



**ILLINOIS NATURAL
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PRAIRIE RESEARCH INSTITUTE

University of Illinois
Prairie Research Institute
Brian D. Anderson, Interim Executive Director

Illinois Natural History Survey
Geoffrey A. Levin, Acting Director
Forbes Natural History Building
1816 South Oak Street
Champaign, IL 61820
217-333-6830

**Fish and aquatic vegetation response to different
flood regimes at The Nature Conservancy's
Emiquon and Merwin Preserves: Implications for
floodplain connection**

Todd D. VanMiddlesworth and Andrew F. Casper

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Short-term effects of initial flood disturbance on restoration projects

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Authors:

T.D. VanMiddlesworth, Andrew F. Casper

Abstract:**Introduction:**

In 1999, The Nature Conservancy (TNC) initiated restoration at the 2,000 acre Merwin Preserve at Spunky Bottoms, which lies alongside the Illinois River in Brown County, Illinois (Figure 1). Before its disconnection from the river due to levee construction and conversion to farmland in 1921, the Merwin Preserve consisted of two floodplain lakes known as Elbow and Long lakes and were both rich in natural resources characteristic of floodplain lakes of the Illinois River (Blodgett et al. 2007, TNC Personal Communication 2014). During the initial restoration phase, the Merwin Preserve was allowed to naturally fill with water from precipitation and a native plant community was established through natural colonization and establishment processes (Blodgett et al. 2007). Thus, restoration efforts at the Merwin Preserve have been largely occurring without dramatic interventions such as plantings or habitat construction, a process much like old field succession. The Illinois Natural History Survey's (INHS) Illinois River Biological Station (IRBS) has been conducting a light monitoring (daytime electrofishing

only during November) of the fish community since 1999. This data is used to evaluate changes in the fish community overtime.

A few years later, TNC initiated restoration of Thompson and Flag lakes of the Emiquon Preserve, which were two of the most productive backwater lakes in the Illinois River Valley (Havera et al. 2003) (Figure 2). Both lakes were disconnected from the Illinois River and reduced to agricultural drainage ditches in the early 1900s. These former floodplain lakes became one of the largest farms in Illinois and remained disconnected behind levees and in agricultural production until 2006. TNC purchased this property in 2000 and began aquatic restoration in 2007. A group of Key Ecological Attributes (KEA's) were developed in 2004 by the Emiquon Science Advisory Council (i.e. TNC and partners) to serve as the driving management tool, success criteria, and a basis describing the Emiquon restoration. Prior to the 2007 restoration, rotenone was applied to the agricultural drainage ditches to eradicate all fish species and allow a new start. The site was allowed to naturally fill through precipitation and >30 native fish species were stocked based on historical records of both lakes (Havera et al 2003). The INHS IRBS has been monitoring the fish and aquatic vegetation communities since 2007. The resulting data is used to evaluate whether the project has been successful in restoring the property based on KEA goals (VanMiddlesworth and Casper 2014).

On April 25, 2013, the Merwin Preserve levee (99% at 446 ft asl) was overtopped at 447.52 ft asl which matched the historic river stage crest (447.52 ft asl) for the La Grange reach of the Illinois River in 1995. Once overtopped, the Merwin Preserve levee failed and the property filled within hours. The river stage continued to rise and crested at 448.04 ft asl on April 27, 2013, which was 0.52 ft higher than the former 1995 record

