Growth and Food Habits of Young of Year Walleye X Sauger Hybrids in Cherokee Reservoir, Tennessee

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Abstract: In May 1982, 31,600 sauger (*Stizostedion canadense*) male x walleye (*S. vitreum*) female hybrids and 17,200 fingerlings from the reciprocal cross were stocked into Cherokee Reservoir, Tennessee, in an attempt to reestablish a fishery for large percids where the 2 parental species have been extirpated. Of the 217 fish that were recaptured, 184 (85%) contained food. Gizzard shad (*Dorosoma cepedianum*) and threadfin shad (*D. petenense*) were the primary prey species and were selected over other forage species. Prey/predator length ratios for *Stizostedion* hybrids and shad averaged approximately 0.3 over the range of lengths examined. *Stizostedion* hybrids grew rapidly, attaining a mean total length ($N = 48$) of 30.5 cm by April 1983. This was better first-year growth than reported in other studies. These encouraging results supported continuation of this new stocking program and suggested that the *Stizostedion* hybrid may be a valuable management tool for put-grow-take fisheries in warm eutrophic impoundments.

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Walleye were stocked into Cherokee Reservoir shortly after impoundment in 1941 and again in 1954, 1955, and 1957, in attempts to establish a reproducing population. Limited numbers of adult fish were recovered, but reproduction was minimal and a viable fishery never developed (Heuer and Tomljanovich 1980). Cherokee supported a significant naturally reproducing sauger population for several years following impoundment. A pattern of de-

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creasing numbers of sauger was observed, however, with the last sauger reported from Cherokee Reservoir occurring in a 1974 Tennessee Valley Authority (TVA) cove rotenone sample (Heuer and Tomljanovich 1980).

Several factors are believed to have contributed to the demise of the sauger and walleye populations. The construction of John Sevier Detention Dam at the headwaters of the reservoir in 1954 blocked all fish migration in the only major inflow to the lake. This barrier limited appropriate spawning habitat to a 16-km section of riverine environment below the dam. Pollution, thermal discharges from John Sevier Steam Plant, and fluctuating temperatures and stream levels caused by discharges from Fort Patrick Henry Reservoir upstream were also believed to have contributed to the disappearance of sauger and walleye from Cherokee Reservoir (Edrington et al. 1979).

Recent improvements in water quality and expanded fingerling production capabilities led Tennessee Wildlife Resources Agency (TWRA) biologists to examine the possibility of re-establishing a fishery for large percids in Cherokee on a put-grow-take basis.

Research conducted in Ohio suggested that walleye x sauger hybrids may be better able to tolerate the warm eutrophic conditions found in Cherokee. Comparative studies of walleye and walleye (female) x sauger (male) hybrids (hereafter referred to as "saugeye") stocked into Ohio impoundments have demonstrated superior growth and survival of saugeye (Smith and Carline 1982, 1983). Lynch et al. (1982) observed that saugeye readily adapted to warm pond environments in Ohio achieving a mean length of 400 mm in 1 pond after 3 growing seasons. They noted that saugeye survival in ponds contrasted favorably with walleye. Based on these findings and apparent "hybrid vigor" observed in studies of hybrids of other species, TWRA biologists decided to stock saugeye and the reciprocal cross into Cherokee Reservoir on an experimental basis.

The purpose of the present investigation was to determine first year food habits and growth of saugeye and the reciprocal cross in Cherokee Reservoir.

Methods

Cherokee Reservoir is located on the main stem of the Holston River in Northeast Tennessee and is impounded by Cherokee Dam at Holston River Mile 52.3. This multipurpose storage impoundment was completed in 1941 by TVA and was intended for power generation, flood control, and recreation.

The reservoir level fluctuates approximately 10 m between summer and winter pool levels. At full summer pool (328 m above mean sea level) the reservoir extends 87 km upstream from the dam, the surface area is 12,591 ha, the maximum depth is 46 m, and there are 745 km of shoreline (Schaich 1979). After the drawdown to normal minimum winter pool levels, the upper section of the reservoir becomes riverine and water is backed up only 48 km upstream from Cherokee Dam.

Most of the 8,879 km^2 watershed is drained by the Holston River which carries a heavy load of industrial, municipal, and domestic discharge. In 1973, Cherokee Reservoir received approximately 0.5 metric tons of phosphorus and 6.8. metric tons of nitrogen which contributed to median total phosphorus and nitrogen concentrations of 0.05 and 1.27 mg/liter, respectively (U.S. Environ. Protection Agency 1978). These relatively high concentrations of nutrients create eutrophic conditions which are especially apparent in the upper section of the reservoir where heavy algal blooms have been observed.

