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DISTRIBUTION OF FISHES OF THE MUSCATATUCK NATIONAL WILDLIFE REFUGE, INDIANA

Jacob L. Burskey: Department of Ecology and Organismal Biology, Indiana State University, Terre Haute, Indiana 47809 USA

Thomas P. Simon: U.S. Fish and Wildlife Service, 620 South Walker Street, Bloomington, Indiana 47401 USA

ABSTRACT. The fish fauna of Muscatatuck National Wildlife Refuge in Jennings and Jackson counties, Indiana was studied from 15 sites consisting of lentic and lotic waters. Fifty-one species from 14 families were collected. In the four lentic sites dominant species included *Lepomis macrochirus*, *L. microlophus*, *Micropterus salmoides*, *Gambusia affinis*, *Notemigonus crysoleucus,* and *Amia calva*. At three medium-large (>8 m wetted width) wadeable stream sites the dominant species included *Minytrema melanops*, *Catostomus commersonii*, *Lepomis megalotis*, *L. gulosus, Pimephales vigilax, Cyprinella spiloptera*, and several additional sucker species. Dominant species at seven small stream sites included *Semotilus atromaculatus*, *Lepomis macrochirus*, *L. cyanellus*, and *Umbra limi*. Rare and imperiled species records included the Eastern Sand Darter, *Ammocrypta pellucida*, and Harlequin Darter, *Etheostoma histrio*, from the Vernon Fork Muscatatuck River. The Flier, *Centarchus macropterus*, and Redspotted Sunfish, *Lepomis miniatus*, were collected from three refuge sites. Index of Biotic Integrity scores were highest at the larger stream sites, ranging from "very good" to "excellent." The smaller streams were heavily influenced by management activities targeted at migratory waterfowl and had IBI scores ranging from "fair" to "poor."

Keywords: Conservation, biological integrity, management

The impact of anthropogenic stressors on the environment has led to the loss of high quality natural areas and unspoiled wild areas (Della-Sala et al. 2000). One conservation measure used in the recovery of imperiled species is dependent on preserving either high quality natural areas or large land areas that may be able to maintain ecosystem function (Noss et al. 1997; Noss 2003). In order to maximize ecosystem function, large land areas are managed for diverse and heterogenous habitats in order to maximize biological diversity (Carroll et al. 2004; Meretsky et al. 2006); however, the areas surrounding refuges and preserves may actually contribute to extinction debts that are insurmountable in species recovery (Noss 1982; Carroll et al. 2004). Large land areas possessing unspoiled habitats are virtually nonexistent in North America, especially in the United States east of the Mississippi River. As a result, best management practices have been implemented to reduce wildlife risk and exposure to contaminants and other detrimental land use practices (Noss 2000).

In Indiana, limited aquatic studies have been conducted in nature preserves, parks, and wildlife refuges—especially ones that inventoried the biological diversity of flora and fauna. The Indiana Dunes National Lakeshore, in northwestern Indiana, contains the largest contiguous public land holding along the southern shore of Lake Michigan (Simon & Stewart 1999). None of the federal wildlife refuges have been inventoried for aquatic life. Among the state wildlife refuges, only the Kingsbury Fish and Wildlife Area has been studied (Sever & Duff 1985).

The Muscatatuck National Wildlife Refuge was created for the protection of migratory waterfowl. Water manipulation is an important management tool for the Muscatatuck National Wildlife Refuge (USFWS 2003). Many of the refuge wetland units are connected by pipes and water control structures so that water can be moved between areas at different times of the year. These moist soil units are low open areas surrounded by dikes. Moist soil units are filled with water in the fall and drained in the spring to provide feeding areas for waterfowl and shorebirds. Similarly, green tree units are diked lowland forests that are flooded with water in the fall for waterfowl and drained in the spring

to keep trees healthy. These units are not managed for fishes. One result of this water manipulation is the creation of permanent marshes, which are ideal habitat for migratory birds to raise their offspring. Trees are also planted to reduce forest fragmentation and provide diverse habitats for wildlife.

The purpose of this study was to document the fish species occurring in lotic and lentic waters of the Muscatatuck National Wildlife Refuge and describe species richness, structure, and biological integrity.

