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Distribution and Population Characteristics of Walleye in the Lower Eleven Point River, Arkansas

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Abstract

Walleye *Sander vitreus* (Mitchill) distributions and ecology have been poorly studied in southern river basins. We studied the longitudinal distribution and population characteristics of walleye in an unregulated river within the Ozark region of the U.S., the lower Eleven Point River, Arkansas, which has high species diversity. Walleye were collected in a 60 km segment of the river by daytime boat electrofishing over a three year period (2002-2004). Catch rates, growth rates and size structure were high relative to other streams studied in North America. Catch per effort (0 = 5.2/h) was similar seasonally, spatially and among years. Proportional stock structures were quite high (0 = 80), with numerous fish collected over 600 mm total length, 4 kg in mass and greater than 10 years of age. Relative weights of all length groups (stock size, proportional size structure, relative size structure) were at or greater than 90. Stomach contents of walleye were more suggestive of a generalist strategy in a stream of high species diversity, as compared to the targeting of a single numerically dominant prey, which is common in lentic systems.

Introduction

Walleye *Sander vitreus* (Mitchill) have a widespread distribution that includes both lotic and lentic systems of North America. In lotic systems, they are found in middle to larger river systems of moderate flow (Paragamian 1989) and low to moderate turbidity (Smith 1979, Smith 1985, Boschung and Mayden 2004).

Much attention has been given to northern walleye populations, particularly in lentic systems (e.g., Rawson 1956, Knight et al. 1984, Hartman and Margraf 2006). Far less effort has been placed on lotic populations (e.g., Mayhew 1956, Little et al. 1988, Diana 2006), and many of these streams have been greatly modified by reservoir construction (Maule and Horton 1985, Billington and Maceina 1997) and/or lock and dam systems along the Mississippi River (Vasey 1967, Gebken and Wright 1972, Pitlo 1989). Studies of southern walleye populations have focused on reservoirs where walleye have been introduced (Dendy 1946, Quist et al. 2003, Provine et al. 2004). Walleye distributions and ecology have been poorly studied in southern river basins (Billington and Maceina 1997, Lowie et al. 2001), with no previous published work on Ozark (Arkansas, Missouri) walleye populations.

Our goal, therefore, was to investigate the longitudinal distribution and population characteristics of walleye in an unregulated river within the Ozark region of the U.S. We studied feeding, condition, and size structure for walleye in the lower Eleven Point River, Arkansas, which has high species diversity (Johnson and Beadles 1977).

Study Site

The Eleven Point River is a clear, predominantly spring-fed stream located in the extreme eastern Ozark Mountain region of southeast Missouri and northeast Arkansas. The headwaters of the stream originate in Howell County, Missouri, and flow approximately 225 km south before joining the Spring River in Randolph County, Arkansas. The upper 160 km of stream occurs within the borders of Missouri whereas the lower 65 km occurs in Arkansas. There are no streams feeding the Eleven Point River in Arkansas, and stream gradient within Arkansas is 0.57 m/km.

Dominant predatory sportfishes of the lower Eleven Point River within Arkansas includes smallmouth bass *Micropterus dolomieu* Lácepède, shadow bass *Ambloplites ariommus* Viosca, walleye, largemouth bass *M. salmoides* (Lácepède) and spotted bass *M. punctulatus* (Rafinesque). Cyprinids are abundant as forage for predatory fishes, and primary forage fishes include horneyhead chub *Nocomis biguttatus* (Kirtland), bluntnose minnow *Pimephales* *notatus* (Rafinesque), bigeye chub *Hybopsis amblops* (Rafinesque), brook silverside *Labidesthes sicculus* (Cope), central stoneroller *Campostoma anomalum* (Rafinesque) and several *Notropis* and *Moxostoma* species (Johnson and Beadles 1977).

Both the Arkansas Game and Fish Commission (AG&FC) and Missouri Department of Conservation (MDC) have stocked fingerling walleye into the Eleven Point River to augment the native population (Henry et al. 2008). The AG&FC has stocked on average 38,000 fingerlings (mean size of 45 mm total length (TL)) per year (range of 15,000 – 105,000; mean density of 590/river km) since 1986 into three sites (9, 30 and 45 km upstream of the confluence with the Spring River; Table 1) in the Eleven Point River. The MDC first stocked 1,200 15 cm walleye over the lower 21 km of the river in Missouri in 1998 (Mayers 1998). Numbers and sizes and walleye stocked per year by the MDC are also highly variable (range of 252 - 13,000 fingerlings, plus a single stocking of 600,000 fry; mean density of 5,205 fingerlings/km). Stocking contribution represents approximately 25% among cohorts (Henry et al. 2008). Angler pressure on walleye is light due to limited river access and an angler focus on centrarchids and ictalurids.