A wide range of physical features are found in Cherokee Reservoir. Cliffs, gravel shoals, sand and clay beaches, and shallow mud flats are found along the shoreline. The upper section of the reservoir is narrow and meanders through hilly terrain. There are many islands and coves in the deep, broad, lower portion of the reservoir.

Cherokee Reservoir is generally isothermal during the winter, with short periods of ice cover occurring only during the coldest winters. Dissolved oxygen concentrations during this period remain near saturation. Thermal stratification begins in March or April and continues into the summer. Dissolved oxygen becomes depleted in the cool hypolimnion as thermal stratification progresses. By early September most of the cool hypolimnetic water has been discharged through the turbines and there is little thermal gradient from top to bottom (Schaich 1979). At this time, dissolved oxygen levels below 5 to 10 m are negligible. Dissolved oxygen concentrations rise and temperatures drop with fall turnover in late September. Thermal discharge from the John Sevier Steam Plant may elevate temperatures above normal. Total water hardness in the main channel generally ranges from 95 to 125 mg/liter (Waddle et al. 1980).

Cherokee Reservoir presently supports a thriving fishery for stocked striped bass and *Morone* hybrids, as well as native largemouth and white bass. However, significant summer die-offs of striped bass are regularly observed.

On 24 May 1982, 31,600 saugeye fingerlings produced at TWRA's Eagle Bend Hatchery were stocked at Quarryville Access ramp in the upper end of Cherokee Reservoir. Six days later, 17,200 fingerlings of the reciprocal cross were stocked 26 km downstream at the County Line Access ramp. Biweekly sampling was initiated on 17 June and continued through October, followed by monthly sampling from November through May 1983. Fish were collected by shoreline seining (15.2 x 1.8 m, 9.5-mm mesh straight seine) at 3 to 5 sites on each collecting date in June and July. Three to 9 gill nets were set on each sample trip from August through May 1983. Sinking nets, 45.7 x 1.8 m with mesh sizes (bar mesh) of 12.7, 19.1, 25.4, and 31.8 mm, were anchored perpendicular to shore and marked with labeled buoys. Efforts were made to sample a wide variety of different habitat types. Areas sampled with gill nets were up to 25 m deep and ranged from shallow mud flats to steep rocky drop-offs. Electrofishing with a boat-mounted, boom-type 230-V (500-watt) high cycle AC generating unit was also used to collect fish on all sample trips.

Forage fish samples were collected on each sample date by shoreline electrofishing for 0.5 hour. In June through August, seining with a small-mesh seine (6.1 x 1.2 m, 3.2-mm mesh straight seine) was also used to collect the smallest forage fish. All fish <10 cm were included in forage analyses. All sampling was conducted after sundown. Fish were preserved in the field in 10% formalin. Before fish >15 cm were preserved, an incision was made through the body wall to facilitate preservation of stomach contents and internal organs.

Food habits of all saugeye and reciprocal hybrids collected were examined. Fish were weighed to the nearest 0.1 g and measured to the nearest mm (TL). Stomach contents were examined under a 40x dissecting microscope and all food organisms were identified to the lowest taxon practical. Lengths of fish found in stomachs were measured directly or calculated from vertebral column measurements. Frequency of occurrence and percentage of total numbers of food items by month and by 2.5-cm length class were calculated.

Results and Discussion

Hatchery samples of the 2 *Stizostedion* crosses were carefully examined in the hope that characteristics would be found that would reliably separate them. These efforts were unsuccessful (Bruce Saul, pers. commun.) as were efforts to separate the 2 crosses in reservoir samples. Nelson (1967) observed that larval *Stizostedion* hybrids closely resembled the female parent, but he was also unable to distinguish between the 2 crossed at larger sizes. Thus, all calculations presented in this study represent combined data from both crosses. A total of 217 *Stizostedion* hybrids was collected during the sample period.

Growth

Stizostedion hybrids stocked in May at total lengths of 2.5 to 6.0 cm grew rapidly, attaining a mean total length ($N = 48$) of 30.5 cm by April 1983 (Fig. 1). This was much better first-year growth than was observed by Stroud (1948) for naturally produced *Stizostedion* hybrids in Norris Reservoir, Tennessee (22.1 cm). First-year growth of 4 year classes in Pleasant Hill Reservoir, Ohio (22.8–24.15 cm), was also somewhat less than that observed in this study (Smith and Carline 1982, 1983). Saugeye stocked in Ohio ponds only reached 19.5 to 21.4 cm after 1 year and 28.4 cm after 2 years of growth (Lynch et al. 1982), and saugeye reared in a South Dakota hatchery pond averaged only 12.7 cm after 1 growing season (Nelson et al. 1965).