METHODS

Study area.—The Muscatatuck National Wildlife Refuge is located in south-central Indiana and lies in Jennings and Jackson counties. The refuge is part of the Eastern Corn Belt Plain ecoregion (Omernik & Gallant 1988) and consists of 3126 hectares of managed wetlands, hardwood forest, and farmed lands. Approximately 36% of the refuge is within the flood plain of the Vernon Fork of the Muscatatuck River, which forms the southern boundary of the property and drains the refuge. The refuge was established in 1966 with the primary purpose of providing migratory waterfowl with a feeding/resting area. To achieve this objective more than 486 hectares of managed waters consisting of lakes, moist soil units, and green tree units were constructed (USFWS 2003). Currently, the majority of the aquatic habitat on the refuge, not including the Vernon Fork, is a product of these management activities.

Collection methodology.—Thirteen sites were sampled within the boundaries of the Muscatatuck National Wildlife Refuge, along with one site downstream and one site upstream of the refuge on the Vernon Fork Muscatatuck River to assess fish communities (Table 1, Fig. 1). Sampling was done during June 2007. Fish assemblages were assessed using electrofishing equipment. Lakes and wetland areas were sampled using a boat mounted Smith Root 2500 watt DC generator unit. Large-to-medium size streams (>8 m wetted width) were assessed using a long-line and backpack electrofishing units. The long-line system employed a Smith Root 2500 watt DC generator stationed on the bridge crossing. The long-line system is analogous to using an extension cord attached to the anode and uses the earth as ground, allowing the cathode to remain stationary. Small steams (<8 m wetted width) were assessed using a Smith Root DC backpack electrofishing unit equipped with an 800 watt generator capable of 300 volts and 3–5 amps. Sampling of streams was conducted along a linear reach based on 15 times the wetted width bounded by 50 m increments. Sample reach length was a minimum of 50 m (wetted width <3.3 m) and maximum of 500 m. Lakes and moist soil units were sampled based on 500 m reaches. Lake reaches were selected based on natural shoreline features, which included intact riparian vegetation and bank condition. Lake Linda, Stansfield Lake, and the moist soil unit south of Moss Lake (MSU) had two 500 m sample reaches on separate shores. Approximately 500 m of accessible water at a single site was sampled on Moss Lake.

Table 1.—List of collection locations corresponding to Figure 1, along with Index of Biotic Integrity (IBI) score and classification for each site.

Site	Water body	IBI	Classification
Lakes/Moist soil units			
1	Lake Linda	-	-
2	Moss Lake	-	-
3	MSU South of Moss Lake	-	-
4	Stansfield Lake	-	-
Large-medium streams			
5	Mutton Creek	48	Very good
6	Vernon Fork Muscatatuck River	46	Very good
14	Vernon Fork Muscatatuck River	52	Exceptional
15	Vernon Fork Muscatatuck River	56	Exceptional
Small streams			
7	Richart Lake outlet	26	Poor
8	Richart Lake tributary	28	Fair
9	Tributary	32	Fair
10	Mutton Creek tributary	34	Fair
11	Storm ditch	30	Fair
12	Mutton Creek	28	Fair
13	Sandy Branch	32	Fair

Community assessments.—Captured fish were kept in a live well during sampling. Upon completion of sampling, specimens were identified to species, counted, measured for minimum and maximum total length, and weighed to the nearest gram. Voucher specimens were preserved in 5% formalin, and all other fish were released. Fish data for streams were analyzed using an Index of Biotic Integrity (IBI) calibrated for the Eastern Corn Belt Plain ecoregion (Simon & Dufour 1998). Community

