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CHANGES IN THE BROWN TROUT POPULATION IN GARY CREEK, SOUTH DAKOTA,1988-1993

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ABSTRACT

Brown trout (*Salmo trutta*) were sampled in Gary Creek, South Dakota, during the fall of 1988 and 1990-1993 using a backpack-mounted, pulsed-DC electrofishing unit. Relative abundance of stock-length (≥15 cm) brown trout was not significantly different among years; however, size structure increased. Brown trout proportional stock density (PSD; percentage of 15-cm and longer fish that are also longer than 23 cm) was 50 and relative stock density or preferred-length fish (RSD-P; percentage of 15-cm and longer fish that are also longer than 30 cm) was 4 in 1988. In 1993, PSD was 100 and RSD-P was 61. Natural reproduction of brown trout has declined over the 1988-1993 time period. However, the stream was annually stocked with catchable-size (20-23 cm) brown trout. Habitat may be limiting natural reproduction and recruitment. While Gary Creek might be considered a "quality" brown trout population for a stocked population, the high PSD certainly reflects the lack of natural recruitment in recent years.

Put-and-take fisheries management is desirable in situations where angler harvest is high, or natural recruitment is limited (Cooper, 1959; Vincent, 1987). In 1983, the South Dakota Department of Game, Fish and Parks (SDGFP) established a put-and-take fishery in Gary Creek (Deuel County), stocking brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*).

Milewski and Willis (1989) documented natural reproduction of brown and rainbow trout in Gary Creek, but found low winter survival of age-0 trout, which suggested that habitat may be limiting natural recruitment. They also noted that survival of adult trout was low. The purpose of this paper is to document year-to-year variation in natural recruitment and its potential effects on brown trout relative abundance and size structure from 1988 to 1993.

STUDY SITE

Gary Creek originates in Deuel County, South Dakota on the eastern edge of the Coteau des Prairies. It is a low-discharge, groundwater-dependent stream. The study site is west of the town of Gary, South Dakota. Characteristics of the stream within the study site include: cold, clear water; rubble and gravel substrate; and a succession of pools, runs and riffles. Fishes collected in Gary Creek during 1988 electrofishing included rainbow trout, brown trout, longnose dace (*Rhinichthys cataractae*), creek chubs (*Semotilus atromaculatus*), northern redbelly dace (*Phoxinus eos*), fathead minnows (*Pimephales promelas*), brassy minnows (*Hybognathus hankinsoni*), and Iowa darters (*Etheostoma exile*) (Milewski and Willis 1989). SDGFP stocked catchable-size (20-23 cm) brown trout in 1983 and during 1988-1992, and rainbow trout into Gary Creek during 1983-1987.

METHODS

We sampled Gary Creek during the fall of 1988 and 1990-1993 (no data were collected in 1989 because of equipment failure) using a backpack-mounted, pulsed-DC electrofishing unit. On 28 September 1993, population estimates were made in the same study section sampled by Milewski and Willis (1989) using the removal method (Zippin, 1958). Stream sections were blocked with 9.5-mm mesh block nets before successive removal of trout. Actual stream length in the blocked section was 100 m in our study and 90 m in the 1988 study (Milewski and Willis 1989). Three passes (upstream) were made through each section. To increase sample size of trout caught in 1990-1993, one pass (upstream) was also made through the 425-m section of stream that was sampled in 1988 by Milewski and Willis (1989). All trout collected were identified to species, tallied, measured [nearest mm total length (TL)], and weighed (nearest g). After data were collected, fish were released. Fish collected in the blocked sections were released below that section.

Differences in catch per unit effort (CPUE; number/hr of electrofishing) of brown trout between years were tested using a Kruskal-Wallis one-way analysis of variance by ranks (Daniel, 1990) because the data were not normally distributed. When the null hypothesis was rejected (i.e., when we found differences in the rank distributions) at alpha=0.05, we used Dunn's multiple comparison to determine which years differed at an alpha level of 0.15 (Daniel, 1990).

