

## Fishes of Vigo County, Indiana

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### Abstract

The occurrence, distribution and habitats of the fishes of Vigo County were studied between November 1962 and November 1965. A total of 321 sites was visited of which 282 yielded fish. One hundred one species were taken and 25 of these are new records for Vigo County, 21 of which were previously reported. Additional new species are *Notropis boops*, *Noturus gyrinus*, *N. nocturnus*, and *Etheostoma asprigene*. Seven species previously reported were not taken in this study.

No relationship was found between width of stream and the number of species present, except that streams less than 5 feet wide contained significantly fewer species than larger streams. There were significantly more species in deeper streams, and with increased number of bottom types per collecting area. Species most commonly found in highly polluted areas were *Notropis atherinoides*, *Semotilus atromaculatus*, *Notropis spilopterus*, *N. blennioides* and *Ericymba buccata*. A dam built across Otter Creek in 1816 has greatly influenced fish populations. There were fewer species above the dam, due mostly to the lack of river species.

### Introduction

One previous study of the fishes of Vigo County, Indiana (6) included collections from the Wabash River, from Otter, Honey, Lost, and Coal Creeks and from various ponds. Jenkins (6) reported 63 species, and other authors (1, 3, 4, 5, 7, 8, 9) have added to this until at the outset of the present study, 83 species were known.

A preliminary report concerning this work (12) consisted only of a list of species taken through the summer of 1965, before sampling had been completed. No information was presented on relative abundance, distribution, habitat factors, effects from pollution and effects on fish populations by a dam built on one stream in 1816. The purpose of the present paper is to present the results of studies of these factors.

### Materials and Methods

Most collections were taken with 15 and 30-foot, 1/4" mesh seines, but 50-foot, 1/4" and 50-foot, 1" seines were used occasionally. Several collections were made using the Indiana Department of Natural Resources shocker boat, most of them in the Wabash River. A total of 321 collection sites was visited (Fig. 1). An effort was made to sample as much of the area in the streams and as many of the ponds and lakes of the county as possible. All but about 2 miles of the Wabash River was covered by shocker boat, and additional collecting was done by seining whenever possible. Most streams were sampled rather well, with coverage approaching 100% in many, particularly Otter, Brouillette, Clear and Prairie Creeks.

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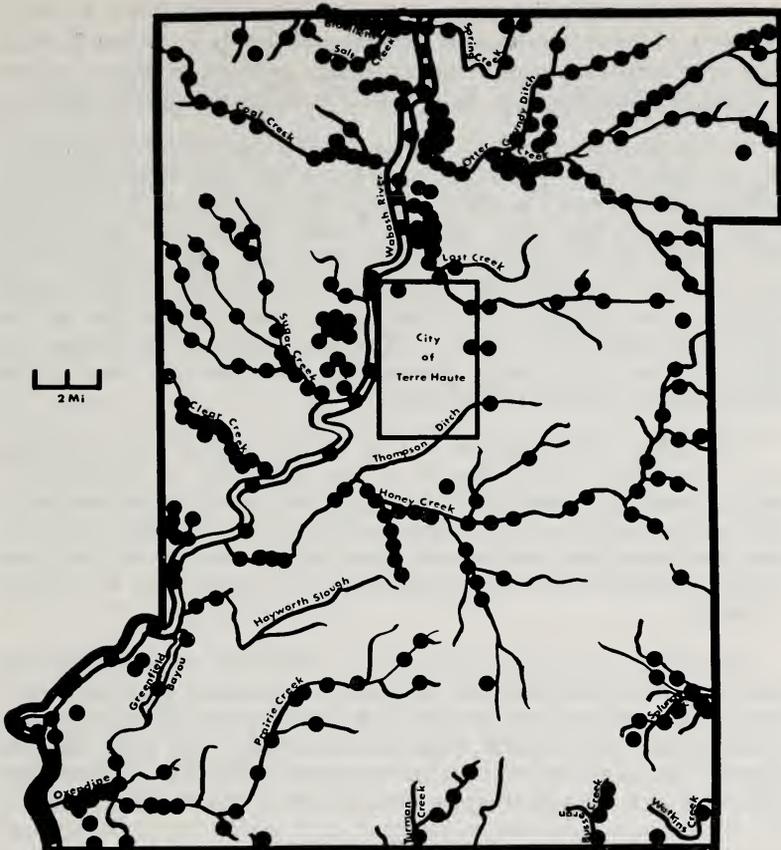


FIGURE 1. Map of Vigo County showing all collecting localities.

The distance covered in a stream collection averaged about 1/2 mile. Collection site designations on Figure 1 are of such diameter that they represent about 1/2 mile of distance; hence Figure 1 gives a relatively good estimate of the sampling coverage of the streams of the county, not including the Wabash River.

Ponds and lakes were less well sampled. Seining took place in most ponds known to us in which this operation could be conducted, but numerous strip pit lakes were deep and could not be worked. Most of these are of recent origin and probably do not contain fish unless stocked.

Ecological information was recorded at each collecting site as follows: date, time of day, hours spent making collections, air and water temperatures and weather. The type of bottom was recorded as mud, sand, gravel or rock. The greatest width and depth were recorded in feet. The type of shore was recorded as wooded, brushy or open. The flow was recorded by estimation as none, slow (less than 0.7 feet per

sec.), moderate (0.8 to 1.5 per sec.) or fast (more than 1.5 feet per sec.). The limits of the categories were checked periodically by timing floating items by stopwatch. Aquatic vegetation was recorded as absent, sparse or abundant. Collecting was done in most habitats throughout the year.

To compare the occurrence of the various species in various habitats and under varying ecological conditions, the data were reduced to average numbers taken per hour. Conclusions were drawn by inspection of the summarized data, and often were tested for significance (95% level) by Chi-square goodness-of-fit tests. If a species was common only in certain areas (*e.g.*, in only the Prairie Creek drainage system) it was assumed that other areas were not available to the species and information from only that area was used in making the tests. Conversely, if a species was common throughout the county, then all information was used for that test.

Two values were calculated for the various species under different sets of conditions, the frequency, or the percentage of collections in which a species occurred, and the rate or the number taken per hour. These values are given for all species taken in any of our 282 collections containing fish, but are not given for species taken other than in those collections, for example, when our only specimens were taken by anglers.

