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Food Habits of Stunted and Non-Stunted White Perch (*Marone americana*)

Nathan J.C. Gosch
Nebraska Cooperative Fish and Wildlife Research Unit, Nathan.J.Gosch@usace.army.mil

Jeffrey R. Stittle
Nebraska Cooperative Fish and Wildlife Research Unit

Kevin L. Pope
University of Nebraska-Lincoln, kpope2@unl.edu

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Nathan J.C. Gosch[a] and Jeffrey R. Stittle[b]
Nebraska Cooperative Fish and Wildlife Research Unit

and

Kevin L. Pope
USGS—Nebraska Cooperative Fish and Wildlife Research Unit

School of Natural Resources, University of Nebraska-Lincoln
Lincoln, Nebraska 68583-0984 USA

ABSTRACT

We studied food habits of white perch (*Morone americana*) from two populations with different stable states (stunted [Branched Oak Lake, Nebraska] and non-stunted [Pawnee Lake, Nebraska]) to determine if change in food habits of white perch is likely to occur in situations where a stunted white perch population is altered to a non-stunted state and vice versa. Three approaches were used to quantitatively describe seasonal (spring = March-May, summer = June-August, autumn = September-November) diets of white perch – 1) frequency of occurrence, 2) percentage of composition by volume, and 3) mean stomach fullness. White perch diets were dominated by cladocerans and dipterans in both reservoirs during all seasons. Fish egg predation was similar between reservoirs, and white perch rarely consumed fishes in either the stunted or the non-stunted population. Shifting a white perch population between stunted and non-stunted states will likely cause little or no change in food habits; fish in both states will primarily consume invertebrates.

INTRODUCTION

The white perch (*Morone americana*) is native to the east coast of North America, naturally occurring from South Carolina, USA north to Quebec, Canada (Scott and Crossman 1973). In its native range, the white perch is a valuable commercial fish and sportfish (Ballinger and Peters 1978). In Nebraska, however, the white perch is an invasive species with little commercial or recreational value because average size of adults is small (<200 mm total length). The Nebraska Game and Parks Commission (NGPC) stocked white perch in several Nebraska Sandhill lakes during 1964 (Hergenrader and Bliss 1971), believing that this species would flourish in these highly alkaline lakes (McCarraher 1971). Unfortunately, the white perch was inadvertently stocked into Wagon Train Reservoir, Nebraska during 1964, and it dominated the fish community in this reservoir by 1967 (Hergenrader and Bliss 1971). White perch was discovered in nearby Stagecoach Reservoir two years later with the same result; it dominated the fish community in this reservoir three years after discovery (Hergenrader 1980a). The NGPC renovated and restocked both of these reservoirs; however, white perch still remained in Salt Creek (Ballinger and Peters 1978) and in the Platte River and Missouri River (Bliss and Schainost 1974). The white perch has been recently rediscovered in the previously renovated reservoirs (pers. comm., M. Porath[c]) and continues to spread. This species also currently inhabits numerous water bodies in Kansas and Oklahoma (Kuklinski 2007).

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[a] Present address: Missouri Department of Conservation – Sedalia Office, 2000 South Limit Avenue, Sedalia, Missouri 65301 USA; E-mail: Nate.Gosch@mdc.mo.gov
[b] Present address: 40930 Rd 764, Gothenburg, Nebraska 69138 USA
[c] Fisheries Biologist, Nebraska Game and Parks Commission

The white perch tends to overpopulate in inland waters outside of its native range, resulting in fish communities dominated by stunted individuals. An ability to reproduce during its first year of life and withstand a wide range of environmental conditions allows quick establishment of this species and potential domination of fish communities (Ballinger and Peters 1978, Hodkin 2001). White perch will also consume eggs of other fishes, such as walleye (*Sander vitreus*) and white bass (*Morone chrysops*), which could negatively affect recruitment (e.g., result in weak or missing year classes) of those species (Schaeffer and Margraf 1987, Hodkin 2001).

White perch was discovered in Branched Oak Lake, Nebraska in 1987 (pers. comm., M. Porath[a]). Within a few years, white perch dominated the biomass of the fish community, and the current population is stunted (i.e., high density of slow-growing individuals that have a reduced size and age at maturity, reduced maximum size, and higher survival rates) (Chizinski 2007). In nearby Pawnee Lake, white perch was discovered in 2001 (Jackson 2008). Similar to Branched Oak Lake, white perch dominated the fish community within a few years of discovery; however, the population is not stunted in this reservoir (Chizinski 2007). Thus, the objective of this study was to compare food habits of white perch from a stunted population with food habits of white perch from a non-stunted population.