Adult brown trout population size structure was quantified using proportional stock density (PSD; Anderson, 1976) and relative stock density of preferred-length fish (RSD-P; Wege and Anderson, 1978). The formulae for these indices are:

$$PSD = \frac{\text{Number of quality-length fish X 100}}{\text{Number of stock-length fish}},$$

and

$$RSD\text{-}P = \frac{\text{Number of preferred-length fish X 100}}{\text{Number of stock-length fish}}.$$

For stream-dwelling brown trout, minimum stock, quality, preferred, memorable, and trophy lengths are 15, 23, 30, 38, and 46 cm, respectively (Willis et al., 1993). The 95% confidence intervals (CI) for PSD and RSD-P were calculated using the table provided by Gustafson (1988). Relative weight (*Wr*) was used to determine body condition (Wege and Anderson, 1978). The standard weight (*Ws*) equation for stream-dwelling brown trout, as determined by the "regression line percentile" (RLP) technique (Murphy et al., 1991), is $\log_{10}Ws = -4.867 + 2.960(\log_{10}TL)$, with *Ws* in grams and TL in millimeters (Milewski and Brown, 1994). The RLP technique is used to develop *Ws* values based on the 75-percentile weights of fishes collected over a broad geographic area. For this study, recruitment was defined as having occurred if fish were present in the fall as age-1 fish.

RESULTS AND DISCUSSION

Rainbow trout were not collected during 1990-1993, although natural reproduction and recruitment were documented in 1988. Rainbow trout disappeared from this site with the cessation of rainbow trout stockings and subsequent stockings of catchable brown trout. Thus, we excluded rainbow trout from further analysis.

The brown trout population estimate and 90% CI for 1993 in the 100-m section of stream was 8.09 ± 0.71, with 12.5% of this estimate being composed of age-0 brown trout. This estimate is much lower than the 1988 estimate of 37.6 ± 12.5 brown trout per 90 m of stream. However, in 1988, age-0 brown trout composed 81% of the population estimate (Milewski and Willis, 1989). When age-0 brown trout were removed from these estimates, the density estimates of adult trout were similar (i.e., 7 per 90 m of stream in 1988 and 7 per 100 m of stream in 1993). Additionally, relative abundance (evidenced by CPUE) of stock-length brown trout has not changed during 1988 to 1993 (Table 1).

Over time, relative abundance (evidenced by CPUE) of age-0 and age-1 brown trout has declined while size structure has increased (Table 1, Figure 1). Natural reproduction of brown trout (evidenced by CPUE of age-0 fish) declined to the point where no age-0 brown trout were collected in 1992 and only one was collected in 1993 (Table 1), compared to estimates of one age-0 brown trout per 3 m of stream in 1988. Catchable brown trout were stocked in early summer at a length of approximately 20-23 cm. Thus, all sub-stock and most stock- to quality-length brown trout collected during our fall sampling were wild fish. Brown trout in the larger length categories may be wild or hatchery stock.

The trend in the brown trout population of Gary Creek during 1988-1993 has been reduced natural reproduction with an increase in size structure of adult fish. We do have some evidence that water discharge at Gary Creek has increased nearly three-fold in recent years (Table 2). Increased water discharge may be favorable for annual survival of adult brown trout, thus increasing brown trout size structure. Milewski and Willis (1989) reported high total annual mortality for adult brown trout and suggested winter habitat was limiting. Increased water discharge may increase winter habitat.

Gary Creek produced a trophy-length (≥46 cm) brown trout in 1993. This is a favorable situation for anglers who prefer to catch larger brown trout. Typically with improved quality of individual fish, CPUE (which is directly related to density) and presumably numbers harvested declines (i.e., anglers do not generally catch as many fish). However, CPUE of stock-length brown trout did not decrease with the increased trout size structure in Gary Creek.

Mean *Wr* of brown trout varied across length categories (Figure 2). Brown trout in the preferred- to memorable-length and memorable- to trophy-length categories had higher *Wr* than fish in the quality- to preferred-length category in 1992 and 1993. The quality- to preferred-length category included the catchable-size fish stocked that year, and intraspecific competition may have been high. There may also be a diet shift for larger brown trout, resulting in higher *Wr*. Frost and Brown (1967) concluded that larger brown trout are more likely to be piscivorous than smaller ones. However, they cautioned that the extent to which brown trout are piscivorous and the size at which they become piscivorous is variable.

Based on the results of this study, Gary Creek currently produces a quality brown trout fishery based on two components: put-and-take, and put-grow-and-take. Continued annual stockings appear necessary to retain a sport fishery because natural reproduction and recruitment of brown trout has declined substantially in recent years. Stream habitat improvements on Gary Creek would create deep pools and hiding cover, and likely result in increased overwinter survival (Thorn, 1988) and biomass (Hunt, 1988).

Table 1. Number (N), catch per unit effort of age-0 fish (CPUE-A_0; mean number caught per min of electrofishing ± 1 SE), CPUE of stock-length fish (CPUE-SL; mean number caught per min of electrofishing ± 1 SE), proportional stock density (PSD ± 95% CI), and relative stock density of preferred-length fish (RSD-P ± 95% CI) for brown trout collected in 425-m section of Gary Creek, South Dakota.