Sometimes a very large number of individuals of a species was taken in a single collection. For example, let us assume that there were 10 collections on sand bottom and 10 on mud and that all sand bottom collections and 9 mud bottom collections contained 10 fish each, but that the remaining mud bottom collection contained 1,000 fish. The average number of fish per collection on sand bottom would be 10,

$$\left( \frac{10 \text{ fish} \times 10 \text{ collections}}{10} \right)$$

while the average number of fish per collection on mud would be 109,

$$\left( \frac{1000 + 90}{10} \right)$$

giving the appearance that the rate of occurrence was very different on the two types of bottoms. In reality, except for the one collection, the numbers of fish were exactly the same on both types of bottom. We decided that the 1,000 should not be added in directly in such a case, but that a certain top limit should be set as the maximum to be included from any one collection. Since there were few cases with more than 60 individuals per species in a collection, this number was taken as the maximum. To compensate for over-weighting, each time more than 60 individuals were taken in a collection, only 60 were tabulated. Handling the case cited above in this way would result in a rate of 10 fish per hour on sand, and 15 fish per hour on mud, a much more realistic appraisal of the situation.

### Description of Vigo County and Fish of Important Habitats

Vigo County lies in west-central Indiana and covers an area of 416.5 square miles. The Wabash River flows through the county from north to southwest, forming the Indiana-Illinois border in the southwest (Fig. 1). Associated with the river is a valley 3-6 miles wide which represents the glacial valley of the Wabash River. This is covered by Wisconsinan age valley train. The remainder of the county is covered with Illinoian drift except for a small portion in the northwest corner of the county which contains Wisconsinan terminal moraine.

The area of the glacial Wabash River is marked by level lowland or "bottomland" streams with associated flood ponds, oxbow lakes, and sloughs while the streams in the Illinoian upland more often cut their way through deeper channels. A few rock outcroppings occur in the northern parts of the county. Coal Creek, in particular, cuts through rock for much of its distance.

Strip-mining for coal has disrupted much of the land and some of the streams. The major southern branch of Honey Creek where only one collection was made (Fig. 1) has been almost completely destroyed. Strip-mined areas have numerous isolated lakes and ponds, usually deep, many of which have been stocked.

#### Wabash River

The Wabash River in Vigo County is about 300 to 500 feet wide and generally has slow to moderate flow. The stream has a mud bottom, but a few sand and gravel bars are present. The water is nearly always very muddy. Little herbaceous vegetation is present. The river is badly polluted directly below Terre Haute, where relatively few fish exist. The pollutants are mainly from factories in the Terre Haute area, but some enter the stream from dwellings and some from mining operations. North of Terre Haute and farther south of the city, the river supports more fish.

Six of the 32 collections made in the Wabash River were by shocker boat; the remainder were by seining. The shocker collections yielded larger fish from deep water, while seining yielded mostly smaller fish from shallow water. All collections contained fish. The average number of species taken per collection was 15.2. The most abundant of the small fish in the portions of the river that could be seined were *Notropis atherinoides* (rate of 27.0), *N. blennioides* (26.6), *N. spilopterus* (13.0), *Pimephales vigilax* (11.7), *Hybopsis storeriana* (5.9), *Carpionotus carpio* (5.8) and *Dorosoma cepedianum* (4.8). The most abundant species as indicated by the shocker collections were *Dorosoma cepedianum* (15.0) and *Cyprinus carpio* (11.7).

#### Wabash River Temporary Flood Ponds

The Wabash River overflows its banks in the Terre Haute area nearly every year. When the water recedes, numerous ponds are left which persist for periods of a few weeks to throughout the year. Ponds which appeared to dry up during most or all years were included in this

category. The water was generally milky or turbid and most of the ponds were over 40 feet wide. In all cases the bottom was mud. The shore varied from open to wooded. The depth was less than 1 foot in 7 of the ponds.

Sixteen collections were made in areas listed as flood ponds and all contained fish. The average number of species taken per collection was 9.06. A total of 41 species was taken in flood ponds, but most were in low numbers and in few ponds. Only 10 species were taken in 5 or more collections, and at a rate of at least 1 per hour. The carp was the most abundant, being taken at a rate of 22.9 per hour. The others, with their frequencies and rates were *Lepomis macrochirus* (68.7, 19.47), *Ictalurus melas* (56.3, 14.84), *Dorosoma cepedianum* (62.5, 9.37), *Pomoxis annularis* (62.5, 8.53), *Notemigonus crysoleucas* (62.5, 7.53), *Lepomis cyanellus* (50.0, 5.84), *Ictiobus niger* (25.0, 5.32), *Micropterus salmoides* (31.3, 3.32), and *Ictiobus cyprinellus* (43.6, 2.53).

Many young *Cyprinus*, *Lepomis macrochirus*, *Ictalurus*, *Dorosoma*, *Pomoxis*, and *Ictiobus* were found in some ponds, indicating that the ponds are used for breeding by these forms. No small young of *Notemigonus*, *Lepomis cyanellus* or *Micropterus salmoides* were taken. These species were not breeding in flood ponds.

#### Permanent Ponds and Lakes

This category contained those permanent ponds and lakes which were not inundated by flooding from the Wabash River.

The ponds varied from clear to turbid, and except for very slow movement in the Otter Creek bayou, the water was still. The ponds varied from 15 feet to over 40 feet wide. The bottom was mud in every case. Depth varied from less than 1 foot to over 4 feet. Aquatic vegetation was abundant at 12 sites, sparse at 5, and lacking at 2 sites. Many additional ponds, especially those formed during strip-mining are present. Many have been stocked, but few were sampled during the present study.

Nineteen collections were made in ponds and lakes, two with the shocker boat, the remainder by seining. Three ponds contained no fish. Two of these were isolated small ponds; the third was a marshy area which apparently had been polluted by mining operations. In the areas with fish, an average of 1.63 hours was spent at each collecting site. A total of 29 species was taken, but the average number of species per collection was only 5.06. Since such ponds were generally isolated, the fish fauna of any one pond depended greatly on its location, past history, and chance. These factors probably account for the low average number of species, and for the fact that of the 29 species, 20 were taken in only 1 or 2 ponds.

Only four species were taken regularly enough in ponds to be called characteristic. These were *Lepomis macrochirus* (taken at a frequency of 68.8% and at a rate of 16.96), *L. cyanellus* (56.3 and 5.22), *Micropterus salmoides* (56.3 and 4.48), and *Esox americanus* (37.5 and 1.37).

## Sloughs

Eleven collections were in an interconnecting system of ditches east of the Wabash River in the southern part of the county. These ditches were filled during spring floods and then retained water at least in pools during the remainder of the year. They differ from ponds influenced by the river in that the system was extensive rather than being broken up into isolated ponds, and from flood ponds in being relatively permanent. There were usually, however, major ponds associated with the sloughs. All but one of the collections were made in slowly-forming turbid water. Most collection areas ranged from 15 to 40 feet wide. Aquatic vegetation was generally lacking, and the bottom was usually mud. All collections in sloughs were by seining. The number of species averaged 12.27 in the 10 slough collections made. A total of 39 species was taken, and 20 were taken in at least 3 collections and at rates of at least 1 per hour. The most abundant species, with frequencies and rates, were *Cyprinus carpio* (100, 22.42), *Lepomis macrochirus* (70, 13.67), *Pomoxis nigromaculatus* (40, 10.75), *Notropis spilopterus* (90, 10.00), *Lepisosteus platostomus* (60, 8.67), *Ictiobus cyprinellus* (60, 7.75), *Amia calva* (50, 7.58), *Lepomis cyanellus* (50, 7.50), *Ictiobus niger* (40, 7.42), and *Dorosoma cepedianum* (30, 6.75).

