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# Impact Analysis on the Invasive Oriental Weather Loach (Misgurnus anguillicaudatus) in the Grant Creek and Prairie Creek Watersheds at Midewin National Tallgrass Prairie

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## Abstract

In 2014, the invasive Oriental weather loach was found in the Prairie Creek wetland at Midewin National Tallgrass Prairie. While little is known about the Oriental weather loach and its impact on freshwater ecosystems it has become a widespread invasive species. Being the first to investigate the impact of the Oriental weather loach on the Grant Creek and Prairie Creek watersheds at Midewin National Tallgrass Prairie, we set traps for specimens from early June till late July in both watersheds. Each loach that was caught was euthanized and dissected in order to understand what the Oriental weather loaches are eating and how they are likely impacting the ecosystem. Of the 138 total Oriental weather loaches caught, none were found in the Grant Creek watershed or the creek of the Prairie Creek watershed. The stomach contents contained a wide variety of prey items but Alonella, Nonbiting midge larvae, insect eggs, and Simocephalus were the most abundant. The Oriental weather loach's diet was similar to that of native Bluegill, Central mudminnows, and tadpoles, which could suggest that they are competing with these native species. The results of this study suggest that Oriental weather loaches may be negatively impacting the freshwater ecosystem of the Prairie Creek wetland at Midewin National Tallgrass Prairie. Future studies are needed to better understand the severity of the Oriental weather loaches impact at Midewin National Tallgrass Prairie and other freshwater ecosystems.

## Introduction

The introduction and establishment of invasive species into non-native regions is one of the numerous environmental issues the world is currently facing. In the United States alone, it is believed that there are 30,000-50,000 invasive species of flora and fauna present (Pimentel et al. 2005, Corn et al. 1999). Many of these non-native species were intentionally introduced for agriculture, consumption, biocontrol, or the pet-trade. Others were unintentionally introduced

through foreign ballast water, animal or trade good hitchhiking, and many other pathways (Invasive Species 2012). Non-native species are often able to invade new regions successfully and adapt to new ecosystems. This allows invasive species to compete against and possibly drive out native species.

Freshwater habitats are one of the most significantly impacted ecosystems by invasive species. Aquatic invasive species (AIS) decrease natural abundance and biodiversity in all aquatic ecosystems but freshwater ecosystems are likely impacted the most due to the additional human interferences such as unsustainable use of freshwater (Sala et al. 2000, Dudgeon et al. 2007). AIS can act as ecosystem engineers changing the structure and balance of entire ecosystems. The Hudson River's change from a pelagic-based food web to a littoral-based food web due to the infestation of Zebra mussels (*Dreissena polymorpha*) is just one example of how AIS can alter an entire freshwater ecosystem (Strayer et al. 2008). AIS can also lead to native species decline by out competing and preying on native species, spreading diseases, threatening endangered species, and causing other ecological issues (Corn et al. 1999).

The United States suffers both environmentally and economically from AIS in freshwater ecosystems. In 1989, non-native species were linked to 68% of native North American fish extinctions (Miller et al. 1989) . Now that there are currently over 250 AIS in the United States, it is likely that more native fish species have disappeared since 1989 due to non-native species (Aquatic Invasive Species 2020). The impacts of AIS range from habitat alterations to loss in commercial and recreational fishing (Cucherousset and Olden 2011, Corn et al. 1999). The Great Lakes has been battling AIS for decades while spending well over $100 million annually to manage these populations (Rosaen et al. 2012). Many of the AIS that have entered the Great Lakes have come up from Illinois waterways. Among these invaders is the Common Carp

(*Cyprinus carpio*) which have increased dramatically in number in the Great Lakes causing the decline of many native fish species due to its tremendous appetite and ability to reproduce quickly. Much research and population management has been dedicated to controlling these *Cyprinus* species but little is still known about a recent Illinois freshwater invader: the Oriental weather loach.

The Oriental weather loach (*Misgurnus anguillicaudatus*) is a small, brown marbled fish with an eel-like body and six barbels around its mouth (Nico et al. 2020). Oriental weather loaches can live in a variety of habitats such as streams, drainage ditches, and other stagnant, shallow bodies of water due to their ability to breath air and deal with high ammonia levels in six different ways (Tsui et al. 2004). Originating in East Asia, from eastern Russia, Korea, Japan, and East China to northern Vietnam (Zhao 2012), the Oriental weather loach has been introduced to the United States through the pet-trade, live-bait, and other human pathways (Keller and Lake 2007). Illinois is one of the 18 states that the Oriental weather loach has been found and it has been observed in the Chicago Area Waterways System (CAWS) since its first sighting in 1987 in the North Shore Channel in Cook County, Illinois (Nico et al. 2020, Norris 2015). Not much is currently known about how the Oriental weather loach is impacting Illinois waterways and watersheds. A recent study looking at the abundance, diet, age, growth, and fecundity of Oriental weather loaches in the CAWS found that the Oriental weather loaches were opportunistic feeders that fed primarily on macroinvertebrates, fish eggs, tadpoles, and other benthic invertebrates (Norris 2015). Their diet suggests the possibility that Oriental weather loaches could compete with and threaten Central Mudminnows (*Umbra limi*) as well as other fish in Illinois waterbodies due to their similar diet and habitats. A study of Oriental weather loaches in Hudson Valley, New

York also suggested the possibility of negative interactions between the weather loaches and the native Eastern Mudminnow (*Umbra pygmaea*) (Schmidt and Schmidt 2014).

Recently at Midewin National Tallgrass Prairie, a tadpole survey found Oriental weather loaches in the watershed at Lobelia Meadows (Cox 2014). Although Oriental weather loaches were found in the Prairie Creek wetlands, the presence of the Oriental weather loach in the Grant Creek watershed and creek of the Prairie Creek watershed at Midewin National Tallgrass Prairie is completely unknown. The focus of this study is to assess the abundance, distribution, and ecological impact of the Oriental weather loach on the Grant Creek and Prairie Creek watersheds at Midewin National Tallgrass Prairie. The Midewin wetlands are an important home for many species of frogs, birds, and insects. These native residents may be negatively impacted by the invading weather loach's presence. Overall, this will be the first study done on the Oriental weather loaches abundance, distribution, and ecological impact in the Grant Creek and Prairie Creek watersheds. Furthermore, this investigation will provide new information on how Oriental weather loaches impact wetland ecosystems and what state the Midewin National Tallgrass Prairie's wetland ecosystem is in.

**Methods**

**Specimen Collection**

To assess the abundance, distribution, and ecological impact of the Oriental weather loach on the Midewin wetlands, thirty-two sites were originally selected for placing minnow traps. Sixteen sites were located in the Grant Creek watershed and the other sixteen sites were in the Prairie Creek watershed. Within each watershed, the traps were divided evenly between the wetlands and creek. From June 5 until July 7, traps were baited and checked 24 hours later, rotating between the Prairie Creek and Grant Creek watersheds. Then starting July 9, all traps

were removed from the creek of Prairie Creek watershed and the entire Grant Creek watershed. Eight more traps were placed in the Prairie Creek wetland. The sixteen Prairie Creek wetland traps were baited and checked 24 hours later five days a week. Overall, collections took place between June 5 and July 28.

