

# Distribution of the Native Freshwater Mussels in the Rivers Of Allen County, Indiana

9 September 2005

Warren W. Pryor, Assistant Professor of Biology, University of St. Francis,  
2701 Spring Street, Fort Wayne, IN 46808. [Wpryor@sf.edu](mailto:Wpryor@sf.edu)

## **Abstract**

A total of 2899 specimens of 30 native freshwater mussel species were found in the rivers of Allen County, Indiana during 1997-2004, of which 169 live specimens were observed. The most widespread species was *Pyganodon grandis*, and the most locally abundant was *Truncilla truncata*. The greatest species abundance was found in the St. Joseph River (29 species), followed by the Maumee River (17 species), Cedar Creek (15 species), the St. Mary's River (5 species) and the Eel River (3 species).

## Table of Contents

Abstract.....	1
Table of Contents.....	2
List of Figures.....	3
List of Tables.....	4
Introduction.....	5
Intent of this Report.....	5
Physical Description of the Rivers of Allen County.....	5
Other Unionid Surveys.....	6
Potential Fish Hosts.....	6
Methods.....	7
Field Techniques.....	7
Distribution.....	7
Results.....	8
Species Distributions.....	8
Discussion.....	11
Patterns of Distribution.....	11
Historical Comparisons.....	12
County-wide Historical Mussel Presence.....	12
Changes in Composition Among Rivers.....	13
References.....	13
Acknowledgements.....	14
Figures.....	15
Tables.....	53

## List of Figures

1. Schematic and Map of River Segments in Allen County, Indiana
2. Shells of selected mussel species of Allen County, Indiana
3. Distribution of *Actinonaias ligamentina*
4. Distribution of *Alasmidonta marginata*
5. Distribution of *Amblema plicata*
6. Distribution of *Cyclonaias tuberculata*
7. Distribution of *Elliptio dilatata*
8. Distribution of *Epioblasma obliquata*
9. Distribution of *Fusconaia flava*
10. Distribution of *Lampsilis cardium*
11. Distribution of *Lampsilis fasciola*
12. Distribution of *Lampsilis siliquoidea*
13. Distribution of *Lasmigona complanata*
14. Distribution of *Lasmigona compressa*
15. Distribution of *Lasmigona costata*
16. Distribution of *Leptodea fragilis*
17. Distribution of *Ligumia recta*
18. Distribution of *Ligumia subrostrata*
19. Distribution of *Obovaria subrotunda*
20. Distribution of *Pleurobema clava*
21. Distribution of *Pleurobema sintoxia*
22. Distribution of *Potamilus alatus*
23. Distribution of *Ptychobranhus fasciolaris*
24. Distribution of *Pyganodon grandis*
25. Distribution of *Quadrula cylindrica*
26. Distribution of *Quadrula nodulata*
27. Distribution of *Quadrula pustulosa*
28. Distribution of *Quadrula quadrula*
29. Distribution of *Toxolasma parvus*
30. Distribution of *Truncilla truncata*
31. Distribution of *Utterbackia imbecillis*
32. Distribution of *Villosa fabalis*

## List of Tables

1. Summary of presence and relative abundance of mussels in Allen County, Indiana, in 1908, based upon data in Clark & Wilson (1912).
2. Summary of presence and relative abundance of mussels in Allen County, Indiana, in 1988, based upon data in Watters (1988).
3. Summary of presence and relative abundance of mussels in Allen County, Indiana, in 1998, based upon data in Watters (1998).
4. Synonyms of scientific names of mussels found in Allen County, Indiana, from 1908 to 2004.
5. Description of River Segments in Allen County, Indiana, during 1997-2004.
6. Number of visits to sites in River Segments in Allen County, Indiana, during 1997-2004.
7. Summary of presence and relative abundance of mussels in Allen County, Indiana, during 1997-2004.
8. Mussel species distribution patterns in the rivers of Allen County, Indiana, during 1997-2004.
9. Historical presence of mussel species in the rivers of Allen County from 1908 to 2004. Data summarized from Clark & Wilson (1912), Watters (1988) and the present study (1997-2004).
10. Historical presence of mussel species in the rivers of Allen County from 1908 to 2004. Data rearranged from Table 9 to emphasize species histories.
11. Number of live mussel specimens observed in Allen County during 1997-2004.

# **Introduction**

## ***Intent of this Report***

This report summarizes the author's observations on the distribution of freshwater mussels of Allen County, Indiana, between 1997 and 2004. It is to be posted on the website of the St. Joseph River Watershed Initiative, in order to facilitate local mollusk conservation. It should also be of value to persons and groups working to improve the quality of the rivers of the area, and to scientists and science students desiring to conduct research here.

This study aimed to answer four questions. What mussel species exist in Allen County? Where are each of those species located? How do the rivers compare in unionid species diversity? How have the presence of mussel species and their distributions changed over the past century?

## ***Physical Description of the Rivers of Allen County***

The St. Joseph River and the St. Mary's River join to form the Maumee River (Figure 1), which flows into Lake Erie, the waters of which enter the Atlantic Ocean through the St. Lawrence River. The Eel River begins in the extreme northwest corner of Allen County, and flows southwest as a tributary of the Wabash River. Thus, elements of two major watersheds, the St. Lawrence and the Mississippi are found in Allen County.

The ground over which the rivers flow is glacial till and moraine material (Ulrich 1966) over bedrock of Silurian rocks and Devonian limestone (Gutschick 1966). The oak-hickory and beech-maple forests and the wetlands that once dominated the landscape (Petty & Jackson 1966) have been almost entirely converted into cropland, pasture, second-growth woodland, buildings, parking lots, roads, and houses during the last 200 years.

Flow rates vary seasonally, with annual peaks typically in the spring and minimum flows during August and September. The ten year annual mean stream flow (1993 to 2002) for the Maumee River at New Haven, Indiana (USGS gauge #04183000) was 1927 cfs (cubic feet per second) ([http://water.usgs.gov/cgi-bin/daily\\_flow?in](http://water.usgs.gov/cgi-bin/daily_flow?in)). On average, the St. Joseph River (measured at USGS gauge #04180500) contributed about 53% of the water in the Maumee, and the St. Mary's River (measured at USGS gauge #04182000) contributed 34%. The remaining 13% of the water in the Maumee River came from small streams, drainage ditches, storm sewers, waste treatment plant effluent, and field drainage tiles. The ten year annual mean stream flow for the Eel River measured at North Manchester, Indiana (USGS gauge #03328000) was 433 cfs. During periods of average flow, midstream depths range from a few cm to more than 10 m in places.

Three dams exist, two of which are the Cedarville Dam and Johnny Appleseed Park Dam, both located on the St. Joseph River. The Anthony Street Dam (also known as the Hosey Dam) impound part of the Maumee River (Figure 1).

The Maumee River and its tributaries are included in “Ecoregion ‘Erie,’ Number 45” of Abell, et al. (2000), which they include as part of the St. Lawrence Complex of the Arctic-Atlantic Bioregion. Those authors consider the entire Ecoregion to be nationally important for biological distinctiveness, but note that agricultural runoff and eutrophication are ongoing threats. The same authors include the Eel River in “Ecoregion ‘Mississippi,’ Number 24,” an Ecoregion considered to be outstanding for biological distinctiveness.

### **Other Unionid Surveys**

Clark & Wilson (1912) were the first to thoroughly examine the mussel fauna in Allen County in the summer of 1908. They found a total of 28 species in the county (Table 1), of which, 20 were present in the St. Mary’s River, 25 in the St. Joseph River, and 24 in the Maumee River. The most abundant and widespread mussels were *Actinonaias ligamentina*, *Amblema plicata*, *Fusconaia flava* and *Lasmigona costata*. For this report, the numbers of specimens given in Clark & Wilson (1912) and the (following study) were summarized as the descriptive terms: “many” (ten or more shells per site visit, or their terms “common” or “abundant”), and “few” (less than ten shells per site visit, or their term “few”).

Watters (1988) surveyed the area in the summer of 1988 and found live and/or fresh specimens of 27 unionid species in the county (Table 2), of which 22 were present in the St. Joseph River, 10 in Cedar Creek and its tributaries, and 15 in the Maumee River. No observations were made on the St. Mary’s River. The most abundant and widespread species were *Amblema plicata*, *Leptodea fragilis* and *Quadrula pustulosa*.

Watters (1998) resurveyed one location on Little Cedar Creek (a tributary of Cedar Creek) and two on the St. Joseph River in the summer of 1998, and found 18 mussel species (Table 3), of which 15 were present in the St. Joseph River, and 3 in Little Cedar Creek. Many specimens were found of *Leptodea fragilis* and *Quadrula pustulosa*.

Collectively, these studies (Clark & Wilson 1912, Watters 1988, 1998) documented 36 mussel species in Allen County from 1908 to 1998. Since the scientific names of several species have changed during that period, their synonyms are given in Table 4, based upon Parmalee & Bogan (1998).

### **Potential Fish Hosts**

In 1989, the Indiana Department of Natural Resources conducted a fish census in the Fort Wayne area (Pearson 1990). As part of that investigation, four locations were sampled on the St. Joseph River (near the Mayhew Bridge, Shoaff Park, Johnny Appleseed Park, and the State Street Bridge). A total of 36 fish species and one hybrid sunfish were collected. Eight species dominated the community, accounting for 70% of the total

number of fishes observed; they were golden redhorse, carp, gizzard shad, green sunfish, largemouth bass, bluegill, smallmouth bass, and longear sunfish.

## **Methods**

### ***Field Techniques***

A total of 108.1 km of river were examined, and eighteen River Segments were defined (Figure 1), using permanent landmarks as borders between each segment (Table 5). These River Segments were searched at times when weather permitted and river flows were minimal. A total of 151 field trips were made during the eight year period, 126 of which were to the St. Joseph River and its tributary, Cedar Creek (Table 6).

Unionid specimens were sought in three different ways. One was by slowly walking at the water's edge, paying particular attention to tree roots and muskrat burrows. Another was by wading in shallow water and searching the bottom with a glass-bottom bucket. A third was by searching the bank from a small boat, maneuvered as close to shore as possible given conditions of depth, snags, and water flow.

When a specimen was found, it was cleaned with a soft brush and identified to species by making comparisons to characters of voucher specimens that had been collected in 1994 and 1995 (Indiana DNR Scientific Collector's Licenses #977 and #1179), the identities of which were verified by a unionid taxonomist (Cummings, personal communication). Supplemental descriptive information was also used from Call (1899), Cummings & Mayer (1992), and Parmalee & Bogan (1998). Specimens of federally endangered species were collected in 1997 under USFWS Permit number PRT 827310 and were deposited in the Indiana State Museum.

Each specimen was judged to be in one of four conditions. "Live" specimens were alive at the time of observation. "Good" shells had at least 75% of their periostracum intact and shiny nacre. "Fair" shells were in a state of weathering between "good" and "poor." "Poor" shells had less than 25% of their periostracum, and dull nacre. Only data from live and good specimens were used to prepare this report.

### ***Distribution***

A modified presence list was produced for each river segment by calculating for each species the average number of mussels per site visit, using the following formula:

$$M_X = (X_{\text{Live}} + X_{\text{Good}})/(V)$$

Where:

$M_X$  = average number of mussels per site visit

$X_{\text{Live}}$  = number of live specimens of species "X"

$X_{\text{Good}}$  = number of good specimens of species “X”

V = number of site visits to River Segment.

## Results

A total of 2899 mussel specimens were observed in Allen County during 1997-2004, of which 169 were alive, and 2730 were shells in good condition. The greatest number of live specimens found were *Lampsilis siliquoidea* (31 specimens), followed by *Lasmigona costata* (25 specimens), *Quadrula pustulosa* (25 specimens), *Leptodea fragilis* (19 specimens), *Potamilus alatus* (16 specimens), *Lasmigona complanata* (13 specimens), *Alasmidonta marginata* (8 specimens), *Pyganodon grandis* (6 specimens), *Truncilla truncata* (5 specimens), *Fusconaia flava* (4 specimens), *Lampsilis cardium* (4 specimens), and *Lasmigona compressa* (4 specimens). These 12 species accounted for 95% of the live specimens encountered. The remaining 5% were represented by six species: *Actinonaias ligamentina* (2 specimens), *Elliptio dilatata* (2 specimens), *Toxolasma parvus* (2 specimens), *Ligumia subrostrata* (1 specimen), *Utterbackia imbecillis* (1 specimen) and *V. fabalis* (1 specimen). It is noteworthy that no specimens of the exotic and invasive zebra mussel (*Dreissena polymorpha*) were found in Allen County during 1997-2004, and only a few individuals of Asian clam (*Corbicula fluminea*) were found in one Maumee River Segment (MU5)

The average number of specimens per site visit ( $M_x$ ) of the 30 mussel species in Allen County during 1997-2004 is shown in Table 7. A total of 30 species were found, of which *P. grandis* was the most widespread (12 of 18 River Segments), and *T. truncata* was the most locally abundant (more than 10 mussels per site visit) in 4 River Segments.

## Species Distributions

A description of the distribution of each species is given below, based upon schematic maps drawn for each, which were based upon  $M_x$  values in Table 7. Photographs (taken by the author) are also provided for 16 of the species (Figure 2). Images of the remaining species are available by following the links in Figure 2q to the website of the Illinois Natural History Survey

<http://www.inhs.uiuc.edu/cbd/collections/mollusk/fieldguide.html>.

*Actinonaias ligamentina* (Figure 2a) was present in four River Segments (Figure 3), two of which were adjacent to one another (CC1 and SJ4), while the next (SJ1) was separated from these by 11.2 km. The other (MU5) was located 21.3 km farther downstream. *A. ligamentina* was confined to the St. Joseph River (including Cedar Creek) and the Maumee River.

*Alasmidonta marginata* was found in five River Segments (Figure 4), three of which were adjacent (CC2, CC1 and SJ4), while the next (SJ1) was separated from these by 11.2 km. The other (MU5) was located 21.3 km farther downstream. *A. marginata* was confined to the St. Joseph River (including Cedar Creek) and the Maumee River.

*Amblema plicata* (Figure 2b) was found in three River Segments (Figure 5), two of which were adjacent (CC1 and SJ4), while the other (SJ1) was separated from these by 11.2 km. *A. plicata* was confined to the St. Joseph River (including Cedar Creek).

*Cyclonaias tuberculata* (Figure 2c) was found in three River Segments (Figure 6), two of which were adjacent to each other (SJ4 and SJ3), while the other (SJ1) was separated from them by 2.6 km. *C. tuberculata* was confined to the main stem of the St. Joseph River.

*Elliptio dilatata* (Figure 2d) was found in four River Segments (Figure 7), two of which were adjacent to each other (CC1 and SJ4), while the next (SJ1) was separated from these by 11.2 km. The other (MU5) was located 21.3 km farther downstream. *E. dilatata* was confined to the St. Joseph River (including Cedar Creek) and the Maumee River.

*Epioblasma obliquata* was found in one River Segment (SJ1) (Figure 8). *E. obliquata* was confined to main stem of the St. Joseph River.

*Fusconaia flava* was found in six River Segments (Figure 9), three of which were adjacent (CC1, SJ4 and SJ3). One (SJ6) was located 8.2 km upstream from them, while another (SJ1) was 2.6 km downstream. The most isolated River Segment population (MU5) was located 21.3 km downstream from SJ1. *F. flava* was confined to the St. Joseph River (including Cedar Creek) and the Maumee River.

*Lampsilis cardium* (Figure 2e) was found in three distinct River Segments (Figure 10): CC1 was separated by 8.6 km from SJ3, which was separated by 2.6 km from SJ1. *L. cardium* was confined to the St. Joseph River (including Cedar Creek).

*Lampsilis fasciola* was found in one River Segment (SJ1) (Figure 11). *L. fasciola* was confined to the main stem of the St. Joseph River.

*Lampsilis siliquoidea* (Figure 2f) was found in six River Segments (Figure 12), of which three were adjacent (CC2, CC1 and SJ4), while another (SJ1) was located 11.2 km downstream, and one more (MU2) was 1.7 km beyond that. Specimens were also present in the hydrologically distinct ER1. *L. siliquoidea* was confined to the St. Joseph River (including Cedar Creek), the Maumee River and the Eel River.

*Lasmigona complanata* (Figure 2g) was found in four River Segments (Figure 13), of which two were adjacent (CC2 and SJ4), while the other while another (SJ1) was located 11.2 km downstream, and one more (MU6) was 21.3 km beyond that. *L. complanata* was confined to the St. Joseph River (including Cedar Creek) and the Maumee River.

*Lasmigona compressa* was found in two adjacent River Segments (CC2 and CC1) (Figure 14). *L. compressa* was confined to Cedar Creek (tributary of the St. Joseph River).

*Lasmigona costata* (Figure 2h) was found in six River Segments (Figure 15), of which four were adjacent (CC2, CC1, SJ4 and SJ3), while another (SJ1) was located 2.6 km

downstream, and one more (MU2) was 1.7 km beyond that. *L. costata* was confined to the St. Joseph River (including Cedar Creek) and the Maumee River.

*Leptodea fragilis* (Figure 2i) was found in six River Segments (Figure 16), of which two were adjacent (MU2 and MU3), while another (MU5) was located 10.7 km downstream. Specimens were also found upstream from MU2 in SJ1, SM1 and SM3. *L. fragilis* was confined to the main stem of the St. Joseph River, the St. Mary's River, and the Maumee River.

*Ligumia recta* was found in one River Segment (SJ1) (Figure 17). *L. recta* was confined to the main stem of the St. Joseph River.

*Ligumia subrostrata* was found in three River Segments (Figure 18), of which the farthest upstream was SJ4. Specimens were also found 11.2 km downstream at SJ1, and 1.7 km farther at MU2. *L. subrostrata* was confined to the main stem of the St. Joseph River and the Maumee River.

*Obovaria subrotunda* was found in one River Segment (SJ1) (Figure 19). *O. subrotunda* was confined to the main stem of the St. Joseph River.

*Pleurobema clava* was found in three River Segments (Figure 20). The farthest upstream was SJ4. Specimens were also found 11.2 km downstream at SJ1, and 4.1 km farther at MU3. *P. clava* was confined to the main stem of the St. Joseph River and the Maumee River.

*Pleurobema sintoxia* was found in one River Segment (SJ1) (Figure 21). *P. sintoxia* was confined to the main stem of the St. Joseph River.

*Potamilus alatus* (Figure 2j) was found in seven River Segments (Figure 22), of which CC2 and CC1 were adjacent and were separated by 19.8 km from the others. MU2 and MU3 were also adjacent, and were separated from SJ1 by 1.7 km, from SM 3 by 11.6 km, and from MU5 by 10.7 km. *P. alatus* was confined to the St. Joseph River (including Cedar Creek), the St. Mary's River, and the Maumee River.

*Ptychobranhus fasciolaris* (Figure 2k) was found in two River Segments (CC1 and SJ1) (Figure 23), which were separated from one another by 19.8 km. *P. fasciolaris* was confined to the St. Joseph River (including Cedar Creek).

*Pyganodon grandis* was found in twelve River Segments (Figure 24), of which CC2, CC1 and SJ4 were adjacent, and separated by 8.6 km from the next downstream pair of adjacent River Segments (SJ2 and SJ1). The 1.7 km MU1 separated these from locations of additional specimens in the adjacent SR1 and SM1, and from the adjacent MU2 and MU3. Specimens were also found in SM3 and MU5, which were separated from the above mentioned populations by 6.4 and 10.7 km respectively. Shells were also found in the hydrologically distinct ER1. *P. grandis* was found in all of the rivers of Allen County.

*Quadrula cylindrica* was found in one River Segment (SJ1) (Figure 25). *Q. cylindrica* was confined to the main stem of the St. Joseph River.

*Quadrula nodulata* (Figure 2l) was found in one River Segment (SJ1) (Figure 26). *Q. nodulata* was confined to the main stem of the St. Joseph River.

*Quadrula pustulosa* (Figure 2m) was found in eight River Segments (Figure 27), of which three were adjacent (CC1, SJ4 and SJ3), while another was located 2.6 km downstream (SJ1). Another pair of adjacent River Segments were located 1.7 km downstream (MU2 and MU3), and one more (MU5) 10.7 km beyond that. Specimens were also found separated from these by 11.6 km in SM3. *Q. pustulosa* was confined to the St. Joseph River (including Cedar Creek), the St. Mary's River and the Maumee River.

*Quadrula quadrula* (Figure 2n) was found in four River Segments (Figure 28), of which three were adjacent (MU3, MU4 and MU5). One (SJ1) was located 4.1 km upstream from these. *Q. quadrula* was confined to the main stem of the St. Joseph River and the Maumee River.

*Toxolasma parvus* (Figure 2o) was found in two River Segments (SJ1 and MU2) (Figure 29) which were separated from one another by 1.7 km. *T. parvus* was confined to the main stem of the St. Joseph River and the Maumee River.

*Truncilla truncata* (Figure 2p) was found in six River Segments (Figure 30), of which two were adjacent (SM3 and SM2), and separated by 5.9 km from the next pair of adjacent River Segments (MU2 and MU3) and from SJ1. Specimens were also found 10.7 km downstream from MU3 in MU5. *T. truncata* was confined to the main stem of the St. Joseph River, the St. Mary's River and the Maumee River.

*Utterbackia imbecillis* was found in four distantly separated River Segments (Figure 31). One was the hydrologically distinct ER1, and the others were CC2, separated by 28.5 km from SJ1, which was in turn separated by 35.9 km from MU5. *U. imbecillis* was confined to the St. Joseph River (including Cedar Creek), the Maumee River and the Eel River.

*Villosa fabalis* was found in one River Segment (SJ1) (Figure 32). *V. fabalis* was confined to the main stem of the St. Joseph River.