MATERIALS AND METHODS

Food habits of white perch were investigated during the ice-free period (approximately March through November) of 2006 and 2007 in Branched Oak Lake and Pawnee Lake, Nebraska. Branched Oak Lake, located in Lancaster County, is a 728-ha, hypereutrophic reservoir. This reservoir does not permanently stratify (Hergenrader 1980b). The fish community consists of walleye, hybrid striped bass (*M. saxatilis* x *M. chrysops*), largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), white crappie (*Pomoxis annularis*), black crappie (*Pomoxis nigromaculatus*), common carp (*Cyprinus carpio*), blue catfish (*Ictalurus furcatus*), channel catfish (*I. punctatus*), flathead catfish (*Pylodictis olivaris*), gizzard shad (*Dorosoma cepedianum*), brook silverside (*Labidesthes sicculus*), and white perch. Early in the life of this reservoir, littoral fishes, such as largemouth bass, bluegill, and crappie, comprised the majority of angler catches. However, the sportfish community is now dominated by more pelagic fishes, such as walleye and hybrid striped bass, due to a loss of littoral habitat caused by sedimentation and erosion. Currently, Branched Oak Lake has restrictive harvest regulations (i.e., catch-and-release fishing for hybrid striped bass and flathead catfish, a daily bag limit of one walleye longer than 56 cm, and a 25-cm minimum length limit for crappie).

Pawnee Lake, located in Lancaster County, is a 299-ha, hypereutrophic reservoir located 14 km south of Branched Oak Lake. Like Branched Oak Lake, it does not thermally stratify (Hergenrader 1980b). The fish community at Pawnee Lake consists of walleye, sauger (*Sander canadensis*), white bass, largemouth bass, black crappie, white crappie, channel catfish, flathead catfish, freshwater drum (*Aplodinotus grunniens*), common carp, and white perch. Less restrictive harvest regulations are in place at Pawnee Lake (i.e., daily bag limit of 10 panfish) compared to Branched Oak Lake.

White perch were captured with a boat-mounted electrofisher (pulsed DC). Each reservoir was sampled monthly, and target sample size was 25 individuals. Captured fish were euthanized with 1 g/L of MS-222 and preserved in a 10% buffered-formalin solution. These individuals were weighed to the nearest 0.1 g and measured to the nearest 1 mm. Stomachs were removed via dissection, and the contents were removed. Stomach contents were identified to species for fishes and to order for invertebrates using

[a] Fisheries Biologist, Nebraska Game and Parks Commission

keys contained in Scott and Crossman (1973) and Thorp and Covich (1991). Items were grouped by taxa and measured volumetrically by water displacement.

Three approaches were used to quantitatively describe seasonal (spring = March-May, summer = June-August, autumn = September-November) diets of white perch – 1) frequency of occurrence, 2) percentage of composition by volume, and 3) mean stomach fullness. Frequency of occurrence quickly and easily describes the regularity of each prey taxa consumed by each predator species, and percentage of composition by volume describes the quantity of each prey taxa consumed by each predator species (Bowen 1996). Mean stomach fullness was also used to describe seasonal diets of white perch because this index was highly correlated with total caloric intake making it useful for energetic assessments of diet (Pope et al. 2001). Prey taxa with <5% frequency of occurrence and <5% percentage of composition by volume were not included in analyses.

Mean stomach fullness cannot be calculated without stomach capacity values for individual white perch; thus, we determined stomach capacity for white perch by constructing a stomach capacity-length equation according to the methods of Knight and Margraf (1982) by plotting maximum total stomach volume found in each length group as a function of the midpoint of each 10-mm length group. Length groups with fewer than 10 individuals were excluded from analysis. Length groups for which the plotted stomach capacity was less than the previous two length groups were removed because it was evident that no fish within that length group contained full (or nearly so) stomachs. Remaining data points were used to develop an exponential regression equation relating stomach capacity of white perch to total length (Fig. 1). Statistical analysis was performed with Curvefit software (Version 2.10-O, Shareware, Thomas S. Cox) with significance set at $\alpha = 0.05$.