Using methods similar to Norris (2015), a minnow trap baited with 30 grams of dry dog food wrapped in a breathable mesh bag was placed at each site. The bag prevents fish from eating the bait upon entering the trap. After 24 hours all traps were checked, and any Oriental weather loaches were recorded and immediately euthanized. All other species were identified, recorded, and released. The euthanized Oriental weather loaches were transported to Olivet Nazarene University, where they were dissected for further analysis.

**Dissection**

The dissections consisted of sexing, weighing, and measuring specimens, opening the stomach, counting eggs, and weighing embryos of females. For stomach dissections, stomach contents were weighed in a Petri dish and examined under a dissection microscope. Prey items were identified to the lowest possible taxonomic group with the assistance of Needham and Needham (1962), *Aquatic Macroinvertebrates of Illinois: A Supplement for the Illinois RiverWatch Program*, and Derek Rosenberger, Ph.D. of Olivet Nazarene University. Every taxonomic prey group was weighed to analyze the diet of Oriental weather loaches.

**Results**

No loaches were found in the Grant Creek watershed and the creek of Prairie Creek. Oriental weather loaches were only found in the Prairie Creek wetlands (see Appendix 1). The Prairie Creek wetland was found to have 18 different species with physid snails (747), American bullfrogs (456), and Northern leopard frogs (281) being the most abundant species (Fig. 1). The

Grant Creek wetlands showed a lower diversity than the Prairie Creek wetlands with only 12 different species (Fig. 2). Of the 12 different species, White river crayfish (1815) made up 96% of the total specimens collected in the Grant Creek wetlands (Fig. 2). The Grant Creek wetlands had a higher abundance of crayfish than the Prairie Creek wetlands, but Prairie Creek had a higher abundance of fish, amphibians and reptiles, and other invertebrates (Fig. 3).

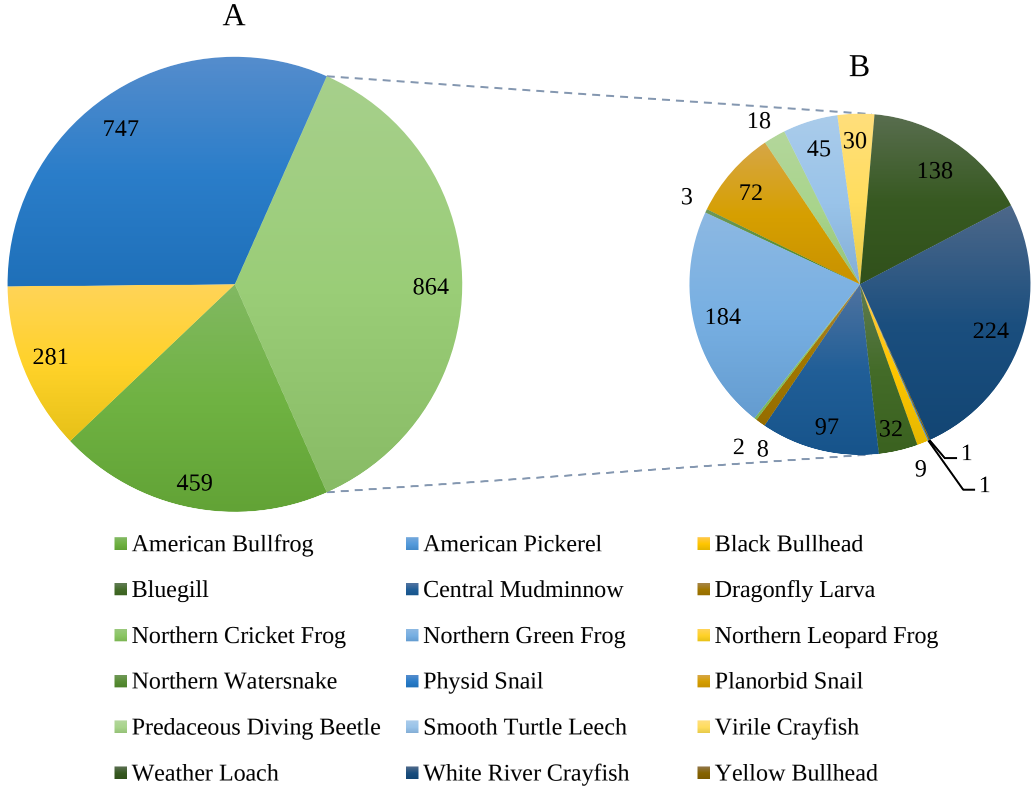


**Figure 1.** Total species found in the Prairie Creek wetland where A represents the three most abundant species and B represents the remaining species.

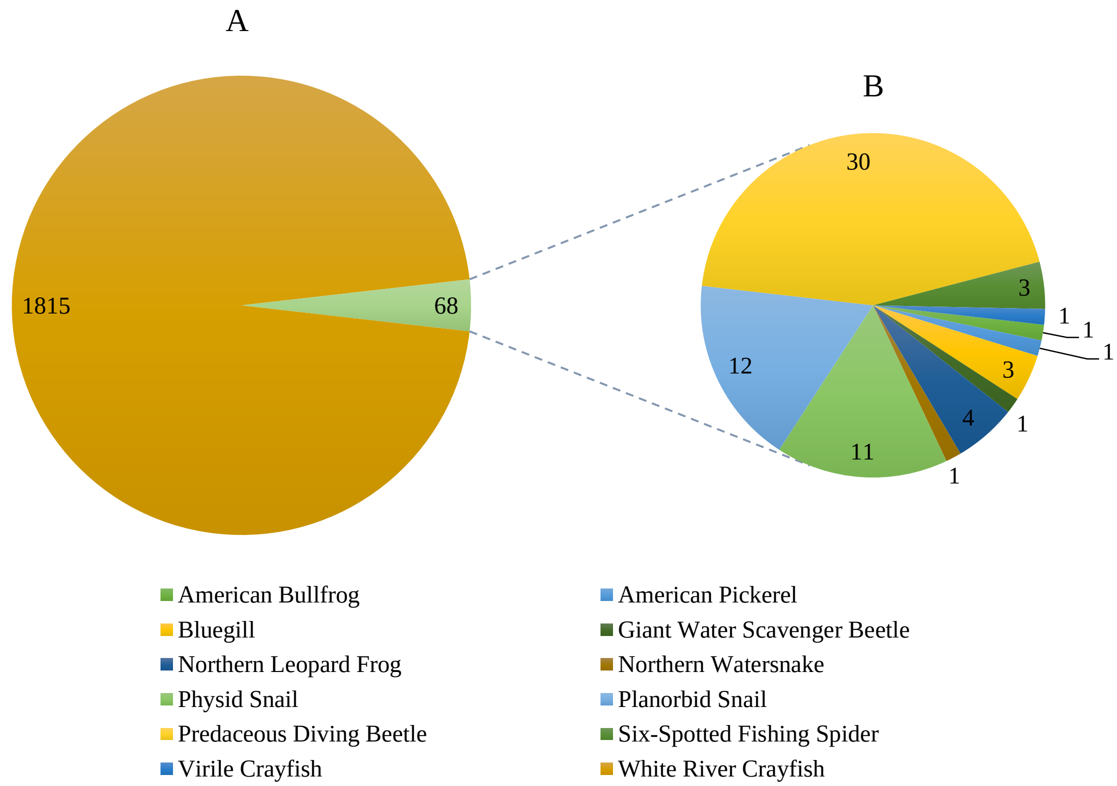


**Figure 2.** Total species found in the wetland of the Grant Creek watershed where A represents the most abundant species and B represents the remaining species.