Year	N	CPUE-A_0[a]	CPUE-SL[b]	PSD	RSD-P
1988	106	0.73	0.24	50 ± 24	4[c]
1990	120	1.54 ± 0.50[x]	0.24 ± 0.10	28 ± 28	0[c]
1991	70	-	-	38 ± 14	0[c]
1992	29	0.00 ± 0.00[y]	0.83 ± 0.30	93[c]	19 ± 19
1993	29	0.05 ± 0.05[y]	0.36 ± 0.14	100[c]	59 ± 23

[a] The same letters in this column indicate no difference in the ranked median based on Dunn's multiple comparison (alpha=0.15). 1988 data were excluded from this analysis because no variance existed due to sampling technique.

[b] No difference in the ranked median was found based on Kruskal-Wallis one-way analysis of variance (alpha=0.05). 1988 data were excluded from this analysis because no variance existed due to sampling technique.

[c] Sample size was insufficient to calculate the 95% CI.

Table 2. Discharge (m^3/s) and conductivity ($\mu S/cm$) measurements obtained at Gary Creek.

Date	Discharge	Conductivity
9-2-88	0.0784	630
4-28-90	0.0868	830
9-4-92	0.2128	690
10-19-93	0.2436	600

ACKNOWLEDGMENTS

Manuscript review was provided by M. Flammang, C. Milewski, and R. Neumann. This manuscript was approved for publication by the South Dakota Agricultural Experiment Station as Journal Series Number 2781.

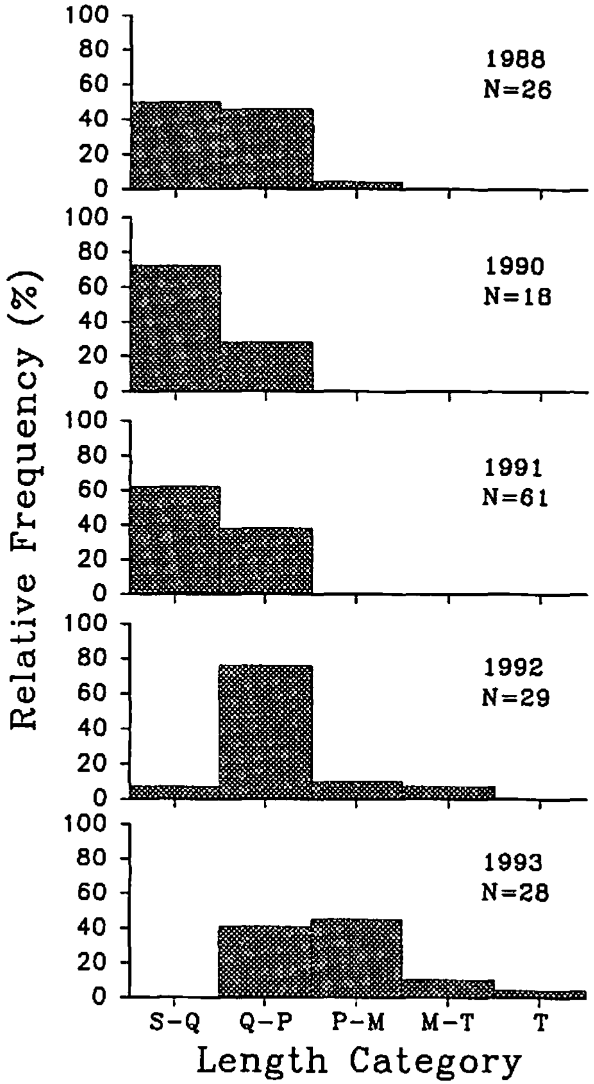

Figure 1. Relative size structure of brown trout collected from Gary Creek, South Dakota during fall electrofishing [S = stock (15 cm), Q = quality (23 cm), P = preferred (30 cm), M = memorable (38 cm), and T = trophy (46 cm)]. Sample size (N) is indicated under the year.

