Historical Changes in the Brown Trout Fishery in the Smith River Tailwater, Virginia: A Case History

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Abstract: Historical data on brown trout from the Smith River tailwater, Virginia, below Philpott Dam, from 1971–2002 were reviewed to assess changes in the fishery during the time period. Data from citation brown trout (>2268 g) and electrofishing data were evaluated for changes in size distribution and fish condition. The number of citation brown trout declined over the time period. Relative stock density also decreased. Although relative condition of citation brown trout was high in the early 1970s, values decreased and remained stable after 1980. Declines in the number of trophy-sized trout and smaller size distribution may be related to trophic interactions, overexploitation, water quality or trophic status changes, or limitations in food availablility.

Key words: Brown trout, *Salmo trutta,* tailwater

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The Smith River tailwater below Philpott Dam has been called a top quality trout fishery and has been nationally recognized as one of the top 100 trout streams by Trout Unlimited (Ross 1999). In the Southeastern United States, the numbers of natural coldwater areas are limited; however, many tailwater trout fisheries exist where hypolimnetic dam releases occur. Unlike many tailwater trout fisheries, the Smith River tailwater contains a self-sustaining population of brown trout *(Salmo trutta)* which provides a unique opportunity for anglers to fish for wild brown trout.

Historical accounts of the Smith River trout fishery indicate that the tailwater produced trophy-sized brown trout. Over a three-week period in 1974, the state brown trout record was broken on three separate occasions in the Smith River, with the largest trout weighing 6.5 kg (Cochran 1975). With the potential to catch a trophy-sized brown trout, the Smith River tailwater gained popularity with regional anglers.

While it was once common for anglers to catch brown trout weighing more than 1.6 kg, the trout population seldom produced fish of the size (>406 mm) desired by anglers (Hartwig 1998). The Smith River tailwater has been a trout fishery since

1954, when trout were first stocked into the tailwater area. Although changes in the reservoir and tailwater fisheries have occurred, these changes have not been documented. This case history will report historical changes in the tailwater fishery from 1971–2002 and discuss possible causes for changes in the fishery.

Study Area

The Smith River is a fifth order tributary of the Dan River located in Henry County, Virginia. The Smith River became impounded in 1953 with the completion of Philpott Dam, which is owned and operated by the U. S. Army Corps of Engineers. The dam was built for flood-control purposes and to serve as an electric hydropeaking facility. Currently, flows fluctuated between 1.27 cubic meters per second (cms) minimum base flow and 39.65 cms generation flow. Hypolimnetic water releases from Philpott Reservoir, drawn from 26 m below the surface, maintain cold temperatures in the tailwater for approximately 23 km (Krause, in review).

The tailwater was stocked with rainbow trout *(Oncorhynchus mykiss)* and brown trout by the Virginia Department of Game and Inland Fisheries (VDGIF) following completion of Philpott Dam to create a coldwater fishery. However, beginning in the late 1960s, there was anecdotal evidence of brown trout reproduction, which was documented in 1977 by biologists from VDGIF. By the mid-1980s, brown trout stocking was discontinued in the Smith River, but 31,000 harvestable sized rainbow trout (250–325 mm) are still stocked annually.

In 2002, the tailwater fishery was managed by VDGIF, with two trout management strategies in the Smith River tailwater. The section immediately below Philpott Dam to Town Creek (5.3 km below the dam) and the section from the towns of Bassett to Koehler (10.0–24.0 km below the dam) were managed with a 178-mm minimum length limit and 6 trout per day creel limit. In July 1976, the section of the tailwater from Town Creek to the town of Bassett (5.3–10.0 km below the dam) was established as a Special Regulations Section and management as a trophy trout area began with a 406-mm minimum length limit, two-trout-per-day creel limit, and single hook artificial lure gear restriction.

