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A CENTURY OF SHIFTING FISH ASSEMBLAGES IN WOLF LAKE, ILLINOIS-INDIANA

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ABSTRACT. Urban areas have suffered from declines in environmental quality and biodiversity; however, there is a lack of long-term studies examining these issues because people rarely collect data from a single locality for extended periods. An exception is Wolf Lake, half of which is located in Chicago, Illinois and half in Hammond, Indiana. Fishes have been collected from Wolf Lake over the past 109 years, and there is a detailed history of environmental changes, including shifts in fish assemblages. Two primary factors have caused the fish assemblages to shift, but these were active at different times. Initially, marshes around the lake were drained and filled with waste from the local steel industry. The lake bottom was subsequently dredged. Fishes sensitive to these environmental perturbations were extirpated, while habitat generalists survived. Later, there was an influx of invasive species. When making conservation/management decisions, it is important to realize that multiple factors working at different times can influence present biodiversity.

Keywords: Wolf Lake, Illinois, Indiana, fish assemblage, invasive species, urban degradation

Urban areas have long suffered from declines in environmental quality and biodiversity. There are a variety of reasons and explanations for these declines and many short-term studies addressing the issues. However, there is a lack of studies looking at long-term trends because people have not consistently collected data from a single locality for extended periods. Long-term studies are important when making conservation and management decisions because one never knows if short-term studies are documenting minor environmental perturbations that will 'correct' themselves over longer periods of time.

In order to conduct a long-term analysis, one must first locate a place with a significant history of data collection. An ideal candidate is Wolf Lake (Fig. 1), a 395 ha lake located half in Chicago, Illinois and half in Hammond, Indiana. Lake Michigan is 1 km to the north. Wolf Lake drains into the Calumet River via Indian Creek. The lake is well-known to the general public, both because it is intersected by Interstate highway 90, and also because it is a popular fishing and duck-hunting locality. Three parks are in the immediate vicinity (Forsythe Park, Wolf Lake Park, and William W. Powers Conservation Area), and it is visited by thousands of people every year.

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Because of its proximity to downtown Chicago, Wolf Lake has been subjected to regular fish sampling since 1898. Fishes were preserved in museum collections, reported in literature accounts, or both. This interest in Wolf Lake fishes continues today, including the 2002 Calumet Biodiversity Blitz, a 24-hour survey of all flora and fauna in and around the lake. Wolf Lake was classified as Cook County's only exceptional lake by *Chicago Wilderness* (Chicago Region Biodiversity Council 1999).

Formation and history of Wolf Lake.—Because there is a large amount of historical fish data and a detailed record of physical changes, Wolf Lake provides an excellent opportunity to study the impact of a century of urbanization on aquatic habitats.

Wolf Lake exists because of southerly currents that have eroded the western shoreline of Lake Michigan. These eroded sediments were then deposited along the southern edge of the Lake Michigan basin, creating beaches and dunes. This deposition has formed an alternating series of characteristic ridges and swales that mark the position of Lake Michigan's historical shorelines. At times there were imperfections in the deposition of sediments, resulting in the formation of bays. Over time some of these bays have become isolated from Lake Michigan by continual sedimentation across their mouths. Wolf Lake was formed

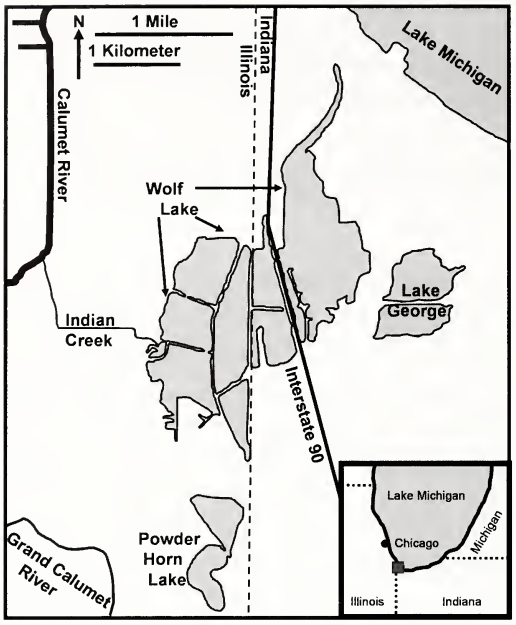


Figure 1.—Map of modern Wolf Lake, adjacent waters, Interstate Highway 90, and the Illinois-Indiana state line.

in this way (Chrzastowski & Thompson 1994; Chrzastowski et al. 1994), and radiocarbon dating of peat material indicates that it is approximately 1000 years old (Chrzastowski et al. 1994).