## Discussion

### ***Patterns of Distribution***

The 30 species of mussels observed in this study conformed to three broad patterns of distribution among the rivers of Allen County (Table 8). Species in **Group 1** were widespread among the rivers, and included *P. grandis*, *P. alatus* and *Q. pustulosa*. Those in **Group 2** were found in the St. Mary's River but not Cedar Creek, and were *L.*

*fragilis* and *T. truncata*. Species in **Group 3** were found in either Cedar Creek or the St. Joseph River, but not the St. Mary's River, and included the remainder.

## **Historical Comparisons**

### **County-wide Historical Mussel Presence**

The following broad categories of historical mussel distribution in Allen County were apparent (Table 9).

Those found in all three studies.

Eighteen species were found in Allen County by Clark & Wilson (1912), Watters (1988) and the present study (*A. ligamentina*, *A. marginata*, *A. plicata*, *C. tuberculata*, *E. dilatata*, *F. flava*, *L. cardium*, *L. siliquioidea*, *L. complanata*, *L. compressa*, *L. costata*, *L. fragilis*, *L. recta*, *P. sintoxia*, *P. alatus*, *P. fasciolaris*, *P. grandis* and *Q. pustulosa*). It is safe to conclude that these species were long-time, permanent residents. While it is true that each of these species was present in 1908, 1988 and during 1997-2004, it is important to note that their distribution within the county varied according to species (Table 10). The distribution of 13 of the 18 species decreased or stayed about the same from 1908 to 1997-2004 (*A. ligamentina*, *A. plicata*, *C. tuberculata*, *E. dilatata*, *F. flava*, *L. cardium*, *L. siliquioidea*, *L. compressa*, *L. costata*, *L. recta*, *P. sintoxia*, *P. fasciolaris*, and *Q. pustulosa*), and the distribution of five species increased (*A. marginata*, *L. complanata*, *L. fragilis*, *P. alatus* and *P. grandis*).

Those found in only two of the three studies.

Two species were seen by only Clark & Wilson (1912) and Watters (1988) (*A. ferussacianus* and *S. undulatus*), five species by only Clark & Wilson (1912) and the present study (*E. obliquata*, *L. fasciola*, *O. subrotunda*, *P. clava*, and *Q. cylindrica*), and five species only by Watters (1988) and the present study (*Q. nodulata*, *Q. quadrula*, *T. truncata*, *U. imbecillis* and *V. fabalis*). These species probably constitute a heterogeneous group whose sporadic representation may be due to the presence of small, isolated populations, small maximum physical size (therefore easy to overlook), species near the edge of their range, and species whose morphologies are similar to other mussels (and therefore prone to misidentification).

Those found in only one of the three studies.

Three species were found only in 1908 (Clark & Wilson 1912) (*E. lineolata*, *T. lividis* and *V. iris*), two were observed only by Watters (1988) (*F. subrotunda* and *T. donaciformis*), and two were seen only in the present study (*L. subrostrata* and *T. parvus*). The same reasons may apply to the inconsistent appearance of these species as they did to the previous distributional category; however, it is likely that *E. lineolata* has been extirpated from the county, since its distinctive appearance and large body size (to 102 mm shell length, Cummings & Mayer 1992) would have drawn attention by Watters (1988) or in the present study. On the other hand, it is quite possible that specimens of *V.*

*fabalis* may have been simply misidentified by Clark and Wilson (1912) as *V. iris*. However, unless their voucher specimens are located and examined, this cannot be confirmed.

## Changes in Composition Among Rivers

It is useful to consider the historical changes in the numbers of mussels in each of the major rivers (Table 9). The mussel species diversity has fluctuated but remained high in the St. Joseph River from 25 species in 1908 (Clark & Wilson, 1912), to 22 species in 1988 (Watters, 1988) and 29 species during 1997-2004 (present study). Unfortunately, Cedar Creek was not visited by Clark & Wilson (1912); however, Watters (1988) reported 10 species in 1988, and the present study found 15 species during 1997-2004.

Mussel diversity has generally declined in the Maumee River from 24 species in 1908 (Clark & Wilson, 1912), to 15 in 1988 (Watters, 1988) and 17 during 1997-2004 (present study). The decline was even more pronounced in the St. Mary's River, which yielded 20 species in 1908 (Clark & Wilson, 1912), and only 5 species during 1997-2004. The St. Mary's River was not visited by Watters (1988).

The mussel species that dominated the community in Allen County in 1908 (*A. ligamentina*, *A. plicata*, *F. flava* and *L. costata*) were no longer present in the St. Mary's River during 1997-2004; however, they maintained strong presences in both Cedar Creek and the St. Joseph River (main stem). On the other hand, four species (*L. fragilis*, *P. alatus*, *P. grandis* and *T. truncata*) that were absent from the St. Mary's River in 1908 were present and thriving during 1997-2004. One of these (*T. truncata*) deserves particular mention, as it was completely absent from the County in 1908, yet came to dominate the mussel fauna of both the St. Mary's and Maumee Rivers by 1997-2004.

## References

Abell RA, Olson DM, Dinerstein E, Hurley PT, Diggs JT, Eichbaum W, Walters S, Wettengel W, Allnutt T, Loucks CJ and Hedao P. 2000. Freshwater Ecoregions of North America: A Conservation Assessment. Inland Press, Washington, DC.

Call RE. 1899. A descriptive illustrated catalogue of the Mollusca of Indiana. In: Indiana Department of Geology and Natural Resources Twenty-Fourth Annual Report, W. S. Blatchely (ed.). Wm. B. Burford, Indianapolis. Pp. 335-532.

Clark HW & Wilson CB. 1912. The mussel fauna of the Maumee River. Bureau of Fisheries Document No. 757.

Cummings KS & Mayer CA. 1992. Field Guide to Freshwater Mussels of the Midwest. Illinois Natural History Survey, Manual 5, Champaign, Illinois.

Gutschick RC. 1966. Bedrock geology. In: Natural Features of Indiana, AA Lindsey, editor. Indiana Academy of Science, Indianapolis. Pp. 1-20.

Parmalee PW & Bogan AE. 1998. The Freshwater Mussels of Tennessee. University of Tennessee Press, Knoxville.

Pearson J. 1990. Current Fish Resources and Fishing Opportunities in Fort Wayne, Indiana. Division of Fish and Wildlife, Indianapolis, Indiana.

Petty RO & Jackson MT. 1966. Plant communities. In: Natural Features of Indiana, AA Lindsey, editor. Indiana Academy of Science, Indianapolis. Pp. 264-296.

Ulrich HP. 1966. Soils. In: Natural Features of Indiana, AA Lindsey, editor. Indiana Academy of Science, Indianapolis. Pp. 57-90.

Watters GT. 1988. A Survey of the Freshwater Mussels of the St. Joseph River System, with Emphasis on the Federally Endangered White Cat's Paw Pearly Mussel. Prepared for the Indiana Department of Natural Resources, West Lafayette, Indiana.

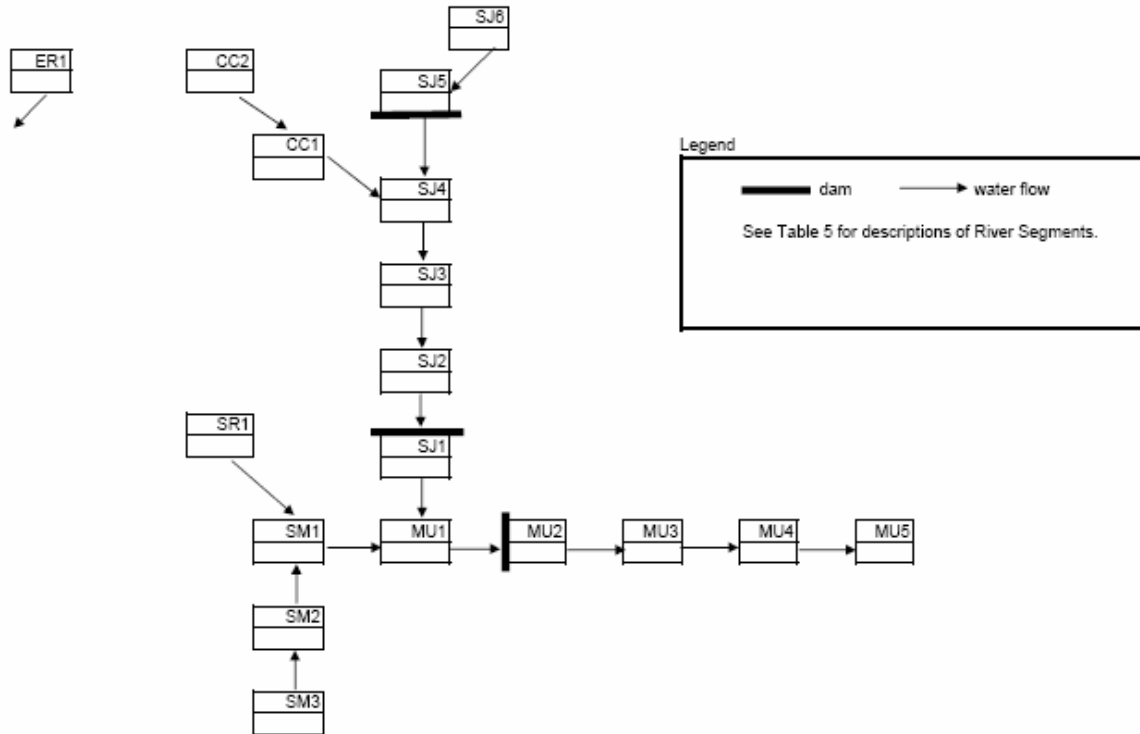
Watters GT. 1998. Freshwater Mussel Survey of the St. Joseph River Drainage, Exclusive of Fish Creek. Final Report to the Indiana Chapter of the Nature Conservancy.

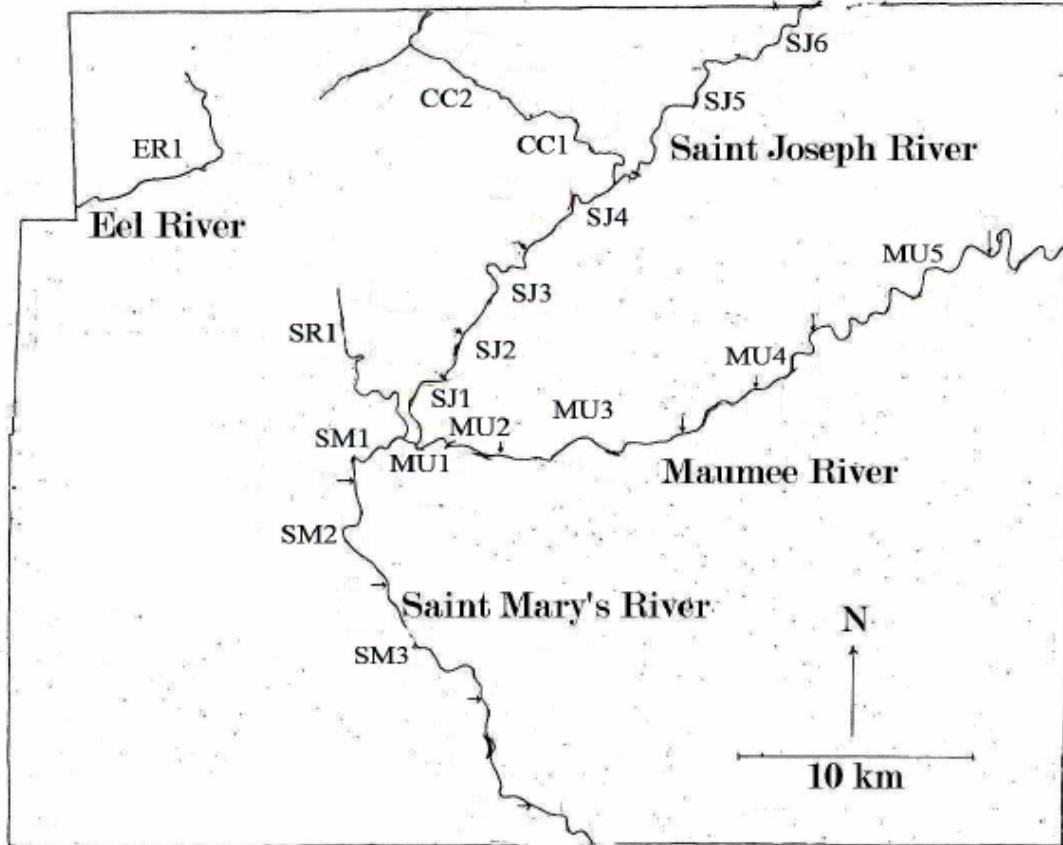
## **Acknowledgements**

The author thanks the Fort Wayne Children's Zoo and the University of St. Francis for their support of this project, as well as these individuals: Ellen C. Fagan-Pryor, Gary Tieben, Lauren Kowalenko, Cheryl Piropatto, Jim Anderson, Earl B. Wells, Gary Stoops, Amanda Delagrange, Augusta Pryor, Annie Pryor, George Pryor, Marie J. Limoges, and Amy Williamson. Data for Cedar Creek was collected in collaboration with Stephanie Goodman and Robert Gillespie of IPFW. The author also is grateful to the St. Joseph River Watershed Initiative for presenting this report on their website, and to anonymous reviewers whose comments greatly improved the text.

# Figures

Figure 1. Schematic and Map of River Segments in Allen County, Indiana





Allen County, Indiana

Figure 2a. *Actinonaias ligamentina*

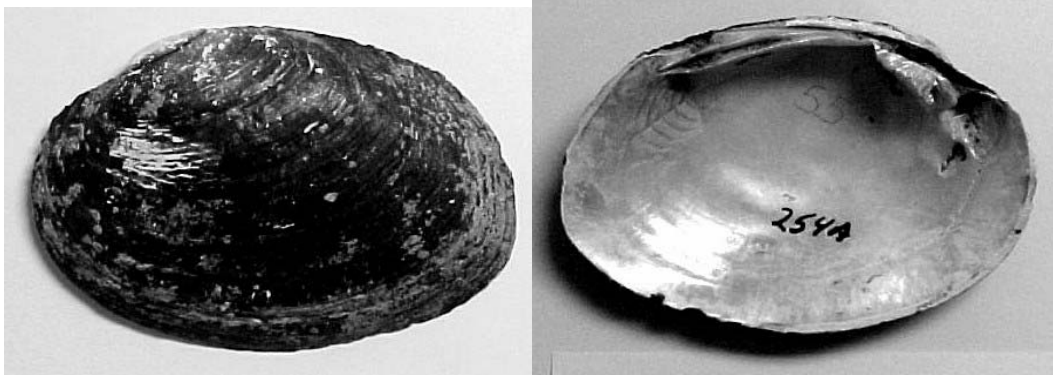


Figure 2b. *Amblema plicata*

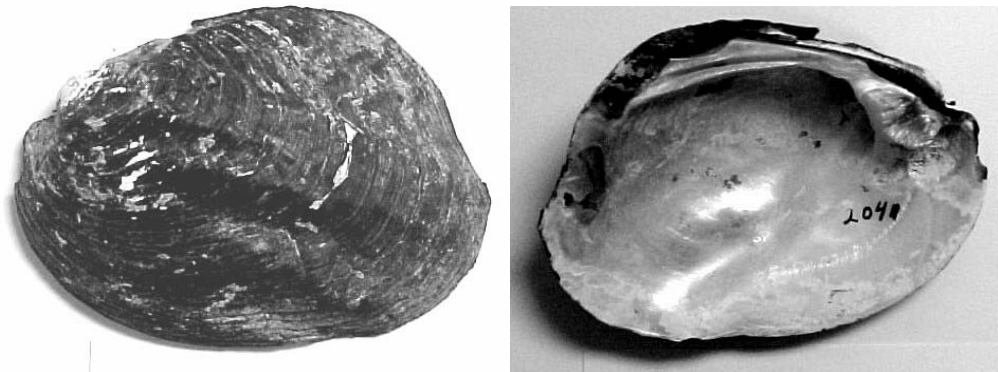


Figure 2c. *Cyclonaias tuberculata*

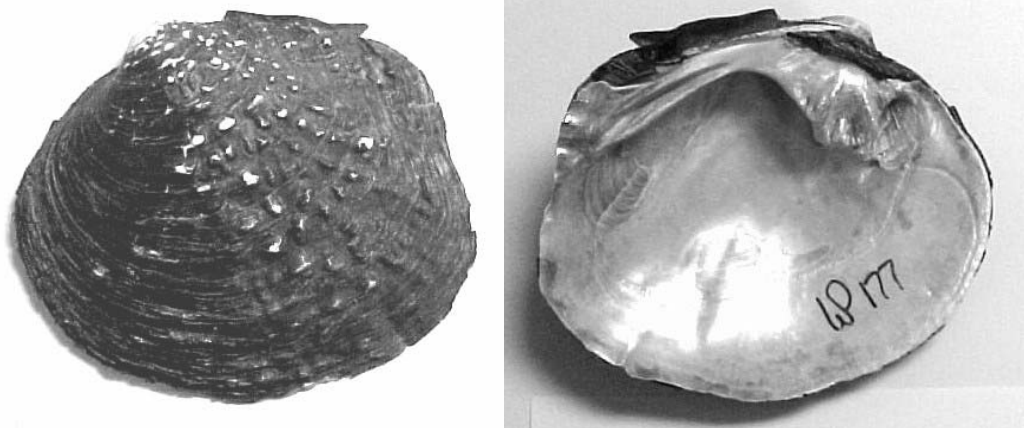


Figure 2d. *Elliptio dilatata*



Figure 2e. *Lampsilis cardium*



Figure 2f. *Lampsilis siliquoidea*

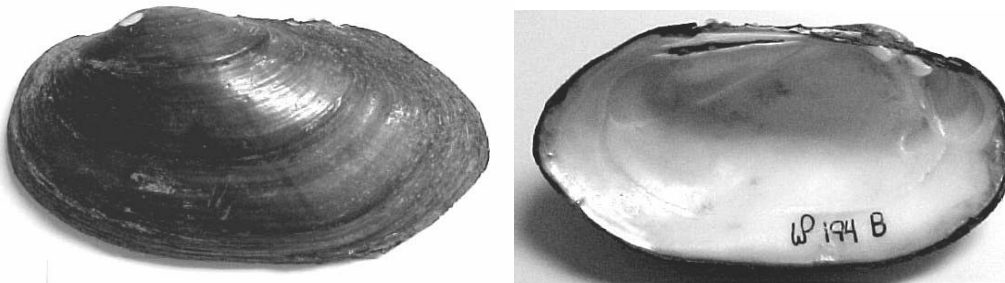


Figure 2g. *Lasmigona complanata*



Figure 2h. *Lasmigona costata*



Figure 2i. *Leptodea fragilis*



Figure 2j. *Potamilus alatus*



Figure 2k. *Ptychobranchus fasciolaris*



Figure 2l. *Quadrula nodulata*



Figure 2m. *Quadrula pustulosa*



Figure 2n. *Quadrula quadrula*

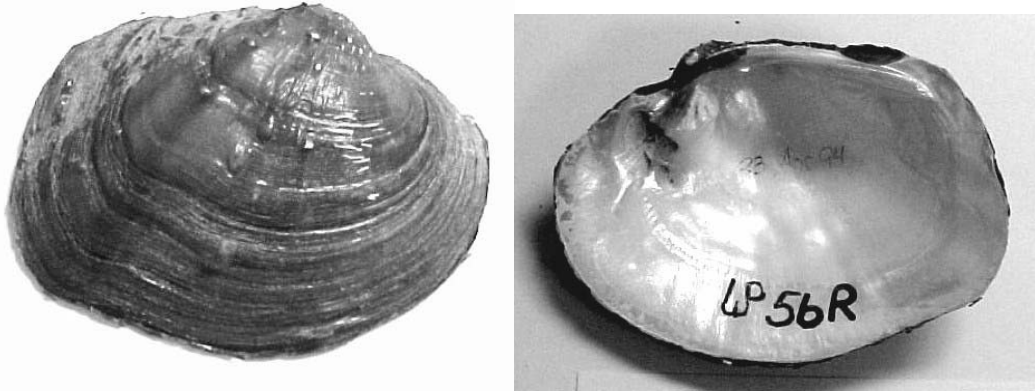


Figure 2o. *Toxolasma parvus*

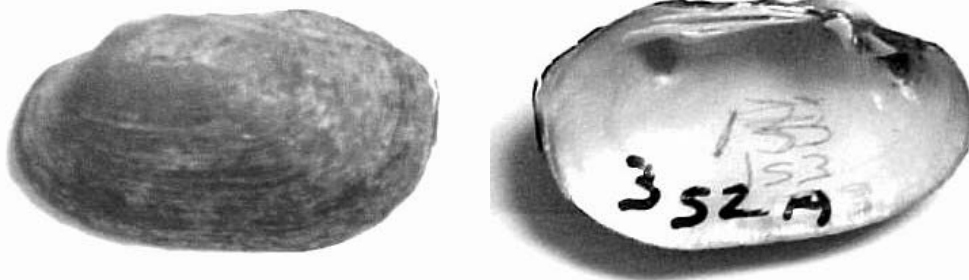


Figure 2p. *Truncilla truncata*

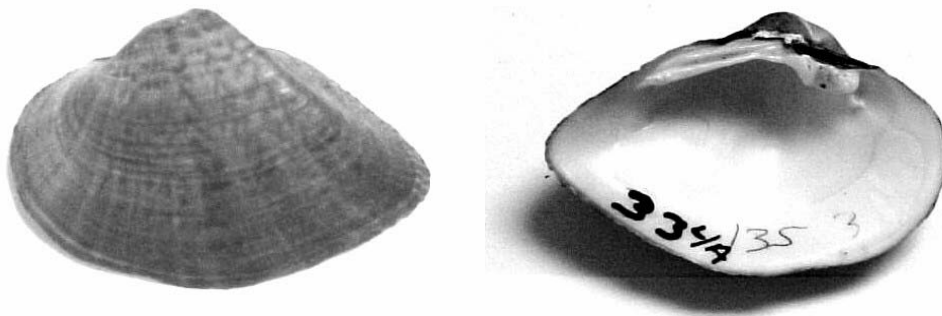


Figure 2q. Images of additional species are available on the website of the Illinois Natural History Survey <http://www.inhs.uiuc.edu/cbd/collections/mollusk/fieldguide.html>, or by following these links to images photographs on that website:

