ILLINOIS NATURAL HISTORY SURVEY
PRAIRIE RESEARCH INSTITUTE

The Nature Conservancy's Emiquon Preserve

Fish and Aquatic Vegetation Monitoring

9-Year (2007-2015) Report

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Floodplain restoration monitoring of the aquatic vegetation and fish communities of The Nature Conservancy's Emiquon Preserve 2007-2015
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Disclaimer

Under contract with The Nature Conservancy (TNC), fish and aquatic vegetation monitoring (2007-present) was conducted on Thompson and Flag lakes of the Emiquon Preserve by the Illinois Natural History Survey, Illinois River Biological Station (INHS-IRBS) in order to evaluate a series of key ecological attributes (KEA) relevant to restoration success. This report presents a summary of data collected during 2007-2015. The findings, conclusions, and views expressed herein are those of the researchers and should not be considered as the official position of TNC or the INHS.

Executive Summary

Overall conclusion: The Emiquon Reserve maintains a growing and healthy assemblage of aquatic vegetation and fish, with little indication that non-native species are becoming dominant or degrading environmental conditions in the immediate future. Of 19 relevant KEAs, 12 were evaluated in 2007, 15 in 2008, 16 in 2009, 15 in 2010, 18 in 2011, and 16 from 2012-2015 through standardized monitoring of the fish and aquatic vegetation communities. Of the total KEAs evaluated during 2007-2015, goals for 8 were met in 2007, 12 in 2008, 12 in 2009, 10 in 2010, 11 in 2011, 10 in 2012, 11 in 2013,9 in 2014, and 11 in 2015.

Detailed conclusions: Through the ninth year of establishment, the status of the aquatic biota at the Emiquon Preserve has continued to follow its trends, reflecting a relatively stable, productive wetland. Since the last three-year report in 2013, there have been no significant changes to the 19 Key Ecological Attributes (KEAs) regularly measured. With a brief exception of a flood in the spring 2013, there has been no input from the river during 2007 - 2015, and there is little evidence to suggest that the limited 2013 inputs have substantively affected any biological aspects in subsequent years.

Out of the 5 goals established for the 2015 evaluation of submerged aquatic macrophytes three were met and two were not met. The two KEAs that were not met, water transparency and the rate of change in water levels, have been out the desired range for several preceding years and remained so. In addition, the abundance of non-native species in the submersed aquatic vegetation exceeded the threshold of 10%, which has occurred each year since 2010; however, the proportion of the SAV assemblage made up by non-native species may have plateaued at roughly 25%.

Out of the 14 goals established for the 2015 evaluations of the fish community eight were met, three were not met, and 3 were not measured. Since 2007, the number of native species sampled in a single year has never met the goal of 25 or more. In spite of this, and the virtually complete separation of the preserve from the river, there is evidence that this KEA goal is, in fact, being met cumulatively: while the fish species richness is lower than the goal of 25 in any given year, the cumulative richness is higher, even reaching 26 species from 2013 to 2015. We believe the disparity is explained by considering that a proportion of less abundant species are still present in the preserve across the years, but not collected because our current level of sampling effort is not enough to encounter them every year.

Both the KEAs for abundance and biomass of native fish species are well above their respective goals, with natives exceeding 96% of the community since 2011 (non-natives have not exceeded 3%). Dissolved oxygen levels remain above minimum levels required by fish during spawning, as well. The catch-per-unit-effort of largemouth bass, an index of their abundance, varied from poor to fair over the past three years. This likely reflects a recruitment bottleneck, which may be created by cannibalism of young from large, adult largemouth bass. Despite the low bass CPUE, the body condition of 5 other important predator species remains within healthy ranges. Although overwintering conditions were not explicitly measured in recent years, the abundance and condition of adult fish in summer months attests to year-round suitability for fish species.

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Introduction

Historically, the backwaters that make up the Emiquon Preserve of the most productive backwater lakes in the Illinois River Valley (IRV). Both lakes were disconnected from the Illinois River and reduced to agricultural drainage ditches by the 1930's and remained both drained and in continuous agricultural production, becoming one of the largest farms in Illinois, until 2006. The Nature Conservancy purchased this property in 2000 and began aquatic restoration in 2007. As a part of the restoration, the surrounding levees were left in place but the drainage of accumulating water was discontinued and the drainage ditches were treated with rotenone, in an attempt to limit the risk from any non-native Common carp (*Cyprinus carpio*) that were living in the ditches. The preserve was allowed to naturally fill through precipitation and >30 native fish species were stocked by Illinois DNR based on historical records of both lakes (VanMiddlesworth et al. 2016, Havera et al. 2003). The staff of the Illinois Natural History Survey's Illinois River Biological Station has been monitoring the submerged aquatic vegetation and fish assemblages from 2007 to the present. The data collected is used to evaluate Key Ecological Attributes (KEAs) of restoration success. The 19 KEA's assessed in this report were developed in 2004 by the Emiquon Science Advisory Council (i.e. The Nature Conservancy and partners) to serve as the driving management tool for the Emiquon Restoration. The knowledge gained may aid in future management efforts at the Emiquon Preserve and other floodplain restoration efforts.

Methods

Submersed Aquatic Vegetation

Submersed aquatic vegetation density is estimated by percent coverage on a vegetation rake, while emergent, non-rooted floating-leaved, and rooted floating-leaved aquatic vegetation density is estimated by percent cover observed within a 2 m perimeter around the boat. All aquatic vegetation data were collected according to the U.S. Army Corps' of Engineers Upper Mississippi River Restoration-Environmental Management Program (UMMR-EMP) Long Term Resource Monitoring Program (LTRMP) aquatic vegetation monitoring protocols of Yin et al. (2000).

Fish Monitoring

Monthly fish sampling is conducted from April to October annually using a multiple gear approach at random and fixed sites. Sampling gear types include: pulse DC electrofishing runs (15 minutes of effort per site), fyke net sets (24 hours each), and mini-fyke net sets (24 hours each) at shoreline or pseudo-shoreline (used for shoreline gear) sites. In addition to the shoreline gears, tandem fyke net sets (24 hours each) and tandem mini-fyke net sets (24 hours each) are deployed at open water (pelagic) sites. Fish sampling was stratified by habitat (shoreline, open water, and ditch) and all gears were fished according to the LTRM fish monitoring protocols of Ratcliff et al. (2014).

Sampling Effort (2007-2015)

Submersed Aquatic Vegetation

Full-scale aquatic vegetation monitoring was not conducted in 2007 to reduce disturbance caused by boat and plant collections to allow establishment of aquatic vegetation during the first year of restoration. However, we did note the presence of aquatic plant species at Thompson Lake in 2007 while conducting fish monitoring. During 2008-2009, we began to monitor aquatic vegetation by sampling random littoral (<15 m from the shoreline) and pelagic (>15 m from the shoreline) areas at Thompson Lake. Sampling was conducted monthly at five random littoral and pelagic sites each during April-October and at 20 random littoral and pelagic sites each in July during the peak of the growing season. Additionally, three east/west fixed site transects were sampled monthly at seven locations along each transect for aquatic vegetation from May-October. Flag Lake was not sampled from 2007-2009 due to insufficient water levels.

During 2010-2015, we sampled aquatic vegetation May-September at both Thompson and Flag lakes, which were sampled as one water body, but spatially stratified into north, middle, and south units. The number of sites sampled per unit was proportional to the surface area of each unit and was determined monthly. Sampling was conducted at 30 random sites each month during May, June, and September but at 60 random sites each month in July and August, during the peak of the growing season.

Fish Monitoring

Fish sampling was conducted July-November, 2007 (excluding September) using a multiple gear approach at fixed sites including 9 pulsed-DC electrofishing runs (15 minutes each), 12 fyke net sets (24 hours each), 12 mini-fyke net sets (24 hours each), and 25 minnow trap sets (24 hours each) at shoreline or pseudo-shoreline (used for shoreline gear) sites. Also, 2 tandem fyke net sets (24 hours each), 2 tandem mini-fyke net sets (24 hours each), 1 trammel net set (1.5 hour set) and 1 experimental gill net set (1.5 hour set) were deployed at open water (pelagic) sites.

In 2008, fish sampling was conducted April-October at Thompson Lake using a multiple gear approach at random and fixed sites including 28 electrofishing runs (15 minutes each), 28 fyke net sets (24 hours each), 28 mini-fyke net sets (24 hours each), and 25 monthly minnow trap sets (24 hours each) at shoreline or pseudo-shoreline (used for shoreline gear) sites. Seven tandem fyke net sets (24 hours each) and seven tandem mini-fyke net sets (24 hours each) were deployed at open water (pelagic) sites. Flag Lake was also sampled with two electrofishing runs (15 minutes each). Gill and trammel nets became fouled by aquatic vegetation and algae in 2007 and were discontinued in 2008.