Methods

Brown trout length and weight data from citation brown trout and citation numbers were collected using citation catch records from 1971–2002 from the Virginia Angler Recognition Program of VDGIF. Through the Virginia Angler Recognition Program, citation fish are certified by weight by taking the fish to a designated store with certified scales with the clerk completing the weight witness information on the application. Citation fish are certified by length by having an observer witness the length and completing the witness information on the application or by submitting a photo of the fish on a measuring rule with the application. Beginning in the 1990s, a US$4 fee was added for issuing a citation. The citation criteria for brown trout changed over the years with a 907-g minimum weight from 1971–1983. From

1984–1988, minimum citation weight for trout was 1361 g; and from 1989–1991, the minimum weight was 1814 g. Beginning in 1992, the minimum weight requirements for brown trout was raised to 2268 g, and starting in 1995, a 635-mm minimum length could be used in place of minimum weight requirements. Data from citation trout from 1971–1983 was used to assess trends from 1971–1983, and data from citation trout > 2268 g was analyzed to assess changes from 1971–2002.

Electrofishing was used to assess the trout population in 1983–1984, 1989, 1991–2002. During the 1980s and 1990s a variety of electrofishing gear types were used including barge, boat, and backpack electrofishing units. From 2000–2002, paired electrofishing barges were used to collect brown trout. During all collection years, brown trout were measured to the nearest mm TL. In 1991–1992 and 1998–2002, trout were weighed to the nearest g.

Relative stock density (RSD) indices were used to assess length-frequency distribution of trout sampled by electrofishing. Relative stock density (Wege and Anderson 1978) was calculated by the formula: RSD = (number of fish≥specified length/number of fish≥minimum stock length) × 100; where the specified lengths are 230 mm (quality length) and 300 mm (preferred length) and minimum stock length is 150 mm (Milewski and Brown 1994). Confidence intervals were calculated for RSD values according to Gustafson (1988).

Trout condition was assessed by relative weight (W_r; Wege and Anderson 1978) and was calculated for all citation trout and trout sampled by electrofishing. Relative weight of trout > 140 mm was calculated by the formula: $W_r = (W/W_s) \times 100$; where W is the weight of the individual fish and W_s is the length-specific standard weight of the fish. The standard weight (W_s) equation was proposed by Milewski and Brown (1994) and is: $\log_{10}W_s$ (g) = –4.867 + 2.960 $\log_{10}$TL (mm).

Regression analysis was used to assess trends in RSD, the mean total length and W_r of citation trout, and W_r of trout captured by electrofishing over time. Analysis of variance (ANOVA) was used to test for differences in mean total length of citation brown trout from 1971–1983. Tests were considered significant at alpha 0.05.

Results

Size Structure

The size structure of the brown trout population in the Smith River tailwater has changed since the 1980s. Relative stock densities have significantly declined since 1983 for both RSD-230 ($P = 0.0172$) and RSD-300 ($P = 0.0087$; Fig. 1). During the early and mid 1980s, RSD values for brown trout collected by electrofishing were high for both the RSD-230 and RSD-300 categories (Fig. 1). However, in the late 1980s, RSD values decreased and have remained between 40 and 50 from 1990 to 2002.

The size of citation trout has changed over time. Significant differences between years were observed in the mean total length of citation brown trout from 1971–1983 (ANOVA; $P < 0.0001$). The largest mean total length of citation trout was observed in the early-mid 1970s, with smaller mean citation lengths being observed in the late

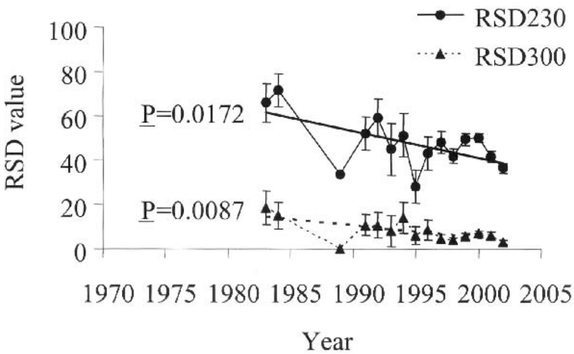

Figure 1. Relative stock density (RSD) indices values and 95% confidence intervals for brown trout collected by electrofishing from the Smith River, Virginia, during 1983–1984, 1989, and 1991–2002. Years with open symbols indicate a sample size of < 20 trout.