Methods

Population structure

Daytime electrofishing by boat using a 16', aluminum, flat-bottom boat equipped with a 45 H.P. Mercury outboard motor and jet propeller occurred sequentially downstream, beginning 1.5 km of the Missouri border and ending 5 km upstream of the river's confluence with the Spring River (~ 60 total km). The river was subdivided into five sections (hereafter labeled as Sections A (upstream) through E (downstream)), primarily as a function of boat access and distance, with sampling performed from June to November in 2002 (9 sampling trips), January to October in 2003 (9 trips), and May to June in 2004 (7 trips).

Length of the five sections in an upstream to downstream order was: Section A (5.40 km); Section B (8.74 km); Section C (15.33 km); Section D (9.80 km); Section E (17.29 km). Stream gradient for each section was determined using USGS topographic maps. Gradients within sections were similar other than Section E, which was greatly reduced in slope: Section A, 0.56 m/km; Section B, 0.66 m/km; Section C, 0.46 m/km; Section D, 0.60 m/km; Section E, 0.24 m/km.

The entire 60 km stretch within Arkansas was sampled annually during these years. Sampling was not performed during the late fall and winter months (December – February) due to the potential of disrupting Ozark hellbender *Cryptobranchus alleganiensis bishopi* Grobman spawning in the river. Sampling involved a range of river habitats rather than just in presumed walleye habitat because of multiple target species (e.g., black basses *Micropterus*).

Total length (TL; mm) and mass (g) were collected from each walleye. Population structure information (catch-per-effort (CPE), proportional stock structure (PSS) and relative stock structure (RSS)) was calculated for fish stock size (250 mm or greater} in each river section. Stock sized individuals were divided into three length groups for comparisons of condition and feeding. Proportional stock distribution was based on a quality fish size of 380 mm and a preferred size of 510 mm (Gabelhouse 1984). Length groups were: stock – PSD (stock), PSD – PSD-P (PSD), and PSD-P+ (PSD-D) (Guy et al. 2007). Catch per effort and size structure (mean length, PSS, RSS) were compared among stream sections using ANOVA. Each sampling trip represented one sample. River means of size structure and standard errors were calculated by averaging all section totals. ANOVAs demonstrating significance were followed with an *a posteriori* Tukey's multiple comparison test to investigate treatment and interaction effects. All significance levels were set at $\alpha = 0.05$.

Condition and feeding comparisons

Condition, expressed as relative weight (W_r) values, was calculated for stock size individuals using the parameters of Murphy et al. (1990). Relative weights were compared among sections, length groups and sample months (March/April, May/June, July/August, and September/October) using ANOVA. Comparisons of condition among size classes can provide insight into prey availability among those size classes (Wege and Anderson 1978, Murphy et al. 1990).

Feeding was studied in a qualitative versus a quantitative manner for 102 walleye collected during May to August 2002. Stomach contents were identified in the field to broad taxa (fish, crayfish, insects, other). Diet composition and proportion of individuals feeding were to be compared by sample months (May/June, July/August, October/November)

Table 1. Population characteristics of walleye populations as determined by catch per effort (CPE), size structure as determined by proportional (PSD) and preferred (PSD-P) stock distributions and relative weights of walleye sampled relative to section in the Eleven Point River, AR. Standard errors are in parentheses.

Section	CPE	n	PSD	PSD-P	Wr
A	4.94 (0.99)	33	82	27	90 (1.7)
B	5.38 (1.36)	58	76	29	90 (1.1)
C	6.39 (1.37)	46	91	35	89 (1.1)
D	5.15 (0.40)	135	80	22	92 (0.7)
E	4.06 (2.05)	71	70	24	94 (1.8)
Totals	5.18 (0.48)	303	80 (3.5)	27 (2.2)	91 (0.5)

and by size group (stock, PSD, and PSD-P); however, all prey consumed were fishes other than for one individual, so diet comparisons were limited to proportion of walleye feeding relative to those variables.

Results

Population structure

Walleye were the third most frequent game fish species collected in the Eleven Point River (n = 301), with other dominant species being smallmouth bass (n = 1,032), shadow bass (631), largemouth bass (197) and spotted bass (166). Catch declined among successive years (n = 131 in 2002; 109 in 2003; 61 in 2004). Increased turbidity in 2004 coupled with higher than normal water levels led to fewer sampling trips (7 in 2004 versus 9 in 2002 and 2003), which could account for that year's decrease. Support of this hypothesis is the lack of significant differences in CPE (0 = 5.2/h) among sections (p = 0.831) or year sampled (p = 0.905) (Table 1).

