

FISH COMMUNITY ASSESSMENT OF WHITE OAK CREEK, BROWN/HIGHLAND COUNTY, OHIO.

JOHN P. SPAETH

*Current Address: Dept. of Biological Sciences, University of Southern Mississippi
118 College Drive #5018, Hattiesburg, MS 39406*

INTRODUCTION

White Oak Creek (WOC) has a relatively diverse fish assemblage within its 234 mi.² drainage basin in Brown and Highland Counties, Ohio. Data collected by the Ohio EPA has documented 54 fish species (and 5 hybrid sunfish species) occurring in WOC since 1983 (Ohio EPA, unpubl. data). Like many streams in southern Ohio, the dominant land-use (80%) in the watershed is agricultural development. Fish communities may be exposed to various pollutants including pesticides, nutrient loading, fecal coliforms, turbidity, siltation, organic waste, etc (Karr 1991, Gorman & Karr 1978). The surrounding land-use has also attributed to the installation of low-head dams to aid in flood control, hence altering the stream morphology. These are present in nearly all major tributaries of the system. There is one impoundment (Grant Lake) established on Sterling Run which is a main channel tributary. Despite these alterations over the years, many species (even those sensitive to degradation) have maintained persistent populations. The objective of this investigation is to: 1) assess the present fish community using the index of biotic integrity (IBI) and selected metrics, 2) evaluate the population status of the bigeye shiner (*Notropis boops*), an Ohio threatened species, and 3) educate the public of the distribution and occurrence of species within the watershed using 2004 and previous records.

METHODS

Fishes were sampled at nine separate sites within the WOC watershed (Table 1) in 2004. (However, abundance data was only recorded at 8 sites.) Sampling occurred in 100 meter, single-pass reaches using standard backpack electrofishing techniques and/or seines of appropriate size. At each site, all available habitats were sampled (riffles, runs, pools, vegetation, snags, etc.) to try to obtain a suffice representation of the fish community. Fishes were identified to species and then released.

Table 1: The number of sites sampled within the drainage basin portions of White Oak Creek in 2004.

MAJOR DRAINAGE BASIN	NUMBER OF SITES
Main Channel	1
East Fork	3
North Fork	2
Sterling Run	2*
Little North Fork	1

*Only 1 site contains species-abundance data.