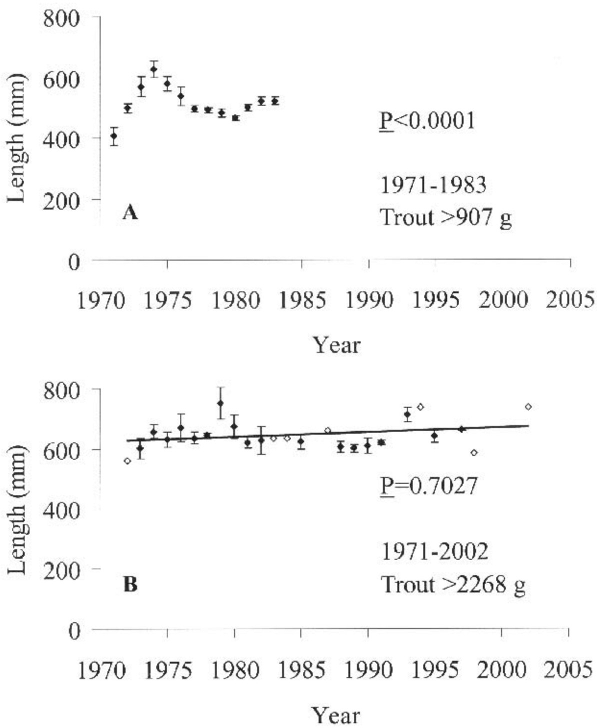

Figure 2. Mean length and standard errors for citation brown trout from the Smith River, Virginia, from 1971–1983 (panel A) and citation brown trout > 2268 g from 1971–2002 (panel B). Years with open symbols indicate a sample size of 1.

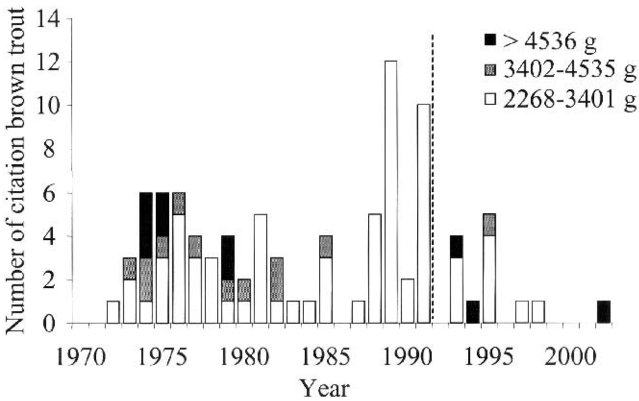

Figure 3. Total number of citation brown trout from the Smith River, Virginia, from 1971–2002. Dashed line represents when $4 fee was initiated by VDGIF for issuing a citation.

1970s (Fig. 2A). Mean total length of citation brown trout > 2268 g showed no trends over time ($P = 0.7027$) and remained consistent over 1971–2002 (Fig. 2B).

Number of Citation Brown Trout

The number of citation brown trout > 2268 g varied from 1971–2002, with a large decline in numbers after 1995. The number of citation brown trout > 2268 g was consistent until 1985 (Fig. 3). After 1985, there were peaks of smaller citation trout (2268–3402 g) in 1989 and 1991, but following these peaks, the number of citation brown trout diminished. From 1973–1977, the number of citation brown trout > 3402 g peaked (Fig. 3). From 1971–1979, seven citation brown trout > 4536 g were caught; however, only three were reported after 1980.

Relative Weight

The condition of citation brown trout from 1971–1983 showed significant decreasing trends over time ($P = 0.0002$; Fig. 4A). The highest W_r values were observed in the early to mid 1970s with lower W_r values observed in the 1980s. The condition of citation brown trout > 2268 g significantly declined from 1971–2002 ($P < 0.0001$; Fig. 4B). Relative weight of citation brown trout was high in the early 1970s. From 1971–1975, average W_r values for citation brown trout were > 120, with average W_r values being as high as 160 in 1971 (Fig. 4B). However, in 1975 average W_r values for citation brown trout decreased, and the values remained stable at 100–120 after the late 1970s.

Relative weight values of brown trout > 300 mm collected by electrofishing remained stable from 1991 until 2002 ($P = 0.7485$; Fig. 5). Relative weight values of trout 200–299 mm sampled in the field show a decreasing trend in W_r from 1991–2002 ($P < 0.0001$; Fig. 5). Relative weight values for citation brown trout are greater than W_r values for trout collected by electrofishing.

