DISCOVERING A FISH FAUNA: A HISTORY OF THE FISHES AND FISH SCIENTISTS OF WISCONSIN UP TO THE PUBLICATION OF GEORGE C. BECKER'S *FISHES OF WISCONSIN* IN 1983

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If you want to know anything about the fish fauna of Wisconsin, your first order of business should be to consult George C. Becker's magnificent book *Fishes of Wisconsin* (Figure 1), published in 1983 (available online at https://digicoll.library.wisc.edu/cgi-bin/EcoNatRes/EcoNatRes-idx?id=EcoNatRes.FishesWI). This classic provides detailed information about the identification, taxonomy, morphology, distribution, abundance and status, habitat, reproduction, age and growth, diet, ecology, and conservation and management of every species then known from the state. Lyons et al. (2000) and many scientific articles since 1983 have provided additional updates on the fishes of Wisconsin. Nowadays, it is easy to take for granted the voluminous, well-organized, and high-quality information we have at out fingertips. But of course, it wasn't always that way, and the publication of Becker's book was a watershed moment in the history of Wisconsin and North American ichthyology.

Becker worked on his opus for over 25 years and was aided by countless students and fellow biologists during his efforts. But of course, he didn't begin from scratch, and he relied heavily on the observations and investigations of earlier naturalists and scientists as the foundation upon which he built. Although Becker's book is clearly the single most important summary on Wisconsin fishes, the contributions of his predecessors should not be underestimated or forgotten. Some were eccentric and had eclectic, even scandalous, careers, but all collected data that notably increased our understanding of the Wisconsin fish fauna and how it had changed over time. Let's look at some of them and their findings and explore the ichthyological landscape leading up to the publication of Becker's *Fishes of Wisconsin*.

THE WISCONSIN FISH FAUNA BEFORE EUROPEAN SETTLEMENT

Nearly all of Wisconsin fishes are recent immigrants, at least geologically speaking. From 12,000 to 75,000 years ago, during the last ice age, most of the state was covered by thick glaciers. Only in the southwestern corner of the state, the so-called Driftless Area (Figure 2), where glacial drift—the gravels and finer sediments left behind by retreating glaciers—does not occur, was ice absent and unfrozen surface streams present. But in those days the Driftless Area must have been a harsh landscape for fishes, tundra-like and inhospitable. No fossils from this period exist, but given their preferences for cold water, perhaps Brook Trout *Salvelinus fontinalis* and Slimy Sculpin *Cottus cognatus* persisted in the region's streams throughout the glacial period. However, all the other fishes known from the state had to colonize as the glaciers receded over 12,000 years ago.

Humans entered the Wisconsin landscape soon after the glaciers were gone, and they undoubtedly caught and ate fish. However, the first fish remains identifiable to species do not appear in the archaeological record until about 2,000 years ago during the Woodland

Figure 1. One of my three heavily used copies of George Becker's 1983 book *Fishes of Wisconsin,* the most important single work on Wisconsin fishes.

Photos by the author unless otherwise indicated.

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Figure 2. Map of Wisconsin showing major rivers and lakes and places mentioned in the text.

Figure 3. The primary earthen pyramid at the archaeological site at Aztalan and the adjacent Crawfish River, summer 2020.

Figure 4. Fish bones recovered from an archaeological dig in 1967 at Aztalan and dating from 1000–1250 CE (JC-I-67). Left: *Esox* species (probably *E. lucius,* Northern Pike); right: *Ameiurus* species (probably *A. natalis,* Yellow Bullhead).

Period. At that point, Wisconsin was dotted with small settlements of Native Americans, many located along rivers or lakes, and their inhabitants regularly consumed fish. Perhaps the most interesting site is Aztalan, located in southeastern Wisconsin (Figure 2) along the Crawfish River. About 1,000 years ago emigrants from the great earthen-pyramid builders of the Middle Mississippian Culture, centered at Cahokia near present-day St. Louis, established a community at Aztalan among the Woodland people. They built a smaller version of Cahokia with large earthen pyramids (Figure 3). A stone weir was constructed across the Crawfish River to catch migrating fish, which are estimated to have made up 15–25% of their diet (Liegl 2014). Sixteen species have been reported from the site, the most common being Bigmouth Buffalo *Ictiobus cyprinellus*, Shorthead Redhorse *Moxostoma macrolepidotum*, Bullheads *Ameiurus* spp., Channel Catfish *Ictalurus punctatus*, Sunfishes *Lepomis* spp., Largemouth Bass *Micropterus salmoides*, and Freshwater Drum *Aplodinotus grunniens* (Figure 4; Table 1). The Aztalan settlement persisted for over 200 years before it was burned and abandoned for unknown reasons about 1250 CE (AD).