Since the slough system is flooded nearly every year, the majority of the fish are river species of which *Cyprinus carpio*, *Lepisosteus platostomus*, *Ictiobus cyprinellus*, and *I. niger* apparently often breed. Most individuals of these species in sloughs were young of the year. It appeared that most of the other river species simply became stranded after flooding and did not breed.

Several common slough species were not found in the river. Some of these, *Lepomis macrochirus*, *L. cyanellus*, *Notemigonus crysoleucas*, *Ictalurus melas*, and *Micropterus salmoides*, were widespread in the county, and probably entered the sloughs from streams or ponds via the river during flooding. Two species, *Amia calva* and *Aphredoderus sayanus*, were essentially limited to the slough area and Prairie Creek.

## Streams

Most of the streams in Vigo County lead directly into the Wabash River (Fig. 1). In general, the streams of Vigo County are slow moving, and sand or mud-bottomed. Major exceptions are Brouillettes Creek, some parts of Otter Creek and Coal Creek which cut through shale bedrock. Smaller stony-bottomed areas are found in Sugar, Honey, and Prairie Creeks.

One of the most common habitats in Vigo County is the sandy-bottomed stream. Four species were particularly characteristic of this type of habitat, *Ericymba buccata*, *Semotilus atromaculatus*, *Pimephales notatus* and *Campostoma anomalum*. These were taken in 44, 41, 40, and 37 of the 46 collections, respectively, and at rates of 29.89, 17.80, 16.14, and 14.70. Two other species, somewhat less prominent, were *Notropis chrysocephalus* (10.77) and *N. spilopterus* (10.70).

In muddy-bottomed streams, *Semotilus atromaculatus*, *Ericymba buccata*, *Aphredoderus sayanus*, *Lepomis macrochirus*, *Notemigonus crysoleucas*, *Lepomis cyanellus* and *Notropis spilopterus* were the most abundant species, occurring at rates of 20.45, 13.31, 11.86, 11.45, 7.45, 7.41 and 6.83 fish per hour. Most of the species on mud bottom were widespread on various types of bottom in the county, but *Aphredoderus*, *Notemigonus*, *Erimyzon*, *Esox americanus* and *Etheostoma gracile* were more or less restricted to muddy-bottomed areas.

Stream-bottom areas exclusively of gravel (*i.e.*, not associated with shale bottom) had fish associations similar to those of the sand-bottomed areas of the county. The same four species, *Ericymba buccata*, *Semotilus atromaculatus*, *Pimephales notatus* and *Campostoma anomalum*, were the most common species on both types of bottoms. These occurred at rates of 37.90, 33.00, 28.00 and 22.30 per hour on gravel areas. No species were restricted to areas with gravel bottom.

Gravel-rock areas were very different from gravel areas, there being pieces of loose shale present, in addition to the gravel, thus creating numerous hiding places. The most common species in the gravel-rock areas where river species were not abundant (river species occurred there at a rate of 29.78 per hour), with their rates of occurrences were *Pimephales notatus* (27.37), *Campostoma anomalum* (22.84), *Semotilus atromaculatus* (22.42), *Notropis chrysocephalus* (20.47), *N. spilopterus* (20.47), *Ericymba buccata* (16.74), *Etheostoma blennioides* (16.10), *Notropis umbratilis* (11.89), *Etheostoma caeruleum* (11.68), *E. nigrum* (9.53), *Phenacobius mirabilis* (8.11), and *Hybognathus nuchalis* (7.84).

*Etheostoma blennioides* and *E. caeruleum* were essentially restricted to the gravel-rock type of habitat. *Rhinichthys atratulus* and *Etheostoma flabellare* were favorably affected by it but were not restricted to it, while *Notropis umbratilis* and *Phenacobius mirabilis* reached their peaks of abundance there.

In stream areas with abundant vegetation, the four very common stream species in the county, *Semotilus atromaculatus*, *Ericymba buccata*, *Campostoma anomalum* and *Pimephales notatus*, were all among the top five species in abundance in habitats with abundant vegetation, occurring at rates of 25.72, 21.63, 14.46, and 14.00. *Notropis chrysocephalus* (15.97) was more common than expected, as was *N. spilopterus* (14.00). The only species that might have been directly benefited by the vegetation was *Erimyzon oblongus*. This species was taken at much higher rates in areas with abundant vegetation than it averaged for streams as a whole.

#### Annotated List of Fishes Known to Occur in Vigo County

We have listed 108 species of fishes below which were either taken during the present study (101 species), or were previously reported (7 species). Those seven species previously reported but not taken during this study are indicated by two asterisks instead of rate. Fish species are listed in alphabetical order within families; the families are listed in approximate phylogenetic order. Three values are given for most

species. The first is the rate (number taken per hour). The second is the frequency (percentage of collections in which a species was taken). Previous records are indicated by number which indicates a reference in the literature cited. In four cases, no specimens of a species were taken from the 321 samples, but individuals from other sources were obtained. In these cases, the number taken is indicated, instead of the rate, and is marked with a single asterisk.

#### Petromyzontidae

*Ichthyomyzon bdellium* (Jordan); Ohio lamprey: (\*\*; —; 5)

*I. unicuspis* Hubbs and Trautman; Silver lamprey: (0.03; 2.1; None).

*Lampetra lamottei* (Lesueur); American brook lamprey: (0.003; 0.4; None).

#### Acipenseridae

*Acipenser fulvescens* Rafinesque; Lake sturgeon: (\*\*; — 6). None taken; fisherman still claim it is taken occasionally in the Wabash. Jenkins (6) listed it as "not common, although said to be so a few years ago."

*Scaphirhynchus platyrhynchus* (Rafinesque); Shovelnose sturgeon: (2\*; —; 4, 6, 9). Fairly common in the Wabash.

#### Polyodontidae

*Polyodon spathula* (Walbaum); Paddlefish: (1\*; —; 6).

#### Lepisosteidae

*Lepisosteus osseus* (Linnaeus); Longnose gar: (0.06; 2.8; 6).

*L. platostomus* Rafinesque; Shortnose gar: (0.84; 6.7; 6). Adults of both species were taken at rates of 0.78 and 1.87 per hour in the Wabash. Juvenile *L. platostomus* were common in sloughs (13.00 per hour), and in flood ponds (4.53), probably indicating reproduction.

#### Amiidae

*Amia calva* Linnaeus; Bowfin: (0.30; 3.2; 1, 6). Taken at 8.0 per hour in the slough system associated with Prairie Creek.