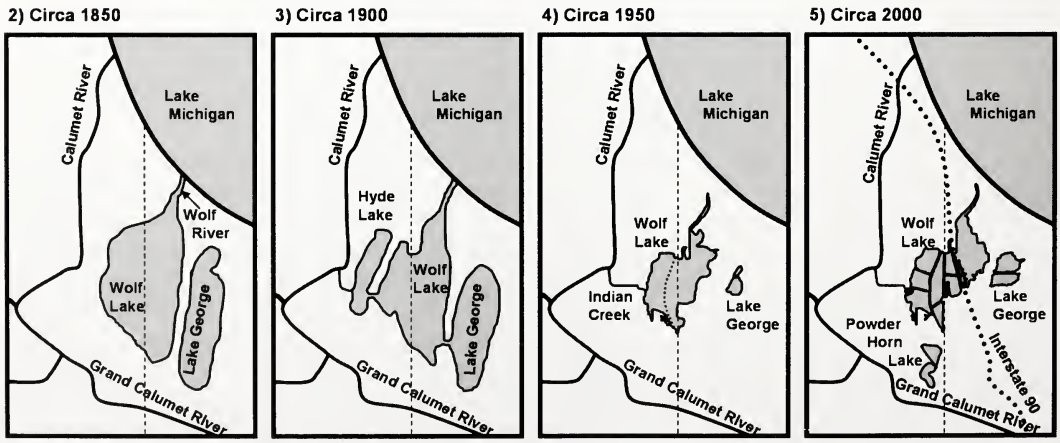
The area of depositional sediment in which Wolf Lake was formed is called the Calumet Lacustrine Plain. It is a level area between Lake Michigan to the north and glacial moraines to the south. Elevation is slightly above that of Lake Michigan, and the Calumet River forms the dominant drainage. Much of the area was marsh, with scattered ponds and lakes.

People inhabited the area from the time of its formation. Native American trails and settlements were located near Wolf Lake (Meyer 1954). Unfortunately, we have no direct evidence of how they utilized its natural resources.

The area began to change significantly in 1803 with the construction of Fort Dearborn on the site of modern day Chicago. European settlers soon began to build communities, roads, etc. throughout the Calumet region. Fortunately they also conducted surveys and drew maps.

Maps from 1804 to 1838 show a Wolf Lake that extended to the east and west, incorporating what was once known as Hyde Lake and very close or connected with modern day Lake George (Meyer 1954). Its northern and southern boundaries were relatively similar to what we see today. Wolf Lake was connected to Lake Michigan via the Wolf River, but it is unclear if there was a direct connection with Lake Calumet and the Calumet River, or only indirect connections via intervening marshes (Fig. 2).

By 1876, communities were growing in the region, but the marsh prevented habitation adjacent to Wolf Lake (Andreas 1876). This changed quickly, as maps from 1881 to 1896 indicate that fill and drains had reduced the size of the lake (Higley & Raddin 1891; Kay et al.



Figures 2–5.—Changes in geography of Wolf Lake and surrounding region over the past 150 years. Many boundaries are approximate because of vagaries in the historical record and the marshy nature of the region. Dashed line is border between Illinois and Indiana. See text for relevant citations. 2. Wolf Lake circa 1850; 3. Wolf Lake circa 1900; 4. Wolf Lake circa 1950; 5. Wolf Lake circa 2000.

1997). To the west, Hyde Lake was a separate entity, although there was a direct connection to the east with Wolf Lake and a direct connection to the west with the Calumet River (Fig. 3). To the east, Lake George was an independent water body, although there was a direct connection with Wolf Lake.

A U.S. Army Corps of Engineers map from 1896 (Tetra Tech 2002) shows four ice houses along Wolf Lake and Wolf River, and there were also railroads and roads around the lake. The shores were predominantly marsh, but there was evidence of fill along the northern edge. Maximum depth was a little over one meter. Wolf River still existed, but the section near Lake Michigan was small and possibly intermittent.