*Alasmidonta marginata*, [www.inhs.uiuc.edu/chf/pub/mussel\\_man/page84\\_5.html](http://www.inhs.uiuc.edu/chf/pub/mussel_man/page84_5.html)

*Epioblasma obliquata*, [www.inhs.uiuc.edu/chf/pub/mussel\\_man/page164\\_5.html](http://www.inhs.uiuc.edu/chf/pub/mussel_man/page164_5.html)

*Fusconaia flava*, [www.inhs.uiuc.edu/cbd/musselmanual/page46\\_7.html](http://www.inhs.uiuc.edu/cbd/musselmanual/page46_7.html)

*Lampsilis fasciola*, [www.inhs.uiuc.edu/cbd/musselmanual/page160\\_1.html](http://www.inhs.uiuc.edu/cbd/musselmanual/page160_1.html)

*Lasmigona compressa*, [www.inhs.uiuc.edu/cbd/musselmanual/page96\\_7.html](http://www.inhs.uiuc.edu/cbd/musselmanual/page96_7.html)

*Ligumia recta*, [www.inhs.uiuc.edu/chf/pub/mussel\\_man/page136\\_7.html](http://www.inhs.uiuc.edu/chf/pub/mussel_man/page136_7.html)

*Ligumia subrostrata*, [www.inhs.uiuc.edu/chf/pub/mussel\\_man/page138\\_9.html](http://www.inhs.uiuc.edu/chf/pub/mussel_man/page138_9.html)

*Obovaria subrotunda*, [www.inhs.uiuc.edu/chf/pub/mussel\\_man/page110\\_1.html](http://www.inhs.uiuc.edu/chf/pub/mussel_man/page110_1.html)

*Pleurobema clava*, [www.inhs.uiuc.edu/cbd/musselmanual/page56\\_7.html](http://www.inhs.uiuc.edu/cbd/musselmanual/page56_7.html)

*Pleurobema sintoxia*, [www.inhs.uiuc.edu/chf/pub/mussel\\_man/page58\\_9.html](http://www.inhs.uiuc.edu/chf/pub/mussel_man/page58_9.html)

*Pyganodon grandis*, [www.inhs.uiuc.edu/chf/pub/mussel\\_man/page78\\_9.html](http://www.inhs.uiuc.edu/chf/pub/mussel_man/page78_9.html)

*Quadrula cylindrica*, [www.inhs.uiuc.edu/chf/pub/mussel\\_man/page32\\_3.html](http://www.inhs.uiuc.edu/chf/pub/mussel_man/page32_3.html)

*Utterbackia imbecillis*, [www.inhs.uiuc.edu/cbd/musselmanual/page74\\_5.html](http://www.inhs.uiuc.edu/cbd/musselmanual/page74_5.html)

*Villosa fabalis*, [www.inhs.uiuc.edu/chf/pub/mussel\\_man/page142\\_3.html](http://www.inhs.uiuc.edu/chf/pub/mussel_man/page142_3.html)

Figure 3. Distribution of Mussel Species in Allen County, Indiana, during 1997-2004.

Distribution of *Actinonaias ligamentina*

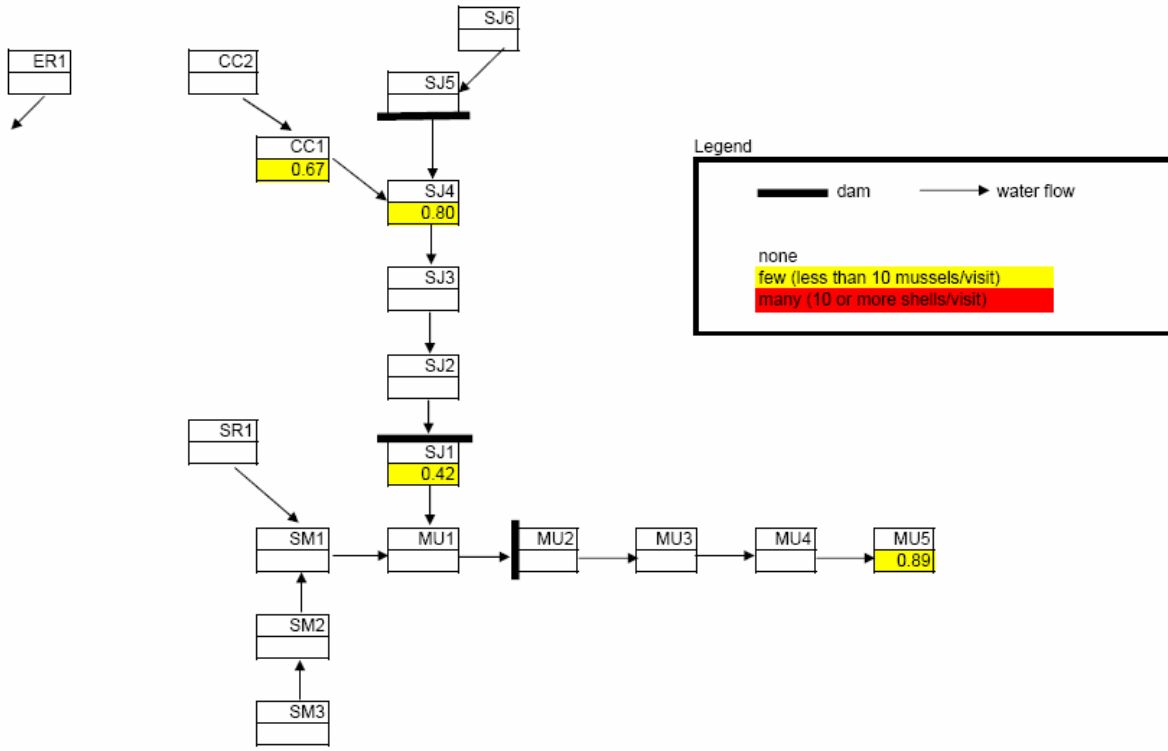


Figure 4. Distribution of Mussel Species in Allen County, Indiana, during 1997-2004.

Distribution of *Alasmidonta marginata*

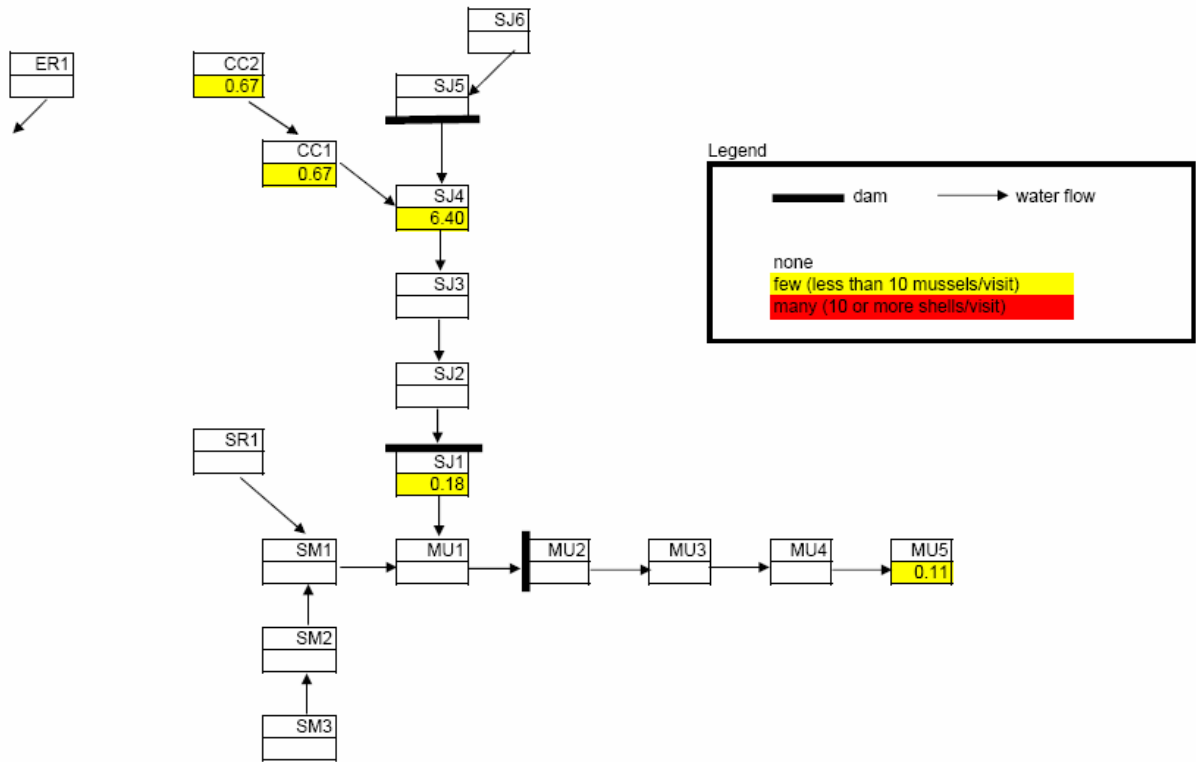


Figure 5. Distribution of Mussel Species in Allen County, Indiana, during 1997-2004.

Distribution of *Amblema plicata*

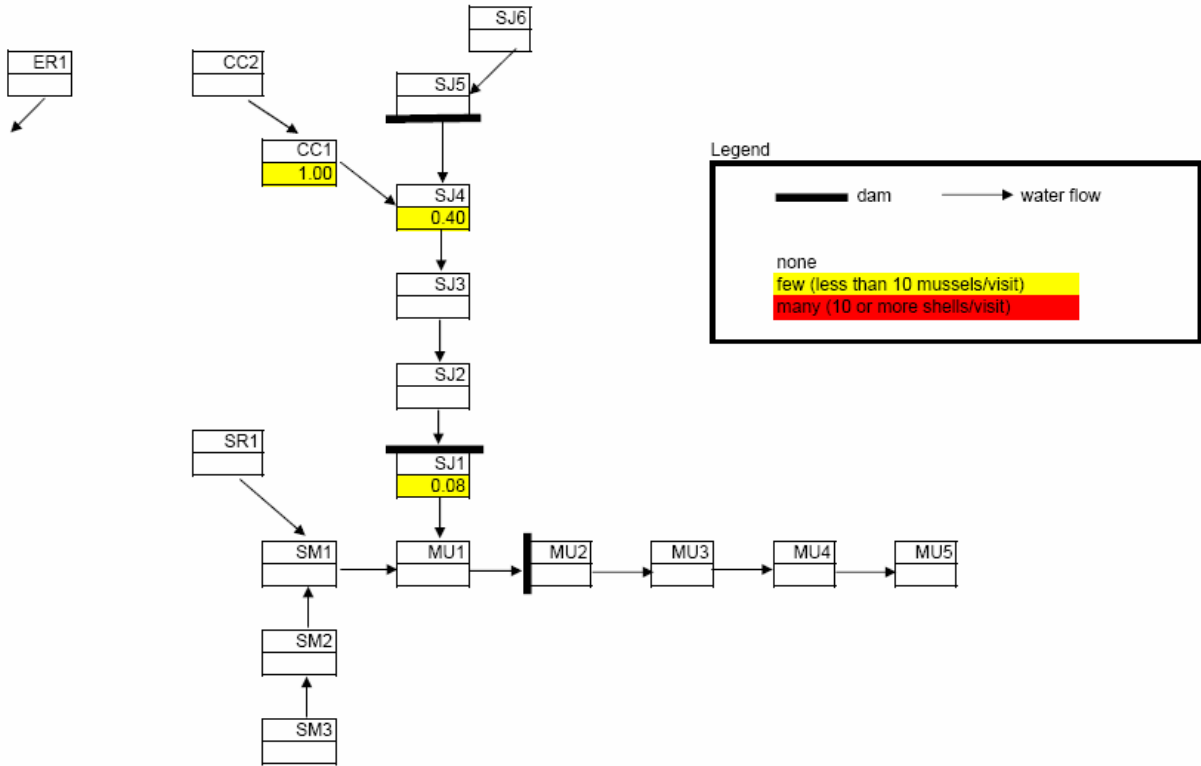


Figure 6. Distribution of Mussel Species in Allen County, Indiana, during 1997-2004.

Distribution of *Cyclonaias tuberculata*

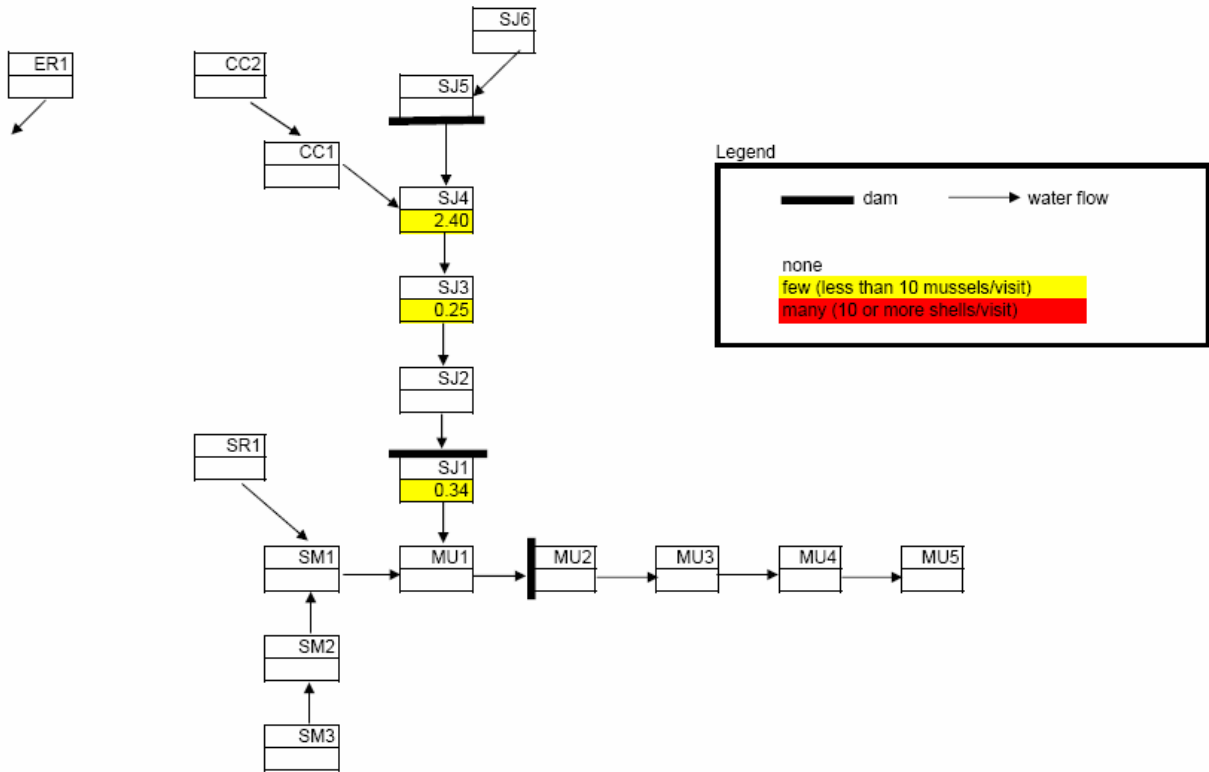


Figure 7. Distribution of Mussel Species in Allen County, Indiana, during 1997-2004.

Distribution of *Elliptio dilatata*

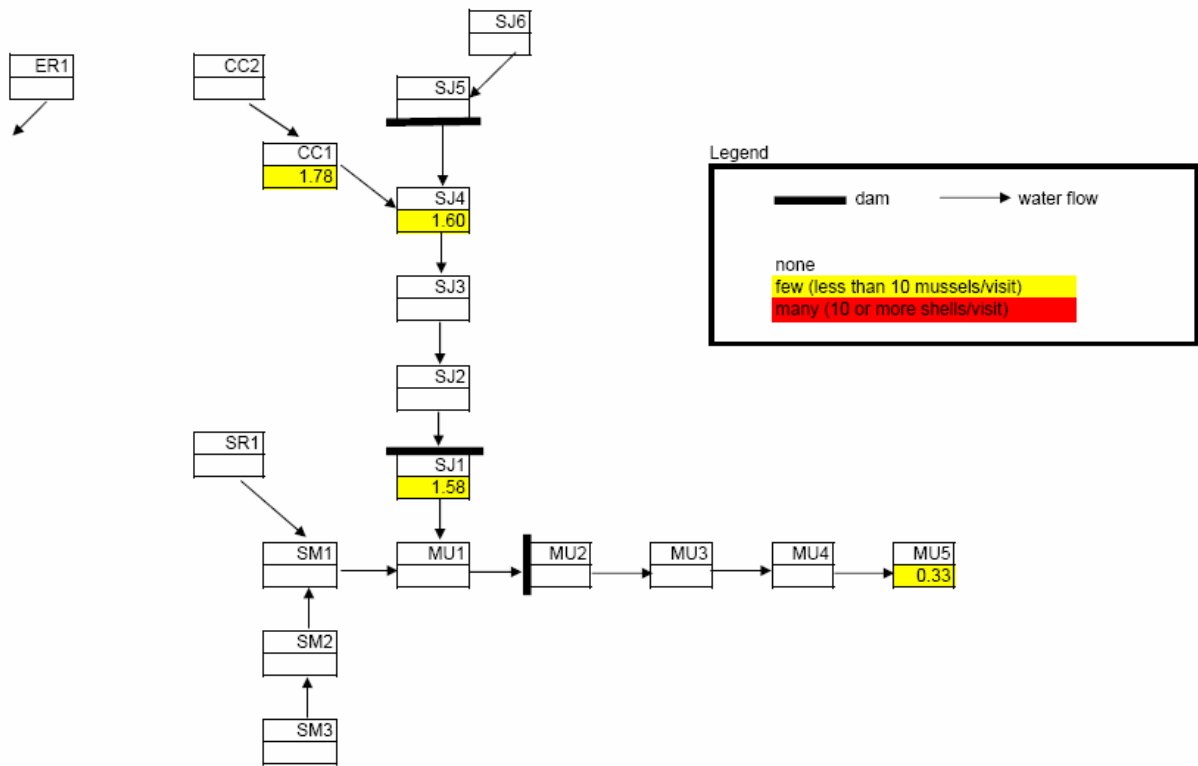


Figure 8. Distribution of Mussel Species in Allen County, Indiana, during 1997-2004.

Distribution of *Epioblasma obliquata*

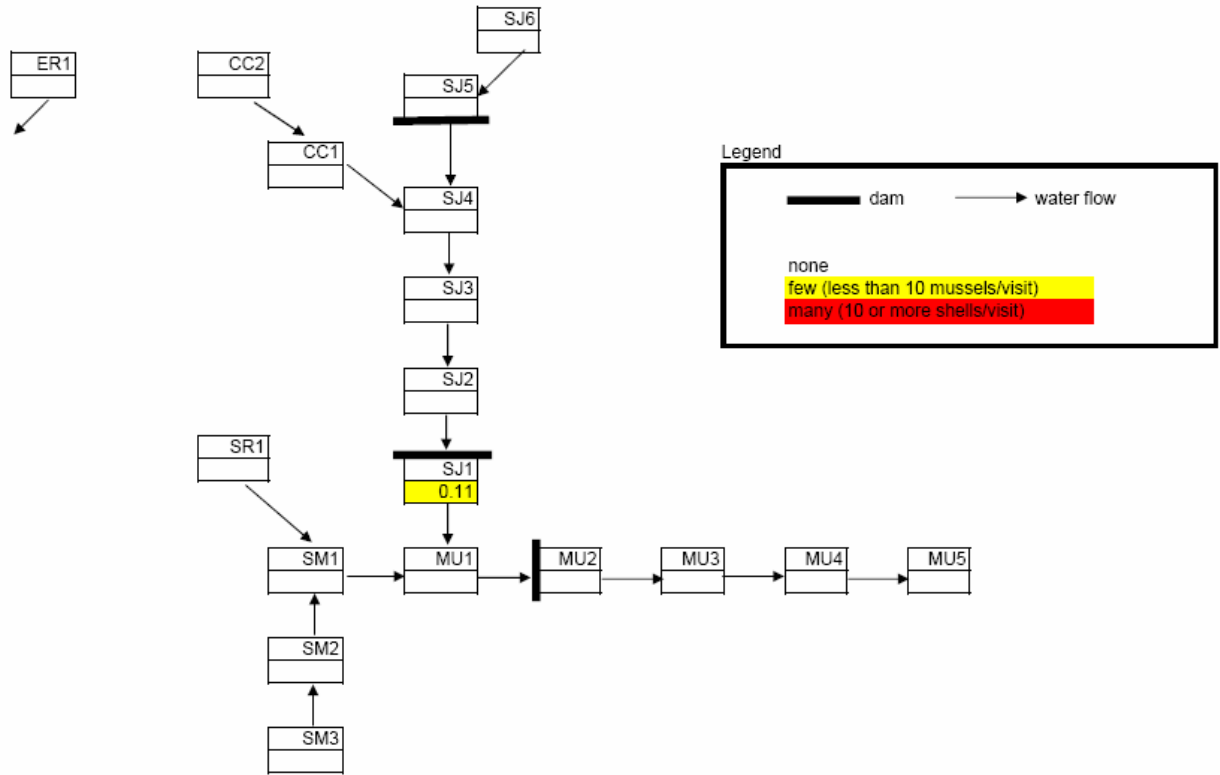


Figure 9. Distribution of Mussel Species in Allen County, Indiana, during 1997-2004.