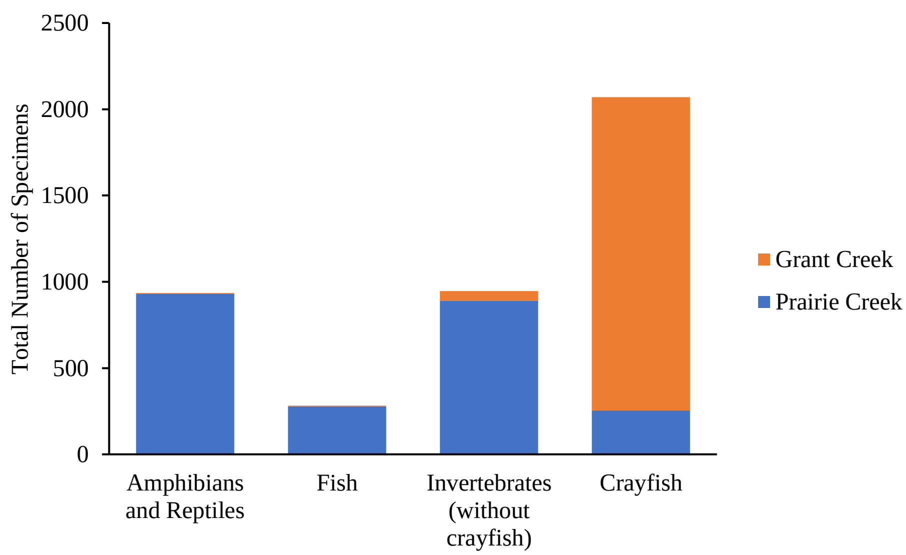


**Figure 3.** The abundance of different specimens between the wetlands of the Grant Creek and Prairie Creek watersheds where orange represents Grant Creek and blue represents Prairie Creek.

The creek of Prairie Creek was found to have 11 different species with Northern clearwater crayfish (535) and Virile crayfish (106) being the most abundant species (Fig. 4). The creek of the Grant Creek watershed showed a lower diversity than the creek of the Prairie Creek watershed with only 8 different species (Fig. 5). The creek of Prairie Creek had a higher abundance of crayfish and fish than the creek of Grant Creek, but Grant Creek had a higher abundance of other invertebrates (Fig. 6).

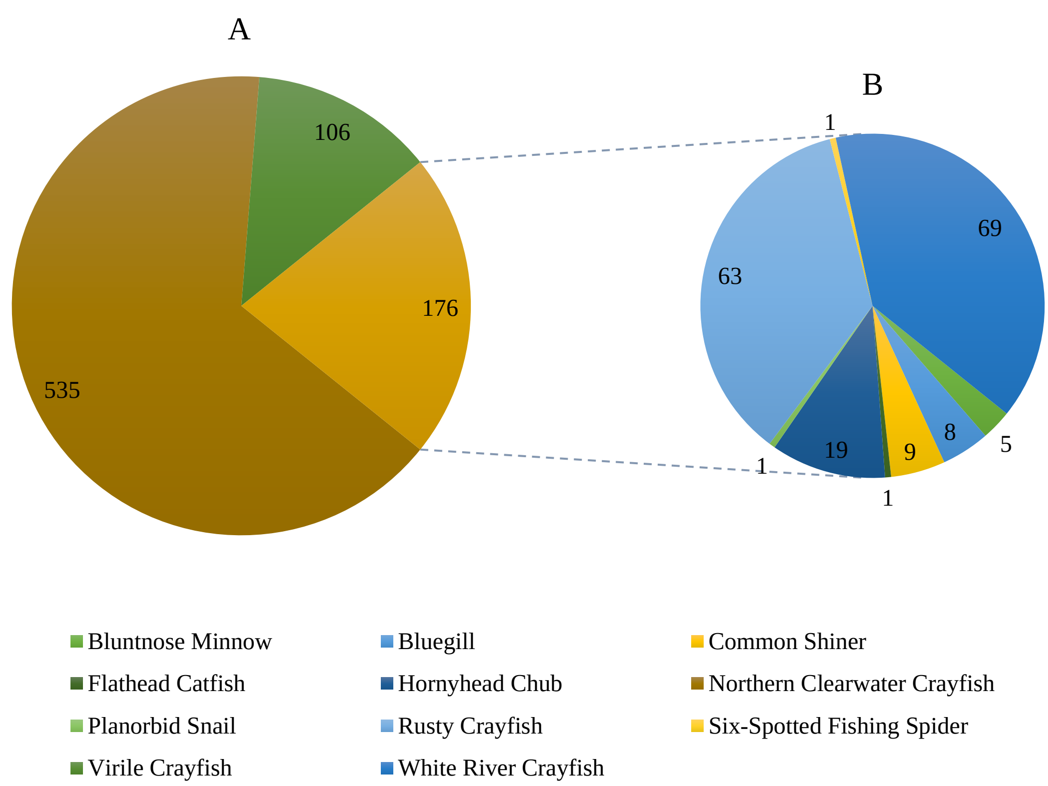


**Figure 4.** Total species found in the creek of the Prairie Creek watershed where A represents the two most abundant species and B represents the remaining species.

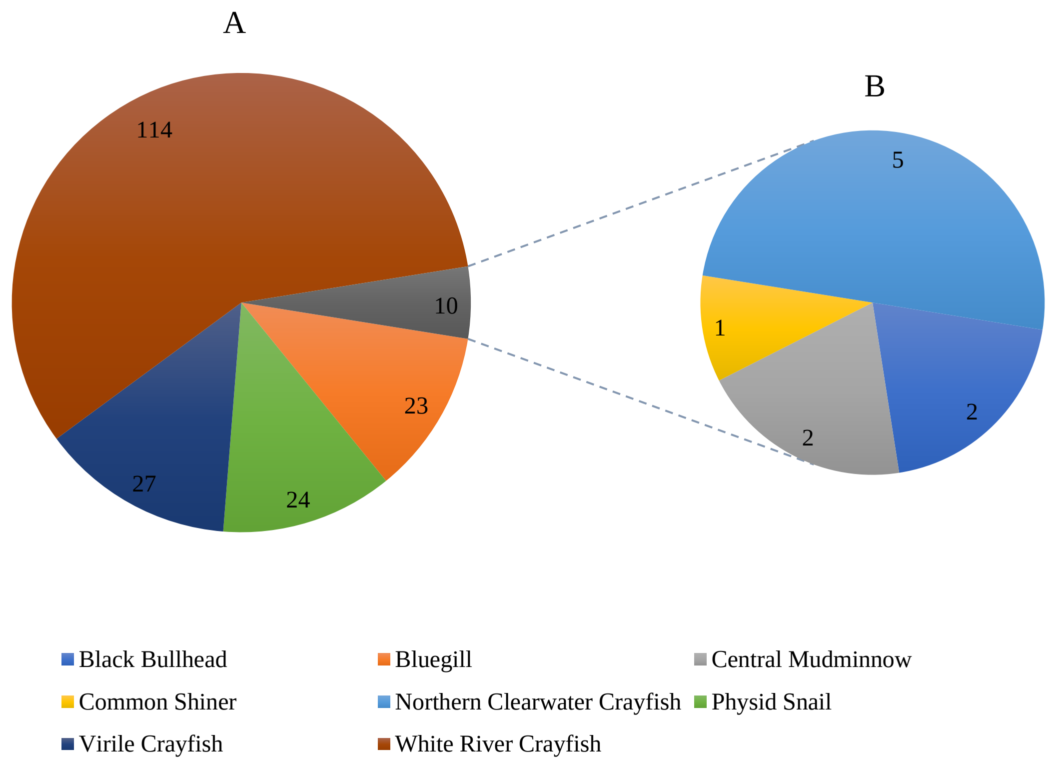


**Figure 5.** Total species found in the creek of the Grant Creek watershed where A represents the most abundant species and B represents the remaining species.