Photos of Wolf Lake (Shelford 1913) show a lake with bullrush marsh along the edges. The center was choked with floating aquatic macrophytes, and the lake was evidently shallow. Farther from the water was a successional series with a wide prairie area followed sequentially by taller weeds, low shrubs, high shrubs, and finally trees (Shelford 1913). The number of species and variety of pondweeds and other aquatic plants was high in the 1920s (Greenberg 2002).

A U.S. Geological Survey map from 1929 showed that Wolf River no longer reached Lake Michigan (Tetra Tech 2002). There was no longer a direct connection with Lake George, and Hyde Lake had disappeared (Kay et al. 1997). Indian Creek was present and provided a connection with the Calumet River (Fig. 4). There were many more homes and industries in the region, particularly along the northeastern shoreline. Furthermore, there was a railroad running across the north-south axis of the lake, and another running along the southern and southeastern shorelines.

A significant amount of fill was deposited around Wolf Lake between 1928 and 1953. Much of the material dumped into the local wetlands was slag produced by nearby steel mills (Kay et al. 1997). A 1953 U.S. Geological Survey map (Tetra Tech 2002) provides evidence of encroaching development from all sides. The southeastern corner of the lake was filled in, and there was an artificial dike with a small opening along the Illinois-Indiana border.

The last major physical impact on Wolf Lake was the construction of the Indiana Toll Road, or Interstate 90 (also known as the Chicago Skyway). Work started in 1954, and was finished in 1956. Not only did the Interstate run across the middle of Wolf Lake, but the lake was used as a source of fill, meaning that it was dredged to a depth of 3–6 m. Levees were built to facilitate access of construction equipment to the entire lake (Fig. 5). These levees were left in place since this allowed people to walk or drive to the center of the lake. These also served to divide Wolf Lake into nine semi-discrete pools, and this is how it appears today. The marsh to the south of Wolf Lake was also used as a source of fill, resulting in the creation of Powder Horn Lake (Schoon 2003).

After the completion of the Indiana Toll Road, only minor changes were made to the physical structure of the lake. However, humans continued to influence the area, primarily through the stocking of game fishes to enhance fishery appeal. Since at least the 1970s, there are records of Walleye (*Sander vitreus*), Tiger Musky (*Esox lucius* × *Esox masquinongy*), Channel Catfish (*Ictalurus punctatus*), Northern Pike (*Esox lucius*), and Smallmouth Bass (*Micropterus dolomieu*) being introduced into the lake (Tetra Tech 2002; Robertson 2006). Additional stockings are possible, but have not been officially recorded. These efforts have made modern Wolf Lake popular with fishermen.

Other studies have examined historical changes in Calumet region fish assemblages, but they lacked the long-term resolution of the data available for Wolf Lake. For example, Greenfield & Rogner (1984) studied the fishes of Lake Calumet, but they were unable to find a significant amount of data from the late 1800s and early 1900s. Instead, they relied on information from the Calumet River and surrounding region. Their results indicated that a number of fishes were extirpated from Lake Calumet, and that habitat modification may have been responsible.

Another project was initiated for the purpose of examining changes in the fish assemblages of the Grand Calumet River watershed, mostly between the years 1976 to 1996 (Simon & Stewart 1999; Simon & Moy 1999/2000). Data prior to the 1970s are scant, and are based almost entirely on studies by Meek & Hildebrand (1910) and Shelford (1913). These data show a decrease in the number of native species and increase in the number of invasive species.

METHODS

Data were obtained from two sources: literature records and specimens preserved in museum collections. The Field Museum of Natural History, Illinois Natural History Survey, and Southern Illinois University – Carbondale all have fishes collected from Wolf Lake. These records are considered the most reliable because they can be verified. It is often impossible to verify literature records, so only reports from reliable sources were considered (e.g., Meek & Hildebrand 1910; Robertson 1970, 1978, 2006; Indiana Department of Natural Resources in Tetra Tech 2002; U.S. Army Corps of Engineers in Tetra Tech 2002). In some cases literature records overlap museum records (e.g., Meek & Hildebrand 1910). Recent data were supplemented by the author's personal fieldwork. This yielded a total of 35 independent collecting events.