Distribution of *Fusconaia flava*

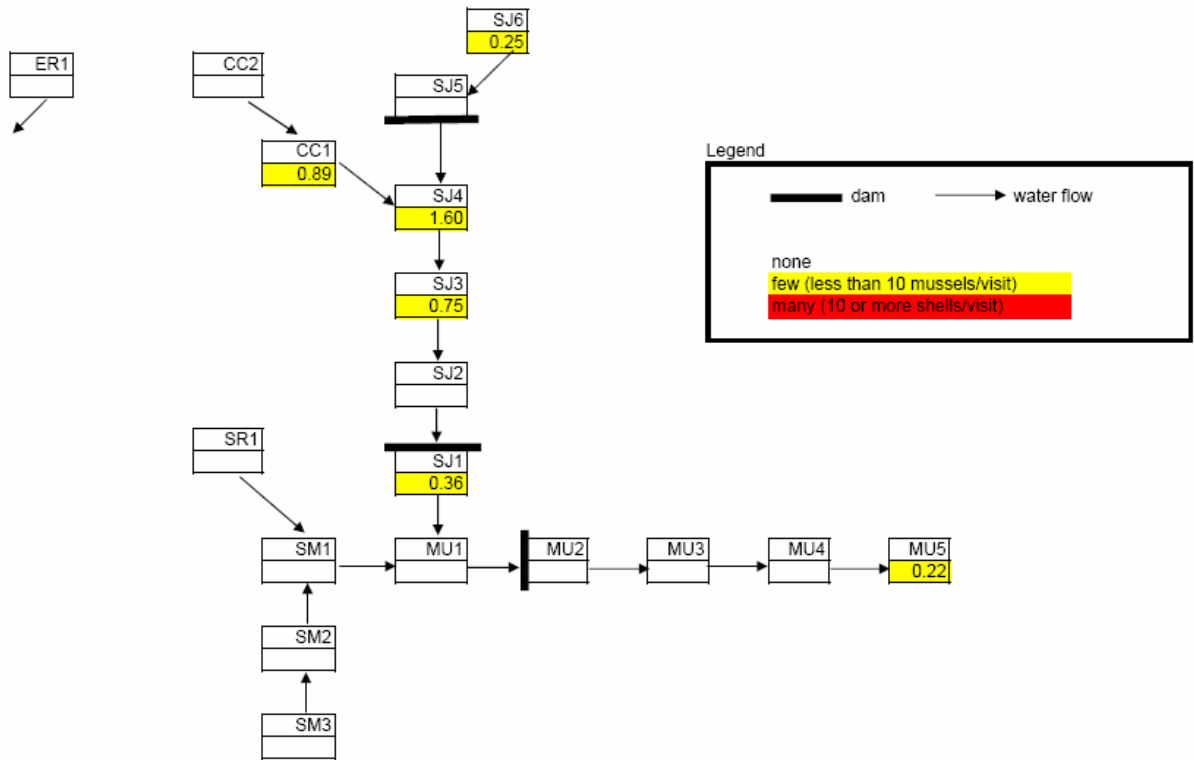


Figure 10. Distribution of Mussel Species in Allen County, Indiana, during 1997-2004.

Distribution of *Lampsilis cardium*

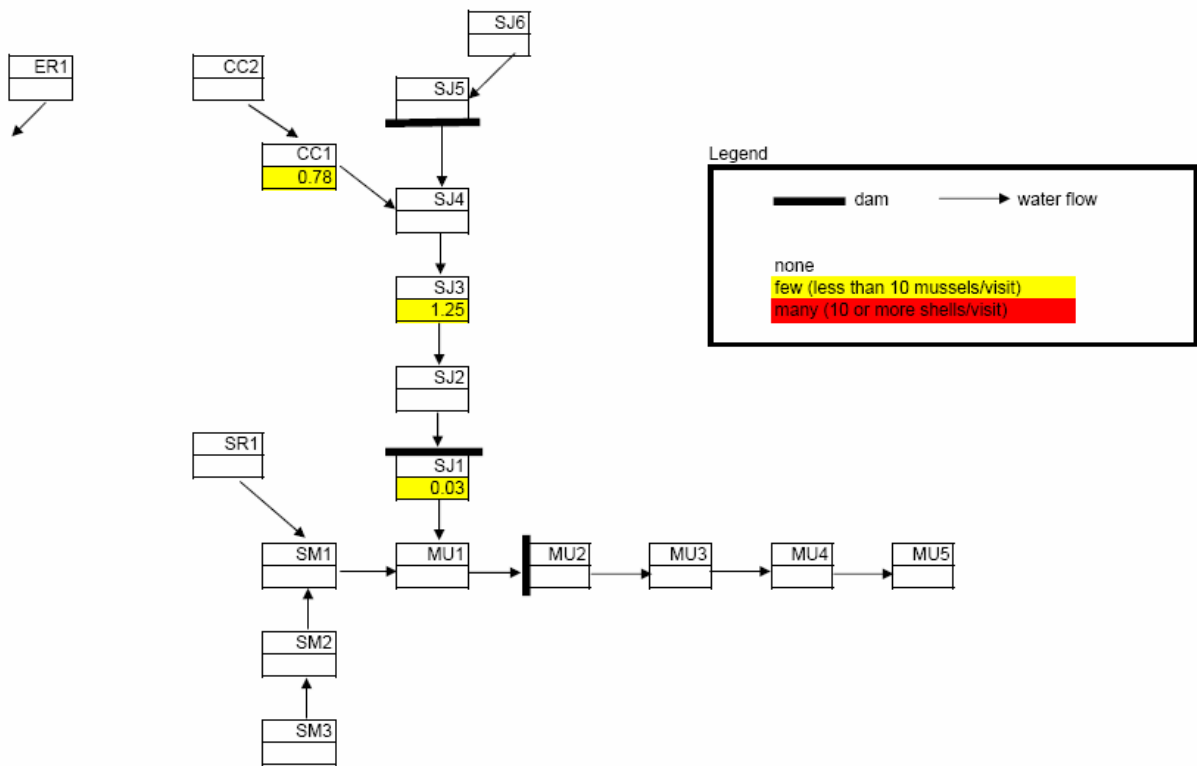


Figure 11. Distribution of Mussel Species in Allen County, Indiana, during 1997-2004.

Distribution of Lampsilis fasciola

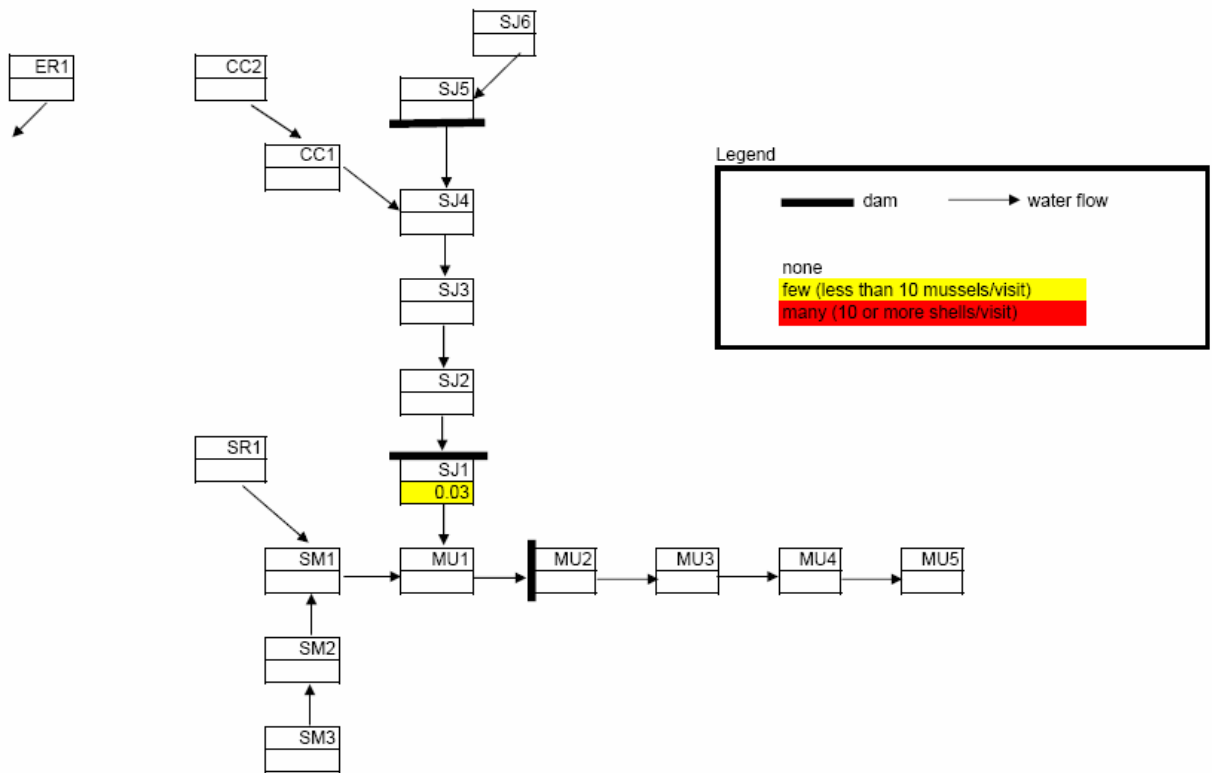


Figure 12. Distribution of Mussel Species in Allen County, Indiana, during 1997-2004.

Distribution of *Lampsilis siliquoidea*

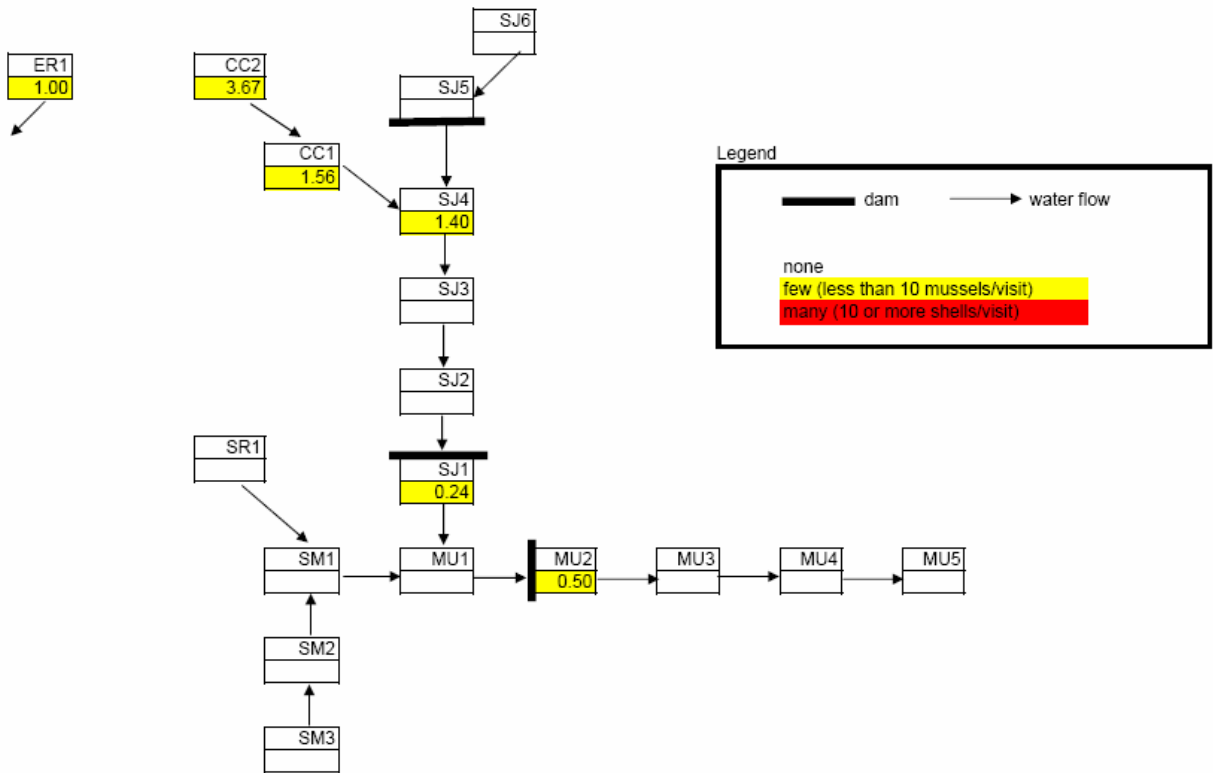


Figure 13. Distribution of Mussel Species in Allen County, Indiana, during 1997-2004.

Distribution of *Lasmigona complanata*

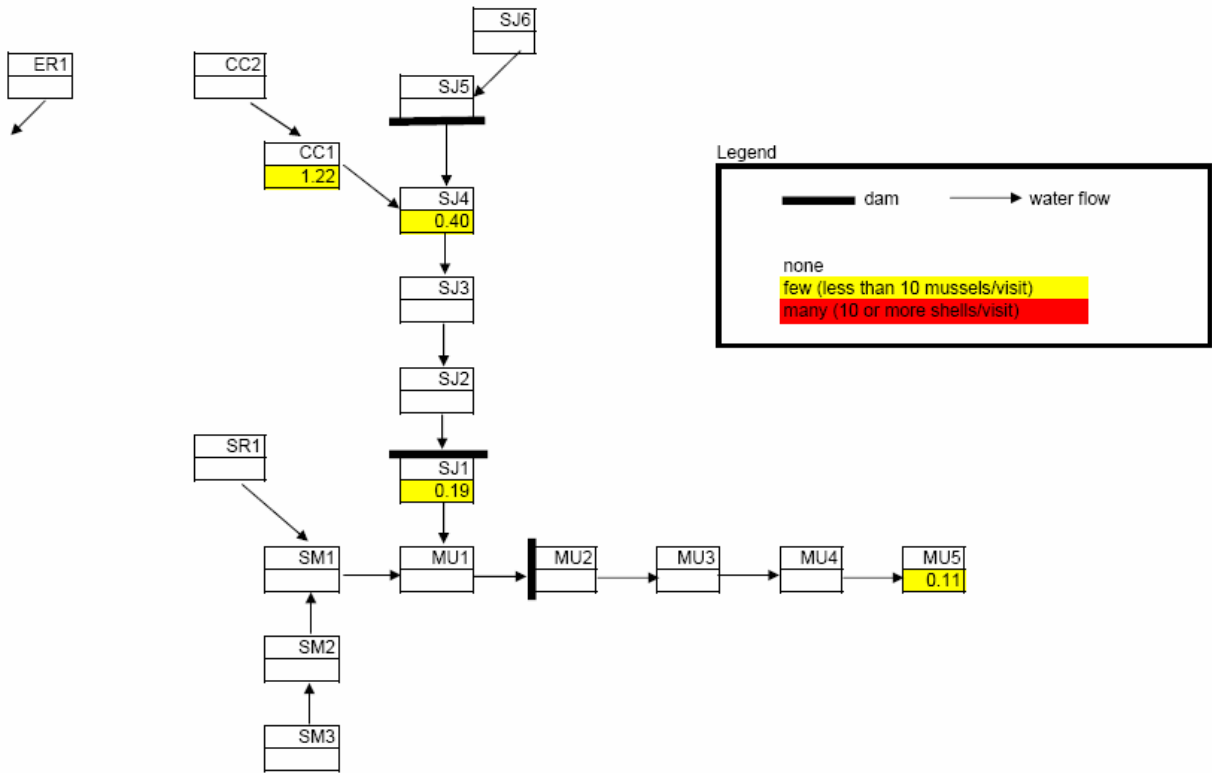


Figure 14. Distribution of Mussel Species in Allen County, Indiana, during 1997-2004.

Distribution of *Lasmigona compressa*

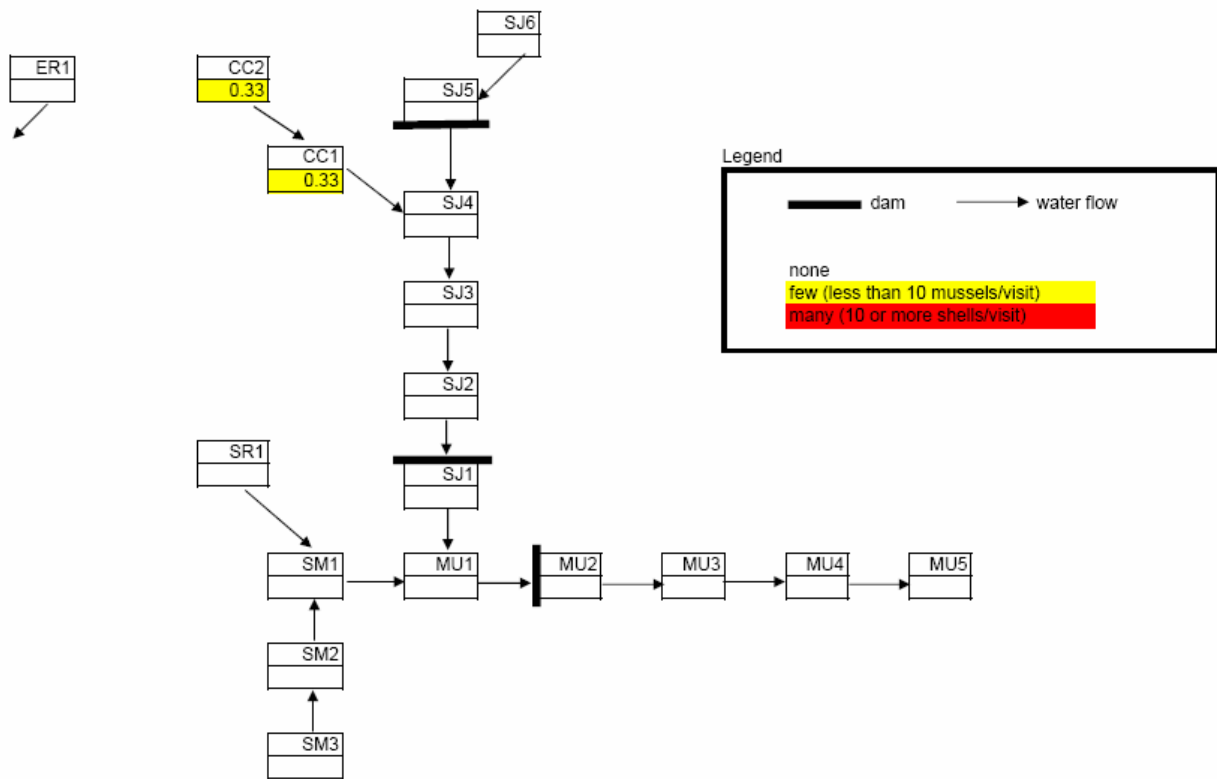


Figure 15. Distribution of Mussel Species in Allen County, Indiana, during 1997-2004.

Distribution of *Lasmigona costata*

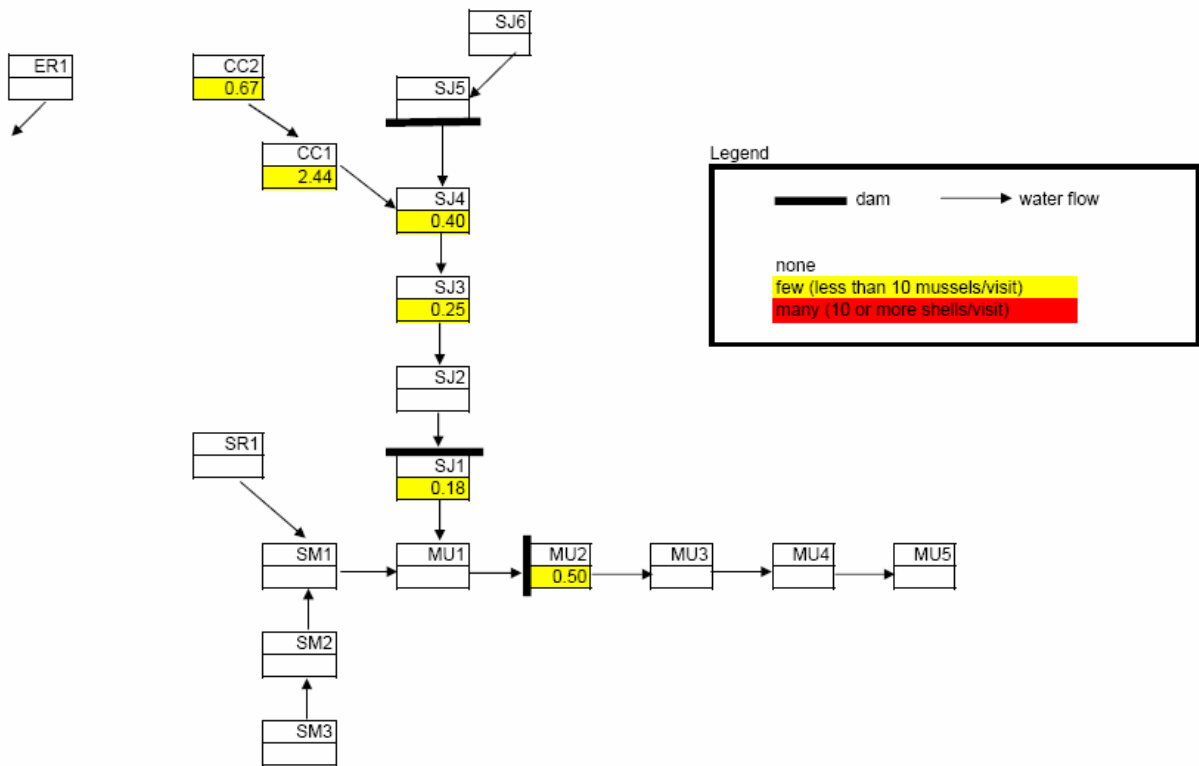


Figure 16. Distribution of Mussel Species in Allen County, Indiana, during 1997-2004.

