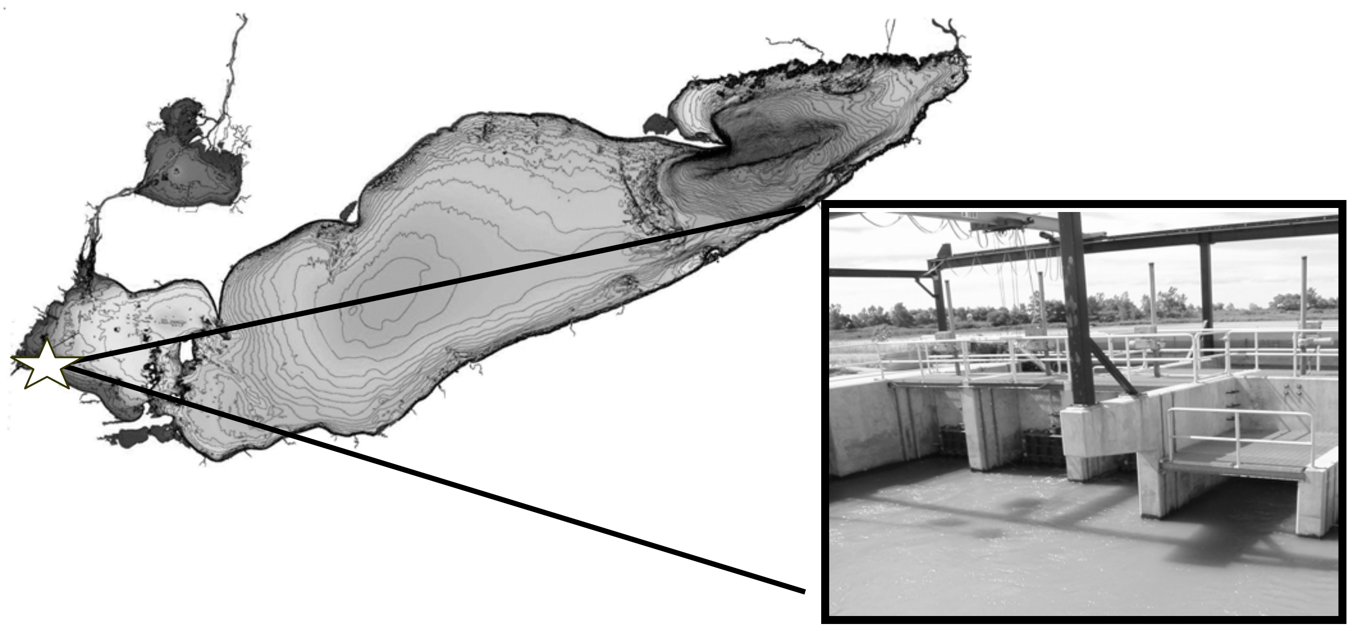
FISH PASSAGE BETWEEN LAKE ERIE AND METZGER MARSH

MONITORING OF AN EXPERIMENTAL FISH PASSAGE STRUCTURE

2000 – 2001
Progress Report

August 20, 2002



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Abstract *Metzger Marsh is a 367 hectare (906 acres) coastal wetland jointly managed by US Fish and Wildlife Service (Service) and the Ohio Department of Natural Resources Division of Wildlife (ODOW). In 1995, construction of a 2,348 meter (7,700 feet) dike designed to mimic the eroded barrier beach, completed the Metzger Marsh Wetland Restoration Project. In order to prevent further isolation of wetlands to Lake Erie fish communities, a fish passage structure was integrated into the design. The structure includes trapping apparatuses in front of two of the five water control gates (screw gates), designed for sampling fish movement into and out of the marsh. The Army Corps of Engineers permit requires that the five screw gates be open for a minimum of four years to evaluate marsh and fish community response. Conceptually, this will allow the system to interact with Lake Erie on a hydrological and biological basis. The gates were opened in March of 1999 and fish monitoring began in the April of 1999. Fish community monitoring at the structure and within the marsh has revealed the importance of this system to Lake Erie fishes, both seasonally and for the resident community. Preliminary data suggest that the marsh is of great importance as a nursery area for several key species. As of fall 2001, 39 species of fish from 16 families were identified in fish sampled at the Metzger Marsh fish structure. The fishery data will be important to agency managers for future operation and management planning purposes.*

Introduction

The Great Lakes coastal wetlands are sources of high productivity. They provide reproductive, rearing, and protective habitats for numerous animal species along with nutrient exchange with the lakes. The Great Lakes have suffered substantial loss of their coastal wetlands over the past century. Agriculture and development have claimed an estimated 60 to 80% of the original wetlands (Comer et al. 1995). The shoreline of Lake Erie has been developing at a faster rate than any other part of the Great Lakes (Bookhout et al. 1989). Approximately 90% of Ohio's original coastal marshes have been lost to development and agricultural activities (Dahl and Johnson 1991; Herdendorf 1987).