Food Habits

Of the 217 *Stizostedion* hybrid stomachs examined, 184 (85%) contained food and 33 (15%) were empty. Fish were the most important food items in terms of frequency-of-occurrence and percent-of-total numbers for all length classes, in all months, and at all locations (Table 1). The vast majority of these fish were shad (96.1%), many of which could not be identified to

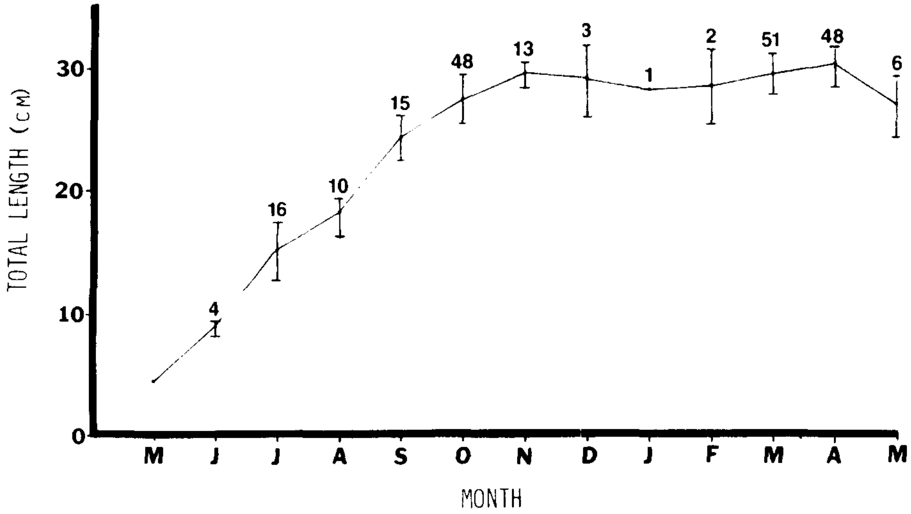

Figure 1. Mean total length (and standard deviations) of 1982 year class *Stizostedion* hybrids during each month (May 1982 to May 1983).

species. The larger gizzard shad were frequently consumed late in the year by larger-sized *Stizostedion* hybrids. Of 328 fish consumed, only 12 were identified as non-shad. These included 7 sunfish (*Lepomis* spp.), 3 cyprinids, and 2 channel catfish (*Ictalurus punctatus*). Comparison of the percentage composition of forage fish from seining and electrofishing samples with the per-

Table 1. Food items in the guts of *Stizostedion* hybrids of percentage of total numbers consumed and by frequency of occurrence in stomachs that contained food.

Food item	% of total	Frequency of occurrence (%)
Pisces	95.9	97
Dorosoma spp.	86.5	85
Dorosoma petenense	7.9	10
Dorosoma cepedianum	10.2	18
Unidentified *Dorosoma*	68.4	68
Cyprinidae	0.9	2
Lepomis sp.	2.0	4
Ictalurus punctatus	0.6	1
Unidentified fish	5.9	10
Insecta	4.1	3
Chironomidae	1.2	2
Chironomidae larvae	0.3	1
Chironomidae pupae	0.4	1
Ephemeridae	2.9	2
N fish with food	184	
N food items	342	

Table 2. Percentage composition of forage fish in seining and electrofishing samples, and in stomachs of *Stizostedion* hybrids.

Forage fish[a]	Seining and electrofishing ($N = 9{,}501$)	*Stizostedion* hybrid stomachs ($N = 308$)
Dorosoma spp.	63.9	96.1
Cyprinidae[b]	15.4	1.0
Labidesthes sicculus	11.3	0.0
Lepomis sp.	5.8	2.3
Ictalurus punctatus	0.3	0.6
Other fish	3.2	0.0

[a] All fish <10 cm in total length in seining and electrofishing samples were considered to be forage fish.

[b] Cyprinidae includes *Notropis* spp., *Pimephales* spp., river chubs (*Nocomis micropogon*), carp (*Cyprinus carpio*), and goldfish (*Carassius auratus*).

centage composition of fish identified in stomachs revealed that *Stizostedion* hybrids selected for shad and against other species that were present, with the possible exception of channel catfish which were present in very low numbers in stomachs and in forage samples (Table 2). This may have been because feeding behavior was oriented toward shad which were the predominant forage species or could have been the result of foraging away from shore where shad were abundant and other forage species were scarce.

Insects (exclusively Chironomidae and Ephemeridae) were of moderate importance to small fish early in the season in the upper portion of the reservoir. Although copepods and cladocerans were fairly abundant, no crustaceans were consumed.

