamloops strain usually outperformed the Shasta and Whitney strains in four impoundments over several years. Several times, however, the Kamloops performed more poorly or equal to the other two strains. Performance depended on stocking time and the age and weight at stocking. Ayles (1976) found differences in the return of a strain stocked in the same ponds in two consecutive years. Differences depended on the year to year environmental conditions, stocking rate, strains with which it was stocked, and population levels of other fish in the pond. In Montana, four strains were stocked in two ponds in consecutive years (Dolan and Piper 1979, Dwyer et al. 1980). The McConaughy and Fish Lake strains performed differently relative to each other and varied as much as 18 percent in return from year to year in the same pond. These studies indicate that variable results in performance of the same strain, in the same body of water, can be expected. I feel that when choosing a strain for a management program, one should consider not just the performance over 2 years, but over a number of years under different conditions and in different bodies of water.

Overall, I conclude that the strains of rainbow trout used in this study had differences in survival to the creel. In addition, I conclude that spring stocking is superior to fall stocking for survival to the creel in Porcupine Reservoir.

Strain differences in survival to the creel can have a great effect on the economics of a fingerling stocking program. If strains that have superior survival to the creel are stocked, fewer fish would be needed to maintain the present harvest. The fewer the fish that are needed for stocking, the greater the reduction of hatchery costs. A hypothetical case based on my actual data can be used to illustrate. In Porcupine Reservoir, roughly 30,000 fingerlings are stocked each year. Over the 2 years of the study, the TS and SH strains were statistically equal in survival to the creel with a 8.3 percent return, while the SC strain had a 7.3 percent return. If all fish stocked were SC instead of TS or SH, an additional 4,109 fish would have to be stocked to provide the same harvest to anglers. Raising these fish would require additional hatchery space, food and personnel which adds directly to the costs of a fingerling management program. Although 4,000 additional fish a year is a small number, the figure represents only one reservoir and only a 1 percent difference in survival to the creel. Overall in Utah, 14 to 15 million fingerlings are stocked statewide every 2 years (Utah Divison of Wildlife Resources 1978). Strain differences in survival to the creel can also be much greater than 1 percent as was the case in the July 78 group in Porcupine Reservoir. If strain performance found in my study could be applied to reservoirs statewide, the present level of fishing success in those reservoirs could be maintained by stocking fewer fish. More

importantly, by maintaining the present hatchery production and matching strains to environments where they perform well, the catch rate and the anglers' satisfaction with Utah's trout fishing would be increased greatly.

Data from this study indicate that slight increases in the overall catch rate can dramatically increase angler satisfaction. During June 1979, 27.2 percent of the fishermen at Porcupine Reservoir were satisfied with the numbers of fish caught (no species preference indicated) when the catch rate was .33 fish/hr. Satisfaction increased to 58.9 percent in June 1980 when the catch rate increased to .51 fish/hr. By stocking strains with superior survival to the creel, it can be expected that the catch rate and angler satisfaction with the fishery will increase. Using 1979 stocking and fishing pressure data, every 4 percent increase in survival to the creel would have increased the catch rate for the entire year by .1 fish/hr. Clearly small increases in catch rate can change angler satisfaction, because a .2 fish/hr. increase in the 1980 catch rate nearly doubled the percentage of anglers satisfied with the numbers of fish caught. Small increases in catch rate could be accomplished by selecting strains with superior survival to the creel. I realize that there are many other aspects of a fishery (i.e. fish size, aesthetics, user density) which form angler opinion (Weithman and Katti 1980, Manning 1979); however, the number of fish caught is certainly a major factor.

I recommend that TS and SH be stocked with new untested strains in Porcupine Reservoir and other waters. The TS and/or SH strains could be used as a reference (Kincaid 1978) to which other strains

could be compared. Strains that consistently outperform the TS or SH can replace these strains in management use.