Mean walleye PSS in the Eleven Point River was 80 while the mean RSS was 27 (Table 1). There were no significant differences in size structure among sampling years (p = 0.093) or section (p = 0.261). Few walleye collected (~ 1 %) were less than stock size, which is probably due to the size biases of boat electrofishing (Reynolds 1996). A high number of walleye were collected greater than 600 mm TL (n = 17) and masses greater than 4 kg (n = 11), with the largest individual 802 mm TL and 5.9 kg in mass.

Condition and feeding comparisons

Mean relative weights for walleye were greater than 90 for all size groups (Figure 1). Fish of PSD size had significantly greater relative weights than PSD-P fish ($F_{2,299} = 4.184$; $p = 0.016$; Tukey's, $p < 0.05$). Significant differences in mean relative weights also occurred among sample months ($F_{3,299} = 10.985$; $p < 0.001$; Tukeys, May/June = July/August > September/October) and among years ($F_{2,300} = 21.579$; $p < 0.001$; Tukeys, 2002 > 2003 > 2004; $p < 0.01$). No significant differences for relative weights were identified among sections (p = 0.119), however. 51.0% of the 102 walleye stomachs examined contained fish remains, with no other taxa identified. Species identification of the fish matter was not always possible but most remains appeared to be minnows (*Pimephales)* or bottom dwelling fish such as stonerollers (*Campostoma*), chubs (*Hybopsis* or *Nocomis*) and sculpins (*Cottus*). In addition, a 33 cm northern hogsucker *Hypentelium nigricans* (Lesueur) was found in one large walleye while remnants of large gizzard shad *Dorosoma cepedianum* (Lesueur) occurred in some of the other larger walleye. No centrarchids were identified despite their high frequency in the river. Feeding of walleye was more common during May/June (n = 73; 54.8%) than during July/August (n = 29; 41.3%). Additionally, feeding was more evident in the smaller size groups (stock, 58.8 %; PSD, 58.6%) than in the largest size group (PSD-P, 44.6%).

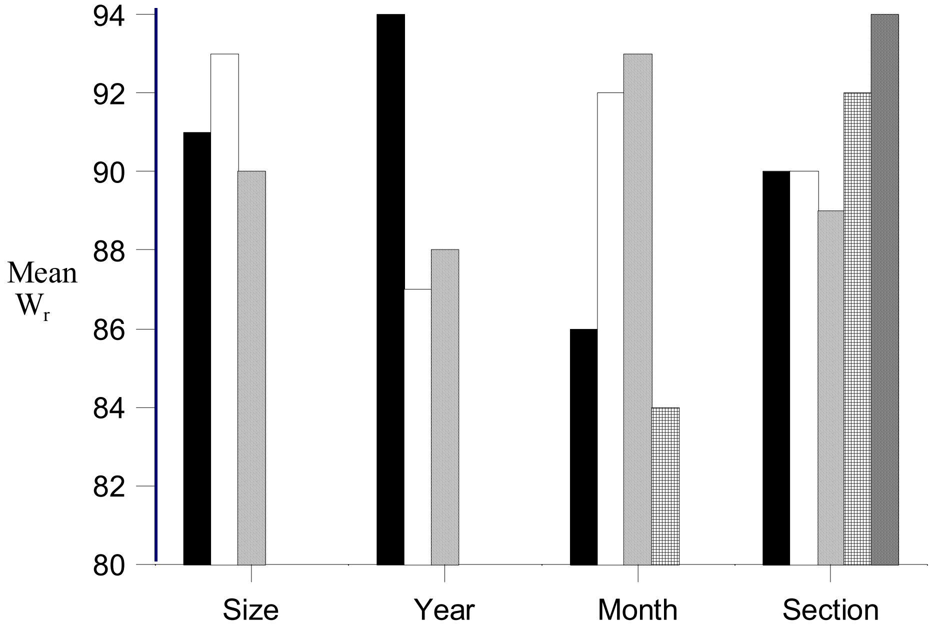

Figure 1. Relative weights of walleye in the Eleven Point River, Arkansas, on the basis of size (stock; PSD; PSD-P), year sampled (2002, 2003, 2004), month sampled (March/April; May/June; July/August; September/October) and section of the river sampled (Sections A-E). Bars are arranged in the order presented.

Discussion

Population structure

Both the number of walleye caught per effort and the size structure of those walleye were high in the Eleven Point River. Despite our multi-species approach in sampling, catch rates (0 = 5.2/h) are much greater than one lotic walleye population (x = 0.16/h; Columbia River, Zimmerman 1995), yet considerably less than another population (0 = 9.5/h; Muskegon River, Diana 2006). Nonetheless, our catch rates may have been greater had we targeted a single species in a narrow habitat. Direct comparisons of catch rates among studies are problematic due to a wide range of variables both among study methods and rivers studied.