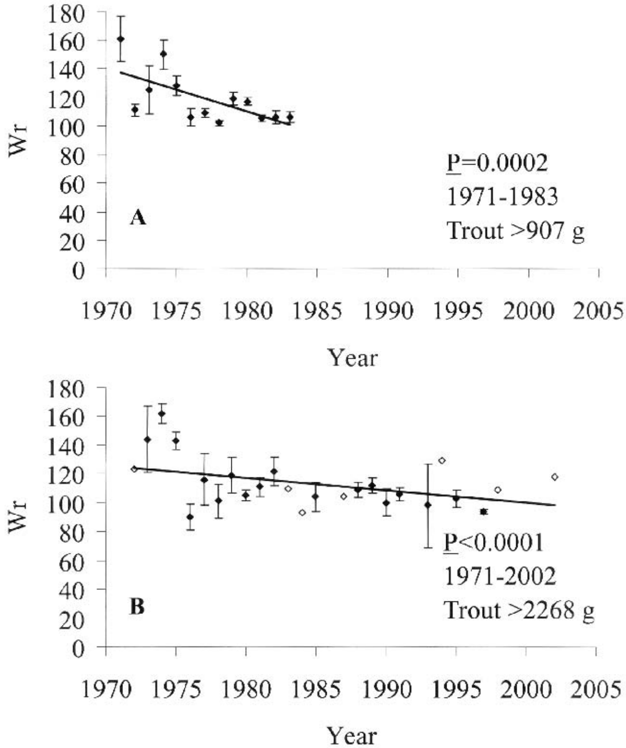

Figure 4. Mean relative weight and standard errors for citation brown trout (greater than 907 g) from the Smith River, Virginia, from 1971–1983 (panel A) and citation brown trout greater than 2268 g from 1971–2002 (panel B). Years with open symbols indicate a sample size of 1.

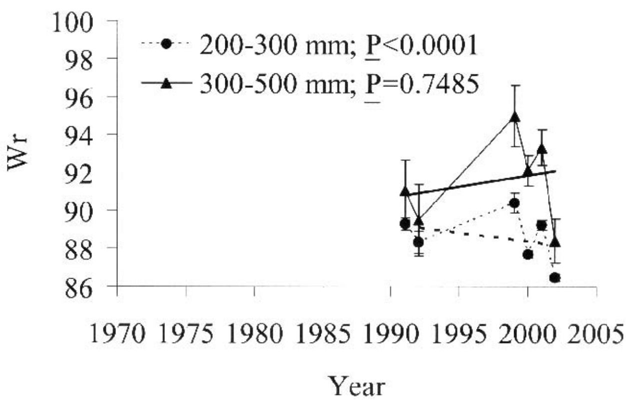

Figure 5. Average relative weight *(Wr)* and standard errors for brown trout from the Smith River, Virginia, collected by electrofishing during 1991–1992 and 1999–2002.

Discussion

The Smith River brown trout population changed over 1971–2002. During the early years of the tailwater fishery, the population apparently included numbers of large trophy-sized brown trout. However, the population has shifted through time to a distribution dominated by smaller brown trout. This is apparent through shifts in the RSD values and a decline in the number of citation brown trout. In addition, W_r values were high for citation brown trout in the 1970s and have decreased to stable lower values in recent times.

The declines in the number of trophy-sized trout and smaller size distribution may be related to trophic interactions or overexploitation of trout in the tailwater. During the 1970s, a large number of trophy brown trout were caught in the tailwater, which may have increased the popularity of the fishery. At this time there were no gear restrictions and spin fishing with large lures was common. With the additional fishing pressure during the 1970s, overexploitation of the brown trout may have occurred. However, if the fishery was overexploited, the fishery should have had the potential to rebound after restrictive regulations were imposed. In 1995, an estimated 6,600 brown trout were caught, but only 5% were harvested, which indicates that overexploitation of brown trout may not be the cause of the reduction in trout size and citation numbers (Hartwig 1998).

Another potential cause for the changes to the trout fishery is that water quality and reservoir trophic status may have changed. Because of the connectivity between reservoirs and the downstream tailwater areas, changes in the reservoir can impact the primary production potential in the tailwater area, which can alter forage availability. In the initial years after reservoir completion, a reservoir is highly productive, which is followed by a reduction in productivity levels until productivity equilibrium is reached (Kimmel and Groeger 1986). Sport fish may dominate the standing stock in the reservoir during the increased productivity phase but decrease during the reduction in productivity; however, the subsequent reduction in productivity does not reduce the overall standing stock in the reservoir because of changes in the species composition (Jenkins and Morais 1971). As reservoirs age, oligotrophication may occur, which would not only limit the amount of nutrients downstream of the reservoir but also reduce the standing stock of forage fish in the reservoir (Ney 1996). Long term data on water quality in Philpott Reservoir is unavailable, so it is unclear what changes have occurred in the reservoir productivity since the completion of the dam.