Growth

I found that the strains of rainbow trout had differences in growth after stocking as fingerlings in Porcupine Reservoir. In the July 78 group, the greatest change in length was attained by the TS strain, followed by the SC, B, SH, FLD and NZ. The TS strain also had the greatest change in weight, followed by SC, FLD, SH, B and NZ. In the May 79 group, the SC strain attained the greatest change in both length and weight, followed by TS then SH. Before the factors affecting strain growth can be examined, the manner in which growth was evaluated should be discussed.

Each strain's growth was determined from stocking until opening weekend. This period of time was 10 months for the July 78 group and 14 months for the May 79 group. Statistical analysis of growth past opening weekend was not conducted because of the small sample sizes obtained by either angling or gillnetting. Although growth differences among strains were evident from stocking until opening weekend, the possibility exists that the growth ranking may change with time. Growth rate changes with time have been observed in the hatchery (Leppink 1977). The Fish Lake strain weighed less at 13 weeks compared to six other strains; however, at 38 weeks the Fish Lake strain had attained the greatest weight. Although I believe growth rates of strains in Porcupine Reservoir may change during their second year, it is of little importance to management since most stocked rainbow trout are creeled in the first year (96 percent). The possibility

also exists that larger fish may have been selected to the creel. If selection was not equal among strains, ranking for growth from angler returns would not be valid. However, data collected in May 1980 by electrofishing and gillnetting indicate that measuring creeled fish was a reliable means of ranking strains for growth performance. Fish caught by angling had the same strain rank in growth as fish collected by gillnetting and electrofishing. Fish caught by angling were larger because they were collected 25 days later. Although the methods for determining growth were not biased for any one strain, many other factors could effect growth.

In the July 78 group, the rank in growth of each strain in the hatchery was correlated (α = .10, Spearman's Rank) with growth in the reservoir. In the May 79 group, captive and noncaptive growth performance could not be compared because there were not enough strains in the group to conduct a rank correlation test. However, SC had the poorest growth in the hatchery and the best growth in the reservoir, suggesting no relationship between hatchery and poststocking performance. Reinitz et al. (1979) found that the growth in the hatchery of genetically distinct strains, relative to each other, was the same regardless of which common diet was fed to all strains. However, I feel that in a reservoir strains may 1) not be on a common diet, and/or 2) have different abilities to forage for a common diet. Either of these possibilities may explain the growth differences I observed. However, food habit comparisons among strains was outside the scope of my study. I conclude that there are strain growth differences in noncaptive environments.

Although there were statistical growth differences among the strains stocked in Porcupine Reservoir, these differences are probably insignificant in terms of angler satisfaction. During the 1979 fishing season, anglers who were satisfied with fish size caught fish that averaged 260mm in length, while anglers who were dissatisfied caught fish that averaged 238mm, a difference of 22mm. In the July 78 group, only differences in length between the best growing strain (TS, 157mm) and the worst growing strain (NZ, 141mm) were great enough to possibly effect angler satisfaction. Mean differences less than 15mm could only be detected with large sample sizes and would go unnoticed by an angler with a creel limit of eight fish. Although strain differences in growth would have only slight effects on angler satisfaction, the time of stocking is very important in terms of the quality of the fall rainbow trout fishery in Porcupine and the anglers' satisfaction with fish size the following spring.

In Porcupine Reservoir, fingerling rainbow trout grew as much as 32mm/month and 21g/month from May through September. The remainder of the year rainbow trout growth was minimal. The July 78 group experienced only 3 months when growth conditions were optimum and consequently were not large enough to contribute to the fall fishery (less than 200 caught). These fish were also of a satisfactory size to only 25 percent of the anglers opening weekend 1979. Strains stocked in the May 79 group had nearly 6 months of growth by October and were accepted by fall anglers (over 1,700 caught). These fish were of a satisfactory size to 57 percent of the anglers on opening weekend 1980. As long as <u>only</u> 75mm fish are available for stocking in Porcupine Reservoir, I recommend that stocking take place in the

early spring to maximize angler satisfaction with the size of fish. If 125mm fish are available, stocking can occur 2 months later with no reduction in fish size.

I recommend that the TS and/or SC strains be stocked early each spring in Porcupine Reservoir to maximize growth, increase angler satisfaction and increase harvest in fall rainbow fishery.