High fish densities as demonstrated by high catch rates are often associated with reductions in PSD values (Anderson 1973, Reynolds and Babb 1978). Anderson and Weithman (1978) have recommended PSD values of 30 - 60 for balanced populations. Our PSD of 80 for walleye of the Eleven Point River may be indicative of poor recent recruitment (Anderson and Weithman 1978), despite walleye being stocked in the river by the AGFC annually since 1984 (Henry et al. 2008).

Condition and feeding

Feeding of walleye was similar to previous studies of other systems, both in prey selection and frequency of feeding. Adult walleye were solely piscivorous, similar to many other studies (e.g., Maule and Horton 1985, Vigg et al. 1991, Mittlebach and Persson 1998), with most prey soft-rayed fishes (Parsons 1971, Knight et al. 1984). In lentic waters, benthopelagic yellow perch *Perca flavescens* (Mitchill) and schooling pelagic species such as alewives *Alosa pseudoharengus* (Wilson) and gizzard shad are often targeted (Swenson and Smith 1976, Quist et al. 2002, Lyons and Magnuson 1987, Porath and Peters 1997), although walleye are considered to be opportunistic predators (Ryder and Kerr 1978, Lyons and Magnuson 1987). Fish diversity in the Eleven Point River is quite high (Johnson and Beadles 1977), and there are no numerically dominant littoral species. Diet of these walleye was also diverse, suggestive of a generalist feeding strategy, similar to another lotic walleye population (Stephenson and Momot 1991).

Frequency of walleye having empty stomachs is highly variable among differing population studies, ranging from 11 - 80% (Dendy 1946, Rawson 1957, Little et al. 1988, Stephenson and Momot 1991, Kocovsky and Carline 2001, Quist et al. 2002; Diana 2006). The proportion of walleye in the Eleven Point River having empty stomachs fits in the middle of this range. The frequency of walleye empty stomachs increased during the summer months, as water temperatures surpassed 23 ^{o}C in July and August (Christian et al. 2006). Walleye activity and feeding both in laboratory and field studies tend to decline above this temperature (Kelso 1972, Ager 1976, Hokanson 1977, Quist et al. 2003, Diana 2006).

Larger walleye (PSD-P) had a greater proportion of empty stomachs than smaller fish. This may be due to a lack of size-specific prey for larger fish (Wege and Anderson 1978, Murphy et al. 1990) or that larger fish feed less frequently on larger prey items (Ivlev 1961). Relative weights for the largest fish were lower than for smaller individuals, supporting a lack of suitable prey for these fish. Nonetheless, internal examination of fish sacrificed for age estimation indicated that even the largest fish collected had large deposits of fat within their body cavities, evidence of good condition for all size classes.

Condition was slightly less than that recommended (95 – 105) for walleye populations (Murphy et al. 1990). A comparison of other lotic walleye population relative weights compiled by Murphy et al. (1990) indicates that relative weights were greater than some river populations (< 90; Clinch River, TN; Wisconsin River, WI; Mosquito Creek, Northwest Territories), comparable to other river populations (90-95; Luxapallia Creek, MS; Kirwin River, KS; Muskegon River, MI; Missouri River, SD) and less than one walleye population (> 100; Morean River, SD). Additionally, Billington and Maceina (1997) identified Mobile basin walleye river populations to be greater than 90. It is possible that the hydrodynamic forces of streams may favor a more stream-lined body plan particularly for larger fish and therefore lower relative weights compared to lotic populations (Hubbs 1941, Winemiller 1991, Matthews 1998); this hypothesis remains to be tested for riverine walleye.

We expected relative weights to be lowest following the spawn in March (Hansen and Nate 2005) and during the July/August sampling due to increases in water temperature and reductions in feeding (Kitchell et al. 1977, Kocovsky and Carline 2001). Surprisingly, we found the lowest relative weights during September and October, which is inconsistent with our feeding data and other studies (Hansen and Nate 2005, Hartman and Margraf 2006). Fish had apparently recovered from spawning and increased biomass by our May sampling. Sampling during late March/early April may have revealed these expected post-spawning trends in condition, but this sampling was prevented due to high water.

In summary, we have identified that the lower Eleven Point River contains a quality walleye fishery. Catch rates and size structure were high relative to other streams studied in North America. Relative weights of all length groups were greater than 90. Stomach contents of walleye were more suggestive of a generalist strategy in a stream of high species diversity, as compared to the targeting of a single numerically dominant prey, which is common in lentic systems.

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