Distribution of Leptodea fragilis

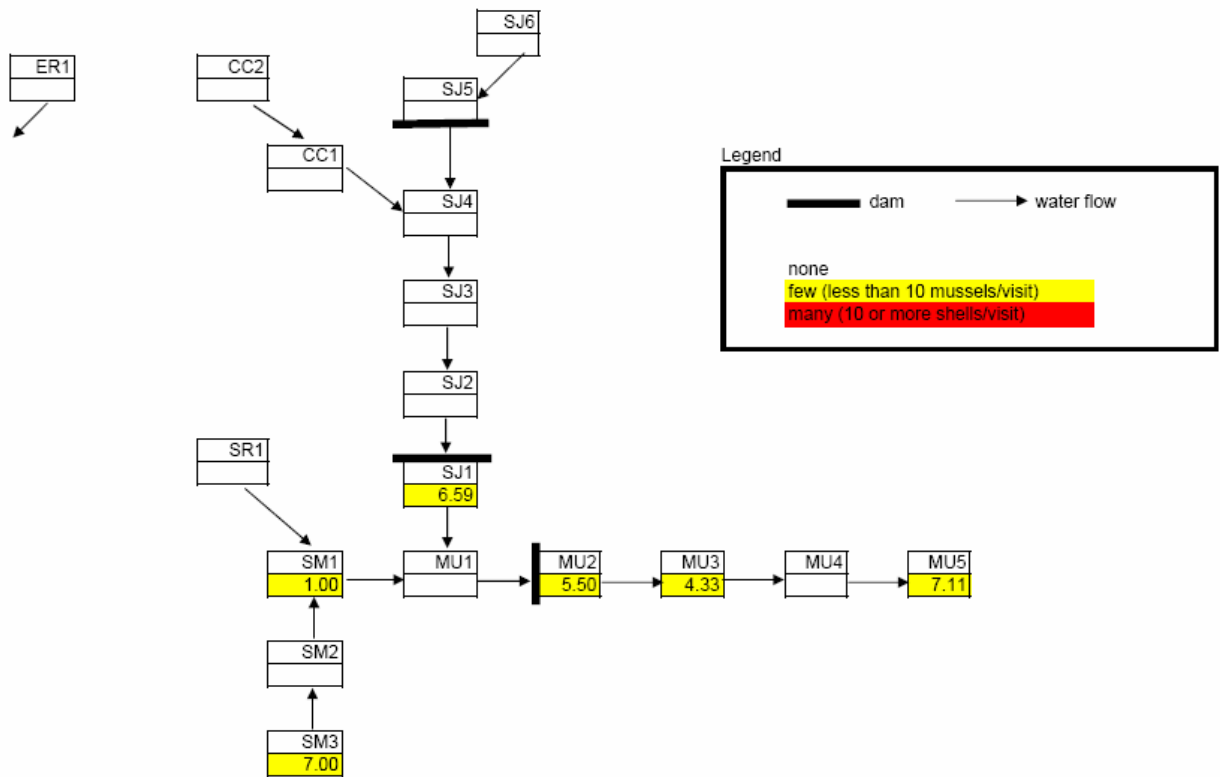


Figure 17. Distribution of Mussel Species in Allen County, Indiana, during 1997-2004.

Distribution of Ligumia recta

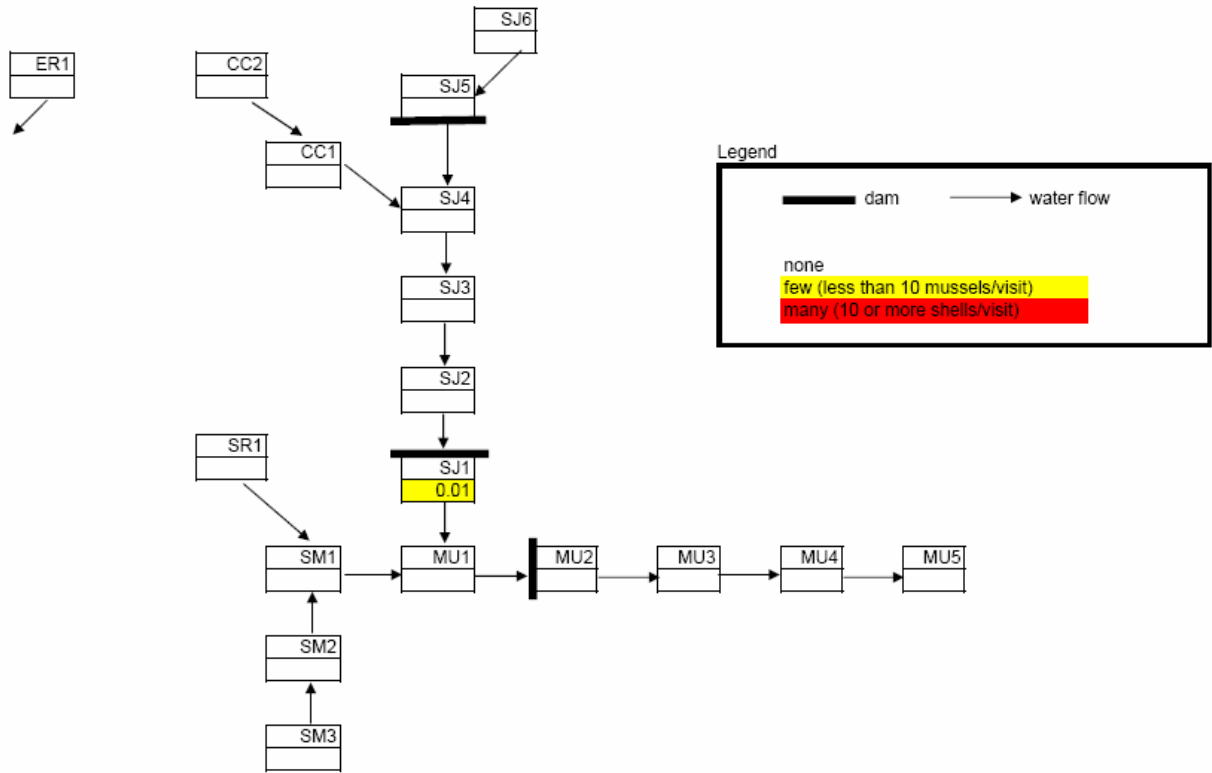


Figure 18. Distribution of Mussel Species in Allen County, Indiana, during 1997-2004.

Distribution of *Ligumia subrostrata*

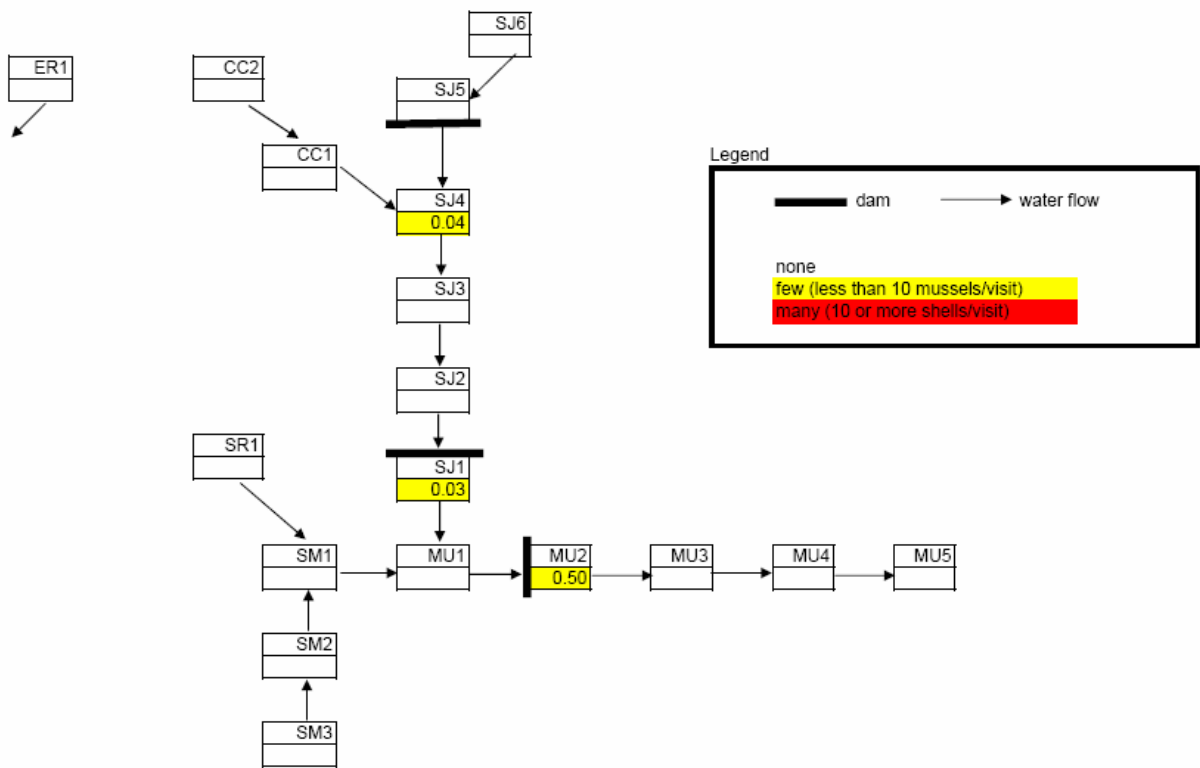


Figure 19. Distribution of Mussel Species in Allen County, Indiana, during 1997-2004.

Distribution of *Obovaria subrotunda*

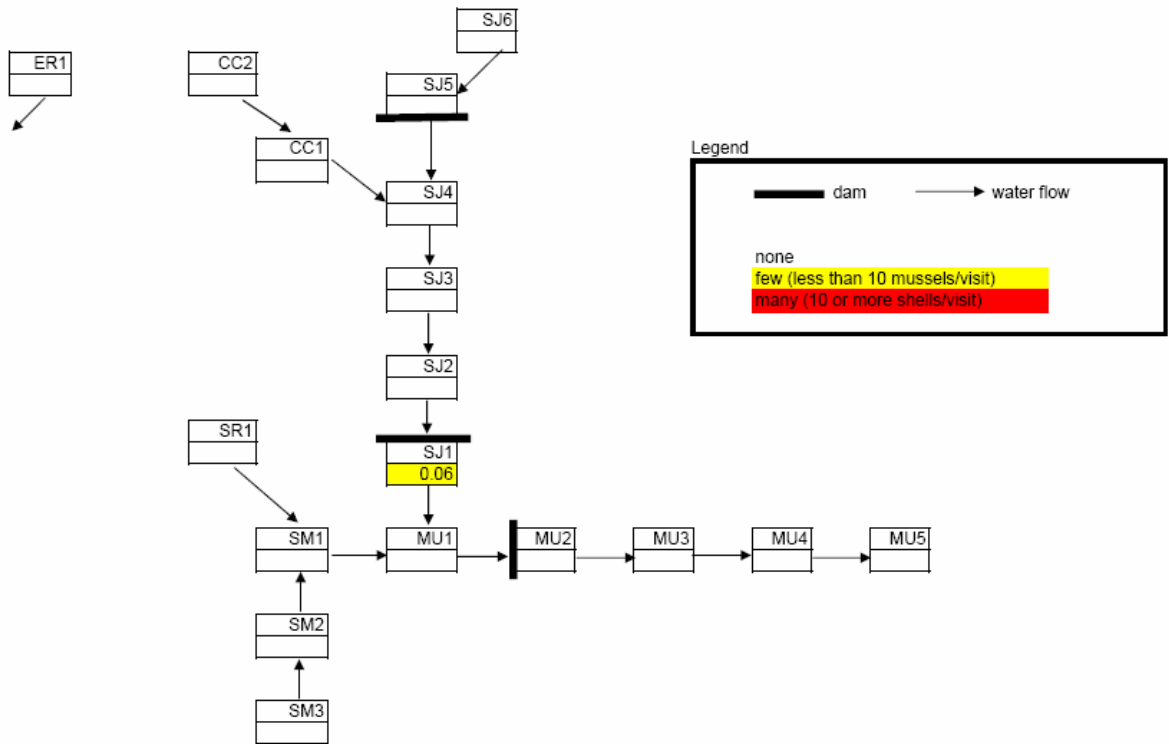


Figure 20. Distribution of Mussel Species in Allen County, Indiana, during 1997-2004.

Distribution of Pleurobema clava

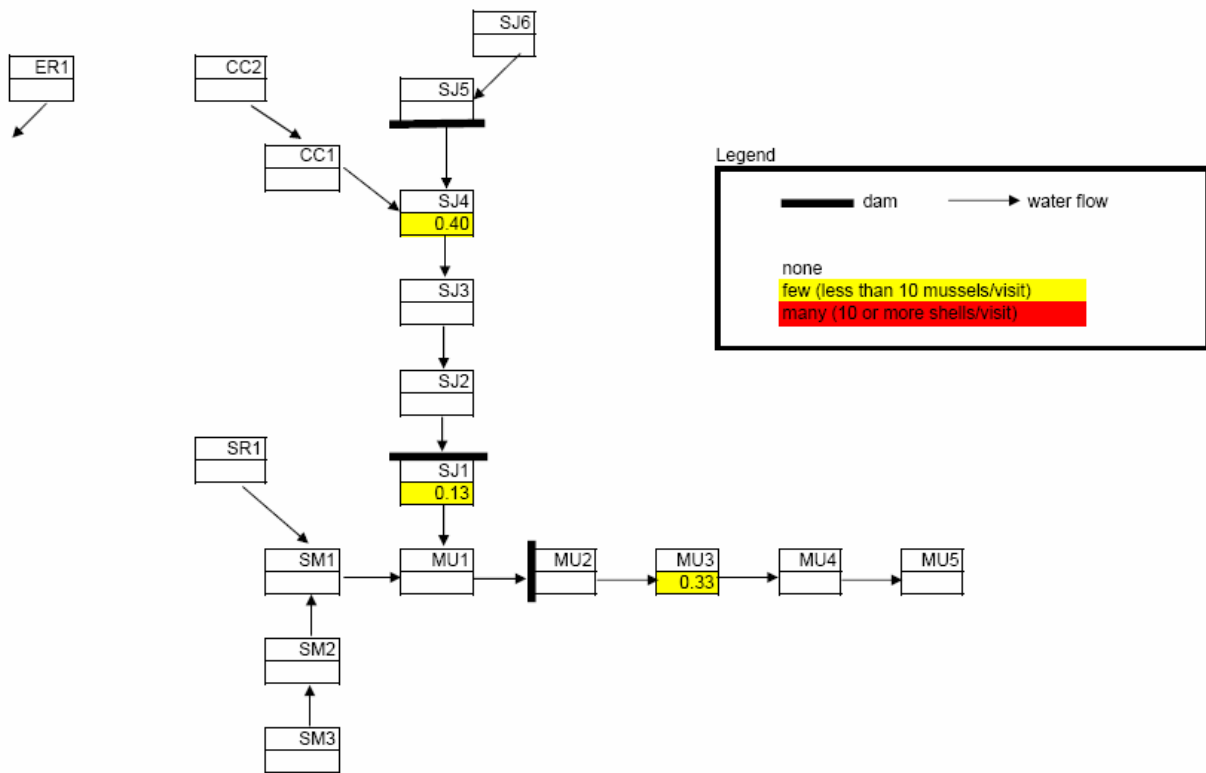


Figure 21. Distribution of Mussel Species in Allen County, Indiana, during 1997-2004.

Distribution of Pleurobema sintoxia

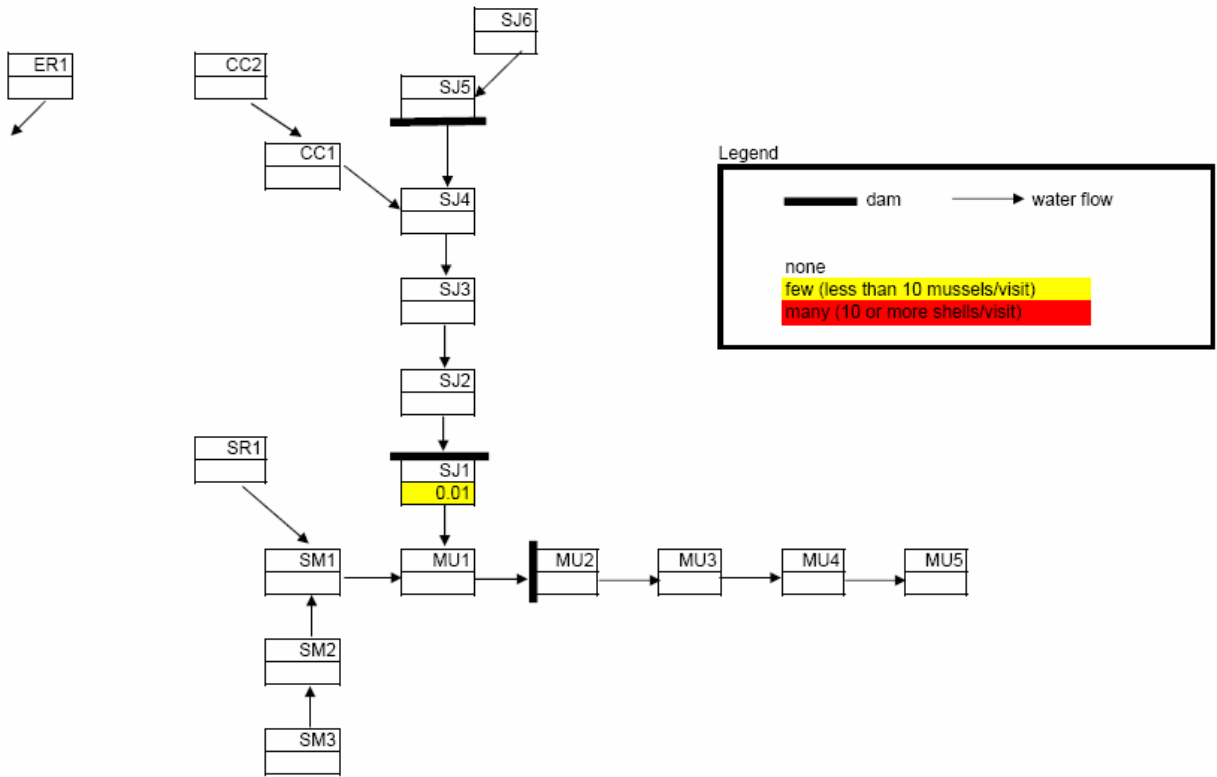


Figure 22. Distribution of Mussel Species in Allen County, Indiana, during 1997-2004.

Distribution of *Potamilus alatus*

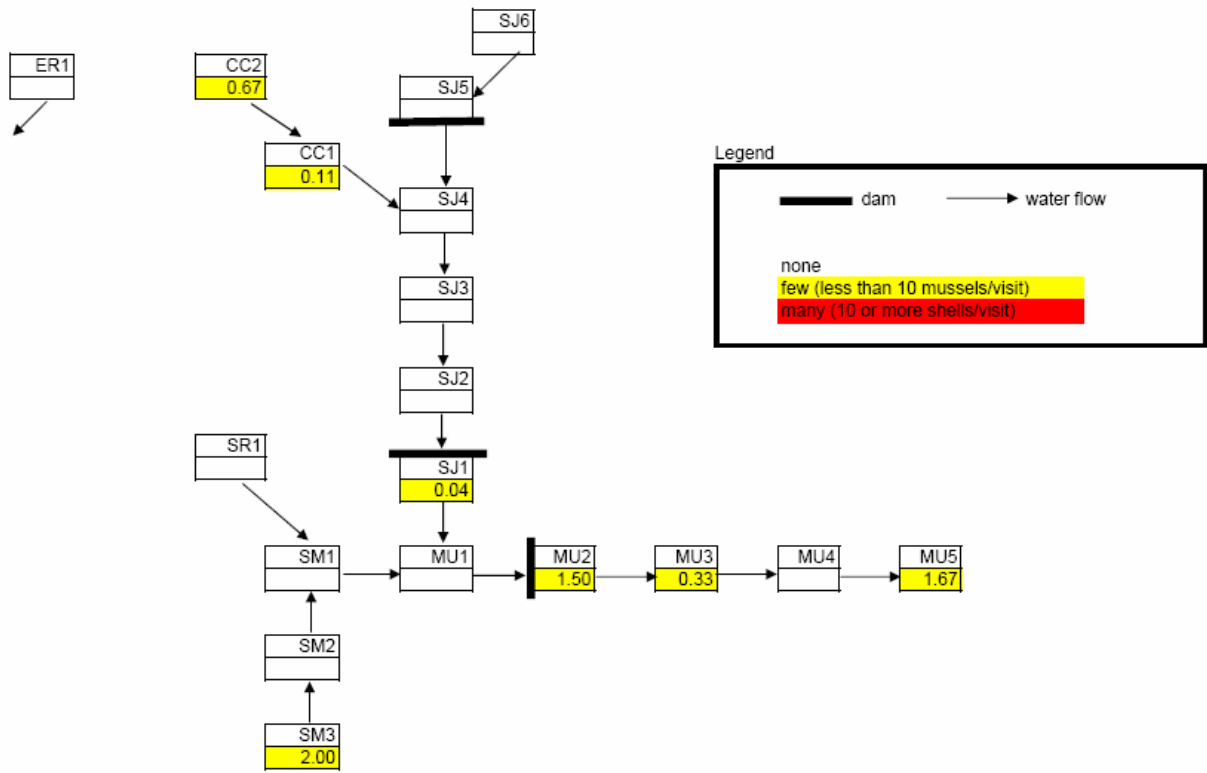


Figure 23. Distribution of Mussel Species in Allen County, Indiana, during 1997-2004.