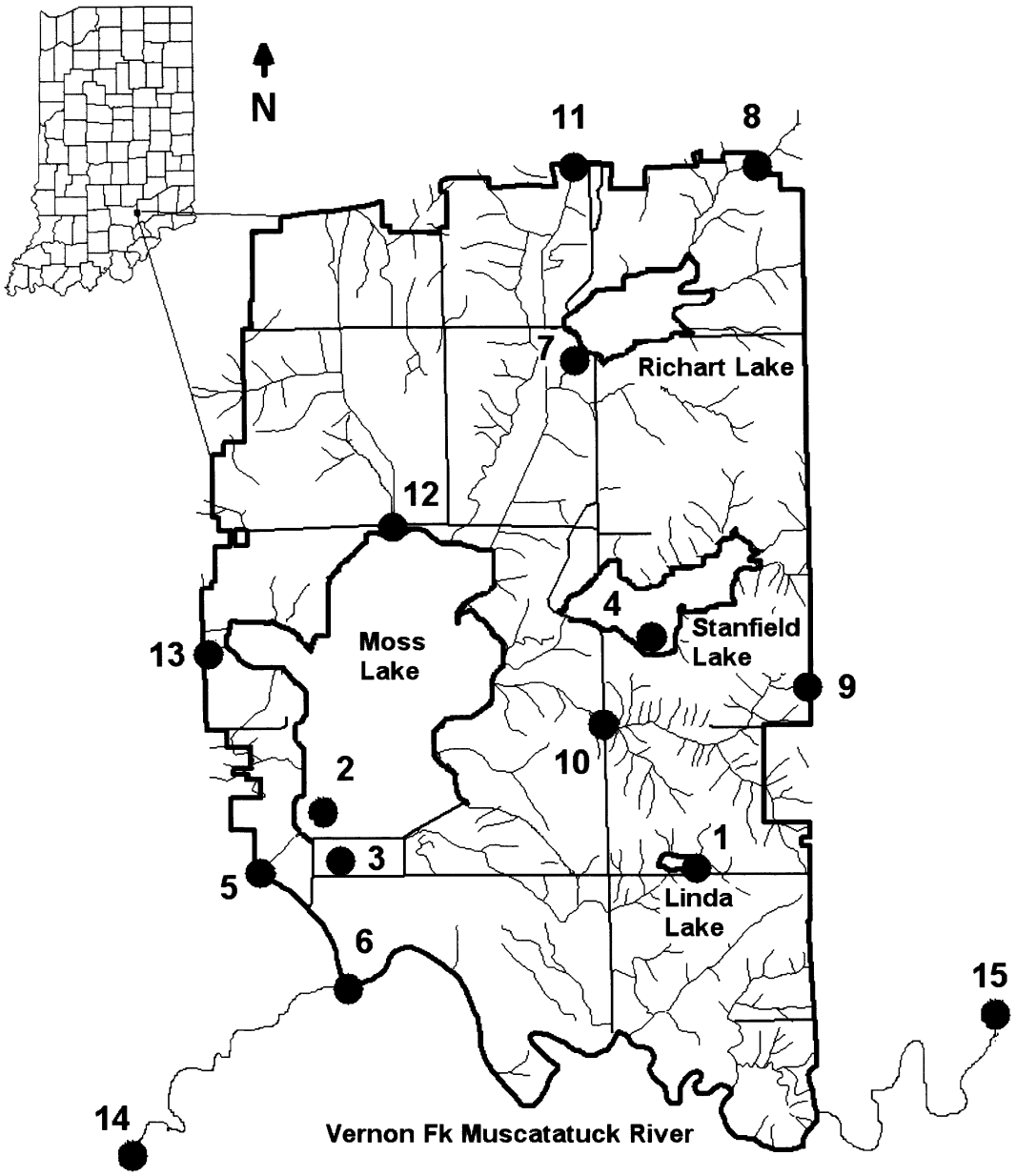

Figure 1.—The Muscatatuck National Wildlife Refuge consists of 3124 hectares and lies within Jennings and Jackson counties in southeastern Indiana. Black dots denote sample locations, and numbers correspond to site numbers in Table 1.

composition in streams and lakes was also assessed using weight and numerical data for each species.

RESULTS AND DISCUSSION

Fishes of Muscatatuck NWR.—Fifty one species of fish representing 14 families were collected from the 15 sample sites (Table 2). Overall, minnows (Cyprinidae), suckers (Catostomidae), sunfish (Centarchidae), and darters (Percidae) were the most dominant families. Fish assemblage structure differed according to stream size and hydrologic characteristics of each environment.

Table 2.—Fish species collected from Muscatatuck National Wildlife Refuge during June 2007. Numbers represent site locations corresponding to Table 1 and Figure 1. Numbers in parentheses represent number of individuals collected followed by weight (g) collectively for each species.