Of the remaining coastal wetlands along western Lake Erie, approximately 84% are disconnected from the lake because of diking activities used to promote agriculture, development, and single-use habitat production. This has resulted in a decline of water quality and aquatic species diversity (Steedman and Regier 1987). Lacking a connection, the coastal wetlands and nearshore habitats of western Lake Erie no longer function as a single ecosystem. It has been speculated that the diversity of aquatic species utilizing coastal wetlands is related to high levels of primary productivity associated with the marshes (Stephenson 1990). This species diversity is maintained within a coastal wetland by rejuvenation from the fluctuations of Great Lakes water levels (Geis 1979). Coastal wetlands are buffer zones which normally trap sediment and moderate flood events. Without coastal wetlands, Lake Erie is vulnerable to degradation from pollution and lack of enrichment because runoff from surrounding lands is no longer filtered through these wetlands (Mitsch and Bouchard 1998).

Fishery management within diked systems has been given little consideration. Fish communities utilize coastal wetland systems for spawning, nursery, feeding and protective areas. Fish diversity within a freshwater coastal marsh can be quite extensive. Almost all freshwater fish species use wetland areas at some point in their life cycle (Mitsch and

Gosselink 1993). It has been estimated that 47 species of Lake Erie fish are or have been associated with the coastal wetlands during some stage of their life cycle (Johnson 1989). Decline in fish abundance since 1850 has been attributed to inaccessibility, due to diking and draining, of coastal wetlands (Trautman 1981).

The Ohio Division Of Wildlife (ODOW), United States Fish and Wildlife Service (Service), and Ducks Unlimited initiated a joint wetland restoration project for Metzger Marsh in 1992. The purpose of the project was to restore 367 hectares of lucastruine / palustrine habitat by building a 2,348 meter dike to mimic the eroded barrier beach. From the 1930's until the mid 1940's the marsh was owned and operated as an onion farm. During that period, a barrier beach existed in front of the marsh. This beach acted as a buffer, protecting the farm from wave energy and other erosion forces. In the early 1960's lake levels began to rise. Water levels continued to rise and maintained their high levels for three decades. The resulting wave energy finally caused the barrier beach to erode away during a storm event in 1972 leaving the marsh open to unimpeded wave action. In an effort to maintain connectivity with Lake Erie, an experimental structure was proposed for Metzger Marsh. The newly renovated dike would maintain an opening to the lake allowing for nutrient exchange and species migration between the two systems by incorporating a fish passage and water control structure into the design. The purpose for this experimental structure was to explore other methods of marsh management that would embrace an ecosystem approach and optimize species diversity while providing protection from large storm events. This structure was added to the dike in 1996 and began operating in the spring of 1999. A U.S. Army Corps of Engineers (Corps) permit allowed the construction and contained requirements to evaluate the ecological effectiveness of the restored system. The permit also states that after re-vegetation of the marsh, the five water control gates and screw gates at Metzger Marsh are to remain open for a minimum of four years. This will allow the marsh water levels to fluctuate "naturally" with lake levels. During this time, the fish trapping facility will be in operation to monitor the migration of fish in and out of the marsh while excluding carp by means of the grating system. One of the components of the permit was a requirement to evaluate and compare the pre- and post-construction flora and fauna utilizing the marsh. Critical to future management of the marsh was a need to determine the temporal use of the marsh by Lake Erie fish species. This report provides an update on the findings relative to monitoring of the fish community utilizing the restored (post-construction) marsh.

Study Site

Metzger Marsh is a 367 hectare coastal wetland on Lake Erie. It is approximately 32 kilometers east of Toledo, Ohio. A 2,348 meter lakefront dike was built in Metzger Marsh with an experimental fish passage structure to promote species diversity and maintain a connection with Lake Erie.