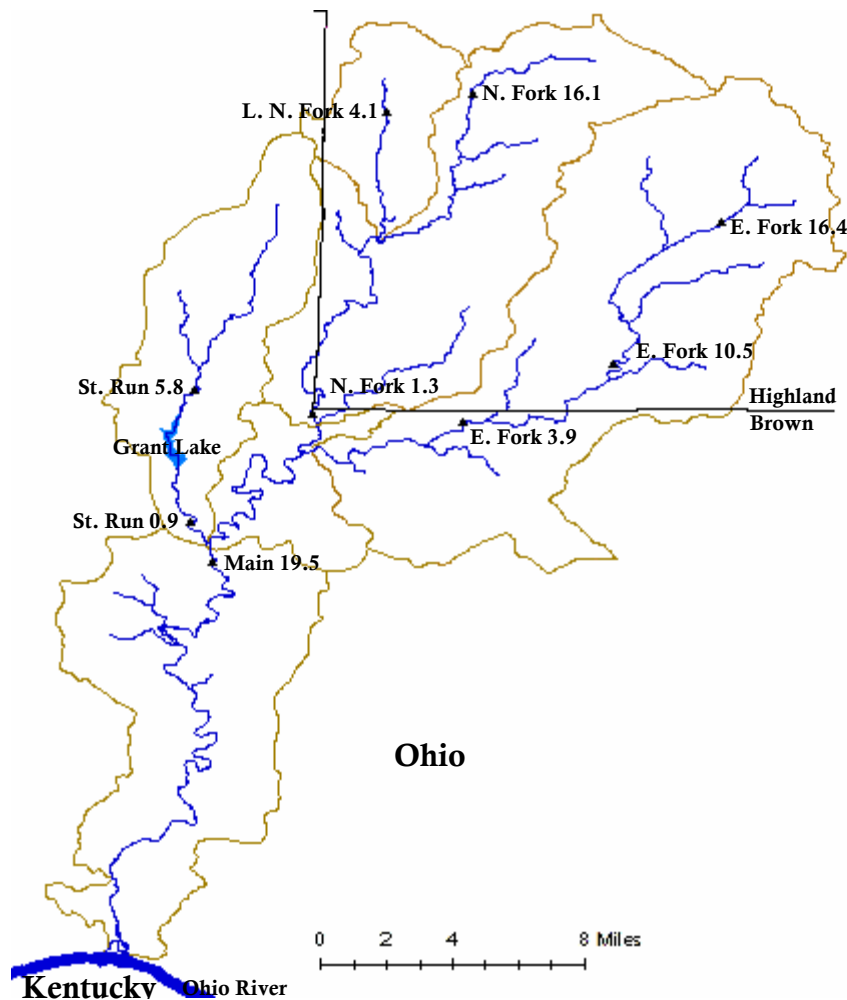


Figure 1: Nine sites were sampled within the watershed of White Oak Creek (WOC) in 2004. The boundaries shown are the watershed boundaries for particular sections or major tributaries of WOC.

The index of biotic integrity (IBI) was developed by Karr (1981) (modified for regional application by the Ohio EPA (1988)) and can be a powerful resource management tool in assessing the comparative health of a fish community. There are numerous advantages to evaluating the fish communities such as: fish communities include a range of species representing different tolerance levels, reproduction methods, and trophic levels; identification to species level is comparatively easy; fish are typically found in all but the extreme ephemeral or degraded habitats; and statements regarding the status of fish communities can generally be understood by the public (Karr 1981).

The IBI was calculated using 12 metrics for both wading (≥ 20 mi²) and headwater (<20 mi²) sites (Table 2). Each metric was assigned a score of 1, 3, or 5, depending on the quality, then all metrics were summed (maximum score = 60) (Ohio EPA 1988). These scores are valuable for comparison to previous data in WOC as well as other drainages in the region.

Table 2: The twelve metrics used to calculate the IBI scores for wading (W) and headwater (H) sites as defined by Ohio EPA (1988).

IBI Metrics	Site size	
	W	H
Total Number of Native Species	W	H
Number of Darter Species	W	H
Number of Sunfish Species	W	
Number of Sucker Species	W	
Proportion of Headwater Species		H
Number of Minnow Species		H
Number of Intolerant Species	W	
Number of Sensitive Species		H
Percent Abundance of Tolerant Species	W	H
Proportion of Omnivores	W	H
Proportion of Insectivores	W	H
Proportion of Top Carnivores	W	
Proportion of Pioneering Species		H
Proportion of Simple Lithophilic Spawners	W	
Number of Simple Lithophilic Spawners		H
Proportion of Individuals with DELTs	W	H
Number of Individuals/ 300m	W	H

Certain variables of 2004 data were compared to previous data to monitor any major changes. Previous samplings conducted by the Ohio EPA occurred in 1983, 1987, 1990, and 1997 which consisted of 2 sites (sampled thrice), 2 sites, 13 sites, and 15 (sampled twice) sites, respectively (total = 51 collections). The species richness and abundance data collected from sites sampled more than once per year was combined for that particular site. IBI scores were the exception and were calculated for each collection (Ohio EPA unpubl. data.)

The relative frequencies of occurrences were categorized for all species in each of the major drainages and respective tributaries within WOC. This conveys to the general public the likeliness of encountering a species within a specific section of the watershed (Table 6). The four generalistic categories are “Common”, “Sparse”, “Rare”, and where it is blank indicates no documentation of that species (yet) within the drainage. “Common” indicates the collection of this species would be expected. “Sparse” means the collection of this species 1) may be expected but in low abundance or 2) occurs in high abundance but low frequency or 3) has only been found in defined parts of the drainage (upper/lower section, tributary, etc.). “Rare” implies the species occurs in very low frequency and/or abundance. Assignments to these classifications were based on the relative abundances and frequencies encountered using 2004 and previous data sets.