Distribution of *Ptychobranchus fasciolaris*

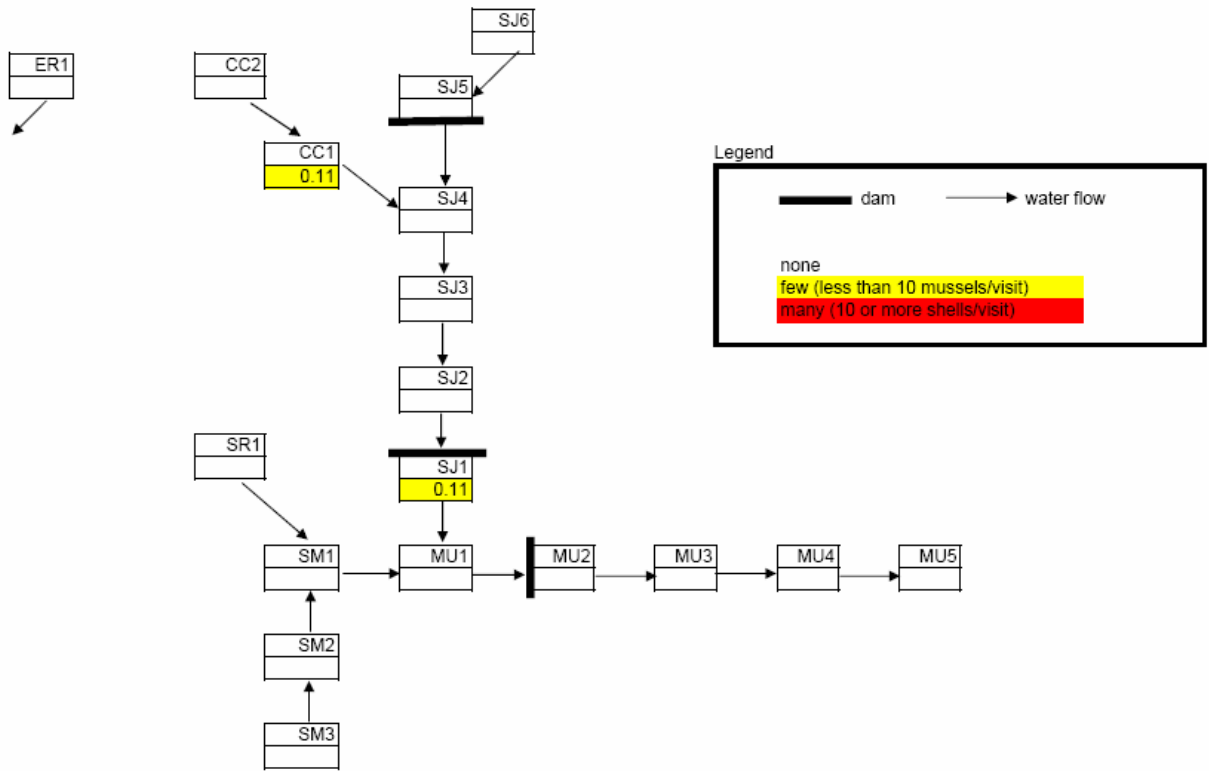


Figure 24. Distribution of Mussel Species in Allen County, Indiana, during 1997-2004.

Distribution of *Pyganodon grandis*

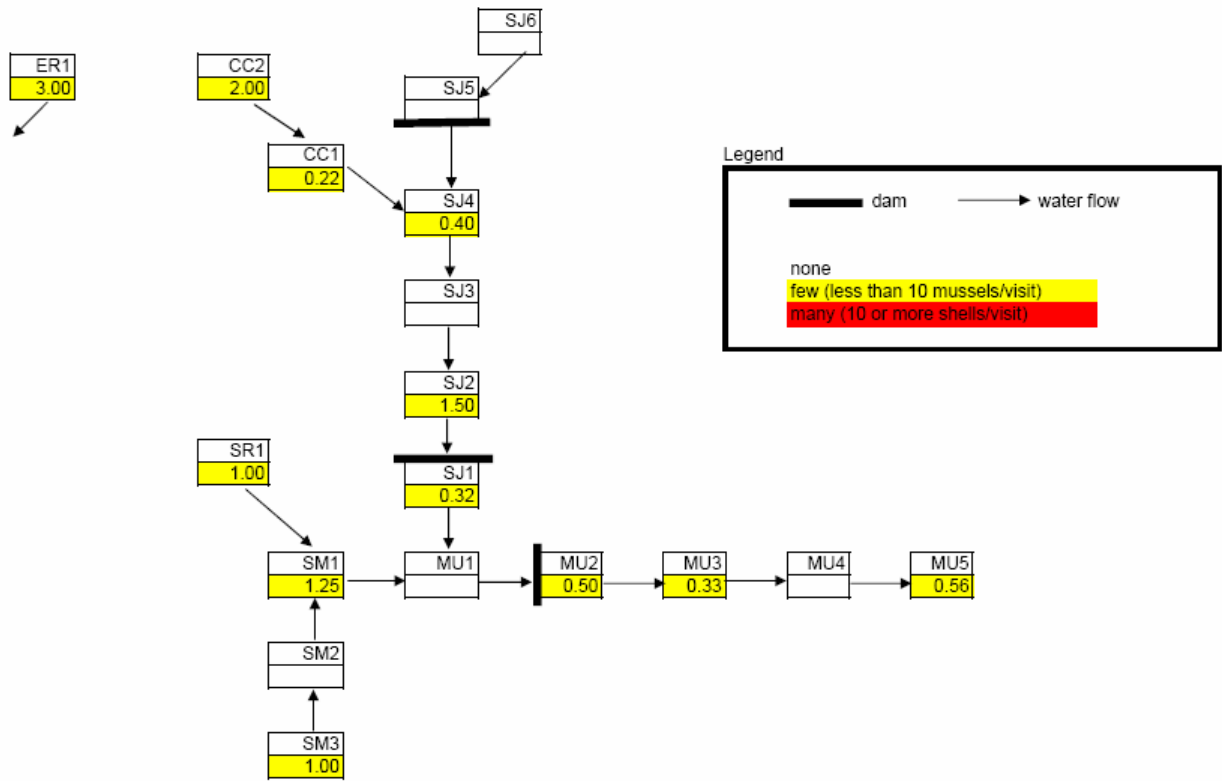


Figure 25. Distribution of Mussel Species in Allen County, Indiana, during 1997-2004.

Distribution of *Quadrula cylindrica*

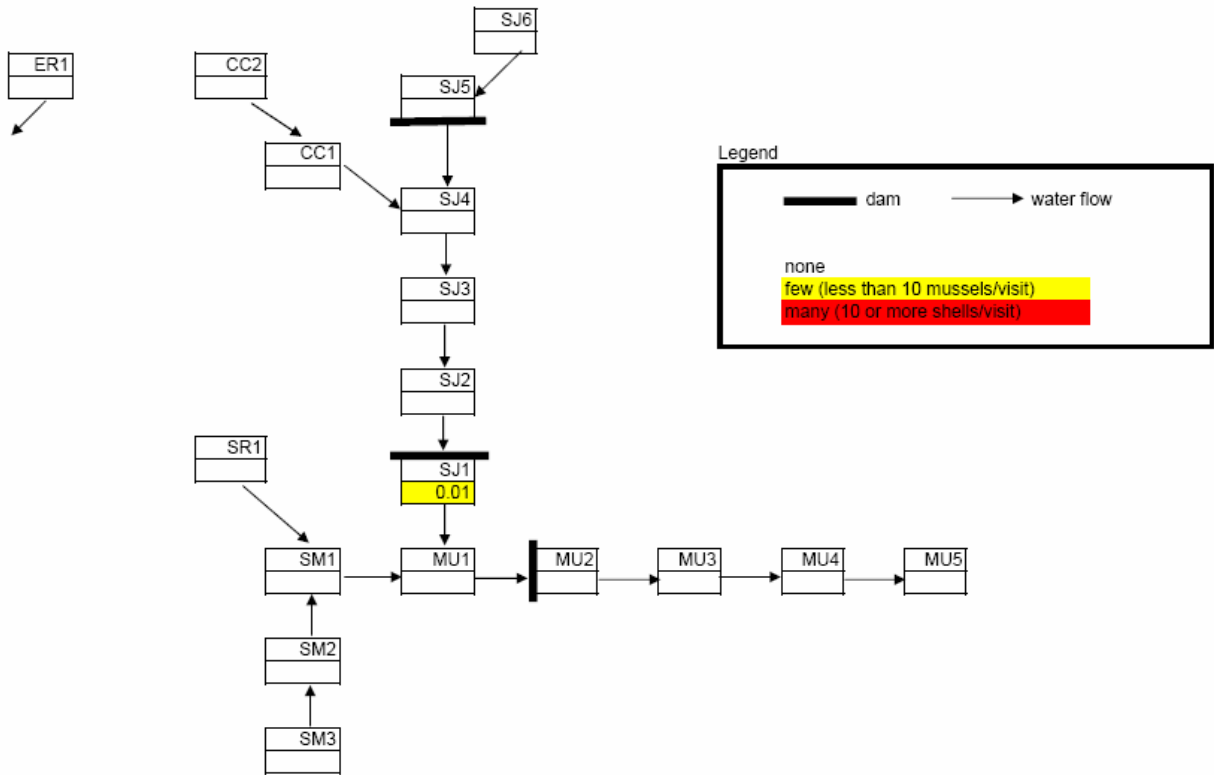


Figure 26. Distribution of Mussel Species in Allen County, Indiana, during 1997-2004.

Distribution of Quadrula nodulata

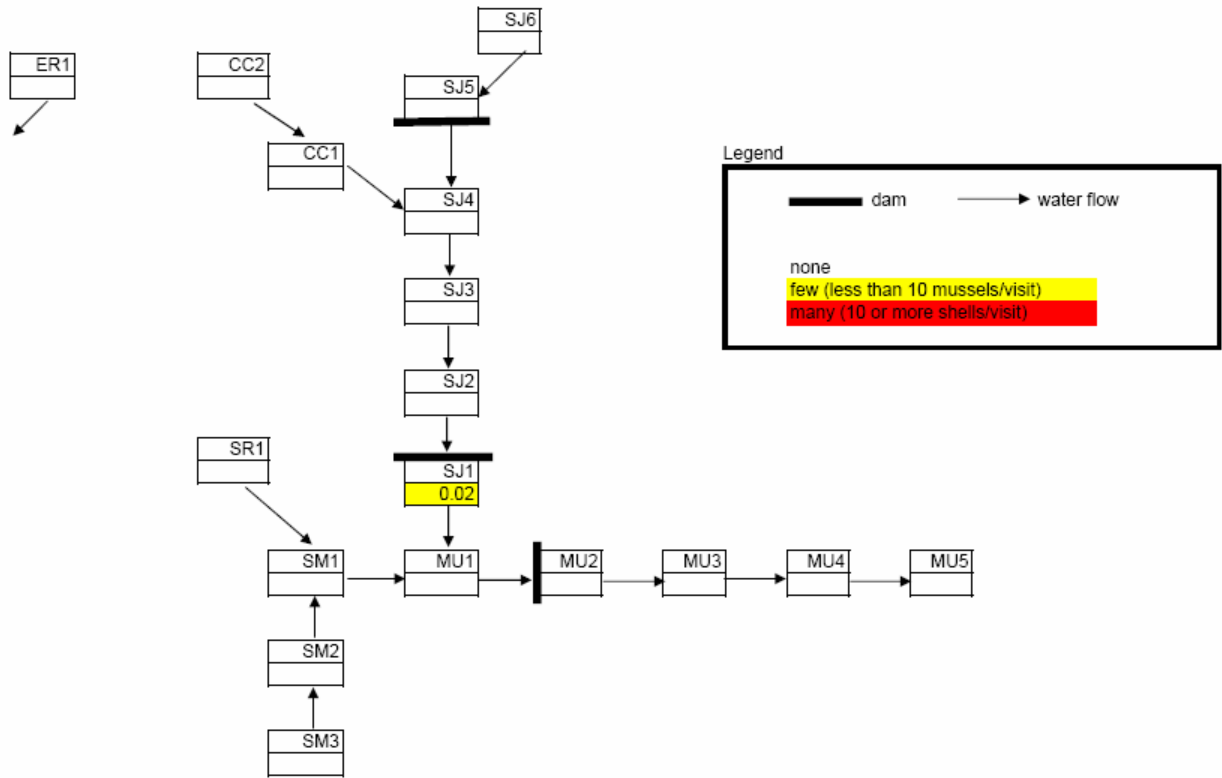


Figure 27. Distribution of Mussel Species in Allen County, Indiana, during 1997-2004.

Distribution of *Quadrula pustulosa*

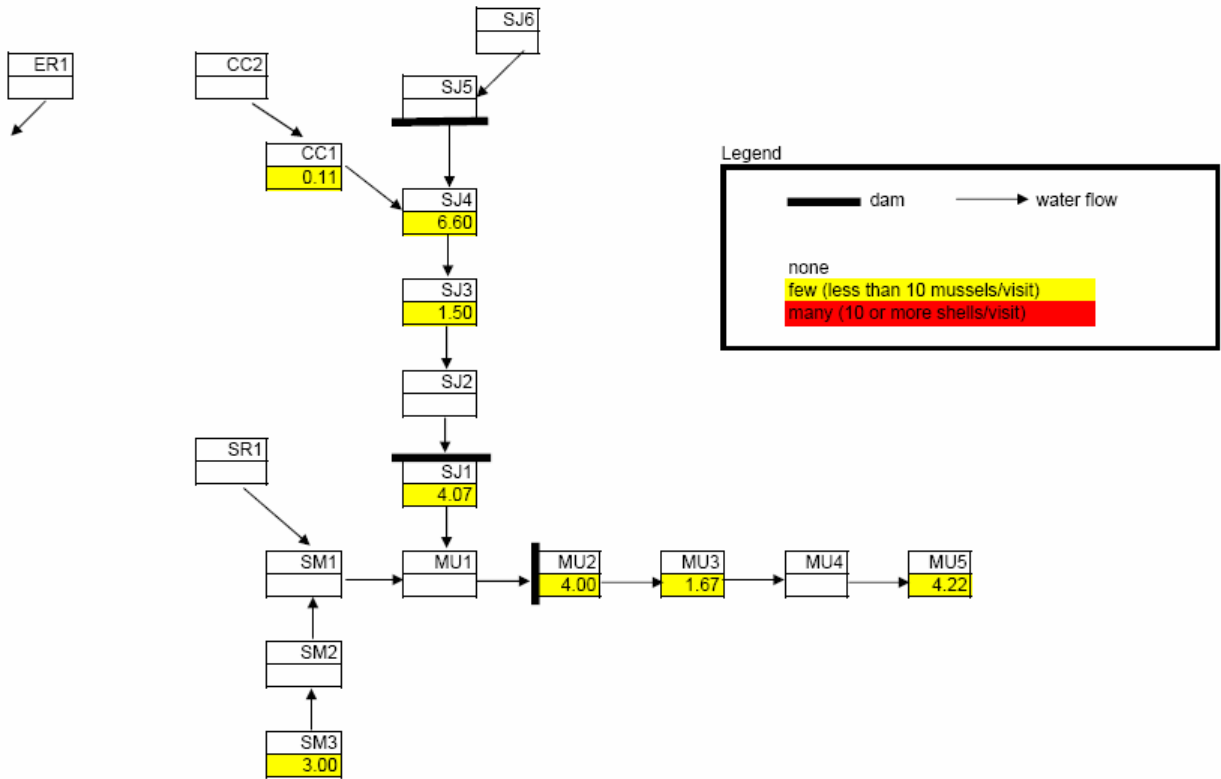


Figure 28. Distribution of Mussel Species in Allen County, Indiana, during 1997-2004.

Distribution of Quadrula quadrula

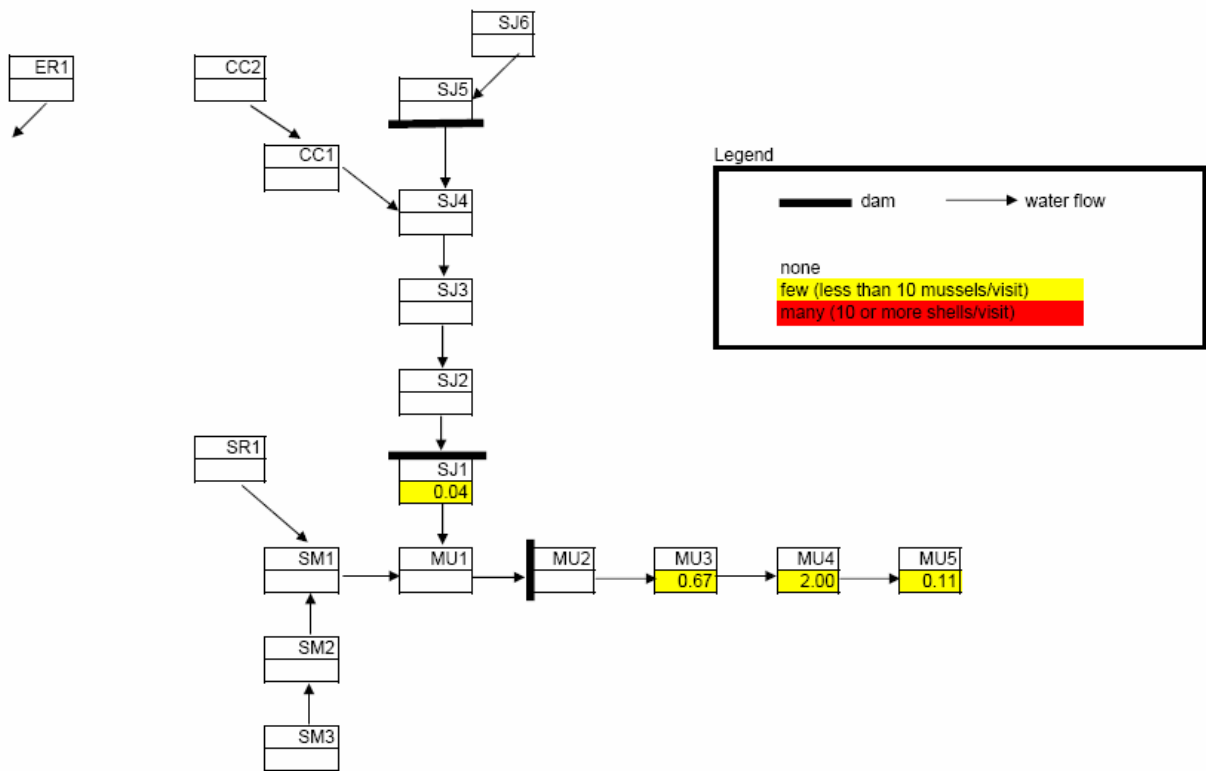


Figure 29. Distribution of Mussel Species in Allen County, Indiana, during 1997-2004.

Distribution of Toxolasma parvus

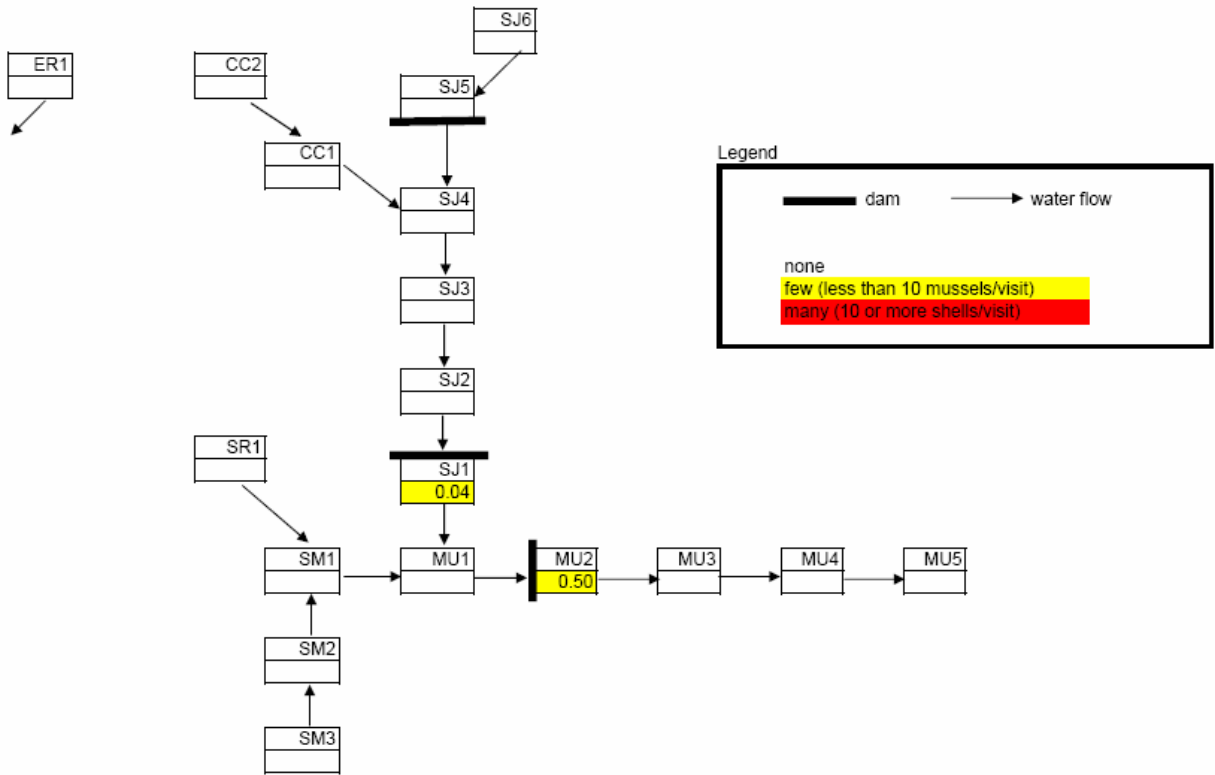


Figure 30. Distribution of Mussel Species in Allen County, Indiana, during 1997-2004.