#### Anguillidae

*Anguilla rostrata* (Lesueur); American eel: (1\*; —; 6).

#### Clupeidae

*Alosa chrysochloris* (Rafinesque); Skipjack herring: (0.14; 2.1; None).

*Dorosoma cepedianum* (Lesueur); Gizzard shad: (3.23; 19.1; 6). One of the most common river species; taken there at an overall rate of 9.98 per hour, and at 15.65 per hour by shocker boat. Abundant in all river-influenced areas, being taken at high rates in flood ponds (11.79), river-influenced ponds (12.20) and in sloughs (10.08). Only 77 were taken in streams (0.3 per hour).

#### Hiodontidae

*Hiodon alosoides* (Rafinesque); Goldeye: (0.008; 0.7; 6).

*H. tergisus* Lesueur; Mooneye: (0.008, 0.7; None).

#### Umbridae

*Umbr limi* (Kirtland); Central mudminnow: (0.07; 1.8; 6, 8). Taken in only two areas with still water, mud bottom and abundant vegetation. 27 of 28 specimens taken were in the bayou near Otter Creek dam or in an associated pond. One was taken in Oxendine Bayou near Prairie Creek.

#### Esocidae

*Esox americanus* (Gmelin); Redfin pickerel: (0.42; 6.0; 6). Taken mostly in the bayou and grassy pond above the Otter Creek dam and in the Prairie Creek drainage; a few

taken elsewhere in Otter Creek. Taken at 7.88 per hour in Prairie Creek areas with no vegetation, 4.11 per hour in sparse vegetation, and none taken in abundant aquatic vegetation. Taken in Otter Creek areas with abundant aquatic vegetation, as is usual for the species (2). Associated with mud bottom and little or no flow, in both areas.

#### Cyprinidae

- Campostoma anomalum* (Rafinesque); Stoneroller: (11.52; 53.2; 4, 6). Taken in 70% of the stream collections at 17.9 per hour. Taken at 0.48 per hour in the Wabash, mostly at stream mouths. Significantly more abundant in slow streams less than 15 feet wide and less than 1 foot deep and in vegetated areas. Significantly higher frequencies on gravel and gravel-rock bottom (25.6 per hour), than on sand (18.94 per hour); or mud (5.93 per hour).
- Carassius auratus* (Linnaeus); Goldfish: (0.29; 3.5; 6).
- Cyprinus carpio* Linnaeus; Carp: (3.32; 18.1; 6). Of 51 collections 80.4% were over mud bottom, 76.5% were over 2 feet deep, 98.0% were over 5 feet wide and 66.7% had no aquatic vegetation.
- Ericymba buccata* Cope; Silverjaw minnow: (12.32; 54.6; 4, 6). One of the most common species; taken at 12.32 per hour overall, and at 19.23 in stream collections. Taken at significantly higher rates in streams with slow or moderate flow, widths of 5-15 feet, and over sand bottom. No correlation with depth or vegetation. Wallace (11) reported on the biology of *Ericymba* in Vigo County.
- Hybognathus nuchalis* Agassiz; Silveryminnow: (2.91; 25.5; 4, 6). Occurred at similar rates in all habitats except was absent in permanent ponds. No association with factors studied, except increased rates in wider streams.
- Hybopsis aestivalis* (Girard); Speckled chub: (0.18; 1.8; 1 —as *M. hyostoma* Sixty-six taken for a rate of 1.74 in Wabash; most on sand bars.
- H. amblops* (Rafinesque); Bigeye chub: (0.003; 0.4; 4). One taken in Otter Creek.
- H. storeriana* (Kirtland); Silver chub: (0.63; 3.5; 4). Over 1300 taken in the Wabash.
- H. x-punctata* Hubbs and Crowe; Gravel chub: (0.01; 0.7; None). Two taken, one in Wabash; one in Brouilletes Creek.
- Nocomis micropogon* (Cope); River chub: (0.04; 1.8; 6—as *H. kentuckinensis*).
- Notemigonus crysoleucas* (Mitchill); Golden shiner: (1.53; 18.4; 4, 6). Taken at highest rates in flood ponds and sloughs. Of 260 taken in streams, 216 occurred over mud bottom (7.45 per hour). None in sand or gravel areas; one over gravel-rock bottom; remainder taken over mixed bottom. Significantly higher rates of occurrence in slow water. No clear association with other habitat factors.
- Notropis atherionoides* Rafinesque; Emerald shiner: (10.94; 37.9; 6) Abundant in the Wabash River and in lower portions of major streams; infrequent in flood ponds and river-influenced ponds. Taken at similar rates over gravel (6.60 per hour), sand (5.68) and mud (5.14) in streams, but at greater rates over gravel-rock (24.57 per hour). Occurred at significantly higher rates in faster streams; but width, depth and amount of vegetation had little influence.
- N. bleinnius* (Girard); River shiner: (7.65; 35.5; 4). Distribution similar to *N. atherionoides*. More common over sand (6.21 per hour), than on gravel-rock (4.82), gravel (3.00) or mud (2.27). Occurrence increased significantly with depth, and in medium current; no relation was found with vegetation or stream width.
- N. boops* Gilbert; Bigeye shiner: (0.003; 0.4; 4).
- N. chrysocephalus* (Rafinesque); Striped shiner (5.64; 31.9; 4, 6). Most common in streams, but present in sloughs and Wabash. Low occurrence in polluted streams. Had a higher rate on gravel-rock bottom (20.47 per hour) than on sand (10.77), mud (3.55) or gravel (2.20). Significantly higher rate in slower current, increased vegetation and in wide streams. Depth of stream not significant.
- N. rubellus* (Agassiz); Rosyface shiner: (0.06; 3.2; 4, 6).
- N. spilopterus* (Cope); Spotfin shiner: (9.42; 50.0; 4). Abundant and widespread. Of the *Notropis*, it occurred second only to *N. atherionoides* and had the highest frequency. Greatest occurrence in streams (11.84 per hour), at high rates in sloughs (9.23), and the Wabash (8.24); less common in flood ponds (2.05). Occurrence on gravel-rock

(20.47), sand (10.70), mud (6.83), gravel (2.20). Occurred at significantly higher rates in wide streams with increased vegetation. Most abundant in slow streams (25.25), less so in still water (3.83), and decreased rates in medium (17.63) and fast streams (7.08). Depth not significant. Distribution similar to *N. atherinoides* and *N. blennioides*.