Other Woodland-Period archaeological sites have also yielded numerous fish bones. All told, 45 species have been reported from scientific excavations of sites in and adjacent to Wisconsin that were occupied between 0 and 1800 CE (Table 1). Most of the species are common in Wisconsin today, but three findings are noteworthy. First, a single Blue Catfish *I. furcatus* bone was collected from the Lundy Site near Galena, Illinois, which is about 10 miles south of the Wisconsin border (Emerson et al. 2007). There are no confirmed reports of this species from Wisconsin until unsuccessful stockings in the 1970s and 1980s, and the species was not considered part of the native fauna of the state by Becker (1983) and Lyons et al. (2000). This archaeological find suggests that the fish may have once been found in the state's waters. Second, three widely scattered sites, two near the Mississippi River (Theler 2000; Emerson et al. 2007) and one near Lake Winnebago in the Fox River drainage (Lake Michigan Basin) (Koziarski 2012), have produced Black Redhorse *Moxostoma duquesnei* bones. Currently, this species (Figure 5) is extremely rare in the state and known from only the Wisconsin River drainage (Mississippi River Basin). Archaeological evidence indicates that the species was probably more widespread and common in the state in the past. Finally, a striking feature of all excavations to date is the absence of Brook Trout. Early European settlers reported Brook Trout as abundant in many different streams and indicated that indigenous peoples ate them, so the lack of Brook Trout bones at archaeological sites is a little surprising. That said, none of the sites were on trout streams, although several had trout streams just a few miles away.

EARLY EUROPEAN ACCOUNTS

European explorers first passed through Wisconsin in the 1600s and settlers arrived in the 1700s. The first Europeans were drawn to the area in part by the rich fishing grounds, particularly along the Great Lakes (Bogue 2000). They often referred to the large numbers of easily captured fish of many different species including Lake Sturgeon *Acipenser fulvescens*, Lake Whitefish *Coregonus clupeaformis*, Lake Trout *Salvelinus namaycush*, and Yellow Perch *Perca flavescens* from the Great Lakes and tributaries; Suck-

Table 1. List of fish species reported from pre-European archaeological locations in and near Wisconsin. References: Mississippi: Theler 2000, 2017; Emerson et al. 2007; Inland: Rostllund 1952; Parmalee 1960; Cleland 1966; Koziarski 2012; Liegl 2014, Jason Miszaniec, UWZM, personal communication, 2021; Great Lakes: Rostlund 1952; Cleland 1966; Dunham 2014. Species recorded from the Aztalan site (Inland Lakes and Rivers) are indicated with an asterisk.

COMMON NAME	SCIENTIFIC NAME	LOCATION		
		MISSISSIPPI RIVER AND TRIBUTARIES	INLAND LAKES AND RIVERS	GREAT LAKES AND TRIBUTARIES
Sturgeons	**Acipenseridae**			
Lake Sturgeon	*Acipenser fulvescens*	X	X	X
Shovelnose Sturgeon	*Scaphirhynchus platorynchus*	X		
Paddlefishes	**Polyodontidae**			
Paddlefish	*Polyodon spathula*	X		
Gars	**Lepisosteidae**			
Longnose Gar	*Lepisosteus osseus*	X	X*	X
Shortnose Gar	*Lepisosteus platostomus*	X		
Bowfins	**Amiidae**			
Bowfin	*Amia calva*	X	X*	
Suckers	**Catostomidae**			
River Carpsucker	*Carpiodes carpio*	X		
Quillback	*Carpiodes Cyprinus*	X		
Longnose Sucker	*Catostomus catostomus*		X	
White Sucker	*Catostomus commersonii*	X	X*	X
Northern Hog Sucker	*Hypentelium nigricans*	X		
Smallmouth Buffalo	*Ictiobus bubalus*	X		
Bigmouth Buffalo	*Ictiobus cyprinellus*	X	X*	
Black Buffalo	*Ictiobus niger*	X		
Spotted Sucker	*Minytrema melanops*	X		
Silver Redhorse	*Moxostoma anisurum*	X		X
River Redhorse	*Moxostoma carinatum*	X		
Black Redhorse	*Moxostoma duquesnei*	X	X	
Golden Redhorse	*Moxostoma erythrurum*	X		
Shorthead Redhorse	*Moxostoma macrolepidotum*	X	X*	X
Catfishes	**Ictaluridae**			
Black Bullhead	*Ameiurus melas*	X	X*	
Yellow Bullhead	*Ameiurus natalis*	X	X*	
Brown Bullhead	*Ameiurus nebulosus*	X	X	X
Catfishes (continued)				
Blue Catfish	*Ictalurus furcatus*	X		
Channel Catfish	*Ictalurus punctatus*	X	X*	X
Tadpole Madtom	*Noturus gyrinus*	X		
Flathead Catfish	*Pylodictus olivaris*	X		
Pikes	**Esocidae**			
Northern Pike	*Esox Lucius*	X	X*	X
Trouts and Salmons	**Salmonidae**			
Cisco	*Coregonus artedi*			X
Lake Whitefish	*Coregonus clupeaformis*			X
Lake Trout	*Salvelinus namaycush*			X
Codfishes	**Gadidae**			
Burbot	*Lota lota*			X
Temperate Basses	**Moronidae**			
White Bass	*Morone chrysops*		X	X
Sunfishes	**Centrarchidae**			
Rock Bass	*Ambloplites rupestris*	X		X
Green Sunfish	*Lepomis cyanellus*	X		
Pumpkinseed	*Lepomis gibbosus*	X	X*	
Bluegill	*Lepomis macrochirus*	X	X*	
Smallmouth Bass	*Micropterus dolomieu*	X		X
Largemouth Bass	*Micropterus salmoides*	X	X*	X
White Crappie	*Pomoxis annularis*	X		
Black Crappie	*Pomoxis nigromaculatus*	X	X*	
Perches	**Percidae**			
Yellow Perch	*Perca flavescens*	X		X
Sauger	*Sander canadense*	X	X	X
Walleye	*Sander vitreus*	X	X*	X
Drums	**Sciaenidae**			
Freshwater Drum	*Aplodinotus grunniens*	X	X*	X