RESULTS AND DISCUSSION:

In 2004, 3,658 individuals were collected and identified to 38 species. Of all collections, minnows (Family: Cyprinidae) were most abundant (76.8%), followed by darters (Family: Percidae) (15.3%), and sunfishes/black basses (Family: Centrarchidae) (5.6%). Bluntnose minnows (1002, *Pimephales notatus*) were the most abundant species, followed by rosefin shiners (713, *Lythrurus ardens*), rainbow darters (308, *Etheostoma caeruleum*), and bigeye shiners (236, *Notropis boops*). Of the 38

species collected, only two (bluntnose minnows, *Pimephales notatus* and longear sunfish, *Lepomis megalotis*) occurred at each sampling site.

Index of Biotic Integrity

The IBI scores classified 75% of the sites as “good” and 25% as “fair” (Table 3). Biotic integrity class “good” indicates a community as having high species richness, sensitive species present, and the predictable association of expected species. A “fair” community is described as having declining species richness, sensitive and expected species absent or low in abundance, and an increase in tolerant species that may be predominate (Ohio EPA 1988). These class descriptions appear to address a more accurate depiction of the communities in WOC than those first proposed by Karr (1981). Sites with “good” ratings appear to match all the criteria described. These designations indicate the fish communities have similar assemblage structure to those of other “relatively healthy” sites in the drainage. This inference can also be expanded to encompass similarity to other communities in the region.

The East Fork 10.5 site is located near Mowrystown and contained a low-head dam directly upstream of the sampling reach. Below the dam were excellent heterogeneous habitats and substrata. It was balanced with 20% (by distance) pool, 40% riffle and 40% run habitats of a variety of depths. Vegetation was abundant within the channel and along the banks, providing root mats and mussel beds. This was the only site at which brindled madtoms (*Noturus miurus*) (4 individuals) were collected.

At Sterling Run 5.8 site, no sensitive species were collected and the abundance of tolerant-species dominated the community (87.7%). A second pass in the 100-m reach was performed in attempt to increase the number of individuals collected, however only 73 total individuals were gathered. This low abundance may be attributed to a relatively homogenous habitat gradient. Pools (88%) dominated this sampling reach with only 2 small riffles comprising only 6% of the reach distance. Canopy cover and instream cover/snags were quite abundant. This site also experiences periodic inundation due to the backwaters of Grant Lake. These may be contributing factors to the lack of structure and balance to the community.

The main 19.5 site generated a “fair” IBI rating (Table 3) and may be underestimated. The large water volume and high stream gradient at this site decreased sampling efficiency, thus providing a potential inaccurate representation of the entire fish community. For this reason, only one site was sampled in the main channel.

Table 3: The IBI scores and ratings at each site in 2004.

Site & Stream mile	Drainage Area (mi. ²)	IBI Score	Rating
Main 19.5	192	34	Fair
E. Fork 3.9	63	42	Good
N. Fork 1.3	54	36	Good
E. Fork 10.5	26.7	46	Good
Sterling Run 5.8	19	30	Fair
E. Fork 16.4	11	46	Good
N. Fork 16.1	8.5	44	Good
L. N. Fork 4.1	4.5	42	Good

Osborne et al. (1992) suggested that most regional IBI applications underestimate the quality of headwater tributaries. In 2004, three of the four headwater reaches were classified as “good.” IBI scores from previous years indicate only 2 of the 16 headwater collections received a “good” or “exceptional” rating; ten were “fair” and 4 were “poor.” Previous collections imply an underestimation could potentially have resulted but testing for this would require more data. Whichever the case, the 2004 scores still indicate an improvement in quality ratings.

Status of the Bigeye Shiner (*Notropis boops*)

The bigeye shiner (*Notropis boops*) is listed as a threatened species by the state of Ohio and has been found predominantly in the southern portion of the state (Figure 2). It has a tolerance rating of “rare intolerant” (Ohio EPA 1988) indicating its sensitivity to degraded aquatic systems. *N. boops* had been previously documented in the White Oak Creek watershed, but in limited numbers. Collections made in 2004 recorded a significant difference ($\chi^2=438.12$, $df = 3$, $p<0.001$) in the number of individuals collected in comparison to previous years (Table 4). Of nine sites sampled in 2004, eight yielded successful collections. Previous data from 1990 and 1997 yielded 7 of 13 and 6 of 16 successful collections, respectively. The majority of individuals collected in 2004 were in the North Fork, largely due to their dominance (122 individuals) at one site (N. Fork 16.1). This was the highest density of *N. boops* that was encountered in 2004 and well above any of the previous data.