- N. stramineus* (Cope); Sand shiner: (1.84; 22.0; 4). 660 taken; 632 from streams (2.76 per hour) and 28 from the Wabash (0.42). Higher occurrence over sand bottom (6.16 per hour) than gravel-rock (4.63), mud (0.14) or gravel (0.00). Significantly more common in vegetated areas and in slow streams. Depth and width not important.
- N. umbratilis* (Girard); Redfin shiner: (2.02; 23.0; 4, 6). Widespread in streams; few from the Wabash. More common over gravel-rock (11.80 per hour), than mud (3.83), sand (2.34) or gravel (0.50). Significantly more abundant in slow, wide streams.
- N. volucellus* (Cope); Mimic shiner: (1.31; 13.1; 4). Found in the Wabash (4.52 per hour) and lower portions of streams (0.82).
- N. whipplei* (Girard); Steelcolor shiner: (0.006; 0.7; 4, 6).
- Phenacobius mirabilis* (Girard); Suckermouth minnow: (1.66; 23.4; 4) Higher occurrence in the Wabash than in streams, except for Brouilletes and Otter Creeks (respective rates of 4.38 and 3.44). Taken at a higher rate in streams with gravel-rock bottoms (8.11 per hour) than sand (2.66 per hour), gravel (0.30 per hour) or mud (0.27 per hour). Most abundant in riffles. Depth or width of streams not important.
- Phoxinus erythrogaster* (Rafinesque); Southern redbelly dace: (1.10; 4.3; None). Taken in 50% of the Sugar Creek collections at 20.63 per hour. Occurred at 16.18 per hour in 41 collections from gravel bottom areas; at 11.8 per hour in 10 sand bottom collections. This difference was significant.
- Pimephales notatus* (Rafinesque); Bluntnose minnow: (8.28; 54.6; 4, 6). One of the most common stream species, especially in non-polluted streams. Significant decrease in faster streams, while depth, width and extent of aquatic vegetation were not important. More common on gravel-rock (27.37 per hour), than gravel (22.30), sand (16.14) or mud (5.11).
- P. promelas* Rafinesque; Fathead minnow: (0.003; 0.4; None). One individual taken in Otter Creek.
- P. vigilax* (Baird & Girard); Fathead minnow: (1.98; 13.8; 6). Taken in the Wabash at 8.35 per hour; in flood ponds, sloughs, and ponds influenced by the Wabash at rates of 3.16, 2.23 and 1.67 respectively. Occurred at 0.39 per hour in streams, but 84 of the 89 specimens were taken near the river.
- Rhinichthys atratulus* (Hermann); Blacknose dace: (1.00; 12.8; None). Primarily in Clear and Sugar Creeks, and in tributary ditches of Otter Creek. In Sugar and Clear Creeks taken in slow-moving water; apparently not affected by either depth or vegetation. In Clear and Otter Creeks occurred over sand bottom; in Sugar Creek over stone or gravel bottom.
- Semotilus atromaculatus* (Mitchill); Creek chub: (11.80; 61.0; 4, 6). Common only in streams (18.40 per hour). More common over gravel bottom (33.00) than gravel-rock (22.42), mud (20.45) or sand (17.80). Significantly higher rates in slow, small streams.

#### Catostomidae

- Carpionides carpio* (Rafinesque); River carpsucker: (1.27; 11.7; None).
- C. cyprinus* (Lesueur); Quillback: (0.35; 10.3; 6, 4).
- C. velifer* (Rafinesque); Highfin carpsucker: (0.31; 5.3; 4, 6).
- Catostomus commersoni* (Lacépède); White sucker: (1.60; 29.1; 4, 6). Almost completely restricted to streams (2.48 per hour). Significantly higher occurrence in slow streams over 5 feet wide with little or no vegetation and deeper water. Occurred at the higher rates on mud, of all homogeneous bottomed streams.
- Cycleptus elongatus* (Lesueur); Blue sucker: (\*\*; —; 6).
- Erimyzon oblongus* (Mitchill); Creek chubsucker: (1.39; 18.1; 4). Occurred at higher rates in very slow, wide streams (5-15 feet), with abundant vegetation and deep water. Significantly higher rates over mud than sand or gravel.

- Hypentelium nigricans* (Lesueur); Northern hog sucker: (0.80; 19.5; 6). A stream species (1.15 per hour). Significantly higher occurrence in deep, slow water. Had higher rates over gravel-rock bottom (4.32 per hour) than sand (0.93), mud (0.07), or gravel (0.00).
- Ictiobus bubalus* (Rafinesque); Smallmouth buffalo: (0.06; 2.5; 4, 6). Occurred at 0.92 in sloughs, 0.32 in flood ponds, 0.22 in ponds influenced by the Wabash, and 0.03 in the Wabash.
- I. cyprinellus* (Valenciennes); Bigmouth buffalo: (0.62; 9.2; 6, 9). Most abundant in sloughs (7.15 per hour), river-influenced ponds (6.67), and flood ponds (2.53) where many small juveniles were taken. Large adults taken mainly in shocker collections in the river (0.24) and in river-influenced ponds.
- I. niger* (Rafinesque); Black buffalo: (0.66; 9.3; 6—as *I. urus*). Occurred in the Wabash and associated flood ponds and sloughs, at 0.10, 5.32, and 7.62 per hour, and at 0.66 in ponds influenced by the Wabash.
- Minytrema melanops* (Rafinesque); Spotted sucker: (0.02; 2.8; 4).
- Moxostoma anisurum* (Rafinesque); Silver redbhorse: (0.06; 3.5; None).
- M. carinatum* (Cope); River redbhorse: (0.003; 0.4; 3, 7). One individual taken in the Wabash.
- M. duquesnei* (Lesueur); Black redbhorse: (0.01; 0.7; 4).
- M. erythrurum* (Rafinesque); Golden redbhorse: (0.54; 12.1; 4, 6). Most abundant *Moxostoma* species. Taken in the Wabash and streams (1.26 and 0.51, respectively).
- M. macrolepidotum* (Lesueur); Shorthead redbhorse: (0.11, 3.5; None).
- M. valenciennesi* Jordan; Greater redbhorse: (0.006; 0.7; None). Two individuals taken, one each in Prairie Creek and the Wabash.