During 2009-2015, we conducted monthly fish sampling April-October using a multiple gear approach at random and fixed sites including 28 electrofishing runs (15 minutes each), 28 fyke net sets (24 hours each), and 28 mini-fyke net sets (24 hours each) at shoreline or pseudo-shoreline (used for shoreline gear) sites. Seven tandem fyke net sets (24 hours each) and seven tandem mini-fyke net sets (24 hours each) were deployed at open water (pelagic) sites. Minnow traps were discontinued in 2009 because they were a less effective gear than mini-fyke nets. Flag Lake was not sampled during these years due to shallow water depth. Fish sampling was stratified by habitat (shoreline, open water, and ditch) and all gears were fished according to the LTRM fish monitoring protocols of Ratcliff et al. (2014).

Key Ecological Attributes (KEAs) Results for Submersed Aquatic Vegetation

KEA 1: Underwater Irradiance

Indicator: Secchi disc transparency

Desired Range: In submersed aquatic vegetation target areas (where water depth is ≤1.5 m), Secchi disc reading is ≥ half the maximum water depth, measured during late spring/early summer

Goal Met:

2007	Not Measured	2010	Yes	2013	Yes
2008	Yes	2011	Yes	2014	Yes
2009	Yes	2012	Yes	2015	Yes

Secchi transparency were taken from fish and vegetation sites in April and May each year, with the exception of 2007, when all secchi disc transparencies were equal to the maximum water depth. Data were excluded for sites where the depth exceeded 1.5 m. From 2008 to 2010, the mean Secchi depth in areas less than 1.5 m deep was at least half of the depth between 87% and 97% of the time. From 2011 to 2015, the percentage of samples in which the Secchi depth was at least half of the water depth varied, with a low of 50% in 2012 to a high of 64% in 2015 (Figure 1).

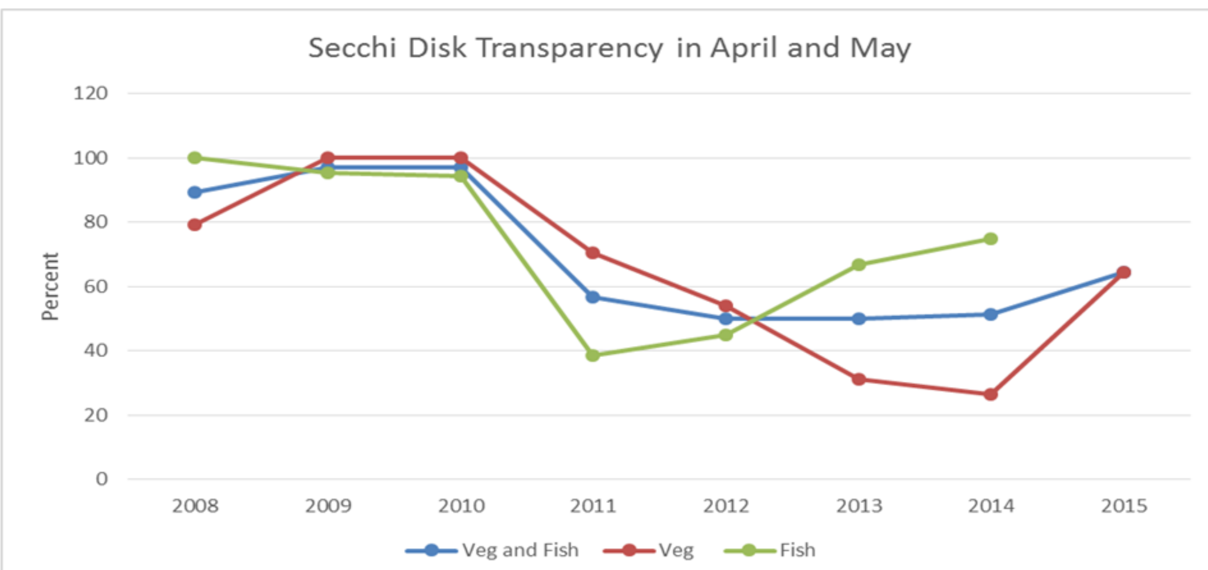

Figure 1

KEA 2: Hydrology

Indicator: Water depth

Desired Range: Rate of water rise should not exceed 1.5 cm/day during the growing season (May-September); water level fluctuations (rise) should not exceed 1 m total (May-September)

Goal Met:

2007	Yes	Yes	2010	Yes	Yes	2013	Yes	Yes
2008	Yes	Yes	2011	Yes	Yes	2014	Yes	Yes
2009	Yes	Yes	2012	Yes	Yes	2015	Yes	Yes

Daily water gauge data were collected by TNC from the Emiquon pumphouse. The goal was evaluated by excluding days where no data was collected and days that were not within time period (May-September). Several years had a higher frequency of days in which the rate of rise exceeded standards: 17% in 2008, 20% in 2014, and 15% in 2015. (17%, 20%, 15%). In 2013, there were no days in which the water levels rose greater than 1.5cm/day (Figure 2). The total rise of water levels between May and September have not exceeded 1 m during any year (Fig 3).

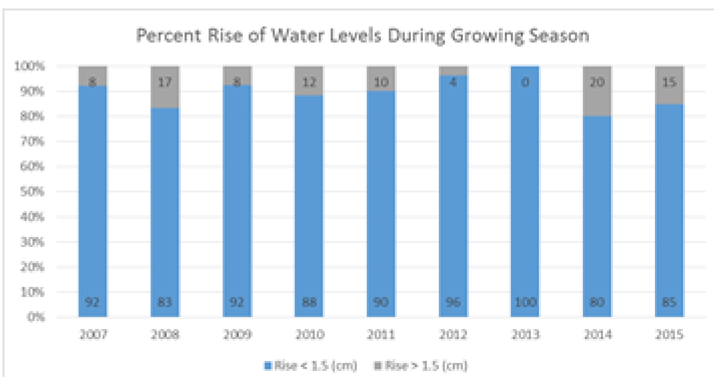

Figure 2

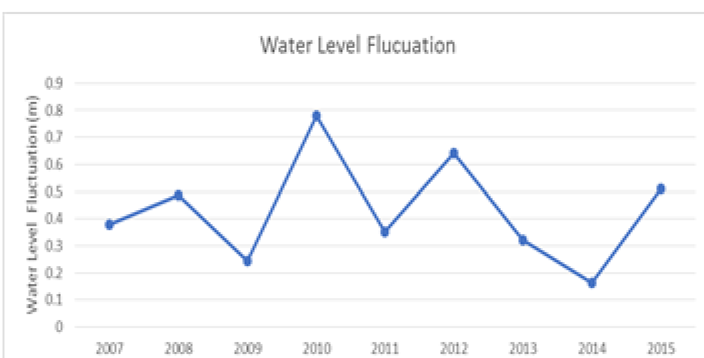

Figure 3

KEA 3: Community Composition

Indicator: Percent natives vs. invasive

Desired Range: ≤10% exotics, e.g., Eurasian watermilfoil *Myriophyllum spicatum,* curly-leaf pondweed *Potamogeton crispus*

Goal Met:

2007	Not Measured	2010	No	2013	No
2008	Yes	2011	No	2014	No
2009	Yes	2012	No	2015	No

Community composition of native verses the percent of non-native (invasive) species was determined by percent abundance of each species using data collected using LTRM rake methods. Data was collected by combining the sum of each species per rack (6 total per site) and taking the average of each species abundance that occurred throughout the given year. Native species were dominate (greater than 90 % of total abundance) in 2008 and 2009 with 95 % native species present in sample sites. Native species abundance began to decline starting in 2010 (88 %), and continued into 2011 (81 %) and 2012 (75%) until 2013 when native species abundance increased 84 % but declined again in 2014 (79 %) and 2015 (75 %). Subsequently, exotic species have almost steadily increased since 2008 but has not exceed 25 % of total species abundance (Figure 4). Invasive aquatic plant species collected between 2007 and 2015 consist of Eurasian watermilfoil *Myriophyllum spicatum* and curly-leaf pondweed *Potamogeton crispus* (Figure 4). The proportion of non-native plants increased to about a quarter of the samples by 2012 but have not increased since then.