Scientific name	Lake/moist soil units	Large-medium streams	Small streams
Petromyzontidae			
Lampetra appendix		6 (2, -)	11 (1, 10.6)
Amiidae			
Amia calva	2 (17, 21484), 3 (8, 9829)	5 (1, 1500)	
Lepisosteidae			
Lepisosteus osseus		14 (1, 0.5)	
Umbridae			
Umbra limi	2 (1, 0.3)		7 (1, 4.1), 9 (21, 158.3), 11 (3, 27.6), 13 (42, 31)
Esocidae			
Esox americanus	2 (3, 6.4)	6 (4, 16.3)	7 (8, 228.1), 10 (1, 62.3), 11 (3, 149.7), 12 (8, 375), 13 (3, 36.4)
Cyprinidae			
Campostoma anomalum		6 (8, 6.8), 14 (16, 13.7)	8 (2, 6.5)
Cyprinella spiloptera		6 (9, 38.6), 14 (24, 81) 15 (10, 23)	
Cyprinella whipplei		6 (7, 18.4), 14 (24, 73) 15 (8, 18)	
Hybopsis amblops		15 (7, 15)	
Lythrurus umbratilis		6 (1, 0.3), 14(1, 0.8) 15 (6, 0.2)	11 (1, 3)
Notemigonus crysoleucas	1 (4, 1.4), 2 (35, 100.6), 4 (4, 84.7)		10 (5, 51.9), 12 (3, 71.5)
Notropis atherinoides		15 (1, 0.1)	
Notropis buccata		15 (7, 179)	13 (24, 53.5)
Pimephales notatus		6 (9, 15.4), 14 (11, 33.9) 15 (9, 21.4)	8 (13, 13.7), 11 (3, 1.1), 13(24, 53.5)
Pimephales vigilax		6 (106, 123), 14 (56, 140) 15 (26, 42)	
Semotilus atromaculatus		14 (7, 4.8), 15 (5, 1.9)	8 (258, 357.3), 9 (6, 150.8), 10 (69, 599), 11 (8, 1.6)
Catostomidae			
Catostomus commersonii		5 (7, 2343)	8 (2, 54.2), 11 (3, 1.0)
Hypentelium nigricans		5 (2, 281), 14 (14, 285.5) 15 (14, 540)	
Minytrema melanops	2 (2, 372), 3 (5, 401.5)	5 (38, 12511), 15 (1, 99)	
Moxostoma anisurum		5 (1, 136), 6 (1, 148) 15 (5, 69.4)	
Moxostoma duquesnei	3 (1, 89.2)	5 (4, 1482), 6 (5, 1.2), 14 (1, 44.2), 15 (17, 1172)	
Moxostoma erythrurum		5 (1, 139), 14 (1, 69) 15 (8, 1475)	
Ictaluridae			
Ameiurus melas			9 (2, 132.2)
Ameiurus natalis		5 (1, 69)	7 (1, 82.7), 9 (3, 104.8), 10 (2, 23.1), 12 (1, 20.2)
Ameiurus nebulosus	3 (3, 1284)	15 (1, 188)	
Noturus miurus		6 (2, 7.4), 14 (5, 26.5) 15 (4, 44)	

Table 2.—Continued.