Figure 5. Black Redhorse, a species currently extremely rare in Wisconsin but more widespread and common prior to European settlement based on archaeological finds.

ers, Redhorses *Moxostoma* spp., Northern Pike *Esox lucius*, and Brook Trout from inland streams and rivers; Largemouth Bass and Smallmouth Bass *M. dolomieu*, Sunfishes, Crappies *Pomoxis* spp., and Walleye *Sander vitreus* from inland lakes; and Sturgeons, Catfishes, Buffalos *Ictiobus* spp., Basses, and Freshwater Drum *Aplodinotus grunniens* from the largest rivers. Accounts regularly extolled the huge numbers and massive sizes of fish and the ease of their capture. A typical example is:

> Fine trout, perch, bass, catfish, eels, buffalo, muskelonge [sic] and other excellent fish are found in all the waters… I have seen the buffalo, muskelonge and catfish of enormous size brought by wagon loads to Mineral Point. (Smith 1838, p. 24)

Mineral Point is in southwestern Wisconsin, which was the first inland area settled by Europeans, primarily for lead mining (Figure 2). While some of these early accounts were no doubt exaggerated, the large number and consistency of the descriptions indicates that Wisconsin in the early 1800s was an ichthyological paradise. However, as soon as European settlements arose, environmental modifications and destruction began. By the late 1800s much of the land had been plowed, the forests cut, the rivers dammed, the harbors and rivers polluted, and the easily accessible waters overharvested, to the detriment of the fish fauna.

THE FIRST COMPREHENSIVE WISCONSIN FISH LIST

The first attempt to list the fishes of Wisconsin was published by Hoy in 1883, well after environmental damage to Wisconsin waters had begun. Philo Romaine Hoy (1816–92; Figure 6) was a medical doctor residing in Racine in southeastern Wisconsin (Figure 2) who was also a very active naturalist. Typical of many naturalists of the era, he did not specialize and studied a wide variety of topics including geology, paleontology, archaeology, botany, and all aspects of zoology. He had previously published the first scientific paper on the fishes of Wisconsin, an investigation into the deep-water fauna of Lake Michigan off Racine (Hoy 1872). Two new species, the Blackfin Cisco *C. nigripinnis* and the Bloater *C. hoyi*, which was named after Hoy, were described within the paper by the ichthyologist Theodore Gill, who, curiously, has been attributed as the describer in subsequent publications but was not listed as an author of the paper in which the species were described. In his 1883 publication, Hoy listed 145 species from Wisconsin. However, he used the poorly resolved taxonomy and nomenclature of his time and did not provide any distinguishing features or illustrations nor preserve voucher specimens and, as a result, only about 85 (59%) of his species can be assigned unambiguously to current species.

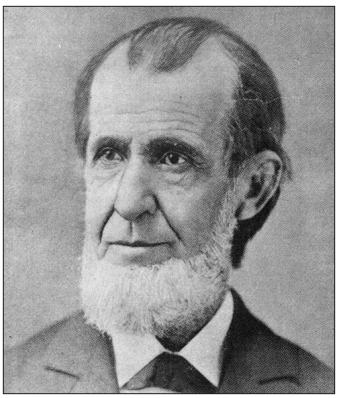

Figure 6. Philo Romaine Hoy, who published the first scientific paper on Wisconsin fishes in 1872 and compiled the first scientific list of Wisconsin fishes in 1883. Illustration from his obituary (McMynn 1893).

INITIAL FISH INTRODUCTIONS AND THEIR EFFECTS

About the time of Hoy's work, non-native species began to be introduced into Wisconsin waters. Fish populations and fisheries were in decline from the environmental destruction wrought by European settlement, and hatcheries and stocking were seen as the best solutions. From 1875 through 1925, at least ten non-native species (American Shad *Alosa sapidissima*, Goldfish *Carassius auratus*, Common Carp *Cyprinus carpio*, Rudd *Scardinius erythrophthalmus*, Tench *Tinca tinca*, Arctic Grayling *Thymallus arcticus*, Atlantic Salmon *Salmo salar*, Brown Trout *S. trutta*, Rainbow Trout *Oncorhynchus mykiss*, and Chinook Salmon *O. tshawytscha*) and 15 native species (Cisco *C. artedi*, Lake Whitefish, Brook Trout, Lake Trout, Northern Pike, Muskellunge *E. masquinongy*, White Bass *Morone chrysops*, Pumpkinseed *Lepomis gibbosus*, Bluegill *L. macrochirus*, Smallmouth Bass, Largemouth Bass, Black Crappie, Yellow Perch, Sauger *S. canadensis*, and Walleye) were raised in captivity and stocked in Wisconsin waters. With few roads in those days outside of the cities, much of the stocking was done from specially modified railroad cars (Figure 7). Of the non-native species, Goldfish, Common Carp, Brown Trout, and Rainbow Trout became established, and the stocking of the native species completely obscured their original distributions in many areas. Goldfish never became common, and Brown Trout and Rainbow Trout were generally welcomed, but Common Carp

Figure 7. The "Badger Two," a modified railroad car used for stocking fish throughout Wisconsin during the 1920s. This car replaced the original railroad car, "Badger One" which went into service in the late 1800s. Photo from the Mid-Continent Railway Museum in North Freedom, Wisconsin.