We also investigated differences in the presence of fish in the diets of white perch of the stunted population and those of the non-stunted population. Scattergrams were constructed with the proportion (by volume) of fish prey in stomachs plotted as a function of white perch total length. Logistic regression was used to determine if there was a relationship between presence of fish in white perch diets and total length of white perch. White perch with empty stomachs were excluded from this analysis.

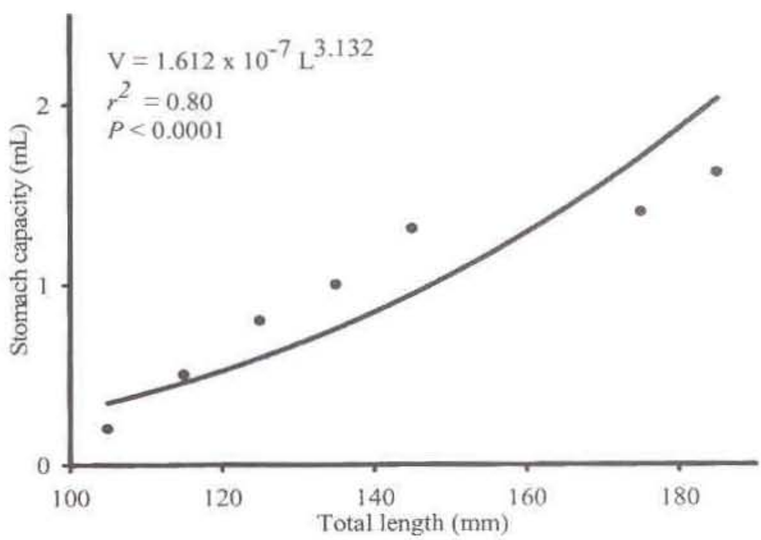

Figure 1. Relation between maximum stomach capacity (V) and total length (L) of white perch. A point represents the maximum total volume of prey observed in an individual stomach plotted as the midpoint for each length group.

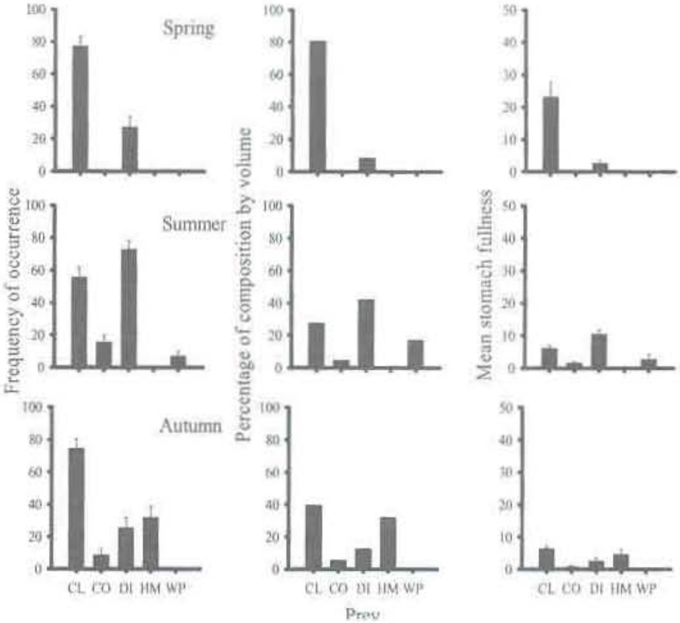

Figure 2. Frequency of occurrence ± SE (left panels), percentage of composition by volume (middle panels), and mean stomach fullness ± SE (right panels) for prey consumed (CL = cladocera, CO = coleoptera, DI = diptera, HM = hemiptera, WP = white perch) by white perch in a stunted population (Branched Oak Lake, Nebraska) during spring (top panels), summer (middle panels) and autumn (bottom panels) 2006.