Figure 2: The relatively recent distribution of the bigeye shiner (*N. boops*) has only been documented in the south/southeastern portion of Ohio’s political boundaries (Bauer 1978, Trautman 1981, U.S. Geological Survey 2003). (Map modified from U.S. Geological Survey 2003)

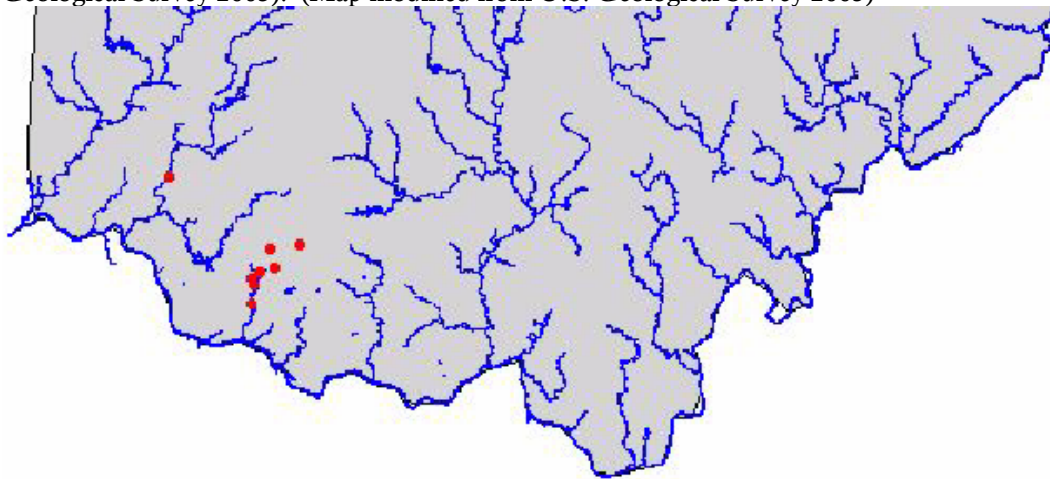


Table 4: Collections of the bigeye shiner (*N. boops*) made in 1983-2004 and the percentage of individuals collected within the drainage basin of White Oak Creek.

	1983 (%)	1987 (%)	1990 (%)	1997 (%)	2004 (%)
Main Channel	0.0	0.0	22.9	53.8	2.5
East Fork	0.0	100.0	17.1	7.7	31.4
North Fork	0.0	0.0	48.6	15.4	66.5
Sterling Run	0.0	0.0	2.9	23.1	1.3
Other tributaries	0.0	0.0	8.6	0.0	2.5
Total Individuals	0	25	35	13	236

The apparent improvement of the *N. boops* populations have not been correlated with any discrete environmental improvements over the past 21 years. It is known that *N. boops* is sensitive to turbid waters and populations have been documented to decline once a stream becomes covered in silt (Trautman 1981). Speculations on improvement of the populations may be potentially associated with enforced conservation efforts (since 2000) by the Brown County Soil and Water Conservation District. Actions such as establishing grass waterways in fields, installing fences to exclude livestock from streams, and restoring riparian buffer zones have aimed at reducing erosion, siltation, and turbidity. The effects of these management practices on these populations were not directly investigated in the scope of this study. Speculations are based on improvements associated with these implementations since the 1990 and 1997 collections. An investigation is encouraged to observe the direct effects of these practices on the population dynamics of *N. boops*.

Conditions within the drainage appear to be favorable for the persistence of this species. The status of *N. boops* in WOC is currently stable.

Trophic Structure

Insectivorous individuals dominated the trophic structure at each site throughout the watershed. Omnivores were second-most abundant and had a significant inverse relationship with insectivores ($R = -0.714$, $p = 0.022$, Figure 3). The substantial presence of insectivores can infer an established aquatic insect community. Equilibrium involving variant trophic levels may superficially indicate a health of a stream community. Schlosser (1982) noticed that in polluted reaches of streams, omnivores and herbivore-detritivore species were most common. Unpolluted sites contained more insectivore and insectivore-piscivore species.