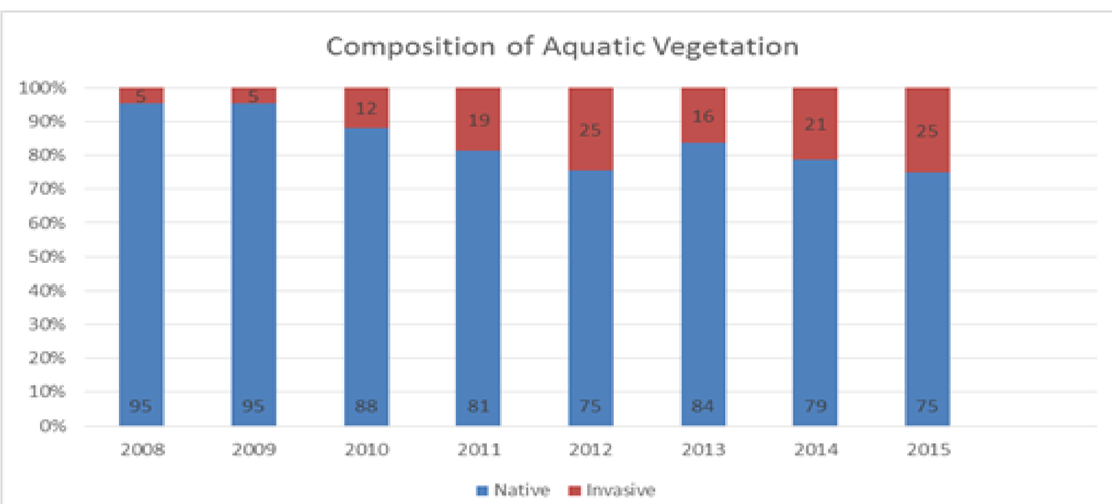

Figure 4

Key Ecological Attributes (KEAs) Results for Emergent and Floating Leaved Plants

KEA 4: Hydrology

Indicator: Stable water depth

Desired Range: Rate of water rise does not exceed 1.5 cm/day during the growing season (May-September); Water level fluctuations (rise) do not exceed 1 m total (May-September)

Goal Met:

2007	Yes	Yes	2010	Yes	Yes	2013	Yes	Yes
2008	Yes	Yes	2011	Yes	Yes	2014	Yes	Yes
2009	Yes	Yes	2012	Yes	Yes	2015	Yes	Yes

Water gauge data used was collected by TNC from the Emiquon pumphouse on a day to day basis excluding days where no data was collected and was days that were not within time period (May-September). Several years (2008, 2014, and 2015) showed higher percent of time in which the water levels rose greater than 1.5 cm/day while in 2013 there were no days in which the water levels rose greater than 1.5cm/day (Figure5*)*. Fluctuations (rise) of water levels have not exceeded 1m total from May to September from 2007-2015 (Figure 6).

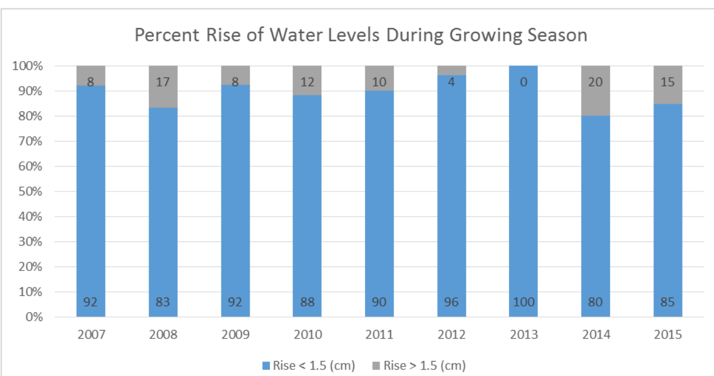

Figure 5

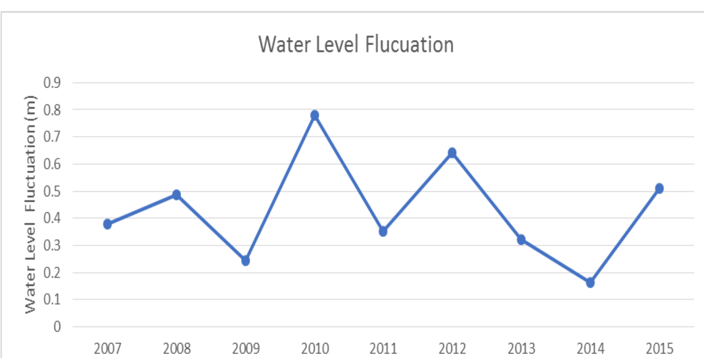

Figure 6

KEA 5: Community Composition

Indicator: Percent natives vs. invasive

Desired Range: ≥90% dominance by native species

Goal Met:

2007	Not Measured	2010	No	2013	No
2008	Yes	2011	No	2014	No
2009	Yes	2012	No	2015	No

Non-native emergent, non-rooted floating-leaved, and rooted floating-leaved aquatic vegetation were not observed during 2008-2015.

Key Ecological Attributes (KEAs) Results for Fish Assemblage

KEA 6: Fish Community Assemblage

Indicator: Number of native species populations

Desired Range: ≥25 native species represented (very good = ≥30 native species)

Goal Met:

2007	No	2010	No	2013	No
2008	No	2011	No	2014	No
2009	No	2012	No	2015	No

The number of native fish species was calculated by taking the total catch of all fish in all gear types in each year. The number of native species present has been below 25 in all years. The highest number of native species collected was 20 in 2015 (Figure 7). Not all species are captured each year, so the total number of native fish species captured in any single year does not necessarily reflect total species richness. From 2013 to 2015, there were a total of 26 native fish species captured.

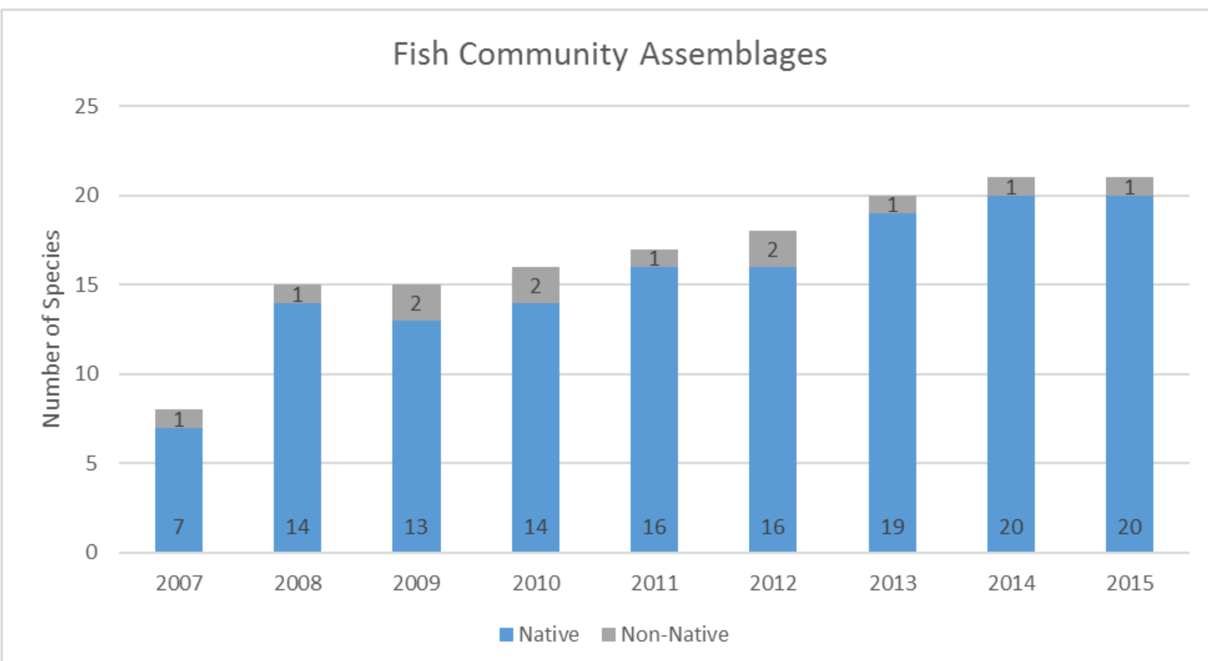

Figure 7

KEA 7: Fish Community Assemblages

Indicator: Number of native species populations

Desired Range: Native species ≥50% of number; Native species ≥50% of total biomass

Goal Met:

2007	Yes	Yes	2010	Yes	Yes	2013	Yes	Yes
2008	Yes	Yes	2011	Yes	Yes	2014	Yes	Yes
2009	Yes	Yes	2012	Yes	Yes	2015	Yes	Yes

The abundance and biomass of native species was calculated using all fish and all gear types in each year. Native fish species dominated the fish community each year, representing 97% or more of the total catch in all years (Figure 8). Native fish species represented 96% or more of the total biomass in all years (Figure 9).