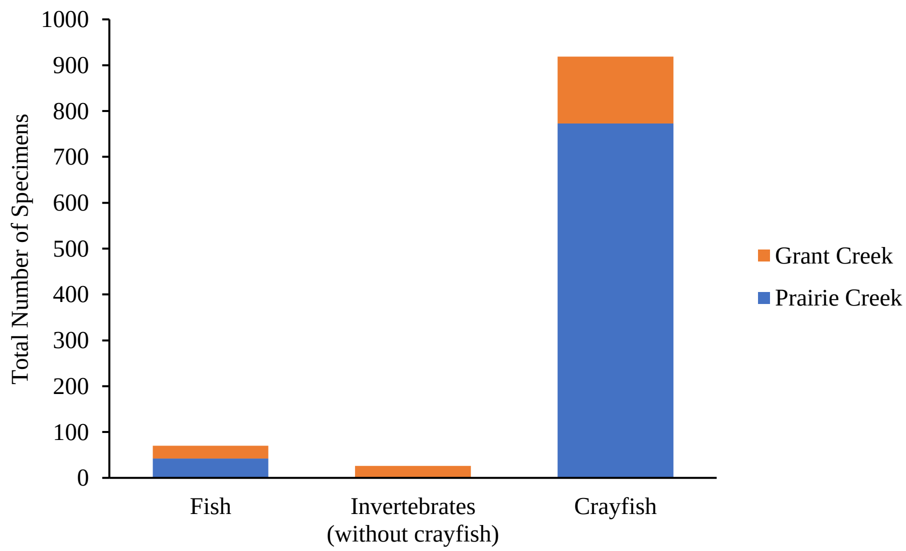


**Figure 6.** The abundance of different specimens between the creeks of Grant Creek and Prairie Creek watersheds where orange represents Grant Creek and blue represents Prairie Creek.

Every trap in the Prairie Creek wetlands yielded at least one loach and overall, 138 loaches were collected (Table 1). Of the 138 loaches, two of them escaped upon collection and fourteen were placed in observation tanks to study the Oriental weather loach's life history. Each weather loach's weight, length, egg count and weight, stomach contents, and stomach content weights were recorded (Table 2). Out of the dissected weather loaches, there were 61 males and females. Every female was found to be carrying eggs (Table 2). On average, the stomachs contained 23.19 prey items and the stomach contents weight made up 15.25 percent of the loach's overall weight (Table 3). Additionally, females averaged to be longer, heavier, and to contain more prey items in their stomach than males (Table 3).

**Table 1.** Total number of Oriental weather loaches caught in each Prairie Creek wetland trap.

| Prairie Creek Wetland Trap Number | Total Loaches |
|---|---|
| P1 | 4 |
| P2 | 1 |
| P3 | 5 |
| P4 | 5 |
| P5 | 12 |
| P6 | 7 |
| P7 | 4 |
| P8 | 2 |
| P9 | 3 |
| P10 | 12 |
| P11 | 15 |
| P12 | 8 |
| P13 | 10 |
| P14 | 11 |
| P15 | 16 |
| P16 | 23 |
| **Total** | 138 |