Distribution of *Truncilla truncata*

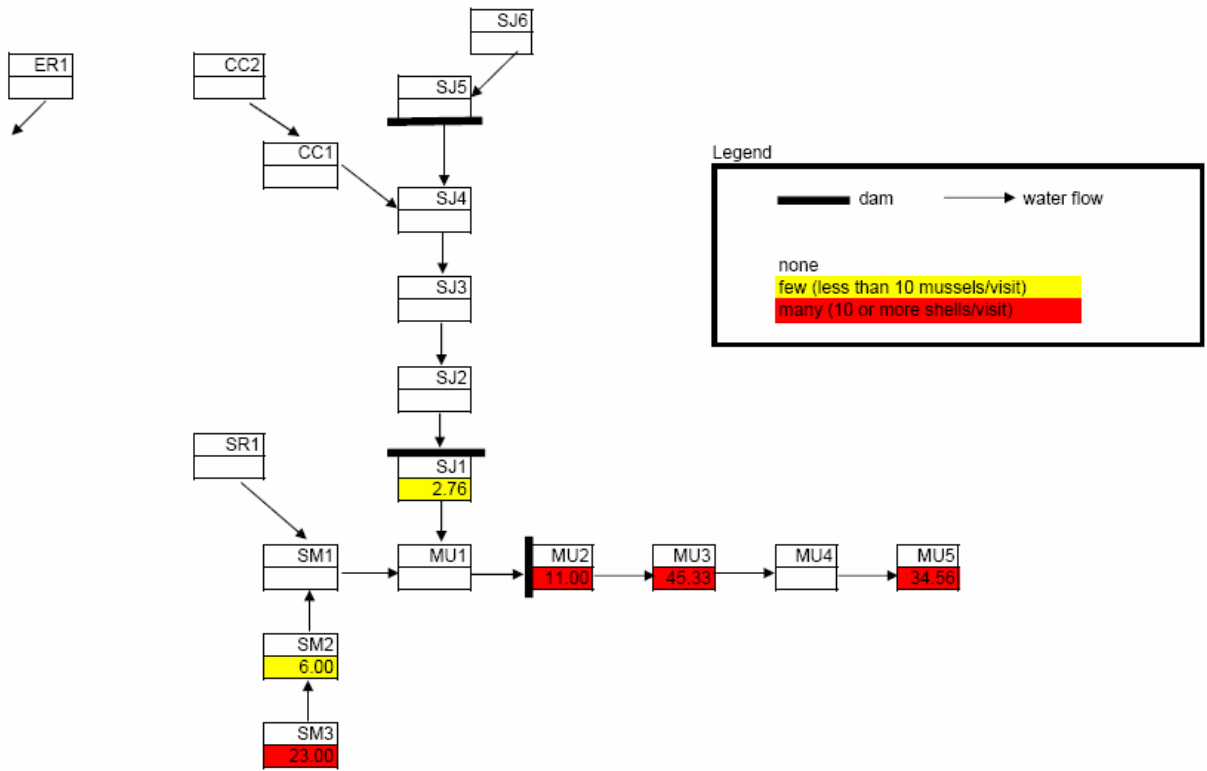


Figure 31. Distribution of Mussel Species in Allen County, Indiana, during 1997-2004.

Distribution of *Utterbackia imbecillis*

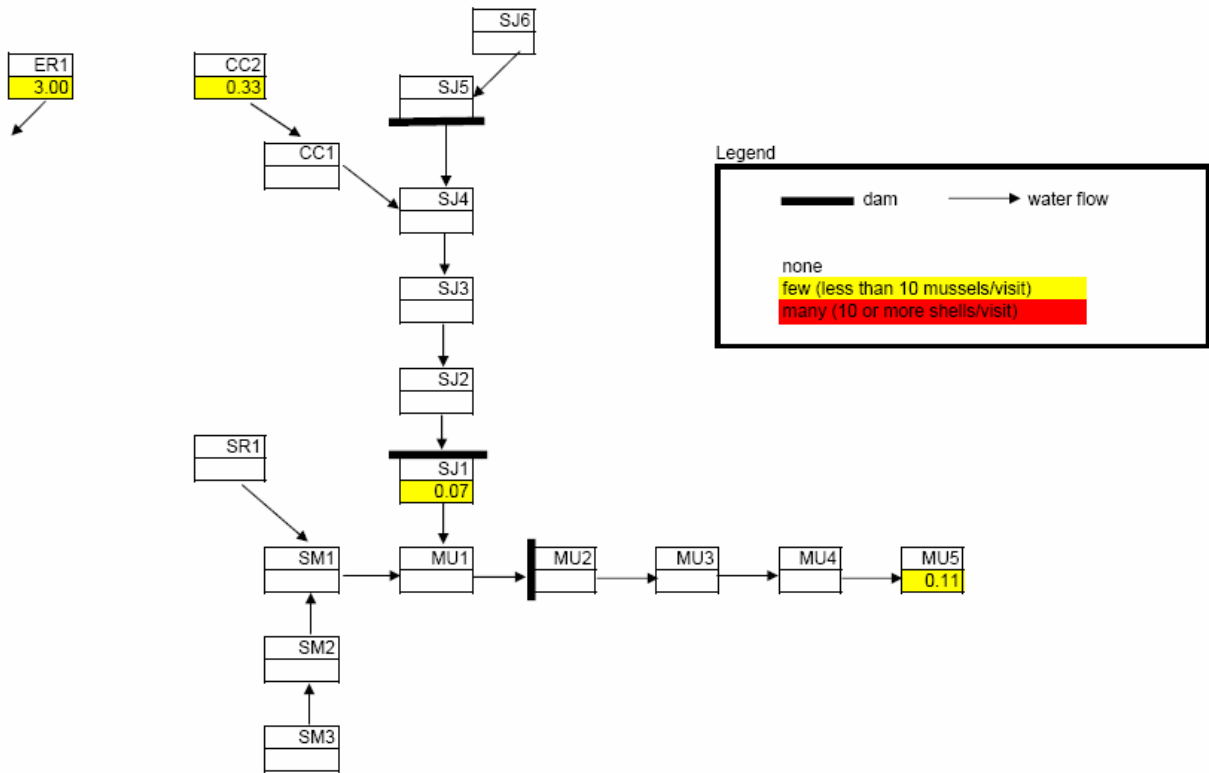
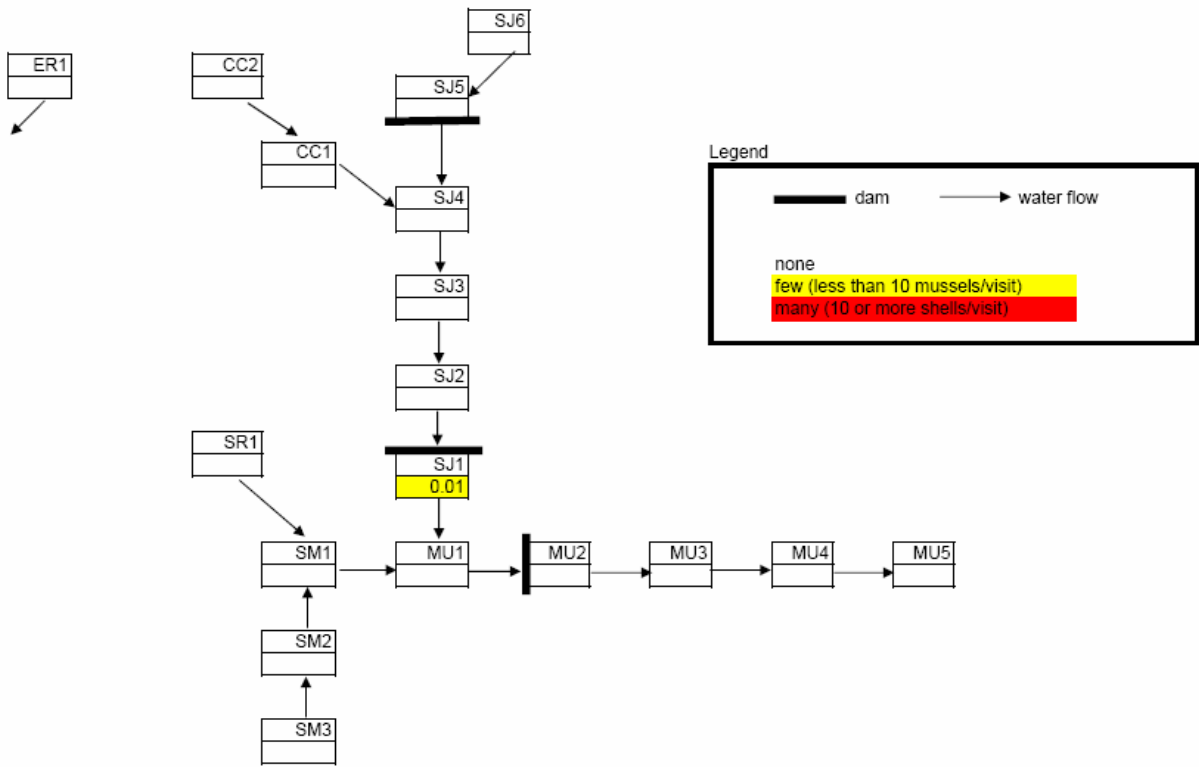


Figure 32. Distribution of Mussel Species in Allen County, Indiana, during 1997-2004.

Distribution of *Villosa fabalis*



## Tables

Table 1 Summary of presence and relative abundance of mussels in Allen County, Indiana, in 1908, based upon data in Clark & Wilson (1912)

	<b>St. Joseph River</b>	<b>Maumee River</b>	<b>St. Mary's River</b>
<i>Actinonaias ligamentina</i>	<b>Many</b>	<b>Many</b>	<b>Many</b>
<i>Alasmidonta marginata</i>	<b>Few</b>	<b>Few</b>	
<i>Amblema plicata</i>	<b>Many</b>	<b>Many</b>	<b>Many</b>
<i>Anodontoides ferussacianus</i>			<b>Many</b>
<i>Cyclonaias tuberculata</i>	<b>Few</b>	<b>Many</b>	<b>Few</b>
<i>Ellipsaria lineolata</i>		<b>Few</b>	
<i>Elliptio dilatata</i>	<b>Few</b>	<b>Many</b>	<b>Few</b>
<i>Epioblasma obliquata</i>	<b>Few</b>	<b>Few</b>	<b>Many</b>
<i>Fusconaia flava</i>	<b>Many</b>	<b>Many</b>	<b>Many</b>
<i>Lampsilis cardium</i>	<b>Few</b>	<b>Many</b>	<b>Few</b>
<i>Lampsilis fasciola</i>	<b>Few</b>	<b>Few</b>	<b>Few</b>
<i>Lampsilis siliquoidea</i>	<b>Many</b>	<b>Few</b>	<b>Many</b>
<i>Lasmigona complanata</i>	<b>Few</b>		
<i>Lasmigona compressa</i>	<b>Few</b>		
<i>Lasmigona costata</i>	<b>Many</b>	<b>Many</b>	<b>Many</b>
<i>Leptodea fragilis</i>	<b>Many</b>	<b>Few</b>	
<i>Ligumia recta</i>	<b>Few</b>	<b>Few</b>	<b>Many</b>
<i>Obovaria subrotunda</i>	<b>Few</b>	<b>Few</b>	<b>Many</b>
<i>Pleurobema clava</i>		<b>Many</b>	<b>Few</b>
<i>Pleurobema sintoxia</i>	<b>Few</b>	<b>Few</b>	<b>Few</b>
<i>Potamilus alatus</i>	<b>Few</b>	<b>Few</b>	
<i>Ptychobranhus fasciolaris</i>	<b>Many</b>	<b>Few</b>	<b>Few</b>
<i>Pyganodon grandis</i>	<b>Many</b>	<b>Few</b>	
<i>Quadrula cylindrica</i>	<b>Few</b>	<b>Few</b>	<b>Few</b>
<i>Quadrula pustulosa</i>	<b>Few</b>	<b>Many</b>	<b>Few</b>
<i>Strophitus undulatus</i>	<b>Few</b>	<b>Few</b>	<b>Few</b>
<i>Toxolasma lividus</i>	<b>Few</b>		
<i>Villosa iris</i>	<b>Few</b>	<b>Many</b>	<b>Many</b>
Number of Species (of 28 total)	<b>25</b>	<b>24</b>	<b>20</b>

Table 2 Summary of presence and relative abundance of mussels in Allen County, Indiana, in 1988, based upon data in Watters (1988)

	<b>Cedar Creek (tributary of the St. Joseph River)</b>	<b>St. Joseph River (main stem)</b>	<b>Maumee River</b>
<i>Actinonaias ligamentina</i>		<b>Many</b>	
<i>Alasmidonta marginata</i>		<b>Few</b>	<b>Few</b>
<i>Amblema plicata</i>	<b>Many</b>	<b>Few</b>	<b>Many</b>
<i>Anodontoides ferussacianus</i>	<b>Few</b>		
<i>Cyclonaias tuberculata</i>		<b>Many</b>	
<i>Elliptio dilatata</i>	<b>Few</b>	<b>Many</b>	
<i>Fusconaia flava</i>		<b>Many</b>	<b>Few</b>
<i>Fusconaia subrotunda</i>		<b>Few</b>	
<i>Lampsilis cardium</i>		<b>Few</b>	
<i>Lampsilis siliquoidea</i>	<b>Many</b>	<b>Few</b>	
<i>Lasmigona complanata</i>	<b>Few</b>	<b>Many</b>	<b>Few</b>
<i>Lasmigona compressa</i>	<b>Few</b>	<b>Few</b>	
<i>Lasmigona costata</i>	<b>Few</b>	<b>Many</b>	
<i>Leptodea fragilis</i>		<b>Many</b>	<b>Many</b>
<i>Ligumia recta</i>	<b>Few</b>	<b>Many</b>	
<i>Pleurobema sintoxia</i>		<b>Few</b>	<b>Few</b>
<i>Potamilus alatus</i>		<b>Few</b>	<b>Few</b>
<i>Ptychobranhus fasciolaris</i>		<b>Few</b>	
<i>Pyganodon grandis</i>	<b>Few</b>	<b>Many</b>	<b>Few</b>
<i>Quadrula nodulata</i>			<b>Few</b>
<i>Quadrula pustulosa</i>		<b>Many</b>	<b>Many</b>
<i>Quadrula quadrula</i>			<b>Few</b>
<i>Strophitus undulatus</i>	<b>Few</b>	<b>Few</b>	<b>Few</b>
<i>Truncilla donaciformis</i>			<b>Few</b>
<i>Truncilla truncata</i>		<b>Few</b>	<b>Many</b>
<i>Utterbackia imbecillis</i>			<b>Few</b>
<i>Villosa fabalis</i>		<b>Few</b>	
Number of Species (of 27 total)	<b>10</b>	<b>22</b>	<b>15</b>

Table 3 Summary of presence and relative abundance of mussels in Allen County, Indiana, in 1988, based upon data in Watters (1998)

	Little Cedar Creek (tributary of the St. Joseph River)	St. Joseph River
<i>Actinonaias ligamentina</i>		Few
<i>Alasmidonta marginata</i>		Few
<i>Cyclonaias tuberculata</i>		Few
<i>Fusconaia flava</i>	Few	
<i>Lampsilis siliquoidea</i>		Few
<i>Lasmigona complanata</i>		Few
<i>Lasmigona compressa</i>	Few	
<i>Lasmigona costata</i>		Few
<i>Leptodea fragilis</i>		Many
<i>Ligumia recta</i>		Few
<i>Pleurobema sintoxia</i>	Few	
<i>Potamilus alatus</i>		Few
<i>Pyganodon grandis</i>		Few
<i>Quadrula pustulosa</i>		Many
<i>Strophitus undulatus</i>		Few
<i>Truncilla truncata</i>		Few
<i>Utterbackia imbecillis</i>		Few
<i>Villosa fabalis</i>		Few
Number of Species (of 18 total)	3	15

Table 4        Synonyms of scientific names of mussels found in Allen County, Indiana,  
from 1908 to 2004

	<b>Present Study's Names</b>	<b>Clark &amp; Wilson (1912)</b>	<b>Watters (1988)</b>	<b>Watters (1998)</b>
1	<i>Actinonaias ligamentina</i> (mucket)	<i>Lampsilis ligamentinus</i> (Lamarck)	<i>Actinonaias ligamentina</i> <i>carinata</i> (Barnes, 1823)	<i>Actinonaias ligamentina</i>
2	<i>Alasmidonta marginata</i> (elktoe)	<i>Alasmidonta truncata</i> (B. H. Wright)	<i>Alasmidonta marginata</i> Say, 1818	<i>Alasmidonta marginata</i>
3	<i>Amblema plicata</i> (threeridge)	<i>Quadrula undulata</i> (Barnes)	<i>Amblema plicata plicata</i> (Say, 1817)	
4	<i>Anodontoides</i> <i>ferussacianus</i> (cylindrical papershell)	<i>Anodontoides</i> <i>ferussacianus</i> <i>subcylindraceus</i> (Lea)	<i>Anodontoides</i> <i>ferussacianus</i> (Lea, 1834)	
5	<i>Cyclonaias tuberculata</i> (purple wartyback)	<i>Quadrula tuberculata</i> (Rafinesque)	<i>Cyclonaias tuberculata</i> (Rafinesque, 1820)	<i>Cyclonaias tuberculata</i>
6	<i>Ellipsaria lineolata</i> (butterfly)	<i>Plagiola securis</i> (Lea)		
7	<i>Elliptio dilatata</i> (spike)	<i>Unio gibbosus</i> (Barnes)	<i>Elliptio dilatata</i> (Rafinesque, 1820)	
8	<i>Epioblasma obliquata</i> (catspaw)	<i>Truncilla sulcata</i> (Lea)	<i>Epioblasma obliquata</i> <i>perobliqua</i> (Conrad, 1836)	
9	<i>Fusconaia flava</i> (Wabash pigtoe)	<i>Quadrula rubiginosa</i> (Lea)	<i>Fusconaia</i> <i>flava</i> (Rafinesque, 1820)	<i>Fusconaia flava</i>
10	<i>Fusconaia subrotunda</i> (long-solid)		<i>Fusconaia maculata</i> <i>maculata</i> (Rafinesque, 1820)	
11	<i>Lampsilis cardium</i> (plain pocketbook)	<i>Lampsilis ventricosus</i> (Barnes)	<i>Lampsilis ventricosa</i> (Barnes, 1823)	
12	<i>Lampsilis fasciola</i> (wavy-rayed lampmussel)	<i>Lampsilis multiradiatus</i> (Lea)	<i>Lampsilis fasciola</i> Rafinesque, 1820	

13	<i>Lampsilis siliquoidea</i> (fatmucket)	<i>Lampsilis luteolus</i> (Lamarck)	<i>Lampsilis radiata luteola</i> Lamarck, 1819	<i>Lampsilis radiata luteola</i>
14	<i>Lasmigona complanata</i> (white heelsplitter)	<i>Symphynota complanata</i> (Barnes)	<i>Lasmigona complanata</i> (Barnes, 1823)	<i>Lasmigona complanata</i>
15	<i>Lasmigona compressa</i> (creek heelsplitter)	<i>Symphynota compressa</i> (Lea)	<i>Lasmigona compressa</i> (Lea, 1829)	<i>Lasmigona compressa</i>
16	<i>Lasmigona costata</i> (fluted-shell)	<i>Symphynota costata</i> (Rafinesque)	<i>Lasmigona costata</i> (Rafinesque, 1820)	<i>Lasmigona costata</i>
17	<i>Leptodea fragilis</i> (fragile papershell)	<i>Lampsilis gracilis</i> (Barnes)	<i>Leptodea fragilis</i> (Rafinesque, 1820)	<i>Leptodea fragilis</i>
18	<i>Ligumia recta</i> (black sandshell)	<i>Lampsilis rectus</i> (Lamarck)	<i>Ligumia recta</i> (Lamarck, 1819)	<i>Ligumia recta</i>
19	<i>Ligumia subrostrata</i> (pondmussel)			
20	<i>Obovaria subrotunda</i> (round hickorynut)	<i>Obovaria circulus</i> (Lea)	<i>Obovaria subrotunda</i> (Rafinesque, 1820)	
21	<i>Pleurobema clava</i> (clubshell)	<i>Pleurobema clava</i> (Lamarck)	<i>Pleurobema clava</i> (Lamarck, 1819)	
22	<i>Pleurobema sintoxia</i> (round pigtoe)	<i>Quadrula coccinea</i> (Conrad)	<i>Pleurobema sintoxia</i> (Rafinesque, 1820)	<i>Pleurobema sintoxia</i>
23	<i>Potamilus alatus</i> (pink heelsplitter)	<i>Lampsilis alatus</i> (Say)	<i>Potamilus alatus</i> (Say, 1817)	<i>Potamilus alatus</i>
24	<i>Ptychobranhus fasciolaris</i> (kidneyshell)	<i>Ptychobranhus</i> <i>phaseolus</i> (Hildreth)	<i>Ptychobranhus fasciolaris</i> (Rafinesque, 1820)	
25	<i>Pyganodon grandis</i> (giant floater)	<i>Anodonta grandis</i> (Say)	<i>Anodonta grandis grandis</i> Say 1829	<i>Pyganodon grandis</i>
26	<i>Quadrula cylindrica</i> (rabbitsfoot)	<i>Quadrula cylindrica</i> (Say)	<i>Quadrula cylindrica</i> <i>cylindrica</i> (Say, 1817)	
27	<i>Quadrula nodulata</i> (wartyback)		<i>Quadrula cf. nodulata</i> (Rafinesque, 1820)	
28	<i>Quadrula pustulosa</i> (pimpleback)	<i>Quadrula pustulosa</i> (Lea)	<i>Quadrula pustulosa</i> <i>pustulosa</i> (Lea, 1831)	<i>Quadrula pustulosa</i>