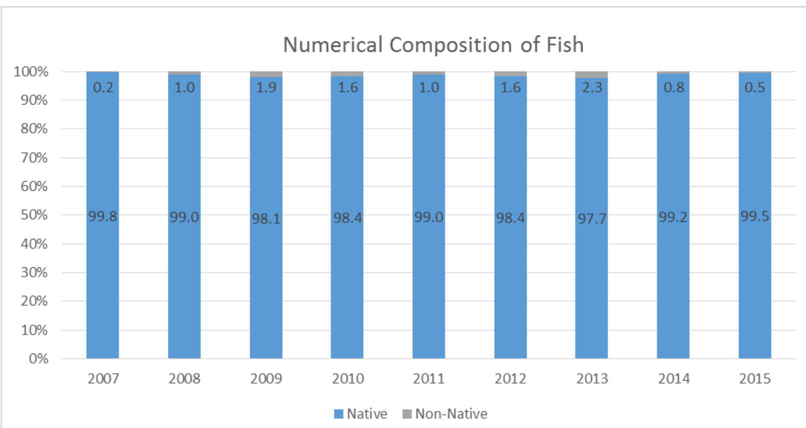

Figure 8

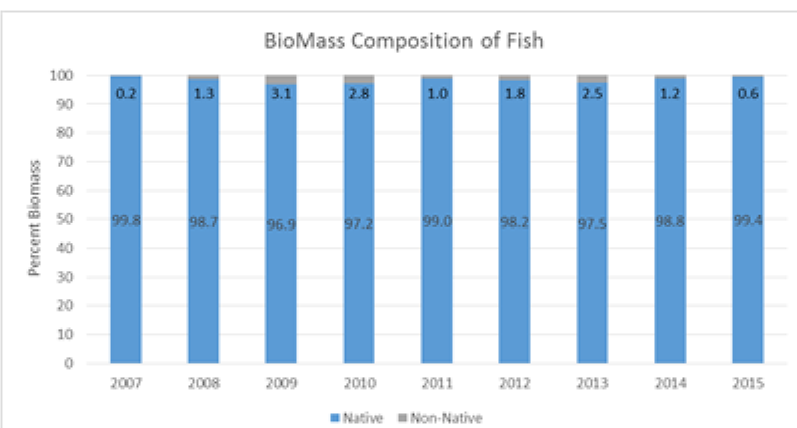

Figure 9

KEA 8: Fish Community Composition

Indicator: Body condition of native predatory fish population

Desired Range: Very good = ≥100 largemouth bass *Micropterus salmoides* CPUE while electrofishing and bowfin *Amia calva* present, good = 75-100 largemouth bass CPUE, fair = 50-75 largemouth bass CPUE, poor = <50 largemouth bass CPUE

Goal Met:

2007	Yes	very good	2010	Yes	good	2013	Yes	fair
2008	Yes	good	2011	No	poor	2014	No	poor
2009	Yes	fair	2012	Yes	good	2015	Yes	fair

Largemouth bass CPUE was calculated using only electrofishing (Figure 10). Mean largemouth bass CPUE was considered poor (< 50 largemouth bass/hr) in 2014 but fair (CPUE 50-75/hr) in 2013 and 2015. High CPUE in the initial years of the project stemmed mostly from large numbers of young fish from the initial stocking of over one million largemouth bass. The catch of largemouth bass has been relatively consistent after 2009, suggesting the population has leveled off after high mortality in the initial cohort. Currently, the population size structure of largemouth bass is skewed toward older and larger fish, and this large group of fish may be preventing high levels of recruitment from occurring. The Bowfin criteria, annual determination of presence or absence, was also assessed from electrofishing data and were present in all years.

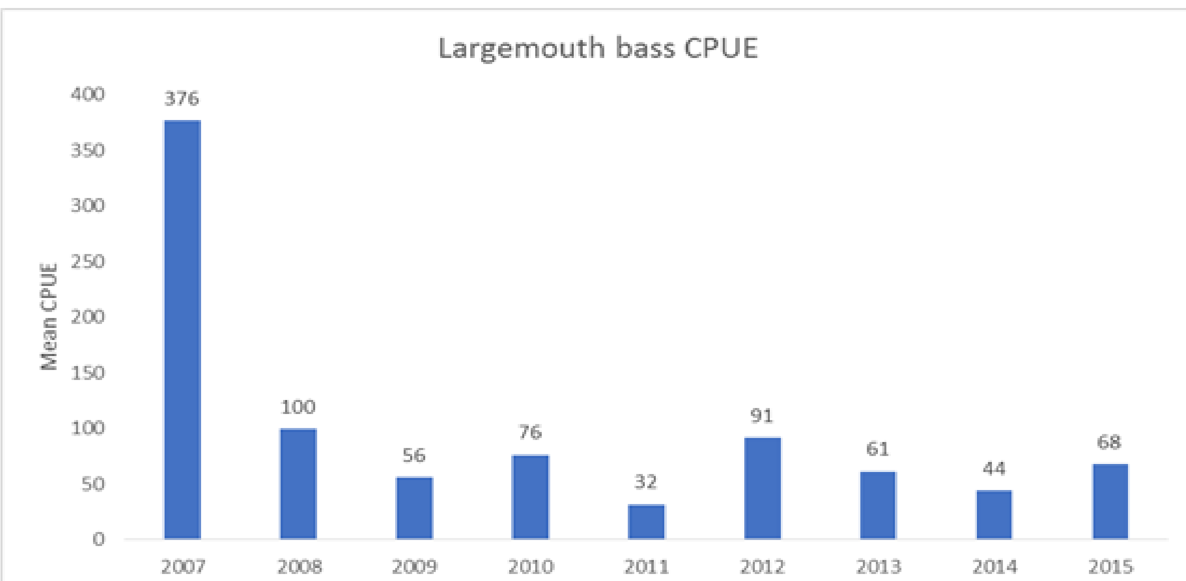

Figure 10

KEA 9: Spawning

Indicator: Water dissolved oxygen

Desired Range: 4 ppm oxygen (very good = ≥5 ppm and <200% saturation oxygen)

Goal Met:

2007	Yes	Not Measured	2010	Yes	Not Measured	2013	Yes	Not Measured
2008	Yes	Not Measured	2011	Yes	Not Measured	2014	Yes	Not Measured
2009	Yes	Not Measured	2012	Yes	Not Measured	2015	Yes	Not Measured

Fish and vegetation sites were each calculated separately using only sites in which dissolved oxygen was measured. Mean monthly (April-October) dissolved oxygen concentrations collected from all aquatic vegetation and fish sampling sites exceeded the desired range from 2007-2015 (Figure 11). Percent saturation was not measured from 2007-2015.

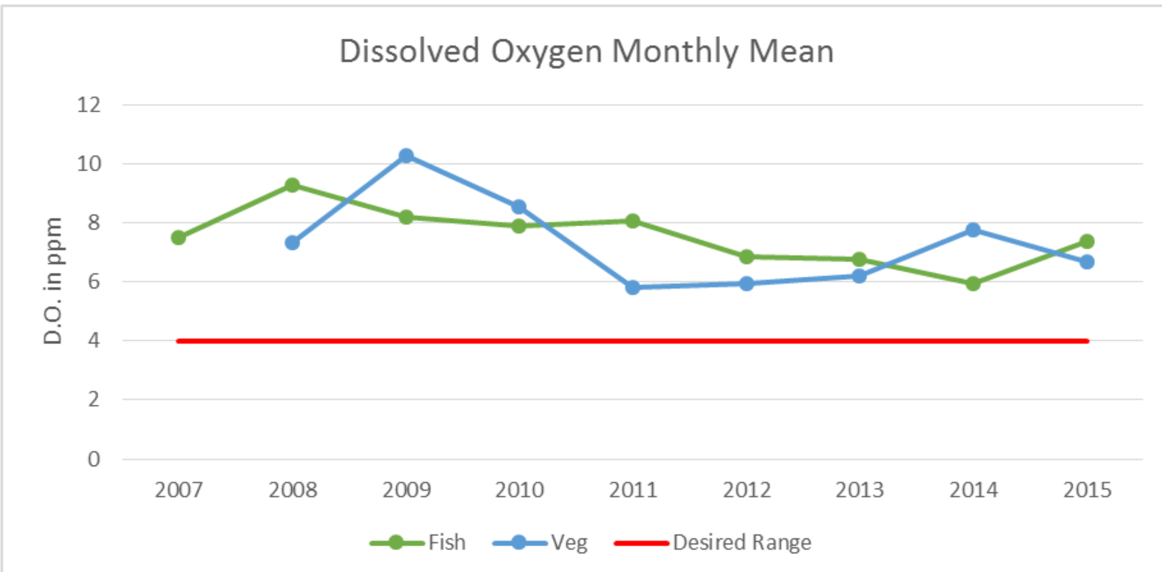

Figure 11

KEA 10: Spawning

Indicator: Substrate variability and structure (large woody debris)

Desired Range: Subset representing several of the following types present: diverse shoreline, shade, fallen trees, open areas, and submerged plants (very good = all types present)

Goal Met:

2007	Yes	good	2010	Yes	very good	2013	Yes	very good
2008	Yes	very good	2011	Yes	very good	2014	Yes	very good
2009	Yes	very good	2012	Yes	very good	2015	Yes	very good

We noted the presence of several aquatic plant beds (mostly submersed and some emergent), along with minimal shoreline habitat diversity, open areas, large woody debris, and shade while conducting fish monitoring in 2007. There was an abundance of diverse shoreline habitats, open areas, as well as submersed, emergent, non-rooted floating-leaved, and floating-leaved aquatic vegetation from 2008-2015. Large woody debris and shading provided by them was minimal during these years, but shade was made abundant by aquatic vegetation.