Catchability

I found that the strains of rainbow trout used in this study were not different in catchability by different methods (boat or shore fishermen) or gear (bait or artificial lures). The relative catchability among strains did not vary by month.

Behavioral differences among strains can lead to specific habitat and food preferences which may effect a strain's vulnerability to different fishing methods or gear. By monitoring vulnerability, behavioral differences may be detected. For example, in California reservoirs the Kamloops strain's preference for limnetic areas made it more susceptible to boat fishermen. Escapement from shore anglers also enabled more of the Kamloops strain to reach a larger size (Cordone and Nicola 1970; Rawstron 1973, 1977). Trojnar and Behnke (1974) found that two strains of cutthroat trout stocked in a Colorado lake had different food habits. The Snake River cutthroat fed on the surface more and consequently was more vulnerable to fly fishing than the Pikes Peak cutthroat.

I found no differences among strains in vulnerability to different fishing methods or gear when stocked as fingerlings in Porcupine Reservoir. However, to use vulnerability to determine behavioral

differences, a diverse habitat is needed. Porcupine Reservoir is a small reservoir with little habitat diversity that would promote strain segregation. Although I found no differences in catchability, I recommend that further study take place on strain habitat and food preferences in larger, more diverse reservoirs.

Migration

I found that migration upstream and downstream out of Porcupine Reservoir was insignificant. Only the B strain was found to have a tendency to migrate.

The physical features of Porcupine Reservoir severely limit downstream migration and therefore preclude a definitive examination of the downstream migration tendencies of rainbow trout strains. Fish can only exit downstream over the spillway during high water years, and then only for short periods during spring runoff. During the remainder of the year fish must exit downstream through an irrigation pipe (1m in diameter) that has an intake in the deepest part of the reservoir. The irrigation pipe is closed off in the fall, after which there is no exit downstream. I feel this limited access is the reason only five fish were collected downstream. However, fish have access upstream throughout the year, which explains the greater number of tagged fish collected upstream from the reservoir.

Most (66 percent) of the fish that were captured upstream ($n = 68$) were the B strain. This movement may have resulted in a lower survival to the creel of this strain in the reservoir. The B and SC strains were equal ($\alpha = .05$) in survival to the creel in the reservoir; but when stream caught fish from 1979 were added to the reservoir catch,

the B was significantly higher in survival to the creel. I feel no tagged fish were caught upstream in June 1980 because the strains that were stocked exhibited little upstream migratory behavior compared to the B strain which was not stocked in 1979.

Differences in migration among strains of rainbow trout have been documented (Cordone and Nicola 1970, Rawstron 1973, Moring 1978) but the reasons for these differences are unclear. The migratory behavior of the B strain may be explained by its ancestry. The B strain originated in Washington and could have in its ancestral gene pool traits characteristic of the steelhead trout, the anadromous form of rainbow trout. Another possible explanation for the migratory tendencies of the B strain is that some fish contained an isozyme, the $B^{2''}$ form of lactate dehydrogenase, in the liver which has been found in steelhead trout (Utter and Hodgins 1972, Tsuyuki and Williscroft 1977). The $B^{2''}$ isozyme of lactate dehydrogenase may confer superior swimming ability and stamina to juvenile rainbow trout (Klar 1978). Berry and Hudy (1980) found no differences in survival in the reservoir among three groups of B strain fish, each possessing a different lactate dehydrogenase isozyme. However, they collected too few livers from fish which had migrated upstream to determine whether migratory behavior was based on the presence of certain lactate dehydrogenase isozymes.

I conclude that, except for the B strain, migration out of Porcupine Reservoir was minimal and therefore did not bias survival to the creel results. However, for reservoirs that have tributaries more conducive to migration, movement from the reservoir may be great

enough to effect the catch in the reservoir proper and, therefore, may effect management objectives.