Data were grouped into four time periods (1898–1937, 1961–1969, 1974–1987, and 1990–2007) reflecting when data were collected and times of significant environmental impact. No fish surveys are known from the 1940s and 1950s. Only presences are indicated. Absences may be true absences or the species was present but not collected. Because of the non-standard methods used to collect the data and its presence/absence nature, most statistical tests cannot be used for analyses. Instead, the different time periods were compared using the tripartite similarity index (Tulloss 1997). The tripartite similarity index is mathematically more rigorous than other similarity indices, such as when analyzing groups of different sizes (e.g., Simpson's and Jaccard's).

RESULTS

A total of 57 species was recorded from Wolf Lake between the years 1898 and 2007 (Table 1). Only one hybrid was included in this list, the Tiger Musky (*Esox lucius* × *Esox masquinongy*), because it is recognizable and sought after by anglers. Many of the sunfishes (*Lepomis* spp.) opportunistically hybridize with one another, but unlike the Tiger Musky there are no clear long-term consistent strains within the lake.

Museum records document the presence of 36 species, and 21 species are known solely from museum records. Literature records document the presence of 36 species, and 21 species are known solely from literature records.

The number of species per time period fluctuated from 31 (54% of the total number of species recorded) to 20, 34, and finally 40 (70%) (Table 2). The low number of species in the 1961–1969 time period is probably due to the relatively lower sampling effort of four collections. Only 12 species (21%) were reported from all four time periods, but 18 species (32%) were reported from both the first and last time periods. Of the original 31 species, 18 (or 58% of the original assemblage) have persisted to the present day.

Seven species are introduced in the Chicago region: Common Carp (*Cyprinus carpio*), Alewife (*Alosa pseudoharengus*), Goldfish (*Carassius auratus*), Chinook Salmon (*Oncorhynchus tshawytscha*), Redear Sunfish (*Lepomis microlophus*), White Perch (*Morone americana*), and Round Goby (*Neogobius melanostomus*), but many others owe their presence in Wolf Lake to human intervention. Four are present only in the last time period.

Five species from this area are considered to be threatened or endangered in Illinois: Iowa Darter (*Etheostoma exile*), Banded Killifish (*Fundulus diaphanus*), Northern Starhead Topminnow (*Fundulus dispar*), Blackchin Shiner (*Notropis heterodon*), and Blacknose Shiner (*Notropis heterolepis*). None of the five are listed in Indiana. Two are only present in the first time period, and one is only present in the first two time periods.

The tripartite similarity indices show that time periods further apart are less similar than those closer together (Table 3). The most similar result was the comparison between 1974–1987 and 1990–2007, which are adjacent time periods. The least similar result was 1961–1969 versus 1990–2007, but this may have been influenced by the low number of collecting events in the 1960s. The second lowest index was 1898–1937 versus 1990–2007, which are the two time periods furthest apart in years.

DISCUSSION

Lake succession is a natural phenomenon. Some of the pioneering studies on this topic were conducted by Shelford (1911a, 1911b, 1913) less than 15 km to the east of Wolf Lake. He looked at a series of ponds formed by low dune formation along the Lake Michigan shoreline. Ponds closer to Lake Michigan were

younger, contained more open water, less vegetation and debris, and more species of fishes. Ponds farther from Lake Michigan were older, contained less open water, more vegetation and debris, and fewer species of fishes. In short, these ponds were slowly filling in over time, converting to marshes.

Wolf Lake was on a similar successional trajectory. Originally an open bay of Lake Michigan, it began to slowly lose its connection with the lake. Vegetation and debris were gradually filling its basin. It was surrounded by encroaching marsh. In time, Wolf Lake would have completely disappeared, gradually changing into field and later to forest. This succession was interrupted as people colonized the area and modified the environment. Vegetation was removed and banks were stabilized. The lake bottom was dredged. Wolf Lake was essentially reset to an earlier time, and the fish assemblages reflect this.