KEA 11: Spawning

Indicator: Frequency of April/May connection to the river

Desired Range: Every three years for long-lived species, more frequently for short-lived species (very good = annual connection)

Goal Met:

2007	No	2010	No	2013	Yes
2008	No	2011	No	2014	No
2009	No	2012	No	2015	No

The Emiquon Preserve was disconnected from the Illinois River during 2007-2015 except in 2013 when the levee was overtopped by flood waters.

KEA 12: Nursery

Indicator: Accessibility for riverine fish

Desired Range: Presence of YOY freshwater drum *Aplodinotus grunniens*, goldeye *Hiodon alosoides*, bigmouth buffalo *Ictiobus cyprinellus* (very good = all of the above plus paddlefish *Polyodon spathula*)

Goal Met:

2007	No	2010	No	2013	No
2008	No	2011	No	2014	No
2009	No	2012	No	2015	Yes

Young-of-the-year (YOY) freshwater drum, goldeye, bigmouth buffalo, and paddlefish were absent in our collections during 2007-2013. In 2014, one adult freshwater drum and one adult bigmouth buffalo were collected. One YOY freshwater drum was collected in 2015.

KEA 13: Nursery

Indicator: Native fish larvae

Desired Range: Dominance of native species

Goal Met:

2007	Yes	2010	Yes	2013	Yes
2008	Yes	2011	Yes	2014	Yes
2009	Yes	2012	Yes	2015	Yes

All fish were considered young-of-the-year (YOY) if they measured less than 100 mm in length. Common carp, goldfish and hybrid common carp x goldfish were the only non-native fish captured and made up 1.5 percent or less of catch rates (Figure 12).

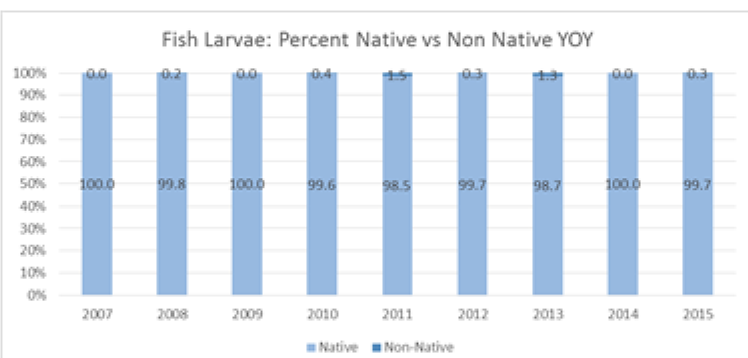

Figure 12

KEA 14: Feeding

Indicator: Presence of adults in good body condition

Desired Range: Mean relative weights 90-110%

Goal Met:

2007	Yes	2010	Yes	2013	Yes
2008	Yes	2011	Yes	2014	Yes
2009	Yes	2012	Yes	2015	Yes

Mean relative weight (Wr) for largemouth bass *Micropterus salmoides* , black crappie *Pomoxis nigromaculatus*, spotted gar *Lepisosteus oculatus,* , gizzard shad *Dorosoma cepedianum*, and common carp *Cyprinus carpio* were calculated using national data (Neumann et al. 2012). Relative weights for bowfin *Amia calva* were calculated using standard weight equations from Michigan's manual of fisheries survey methods II (Schneider et al. 2000). Species were selected from popular sport fish (bass and crappie), predator fish (gar and bowfin), and non-game (Gizzard shad and Common carp) to determine the presence and condition of adult fish. Mean relative weight for largemouth bass has remained steady throughout the year but did decline to 93 in 2015 (Figure 13). Black crappie relative weights were high in 2008 at 114 but have declined since then to 98 in 2015 (Figure 14). Spotted gar met the KEA in 2008-2011 but declined below 90 in 2012 where it has remained (Figure 15). Bowfin relative weights have decreased from 2009 to 2015, although they remain within the desired range (Figure 16). After remaining below target levels from 2011 to 2014, gizzard shad relative weights were within acceptable levels in 2015 (Figure 17). Common carp have steadily declined in relative weight since 2007, but the relative weight has remained higher than the desired range (Figure 18).