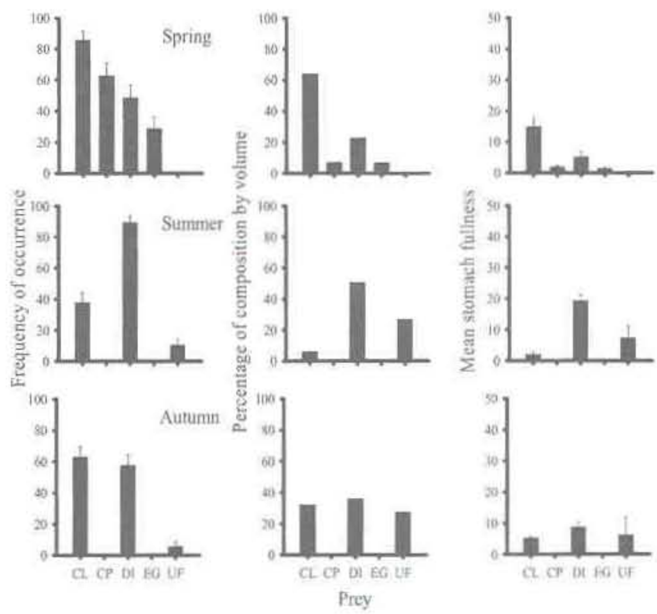

Figure 3. Frequency of occurrence ± SE (left panels), percentage of composition by volume (middle panels), and mean stomach fullness ± SE (right panels) for prey consumed (CL = cladocera, CP = copepoda, DI = diptera, EG = fish eggs, UF = unidentifiable fish) by white perch in a stunted population (Branched Oak Lake, Nebraska) during spring (top panels), summer (middle panels) and autumn (bottom panels) 2007.

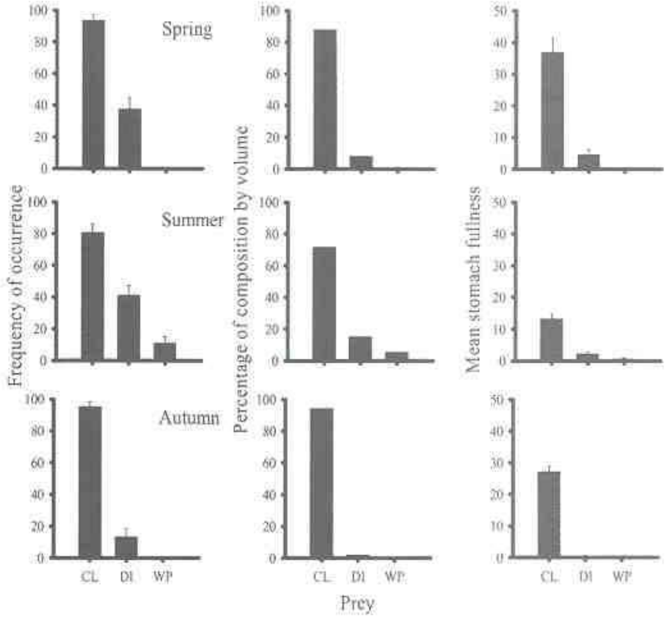

Figure 4. Frequency of occurrence ± SE (left panels), percentage of composition by volume (middle panels), and mean stomach fullness ± SE (right panels) for prey consumed (CL = cladocera, DI = diptera, WP = white perch) by white perch in a non-stunted population (Pawnee Lake, Nebraska) during spring (top panels), summer (middle panels) and autumn (bottom panels) 2006.

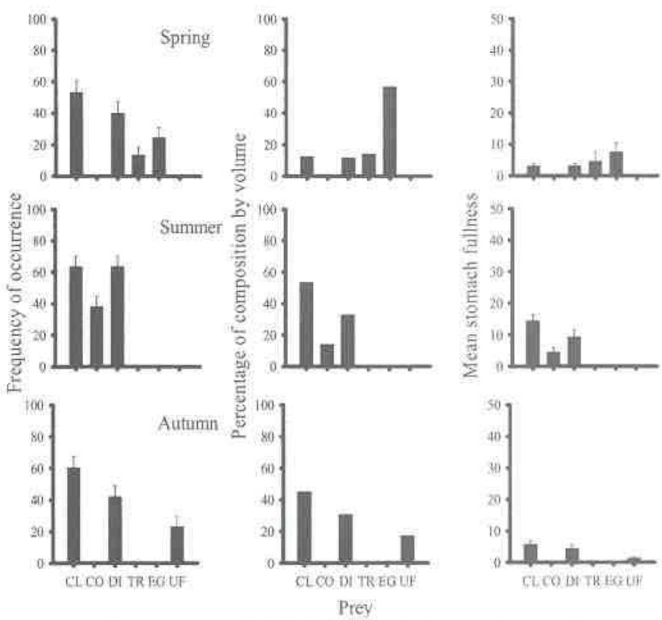

Figure 5. Frequency of occurrence ± SE (left panels), percentage of composition by volume (middle panels), and mean stomach fullness ± SE (right panels) for prey consumed (CL = cladocera, CO = coleoptera, DI = diptera, TR = trichoptera, EG = fish eggs, UF = unidentifiable fish) by white perch in a non-stunted population (Pawnee Lake, Nebraska) during spring (top panels), summer (middle panels) and autumn (bottom panels) 2007.