Data reveal three broad categories of fishes: 1) those that were extirpated in the early years, 2) those that persisted for the entire century, and 3) those that have appeared recently. Roughly half of the original fish assemblage has been extirpated. Of these, some are environmentally sensitive and declining throughout the Chicago region. The Blackchin Shiner, Blacknose Shiner, Pugnose Minnow (*Opsopoeodus emiliae*), and Northern Starhead Topminnow all prefer lakes and marshes with clear water and abundant native vegetation. Initially Wolf Lake would have provided an ideal habitat for these species. As a result of sedimentation, eutrophication, invasive aquatic plants, and general disturbance, they are disappearing region wide. Three of the five are endangered or threatened in Illinois. These were among the first to be eliminated from Wolf Lake.

A little over half of the fishes originally present in Wolf Lake still persist today. These include the Bluntnose Minnow (*Pimephales notatus*), Largemouth Bass (*Micropterus salmoides*), and Bluegill (*Lepomis macrochirus*), which are three of the most common fishes in regards to distribution and abundance throughout the Chicago region. They are found in almost every aquatic habitat in which fishes can survive, so it is no surprise that they have persisted throughout the modern history of Wolf Lake. Golden Shiner (*Notemigonus crysoleucas*) and Common Carp are also widespread throughout the Chicago region.

Yellow Perch (*Perca flavescens*), Northern Pike, Grass Pickerel (*Esox americanus vermiculatus*), Pumpkinseed (*Lepomis gibbosus*), Black Crappie (*Pomoxis nigromaculatus*), and White Crappie (*Pomoxis annularis*) are found in many lakes within the Chicago region. All species are popular among anglers, and their populations are often managed. Northern Pike have recently been stocked in Wolf Lake (Robertson 2006).

The presence or absence of original species in Wolf Lake can largely be explained by changes in aquatic habitats. Environmentally-sensitive species were eliminated and habitat generalists survived. However, many of the current inhabitants of Wolf Lake appeared recently, and many of these are due to accidental or intentional introductions by people. For example, Walleye, Sauger (*Sander canadensis*), Channel Catfish, Smallmouth Bass, Tiger Musky, and Redear Sunfish owe their presence in Wolf Lake to stocking programs (Tetra Tech 2002; Robertson 2006). Chinook Salmon are stocked in Lake Michigan, but swim through Indian Creek into Wolf Lake at various times.

Unintentional introductions include White Perch, which were first seen in the Chicago region in 1988 (Savitz et al. 1989) and are increasing in abundance (Laird & Page 1996). It is an eastern United States fish that gained access to the Great Lakes via the Welland Canal. The Round Goby is another recent invader, first appearing in the Calumet River in 1993 (Laird & Page 1996; Charlebois et al. 1997). It is believed to have arrived in the ballast tanks of freighters from the Black Sea.

Not all species fall within the three broad categories of fishes. Some, such as American Eel (*Anguilla rostrata*), can be found in a variety of habitats, but are rare in the region. Others are common in Lake Michigan, and occasionally enter adjacent waters. According to Nelson (1876, 1878), there are times when consistently strong north winds blow Lake Michigan water into the Calumet River and adjacent wetlands. Lake Michigan fishes follow the water into the Calumet drainage, replacing typical Calumet fishes. When the winds stop, the Lake Michigan water returns to its normal position along with most of the fishes, and the Calumet fishes return to their previous habitats. However, some Lake Michigan fishes remain behind. This phenomenon is not as

Table 1.—List of Wolf Lake fishes and the time period in which they were recorded. Records are from museum specimens (X) or literature reports (O).