Below Philpott Dam, constant cold water temperature limits the ability of fish other than trout to survive in the area. With the loss of non-salmonid fish species, trout have to utilize alternative food resources such as drift and other macroinvertebrates, which are also impacted by the changes in flow. The constant flushing of water during generation periods causes scouring and changes the substrate composition of the tailwater, which potentially limits the macroinvertebrate community. Research has shown that after the completion of hydroelectric facilities, macroinvertebrate species richness decreases as well as total density and biomass (Trotzky and Gregory

1974, Garcia de Jalon et al. 1994). Although long term data sets are unavailable on the macroinvertebrate community in the Smith River, recent studies on the tailwater indicate that macroinvertebrate abundance may be suppressed in comparison to what would be expected in unregulated Virginia streams (Newcomb et al. 2001). If food availability for trout is reduced, growth rates of trout may be suppressed.

If food availability is limited, there may be a concern over competition between brown trout and stocked rainbow trout in the Smith River; however, of the rainbow trout stocked into the tailwater on an annual basis, $>$ 60% of the stocked rainbow trout are harvested by anglers (Hartwig 1998). In a study on stocked rainbow trout in the Clinch River, Tennessee, Bettinger and Bettoli (2002) observed that stocked trout had a low level of persistence (7–20 days) and none of the radio-tagged stocked rainbow trout persisted longer than 77 days. Although rainbow trout are stocked into the Smith River on an annual basis, it is not suspected that the rainbow trout are negatively impacting the brown trout due to the low persistence of stocked rainbow trout.

One primary cause for the trophic change in the tailwater trout fishery is that alewives *(Alosa pseudoharengus)* no longer pass through the turbines during generation, thus eliminating a forage base for trout near Philpott Dam. Discussions with anglers and biologists indicated that trophy brown trout were present near the dam and alewives were present in the tailwater area. The alewives provided a valuable forage base for trout in the tailwater immediately below the dam, and past angler reports indicate that alewives were commonly observed in the stomach contents of brown trout (Cochran 1975), which could account for the fast growth rates in brown trout below the dam. Pfitzer (1967) indicated that tailwater trout exhibited high growth rates by feeding on threadfin shad *(Dorosoma petenense)* that passed through dams from the reservoir.

Alewives were stocked into Philpott Reservoir in the late 1960s, and it is speculated that the alewife population exploded in the 1970s. This could account for the increased number of brown trout trophies in the tailwater area during the early 1970s. Since that time, the number of alewives in Philpott Reservoir may have stabilized, with fewer alewives passing through the dam; however, historical data on alewives in the reservoir is lacking, so it is unclear what trends have occurred in the reservoir alewife population.

Although the number of trophy brown trout in the tailwater has decreased, the Smith River still contains a large number of brown trout. High numbers of brown trout provide numerous opportunities for anglers, but smaller fish are not highly desired by Smith River anglers (Hartwig 1998). In 1995, the value of the Smith River fishery was estimated at $440,000 per year (36,000 angler hours), and if the number of large brown trout in the system were to increase, the value of the fishery could possibly double (Hartwig 1998). Despite the shift to smaller brown trout, the Smith River is still highly valued for naturally reproducing brown trout.

Further research into the causes for the decline in the size structure in the Smith River trout population is needed. Because exploitation rates of brown trout in the tailwater are low, the decline in the trophy fish population appears to be the result of changes in growth rates, mortality, or recruitment. While alewives once provided a valuable prey base, they are no longer available as forage below the dam. Food resources in the tailwater need to be evaluated to determine potential forage options for trout. Additional research is needed to evaluate recruitment and mortality of the brown trout population. If limiting factors could be identified and remedied, the brown trout population could be improved, thus increasing the potential for larger, trophy-size trout.