29	<i>Quadrula quadrula</i> (mapleleaf)		<i>Quadrula quadrula</i> (Rafinesque, 1820)	
30	<i>Strophitus undulatus</i> (squawfoot)	<i>Strophitus edentulus</i> (Say)	<i>Strophitus undulatus undulatus</i> (Say, 1817)	<i>Strophitus undulatus</i>
31	<i>Toxolasma lividus</i> (purple lilliput)	<i>Lampsilis glans</i> (Lea)	<i>Toxolasma lividus</i> (Rafinesque, 1831)	
32	<i>Toxolasma parvus</i> (lilliput)		<i>Toxolasma parvus</i> (Barnes, 1823)	
33	<i>Truncilla donaciformis</i> (fawnsfoot)		<i>Truncilla donaciformis</i> (Lea, 1828)	
34	<i>Truncilla truncata</i> (deertoe)		<i>Truncilla truncata</i> Rafinesque, 1820	<i>Truncilla truncata</i>
35	<i>Utterbackia imbecillis</i> (paper pondshell)		<i>Anodonta imbecillis</i> Say, 1829	<i>Utterbackia imbecillis</i>
36	<i>Villosa fabalis</i> (rayed bean)		<i>Villosa fabalis</i> (Lea, 1831)	<i>Villosa fabalis</i>
37	<i>Villosa iris</i> (rainbow)	<i>Lampsilis iris</i> (Lea)	<i>Villosa iris iris</i> (Lea, 1830)	

Table 5 Description of river segments in Allen County, Indiana, during 1997-2004

Segment	km	River	Upstream Landmark	Downstream Landmark
SM1	3.5	St. Mary's	Jefferson Blvd. Bridge 41 ° 4.28 N 85 ° 9.76 W	Spy Run Avenue Bridge 41 ° 5.02 N 85 ° 8.16 W
SM2	6.4	St. Mary's	Baer Field Thruway Bridge 41 ° 1.73 N 85 ° 8.85 W	Jefferson Blvd. Bridge 41 ° 4.28 N 85 ° 9.76 W
SM3	1.4	St. Mary's	Lower Huntington Road Bridge 41 ° 1.07 N 85 ° 8.53 W	Baer Field Thruway Bridge 41 ° 1.73 N 85 ° 8.85 W
SR1	6.7	St. Mary's	Coliseum Blvd. Bridge 41 ° 7.06 N 85 ° 9.75 W	Fourth Street Bridge 41 ° 5.30 N 85 ° 8.16 W
ER1	1.4	Eel	Carrol Road Bridge 41 ° 11.09 N 85 ° 18.59 W	County Line Road Bridge 41 ° 11.48 N 85 ° 16.6 W
SJ6	4.2	St. Joseph	Railroad Bridge near county line 41 ° 15.55 N 84 ° 56.80 W	Vanzila Road Bridge 41 ° 14.76 N 84 ° 58.4 W
SJ5	8.2	St. Joseph	Vanzila Road Bridge 41 ° 14.76 N 84 ° 58.37 W	Cedarville Dam 41 ° 11.92 N 85 ° 1.10 W
SJ4	8.6	St. Joseph	Cedarville Dam 41 ° 11.92 N 85 ° 1.10 W	Mayhew Road Bridge 41 ° 10.08 N 85 ° 4.45 W

SJ3	8.6	St. Joseph	Mayhew Road Bridge 41 ° 10.08 N 85 ° 4.45 W	St. Joe Center Road Bridge 41 ° 7.98 N 85 ° 6.33 W
SJ2	2.6	St. Joseph	St. Joe Center Road Bridge 41 ° 7.98 N 85 ° 6.33 W	Johnny Appleseed Dam 41 ° 6.74 N 85 ° 7.00 W
SJ1	4.9	St. Joseph	Johnny Appleseed Dam 41 ° 6.74 N 85 ° 7.00 W	Columbia Street Bridge 41 ° 4.92 N 85 ° 7.96 W
CC2	7.0	St. Joseph	Mouth of Willow Creek 41 ° 14.96 N 85 ° 7.96 W	Tonkel Road Bridge 41 ° 13.13 N 85 ° 4.57 W
CC1	8.7	St. Joseph	Tonkel Road Bridge 41 ° 13.13 N 85 ° 4.57 W	St. Joseph River 41 ° 11.58 N 85 ° 1.90 W
MU1	1.7	Maumee	Columbia Street Bridge 41 ° 4.92 N 85 ° 7.96 W	Anthony Street Dam 41 ° 4.92 N 85 ° 6.93 W
MU2	2.4	Maumee	Anthony Street Dam 41 ° 4.92 N 85 ° 6.93 W	Coliseum Blvd. Bridge 41 ° 4.72 N 85 ° 5.26 W
MU3	6.5	Maumee	Coliseum Blvd. Bridge 41 ° 4.72 N 85 ° 5.26 W	Landin Road Bridge 41 ° 5.06 N 85 ° 1.24 W
MU4	10.7	Maumee	Landin Road Bridge 41 ° 5.06 N 85 ° 1.24 W	Platter Road Bridge 41 ° 7.87 N 84 ° 56.13 W
MU5	14.6	Maumee	Platter Road Bridge 41 ° 7.87 N 84 ° 56.13 W	State Road 101 Bridge 41 ° 10.15 N 84 ° 50.97 W

Table 6 Number of visits to sites in river segments in Allen County, Indiana, during 1997-2004

River	River Segment	1997	1998	1999	2000	2001	2002	2003	2004	Total
<b>Eel River</b>	ER1					1				1
	<b>Total</b>					<b>1</b>				<b>1</b>
Maumee	MU1							1		1
	MU2	1			1					2
	MU3	2	1							3
	MU4	1								1
	MU5	1	2	1	3	1	1			9
	<b>Maumee River Total</b>	<b>5</b>	<b>3</b>	<b>1</b>	<b>4</b>	<b>1</b>	<b>1</b>			<b>16</b>
St. Joseph River	CC1			2			2		5	9
	CC2		1						2	3
	SJ1	25	14	18	8	7	12	5	8	97
	SJ2			1			1			2
	SJ3		1				3			4
	SJ4		2				3			5
	SJ5		1			1				2
	SJ6				2	2				4
<b>St. Joseph River Total</b>	<b>25</b>	<b>19</b>	<b>21</b>	<b>10</b>	<b>10</b>	<b>21</b>	<b>5</b>	<b>15</b>	<b>126</b>	
St. Marys River	SM1	3	1							4
	SM2		1					1		2
	SM3			1						1
	SR1	1								1
	<b>St. Marys River Total</b>	<b>4</b>	<b>2</b>	<b>1</b>				<b>1</b>		<b>8</b>
<b>Allen County Total</b>		<b>34</b>	<b>24</b>	<b>23</b>	<b>14</b>	<b>12</b>	<b>22</b>	<b>6</b>	<b>15</b>	<b>151</b>

Table 7 Summary of presence and relative abundance of mussels in Allen County, Indiana, during 1997-2004

	St. Joseph River & Cedar Creek								Maumee River					St. Mary's River				Eel River
	CC1	CC2	SJ1	SJ2	SJ3	SJ4	SJ5	SJ6	MU1	MU2	MU3	MU4	MU5	SM1	SM2	SM3	SR1	ER1
<i>Actinonaias ligamentina</i>	0.67		0.42			0.80							0.89					
<i>Alasmidonta marginata</i>	0.67	0.67	0.18			6.40							0.11					
<i>Amblema plicata</i>	1.00		0.08			0.40												
<i>Cyclonaias tuberculata</i>			0.34		0.25	2.40												
<i>Elliptio dilatata</i>	1.78		1.58			1.60							0.33					
<i>Epioblasma obliquata</i>			0.11															
<i>Fusconaia flava</i>	0.89		0.36		0.75	1.60		0.25					0.22					
<i>Lampsilis cardium</i>	0.78		0.03		1.25													
<i>Lampsilis fasciola</i>			0.03															
<i>Lampsilis siliquoidea</i>	1.56	3.67	0.24			1.40				0.50								1.00
<i>Lasmigona complanata</i>	1.22		0.19			0.40							0.11					
<i>Lasmigona compressa</i>	0.33	0.33																
<i>Lasmigona costata</i>	2.44	0.67	0.18		0.25	0.40				0.50								
<i>Leptodea fragilis</i>			6.59							5.50	4.33		7.11	1.00		7.00		
<i>Ligumia recta</i>			0.01															
<i>Ligumia subrostrata</i>			0.03			0.40				0.50								
<i>Obovaria subrotunda</i>			0.06															
<i>Pleurobema clava</i>			0.13			0.40					0.33							
<i>Pleurobema sintoxia</i>			0.01															
<i>Potamilus alatus</i>	0.11	0.67	0.04							1.50	0.33		1.67			2.00		
<i>Ptychobranchus fasciolaris</i>	0.11		0.11															
<i>Pyganodon grandis</i>	0.22	2.00	0.32	1.50		0.40				0.50	0.33		0.56	1.25		1.00	1.00	3.00
<i>Quadrula cylindrica</i>			0.01															
<i>Quadrula nodulata</i>			0.02															

<i>Quadrula pustulosa</i>	0.11		4.07		1.50	6.60				4.00	1.67		4.22			3.00		
<i>Quadrula quadrula</i>			0.04								0.67	2.00	0.11					
<i>Toxolasma parvus</i>			0.04							0.50								
<i>Truncilla truncata</i>			2.76							11.00	45.33		34.56		6.00	23.00		
<i>Utterbackia imbecillis</i>		0.33	0.07										0.11					3.00
<i>Villosa fabalis</i>			0.01															

Table 8 Mussel species distribution patterns in the rivers of Allen County, Indiana, during 1997-2004

	Cedar Creek	St. Joseph main stem	Maumee	St. Mary's	Eel
<i>Actinonaias ligamentina</i>	X	X	X		
<i>Alasmidonta marginata</i>	X	X	X		
<i>Elliptio dilatata</i>	X	X	X		
<i>Fusconaia flava</i>	X	X	X		
<i>Lasmigona complanata</i>	X	X	X		
<i>Lasmigona costata</i>	X	X	X		
<i>Lampsilis siliquoidea</i>	X	X	X		X
<i>Utterbackia imbecillis</i>	X	X	X		X
<i>Amblema plicata</i>	X	X			
<i>Lampsilis cardium</i>	X	X			
<i>Ptychobranchus fasciolaris</i>	X	X			
<i>Lasmigona compressa</i>	X				
<i>Cyclonaias tuberculata</i>		X			
<i>Epioblasma obliquata</i>		X			
<i>Lampsilis fasciola</i>		X			
<i>Ligumia recta</i>		X			
<i>Obovaria subrotunda</i>		X			
<i>Pleurobema sintoxia</i>		X			
<i>Quadrula cylindrica</i>		X			
<i>Quadrula nodulata</i>		X			
<i>Villosa fabalis</i>		X			
<i>Ligumia subrostrata</i>		X	X		
<i>Pleurobema clava</i>		X	X		
<i>Quadrula quadrula</i>		X	X		
<i>Toxolasma parvus</i>		X	X		
<i>Leptodea fragilis</i>		X	X	X	
<i>Truncilla truncata</i>		X	X	X	
<i>Potamilus alatus</i>	X	X	X	X	
<i>Quadrula pustulosa</i>	X	X	X	X	
<i>Pyganodon grandis</i>	X	X	X	X	X
Number of Species (of 30 total)	15	29	17	5	3

Table 9 Historical presence of mussel species in the rivers of Allen County from 1908 to 2004. Data summarized from Clark & Wilson (1912), Watters (1998) and the present study (1997-2004)

	Cedar Creek in 1908 Cedar Creek in 1988 Cedar Creek during 1997-2004			St. Joseph main stem in 1908 St. Joseph main stem main stem in 1988 St. Joseph main stem during 1997-2004			Maumee River in 1908 Maumee River in 1988 Maumee River during 1997-2004			St. Mary's River in 1908 St. Mary's River in 1988 St. Mary's River during 1997-2004			
	?		X	X	X	X	X	X	X	X	?		X
<i>Actinonaias ligamentina</i>	?		X	X	X	X	X		X		X	?	
<i>Alasmidonta marginata</i>	?		X	X	X	X	X	X	X	X		?	
<i>Amblema plicata</i>	?	X	X	X	X	X		X	X		X	?	
<i>Anodontoides ferussacianus</i>	?	X									X	?	
<i>Cyclonaias tuberculata</i>	?			X	X	X		X			X	?	
<i>Ellipsaria lineolata</i>	?							X				?	
<i>Elliptio dilatata</i>	?	X	X	X	X	X		X		X	X	?	
<i>Epioblasma obliquata</i>	?			X		X		X			X	?	
<i>Fusconaia flava</i>	?		X	X	X	X		X	X	X	X	?	
<i>Fusconaia subrotunda</i>	?				X							?	
<i>Lampsilis cardium</i>	?		X	X	X	X		X			X	?	
<i>Lampsilis fasciola</i>	?			X		X		X			X	?	
<i>Lampsilis siliquoidea</i>	?	X	X	X	X	X		X		X	X	?	
<i>Lasmigona complanata</i>	?	X	X	X	X	X			X	X		?	
<i>Lasmigona compressa</i>	?	X	X	X	X							?	
<i>Lasmigona costata</i>	?	X	X	X	X	X		X		X	X	?	
<i>Leptodea fragilis</i>	?			X	X	X		X	X	X		?	X
<i>Ligumia recta</i>	?	X		X	X	X		X			X	?	
<i>Ligumia subrostrata</i>	?					X				X		?	
<i>Obovaria subrotunda</i>	?			X		X		X			X	?	
<i>Pleurobema clava</i>	?					X		X		X	X	?	
<i>Pleurobema sintoxia</i>	?			X	X	X		X	X		X	?	
<i>Potamilus alatus</i>	?		X	X	X	X		X	X	X		?	X
<i>Ptychobranchus fasciolaris</i>	?		X	X	X	X		X			X	?	
<i>Pyganodon grandis</i>	?	X	X	X	X	X		X	X	X		?	X
<i>Quadrula cylindrica</i>	?			X		X		X			X	?	
<i>Quadrula nodulata</i>	?					X			X			?	
<i>Quadrula pustulosa</i>	?		X	X	X	X		X	X	X	X	?	X

<i>Quadrula quadrula</i>	?		
<i>Strophitus undulatus</i>	?	X	
<i>Toxolasma lividus</i>	?		
<i>Toxolasma parvus</i>	?		
<i>Truncilla donaciformis</i>	?		
<i>Truncilla truncata</i>	?		
<i>Utterbackia imbecillis</i>	?		X
<i>Villosa fabalis</i>	?		
<i>Villosa iris</i>	?		
Number of Species (of 37 total)	?	10	15

		X
X	X	
X		
		X
	X	X
		X
	X	X
	X	X
X		
25	22	29

	X	X
X	X	
		X
	X	
	X	X
	X	X
X		
24	15	17

	?	
X	?	
	?	
	?	
	?	
	?	X
	?	
	?	
X	?	
20	?	5

Table 10 Historical presence of mussel species in the rivers of Allen County from 1908 to 2004. Data rearranged from Table 9 to emphasize species histories

	Cedar Creek	St. Joseph main stem	Maumee River	St. Mary's River
<i>Actinonaias ligamentina</i>				
1908	?	X	X	X
1988		X		?
1997-2004	X	X	X	
<i>Alasmidonta marginata</i>				
1908	?	X	X	
1988		X	X	?
1997-2004	X	X	X	
<i>Amblema plicata</i>				
1908	?	X	X	X
1988	X	X	X	?
1997-2004	X	X		
<i>Anodontoides ferussacianus</i>				
1908	?			X
1988	X			?
1997-2004				
<i>Cyclonaias tuberculata</i>				
1908	?	X	X	X
1988		X		?
1997-2004		X		
<i>Ellipsaria lineolata</i>				
1908	?		X	
1988				?
1997-2004				
<i>Elliptio dilatata</i>				
1908	?	X	X	X
1988	X	X		?
1997-2004	X	X	X	
<i>Epioblasma obliquata</i>				
1908	?	X	X	X
1988				?
1997-2004		X		
<i>Fusconaia flava</i>				

1908	?	X	X	X
1988		X	X	?
1997-2004	X	X	X	
<i>Fusconaia subrotunda</i>				
1908	?			
1988		X		?
1997-2004				
<i>Lampsilis cardium</i>				
1908	?	X	X	X
1988		X		?
1997-2004	X	X		
<i>Lampsilis fasciola</i>				
1908	?	X	X	X
1988				?
1997-2004		X		
<i>Lampsilis siliquoidea</i>				
1908	?	X	X	X
1988	X	X		?
1997-2004	X	X	X	
<i>Lasmigona complanata</i>				
1908	?	X		
1988	X	X	X	?
1997-2004	X	X	X	
<i>Lasmigona compressa</i>				
1908	?	X		
1988	X	X		?
1997-2004	X			
<i>Lasmigona costata</i>				
1908	?	X	X	X
1988	X	X		?
1997-2004	X	X	X	
<i>Leptodea fragilis</i>				
1908	?	X	X	
1988		X	X	?
1997-2004		X	X	X
<i>Ligumia recta</i>				
1908	?	X	X	X
1988	X	X		?
1997-2004		X		
<i>Ligumia subrostrata</i>				
1908	?			
1988				?
1997-2004		X	X	
<i>Obovaria subrotunda</i>				
1908	?	X	X	X
1988				?
1997-2004		X		

<i>Pleurobema clava</i>				
1908	?		X	X
1988				?
1997-2004		X	X	
<i>Pleurobema sintoxia</i>				
1908	?	X	X	X
1988		X	X	?
1997-2004		X		
<i>Potamilus alatus</i>				
1908	?	X	X	
1988		X	X	?
1997-2004	X	X	X	X
<i>Ptychobranchnus fasciolaris</i>				
1908	?	X	X	X
1988		X		?
1997-2004	X	X		
<i>Pyganodon grandis</i>				
1908	?	X	X	
1988	X	X	X	?
1997-2004	X	X	X	X
<i>Quadrula cylindrica</i>				
1908	?	X	X	X
1988				?
1997-2004		X		
<i>Quadrula nodulata</i>				
1908	?			
1988			X	?
1997-2004		X		
<i>Quadrula pustulosa</i>				
1908	?	X	X	X
1988		X	X	?
1997-2004	X	X	X	X
<i>Quadrula quadrula</i>				
1908	?			
1988			X	?
1997-2004		X	X	
<i>Strophitus undulatus</i>				
1908	?	X	X	X
1988	X	X	X	?
1997-2004				
<i>Toxolasma lividus</i>				
1908	?	X		
1988				?
1997-2004				
<i>Toxolasma parvus</i>				
1908	?			
1988				?

1997-2004		X	X	
<i>Truncilla donaciformis</i>				
1908	?			
1988			X	?
1997-2004				
<i>Truncilla truncata</i>				
1908	?			
1988		X	X	?
1997-2004		X	X	X
<i>Utterbackia imbecillis</i>				
1908	?			
1988			X	?
1997-2004	X	X	X	
<i>Villosa fabalis</i>				
1908	?			
1988		X		?
1997-2004		X		
<i>Villosa iris</i>				
1908	?	X	X	X
1988				?
1997-2004				

Table 11      number of live mussel specimens observed in Allen County during 1997-2004

<i>Lampsilis siliquoidea</i>	31	18.3%	18%
<i>Lasmigona costata</i>	25	14.8%	33%
<i>Quadrula pustulosa</i>	25	14.8%	48%
<i>Leptodea fragilis</i>	19	11.2%	59%
<i>Potamilus alatus</i>	16	9.5%	69%
<i>Lasmigona complanata</i>	13	7.7%	76%
<i>Alasmidonta marginata</i>	8	4.7%	81%
<i>Pyganodon grandis</i>	6	3.6%	85%
<i>Truncilla truncata</i>	5	3.0%	88%
<i>Fusconaia flava</i>	4	2.4%	90%
<i>Lampsilis cardium</i>	4	2.4%	92%
<i>Lasmigona compressa</i>	4	2.4%	95%
<i>Actinonaias ligamentina</i>	2	1.2%	96%
<i>Elliptio dilatata</i>	2	1.2%	97%
<i>Toxolasma parvus</i>	2	1.2%	98%
<i>Ligumia subrostrata</i>	1	0.6%	99%
<i>Utterbackia imbecillis</i>	1	0.6%	99%
<i>Villosa fabalis</i>	1	0.6%	100%
	169		