#### Ictaluridae

- Ictalurus melas* (Rafinesque); Black bullhead: (1.54; 35.0; 4, 6). The common bullhead except in the river. Found throughout the county, but most abundant in flood ponds (14.84 per hour), in ponds influenced by the Wabash (7.66); several taken in permanent ponds (3.19) and sloughs (3.15). Not abundant in streams; taken in Coal and Prairie Creeks, at 0.83, 1.11, 0.04 and 0.06 per hour at water speeds of none, slow, moderate, and fast. Nearly all taken over mud bottom. Their predominance in flood ponds and ponds influenced by the Wabash, but their lack in the Wabash itself indicates that black bullheads may distribute themselves over land during flooding.
- I. natalis* (Lesueur); Yellow bullhead: (0.21; 6.0; 4). Uncommon; occurred regularly only in Prairie Creek (1.45 per hour).
- I. nebulosus* (Lesueur); Brown bullhead: (\*\*; —; 6).
- I. punctatus* (Rafinesque); Channel catfish: (0.31; 5.3; 1, 6). Almost restricted to the Wabash (1.69 per hour).
- Noturus eleutherus* Jordan; Mountain madtom: (0.11; 1.8; None). We found two widely separated populations in the Wabash, one just north of Otter Creek, and one near the southern end of the county. Only 30 were taken, despite concerted effort; all in shallow water (1 to 1½ feet) in thick algae.
- N. flavus* Rafinesque; Stonecat: (0.008; 0.7; None). Three taken in Brouillettes Creek.
- N. gyrinus* (Mitchill); Tadpole madtom: (0.003; 0.4; None). One taken in an isolated pond of the southern bayou system.
- N. miurus* Jordan; Brindled madtom: (0.18; 5.7; 6). The only common madtom. Restricted to gravel or gravel-rock bottomed areas of Brouillettes and Otter Creeks with slow to medium flow.
- N. nocturnus* Jordan and Gilbert; Freckled madtom: (0.003; 0.4; None). One taken in Brouillettes Creek.
- Pylodictis olivaris* (Rafinesque); Flathead catfish: (0.06; 3.9; 1, 6). Twenty-two taken from the Wabash (0.35).

#### Aphredoderidae

- Aphredoderus sayanus* (Gilliams); Pirate perch: (1.03; 5.3; None). Restricted to and common in the Prairie Creek drainage. Occurred in 6 or 55% of slough collections (3.8

per hour) and in 9, or 56% of Prairie Creek collections (15.7 per hour). Higher rates in Prairie Creek may result from late summer and fall collections when the fish were concentrated in pools. All 18 specimens collected in sloughs in June were juveniles (22 to 30 mm). The 32 specimens taken there in August included one adult (72 mm), several sub-adults (ca. 50 mm), and one small specimen (35 mm). September collections in Prairie Creek included adults ( $\bar{X}$ =60 mm) and sub-adults ( $\bar{X}$ =40 mm standard length). Apparently this species breeds in Prairie Creek and bayous in the spring, remains in streams throughout the year, then moves into deeper pools as the areas dry in the fall. Occurred in slow or no flow areas with sparse aquatic vegetation; water depth not important. Twelve or 70.6% of collections over mud bottom yielded 288 pirate perch (13.1 per hour); two (25%) of the single collections from the Prairie Creek drainage which had rock and gravel bottom yielded 77 pirate perch (38.5 per hour).

#### Cyprinodontidae

*Fundulus notatus* (Rafinesque); Blackstripe topminnow: (1.19; 18.1; 4, 6). Wide-spread in slow moving permanent waters. Taken at highest rates in ponds influenced by the Wabash (6.78), permanent ponds (3.67), and streams (1.12). Occurred at significantly higher rates in still streams with abundant vegetation and in deeper water.

#### Atherinidae

*Labidesthes sicculus* (Cope); Brook silverside: (0.83; 5.3; 4, 6). Taken most often in ponds influenced by the Wabash (17.78 per hour), and in flood ponds (3.89).

#### Perchichthyidae

*Morone chrysops* (Rafinesque); White bass: (0.05; 2.1; 4).

*M. mississippiensis* Jordan and Eigenmann; Yellow bass: (0.003; 0.4; 1, 6).

#### Centrarchidae

*Ambloplites rupestris* (Rafinesque); Rock bass: (0.02; 1.8; 6).

*L. cyanellus* Rafinesque; Green sunfish: (2.72; 41.3; 4, 6). Taken at high rates in all habitats except river-influenced ponds (0.33) and the Wabash River (0.45). In streams it occurred at higher rates on mud bottom (7.41) than gravel-rock (2.95), gravel (2.80) or sand (2.00).

*L. gibbosus* (Linnaeus); Pumpkinseed (\*\*; —; 6).

*L. gulosus* (Cuvier); Warmouth: (0.09; 5.0; None). Most abundant in permanent ponds and ponds influenced by the Wabash (0.78 and 0.56 per hour, respectively). Few taken in flood ponds (0.16), sloughs (0.08) and streams (0.02). Most common over mud bottom with depths over 2 feet.

*L. humilis* (Girard); Orangespotted sunfish: (0.25; 6.0; 4). Highest rate (3.10 per hour) in flood ponds; 0.59, 0.44, 0.23, 0.06, and 0.02 in permanent lakes and ponds, river influenced ponds, sloughs, the Wabash and streams, respectively. Of 91 specimens taken, 82 were from mud-bottomed areas.

*L. macrochirus* Rafinesque; Bluegill: (6.71; 52.5; 4, 6). Abundant and ubiquitous; taken at 26.22 per hour in ponds influenced by the Wabash, flood ponds (19.47), permanent ponds (14.74), sloughs (17.38), streams (4.92), and at its lowest rate in the Wabash (0.83). Occurred at higher rates over mud bottom in streams (11.45 per hour than on gravel-rock (5.05), gravel (3.90), or sand (3.75). Where it was taken at rates of 5.00 per hour or greater, it favored streams over 5 feet wide with little or no flow and with aquatic vegetation.

*L. megalotis* (Rafinesque); Longear sunfish. (0.38; 9.9; 4, 6). Most common in river influenced ponds (4.22 per hour), and 1.11, 0.68, 0.23 and 0.19 in permanent ponds, flood ponds, the Wabash and streams, respectively.

*L. microlophus* (Günther) Redear sunfish: (0.02; 1.8; None).

*Micropterus dolomieu* Lacépède; Smallmouth bass: (0.05; 5.0; 4, 6). 18 taken in the Wabash (0.15 per hour) and streams (0.04).

*M. punctulatus* (Rafinesque); Spotted bass: (0.13; 7.1; None). Taken in the Wabash River (0.39 per hour), and streams (0.10).

*M. salmoides* (Lacépède); Largemouth bass: (1.31; 27.3; 4, 6). Most common bass, taken at highest rates in ponds influenced by the Wabash (13.22 per hour), and at 3.84, 2.85, 2.62, 0.67, and 0.23 in flood ponds, permanent lakes and ponds, sloughs, streams and the Wabash, respectively. In streams it was taken over mud (1.93 per hour), sand (0.30), gravel (0.20), gravel-rock (0.40), and usually with no current, no aquatic vegetation, and widths over 15 feet.

*Pomoxis annularis* Rafinesque; White crappie: (1.09; 12.1; 6). A fish of the Wabash valley. Taken most often in flood ponds (8.53 per hour), sloughs (7.62), river-influenced ponds (4.44) and river (0.87); few taken in permanent ponds (0.33), or streams (0.13).

*P. nigromaculata* (Lesueur); Black crappie: (0.44; 6.4; 4, 6). Similar distribution to white crappie, but none taken in the Wabash. Rates were 7.85 in sloughs, 1.21 in flood ponds, 0.55 in river influenced ponds, 0.26 in permanent lakes and ponds, and 0.09 in streams.