Fish access was incorporated into the design of the dike to enhance the ecosystem benefits of the restoration project. The fish passage structure is 12.2 meters wide with five openings. Each opening is 1.5 m x 1.5 m with mechanically operated screw gates. The fish passage structure contains two trap baskets. One of the traps is set to sample fish entering the marsh (ingress) while the second trap is set to sample fish leaving the marsh (egress). These traps are set in the east and west openings respectively. The baskets allow a portion of the fish moving between the lake and the marsh to be examined.

The original trap design utilized in 1999 and 2000 was not effective in sampling the entire water column. While the water depth at the structure averaged 1.5 – 1.8 m, the traps were only 0.9 m in height. Once the fish entered the trap, they were free to swim out because the top was completely open. The traps were redesigned in 2000 to more efficiently sample the entire water column. The redesigned traps are 2.4 m in height and are constructed of galvanized steel with a tunnel in the front containing "fingers" which allow fish to enter but not exit (Figure 1). It is comprised of a grating system on all sides which are 5 x 30 cm. A 5-ton overhead crane is used to maneuver the baskets. A series of removable grates can be placed in front of all five openings. There are various grate sizes, ranging from 5 to 20 cm, which will be used to determine the best grate size for prohibiting entry of carp but allowing desirable fish species to pass freely.

Figure 1. Fish trapping baskets were re-designed in 2000 to more effectively sample fish entering Metzger Marsh. Photo on left shows the grate system used to limit access by larger fish and the crane used to lift the basket from the water. Photo on right shows the entrance to the basket guarded by "fingers" to prevent escape once fish have entered the trap.

Methods

Sampling of the fish passage structure began in 1999 and will continue through the spring of 2003. The baskets were lifted twice daily during spring months. Lift frequency was reduced to daily lifts during the summer. As fish migration diminished in the fall, baskets were lifted once daily, twice weekly.

Fish captured in the baskets were identified to species; counted, weighed (g), and measured (total length in millimeters). All sport fish were tagged with t-bar anchor tags and the right pectoral fin was clipped to determine movement patterns relative to entry, exit, and re-entry on a temporal basis. Fin clipping was used on fish over 100 mm in length. Scale samples were also removed from sport fish for age determination.

Abiotic parameters were recorded for every lift and set of the trap baskets. Dissolved oxygen, pH, conductivity, bottom water temperature, surface water temperature, air temperature, wind direction and speed, water depth, flow direction, and transparency were recorded. These same parameters were also collected during larval sampling at the structure.

Larval sampling was conducted, weekly in 2000 and monthly in 2001, during the evening hours beginning in mid-April. Four ten-minute samples were taken using a 0.5 m ichthyoplankton net (303µ) which was positioned on the downstream side of the fish trapping area (dependent on the flow direction at the time of sampling). Larval sampling concluded in August. Samples were preserved in alcohol for later identification. Analysis of those samples has not occurred and is not discussed in this report. Results of that study will aid in determination of larval fish use of the wetland.

Results

Information presented in this report represents combined data collected during the 2000 and 2001 field seasons. Data from the two years have been combined to better illustrate seasonal trends through time. Use of the improved trap design was initiated in late 2000 and throughout the 2001 sample season. There is little question that the catch efficiency was greatly improved with the new design as illustrated in Figure 2. Although a primary objective of the monitoring program was to determine timing of fish migration, any attempts to draw conclusions relative to comparisons between fish ingress and egress, based on the 2000 and 2001 catch, are greatly confounded by the size of the grating used to construct the traps. The 5 cm gap allows all small fish to enter and exit at will from either side of the basket and prevents determination of the direction of travel. Small fish on the inside of structure are just as apt to enter the ingress basket from the back side as they are to enter the egress basket from the front side. Therefore, due to this data bias, the ingress and egress samples were combined for this report and simply represent the catch "at the structure". Common carp migration patterns was another objective of this study as they are an undesirable species that has the potential to detrimentally impact wetland habitat. Since sampling began in 1999, total CPUE for carp has decreased (Figure 2). This trend is especially interesting as the CPUE has increased over the same period for other species and is probably explained by the improved trapping efficiency realized by the re-designed baskets. Closer examination of this trend will occur when the 2002 data are included as this information is critical to future management planning. Timing information regarding this species will be of great importance to marsh mangers.