Movement of fish from reservoirs in which they were stocked can be either beneficial or detrimental depending on the particular management objective. Migration of fish into other waters can provide fishing opportunities where no fish previously existed, or they can augment existing fisheries, both without additional stocking costs. Conversely, stocked fish may move into waters which are not or cannot be fished. In this case, the hatchery product is essentially wasted from a management point of view since reduced angler success can occur (Moring 1978). Movement may also impact existing fish populations through competition or hybridization. Behnke and Zarn (1976) felt that indiscriminate rainbow trout stocking and subsequent hybridization has contributed to a severe reduction of native trout stocks in the west.

I recommend that the migratory behavior of a strain be considered before stocking, since migration could 1) bias catch rate and survival data collected routinely by many agencies, and 2) effect management objectives of the watershed.

Fishing pressure and harvest

I found that an estimated 4,492 fishermen spent 14,659 hours catching 6,530 fish in Porcupine Reservoir during the 1979 fishing season. In 1980 a creel census was only conducted in June during which an estimated 3,798 fishermen spent 14,137 hours catching 6,307 fish.

Confidence limits around the estimates of fishing pressure and harvest in this study were relatively small because weekend and holiday

data were completely censused. Confidence limits were larger in the fall months because of the variance in fishing pressure and harvest caused by the variable fall weather. This trend has also been noticed on other lakes (Malvestuto and Davies 1979).

It is difficult to compare results of this study with previous pressure and harvest estimates obtained by DWR personnel on Porcupine Reservoir. The DWR data were collected for trend analysis and do not have the statistical confidence limits which are needed for valid comparisons. However, some trends are apparent between the two data sets. For example, both were similar in that approximately 50 percent of the yearly fishing pressure and harvest took place in June. The major difference between my study results and the DWR trend data concerned species composition of the harvest. In DWR data, kokanee salmon never made up more than 5 percent of the harvest, while in my study, kokanee were 65 percent of the harvest in 1979 and 88 percent in June 1980. I do not know whether kokanee populations will remain strong or whether the last 2 years were just the peak of a cycle.

Strain differences in behavior or growth might cause strains to enter the creel at different times and subsequently effect monthly harvest and fishing pressure. However, monthly trends in fishing pressure and harvest could not be attributed to strain differences, as the strains used in this study were not different in relative catchability by month. However, the stocking time of fingerling rainbow trout can greatly influence fishing pressure and harvest in the fall at Porcupine Reservoir.

Fish stocked early in the spring can reach an acceptable size to fishermen that fall and greatly increase the catch rate, harvest and

fishing pressure in the fall months at Porcupine Reservoir. In September 1979, 547 fishermen spent 1,892 hours, catching 1,702 fish, 75 percent of which were stocked in May 1979. If the fingerlings had been stocked in July they would not have entered the creel that fall, as they would have been approximately 50mm smaller, and would have reduced the harvest and fishing pressure in the fall months.

No strain used in this study can be recommended that would change monthly fishing pressure and harvest trends in Porcupine Reservoir; however, early spring fingerling stockings can increase fishing pressure and harvest in the fall.

CONCLUSIONS

I reached the overall conclusion that strains are different in noncaptive performance and that these differences can be used as management tools. I recommend that TS and/or SH be stocked in the future at Porcupine Reservoir. These strains will maximize the number of fish available to anglers. Specific conclusions from my work were as follows:

1. The strains of rainbow trout used in this study had differences in survival to the creel when stocked as fingerlings in Porcupine Reservoir.
2. Regardless of strain, spring stocking of fingerling rainbow trout was superior to fall stocking in survival to the creel in Porcupine Reservoir.
3. The strains of rainbow trout used in this study had differences in growth when stocked as fingerlings in Porcupine Reservoir.
4. The strains of rainbow trout used in this study had no differences in catchability by month, method or gear in Porcupine Reservoir.
5. Except for the B strain, there was no appreciable migration of rainbow strains out of Porcupine Reservoir.
6. Differences in noncaptive performance among strains were great enough to affect the anglers' satisfaction with the numbers and size of fish caught in Porcupine Reservoir.

7. An estimated 4,492 fishermen spent 14,659 hours catching 6,530 fish in Porcupine Reservoir during the 1979 fishing season.

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