(Hobson and The Nature Conservancy 2013). The only other time that the Merwin Preserve has been connected to the Illinois River was during a minor flooding event that overtopped the Merwin Preserve levee in 2002. The levee at the Emiquon Preserve, a larger TNC restored floodplain wetland upstream of the Merwin Preserve, has never had floodwater overtop its levee until 2013 when it experienced only a brief influx of river water because its levee is much higher (low spot at 451.3 ft asl and majority at 455.0 ft asl) and remained functional when breached (Blodgett and The Nature Conservancy 2013). The Merwin Preserve, in contrast, underwent a longer and more thorough inundation for 29 days (Hobson and The Nature Conservancy 2013). In addition, the legal requirement to move the water back out of the Merwin Preserve after the river returned to normal stage meant that another breach in the levee closer to the river had to be intentionally created. The levee failure and subsequent planned breaching allowed for the exchange of nutrients and organisms between the river and the Merwin Preserve. Because the goal of these projects is “to restore floodplain native plant and animal communities and to reconnect them to the Illinois River to allow movements of aquatic organisms” (Blodgett et al. 2007), it is important to consider how extreme, but infrequent flood events could potentially impact the dynamics of these and other floodplain restoration projects. Thus, the fish and aquatic vegetation monitoring conducted annually at the Emiquon Preserve was extended to the Merwin Preserve, following the historic spring flood in 2013 to better understand how fish and aquatic vegetation respond to natural flood events and river connection within recently restored floodplain projects.

Materials and Methods:

Aquatic Vegetation Sampling and Gear Effort

Emiquon (May-September, 2013) and Merwin (July-September, 2013) Preserves aquatic vegetation communities were sampled monthly at random sites. 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 circle around the boat (Yin et al. 2000). Historic data was used to examine changes in the aquatic vegetation community at the Emiquon Preserve. No historic aquatic vegetation data was collected at the Merwin Preserve by the INHS IRBS.

Fishing Sampling and Gear Effort

The fish communities at both Emiquon (April-October, 2013) and Merwin (July-October, 2013) Preserves were sampled monthly at random and fixed sites. Fish sampling used a multiple gear approach consisting of daytime pulsed-DC boat electrofishing runs (15 minutes each), fyke net sets (24 hours each), and mini-fyke net sets (24 hours each) at shoreline or pseudo-shoreline (used for shoreline gear) sites. Tandem fyke net sets (24 hours each) and tandem mini-fyke net sets (24 hours each) were deployed at open water (pelagic) sites (Gutreuter et al. 1995). Historic data collected by the INHS IRBS was used to examine changes in the fish community at the Merwin and Emiquon Preserves. Historic fish data collected by the INHS IRBS at the Merwin Preserve during 2010 is currently unavailable.

Results:

Aquatic Vegetation

No submersed, emergent, or non-rooted floating leaved aquatic plant species were sampled at any of the random sites at the Merwin Preserve in 2013. However, native

rooted floating-leaved species, American lotus *Nelumbo lutea*, was observed in 15 small beds while the Merwin Preserve was holding water in July (Figure 3).

The Emiquon Preserve sustains a diverse and abundant native aquatic vegetation community consisting of submersed, emergent, non-rooted floating leaved, and rooted floating leaved aquatic plant species (Table 1). Native submersed aquatic vegetation has remained the dominant aquatic plant type. Although native species richness has increased overtime, it declined in 2013. Also, non-native submersed aquatic vegetation abundance decreased for the first time in 2013 (Figure 4, 5).

Fish

We collected 9,419 fishes representing 37 species and 12 families at the Merwin Preserve and 15,489 fishes representing 19 species and 9 families at the Emiquon Preserve during 2013 (Table 2, 3). Catches at both study areas were dominated by native species regardless of gear used during 2013 (Table 4, 5, 6, 7, 8, 9, 10, 11, 12, 13). Non-native species including common carp *Cyprinus carpio*, silver carp *Hypophthalmichthys molitrix*, and bighead carp *Hypophthalmichthys nobilis* were collected at the Merwin Preserve, while only common carp were collected at the Emiquon Preserve during 2013. All non-native fish species collected were removed from both study areas. Numerous unidentified *Ameiurus* species were likely black bullhead *Ameiurus melas* or brown bullhead *Ameiurus nebulosus* ≤ 100 mm, unidentified *Etheostoma* species were likely a darter species, unidentified *Ictiobus* species were likely bigmouth buffalo *Ictiobus cyprinellus* or smallmouth buffalo *Ictiobus bubalus* ≤ 100 mm, and unidentified *Lepomis* species were likely bluegill *Lepomis macrochirus* or pumpkinseed *Lepomis gibbosus* ≤ 40 mm were collected at both the Merwin and Emiquon Preserves.