Figure 8. Common Carp was hailed as the salvation of Wisconsin fisheries when first introduced in the 1880s, but by the early 1900s had become hated and persecuted for its negative effects on native fishes and their habitats.

(Figure 8) quickly went from a solution to a problem. In the 1870s, Common Carp had been perceived as a savior to fisheries in decline throughout the United States, as articulated by Hoy:

> When you can go with hook and line and bag ten-pound specimens of that most desirable fish, the carp, then you will feel like thanking the men who have so persistently persevered in investigating every condition that can secure benefits so great. These waters that now produce so slender a supply of ordinary fish, then will teem with the best… (Hoy 1876, p. 39)

The waters soon did teem with Common Carp, and their constant stirring up of the bottom, uprooting of aquatic vegetation, and interference with spawning and feeding by other species soon caused further declines in Wisconsin's fisheries. By the early 1900s, the state had embarked on a massive Common Carp control program that continues to this day, has cost many millions of dollars, and has seen only limited and localized success. To most Wisconsinites, the Common Carp is a reviled and despised creature, and few thank the men who brought them to the state.

UNIVERSITY OF WISCONSIN STUDIES

The University of Wisconsin in Madison (Figure 2) began formal aquatic investigations in 1875 with the hiring of Edward Asahel Birge (1851–1950) as its first (and for many years only) instructor and later professor in Natural History. He was expected to teach classes in Botany, Bacteriology, Human Anatomy, Physiology, and Zoology and to develop and maintain the University's "Natural History Cabinet," which eventually gave rise to multiple campus museums including the University of Wisconsin Zoological Museum where I work. Birge and his close colleague and research partner Chancey Juday (1871–1944), who joined the University permanently in 1905, are considered among the most important figures in the development of the science of Limnology, the study of inland waters (Beckel 1987). Juday remained a professor his entire career at Wisconsin, but Birge rose rapidly in university administration, becoming Dean of the College of Letters and Science (the largest College in the University) from 1891–1918, the head of the Wisconsin Geological and Natural History Survey from 1897–1919, acting President of the University from 1900–1903, and permanent President from 1918–25. Although Birge was State Commissioner of Fisheries from 1895–1915, neither Birge nor Juday was a fish specialist, instead focusing mainly on zooplankton and physical and chemical limnology, but they developed a world-renowned aquatic research program that attracted other faculty and students who worked on fishes.

One of the first University of Wisconsin-Madison faculty to study fishes intensively was George Wagner (1873–1954). Upon his arrival in 1903, he began a statewide fish survey. He published four fish papers, including an annotated list of the fishes of Lake Pepin (Wagner 1908), a natural lake on the Mississippi River, in which he reported 44 species, most of which can be assigned to currently recognized species, and a description of a new species, the Deepwater Cisco *C. johannae*, from Lake Michigan (Wagner 1910). However, by the early 1910s he had largely dropped his fish investigations and began to work on birds, which remained his research focus for the rest of his career.

In 1912, Arthur Sperry Pearse (1877–1956) arrived at the University and took up fish work as Wagner transitioned to birds. He wrote seven papers on the food habits, habitats, and parasites of Wisconsin fishes from 1918–24 (e.g., Pearse 1918, Pearse 1924), but left in 1927 for Duke University, where he remained for the rest of his career and worked on a wide variety of topics in ecology. In 1920, he published a paper on Yellow Perch (Pearse and Achtenberg 1920) with a female student, Henrietta Lorraine Achtenberg (1893–1987), highly unusual for the times, and Achtenberg became the first woman to publish on Wisconsin fishes. Juday also had a few female students who studied and published about fishes in the 1930s. But in those days, educational and career opportunities for women in fisheries or ichthyology in Wisconsin were extremely limited, and they were even worse for people of color. Many institutions and government agencies formally or informally banned women and people of color from holding positions, and this did not begin to change in Wisconsin for many years (Matteson 2020). For example, the Wisconsin Department of Natural Resources (WDNR) did not hire its first female fish biologist until 1974 and its first fish biologist of color until 1986. Fish biologists in Wisconsin today remain overwhelmingly male and white.