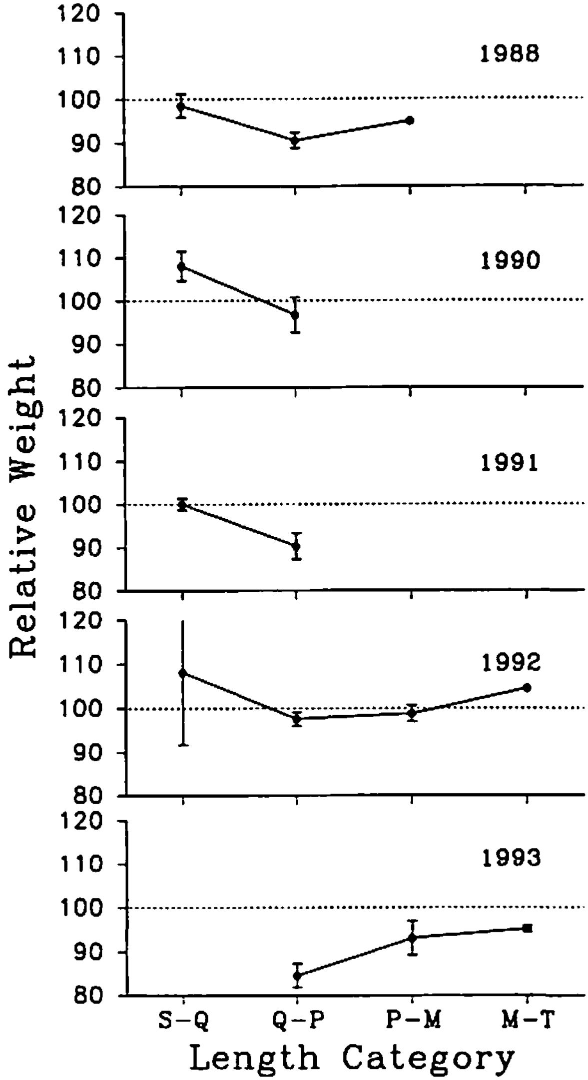

Figure 2. Mean relative weight (*Wr*, ± 1 SE) by length category for brown trout collected from Gary Creek, South Dakota during fall electrofishing [S = stock (15 cm), Q = quality (23 cm), P = preferred (30 cm), and M = memorable (38 cm)]. The dashed horizontal lines indicate a *Wr* of 100, which is a value based on the 75-percentile weights for brown trout populations collected over a wide geographic area.

REFERENCES

Anderson, R. O. 1976. Management of small warm water impoundments. *Fisheries* 1(6):5-7;26-28.

Cooper, E. L. 1959. Trout stocking as an aid to fisheries management. Penn. Ag. Exp. Station, Bulletin Number 663, University Park.

Daniel, W. W. 1990. *Applied nonparametric statistics*, 2nd edition. PWS-Kent Publishing Company, Boston, Massachusetts.

Frost, W. C., and M. E. Brown. 1967. *The trout*. Collins Clear-Type Press, London, England.

Gustafson, K. A. 1988. Approximating confidence intervals for indices of fish population size structure. *North American Journal of Fisheries Management* 8:139-141.

Hunt, R. L. 1988. A compendium of 45 trout stream habitat development evaluations in Wisconsin during 1953-1985. Wisc. Dept. of Natural Resources, Technical Bulletin No. 162, Madison.

Milewski, C. L., and M. L. Brown. 1994. Proposed standard weight (*Ws*) equation and length-categorization standards for stream-dwelling brown trout (*Salmo trutta*). *Journal of Freshwater Ecology* 9:111-116.

Milewski, C. L., and D. W. Willis. 1989. Reproduction, recruitment, and survival of brown and rainbow trout in a prairie coteau stream. *The Prairie Naturalist* 21:147-156.

Murphy, B. R., D. W. Willis, and T. A. Springer. 1991. The relative weight index in fisheries management: status and needs. *Fisheries* 16(2):30-38.

Thorn, W. V. 1988. Evaluation of habitat improvement for brown trout in agriculturally damaged streams of southeastern Minnesota. Minn. Dept. of Natural Resources, Investigational Report No. 394, St. Paul.

Vincent, E. R. 1987. Effects of stocking catchable-size hatchery rainbow trout on two wild trout species in the Madison River and O'Dell Creek, Montana. *North American Journal of Fisheries Management* 7:91-105.

Wege, G. J., and R. O. Anderson. 1978. Relative weight: a new index of condition for largemouth bass. Pages 79-91 IN G. D. Novinger, and J. G. Dillard, editors. *New approaches to the management of small impoundments*. North Central Division, American Fisheries Society, Special Publication Number 5, Bethesda, Maryland.

Willis, D. W., B. R. Murphy, and C. S. Guy. 1993. Stock density indices: development, use, and limitations. *Reviews in Fisheries Science* 1:203-222.

Zippin, C. 1958. The removal method of population estimation. *Journal of Wildlife Management* 22:82-90.