Native species richness increased overtime at both study areas, while the total native species richness at the Merwin Preserve was the highest ever recorded (Figure 6, 7). Total biomass (kg) of native fish at Merwin Preserve was less than that of non-native fish, while total biomass (kg) of native fish was greater than that of non-native fish at the Emiquon Preserve (Figure 8). Additionally, the total biomass (kg) of native fish increased at the Emiquon Preserve overtime (Figure 9).

Discussion:

Due to a dramatic reduction in water levels at the Merwin Preserve when the levee breach was intentionally deepened, we did not observe American lotus after July, 2013, which is likely due to the resulting drainage of wet habitats. Also, massive flood pulse, rapid water fluctuation, low light penetration through the water column due to high turbidity, and high abundance of invasive fish species such as common carp may have resulted in no collection of other aquatic vegetation species. As for the Emiquon Preserve, a sustained and abundant aquatic vegetation community may be the result of a more controlled and lighter flood pulse, lower water fluctuation, higher light penetration through the water column due to lower turbidity, and a lesser abundance of invasive fish species such as common carp.

Fish species richness at the Merwin Preserve during 2013 increased dramatically from previous years. Many species recruited into the floodplain and it was interesting that most of the total catch consisted of juvenile and young of the year fishes, which was likely the result of riverine fishes seeking habitat and food. Fish species richness also increased at the Emiquon Preserve during 2013, which may have resulted from riverine fishes entering and utilizing the resources of the floodplain.

Merwin and Emiquon Preserves seemed to have responded differently to flood conditions, which is understandable since they are two different areas in two different locations. Our results may reveal responses between the aquatic vegetation and fish communities at the Merwin Preserve due to major flooding during 2013 and those at the Emiquon Preserve due to moderate flooding during 2013. Continued research may allow us to identify what causes these responses which will allow us to better understand how large disconnected floodplains like the Merwin and Emiquon Preserves, as well as other projects will respond when they are connected to a mainstem river. The knowledge gained may be very useful for future floodplain restoration projects because they need to function properly under natural flood cycles and conditions.

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Table 1 List showing aquatic plant species observed and/or collected and percent composition at the Emiquon Preserve in 2013; * represents non-native species.

<u>Common name</u>	<u>Scientific Name</u>	<u>Family</u>	<u>%</u>
American pondweed	<i>Potamogeton nodosus</i>	Potamogetonaceae	31.85
* Eurasian watermilfoil	<i>Myriophyllum spicatum</i>	Haloragaceae	15.58
sago pondweed	<i>P. pectinatus</i>	Potamogetonaceae	13.86
southern naiad	<i>Najas guadalupensis</i>	Najadaceae	13.58
coontail	<i>Ceratophyllum demersum</i>	Ceratophyllaceae	11.66
leafy pondweed	<i>P. foliosus</i>	Potamogetonaceae	4.77
brittle naiad	<i>N. minor</i>	Najadaceae	3.49
narrow-leaved cattail	<i>Typha angustifolia</i>	Typhaceae	1.84
American elodea	<i>Elodea canadensis</i>	Hydrocharitaceae	0.88
Lemnaceae	<i>Lemna spp.</i>	Lemnaceae	0.84
Characeae	<i>Chara spp.</i>	Characeae	0.52
creeping water primrose	<i>Jussiaea lutea</i>	Onagraceae	0.32
American lotus	<i>Nelumbo lutea</i>	Nelumbonaceae	0.32
* curly-leaf pondweed	<i>P. crispus</i>	Potamogetonaceae	0.24
Illinois pondweed	<i>P. Illinoensis</i>	Potamogetonaceae	0.24
Total species		13	
Families		10	

Table 2 List showing total catch and percent composition for each fish species collected at the Merwin Preserve in 2013; * represents non-native species.