BEYOND THE UNIVERSITY OF WISCONSIN

In the 1910s and 1920s, fish scientists from outside the University of Wisconsin-Madison also began to investigate Wisconsin fishes. By far the most important of these were Walter Norman Koelz (1895–1989), Alvin Robert Cahn (1892–1971), and Carroll Willard "Bill" Greene (1900–89). Walter Koelz (Figure 9) worked for both the US Bureau of Fisheries in Ann Arbor, Michigan, and later the University of Michigan studying the Coregonid fishes (Ciscoes and Whitefishes; Salmonidae) of the Great Lakes region. He produced several long and detailed publications describing new species and subspecies and summarizing their morphology, distribution, habitats, life history, and food habits, the most important of which were Koelz (1929), which covered the Great Lakes proper, and Koelz (1931), which focused on inland lakes, including many from Wisconsin. Koelz was definitely a "splitter," and he described many forms that are not recognized today. But his work was fundamental in understanding a very complex group. Once his monographs on coregonids were complete, Koelz stopped studying fishes and focused on the collection of plants, birds, and cultural artifacts from Asia, particularly the Himalayas and the Indian sub-continent. Some of his seed and plant collections proved highly valuable commercially, and he was honored for his contributions to US agriculture in the 1950s. Apparently he was somewhat eccentric and rarely wore shoes, even in the snowy depths of winter in northern Michigan.

Figure 9. Walter Koelz, a key figure in Coregonid taxonomy in the Great Lakes region, in garb he obtained in Asia. Apparently, this photo is unusual as he is wearing shoes. Photo from Bentley Historical Library, University of Michigan.

Figure 10. Alvin Cahn, who collected important fish data from southern Wisconsin, but whose career was later tainted by scandals involving illegal wrestling matches. Photo from the University of Illinois.

Alvin Cahn (Figure 10) also had a varied and eventful life. His family was well-to-do, and he grew up in Chicago but spent his summers on Oconomowoc Lake in Waukesha County in southeastern Wisconsin (Figure 2). For his Ph.D. at the University of Illinois, awarded in 1924, he conducted a survey of the fishes of the county and did detailed life history and ecological studies of Brook Silverside *Labidesthes sicculus* and Cisco in Oconomowoc and surrounding lakes (Cahn 1927). He found 90 species, and most of his records can be associated with modern species and specific locations. However, a few of his most interesting reports are of uncertain identity or questionable validity, and unfortunately, he did not preserve voucher specimens that could be used to resolve or confirm these records. Upon completion of his degree, he became a professor at the University of Illinois, where he moved away from fish work and focused more on malacology (the study of clams and mussels) and general ecology (Callomon 2019). However, his career during the 1930s was clouded by scandal. While at Illinois, he began organizing clandestine and illegal wrestling matches in towns around the Midwest under an assumed name, presumably for prize money and gambling. He was eventually discovered and fired from the university. He then moved on to the Tennessee Valley Authority, where he worked on forestry and land-use issues. But he continued to organize illegal wrestling matches and was once again found out and fired. Soon after, World War II broke out and he became a naval officer in the Aleutian Islands where he used his sailors to carry out archaeological investigations. After the war, he joined the staff of the US Occupation Administration in Japan as a biologist. There he focused on malacology, making collections in collaboration with Japanese malacologists. He also found time to become a trainer and manager of Japanese boxers, legally and under his own name this time. One of his boxers, flyweight Yoshio Shirai (1923–2003), won the world championship in 1952, the first Japanese boxer to ever win a world title, making him and Cahn national heroes in Japan. Cahn was known as "*hakase*" or "professor" by the Japanese press. Cahn remained in Japan until his death, and late in life suffered from dementia. During that period, Shirai and his family cared for him, and when Cahn died, having no children, he left Shirai all of his considerable assets.

Bill Greene (Figure 11) was perhaps the most important figure in Wisconsin fish studies prior to George Becker. As part of his Ph.D. degree at the University of Michigan under the direction of the prominent ichthyologist Carl Hubbs (1894–1979), Greene and fellow students and assistants carried out the most thorough and comprehensive survey of Wisconsin fishes to date. The survey went from 1925–28 and had assistance from Juday and Wagner at the University of Wisconsin, the Wisconsin Geological and Natural History Survey, and staff at the Milwaukee Public Museum. All existing preserved material from Wisconsin in natural history museums was examined, and 1,441 new collections were made from around the state, producing nearly 100,000 specimens. Most of these were deposited at the University of Michigan Museum of Zoology, where their identities were verified by Hubbs and Koelz. One-hundred and forty-nine species and 22 subspecies were collected, all of which have precise locality information and can be tied directly to modern species. One new species, the Largescale Stoneroller *Campostoma oligolepis* (Figure 12), was described from the survey (Hubbs and Greene 1935). Greene began work on the Wisconsin project in 1925 and but, oddly, left at the conclusion of the 1927 season before his degree was complete to work with the US Bureau of Fisheries on Lake Erie. In 1929, he moved to New York state where he worked on their famous watershed surveys through their completion in 1939 (Daniels 2011). During the mid-1930s he finally received his doctorate and published the results of the Wisconsin survey (Greene 1935).

Figure 11. The only photo I have been able to find of C. Willard Greene, who did the most complete, comprehensive scientific survey of the fishes of Wisconsin prior to Becker. He is pictured in 1929 during his early days on the New York State Watershed Surveys. Photo of plate in Moore (1930).

Figure 12. Largescale Stoneroller, a species discovered and described as a result of the statewide Wisconsin fish survey carried out by Greene.