In 122 days of sampling a total of 39 species of fish were identified at the fish passage structure in 2000-2001 (Table 1). Fish species sampled at the Metzger March fish passage structure were categorized into three guilds that are most interesting from a marsh management perspective. These categories were phytophilic, lake, and tolerant species. Examination of these guilds can be compared with data collected from inside the marsh, allowing for a more accurate analysis of the direct benefits of coastal marsh restoration efforts to species that rely on these critical habitats. The top ten most abundant species contain representatives from all three guilds and indicate the importance of Metzger Marsh to the Lake Erie ecosystem.

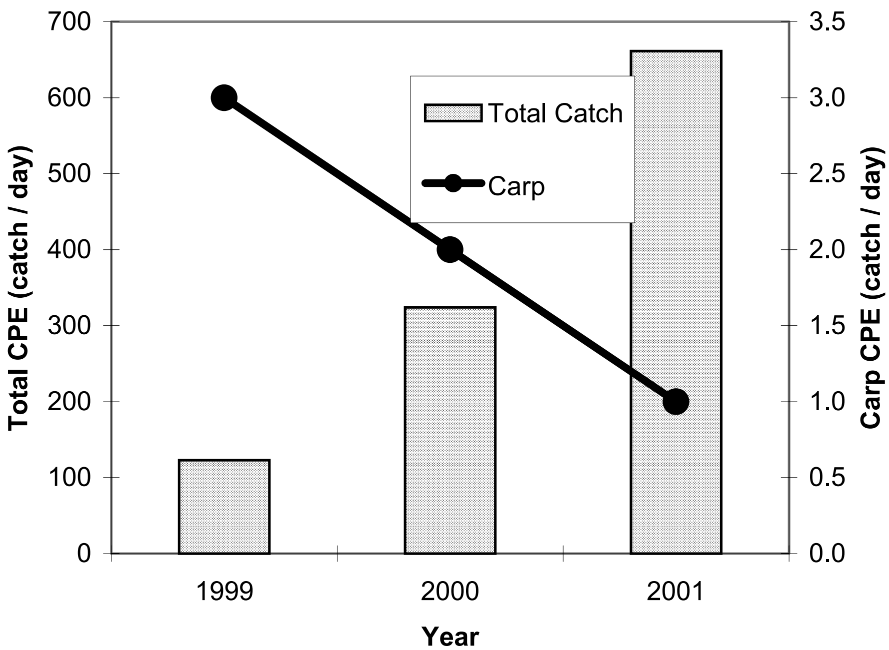

Figure 2. Total CPUE for carp, compared with total CPUE for other fish species as sampled at the Metzger Marsh fish access structure in 1999-2001. Samples from the ingress and egress baskets are combined.

An examination of total CPUE on a temporal basis shows that catch was greatest during the summer months (May - August) with July and August being the months of greatest catch (Figure 3). Further examination of the catch based on life stage (size) illustrates the importance of the marsh as a nursery area.

Figure 4 displays monthly length frequency distribution of gizzard shad, which, by number, was the most abundant species sampled at the fish structure. A majority of the gizzard shad captured in 2000 and 2001 were captured in July and August as young-of-the-year (YOY) fish. Gizzard shad are an important forage species for Lake Erie predators such as walleye.