Scientific name	Common name	Time period			
		1898–1937	1961–1969	1974–1987	1990–2007
Notropis heterodon	Blackchin Shiner	X			
Notropis heterolepis	Blacknose Shiner	X			
Opsopoeodus emiliae	Pugnose Minnow	X			
Etheostoma caeruleum	Rainbow Darter	X			
Percina caprodes	Logperch	O			
Notropis hudsonius	Spottail Shiner	O			
Labidesthes sicculus	Brook Silverside	X			
Ictiobus niger	Black Buffalo	X			
Umbra limi	Central Mudminnow	X			
Noturus gyrinus	Tadpole Madtom	X	X		
Fundulus dispar	Northern Starhead Topminnow	X	X		
Notropis atherinoides	Emerald Shiner	X	X	X	
Notropis stramineus	Sand Shiner	X	X	X	
Pimephales notatus	Bluntnose Minnow	X	X	X	X
Micropterus salmoides	Largemouth Bass	X	X	X	X
Perca flavescens	Yellow Perch	X	X	O	X
Lepomis gibbosus	Pumpkinseed	X	O	X	X
Lepomis macrochirus	Bluegill	X	O	X	X
Lepomis gulosus	Warmouth	X	O	O	X
Notemigonus crysoleucas	Golden Shiner	X	X	O	O
Esox americanus vermiculatus	Grass Pickerel	X	X	O	O
Esox lucius	Northern Pike	X	O	O	O
Cyprinus carpio	Common Carp	X	O	O	O
Pomoxis nigromaculatus	Black Crappie	X	O	O	O
Erimyzon sucetta	Lake Chubsucker	X	O	O	X
Etheostoma nigrum	Johnny Darter	X		X	X
Etheostoma exile	Iowa Darter	X		X	X
Fundulus diaphanus	Banded Killifish	X		X	X
Ameiurus nebulosus	Brown Bullhead	X		O	O
Ictiobus bubalus	Smallmouth Buffalo	X			O
Pomoxis annularis	White Crappie	X			O
Alosa pseudoharengus	Alewife		O	O	O
Ameiurus natalis	Yellow Bullhead		O	X	O
Sander canadensis	Sauger		O		O
Sander vitreus	Walleye		O	O	O
Lepisosteus osseus	Longnose Gar			O	
Ictiobus cyprinellus	Bigmouth Buffalo			O	
Anguilla rostrata	American Eel			O	
Carassius auratus	Goldfish			O	
Lepomis cyanellus	Green Sunfish			X	X
Catostomus commersonii	White Sucker			O	X
Carpiodes cyprinus	Quillback			O	O
Dorosoma cepedianum	Gizzard Shad			O	O
Ameiurus melas	Black Bullhead			O	O
Amia calva	Bowfin			O	O
Ictalurus punctatus	Channel Catfish			O	O
Esox lucius × *Esox masquinongy*	Tiger Musky			O	O
Morone chrysops	White Bass			O	O
Pimephales promelas	Fathead Minnow				X
Fundulus notatus	Blackstripe Topminnow				O
Micropterus dolomieu	Smallmouth Bass				X
Oncorhynchus tshawytscha	Chinook Salmon				O

Table 1.—Continued.

Scientific name	Common name	Time period			
		1898–1937	1961–1969	1974–1987	1990–2007
Lepomis humilis	Orangespotted Sunfish				O
Lepomis peltastes	Northern Longear Sunfish				O
Lepomis microlophus	Redear Sunfish				O
Morone americana	White Perch				X
Neogobius melanostomus	Round Goby				X

common today because Wolf River and most of the wetlands have been destroyed, but Wolf Lake is still connected to Lake Michigan via the Calumet River and Indian Creek.

Examples of Lake Michigan fishes in Wolf Lake are Spottail Shiner (*Notropis hudsonius*), Logperch (*Percina caprodes*), Emerald Shiner (*Notropis atherinoides*), and Alewife. Wolf Lake abundances often reflect their abundance in Lake Michigan. The Emerald Shiner is most common in large rivers and along the shores of Lake Michigan; but they became scarce in Lake Michigan in the 1960s, perhaps due to the explosion in Alewife numbers (Smith 1979; Laird & Page 1996). It was last seen in Wolf Lake soon after it became scarce in Lake Michigan. Alewives first entered Lake Michigan in 1949 (Woods 1960) and were reported in Wolf Lake from the 1960s to the 1980s, which corresponds to their peak numbers in Lake Michigan (Laird & Page 1996).

Another Lake Michigan fish, which is not included in Table 1, is the Lake Sturgeon (*Acipenser fulvescens*). It is often said to be an early inhabitant of Wolf Lake, but there are no authenticated records. They were well-known from Lake Michigan, Calumet River, and Lake Calumet during the 1800s (Nelson 1878); and it is reasonable to assume that they strayed into Wolf Lake at the same time. By 1900 they had become rare and are now almost completely absent from the region (Smith 1979). (A fisherman caught one in Wolf Lake in 2001 [Tetra Tech 2002], but there are questions surrounding the validity of the record.)