Figure 13. The non-native Sea Lamprey devasted Lake Trout, Burbot, and Lake Whitefish populations in the Great Lakes until brought under control with toxicants in the 1960s.

He remained with the New York Department of Conservation for the rest of his career, rising to Chief of Fisheries in the 1960s.

BIG CHANGES IN THE GREAT LAKES FISH FAUNA

During the middle of the 20th century, new fish species appeared in Wisconsin waters of the Great Lakes with huge consequences for native species and fish communities. The expansion of the Welland Canal during the 1930s, which allowed ocean-going ships to bypass Niagara Falls, permitted the Sea Lamprey *Petromyzon marinus* (Figure 13) to invade the Upper Great Lakes. A blood parasite that attached to large sharks and marine mammals in its native Atlantic Ocean, the Sea Lamprey's blood feeding became lethal when it was focused on the much smaller Lake Trout, Lake Whitefish, and Burbot *Lota lota* of the Great Lakes. Combined with overfishing, Sea Lampreys nearly eliminated Lake Trout and Burbot, the main top predators, from the Great Lakes.

At about the same time the Sea Lamprey arrived, the Rainbow Smelt *Osmerus mordax* was introduced into a Michigan lake and soon spread to Lake Michigan and from there the rest of the Great Lakes. Although popular as an easily caught food fish, the Rainbow Smelt competed with and ate the larvae of native Whitefishes and Ciscoes, the main planktivores of the Great Lakes, and combined with overfishing to drive their populations to low levels. After initially reaching very high abundance during the 1930s, Rainbow Smelt populations fluctuated greatly during the 1940s through 1980s in Lake Michigan and are now much less common for reasons that remain unclear.

In the early 1950s another East Coast species, the planktivorous Alewife *A. pseudoharengus*, used the Welland Canal to reach the upper Great Lakes. With all of its potential predators and competitors gone or greatly reduced, the Alewife reached staggeringly high numbers by the 1960s. At one point in the early 1960s it was estimated that perhaps 90% of the total fish biomass in Lake Michigan was Alewives and that the population was in the many billions. Alewives were sensitive to rapid water temperature changes during and after spring spawning, and regular die-offs choked shorelines with huge layers of smelly dead fish. Lake Michigan communities that had once relied on the lake for commercial fishing, transportation, and recreation suffered major economic losses and turned their attention away from the lake.

Great Lakes fish communities changed dramatically again in the mid-1960s. By then a massive research effort had developed a lamprey-specific toxicant to kill larval Sea Lamprey (Brant 2019), and Sea Lamprey numbers had been reduced to a level that permitted efforts to recover top predator populations. The State of Michigan began stocking Coho Salmon *O. kisutch* and Chinook Salmon to take advantage of the abundant and unutilized Alewives. Although previous salmon stockings had been a failure, these new stockings proved wildly successful (Parsons 1973). Salmon survived well and grew quickly to large size, creating a hugely popular sport fishery. Although successful natural reproduction of salmon was initially limited and low, all of the Great Lakes states including Wisconsin ramped up hatchery production and stocking to meet the demand of "Salmon Fever." Brown Trout and Rainbow Trout were also widely stocked and provided good returns. Eventually, naturalized, self-sustaining populations developed for Chinook Salmon, Rainbow Trout, and Brown Trout on the Michigan side of Lake Michigan (Wisconsin tributaries proved to be too warm) and for Coho Salmon, Rainbow Trout, and Brown Trout along the Wisconsin and Michigan shorelines of Lake Superior, but heavy stocking was continued to meet high angler demand. In Lake Michigan, large numbers of salmonid predators coupled with changes in the zooplankton and benthic invertebrate communities wrought by the invasion of non-native Zebra and Quagga mussels decreased the Alewife population and large die-offs became a thing of the past. With their beaches and harbors no longer fouled and good salmon and trout fishing readily available, lakeshore communities recovered, their economies driven largely by sport fishing, pleasure boating, and other forms of lake-centered recreation. Salmon and trout fishing remains key to the economy of many Lake Michigan cities and towns to this day.

GEORGE C. BECKER

The late 1930s not only saw changes in Great Lakes fish communities but also a changing of the guard at the University of Wisconsin-Madison with the hiring of Arthur Davis Hasler (1908–2001) as an instructor in Zoology in 1937. After World War II and the death of Juday, the retirement of Birge, and his promotion to professor, Hasler became the sole faculty member regularly working on fish biology at the University until the hiring of professors John James Magnuson (b. 1934) in 1968 (my major professor 1979–84) and James Fredrick Kitchell (1942–2020) in 1974 (Beckel 1987). Hasler is famous for his work on experimental limnology and on fish navigation, culminating with his groundbreaking studies documenting that migrating salmon use their sense of smell to find their natal stream for spawning (e.g., Hasler et al. 1978). Hasler carried out some of his most important field experiments on salmon homing using stocked Coho Salmon in Lake Michigan (Figure 14). Perhaps most relevant for our story, he also served as the major professor for George C. Becker's M.S. and Ph.D. degrees and encouraged him to work on a book about the fishes of the state.