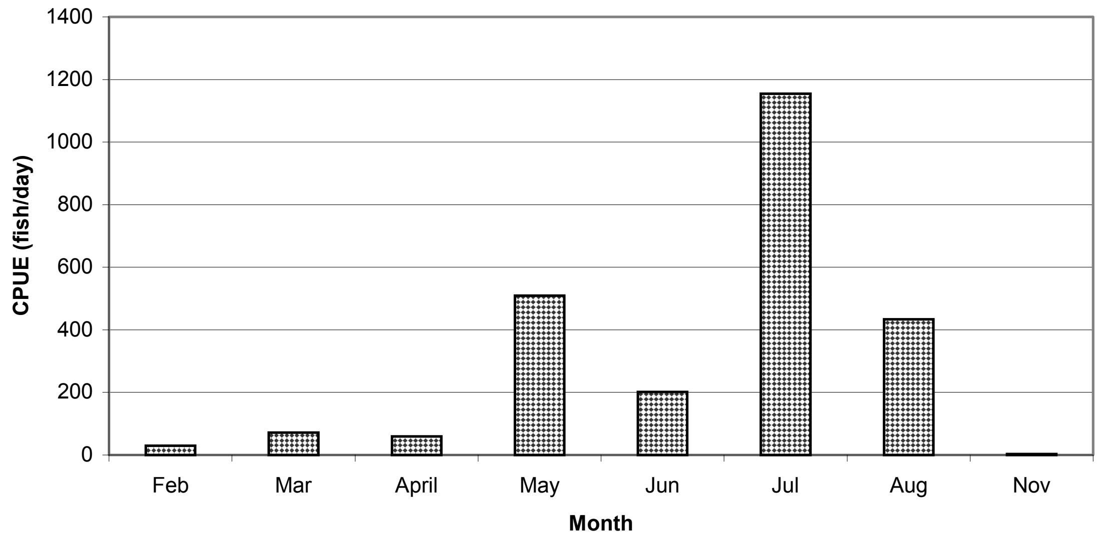

Figure 3. Mean monthly CPUE, all species, ingress and egress combined, for fish sampled at the Metzger Marsh fish passage structure, 2000-2001.

Similarly, largemouth bass were captured in all months March-August, however, the catch was dominated by YOY captured in June-August (Figure 5). In both Figure 4 and Figure 5, although some adult and sub-adult fish were present in the March-June catch, there is nothing to imply or confirm that the recruitment indicated by the abundance of YOY fish came from within the marsh. As previously discussed, the grates in front of the sampling baskets would allow free movement of small fish in and out of the basket. It is, however, probable that the resident population of largemouth bass that has become established in the marsh is reproducing and is likely the source of recruitment for that species.

Table 1. Total and juvenile fish catch per unit effort (catch/day) sampled at the Metzger Marsh fish passage structure 2000-2001. Catches of the five most abundant species of each of three guild classifications are bolded: ^{T} indicates tolerant species, ^{L} indicates open lake species, and ^{P} indicates phytophilic species (per Johnson and Braig 2002).

Common Name	*Scientific Name*	CPUE (catch/day)
Gizzard Shad	***Dorosoma cepedianum***^{T}	**359.17**
Emerald Shiner	***Notropis atherinoides***^{L}	**217.11**
Spottail Shiner	***Notropis hudsonius***^{L}	**18.67**
White Perch	***Morone americana***^{L}	**16.39**
Largemouth Bass	***Micropterus salmoides***^{P}	**10.53**
White Bass	***Morone chrysops***^{L}	**10.48**
Round Goby	*Neogobius melanostomus*	8.51
Alewife	***Alosa pseudoharengus***^{L}	**6.82**
Carp	***Cyprinus carpio***^{T}	**3.04**
Bowfin	***Amia calva***^{P}	**2.48**
Brook Silverside	***Labidesthes sicculus***^{P}	**1.57**
Freshwater Drum	*Aplodinotus grunniens*^{L}	1.19
Pumpkinseed	***Lepomis gibbosus***^{P}	**0.66**
Bluntnose Minnow	***Pimephales notatus***^{T}	**0.55**
Yellow Perch	*Perca flavescens*^{L}	0.52
Spotfin Shiner	***Cyprinella spiloptera***^{T}	**0.44**
Bluegill	***Lepomis macrochirus***^{P}	**0.43**
Northern Logperch	*Percina caprodes semifascita*^{P}	0.39
Sand Shiner	*Notropis stramineus*	0.37
White Sucker	***Catostomus commersoni***^{T}	**0.32**
Golden Shiner	*Notemigonus crysoleucas*^{P}	0.31
Rockbass	*Amploplites rupestris*	0.22
Smallmouth Bass	*Micropterus dolomieu*	0.22
Quillback	*Carpiodes cyprinus*^{L}	0.20
Walleye	*Stizostedion vitreum*^{L}	0.17
Bigmouth Buffalo	*Ictiobus cyprinellus*^{T}	0.16
Black Crappie	*Pomoxis nigromaculatus*^{P}	0.14
Channel Catfish	*Ictalurus punctatus*^{T}	0.11
White Crappie	*Pomoxis annularis*^{T}	0.07
Yellow Bullhead	*Ameiurus natalis*^{P}	0.07
Rainbow Smelt	*Osmerus mordax*^{L}	0.07
Brown Bullhead	*Ameiurus nebulosus*^{P}	0.06
Goldfish	*Carassius auratus*^{P}	0.06
Longnose Gar	*Lepisosteus osseus*^{P}	0.06
Orangespotted Sunfish	*Lepomis humilis*^{T}	0.05
Troutperch	*Percopsis omiscomaycus*^{L}	0.05
Tadpole Madtom	*Noturus gyrinus*^{P}	0.03
Northern Pike	*Esox lucius*^{P}	0.01
Rainbow Trout	*Oncorhynchus mykiss*^{L}	0.01