A dominance of omnivores (or generalists) could indicate a disturbed community due to their opportunistic feeding behavior. If this prediction is accurate, then according to the trophic structure data, there are two sites that may be experiencing some type of disruption: Little North Fork 4.1 and East Fork 16.4 (Figure 3). These sites have a relatively high proportion of omnivores and/or generalists. Both of these sites have anthropogenic disturbances occurring directly upstream of the sampling site. The Little North Fork site had plenty of canopy cover however upstream were huge plots of agricultural fields. There was very little flow throughout the reach and a biofilm was evident in many of the slack water areas. Human or livestock sewage may have been responsible for the biofilm.

Directly upstream of the East Fork 16.4 site was a livestock farm without any riparian buffers or canopy cover. This site contained instream vegetation, a diverse assortment of suitable habitat and flow, and widespread canopy cover within the sampling reach. A field tile outfall was also evident within the sampling reach. Both of these sites appear to be experiencing adverse runoff from the surrounding land uses.

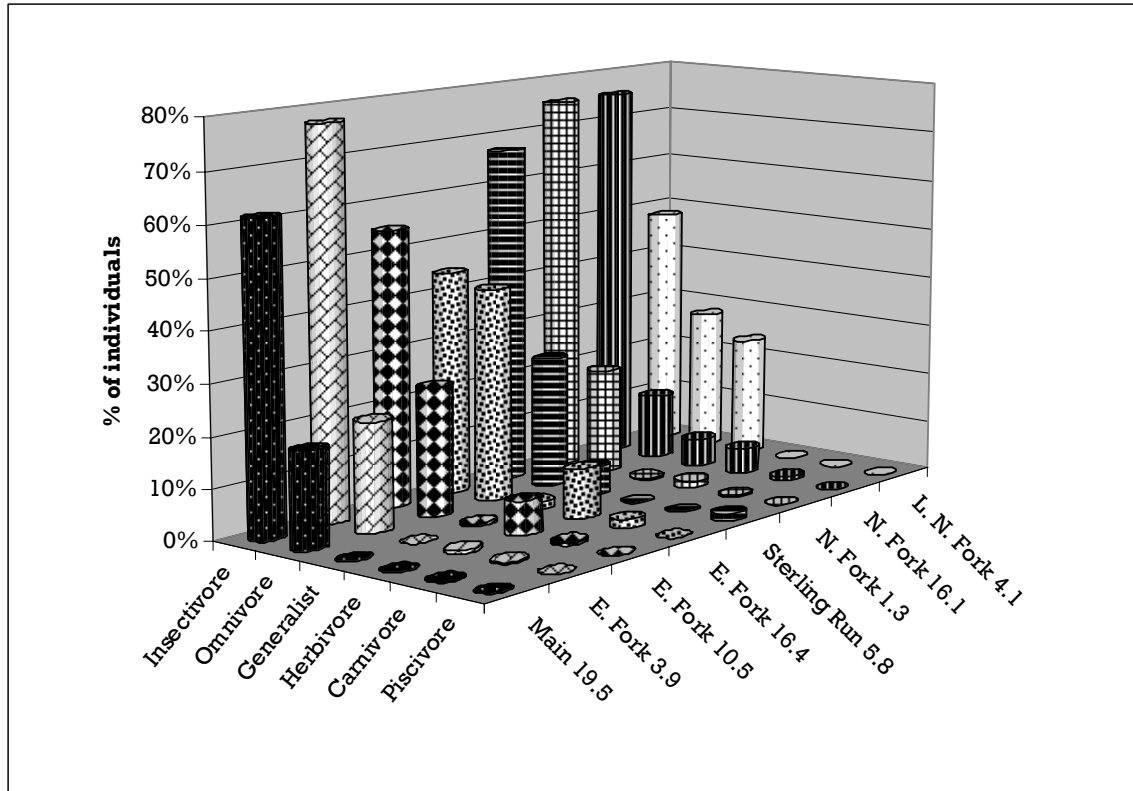


Figure 3: The percentage of individuals by trophic guild (Ohio EPA 1988) at each site in 2004.