**Table 2.** General records of each individual loach.

| Specimen | Sex | Length (mm) | Weight (grams) | Stomach content weight (grams) | Stomach weight percentage of total weight | Total prey items | Approx. egg count | Egg weight (grams) |
|---|---|---|---|---|---|---|---|---|
| 1 | M | 105.62 | 9.62 | 0.0015 | 1.44 | 10 | N/A | N/A |
| 2 | F | 121.41 | 10.56 | 0.0365 | 38.54 | 9 | 1742.65 | 0.79 |
| 3 | F | 109.86 | 8.64 | 0.0098 | 8.47 | 1 | 2652.89 | 1.07 |
| 4 | M | 107.84 | 6.23 | 0.0078 | 4.86 | 9 | N/A | N/A |
| 5 | M | 92.44 | 3.63 | N/A | N/A | N/A | N/A | N/A |
| 6 | M | 86.92 | 5.1 | 0.015 | 7.65 | 191 | N/A | N/A |
| 7 | M | 98.48 | 6.26 | 0.0235 | 14.71 | 23 | N/A | N/A |
| 8 | M | 82.45 | 4.28 | 0.0106 | 4.54 | 66 | N/A | N/A |
| 9 | M | 76.3 | 3.75 | 0.0138 | 5.18 | 10 | N/A | N/A |
| 10 | F | 107.62 | 9.98 | N/A | N/A | N/A | 2157.02 | 0.87 |
| 11 | M | 90.75 | 5.4 | 0.0073 | 3.94 | 4 | N/A | N/A |
| 12 | M | 77.53 | 3.87 | N/A | N/A | N/A | N/A | N/A |
| 13 | M | 79 | 3.78 | 0.0123 | 4.65 | 8 | N/A | N/A |
| 14 | F | 77.5 | 4.3 | 0.0444 | 19.09 | 14 | 1162.16 | 0.43 |
| 15 | M | 73.9 | 3.51 | 0.0117 | 4.11 | 12 | N/A | N/A |
| 16 | M | 79.24 | 4.45 | N/A | N/A | N/A | N/A | N/A |
| 17 | F | 87.26 | 5.78 | 0.0793 | 45.84 | 307 | 1633.93 | 0.61 |
| 18 | M | 94.21 | 6.69 | 0.0088 | 5.89 | 13 | N/A | N/A |
| 19 | F | 110.97 | 10.22 | 0.0238 | 24.32 | 33 | 1539.82 | 0.58 |
| 20 | F | 85.51 | 4.38 | 0.004 | 1.75 | 0 | 445.54 | 0.15 |
| 21 | F | 107.03 | 10.36 | 0.0023 | 2.38 | 1 | 4741.94 | 1.47 |
| 22 | M | 84.02 | 4.06 | 0.0033 | 1.34 | 3 | N/A | N/A |
| 23 | F | 94.3 | 6.71 | 0.0049 | 3.29 | 5 | 914.29 | 0.32 |
| 24 | M | 83.68 | 4.71 | 0.0088 | 4.14 | 2 | N/A | N/A |
| 25 | M | 91.05 | 4.93 | N/A | N/A | N/A | N/A | N/A |
| 26 | F | 93.28 | 6.38 | 0.0003 | 0.19 | 1 | 1636.36 | 0.48 |
| 27 | F | 132.35 | 18.35 | 0.0258 | 47.34 | 7 | 7597.71 | 3.52 |
| 28 | F | 114.63 | 11.82 | N/A | N/A | N/A | 8170.97 | 2.74 |
| 29 | F | 126.04 | 12.78 | N/A | N/A | N/A | 4535.17 | 1.27 |
| 30 | F | 96.49 | 7.17 | N/A | N/A | N/A | 2772.15 | 0.73 |
| 31 | F | 89.87 | 5.06 | 0.0007 | 0.35 | 6 | 360.47 | 0.31 |
| 32 | M | 81.85 | 4.07 | 0.0465 | 18.93 | 11 | N/A | N/A |
| 33 | M | 102.93 | 6.88 | 0.0031 | 2.13 | 3 | N/A | N/A |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 34 | M | 93.42 | 5.97 | 0.0128 | 7.64 | 11 | N/A | N/A |
| 35 | M | 99.43 | 7.28 | N/A | N/A | N/A | N/A | N/A |
| 36 | M | 85.1 | 4.77 | 0.0378 | 18.03 | 21 | N/A | N/A |
| 37 | M | 92.92 | 6.28 | 0.0239 | 15.01 | 7 | N/A | N/A |
| 38 | M | 85.61 | 4.07 | 0.0329 | 13.39 | 79 | N/A | N/A |
| 39 | F | 96.1 | 6.17 | 0.1014 | 62.56 | 169 | 1042.11 | 0.99 |
| 40 | F | 91.4 | 5.02 | 0.0209 | 10.49 | 4 | 588.24 | 0.51 |
| 41 | M | 81.53 | 4.02 | 0.01 | 4.02 | 1 | N/A | N/A |
| 42 | M | 83.43 | 4.71 | 0.0302 | 14.22 | 10 | N/A | N/A |
| 43 | M | 87.6 | 5.22 | 0.0467 | 24.38 | 19 | N/A | N/A |
| 44 | M | 102.72 | 6.9 | 0.0197 | 13.59 | 23 | N/A | N/A |
| 45 | M | 101.83 | 7.84 | N/A | N/A | N/A | N/A | N/A |
| 46 | F | 117.11 | 11.85 | 0.0734 | 86.98 | 56 | 3311.32 | 1.17 |
| 47 | M | 106.53 | 8.37 | 0.0473 | 39.59 | 5 | N/A | N/A |
| 48 | F | 125.91 | 15.8 | N/A | N/A | N/A | 3395.6 | 1.03 |
| 49 | M | 72.53 | 2.52 | N/A | N/A | N/A | N/A | N/A |
| 50 | F | 79.69 | 4.76 | 0.006 | 2.86 | 1 | 2442.86 | 0.57 |
| 51 | F | 93.77 | 5.87 | 0.0452 | 26.53 | 10 | 2058.14 | 0.59 |
| 52 | F | 86.43 | 4.59 | N/A | N/A | N/A | 1450 | 0.49 |
| 53 | F | 115.34 | 11.04 | 0.0344 | 37.98 | 3 | 4225 | 1.69 |
| 54 | F | 102.58 | 6.93 | 0.1122 | 77.75 | 11 | 2411.76 | 0.82 |
| 55 | F | 110.25 | 10.6 | 0.0242 | 25.65 | 101 | 11194.03 | 2.5 |
| 56 | M | 68.34 | 2.19 | N/A | N/A | N/A | N/A | N/A |
| 57 | F | 121.29 | 12.89 | 0.0071 | 9.15 | 5 | 5809.09 | 2.13 |
| 58 | M | 85.43 | 5.28 | 0.014 | 7.39 | 24 | N/A | N/A |
| 59 | F | 104.13 | 8.01 | 0.0525 | 42.05 | 54 | 2514.29 | 0.88 |
| 60 | F | 110.58 | 12.69 | N/A | N/A | N/A | 6500 | 1.69 |
| 61 | M | 85.16 | 4.66 | 0.007 | 3.26 | 2 | N/A | N/A |
| 62 | F | 123.57 | 16.5 | N/A | N/A | N/A | 2339.45 | 0.85 |
| 63 | F | 97.99 | 7.92 | 0.0176 | 13.94 | 7 | 5318.18 | 1.56 |
| 64 | M | 96.72 | 6.8 | N/A | N/A | N/A | N/A | N/A |
| 65 | F | 85.36 | 4.28 | 0.0491 | 21.01 | 8 | 570 | 0.19 |
| 66 | F | 126.82 | 15.7 | 0.0109 | 17.11 | 5 | 5440.3 | 2.43 |
| 67 | F | 93.97 | 7.65 | 0.0142 | 10.86 | 5 | 3616.07 | 1.35 |
| 68 | M | 97.4 | 7.6 | 0.0037 | 2.81 | 15 | N/A | N/A |
| 69 | M | 72.75 | 2.76 | 0.0162 | 4.47 | 42 | N/A | N/A |
| 70 | M | 90.34 | 5.29 | N/A | N/A | N/A | N/A | N/A |
| 71 | F | 91.37 | 5.52 | 0.0033 | 1.82 | 9 | 2883.12 | 0.74 |
| 72 | M | 77.6 | 3.3 | N/A | N/A | N/A | N/A | N/A |
| 73 | M | 93.61 | 6.63 | 0.007 | 4.64 | 6 | N/A | N/A |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 74 | M | 97.8 | 6.23 | N/A | N/A | N/A | N/A | N/A |
| 75 | F | 123.47 | 16.87 | N/A | N/A | N/A | 6564.36 | 2.21 |
| 76 | F | 90.59 | 6.16 | 0.0027 | 1.66 | 0 | 2290.32 | 0.71 |
| 77 | M | 75.14 | 3.18 | 0.0077 | 2.45 | 3 | N/A | N/A |
| 78 | F | 126.55 | 12.18 | 0.0162 | 19.73 | 70 | 1360.47 | 0.39 |
| 79 | F | 80.88 | 4.48 | 0.0021 | 0.94 | 1 | 217 | 0.11 |
| 80 | M | 91.7 | 6.91 | 0.005 | 3.46 | 1 | N/A | N/A |
| 81 | F | 98.73 | 7.86 | N/A | N/A | N/A | 239 | 0.09 |
| 82 | M | 91.22 | 6.21 | N/A | N/A | N/A | N/A | N/A |
| 83 | M | 86.3 | 2.95 | N/A | N/A | N/A | N/A | N/A |
| 84 | F | 92.08 | 6.45 | 0.0293 | 18.90 | 2 | 3521.74 | 1.08 |
| 85 | M | 101.94 | 8.69 | 0.0134 | 11.64 | 0 | N/A | N/A |
| 86 | M | 91.56 | 5 | N/A | N/A | N/A | N/A | N/A |
| 87 | M | 82.32 | 4.11 | 0.0568 | 23.34 | 7 | N/A | N/A |
| 88 | F | 79.64 | 3.35 | 0.0116 | 3.89 | 0 | 647.06 | 0.22 |
| 89 | F | 122.76 | 18.36 | 0.1918 | 352.14 | 100 | 8516.13 | 3.52 |
| 90 | M | 91.83 | 5.78 | 0.0715 | 41.33 | 77 | N/A | N/A |
| 91 | M | 90.58 | 6.21 | 0.0181 | 11.24 | 11 | N/A | N/A |
| 92 | M | 107.72 | 8.46 | 0.0082 | 6.94 | 2 | N/A | N/A |
| 93 | F | 106.43 | 9.39 | 0.0016 | 1.50 | 20 | 1193.89 | 0.39 |
| 94 | F | 127.99 | 15.32 | 0.0162 | 24.82 | 30 | 2878.38 | 1.42 |
| 95 | F | 126.96 | 15.14 | N/A | N/A | N/A | 6195.12 | 2.54 |
| 96 | M | 81.44 | 4.56 | N/A | N/A | N/A | N/A | N/A |
| 97 | F | 126.48 | 16.78 | 0.0016 | 2.68 | 3 | 11201.83 | 4.07 |
| 98 | F | 90.2 | 5.44 | 0.0038 | 2.07 | 14 | 1805.08 | 0.71 |
| 99 | F | 91.89 | 6.13 | N/A | N/A | N/A | 2946.9 | 1.11 |
| 100 | F | 79.45 | 3.6 | 0.0021 | 0.76 | 8 | 1018.87 | 0.36 |
| 101 | F | 71.94 | 2.65 | 0.0074 | 1.96 | 29 | 308 | 0.15 |
| 102 | F | 100.32 | 8.06 | 0.0126 | 10.16 | 162 | 619.83 | 0.25 |
| 103 | F | 102.56 | 9.5 | 0.0045 | 4.28 | 37 | 1238.53 | 0.45 |
| 104 | M | 90.44 | 5.93 | 0.0034 | 2.02 | 12 | N/A | N/A |
| 105 | M | 93.26 | 6.55 | 0.0325 | 21.29 | 66 | N/A | N/A |
| 106 | F | 101.7 | 7.65 | 0.0078 | 5.97 | 5 | 2669.72 | 0.97 |
| 107 | F | 128.34 | 13.99 | 0.1187 | 166.06 | 49 | 5080.65 | 2.1 |
| 108 | M | 87.81 | 5.21 | 0.0482 | 25.11 | 27 | N/A | N/A |
| 109 | M | 105.55 | 8.17 | 0.043 | 35.13 | 20 | N/A | N/A |
| 110 | F | 97.3 | 7.66 | 0.0775 | 59.37 | 407 | 1264.46 | 0.51 |
| 111 | F | 83.98 | 4.42 | 0.0007 | 0.31 | 2 | 1103.45 | 0.32 |
| 112 | F | 109.65 | 10.18 | 0.0066 | 6.72 | 2 | 1564.1 | 0.61 |
| 113 | M | 71.64 | 2.58 | 0.0049 | 1.26 | 0 | N/A | N/A |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 114 | F | 83 | 4.75 | 0.0006 | 0.29 | 5 | 451.61 | 0.14 |
| 115 | M | 102.21 | 6.99 | N/A | N/A | N/A | N/A | N/A |
| 116 | M | 92.32 | 5.67 | N/A | N/A | N/A | N/A | N/A |
| 117 | M | 81.04 | 3.75 | 0.0093 | 3.49 | 41 | N/A | 0.03 |
| 118 | M | 76.56 | 3.15 | N/A | N/A | N/A | N/A | N/A |
| 119 | M | 95.46 | 6.59 | 0.0057 | 3.76 | 10 | N/A | 0.06 |
| 120 | M | 100.04 | 7.62 | 0.0343 | 26.14 | 36 | N/A | N/A |
| 121 | M | 107.38 | 9.26 | 0.0362 | 33.52 | 97 | N/A | N/A |
| 122 | F | 111.02 | 10.64 | 0.0276 | 29.37 | 11 | 4166.67 | 1.5 |

