Recently reconnected Lake Erie coastal wetland use by fishes: comparing native northern pike and invasive common carp spawning migrations

Statement of Work

INTRODUCTION

Eutrophication caused by nutrient loading from point and non-point sources has been an issue in Lake Erie (Ludsin et al. 2001). After phosphorous was deemed to be the limiting nutrient in Lake Erie, The Great Lakes Water Quality Agreement set standards to reduce the phosphorous loading from point source polluters (Dolan 1993). While many of the point source pollution sites were within compliance levels from 1986 to 1990, nutrient loading surpassed the allotted maxima. The main input of phosphorous was found to come from non-point sources within the tributaries' drainage basins (Dolan 1993). One way to combat the nutrient loading and over all deterioration of water quality is through restoring wetlands. As much as 90% of historical wetlands have been lost (Herdendorf 1987), thus magnifying the problem. Recently, there have been multiple watershed restoration projects aimed towards restoring coastal wetlands.

The Lake Erie Protection and Restoration Plan has been in place since 2008 highlighting needs to promote better water quality and habitat restoration projects. Many of these projects are headed by agencies and organizations such as: The Great Lakes Restoration Initiative, The Ohio Division of Wildlife, U.S Fish and Wildlife, The Nature Conservancy and Ducks Unlimited. Many of these wetlands are disconnected from the main lake by earthen dikes. These diked wetlands are often managed for aquatic vegetation that can support waterfowl species which includes disallowing invasive common carp (*Cyprinus carpio*) from entering the system, because turbidity has been observed to be positively correlated with common carp biomass (Lougheed et al. 1998). Increased turbidity often degrades habitat for aquatic macrophytes. While these earthen dikes supply a way to manipulate water levels and limit common carp use to promote aquatic vegetation, they are not accessible to many populations of native fishes that utilize these areas in their life history.

Johnson et al (1997) compared fish communities of diked and undiked wetlands for both species richness and abundance. Diked wetlands were observed to have greater abundance of fishes; however, species richness was greater in the undiked connected wetlands. The greater fish abundance could be attributed to greater abundance of aquatic macrophytes in diked wetlands. In another study, Kowalski et al (2014) found that both fish abundance and species richness were lower in diked wetlands as opposed to the undiked wetlands of Crane Creek. In both studies species richness was positively correlated with connectivity to the main lake.

Of the few coastal wetlands that are connected to Lake Erie, many have water control structures or grate systems designed to prohibit common carp from entering the system. One of the potential systems was described in detail by French et al. (1999). While these systems can be efficient in limiting access to the wetland by common carp, native species often are negatively impacted by being excluded from potential spawning habitats. French et al. (1999) observed that a trade-off occurs with a vertical grate system. A grate system designed to exclude adult common carp may allow a large percentage of northern pike (*Esox lucius*) biomass to enter the wetland, but large individuals may be unable to enter the coastal wetlands due to morphometric exclusion. This may compromise reproductive potential of northern pike population as fecundity is positively correlated with size (Pierce 2012). In Minnesota, Chizinski et al (2016) observed temporal differences in spawning migrations between common carp and northern pike. If such a pattern also occurred in

Lake Erie coastal wetlands, wetland managers may be able to exclude passage of common carp after the northern pike spawning migration had subsided.

The northern pike is a species of interest in Lake Erie coastal wetlands because it is a highly sought-after native game fish that utilize wetland habitats during multiple stages of their life history. Northern pike are a top predator in many systems and often a keystone species. Through biomanipulation, pike have been observed to increase water clarity when a heavy stocking regime is in place (Berg et al 1997). Navarro and Johnson (1992) found that pike may select to prey on the soft rayed common carp over potential spiny prey species present in two disconnected wetlands in Sandusky Bay. Increasing abundance of northern pike could increase predation pressure on common carp and further decrease destructive potential.

Northern pike population abundances are currently much lower than historic levels in Lake Erie (Trautmen 1981). This may be attributed to spawning habitat degradation and wetland loss. To improve the management of Lake Erie northern pike populations as well as direct restoration and connectivity of coastal wetlands efforts, more information is needed on the use of coastal wetlands as spawning and nursery habitat of northern pike as well as how historically disconnected wetlands function as fish habitat when reconnection occurs. The main question being If you restore/reconnect disconnected wetlands will native species utilize the newfound habitat.

The objective of this study is to [1] Determine the extent that northern pike use reconnected wetland as spawning habitat [2] quantify temporal separation of spawning migrations between native northern pike and nonnative common carp [3] determine morphometric and behavioral traits to successfully identify fishes using DIDSON footage.

METHODS

Location selection

This study will take place in West, East, and Middle Harbor on Catawba Island as well as Crane Creek/Ottawa National Wildlife Refuge (ONWR) and Metzger Marsh. Study site selection was determined to encompass a gradient of time since restoration and reconnection to Lake Erie. The harbors on Catawba Island provide a unique opportunity as Middle Harbor has just been opened for fish passage after over 60 years of being a disconnected system. East and West Harbor have a much longer history of being connected to the lake. A diked wetland within ONWR was reconnected to Crane Creek in 2014 (Eggelston and Kowalski 2016) and Metzger Marsh was reconnected to Lake Erie in the 1990's. These sites encompass: recent reconnection, 3 years since connection, connected for nearly 20 years, and historically connected. Comparing estimates of spawning use in these systems will provide insight into the time it takes to reestablish northern pike spawning in restored wetlands as well as determine the role of connectivity in spawning habitat selection. Before connection Fish abundance data before connection to Lake Erie are also available through the Sandusky ODNR office. This would allow us to compare the Catawba Island harbor systems before and after connection to quantify the success of the restoration project.