Lessons Learned

One of the lessons learned by examining the historical changes in the Smith River trout fishery is that more data would be necessary to fully evaluate changes that occurred in the tailwater and reservoir. There was an absence of electrofishing data on the trout fishery prior to the 1990s, so limited data on the early trout fishery came from citation records. Although the citation data was useful for acquiring information on large trout, it does not adequately provide information as to the overall trout population. Changes in citation criteria makes comparisons over time difficult, and it is unclear what influence the initiation of the $4 fee for issuing a citation had on the number of reported citations. Data on brown trout population in the tailwater is lacking during critical time periods in the fishery, which makes evaluation into the cause for the decline in large trout difficult.

In addition, there is a lack of data on alewives in the reservoir and tailwater. We were unable to find documentation that alewives were present in the tailwater other than from anglers who observed alewives in the stomach contents of brown trout. Data on the alewife in the reservoir are necessary to observe trends in the alewife population that may influence the tailwater trout population.

The second lesson learned through the case history on the Smith River trout fishery is that methods need to be in place to sample large brown trout. Few trout > 406 mm are sampled in the Smith River by electrofishing and more large trout may be present in the Smith River but cannot be effectively sampled by electrofishing alone. With the Special Regulations section of the Smith River managed as a trophy trout fishery, information on the large trout is necessary to follow trends in the desired size class. Creel surveys or angler diaries may be necessary to evaluate the large brown trout in the fishery.

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Literature Cited

Bettinger, J. M., and P. W. Bettoli. 2002. Fate, dispersal, and persistence of recently stocked and resident rainbow trout in a Tennessee tailwater. North American Journal of Fisheries Management 22:425–432.

Cochran, B. 1975. Best brown trout stream in the country. Virginia Wildlife 36(8):16–17.

Garcia de Jalon, D., P. Sanchez, and J. A. Camargo. 1994. Downstream effects of a new hydropower impoundment on macrophyte, macroinvertebrate and fish communities. Regulated Rivers: Research and Management 9:253–261.

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

Hartwig, J. J. 1998. Recreational use, social and economic characteristics of the Smith River and Philpott reservoir fisheries, Virginia. Master's thesis. Virginia Polytechnic Institute and State University, Blacksburg.

Jenkins, R. M. and D. I. Morais. 1971. Reservoir sport fishing effort and harvest in relation to environmental variables. Pages 371–384 *in* G. E. Hall, editor. Reservoir fisheries and limnology. Special Publication No. 8, American Fisheries Society, Bethesda, Maryland.

Kimmel, B. L. and A. W. Groeger. 1986. Limnological and ecological changes associated with reservoir aging. Pages 103–109 *in* G. E. Hall and M . J. Van Den Avyle, editors. Reservoir fisheries management: strategies for the 80's. Reservoir Committee, Southern Division American Fisheries Society, Bethesda, Maryland.

Krause, C. W., T. J. Newcomb, and D. J. In review. Thermal habitat assessment of alternative flow scenarios in a tailwater fishery. RiverRes Applications.

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.

Newcomb, T. J., K. M. Hanna, and M. R. Anderson. 2001. Macroinvertebrate forage in the Smith River tailwater. Proceedings of the Annual Conference of Southeastern Fish and Wildlife Agencies 55:116–125.

Ney, J. J. 1996. Oligotrophication and its discontents: effects of reduced nutrient loading on reservoir fisheries. Pages 285–295 *in* L. E. Miranda and D. R. DeVries, editors. Multidimensional approaches to reservoir fisheries management. American Fisheries Society Symposium 16.

Pfitzer, D. W. 1967. Evaluation of tailwater fishery resources resulting from high dams. Pages 477–488 *in* Reservoir fishery resources symposium. Reservoir Committee, Southern Division American Fisheries Society, Bethesda, Maryland.

Ross, J. 1999. Trout Unlimited's guide to America's 100 best trout streams. Falcon Publishing, Helena, Montana.

Trotzky, H. M. and R. W. Gregory. 1974. The effects of water flow manipulation below a hydroelectric power dam on the bottom fauna of the upper Kennebec River, Maine. Transactions of the American Fisheries Society 103:318–324.

Wege, G. J. and R. O. Anderson. 1978. Relative weight (W_r): 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. American Fisheries Society, North Central Division, Special Publication 5, Bethesda, Maryland.