RESULTS AND DISCUSSION

We expected major differences in white perch food habits between reservoirs because the two populations were markedly different. The stunted population was characterized by small, slow-growing individuals that experience much higher survival rates and reach sexual maturity at a much younger age (Chizinski 2007). However, food habits of white perch were remarkably similar for the stunted population (i.e., Branched Oak Lake) and non-stunted population (Pawnee Lake). Both populations relied heavily on invertebrates, with cladocerans and dipterans being consistently important prey items during all seasons.

In Branched Oak Lake, we captured 173 and 197 white perch during 2006 and 2007, respectively; 161 and 146, respectively, contained prey items. Cladocerans and dipterans were the most important prey items for white perch with relatively large frequency of occurrence (O_i), percentage of composition by volume ($\%V_i$), and mean stomach fullness (MSF_i) values during all seasons of 2006 and 2007 (Figs. 2 and 3). Fish (i.e., white perch or unidentifiable fish) were somewhat important ($\%V_i > 15.0\%$ and $MSF_i > 2.5\%$) prey items during the summer of both years and during the autumn of 2007; however, only ~5% of white perch that contained prey items consumed fishes. Fish l for very

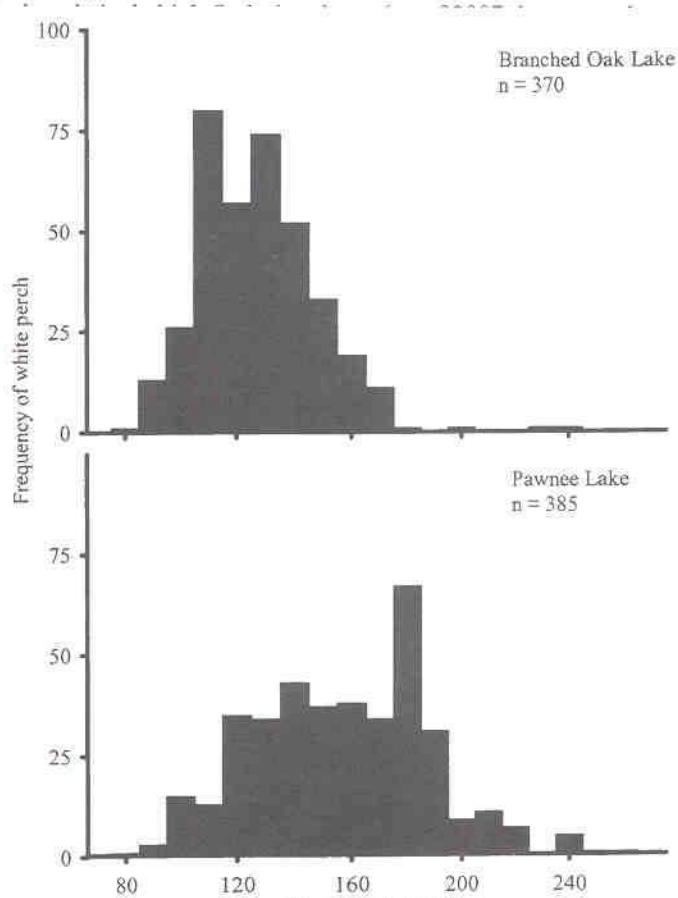

Figure 6. Length-frequency distributions of white perch captured from a stunted (Branched Oak Lake, Nebraska) and non-stunted (Pawnee Lake, Nebraska) population.

In Pawnee Lake, we captured 162 and 223 white perch during 2006 and 2007, respectively; 156 and 143, respectively, contained prey items. Similar to Branched Oak Lake, cladocerans and dipterans were important prey items during all seasons of 2006 and 2007 (Figs. 4 and 5). Fish eggs and trichopterans were also important prey items during the spring of 2007. Fish were marginally important ($5.0\% < \%V_i < 20.0\%$ and $0.5\% < MSF_i < 1.5\%$) during the summer of 2006 and the autumn of 2007. Similar to Branched Oak Lake, only ~5% of white perch that contained prey items consumed fishes.