Scientific name	Lake/moist soil units	Large-medium streams	Small streams
Aphredoderidae			
Aphredoderus sayanus	2 (1, 0.8)		10 (2, 27.0)
Fundulidae			
Fundulus notatus			13 (1, 1.8)
Poeciliidae			
Gambusia affinis	1 (1, 0.7), 2 (37, 56.6)	14 (1, 1.8)	12 (8, 5.5), 13 (6, 1.5)
Atherinidae			
Labidesthes sicculus			12 (1, 1.9)
Centrarchidae			
Ambloplites rupestris		15 (3, 270)	
Centarchus macropterus	2 (8, 459)	5 (2, 35)	12 (1, 8.2)
Lepomis cyanellus	2	5 (4, 34), 6 (2, 74.2), 14 (6, 72), 15 (2, 15.1)	7 (3, 62.6), 8 (16, 125.6), 9 (7, 125.8), 10 (15, 231), 11 (9, 112.8), 12 (8, 158), 13 (1, 1.9)
Lepomis gulosus	1 (7, 75.1), 2 (3, 132.1), 3 (6, 113.9), 4 (3, 74.6)	5 (18, 394.3), 14 (1, 70.8)	7 (4, 30.1), 9 (6, 136.9), 10 (6, 85.7), 11 (4, 97.7), 12 (4, 173)
Lepomis macrochirus	1 (30, 735.5), 2 (8,459), 3 (127, 4511), 4 (135, 1313)	5 (7, 171), 14 (7, 69.5), 15 (1, 5)	7 (5, 56.4), 9 (6, 110.6), 10 (34, 265.8), 12 (2, 39.7)
Lepomis megalotis		5 (46, 705), 6 (18, 348), 14 (42, 51.6), 15 (139, 1594)	9, 11 (7, 132.1), 13 (1, 9.5)
Lepomis microlophus	1 (159, 878), 2 (1, 3.2), 3 (34, 1012), 4 (62, 777.5)		
Lepomis miniatus	2 (1, 40.1)		
Micropterus punctulatus		6 (16, 4.9), 15 (2, 0.2)	
Micropterus salmoides	1 (23, 3136.6), 2 (4, 956), 3 (19, 15890), 4 (52, 8968.2)	5 (1, 340)	9 (7, 124.6), 10 (1, 26.2), 12 (3, 144.6)
Pomoxis nigromaculatus	3 (6, 646.9), 4 (2, 52.9)	5 (2, 226.9)	
Percidae			
Ammocrypta pellucida		15 (3, 3.9)	
Etheostoma asprigene		5 (1, 5), 6 (1, 5.2)	
Etheostoma blennioides		14 (1, 3.8), 15 (1, 0.4)	
Etheostoma caeruleum		14 (2, 3.8)	
Etheostoma histrio		6 (1, 2.9), 14 (1, 1.8)	
Etheostoma nigrum		6 (1, 0.1), 14 (3, 0.8), 15 (1, 0.3)	11 (1, 0.1), 13 (4, 1.2)
Percina caprodes		5 (6, 92.1), 15 (5, 66)	
Percina maculata		15 (1, 3.5)	
Percina phoxocephala		6 (1, 2.8), 14 (8, 29), 15 (6, 22)	
Percina sciera		6 (3, 17), 14 (1, 6.0), 15 (2, 8)	

We sampled four lakes including a moist soil unit (lentic waters) on refuge property (Table 1). All four sites are artificial impoundments and three (Lake Linda, Stansfield Lake, and MSU) have been stocked for sport fishing. Sixteen species belonging to eight families were collected from these sites. The most numerically dominant group at Lake Linda, Stansfield Lake, and MSU was Centarchidae. Bluegill (*Lepomis macrochirus*), Redear Sunfish (*Lepomis microlophus*), and Largemouth Bass (*Micropterus salmoides*) constituted over three-fourths of the catch with 42.3, 32.9, and 13.6% of catch respectively. Largemouth Bass (56.1%), Bowfin (*Amia calva*) (19.7%), and Bluegill (13.2%) were the most dominant fish by weight. These three water bodies remain level year-round and mostly contain stocked fish. The water level in Moss Lake is managed according to season, and its fish assemblage differed from the other lentic sites. Moss Lake was sampled at low pool conditions and was heavily vegetated with aquatic macrophytes. In Moss Lake, Western Mosquito Fish (*Gambusia affinis*), Golden Shiner (*Notemigonus crysoleucus*), and Bowfin were the most numerically dominant fishes, with 32.1, 30.4, and 14.8% of catch, respectively. Bowfin also constituted 91% of the catch by relative biomass, followed by Largemouth Bass (4.1%) and Bluegill (2%).

Four medium-large wadeable streams (>8 m wetted width) were sampled. Mutton Creek was sampled upstream of the US 31 bridge where it is a channelized and slow-flowing stream. Mutton Creek was dominated by centrarchid and catostomid species. Longear Sunfish (*Lepomis megalotis*) (31.7%), Spotted Sucker (*Minytrema melanops*) (26.2%), and Warmouth (*Lepomis gulosus*) (12.4%) were the most numerically dominant species. Spotted Sucker (60.7%), White Sucker (*Catostomus commersonii*) (11.4%), and Bowfin (7.28%) were the most common fish by relative biomass at the Mutton Creek site. In addition to Mutton Creek, the Vernon Fork of the Muscatatuck River was sampled at three locations; one upstream of the refuge, one on the refuge, and one downstream of the refuge. These three sites had similar and diverse fish assemblages (Table 2). Thirty-nine species from nine families were collected from the Vernon Fork. The most dominant species by number were Longear Sunfish (27.9%), Bullhead Minnow (*Pimephales vigilax*) (26.4%), and Spotfin Shiner (*Cyprinella spiloptera*) (6%). Longear Sunfish (23.7%), Golden Redhorse (*Moxostoma erythrurum*) (18.4%), Black Redhorse (*M. duquesnei*) (14.5%), Silver Redhorse (*M. anisurum*) (10%), and Northern Hog Sucker (*Hypentelium nigricans*) (9.8%) were the dominant species by relative biomass at the three Vernon Fork sites.