Grant Lake is a 180-acre impoundment established on Sterling Run by the U.S. Fish and Wildlife Service (Figure 1). Thirty-seven species have been documented in Sterling Run; 33 downstream and only 20 upstream of the reservoir. Twelve of the 13 cyprinid (minnow) species ever recorded in the Sterling Run basin have been documented downstream, however only 6 upstream. Four species of darters exist within the drainage of which only 2 have ever been documented upstream. The two darters species (johnnie darter, *Etheostoma nigrum* and fantail darter *E. flabellare*) that have been recorded upstream are not simple lithophilic spawners, therefore do not require clean gravel substrate for spawning. Also, species richness and IBI scores happen to be higher downstream of the reservoir (Table 5).

Gizzard shad (*Dorosoma cepedianum*) and black and white crappies (*Pomoxis spp.*) were found in reaches flanking Grant Lake; upstream and downstream in considerable abundance. Swink and Jacobs (1983) noticed the rare collections of these species prior to the establishment of the Green River Reservoir, KY. Then, post-impoundment collections documented an increase in abundance of these species, both above and below the reservoir; thus indicating emigration from the reservoir. Due to their feeding ecology (Pierce & Wissing 1981), isolated occurrence, and natural habitat preference, it can be assumed that Grant Lake is the location of a prolific population (Swink & Jacobs 1983) of these species. An investigation is encouraged to determine the direct effects of the impoundment on the fish community, both upstream and downstream.

Table 5: Species richness, IBI scores and ratings for Sterling Run with respect to the location of site to Grant Lake.

Relative position to Grant Lake	Sterling Run Site (by stream mile)	Date	Species Richness	IBI Score	Rating
Downstream	0.9	1990	14	28*	Fair
	0.9	1997	32*	42	Good
	0.9	1997		46	Good
	0.9	2004	20	n/a	----
Upstream	6.4	1997	12*	20	Poor
	6.4	1997		24	Poor
	5.8	2004	12	30	Fair

*Raw data was compiled for these sites in 1997.

Relative Frequency of Occurrence

The most ubiquitous species throughout the drainage, past to present, are the bluntnose minnow (*Pimephales notatus*), longear sunfish (*Lepomis megalotis*), and central stoneroller (*Campostoma anomalum*). These species are most common throughout all of the drainages and can be expected to be present at nearly every site. Table 6 is for use of the general public and should only be used as a guide as to what may be expected. Three categories were used to describe the frequency of occurrence and vaguely termed to account for discrepancy. The table should not be held to its literal components and does not warrant acute accuracy.

SUMMARY

Seven of the nine sites displayed some form of anthropogenic disturbance to the stream morphology within 100 meters upstream/downstream or within the sampling reach. These disturbances included dams, road crossings, channelization and/or bridge abutments. The alterations did not appear to have a large impact on the community composition at any of the sites. None of the disturbances appeared to be recent so if an impact on the community once occurred, it seems to have recovered. However, this does not apply to the installation of an impoundment. Grant Lake reservoir appears to have a profound effect on the stream community and could be an impediment for the movement for certain stream dwelling species (Winston & Taylor 1991). The reservoir may act as a barrier for the dispersal and re-colonization of species and populations. This may account for the lower number of species documented upstream of the reservoir. There is no pre-impoundment data (the author could find) in Sterling Run, therefore no conclusive evidence if any upstream extirpation of species occurred as a result of the damming.

Assigning a numerical value (IBI score) and category on the health of a fish community aids as a reference and should be used in comparative analyses. Information regarding the ecological processes in the stream is not vividly depicted by a number and may not expose factors influencing the integrity of the stream's entity. It is imperative to gain an understanding of the ecological processes influencing a community. This management tool is continually being refined to try to increase the accuracy of an assessment. For example, Heithaus and Grame (1997) suggest that trophic structure and pollution tolerance should be categorized by the proportions of species rather than individuals. Many opinions are expressed as to the validity of specific metrics or the calculation itself. Revised versions of the IBI have been suggested. It is important to stress the comparative effectiveness of the Index of Biotic Integrity when assessing fish communities.