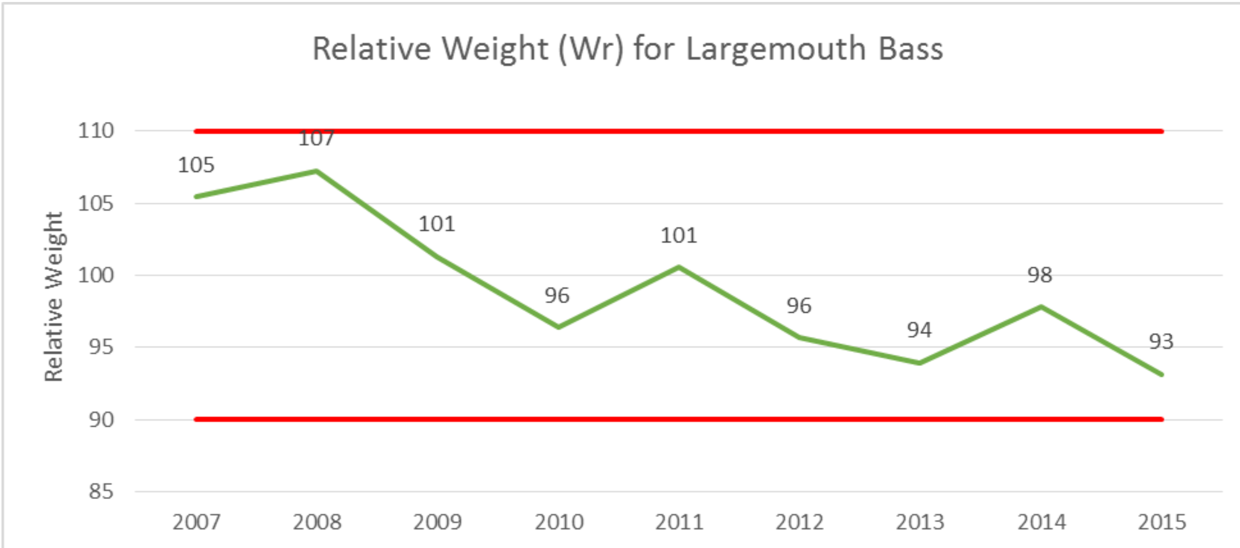

Figure 13

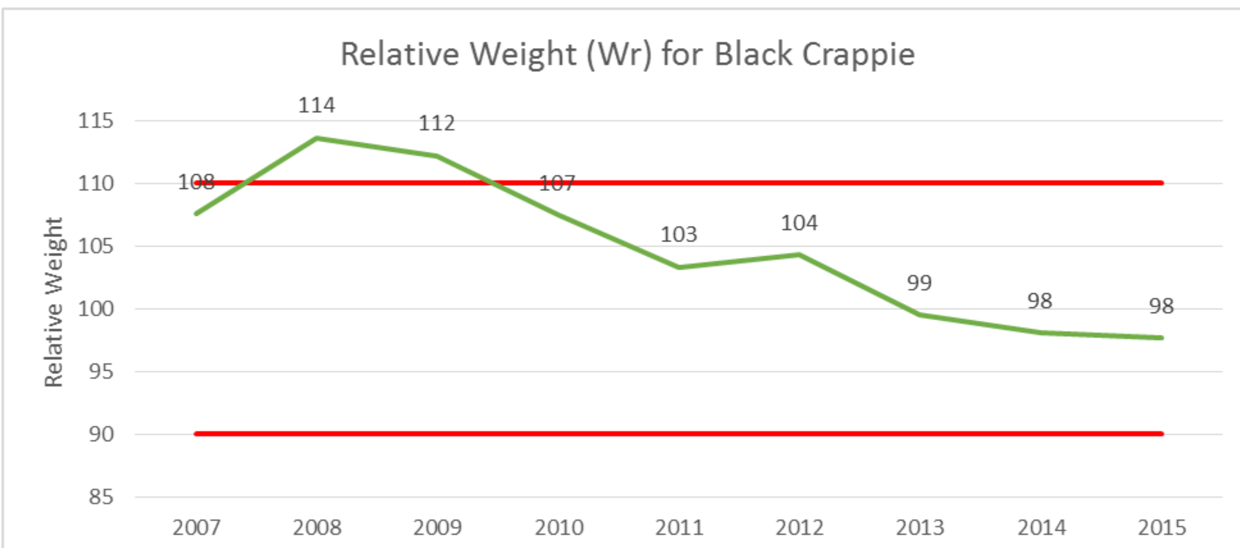

Figure 14

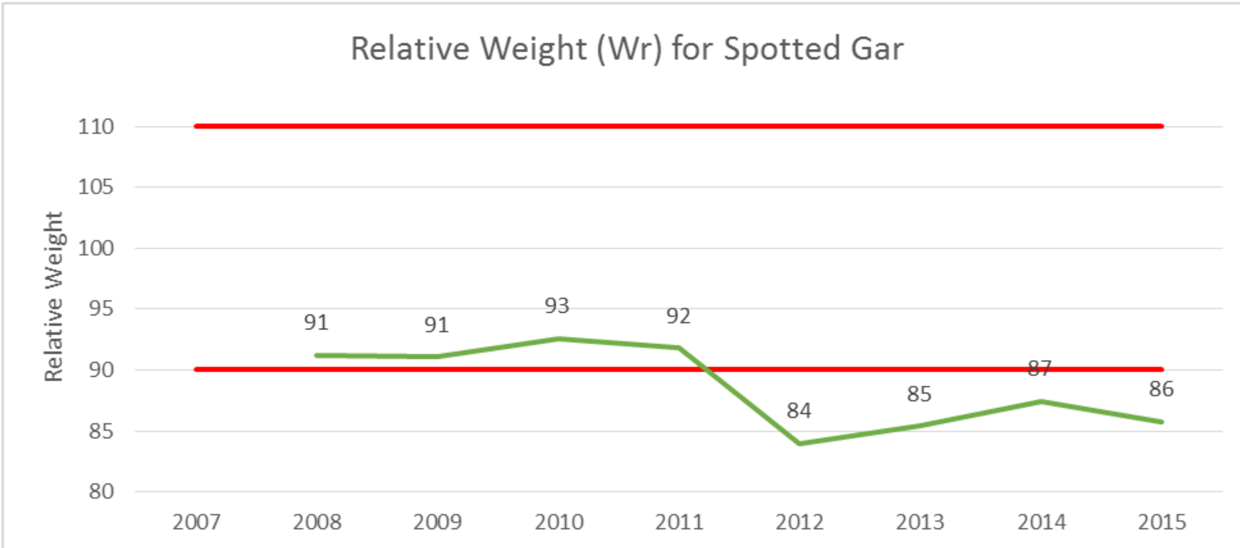

Figure 15

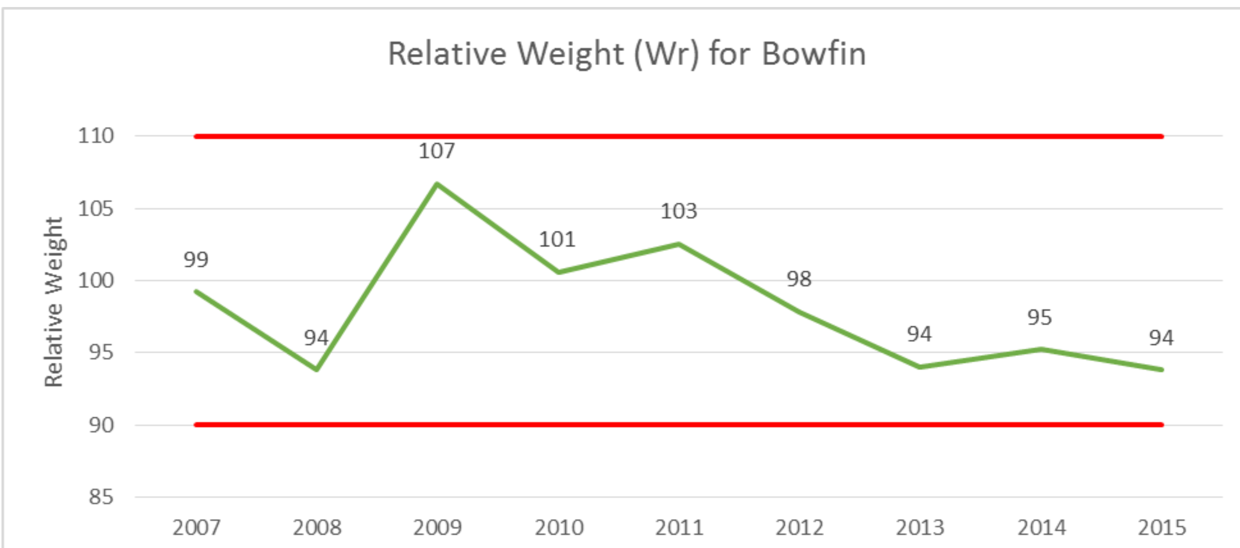

Figure 16

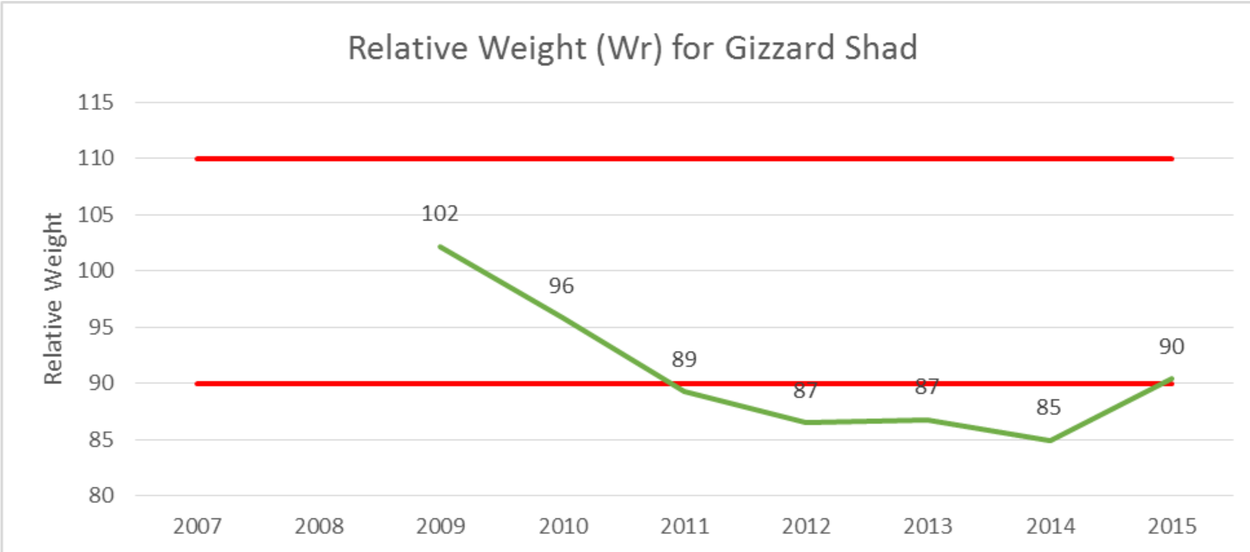

Figure 17

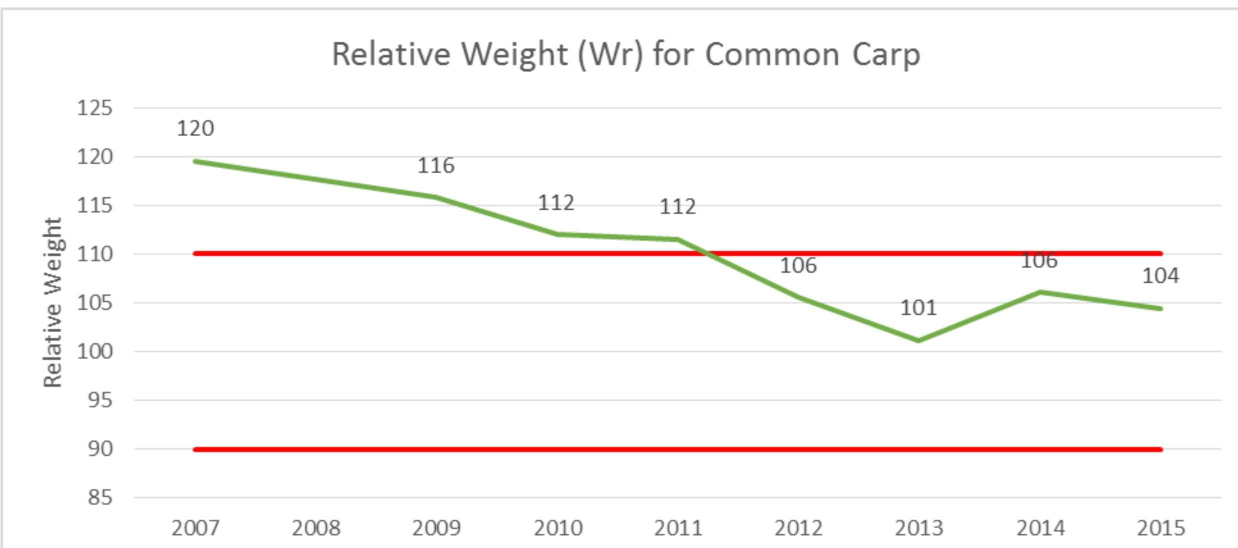

Figure 18

KEA 15: Feeding

Indicator: Distribution of abundant aquatic vegetation

Desired Range: 25-40% of the littoral area contains abundant vegetation during July-August

Goal Met:

2007	Not Measured	2010	Yes	2013	Yes
2008	Yes	2011	Yes	2014	Yes
2009	Yes	2012	Yes	2015	Yes

Out of all littoral (≤1.5 m water depth) aquatic vegetation sites during July-August, contained aquatic vegetation 90-100 % of the time.