Population Estimation

A mark-recapture study in each wetland systems will allow us to make population estimates of spawning adults as well as determine if northern pike use multiple nearby wetlands during a spawning season. To capture northern pike, fyke nets will be set every other day for 24 hours immediately after ice out until mature females are observed in post spawn condition. This could take up to 19 days depending on weather conditions and water temperature (Peirce 2012). Setting nets every other day will allow captured fish to disperse within the population and thus reduce bias from having a greater probability of capturing marked individuals. Adult northern pike will be measured for total length, sexed, and tagged with a Passive Integrated Transponder (PIT). Each capture will be noted with a GPS waypoint. This will allow us to determine the location a fish was originally captured as well as its recapture location. Population size estimates will be calculated by the Jolly-Seber method using program MARK. This method will account for the potential of permanent emigration from the system when spawning has completed.

Temporal migration patterns

A Dual Frequency Identification Sonar (DIDSON) is a multi-beam sonar that enables observation of fishes in their natural environments without the need to physically handle the fish. The DIDSON produces near video quality images that are not limited by low light or low visibility environments. The DIDSON will be deployed at the entrance to Middle Harbor wetlands from the time of ice out (late February to beginning of March) throughout the rest of the northern pike spawning season and into early summer when the spawning season for common carp is thought to have completed. Middle Harbor will be the wetland used because it has a control structure that will allow ease of access as well as a power source for the DIDSON assembly. The DIDSON assembly consists of the DIDSON itself, which will be attached to a mount as well as a laptop computer that can run the program for operation. The DIDSON will be set on the high-resolution identification mode (1.8Hz). It will be situated so the entire fish passageway of the control structure will be in the frame of view. This will eliminate the potential for individuals to evade the beam and thus maximize detection probability as well as observe behavior of fishes as they approach the common carp exclusion grate system. Video footage will initially be analyzed manually along with automated tracking. If results do not vary, automated tracking will be used to maximize efficiency. Count data will be collected with time and date of northern pike and common carp passing through the field of view. These count data will provide temporal patterns in migration as well as abundance. Directionality will also be noted to determine immigration versus emigration. All DIDSON video files will be stored on an external hard drive. Migration patterns of northern pike and common carp observed with the DIDSON footage will be modeled for temporal differentiation to determine if temporal exclusion is possible.

Identification ground-truthing

To ensure proper identification, a laboratory experiment will be conducted to identify a biometric system to distinguish swimming behavior as well as morphometric characteristic differences among the species. A range of sizes of northern pike, bowfin (*Amia calva*), longnose gar (*Lepisosteus osseus*) and common carp will be placed in separate tanks or ponds. The DIDSON will be deployed to observe swimming behavior. Body length and width will be measured using the DIDSON computer program to develop a width to length ratio for each species to be used in identification. Fish will be collected via electrofishing outside of the regular sampling season to minimize time constraints and maximize field data collection.

Previously completed work

Last spring BGSU and the Ohio Department of Natural Resources (ODNR) set the DIDSON at the same location. However, the DIDSON was deployed too late in the season to observe the northern pike spawning migration. Large numbers of common carp were observed to enter the system despite the grate system. This suggests more information on migration patterns is needed to enhance management efforts.

Benefit to coastal wetlands

The magnitude of coastal wetland restoration success should be investigated to direct restoration in other systems. One way of determining success could be the change in abundance of native fishes with northern pike taking a place holder of an indicator species. Northern pike may not use a recently reconnected wetland in high abundance due to natal site fidelity behavior (Miller et al 2001). Therefore, any observed change could indicate an effect in overall health of the system. It is important to determine if or when northern pike population abundance estimates would improve in these new systems if reintroduction does not occur.

Coastal wetlands can have high quality fish habitat. However, wetland managers typically error on the side of exclusion as opposed to inclusion when it comes to fish usage for fear of an influx of common carp that can rapidly degrade aquatic macrophyte abundance and waterfowl habitat. By developing a temporal pattern of spawning migrations, a method of excluding common carp admittance, while allowing native species usage, may be possible with already existing structures. This information could be used to adapt current management strategies and allow access by native species before common carp spawning migrations occur. Managers would then close off the wetland to minimize common carp access. This would benefit macrophyte abundance, fish populations, and greatly increase the overall health and utility of the system.

How funds would be used

Item	Price per unit	Quantity	Cost
Travel (gas)	-	-	$140
Fyke net	$900.00	4	$3600
PIT tags	$3.00	100	$300
Technician	$8.00/hr	120 hrs	$960
Total			$5000

JUSTIFICATION

Travel will be relatively expensive as the field sight is more than an hour away from the university. Finding a location to stay in the area is not an option as the spawning period is during the semester when I have other matters to attend to (class, teaching, etc.). Fyke nets are required for the mark recapture portion of the experiment. We currently do not have enough nets to match needed effort for statistical and ecological power. A technician is needed to work up and set fyke nets as well as help with additional sampling. PIT tags are needed for the mark-recapture experiment.

Plans or opportunities for sharing research results with a larger audience

I plan to present this research at research meetings like the International Association for Great Lakes Research, the Society of Wetland Scientists and the American Fisheries Society. I also plan to provide findings to regional coastal wetland managers to give insight to their management practices, and publish results in either Wetlands or Journal of Great Lakes Research.

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