Consistent with *a priori* expectations, larger white perch were captured in Pawnee Lake compared to Branched Oak Lake (Fig. 6). In Branched Oak Lake, white perch did not start consuming fishes until reaching ~120 mm total length (Fig. 7). There was no relationship ($\chi^2 = 0.09$, $P = 0.76$) between presence of prey fish in diets and total length of white perch in Branched Oak Lake. In contrast, white perch did not start consuming fishes until reaching ~160 mm total length in Pawnee Lake. There was a relationship ($\chi^2 = 5.8$, $P = 0.02$) between presence of prey fish in diets and total length of white perch in Pawnee Lake.

The length of white perch did not have any effect on the presence of fish in diets.

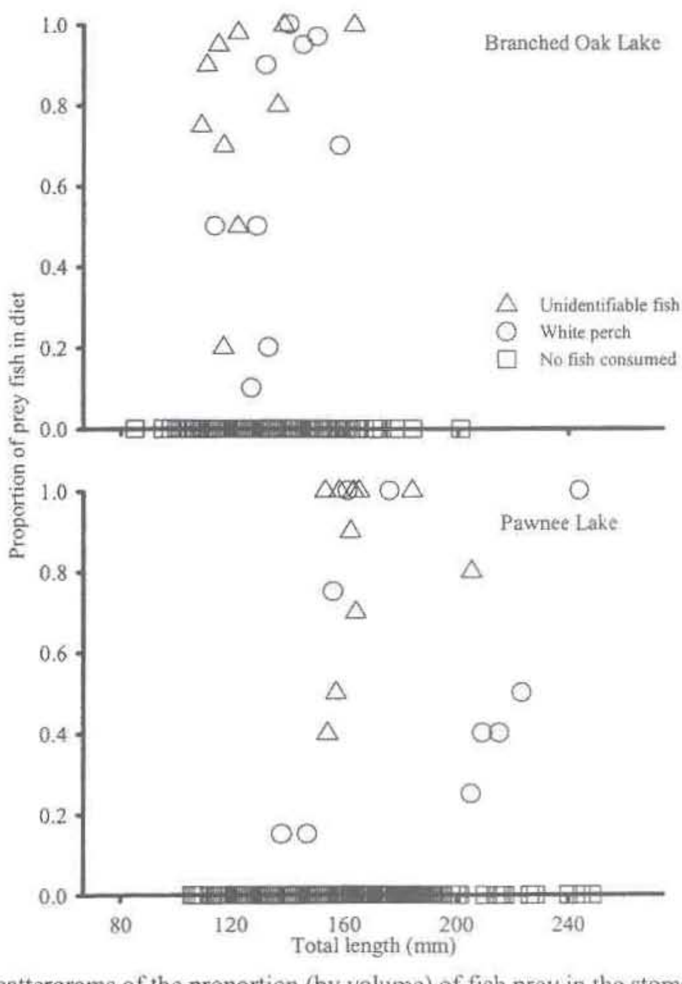

Figure 7. Scattergrams of the proportion (by volume) of fish prey in the stomachs of white perch plotted as a function of total length for fish from a stunted (Branched Oak Lake, Nebraska) and non-stunted (Pawnee Lake, Nebraska) population.

In Maryland, fish were not important in diets until white perch exceeded 200 mm total length (Weisberg and Janicki 1990), and white perch rarely reached 200 mm total length in Branched Oak Lake. In Pawnee Lake, fishes became important in white perch diets at ~160 mm total length, and the presence of fish in the diet increased with length. However, the vast majority of white perch, even large white perch (i.e., >200 mm total length) did not consume any fishes in Pawnee Lake. Instead, they consumed large quantities of invertebrates.

The observed differences in length at which white perch initiated piscivory between reservoirs could be a function of availability of different prey fishes in each reservoir. In Branched Oak Lake, white perch and gizzard shad (*Dorosoma cepedianum*) were the major prey fishes available (i.e., other prey fishes are low in abundance), whereas white perch were the only major prey fish available in Pawnee Lake. Although no gizzard shad were identified, over half of the prey fish found in white perch stomachs from Branched Oak Lake were unidentifiable fish that were mainly consumed during summer when small gizzard shad were readily available to piscivores.

Similarity in food habits of white perch in the two reservoirs provides evidence that preventing the stunting of white perch may not benefit other species. Shifting a white perch population between stunted and non-stunted states will likely cause little or no change in food habits of white perch; fish in both states will primarily consume invertebrates.

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