Young-of-year saugeye in Pleasant Hill Reservoir, Ohio, had similar diets, consuming mostly gizzard shad, with black bass, bottom dwelling percids, and invertebrates being less important (Smith and Carline 1982, 1983). Interestingly, saugeye also ate brook silversides (*Labidesthes sicculus*) when available in Pleasant Hill Reservoir (Smith and Carline 1982) but did not consume this species in Cherokee Reservoir. Saugeye in Ohio ponds were exclusively piscivorous, feeding on a variety of prey but generally utilizing the predominant prey species, which included fathead minnows, golden shiners, green sunfish, and bluegill (Lynch et al. 1982).

The minimum, maximum, and average total lengths of shad found in stomachs increased in successively larger length classes of *Stizostedion* hybrids, and the mean prey/predator length ratio remained fairly constant at about 0.3 (Fig. 2). These data indicate that shad of approximately the same relative length were consumed as hybrids grew, even though smaller shad were abundant. This trend suggests a potential for significant predation on large underutilized gizzard shad as *Stizostedion* hybrids continue to grow.

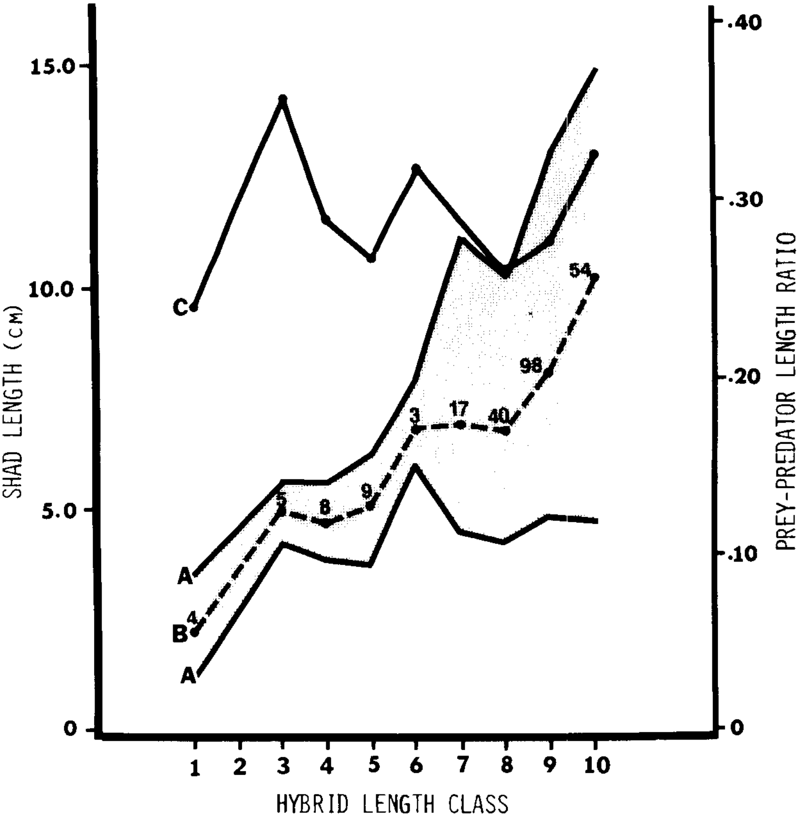

Figure 2. Prey/predator length relationship for shad and *Stizostedion* hybrids (A = maximum and minimum total lengths of shad, B = average total length of shad and numbers measured, C = prey/predator length ratio). Length classes (TL in cm) are as follows: 1 = 5.1 to 7.5; 2 = 7.6 to 10.0; 3 = 10.1 to 12.5; 4 = 12.6 to 15.0; 5 = 15.1 to 17.5; 6 = 17.6 to 20.0; 7 = 20.1 to 22.5; 8 = 22.6 to 25.0; 9 = 25.1 to 27.5; 10 = 27.6 to 30.0; 11 = 30.1 to 32.5.

Conclusions

Stizostedion hybrids stocked into Cherokee Reservoir experienced good survival and rapid growth through their first year on a diet consisting primarily of threadfin and gizzard shad. In the spring of 1983, after 1 year of growth, large numbers of these fish were caught by fishermen in the upper portion of the reservoir (Dave Bishop, pers. commun.). A creel limit of 10 fish >380 mm per day was enacted to prevent over harvest and permit more of these fish to grow to larger sizes. Preliminary examination of 1983 sampling results indicated that these fish continued to grow rapidly through their second growing season, with some fish reaching 457 mm by November 1983. Saugeye and the reciprocal cross were again stocked in 1983. Survival and growth of this year class appeared to have been similar to that of the 1982 year class. Although some evidence exists that suggests that *Stizostedion* hybrids are fertile (Lynch et al. 1982), it does not appear likely that significant reproduction will occur in Cherokee since spawning habitat is still severely restricted.

The preliminary findings presented in this study suggest that the *Stizostedion* hybrid may be a valuable management tool for put-grow-take fisheries in warm eutrophic impoundments.

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