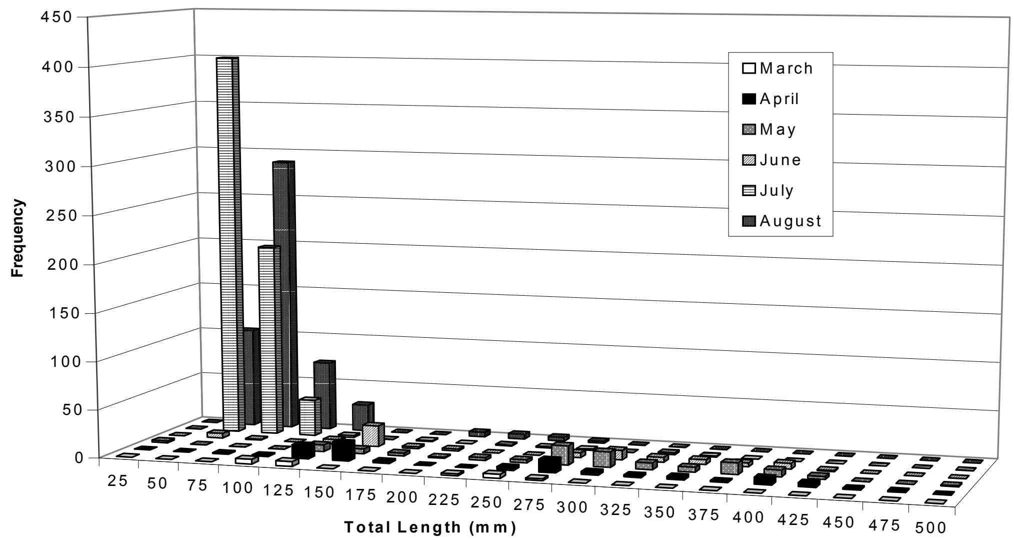

Figure 4. Length-frequency distribution of gizzard shad, ingress and egress combined, by month of sample at the Metzger Marsh fish passage structure, 2000-2001.

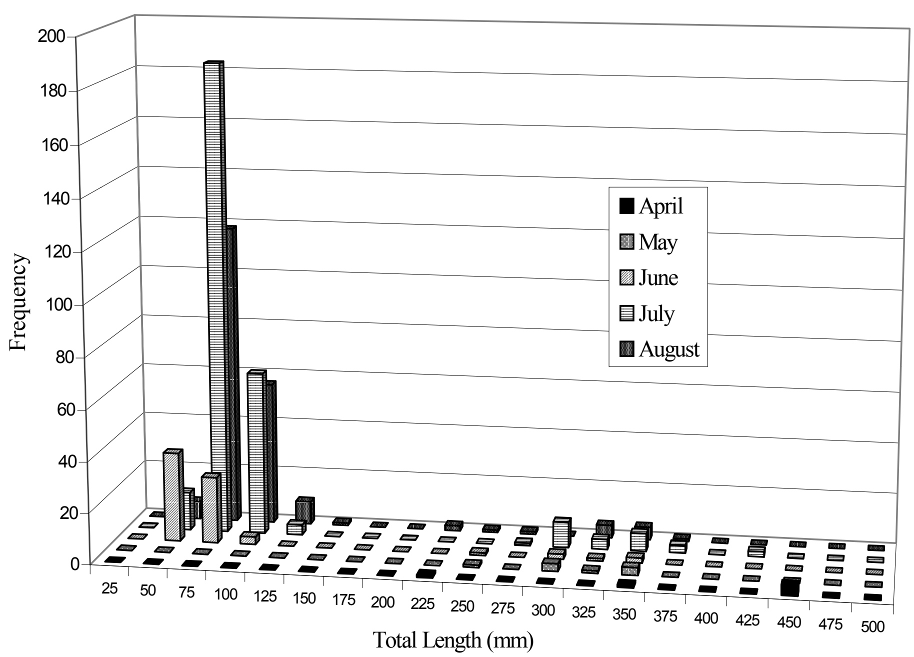

Figure 5. Length-frequency distribution of largemouth bass , ingress and egress combined, by month of sample at the Metzger Marsh fish passage structure, 2000-2001.