Seven small streams (<8 m wetted width) were sampled on refuge property. Many of these streams were channelized or affected by impoundments and were dominated mostly by cyprinid and centrarchid species. Twenty-three species were collected at these stream sites. Creek Chub (*Semotilus atromaculatus*) (50%), Central Mudminnow (*Umbra limi*) (9.8%), Green Sunfish (*Lepomis cyanellus*) (8.6%), and Bluegill (6%) were the most numerically dominant species. Creek chub was also the most dominant species by mass (21.5%) followed by grass pickerel (*Esox americanus*) (16.5%), and green sunfish (16%).

Rare species records.—Several species uncommon within the state were found during this study. The Harlequin Darter (*Etheostoma histrio*) was thought to be extripated from Indiana until its rediscovery in 1991 within the White River Drainage (Simon & Kiley 1993), and has since been collected from other subwatersheds within the White River, including the Patoka River (Simon et al. 1995). The Harlequin Darter was collected at two sites on the Vernon Fork of the Muscatatuck River (Table 2). Two individuals were collected over gravel/sand riffles with swift current. These records constitute the furthest removed records for the Harlequin Darter from the main stem of either fork of the White River.

The Eastern Sand Darter (*Ammocrypta pellucida*) was collected from one site on the Vernon Fork of the Muscatatuck River (Table 2). The Eastern Sand Darter was also once recognized as state-threatened, based on limited presence (Simon et al. 1992), but has since been removed from threatened status. The Eastern Sand Darter is still considered rare and is susceptible to impacts of habitat degradation (Simon 1993). Three individuals were collected from one site on the Vernon Fork over shallow, sandy-riffle habitat.

The Flier (*Centarchus macropterus*) is a centrarchid species largely associated with the southeastern and eastern United States. Its distribution is restricted to the Coastal Plain from the Chesapeake Bay to eastern Texas and

north through the Mississippi Embayment to southern Illinois and Indiana (Smith 1979; Lee et al. 1980). Records for Indiana depict its distribution as limited to the southwestern and central portions of the state (Gerking 1945). The Flier was collected from three sites in this study; in the Vernon Fork, from Mutton Creek, and from Moss Lake (Table 2). Eleven Flier were collected. These records constitute the furthest north and east collections for the species (Gerking 1945; Lee et al. 1980).

The Bigeye Chub (*Hybopsis amblops*) is a rare minnow through much of its northern range and has undergone severe declines in abundance in the last 50 years. Trautman (1981) and Smith (1979) credit the decline of the Bigeye Chub in Ohio and Illinois to intolerance to siltation. The species prefers medium-large streams with sand and gravel substrates (Trautman 1981). Seven individuals were collected from the Vernon Fork of the Muscatatuck River (Table 2, Fig. 1) over sand and gravel bottom.

Assessment of Muscatatuck NWR streams.—The seven small, wadeable streams sampled on refuge ranged from "poor" to "fair" (Table 1) when compared to reference conditions for the Eastern Corn Belt Plain ecoregion. Index of Biotic Integrity scores ranged from 26 to 34 for these stream sites. The low IBI scores are largely a result of hydrologic modifications to the aquatic habitat on refuge to benefit migratory waterfowl and the sport fishery. These streams are dominated by sunfish and bass species and lack sensitive sucker and darter species, the result of habitat modification and stocking of lakes for sport fishing.

The larger streams showed higher quality biological conditions. The four larger stream sites ranged from "very good" to "exceptional" (Table 2). Scores ranged from 46 to 56 with two of the Vernon Fork sites scoring "exceptional." These sites supported populations of sensitive minnow species, such as Bigeye Chub (*Hybopsis amblops*), sucker species including Golden Redhorse, Black Redhorse, Northern Hogsucker; and several sensitive darter species including Greenside Darter (*Etheostoma blennioides*), Rainbow Darter (*E. caeruleum*), Harlequin Darter, Logperch (*Percina caprodes*), Dusky Darter (*P. sciera*), and Eastern Sand Darter. Hydrologic modifications on refuge have had limited impact on the Vernon Fork and the river continues to support a high quality assemblage of native species.

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