#### Percidae

*Ammocrypta pellucida* (Putnam); Eastern sand darter: (0.01; 1.1; 6).

*Etheostoma asprigene* (Forbes); Mud darter: (0.01; 0.4; None).

*E. blennioides* Rafinesque; Greenside darter: (0.98; 8.9; 4, 6). Occurred in riffle areas of larger streams. Associated with gravel-rock bottom (11.11 per hour), but not mud (0.13), sand (0.13), or gravel (0.00) in Brouillettes and Otter Creeks.

*E. caeruleum* Storer; Rainbow darter: (0.67; 7.1; 6). 239 of 241 individuals taken over gravel-rock areas in Brouillettes and Otter Creeks.

*E. chlorosomum* (Hay); Bluntnose darter: (0.09; 2.1; None). Nearly all taken in river-influenced ponds or flood ponds near the Wabash. Twenty-eight of 30 specimens taken over sand.

*E. flabellare* Rafinesque; Fantail darter: (0.25; 6.7; 6). Taken only in streams; most common in the gravel-rock riffle below Otter Creek dam.

*E. gracile* (Girard); Swamp darter: (0.34; 9.2; 6—*E. eos?*). Widespread, but not common except in Prairie Creek (4.45 per hour); taken in river-influenced ponds (0.67 per hour), in streams (0.48), and permanent ponds (0.22). All occurred over mud bottom (1.93 per hour). Apparently not a stream species in Vigo County, but occupies habitats resembling ponds, as in Prairie Creek where water is concentrated in isolated pools, during most of the year.

*E. nigrum* Rafinesque; Johnny darter: (2.58; 38.7; 6). The most common darter; taken in all streams except Lost Creek, which dries seasonally. Significantly more common in deeper streams. No correlation with vegetation or stream width. Taken at higher rates on gravel-rock bottom (9.53 per hour) than mud (5.44), sand (3.07) or gravel (1.00). Uncommon in fast water.

*E. spectabile* (Agassiz); Orangethroat darter: (1.01; 24.5; None). Widespread in tributaries of the Wabash; but not taken in tributaries of the Eel River. Occurred at higher rates in slow, vegetated streams; but width and depth not important. Taken at a higher rate on gravelrock bottom (3.37 per hour) than gravel (2.10), sand (1.98), or mud (0.69).

*Perca flavescens* (Mitchell); Yellow perch: (2\*; —; 6). Two taken from a lake; undoubtedly introduced.

*Percina caprodes* (Rafinesque); Logperch: (0.04; 2.8; 6). Sixteen taken over gravel bottom in slow current.

*P. copelandi* (Jordan); Channel darter: (\*\*; —; 8).

*P. maculata* (Girard); Blackside darter: (0.10; 5.0; 6). Taken in Otter and Prairie Creeks, 22 on gravel or gravel-rock bottom, 8 on sand and 7 on mud.

*P. phozocephala* (Nelson); Slenderhead darter: (0.08; 3.1; 3, 4, 8).

*P. sciera* (Swain); Dusky darter: (0.05; 0.7; None).

*P. shumardi* (Girard); River darter: (1\*; —; 8).

*Stizostedion canadense* (Smith). Sauger. (0.06; 2.5; 1, 6). Taken in sloughs, the Wabash, and in flood ponds at 1.00, 0.10 and 0.10 per hour, respectively.

*S. vitreum* (Mitchill); Walleye: (\*\*; —; 6).

## Scianidae

*Aplodinotus grunniens* Rafinesque; Freshwater drum; (0.08; 3.2; 6). Taken in all six of the Wabash shocker boat collections (1.22 per hour hour).

## Environmental Factors and Species Distributions

There was no direct correlation between width of stream and the number of species taken (Table 1), except that streams less than 5 feet wide yielded significantly fewer species than did streams over 5 feet wide. A slightly greater average number of species was taken in streams 5 to 15 feet wide than was taken in streams greater than 15 feet wide. We conclude that fewer species exist in the small streams of Vigo County, but that in streams over 5 feet wide, width is not important.

TABLE 1. *Relationship between number of species and width, depth and numbers of bottom types of Vigo County streams.*

	No. Collections	Ave. No. of Species per Collection
Width of Stream		
0 to 5 feet	20	6.20
5 to 15 feet	65	12.34
15 or more feet	114	11.29
Depth of Stream		
To 1 foot	63	9.10
To 2 feet	69	11.16
To 3 feet	60	12.82
To 4 feet	7	14.43
Number of Bottom Types per Collection Site		
1	101	9.89
2	67	11.94
3 or 4	31	13.03

There is a direct, significant, correlation between greatest stream depth and the number of species of fishes taken.

The number of types of bottom listed on collection sheets was taken as an indication of the amount of habitat variation at a collection site. There was a significant increase in the average number of species taken per collection with an increased number of bottom types.

Waste material of various kinds is commonly dumped into the Wabash River, but we did not assess amounts or types. Of concern here are the effects on the fish communities. Streams seriously polluted were Splunge, Coal, Sugar, and Honey Creeks, the first three by acid mine drainage, the last by industrial waste (Fig. 2).

Some indications of the effects of the chemical composition of the water on the fishes can be seen. The pH in non-polluted Vigo County waters ranges from about 7.0 to 8.5. In the four areas in which fish populations were markedly reduced, the pH was 6.0 at lowest, or not nearly low enough to inhibit populations. At the other three sites, pH was in the same range as in the areas with no major pollution

problems. In the areas without fish the pH was low at half of the collection sites. The pH may have inhibited fish populations in some of these areas, but more information is needed. The oxygen content of the water ranged from 6 to 17 ppm in the non-polluted areas. In three polluted areas where fish existed, oxygen was in the same range as in the non-polluted areas, while in one area it was very low. The oxygen content of the water was 4 ppm or less in all of the areas with no fish, thus was too low for most fish to exist. Iron content of the water in the non-polluted areas was generally 1.5 ppm or less but was 4.3 and 7 in two areas. In both of these areas the oxygen content of the water was adequate. In 7 of the 10 areas with reduced numbers of fish or with fish lacking, iron content of the water was 2 ppm or more. High iron here may have reduced the fish by combining with the available oxygen.