In the case of white bass however, there is an indication that the adult fish captured in the May sampling may be producing the recruitment observed in the July and August samples (Figure 6). Ripe running male and female white bass were observed during the sampling in May.

Determining the timing of carp migration into and out of Metzger Marsh is a major objective of the study and will be critical to development of marsh management strategies. Fish access to the marsh through the fish passage structure is restricted by the spacing of the grates positioned on the backside of the baskets and at the non-trapping bay openings. The grates on the trapping baskets were designed so that carp greater than 340 mm in length are able to enter but are not able to pass through (French et al. 1999). Examination of carp length-frequency distribution from 2000-2001 data shows that although carp greater than 340 mm begin to appear in the catch in March they were most abundant in May and June (Figure 7). A more detailed examination of the temporal aspects of carp movement will be required to determine if the May and June period is associated with spawning ingress and will be necessary to develop a management strategy to include exclusion of carp from the marsh. Only the 2001 trapping season has ingress and egress data that could be used to determine the direction of temporal movement. A resident carp population does exist in the marsh and confounds this preliminary evaluation. Carp recruitment is occurring in or near the marsh as YOY specimens are showing up in the catch in July and August (Figure 7).

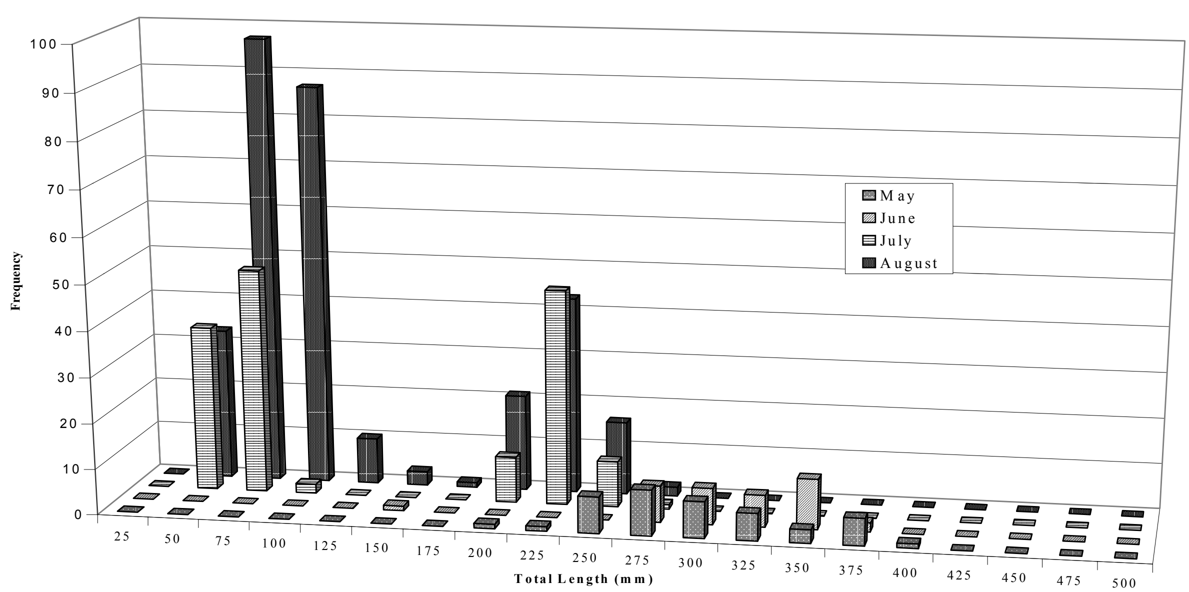

Figure 6. Length-frequency distribution of white bass , ingress and egress combined, by month of sample at the Metzger Marsh fish passage structure, 2000-2001.