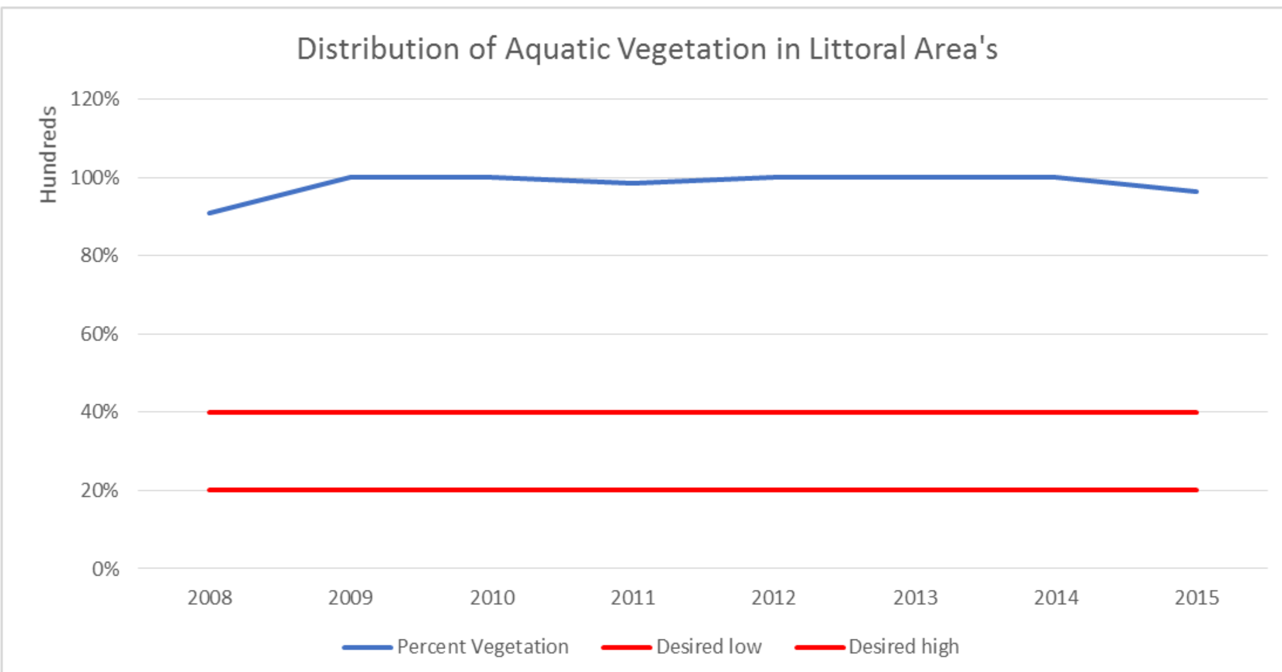

Figure 19

KEA 16: Over-wintering

Indicator: Percent of deep (oxygen rich) water

Desired Range: Water depth (5% >3 m, 10% 2-3 m, 25% 1-2 m, 60% <1 m); Dissolved oxygen (4.0-6.0 ppm at 2 m depth); Water temperature ≥1 °C (34 °F) at 2 m depth

Goal Met:

2007	Not measured	2010	Not measured	2013	Not measured
2008	Not measured	2011	Yes; Yes; Yes	2014	Not measured
2009	Not measured	2012	Not measured	2015	Not measured

Percent of deep water at Thompson and Flag lakes was calculated in 2011 for the first time using a bathymetry map (Figure 20) at 432 ft asl. Approximately 9.5% of Thompson and Flag lakes showed water depths >3 m, 12.9% at 2-3 m, 35.8% at 1-2 m, and 44.8% at <1 m in 2011. Dissolved oxygen (ppm)/temperature (°C) profiles were collected at five fixed sites on Thompson and Flag lakes during January 18, 2011 for the first time to evaluate over-wintering fish habitat (Figure 21). Dissolved oxygen concentrations at all five fixed sites exceeded the desired range of 4.0-6.0 ppm at ≤2 m water depth and temperatures at all sites from surface to bottom exceeded the desired range of 1 °C (Figure 22). Winter fish sampling was not conducted in from 2007-2010 and 2012-2015 due to gear unavailability. The persistence of high numbers of native fish species across years provides evidence that fish have been over-wintering successfully at the Emiquon Preserve.

KEA 17: Over-wintering

Indicator: Presence of backwater species

Desired Range: Water temperature ≥34 °F based on the needs of freshwater drum (Bodensteiner & Lewis 1992)

Goal Met:

2007	Not measured	2010	Not measured	2013	Not measured
2008	Not measured	2011	Yes	2014	Not measured
2009	Not measured	2012	Not measured	2015	Not measured

Water temperatures collected at Thompson and Flag lakes during January 18, 2011 to evaluate over-wintering fish habitat at all five fixed sites were ≥34 °F from surface to bottom

(Figures 21, 22). Winter fish sampling was not conducted in from 2007-2010 and 2012-2015 due to gear unavailability. Only three freshwater drum have been collected across all sampling.

KEA 18: Over-wintering

Indicator: Concentrations of over-wintering native species

Desired Range: Maximum electrofishing CPUE (hot spots) for wintering native species exclusive of gizzard shad *Dorosoma cepedianum* and minnows >1500 individuals/hr and >5 species (very good = >2000/hr)

Goal Met:

2007	Not measured	2010	Not measured	2013	Not measured
2008	Not measured	2011	Not measured	2014	Not measured
2009	Not measured	2012	Not measured	2015	Not measured

Winter electrofishing was not conducted during 2007-2015.

KEA 19: Feeding

Indicator: Secondary production delivered to the river

Desired Range: Loading and timing of plankton, macroinvertebrates, and fish delivered to the river

Goal Met:

2007	No	2010	Unknown	2013	No
2008	Unknown	2011	No	2014	No
2009	No	2012	No	2015	No

*The Emiquon Preserve was disconnected from the Illinois River during 2007-2012. Although we did not quantify secondary production delivered to the Illinois River, it likely occurred when The Nature Conservancy pumped an estimated 204 million gallons of water to the Illinois River during January 5-7, 2008 and an estimated 7 billion gallons of water from February 24, 2010 through September 23, 2010.

<u>Peer-reviewed papers in print, accepted for publication, or in review during grant period</u>

Van Middlesworth TD, Sass GG, Ray BA, Speir TW, Lyons J, McClelland NN and AF Casper. Food habits and relative abundances of bowfin, spotted gar, and largemouth bass: Implications for controlling common carp. Hydrobiologia (River Floodplain Restoration Special Issue, Online: 29 July 2016: 1 – 13). **DOI: 10.1007/s10750-016-2866-8**.

Sparks RE, Blodgett KD, Casper AF, Hagy HM, Lemke MJ, Machado-Velho LF and L Cleide-Rodrigues. Why experiment with success? Opportunities and risks in applying assessment and adaptive management to the Emiquon floodplain restoration project. Hydrobiologia (River Floodplain Restoration Special Issue, Online: 12 May 2016:1 – 24). **DOI: 10.1007/s10750-016-2785-8**

Van Middlesworth TD, McClelland NN, Sass GG, Casper AF, Spier TW and MJ Lemke. Fish community succession and biomanipulation to control two common aquatic ecosystem stressors during a large-scale floodplain lake restoration. Hydrobiologia (River Floodplain Restoration Special Issue: 1-16). **DOI: 10.1007/s10750-016-2696-8.**

Fritts MW, ‡Fritts AK, Pendleton RM, VanMiddlesworth TD, Solomon LE, DeBoer JA and AF Casper. Occurrence of intersex in three Centrarchidae species collected from the Illinois River Watershed. ***In review with*** Hydrobiologia .

Casper AF, VanMiddlesworth TD and NN McClelland. Shifting patterns of composition and dominance in submerged aquatic vegetation during a seven year restoration of a riverine floodplain wetland. ***In review with*** Hydrobiologia (River Floodplain Restoration Special Issue) .

Lemke MJ, Hagy HM, Dungey K, Casper AF, Lemke, AM, VanMiddlesworth TD, Kent A and M Scott. Echoes of an Illinois River flood pulse: Short-term effects of the flood of record on two ecological restoration projects. ***In review with*** Hydrobiologia (River Floodplain Restoration Special Issue) .