**Table 3.** Averages of general records for male and female Oriental weather loaches.

| | **Avg. length (mm)** | **Avg. weight (grams)** | **Avg. stomach content weight (grams)** | **Avg. stomach weight percentage of total weight** | **Avg. total prey items** | **Avg. approx. egg count** | **Avg. egg mass (grams)** |
|---|---|---|---|---|---|---|---|
| Male | 89.55 | 5.45 | .0140 | 8.06 | 16.51 | N/A | N/A |
| Female | 103.08 | 9.04 | .0228 | 22.91 | 30.32 | 3020.95 | 1.08 |
| **Total** | 96.09 | 7.19 | 0.0183 | 15.25 | 23.19 | 3020.95 | 1.08 |

Stomach contents contained a wide variety of different prey items with Alonella (679), nonbiting midge larvae (617), insect eggs (413), and Simocephalus (356) being the most abundant (Fig. 7). Fish eggs (139) made up only 5% of the overall prey items eaten but fish eggs were the only non-invertebrate prey item found among stomach contents (Fig. 7). Unidentified insect body parts were excluded from the stomach content results since these parts were unidentifiable. Also, sediment, and plants were found in stomach contents but were excluded from the results since it was likely inhaled on accident during feeding.

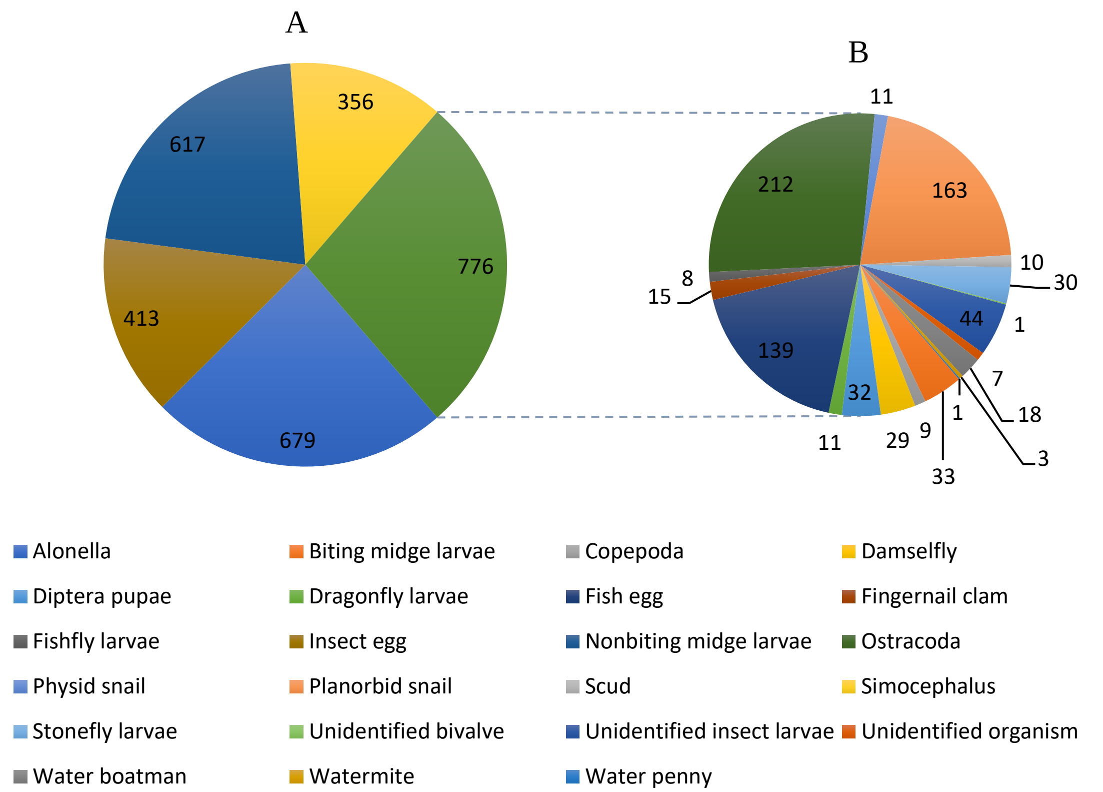


**Figure 7.** Total number of different species found in the stomachs of the dissected Oriental weather loaches where A represents the most abundant prey items and B represents the remaining prey items.