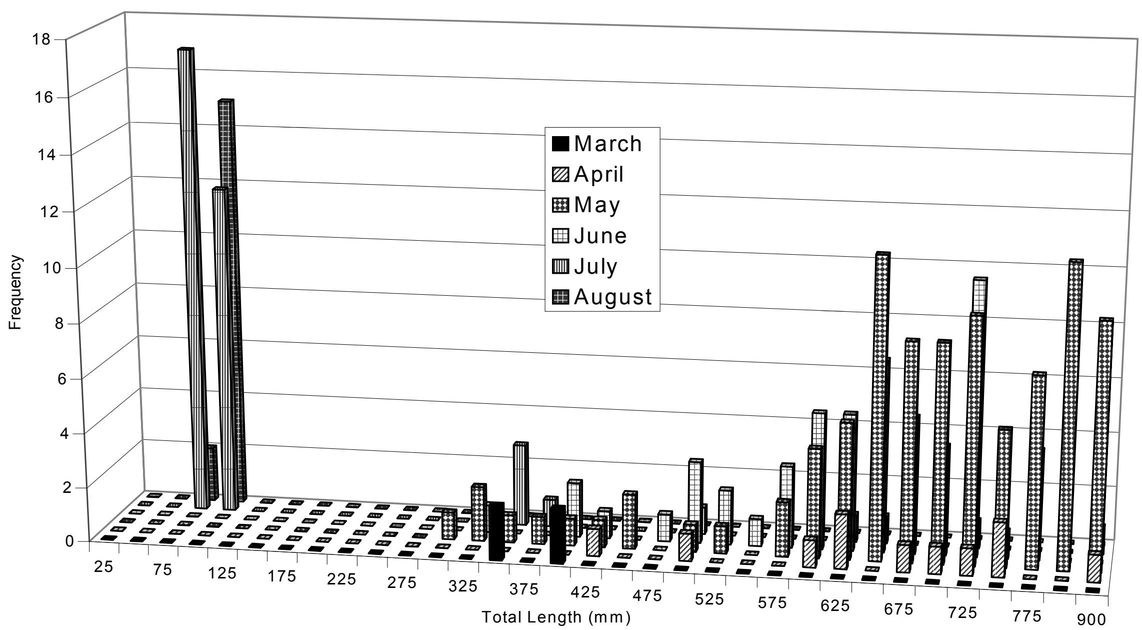

Figure 7. Length-frequency distribution of carp, ingress and egress combined, by month of sample at the Metzger Marsh fish passage structure, 2000-2001.

Discussion

Assessment of the fish community response to the Metzger Marsh Wetland Restoration Project is ongoing. The results discussed in this report are preliminary and are limited due to ineffective sampling apparatus prior to 2001. Addition of data collected during the 2002 field season should strengthen the data set. Based on the evaluation of data collected at the structure in 2000 and 2001, the fishery benefits of the restored marsh are beginning to become apparent and data gaps have been identified.

It has, however, become apparent that Metzger Marsh is important to Lake Erie fisheries as a nursery area. Catches of species such as gizzard shad, an important forage species for walleye; white bass, an important species to Lake Erie sport fishers; and largemouth bass, an important indicator of a healthy marsh fish community, are all dominated by age 0 specimens in July and August. We have not been able to determine whether any of the recruitment is occurring within the marsh, but the capture of sexually mature adult white bass followed by the appearance of YOY white bass in July and August indicates the likelihood of spawning occurring in or near the marsh. The capture of adult northern pike at the structure and YOY pike in traps within the marsh indicate the potential for this marsh system to aid in recovery of this depleted native species.

Figure 8. Restoration of the Metzger Marsh coastal wetland has shown to be beneficial to the Lake Erie fish community as a nursery area to several species of fish, including important forage species such as gizzard shad (L) and may aid in recovery of depleted native species such as northern pike (R).

Seasonal migrations of open lake, tolerant, and phytophilic species are hard to determine at this point. Fish small enough to pass through the grates can enter or leave the marsh on either the ingress or egress side of the structure making direction of movement difficult to ascertain. However, there is an indication that movement of adult carp into the marsh occurs primarily in May and June. Additionally, the appearance of sexually mature white bass in the samples in May and June followed by large catches of YOY white bass in July and August indicates use of the marsh by this species for the reproductive cycle. Without question, the importance of Metzger Marsh as a nursery area has been documented with the initial sampling.

Effective long-term management of this coastal marsh to optimize benefits to all fish and wildlife resources will require an adaptive management strategy based on continued monitoring and periodic adjustment over the next few years. With increased pressure on water resources and lack of habitat for a multitude of wetland dependent species, it is crucial to look at habitat restoration alternatives that encompass an ecosystem approach.

Acknowledgements

I would like to give special thanks to all of those who had helped with this project during this period of study. Included are The Ohio State University Fisheries Management Unit, US Geological Survey - Great Lakes Science Center, Ohio Division of Wildlife, Ohio Division of Geological Survey, and the Ottawa National Wildlife Refuge.

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