George Charles Becker (1917–2002; Figure 15) was born and raised in Milwaukee, where he grew up with a passion for foreign languages, music, nature, and the outdoors. He went to the Wisconsin State Teachers College in Milwaukee (now University of Wisconsin-Milwaukee) and received an undergraduate degree in music (violin) with a minor in German and then moved to the University of Wisconsin-Madison where he completed a master's degree in Germanic philology: the structure, historical development, and relationships among Germanic languages (Matteson 2020). In his last semester of graduate school in 1939, on a bit of a whim, he took

Figure 14. Arthur Hasler with a Lake Michigan Coho used in an experiment on olfaction's role in salmon homing. Photo from the Center for Limnology, University of Wisconsin-Madison.

Figure 15. George Becker, the most important Wisconsin ichthyologist, with specimens from the fish collection he developed at the University of Wisconsin-Stevens Point. Photo from UWSP.

the course "Game Management" taught by famous conservationist Aldo Leopold (1887–1948). That course changed his life (Karl 2002; Ness 2003; Matteson 2020). Although he became a high school foreign language teacher from 1940–49, with a break to serve in the US Army in the Pacific in World War II from 1942–45 and a stint as a high school principal from 1947–49 (Anonymous 2002), his new passion had become biology and conservation. He left teaching in 1949 and used his GI Bill benefits to become a full-time graduate student in Madison in Botany and Zoology in 1949 (Matteson 2020).

Becker had hoped to work with Leopold, but Leopold had died unexpectedly in 1948. Becker was interested in everything: plants, insects, birds, and mammals. At Madison, he met Hasler, who got him started in aquatic biology and ichthyology. Hasler asked Becker if he'd like to help in writing some chapters for a book on Wisconsin fishes that Hasler was planning. Becker enthusiastically agreed, and he wrote a couple of preliminary accounts that served as his Master of Science thesis in Zoology in 1951. But it soon became clear that Hasler was too busy and too involved in other research to ever give the book the attention and effort it deserved. Eventually, Hasler gave Becker his blessing to do the book himself.

The first step in the book project was for Becker to get his Ph.D. He had completed the necessary coursework by the time he finished his master's degree, and he began his doctoral field work in 1952. He and his wife Sylvia Helen (Klenk) Becker (1918–2002) and three young sons rented a home in the country with a stream nearby for his research on the comparative anatomy and ecology of the Western Blacknose Dace *Rhinichthys obtusus* and the Longnose Dace *R. cataractae* (Figure 16). Becker had used up his GI Bill benefits, so he commuted into Madison and taught high school foreign languages to support his family. After doing this for five years, he finally decided he would teach biology full time. He became a professor of biology at the University of Wisconsin-Stevens Point (UWSP) in 1957, and he and the family moved to an old farm on a river outside of town where he could continue his Ph.D. field work. In 1962 he completed his dissertation and received his doctorate from the University of Wisconsin-Madison.

Early on, Becker realized that he would need help in collecting the data necessary for his book. Each summer, he enlisted his wife and sons to help collect field data. They would travel to a specific area of the state and stay in a small camper for several weeks, making fish collections from nearby lakes, rivers, and streams. During the school year when he taught ichthyology, he would send groups of undergraduate students out to conduct fish surveys in various river systems around the state and then to investigate the morphology, age and growth, and diet of the specimens they found. He noted that:

> Some of the students were very conscientious. They came back with some really big collections and a lot of variation in fish species. On the other hand, we had a collection with maybe only ten, 15 fish in the bottom of a bottle, which tells me that these students probably were boozing it up somewhere… (Matteson 2020, p. 292)

Interestingly, Becker never boozed it up himself as he did not drink or smoke. A man of strong principles, he'd made a vow not to as a Boy Scout, and he stuck with his vow for the rest of his life, excepting one beer when he returned from World War II (Ness 2003). Becker published a series of 11 papers from 1959–76 describing results from all of his fish surveys as a build-up to the book (e.g., Becker 1959, 1976). Most of the specimens collected were deposited at the UWSP Natural History Museum, which he helped create. In 1970, he and Marlin Johnson (b. 1940), a professor at the University of Wisconsin-Waukesha County who had done extensive fish collecting in southern Wisconsin, published a revised and annotated list of the fishes of the state (Johnson and Becker 1970). They reported 154 established species and subspecies and 13 additional "problematic" species whose status in the state was uncertain.

Becker also relied extensively on fish data and information from the WDNR (Department of Conservation prior to 1967) for his book. In the early 1970s, the WDNR started a statewide fish survey of their own, and Becker's son Dale Richard Becker (1948-Present) served as principal taxonomist during its early years. Although the survey ended in the early 1980s with only about 40–50% of the state completed (Fago 1992), many of the survey records and observations were included in Becker's book. However, Becker had a complex relationship with the WDNR. On the one hand, he had taught many of the WDNR aquatic and fisheries biologists, and some were friends. He supported many of the environmental protection and resource

Figure 16. Longnose Dace, one of the subjects of George Becker's unpublished Ph.D. dissertation.

management efforts of the WDNR. On the other hand, Becker was a persistent and vocal critic of the WDNR when he disagreed with their actions, particularly their fisheries management policy of "rehabilitation" with toxicants, in which all of the fishes in a lake or stream would be poisoned with toxaphene, antimycin, or rotenone to either eliminate warmwater fishes to allow the stocking of trout, reduce stunted panfish populations to improve growth and size structure, or attempt to eliminate nuisance populations of Common Carp (Klingbiel 1975). Becker considered these poisonings "biological insanity" and argued passionately and eloquently that the possible short-term benefits to fishing from toxicants were more than offset by the long-term damage to native fishes and invertebrates (e.g., Becker 1975). He brought two unsuccessful lawsuits in the late 1960s and early 1970s to try and stop poisoning projects, angering WDNR administrators and fisheries managers. Probably as a result, his requests for collaboration and information from WDNR were often ignored (Matteson 2020).