## Discussion

Oriental weather loaches were only present in the Prairie creek wetland, suggesting that the Oriental weather loaches at Midewin National Tallgrass Prairie were likely introduced by man and not from the Prairie Creek and Grant Creek watersheds. Additionally, it was observed that the Grant Creek wetlands dried up over the course of the summer leading us to believe they are more ephemeral than the Prairie Creek wetlands. This could explain the reduced species diversity in the Grant Creek wetlands compared to the Prairie Creek wetlands (Fig. 3) and the absence of Oriental weather loaches. With the Grant Creek wetlands displaying ephemeral characteristics, this makes a less ideal habitat for fish. However, crayfish can survive out of water for certain periods of times and move across land to new bodies of water. The White river crayfish's abilities to live in low oxygenated bodies of water and move across land combined

with the low number of fish present, explains the abundance of White river crayfish in the Grant Creek wetlands.

The Oriental weather loaches fed on a large variety of different invertebrates in the Prairie Creek wetland (Fig. 7). Many of the prey items could be hard to identify due to being digested and macerated. One individual was found to contain 139 fish eggs which suggests that the loaches could be preying on fish eggs. It is possible that more loaches may have eaten fish eggs but didn't show up in the stomach since fish eggs are softer and can likely be digested faster than invertebrates with hard exoskeletons.

The most abundant prey items were Alonella, insect eggs, Nonbiting midge larvae, and Simocephalus (Fig. 7). The variety of different prey items and presence of sediment and plants in stomach contents support the idea that weather loaches are opportunistic feeders. Alonella and Simocephalus are microscopic freshwater crustaceans that are often found in more benthic zones. Although both Alonella and Simocephalus made up a large portion of the overall number of prey items eaten, they were eaten in large numbers by only a few loaches. This supports the idea that Oriental weather loaches are opportunistic feeders. Nonbiting midge larvae and insect eggs were found in a large majority of stomachs. These appear to be the two most preyed upon invertebrates. Many of the invertebrates found among the Oriental weather loach's stomach contents are major prey species for mudminnows (Schmidt and Schmidt 2014). This data suggests that weather loaches are competing with the native Central mudminnow. Native Bluegill and late-stage tadpoles likely also compete with Oriental weather loaches. Young tadpoles often feed on vegetation and dead aquatic invertebrates, but late-stage tadpoles become more reliant on aquatic invertebrates. Bluegill are also generalist feeders but rely heavily on snails, freshwater crustaceans, and aquatic invertebrates (Moran et al. 2018). The fact that a

greater number of Oriental weather loaches were trapped than Central mudminnows and Bluegill may propose that the loaches are outcompeting the other native fish.

Future studies on the ecological impact of the Oriental weather loach in both the Prairie Creek and Grant Creek watersheds should be done to determine if loaches are found in different areas of the stream. This study only looked at the Prairie and Grant Creek watersheds within Midewin National Tallgrass Prairie, so little to nothing is known about possible loaches in these watershed outside of Midewin. Only a small portion of the creeks of Prairie and Grant Creek were used in this study, which makes it entirely possible that Oriental weather loaches are further up or downstream from Midewin National Tallgrass Prairie. Future assessments would benefit from trapping for a longer period of time and throughout the different seasons. Trapping and dissecting loaches caught in the spring and fall seasons could give a better insight on what the Oriental weather loaches are eating throughout the year. Norris (2015) found that Oriental weather loaches were eating different prey items and different proportions of species during different months. This shows that it would be crucial to see if weather loaches are eating different prey items during different seasons at Midewin National Tallgrass Prairie. For example, it would be important to know if weather loaches are consuming tadpoles and tadpole eggs in the spring season. Finally, future studies should compare the Prairie Creek wetland to another prairie wetland that doesn't have weather loaches. This will increase our understanding on how weather loaches are really impacting the ecosystem. Unfortunately, the Grant Creek wetlands were not a good comparison due to their ephemeral nature.

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**Appendix 1**

| Trap Number | Location | Coordinates | Species collected |
|---|---|---|---|
| G1 | Wetland | N 41° 22' 33.0"<br>W 88° 10' 24.5" | Bluegill<br>Giant water scavenger beetle<br>Northern watersnake<br>Physid snail<br>Planorbid snail<br>Predaceous diving beetle<br>White river crayfish |
| G2 | Wetland | N 41° 21' 50.5"<br>W 88° 10' 22.6" | American bullfrog<br>Northern leopard frog<br>Predaceous diving beetle<br>White river crayfish |
| G3 | Wetland | N 41° 21' 50.1"<br>W 88° 10' 22.3" | Bluegill<br>Planorbid snail<br>White river crayfish |
| G4 | Wetland | N 41° 21' 46.4"<br>W 88° 10' 23.7" | American pickerel<br>Planorbid snail<br>Predaceous diving beetle<br>Six-spotted fishing spider<br>White river crayfish |
| G5 | Wetland | N 41° 21' 57.3"<br>W 88° 10' 16.9" | Physid snail<br>Predaceous diving beetle<br>White river crayfish |

| | | | |
|---|---|---|---|
| G6 | Wetland | N 41° 22' 00.7"<br>W 88° 10' 17.5" | Northern leopard frog<br>Physid snail<br>Planorbid snail<br>White river crayfish |
| G7 | Wetland | N 41° 21' 58.9"<br>W 88° 10' 32.3" | Physid snail<br>Planorbid snail<br>Predaceous diving beetle<br>Six-spotted fishing spider<br>Virile crayfish<br>White river crayfish |
| G8 | Wetland | N 41° 21' 57.0"<br>W 88° 10' 34.6" | Planorbid snail<br>Predaceous diving beetle<br>White river crayfish |
| G9 | Creek | N 41° 22' 10.0"<br>W 88° 10' 24.1" | Black bullhead<br>Bluegill<br>Northern clearwater crayfish<br>Physid snail<br>Virile crayfish<br>White river crayfish |
| G10 | Creek | N 41° 22' 10.0"<br>W 88° 10' 28.7" | Bluegill<br>Virile crayfish<br>White river crayfish |
| G11 | Creek | N 41° 22' 10.0"<br>W 88° 10' 34.1" | Bluegill<br>Northern clearwater crayfish<br>Physid snail<br>Virile crayfish<br>White river crayfish |
| G12 | Creek | N 41° 22' 10.6"<br>W 88° 10' 38.8" | Bluegill<br>Central mudminnow<br>Common shiner<br>Physid snail<br>Virile crayfish<br>White river crayfish |
| G13 | Creek | N 41° 22' 12.4"<br>W 88° 10' 21.3" | White river crayfish |