Despite the slight imbalance of trophic structure at L. North Fork 4.1 and E. Fork 16.4 sites, IBI scores classified them as “good,” inferring the disturbances may be minimally affecting the entire fish community. In fact, this may apply to all sites because it can be inferred that all experience various intensities of disturbances. The most severe alterations and/or disturbances need to be prevented at all cost due to the relatively high abundance of intolerant and sensitive fish species within the watershed. Conservation practices need to continue to ensure the persistence of these species. Some of the most common causes for the depletion of stream fish diversity can be attributed to urbanization. If future infringement is inevitable, public awareness may be the best pre-emptive measure to avoid diminishing WOC’s fish diversity.

REFERENCES:

- BAUER, B. H., B. A. Branson, and S. T. Colwell. 1978. Fishes of Paddy’s Run Creek and the Dry Fork of the Whitewater River, Southwestern Ohio. *Ohio J. Sci.*, 78:144-148
- GORMAN, O. T. and J. R. Karr. 1978. Habitat structure and stream fish communities. *Ecology* 59:507-515.
- HEITHAUS, M. R. and C. Grame. 1997. Fish community of the Vermillion River watershed: Comparison of the main channel and tributaries. *Ohio J. Sci.* 97(5):98-102.
- KARR, J. R. 1981. Assessment of biotic integrity using fish communities. *Fisheries* 6(6):21-27.
- KARR, J. R. 1991. Biological integrity: A long-neglected aspect of water resource management. *Ecol. Appl.* 1:66-84.
- OHIO EPA. 1988. Biological criteria for the protection of aquatic life. Ohio Environmental Protection Agency, Division of Water Quality Monitoring and Assessment, Surface Water Section, Columbus, Ohio.
- OSBORNE, L. L., S. L. Kohler, P. B. Bayley, D. M. Day, W. A. Bertrand, M. J. Wiley, and R. Sauer. 1992. Influence of stream location in a drainage network on the index of biotic integrity. *Trans. Am. Fish. Soc.* 121:635-643.
- PIERCE, R. J. and T. E. Wissing. 1981. Aspects of the feeding ecology of gizzard shad in Acton Lake, Ohio. *Trans. Am. Fish. Soc.* 110:391-395.
- SCHLOSSER, I. J. 1982. Trophic structure, reproductive success, and growth rate of fishes in a natural and modified headwater stream. *Can. J. Fish Aquat. Sci.* 39:968-978.
- SWINK, W. D. and K. E. Jacobs. 1983. Influence of a Kentucky flood-control reservoir on the tailwater and headwater fish populations. *N. Am. J. Fish. Manage.* 3:197-203.
- TRAUTMAN, M. B. 1981. *The Fishes of Ohio*. Columbus, OH: Ohio State University Press. 782p.
- WINSTON, M. R., C. M. Taylor, and J. Pigg. 1991. Upstream extirpation of four minnow species due to damming of a prairie stream. *Trans. Am. Fish. Soc.* 120:98-105.
- U.S. GEOLOGICAL SURVEY, U.S. DEPARTMENT OF THE INTERIOR. 2003. USGS Water resources of Ohio. http://oh.water.usgs.gov/ohgap/fish_pdf/bigeye_shiner.pdf. Accessed 11/20/2004.

Table 6. The relative frequency of occurrence by species, categorized by the relative abundance and/or frequencies in the major drainages and respective tributaries of White Oak Creek. The occurrences are purposely vague to account for marginal discrepancies and should be used for reference only. C= Common; S= Sparse; R= Rare; those that are blank have not been documented in the drainage.