<u>Theses and Dissertations involving Emiquon derived data during this grant period</u>

Van Middlesworth M. 2016. Comparison of intersex prevalence and vitellogenin levels in common carp (*Cyprinus carpio*) and channel catfish (*Ictalurus punctatus*) in relation to landscape and local attributes in a floodplain river system. Theses presented for Masters of Science degre3e in Natural Resources and Environmental Sciences from the University of Illinois Urbana-Champaign.

Van Middlesworth TD. 2014. Food habits of bowfin, spotted gar, and largemouth bass at the Nature Conservancy's Emiquon Preserve, Illinois; Reelfoot Lake, Tennessee; and four Wisconsin lakes. Theses presented for Masters of Science degree in Biology from Western Illinois University Macomb.

Symposia or professional conference presentations during this grant period

Casper, AF. 2016. Restoration in Floodplain Rivers: Expectations, Experiences, and Controversies. Dept. of Biology Western Illinois University, Macomb IL.

Casper, AF. 2016 - Ecosystem Responses to Asian carp Invasion and Removal: Plankton patterns, native fish trends, and Asian carp population dynamics. Presented at the Asian carp monitoring and response workgroup annual science review held February in Springfield IL. Sponsored by the Illinois DNR, Aquatic Nuisance Species Program.

Casper, AF. 2015 – Floodplain Restoration in Rivers: Expectations, Results, and Controversies. Department of Biology, University of Dubuque, Dubuque IA.

Casper, AF. 2015 – Integrating the Spatial Scales and Environmental and Cultural History to Explain the Ecology of Man-eating Lions of Tsavo, Kenya. NSF REU Program Sponsored by American Archeology Institute and National Great River Research and Education Center. Kampsville IL.

Casper, AF. 2015 - Floodplain Restoration in Rivers: Expectations, Results, and Controversies. Sam Parr Biological Field Station, Kinmundy IL.

Casper, AF. 2014 - Restoration in Floodplain Rivers: Expectations, Experiences, and Controversies. Dept. of Zoology, Southern Illinois University Carbondale

Casper, AF. 2014 – Restoration in Floodplain Rivers: Expectations, Experiences, and Controversies. Dept. of Fisheries and Allied Aquaculture, Auburn University, Auburn Alabama

Casper, AF. 2014. Expectations for biotic responses to floodplain restoration in large rivers: insights from the Emiquon and Merwin experiences. Department of Aquaculture and Applied Sciences, Auburn University. October 2014. Platform Presentation.

Casper, A. F., H. M. Hagy, M. J. Lemke, T. D. VanMiddlesworth, J. Walk, and K. Blodgett. Ecological response of floodplain restoration to flooding disturbance: A comparison of the effects of heavy and light flooding. Emiquon Science Symposium, Lewistown, IL. March 2014. Platform Presentation.

Casper, A. F., H. M. Hagy, T. D. VanMiddlesworth, N. N. McClelland, C.R. Hine, A. Yetter, M. Horath, R. Smith, and J. Stafford. Vegetation response to restoration and management of Emiquon Preserve, 2007 – 2012. Emiquon Science Symposium, Lewistown, IL. March 2014. Platform Presentation

DeBoer, J. and M. Fritts. 2014. Ecological Factors Affecting Annual Production of Largemouth Bass and Bluegill. Poster Presentation at the eighth Annual Emiquon Science Conference March 2014.

Solomon, L., R. Pendleton, A. Casper. 2014. Progression of the Fish Community at The Nature Conservancy's Merwin Preserve. Presentation at the Eighth Annual Emiquon Science Conference, 27 March 2014.

Lemke, M. J., A. F. Casper, T. D. VanMiddlesworth, H. M. Hagy, J. Walk, K. Blodgett, and K. Dungey. 2014. Ecological response of floodplain restoration to flooding disturbance: a comparison of heavy and light flooding. Presentation at World Environmental and Water Resources Congress 2014: Water without Borders, Portland, OR.

VanMiddlesworth, T., A. Casper, H. Hagy, M. Lemke, and K. Dungey. 2014. Fish and aquatic vegetation response to different flood regimes at The Nature Conservancy's Emiquon and Merwin Preserves: Implications for floodplain connection. Illinois Water Conference, Urbana, IL. October 2014. Platform Presentation.

VanMiddlesworth, T. D., N. N. McClelland, and A. F. Casper. 2014. Emiquon fish community response to restoration, 2007 – 2013. Emiquon Science Symposium, Lewistown, IL. March 2014. Platform Presentation

VanMiddlesworth, T., G. Sass, T. Spier, and B. Ray. 2014. The feeding habits of native piscivorous fishes: Can they control common carp? Illinois American Fisheries Society Meeting, Bloomington, IL. March 2014. Poster Presentation.

VanMiddlesworth, T., G. Sass, T. Spier, and B. Ray. 2014. The feeding habits and relative abundances of bowfin, spotted gar, and largemouth bass: Can native piscivores control invasive common carp? Emiquon Science Symposium, Lewistown, IL. March 2014. Poster Presentation.

VanMiddlesworth, T., G. Sass, T. Spier, and B. Ray. 2014. The feeding habits and relative abundances of bowfin, spotted gar, and largemouth bass: Can native piscivores control invasive common carp? Mississippi River Research Consortium, La Crosse, WI. April 2014. Poster Presentation.

VanMiddlesworth, T., G. Sass, T. Spier, B. Ray, and A. Casper. 2014. The feeding habits and relative abundances of bowfin, spotted gar, and largemouth bass: Can native piscivores control invasive common carp? National American Fisheries Society, Quebec City, Canada. August 2014. Platform Presentation.

VonBank, J., A.F Casper, H. Hagy, A. Yetter. An Assessment of Aquatic Invasive Plants in the Illinois River: Water Hyacinth Surveillance, Mapping, Persistence, and potential Seed Dispersal. Poster Presentation given at the Eighth Annual Emiquon Science Conference, 27 March 2014.

Technical Reports

VanMiddlesworth TD and AF Casper. The Nature Conservancy's Emiquon Nature Preserve Fish and Aquatic Vegetation Monitoring Annual Report. Illinois Natural History Survey Technical Report 2016 (16). http://hdl.handle.net/2142/90091

VanMiddlesworth TD and AF Casper. Fish and aquatic vegetation response to different flood regimes at The Nature Conservancy’s Emiquon and Merwin Preserves: Implications for floodplain connection. Illinois Natural History Survey Technical Report 2015 (15). http://hdl.handle.net/2142/78820

Solomon LE, Pendleton RM, Casper AF, Grider NT and RB Hilsabeck. Changes in the Fish Community at The Nature Conservancy's Merwin Preserve at Spunky Bottoms. Illinois Natural History Survey Technical Report 2014 (31). http://hdl.handle.net/2142/55152

VanMiddlesworth TD and AF Casper. Annual Report of Patterns and Trends in Fish and Aquatic Vegetation Monitoring at The Nature Conservancy’s Emiquon Preserve. Illinois Natural History Survey Technical Report 2014 (11). http://hdl.handle.net/2142/48841

VanMiddlesworth TD, Michaels NN and AF Casper. Patterns and Trends in Fish and Aquatic Vegetation Monitoring at The Nature Conservancy’s Emiquon Preserve: Perspectives from a 6-year (2007-2012) Summary. Illinois Natural History Survey Technical Report 2014 (1). http://hdl.handle.net/2142/46472

Status of Additional (Non-Monitoring) Fish Projects

- **Mark-Recapture estimation of population sizes Largemouth Bass and Black Crappie**: All field sampling completed in 2015, statistical analysis completed in 2016, Technical Report available online in 2017 (http://hdl.handle.net/2142/95738)

- **NSF 2013 Pre-/Post-flood response grant**: All sampling complete by 2015, statistical analysis complete by 2016, manuscript *In Press* for 2017 in Hydrobiologia Emiquon special issue

- **Merwin monitoring and summary report**: All samples up to 2016 done, summary report uo to 2014 done and available through U. of Illinois library (http://hdl.handle.net/2142/55152)

- **Comparison of reproductive condition (egg counts, GSI, LSI) of river versus Emiquon fish**: All samples collected in 2015, statistical analysis of Common carp and catfish completed in 2016, Common carp and catfish manuscript *in progress* in 2017, Largemouth bass and Black crappie samples are not processed as of 2016

- **Comparison of Intersex condition prevalence in river versus Emiquon fish**: All samples collected in 2015, statistical analysis of Common carp and catfish completed in 2016, Common carp and catfish manuscript *in progress* in 2017, Largemouth bass and Black crappie manuscript by Fritts et al. submitted to peer-review

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Ratcliff, E. N., E. J. Gittinger, T. M. O'Hara, and B.S. Ickes. 2014. Long Term Resource Monitoring Program Procedures: Fish Monitoring, 2nd edition. A program report submitted to the U.S. Army Corps of Engineers' Upper Mississippi River Restoration-Environmental Management Program, June 2014. Program Report LTRMP 2014-P001, 88 pp. including Appendixes A–G, http://pubs.usgs.gov/mis/ltrmp2014-p001/.

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