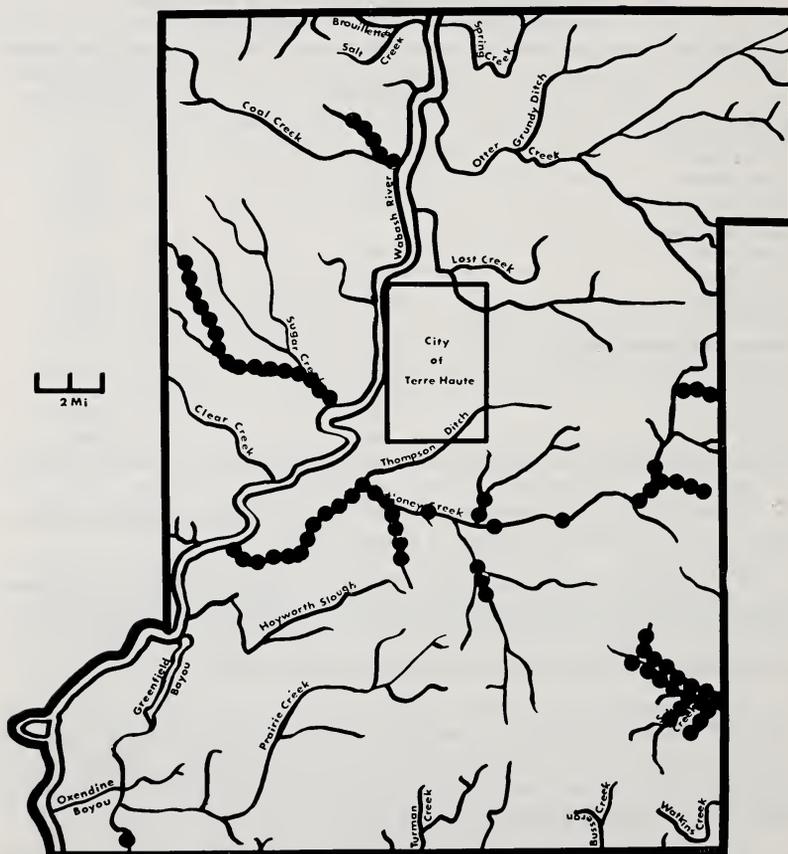


FIGURE 2. Major polluted areas of streams of Vigo County.

Among the areas studied in streams in Vigo County, 28 or 12.3% of the 228 did not contain fish because of obvious pollution in the form of acid mine drainage or industrial wastes. Thirteen more collections

or another 5.7% contained low numbers and few species of fishes. The species most apt to be found in the greatest numbers in the polluted areas were *Notropis atherinoides*, *Semotilus atromaculatus*, *Notropis spilopterus*, *Notropis blennioides* and *Ericymba buccata*. Individuals of 15 other species were taken occasionally. Of the 20 species taken in these collections, 9 could be considered river species, the remainder stream species.

Markle's Dam was built in 1816 and is located about 3 miles upstream from the river on Otter Creek, where the stream is still quite large. This dam has greatly influenced the fish fauna of the creek. The largest number of species was taken in the main stream below the dam, 47, while the stream above the dam had only 25, those lacking being the river species. An average of 20.9 species per collection occurred at the dam, 15.7 in the main stream below the dam, and 9.9 in the stream above the dam. The high number of species just below the dam is because of variable habitat (a permanent extensive gravel-rock area) there. All of the stream species found above the dam also occurred below it, but all at much reduced rates. Presumably they were adversely affected there because of competition with the river species.

The distribution of *Notropis chrysocephalus* was particularly interesting. It is generally considered as a stream species, but occurred only below the dam, being taken at the greatest rate in the rocky area at the dam, but was also abundant in the main stream. Unless *N. chrysocephalus* can be considered a river species and correspondingly is not able to exist without being able to get to the river, then it would appear that it has moved into the creek sometime since 1816. Since the species breeds in streams and since the habitats above and below the dam are similar, it would seem that if the species had been in Otter Creek before the construction of the dam that it would have been found throughout the stream and would still be present above the dam. We believe *N. chrysocephalus* has moved into Otter Creek via the river rather recently.

#### Possible Changes in Vigo County Fish Fauna

Unfortunately, Jenkins (6), gave little information concerning relative abundance of the species in the county. He listed most species as either common or very common. We are unable to make abundance comparisons between our work and his, other than those below.

Some of the large river species which Jenkins lists as common do not appear to be common now. *Polyodon spathula* and *Cycleptus elongatus* are listed as "common" and "rather common" by him. *Polyodon* is common only in one large river influenced lake across the Wabash just west of Terre Haute. *Cycleptus* has not been taken during the present study, but fishermen tell us that it is still taken at Terre Haute in the spring. *Acipenser fulvescens* was listed as "not common although said to be a few years ago." This is the same comment often made by fishermen in the Terre Haute area today. Past abundance would seem questionable.

*Notropis whipplei* and *Lepomis gibbosus* were both listed as common by Jenkins. We question whether Jenkins actually took *L. gibbosus*, especially since this species is native only in northern Indiana. Gerking (4), as well as Jenkins, reported *N. whipplei* from the county. *Notropis spilopterus*, but not *N. whipplei*, is common now. Jenkins did not report *N. spilopterus*, but Gerking (4) reported both species here. If Jenkins was correct in his identification, it would appear that *N. spilopterus* has essentially replaced *N. whipplei* here.

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#### Literature Cited

1. BLATCHLEY, W. S. 1938. The fishes of Indiana. Nature Publ. Co. Indianapolis, Ind. 121 p.
2. CROSSMAN, E. J. 1962. Predator—prey relationships in pikes (Esocidae). J. Fish. Res. Bd. Can. 19:979-980.
3. EVERMANN, B. W., and O. P. JENKINS. 1888. Notes on Indiana fishes. Proc. U. S. Nat. Mus. 11:43-57.
4. GERKING, S. D. 1945. The distribution of the fishes of Indiana. Invest. Indiana Lakes and Streams 3:1-137.
5. HUBBS, C. L., and M. B. TRAUTMAN. 1937. A revision of the lamprey genus *Ichthyomyzon*. Misc. Publ. Mus. Zool. Univ. Mich. No. 35. 109 p.
6. JENKINS, O. P. 1887. List of fishes collected in Vigo County in 1885 and 1886. The Hoosier Natur. 2:93-96.
7. JORDAN, D. S. 1877. On the fishes of northern Indiana. Proc. Nat. Acad. Sci. Phil. 29:42-82.
8. ————. 1890. Report of explorations made during the summer and autumn of 1888, in the Allegheny region of Virginia, North Carolina, and Tennessee, and in western Indiana, with an account of the fishes found in each of the river basins of those regions. Bull. U. S. Fish Comm. 1888. 8:97-173.
9. ————, and B. W. EVERMANN. 1902. American food and game fishes. A popular account of all the species found in America north of the equator, with keys for ready identification, life histories, and methods of capture. Doubleday, Doran and Co., Garden City, N. Y. 573 p.
10. TRAUTMAN, M. B. 1957. The fishes of Ohio. Ohio State Univ. Press. 683 p.
11. WALLACE, D. C. 1972. The ecology of the Silverjaw Minnow, *Ericymba buccata* Cope. Am. Midland Natur. 87:172-190.
12. WHITAKER, J. O., JR., and D. C. WALLACE. 1966. Fishes of Vigo County, Indiana. Proc. Indiana Acad. Sci. 75:279.