Common Name	Species Name	Main Channel	East Fork	North Fork	Sterling Run (disregarding Grant Lake)
Gizzard Shad	<i>Dorosoma cepedianum</i>	S		S	C
Quillback Carpsucker	<i>Carpionodes cyprinus</i>	R	R		
Highfin Carpsucker	<i>Carpionodes velifer</i>	R			
Black Redhorse	<i>Moxostoma duquesnei</i>	S	R	R	
Golden Redhorse	<i>Moxostoma erythrurum</i>	C	S	C	R
Shorthead Redhorse	<i>Moxostoma macrolepidotum</i>	S			
Northern Hogsucker	<i>Hypentelium nigricans</i>	C	C	S	R
White Sucker	<i>Catostomus commersoni</i>	S	C	S	C
Common Carp	<i>Cyprinus carpio</i>	S	R	R	R
Goldfish	<i>Cyprinus auratus</i>		R		
Golden Shiner	<i>Notemigonus chrysoleucas</i>		R	R	
Western Blacknose Dace	<i>Rhinichthys atratulus</i>	R	R		R
Creek Chub	<i>Semotilus atromaculatus</i>	S	C	C	C
Suckermouth Minnow	<i>Phenacobius mirabilis</i>	S	S	S	
Emerald Shiner	<i>Notropis atherinoides</i>	C	S	R	R
Silver Shiner	<i>Notropis photogenis</i>	C	S	R	
Rosefin Shiner	<i>Lythrurus ardens</i>	C	C	C	S
Striped Shiner	<i>Luxilus chrysocephalus</i>	R	C	C	S
Bigeye Shiner	<i>Notropis boops</i>	S	C	C	R
Steelcolor Shiner	<i>Cyprinella whipplei</i>	C		R	R
Spotfin Shiner	<i>Cyprinella spiloptera</i>	C	R	R	C
Sand Shiner	<i>Notropis ludibundus</i>	C	C	C	S
Silverjaw Minnow	<i>Ericymba buccata</i>	C	C	C	C
Bullhead Minnow	<i>Pimephales vigilax</i>				R
Fathead Minnow	<i>Pimephales promelas</i>		R		S
Bluntnose Minnow	<i>Pimephales notatus</i>	C	C	C	C
Central Stoneroller Minnow	<i>Campostoma anomalum</i>	C	C	C	C
Channel Catfish	<i>Ictalurus punctatus</i>	C	R		R
Yellow Bullhead	<i>Ameiurus natalis</i>	R	S	R	S
Brown Bullhead	<i>Ameiurus nebulosus</i>			R	R
Black bullhead	<i>Ameiurus melas</i>	R	R		R
Flathead Catfish	<i>Pylodictis olivaris</i>	S			R
Stonecat	<i>Noturus flavus</i>	C	R		R
Brindled Madtom	<i>Noturus miurus</i>		R	R	
Brook Silverside	<i>Labidesthes sicculus</i>	R	R	S	
White bass	<i>Morone chrysops</i>	R			
White Crappie	<i>Pomoxis annularis</i>	R		S	C
Black Crappie	<i>Pomoxis nigromaculatus</i>	R		R	S
Rock Bass	<i>Ambloplites rupestris</i>	C	S	S	S
Smallmouth Bass	<i>Micropterus dolomieu</i>	C	S	R	S
Spotted Bass	<i>Micropterus punctulatus</i>	S	S	S	R
Largemouth Bass	<i>Micropterus salmoides</i>	S	S	S	C
Green Sunfish	<i>Lepomis cyanellus</i>	C	C	C	C
Bluegill	<i>Lepomis macrochirus</i>	C	C	C	C
Orangespotted Sunfish	<i>Lepomis humilis</i>	C	R	R	
Longear Sunfish	<i>Lepomis megalotis</i>	C	C	C	C
Blackside Darter	<i>Percina maculatus</i>	R	R	R	
Logperch Darter	<i>Percina caprodes</i>	S	S	R	R
Johnny Darter	<i>Etheostoma nigrum</i>	R	C	S	C
Greenside Darter	<i>Etheostoma blennioides</i>	C	C	C	S
Eastern Banded Darter	<i>Etheostoma zonale</i>	R	R		
Rainbow Darter	<i>Etheostoma caeruleum</i>	C	C	C	S
Orangethroat Darter	<i>Etheostoma spectabile</i>	R		R	
Fantail Darter	<i>Etheostoma flabellare</i>	S	C	C	C
Freshwater Drum	<i>Aplodinotatus grunniens</i>	S			