Besides *Fishes of Wisconsin*, Becker had many other interests and activities. His love of music remained strong for his entire life, and he played violin in the Stevens Point Civic Symphony and formed a family string quartet (Anonymous 2002). He enjoyed gardening, maintaining a large vegetable garden wherever he lived, sport fishing, taking his family on extended fishing trips all over North America during the summer, and bird watching, serving a term as the president of the Wisconsin Society for Ornithology (Karl 2002). After his retirement from UWSP, he and Sylvia enjoyed going to nudist camps (Ness 2003). He was active in the Wisconsin Academy of Sciences, Arts, and Letters. He opposed the Vietnam War and nuclear power and helped form and lead the Citizens Natural Resources Association (CNRA), an environmental organization that fought (sometimes with the WDNR) to clean up the Wisconsin River, which in those days was heavily polluted from untreated industrial and municipal wastes (Matteson 2020). In part due to Becker and the CNRA's efforts, the Wisconsin River is now much cleaner and supports much healthier fish communities than in the 1960s (Lyons 2005).

Becker was also a very fine teacher (Matteson 2020). He won the UWSP Excellence in Teaching Award in 1962 and was a finalist in several other years (Anonymous 2002). Several friends of mine who attended UWSP said he was the best professor they had during their college careers. He was rigorous but fair and approachable, and he effectively communicated his love for the subjects he taught. His enthusiasm was contagious. They also noted that he had an uncanny ability to remember student names and backgrounds after just a brief meeting.

COMPLETING AND PUBLISHING THE BOOK

Becker began writing *Fishes of Wisconsin* in 1958 and finished 25 years later in 1983 just a few months before its publication (Matteson 2020). The last years were the most intense, with many late nights, weekends, and vacations spent writing. He had a sabbatical from teaching at UWSP in 1978 during which he averaged 14 hours a day on the book. Friends talk of seeing the lights on in his office, the only ones on in the building, as they left campus and headed out for the bars and parties on Friday and Saturday nights. Becker retired from teaching in 1979 (Karl 2002) but continued working long hours to finish the book. Sylvia was a major help in the last stages, particularly the index, by which time Becker said "I was blue in the face. I just couldn't go any further" (Matteson 2020, p. 297).

But finally, the book was done. It was 1,052 pages, the biggest ever of the "state" fish books up to that time, and it included accounts for 157 established or former species and 25 families plus color and black-and-white plates, detailed illustrated identification keys, a glossary, and sections on Wisconsin waters, fishery management, and fish parasites. The University of Wisconsin Press printed 3,050 copies initially. Sales were a little slow at first because of both the high price, $75 ($200 in 2021 dollars), and the fact that nearly every likely purchaser in the WDNR and University of Wisconsin system had already pre-ordered the book at half-price over a year earlier. This pre-order promotion apparently hurt the University of Wisconsin Press financially, and I remember getting a strange letter from the Press that went out just before the book was released to all those who pre-ordered asking they reorder the book at full price to help them out. I don't think they got many takers.

Reviews of *Fishes of Wisconsin* were generally positive and complimented the book's comprehensiveness and thoroughness. Most of the book's accounts included large amounts of new or previously unpublished data and personal accounts and opinions, which some reviewers disliked, but which most users felt was one of the strengths of the book. It soon became the "bible" for academic and agency fish biologists in and around Wisconsin. Word of mouth from fish professionals to anglers, aquarium hobbyists, and native fish enthusiasts led to increasing sales, and by the late 1980s the first print run had sold out. By then, the book was recognized as a classic, and used copies were fetching $200 (nearly $400 in 2021 dollars).

Becker contemplated a revision, but by that point his age and Sylvia's worsening health made that impractical. The large size and high cost of the book also made revision difficult without substantial outside support for the production and printing to keep the book price reasonable, which was not forthcoming. However, in 2001, the University of Wisconsin Press was able to reprint 500 copies of the book using an inexpensive photo-reproduction technique. Unfortunately, the quality of the print and plates was not nearly as good as in the original. Nonetheless, the book was back in print to Becker's great satisfaction. Sadly, he died the next year. The reprints, costing $100, sold out within a few years and the book is again only available used at well above list price, testifying to its enduring value and popularity.

Becker received many accolades and awards for his book and his career, culminating with his posthumous induction into the Wisconsin Conservation Hall of Fame in 2010. Although he made many important contributions to education, science, and conservation in Wisconsin, his book was his greatest legacy, and it lives on today as a benchmark against which similar "Fishes of" books are judged. It also serves as a solid foundation for all of the extensive fish work that has occurred in Wisconsin since 1983.

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