It is difficult to determine if the number of species has changed significantly over time. Thirty-one species were originally reported from Wolf Lake, and 40 are known today. These numbers are highly influenced by sampling techniques, which have changed considerably over the years. Early collections were primarily with small seines, whereas shocker boats and a wide variety of traps and nets are used today. The increased effectiveness of modern methods would presumably increase the number of species found, and this is indeed the case. It is possible that species richness in modern Wolf Lake is actually higher due to increased habitat heterogeneity, the ability of exotic species to exploit novel niches, or other reasons; but the data cannot be used to test these hypotheses.

It is a mistake to think that Wolf Lake's fish assemblage has reached equilibrium or a climax state, for it is continuing to change even today. This is most obvious with its benthic fishes. Both the Johnny Darter (*Etheostoma nigrum*) and Iowa Darter were recorded from the first and last time periods. The Johnny Darter is the most common darter in the Chicago region, where it is found in almost all aquatic habitats and is not particularly sensitive to environmen-

Table 2.—Number of species, percent of overall total number of species ($N = 57$), and number of collections in each of the four time periods.

Time period	Number of species	Percent of total	Number of collections
1898–1937	31	54%	13
1961–1969	20	35%	4
1974–1987	34	59%	7
1990–2007	40	70%	11

Table 3.—Tripartite similarity indices for comparisons among fish assemblages from different time periods.

	1898–1937	**1961–1969**	**1974–1987**	**1990–2007**
1898–1937	—	—	—	—
1961–1969	0.583	—	—	—
1974–1987	0.563	0.573	—	—
1990–2007	0.496	0.473	0.742	—

tal degradation. The Iowa Darter, on the other hand, prefers lakes, marshes, and slow-moving streams with clear water and abundant native vegetation. It is threatened in Illinois because this type of habitat is becoming rare. The presence of the Iowa Darter has always been a positive sign for Wolf Lake.

In 1993 a Round Goby was collected in nearby Calumet River (Laird & Page 1996; Charlebois et al. 1997). Its numbers have since increased dramatically, and it has been shown to competitively exclude other benthic fishes, such as the Mottled Sculpin (*Cottus bairdii*) (Dubs & Corkum 1996; Laird & Page 1996; Charlebois et al. 1997; Janssen & Jude 2001). The Round Goby entered Wolf Lake and is now abundant in all habitats. Darters, the historically dominant benthic fishes in Wolf Lake, have almost completely disappeared, presumably in response to this invader. Significant Iowa Darter populations were known from several localities in the late 1990s; recent surveys have failed to find any. The last Iowa Darter collected in Wolf Lake was in 2001 (Tetra Tech 2002). Johnny Darters have become extremely rare, and their future in Wolf Lake is uncertain.

There are two other rare fishes that continue to survive in Wolf Lake. The Lake Chubsucker (*Erimyzon sucetta*) prefers lakes and slow-moving streams with clear water and abundant native vegetation. It is slowly being eliminated from the Chicago region as its habitat continues to disappear. The Banded Killifish prefers open water, often adjacent to dense aquatic vegetation. Its numbers have been declining throughout the Chicago region, and it is threatened in Illinois. However, both species are still present in Wolf Lake; and there is a sufficient amount of suitable habitat for them to survive. One of the largest inland populations of Banded Killifish near Chicago is in Powder Horn Lake (Greenberg 2002; Retzer & Batten 2005), which is 0.5 km to the south of Wolf Lake. It is unclear if Banded Killifish move between the two lakes.

Wolf Lake has changed in the past, is changing now, and will change in the future. Historical changes are due to two primary factors. Environmental modification in the first half of the century eliminated sensitive species and then introduced species became established during the second half of the century. If it were simply a matter of aquatic habitats following a successional trajectory, then we could predict the future of Wolf Lake. But the stocking of game fishes and unintentional introductions of exotic species add a wildcard to the mix. It is difficult to predict what the fish assemblage will be 10, 20, or 30 years from now.

It is a matter of opinion as to whether the Wolf Lake of 2007 is 'better' than the Wolf Lake of 1898. On one hand, some people prefer the modern version with its abundance of game fishes. Others, however, prefer the original version with its native fishes and endangered species. Most people fall somewhere between these two extremes. There are no easy answers to these issues, but an understanding of the consequences of our actions is critical to making informed management/conservation decisions for urban areas around the world.

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