| | | | |
|---|---|---|---|
| G14 | Creek | N 41° 22' 16.6"<br>W 88° 10' 17.4" | Bluegill<br>Central mudminnow<br>Common shiner<br>Physid snail<br>Virile crayfish<br>White river crayfish |
| G15 | Creek | N 41° 22' 21.5"<br>W 88° 10' 12.2" | Northern clearwater crayfish<br>Physid snail<br>Virile crayfish<br>White river crayfish |
| G16 | Creek | N 41° 22' 24.2"<br>W 88° 10' 9.8" | Bluegill<br>White river crayfish |
| P1 | Creek | N 41° 21' 45.1"<br>W 88° 10' 1.7" | Bluegill<br>Hornyhead chub<br>Northern clearwater crayfish<br>Rusty crayfish<br>White river crayfish |
| P1 | Wetland | N 41° 22' 10.0"<br>W 88° 9' 22.8" | American bullfrog<br>Bluegill<br>Central mudminnow<br>Oriental weather loach<br>Physid snail<br>Planorbid snail<br>Predaceous diving beetle<br>Smooth turtle leech<br>Virile crayfish<br>White river crayfish |
| P2 | Creek | N 41° 21' 44.9"<br>W 88° 10' 4.2" | Bluegill<br>Northern clearwater crayfish<br>Planorbid snail<br>Rusty crayfish<br>Virile crayfish<br>White river crayfish |
| P2 | Wetland | N 41° 22' 18.0"<br>W 88° 9' 19.2" | American bullfrog<br>Bluegill<br>Central mudminnow<br>Oriental weather loach<br>Physid snail<br>Smooth turtle leech |

| | | | |
|---|---|---|---|
| P3 | Creek | N 41° 21' 39.8"<br>W 88° 10' 7.7" | Bluegill<br>Common shiner<br>Hornyhead chub<br>Northern clearwater crayfish<br>Rusty crayfish<br>Six-spotted fishing spider<br>Virile crayfish |
| P3 | Wetland | N 41° 22' 17.4"<br>W 88° 9' 19.6" | American bullfrog<br>Central mudminnow<br>Northern green frog<br>Oriental weather loach<br>Physid snail<br>Smooth turtle leech |
| P4 | Creek | N 41° 21' 31.9"<br>W 88° 10' 8.2" | Common shiner<br>Flathead catfish<br>Hornyhead chub<br>Northern clearwater crayfish<br>Rusty crayfish<br>Virile crayfish<br>White river crayfish |
| P4 | Wetland | N 41° 22' 18.6"<br>W 88° 9' 18.7" | American bullfrog<br>Central mudminnow<br>Oriental weather loach<br>Physid snail<br>Predaceous diving beetle<br>Smooth turtle leech |
| P5 | Wetland | N 41° 21' 46.3"<br>W 88° 9' 21.4" | Northern green frog<br>Northern leopard frog<br>Physid snail<br>Smooth turtle leech<br>White river crayfish |
| P5 | Wetland | N 41° 21' 17.2"<br>W 88° 9' 20.6" | Central mudminnow<br>Dragonfly larva<br>Northern leopard frog<br>Oriental weather loach<br>Physid snail<br>Smooth turtle leech<br>White river crayfish |

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|---|---|---|---|
| P6 | Creek | N 41° 21' 39.8"<br>W 88° 9' 1.6" | Bluntnose minnow<br>Common shiner<br>Northern clearwater crayfish<br>Virile crayfish<br>White river crayfish |
| P6 | Wetland | N 41° 22' 9.0"<br>W 88° 9' 22.9" | American bullfrog<br>Bluegill<br>Central mudminnow<br>Dragonfly larva<br>Northern green frog<br>Oriental weather loach<br>Physid snail<br>Planorbid snail<br>Smooth turtle leech<br>Virile crayfish<br>White river crayfish |
| P7 | Creek | N 41° 21' 38.8"<br>W 88° 8' 55.6" | Bluntnose minnow<br>Common shiner<br>Northern clearwater crayfish<br>Virile crayfish<br>White river crayfish |
| P7 | Wetland | N 41° 22' 9.5"<br>W 88° 9' 22.8" | American bullfrog<br>Central mudminnow<br>Northern cricket frog<br>Northern green frog<br>Oriental weather loach<br>Physid snail<br>Planorbid snail<br>Predaceous diving beetle<br>Smooth turtle leech<br>Virile crayfish<br>White river crayfish |
| P8 | Creek | N 41° 21' 35.8"<br>W 88° 8' 48.9" | Northern clearwater crayfish<br>Virile crayfish<br>White river crayfish |

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|---|---|---|---|
| P8 | Wetland | N 41° 22' 17.2"<br>W 88° 9' 20.6" | American bullfrog<br>Bluegill<br>Northern cricket frog<br>Northern green frog<br>Northern leopard frog<br>Oriental weather loach<br>Physid snail<br>Planorbid snail<br>Predaceous diving beetle<br>Smooth turtle leech<br>Virile crayfish<br>White river crayfish |
| P9 | Creek | N 41° 21' 33.2"<br>W 88° 8' 41.3" | Hornyhead chub<br>Northern clearwater crayfish<br>Rusty crayfish<br>Virile crayfish<br>White river crayfish |
| P9 | Wetland | N 41° 22' 6.0"<br>W 88° 9' 25.7" | American bullfrog<br>Central mudminnow<br>Dragonfly larva<br>Northern green frog<br>Northern leopard frog<br>Oriental weather loach<br>Planorbid snail<br>Smooth turtle leech<br>Virile crayfish<br>White river crayfish |
| P10 | Wetland | N 41° 22' 8.7"<br>W 88° 9' 23.1" | American bullfrog<br>Bluegill<br>Central mudminnow<br>Northern green frog<br>Oriental weather loach<br>Planorbid snail<br>Smooth turtle leech<br>Virile crayfish<br>White river crayfish |

| | | | |
|---|---|---|---|
| P11 | Wetland | N 41° 22' 6.5"<br>W 88° 9' 25.8" | American bullfrog<br>Black bullhead<br>Central mudminnow<br>Dragonfly larva<br>Northern green frog<br>Oriental weather loach<br>Physid snail<br>Planorbid snail<br>Predaceous diving beetle<br>Smooth turtle leech<br>White river crayfish |
| P12 | Wetland | N 41° 22' 5.2"<br>W 88° 9' 27.1" | American bullfrog<br>Black bullhead<br>Bluegill<br>Central mudminnow<br>Northern green frog<br>Northern leopard frog<br>Oriental weather loach<br>Planorbid snail<br>Predaceous diving beetle<br>Smooth turtle leech<br>Virile crayfish<br>White river crayfish<br>Yellow bullhead |
| P13 | Wetland | N 41° 22' 10.4"<br>W 88° 9' 22.2" | Bluegill<br>Dragonfly larva<br>Northern green frog<br>Northern leopard frog<br>Northern watersnake<br>Oriental weather loach<br>Physid snail<br>Planorbid snail<br>Predaceous diving beetle<br>Smooth turtle leech<br>Virile crayfish<br>White river crayfish |

| | | | |
|---|---|---|---|
| P14 | Wetland | N 41° 22' 18.6"<br>W 88° 9' 18.7" | American bullfrog<br>Central mudminnow<br>Northern green frog<br>Northern leopard frog<br>Northern watersnake<br>Oriental weather loach<br>Physid snail<br>Smooth turtle leech |
| P15 | Wetland | N 41° 22' 16.4"<br>W 88° 9' 20.5" | American bullfrog<br>Central mudminnow<br>Dragonfly larva<br>Northern green frog<br>Northern leopard frog<br>Oriental weather loach<br>Planorbid snail<br>Smooth turtle leech<br>Virile crayfish<br>White river crayfish |
| P16 | | N 41° 22' 15.7"<br>W 88° 9' 20.6" | American bullfrog<br>American pickerel<br>Central mudminnow<br>Dragonfly larva<br>Northern green frog<br>Northern leopard frog<br>Oriental weather loach<br>Physid snail<br>Planorbid snail<br>Predaceous diving beetle<br>White river crayfish |