<u>Common name</u>	<u>Scientific name</u>	<u>Family</u>	<u>No.</u>	<u>%</u>
unidentified <i>Ameiurus</i> spp.	<i>Ameiurus</i> spp.	Ictaluridae	2692	28.58
gizzard shad	<i>Dorosoma cepedianum</i>	Clupeidae	2483	26.36
western mosquitofish	<i>Gambusia affinis</i>	Poeciliidae	1095	11.63
unidentified <i>Ictiobus</i> spp.	<i>Ictiobus</i> spp.	Catostomidae	755	8.02
* common carp	<i>Cyprinus carpio</i>	Cyprinidae	367	3.90
yellow bullhead	<i>Ameiurus natalus</i>	Ictaluridae	319	3.39
black bullhead	<i>A. melas</i>	Ictaluridae	205	2.18
white bass	<i>Morone chrysops</i>	Moronidae	202	2.14
white crappie	<i>Pomoxis annularis</i>	Centrarchidae	171	1.82
* silver carp	<i>Hypophthalmichthys molitrix</i>	Cyprinidae	159	1.69
unidentified <i>Lepomis</i> spp.	<i>Lepomis</i> spp.	Centrarchidae	159	1.69
bluegill	<i>Lepomis macrochirus</i>	Centrarchidae	158	1.68
shortnose gar	<i>Lepisosteus platostomus</i>	Lepisostidae	144	1.53
black crappie	<i>P. nigromaculatus</i>	Centrarchidae	134	1.42
bigmouth buffalo	<i>Ictiobus cyprinellus</i>	Catostomidae	83	0.88
freshwater drum	<i>Aplodinotus grunniens</i>	Sciaenidae	65	0.69
smallmouth buffalo	<i>I. bubalus</i>	Catostomidae	56	0.59
orangespotted sunfish	<i>L. humilis</i>	Centrarchidae	28	0.30
bullhead minnow	<i>Pimephales vigilax</i>	Cyprinidae	24	0.25
green sunfish	<i>L. cyanellus</i>	Centrarchidae	22	0.23
emerald shiner	<i>Netropis atherinoides</i>	Cyprinidae	20	0.21
bowfin	<i>Amia calva</i>	Amiidae	10	0.11
spotted gar	<i>L. oculatus</i>	Lepisostidae	7	0.07
warmouth	<i>L. gulosus</i>	Centrarchidae	7	0.07
slenderhead darter	<i>Percina phoxocephala</i>	Percidae	6	0.06
logperch	<i>P. caprodes</i>	Percidae	5	0.05
largemouth bass	<i>Micropterus salmoides</i>	Centrarchidae	5	0.05
blackspotted topminnow	<i>Fundulus olivaceus</i>	Fundulidae	4	0.04
blackstriped topminnow	<i>F. notatus</i>	Fundulidae	4	0.04
longnose gar	<i>L. osseus</i>	Lepisostidae	4	0.04
* bighead carp	<i>H. nobilis</i>	Cyprinidae	3	0.03
mud darter	<i>Etheostoma asprigene</i>	Percidae	3	0.03
red shiner	<i>Cyprinella lutrensis</i>	Cyprinidae	3	0.03
river carpsucker	<i>Carpoides carpio</i>	Catostomidae	3	0.03
yellow bass	<i>M. mississippiensis</i>	Moronidae	3	0.03
bluegill x warmouth	<i>L. macrochirus x</i> <i>L. gulosus</i>	Centrarchidae	2	0.02
blackside darter	<i>P. maculata</i>	Percidae	2	0.02
golden shiner	<i>Notemigonus crysoleucas</i>	Cyprinidae	2	0.02
pumpkinseed	<i>L. gibbosus</i>	Centrarchidae	2	0.02
channel catfish	<i>Ictalurus punctatus</i>	Ictaluridae	1	0.01
johnny darter	<i>E. nigrum</i>	Percidae	1	0.01
unidentified <i>Etheostoma</i> spp.	<i>Etheostoma</i> spp.	Percidae	1	0.01
Total Fish		9419		
Total Species		37		
Total Families		12		

Table 3 List showing total catch and percent composition for each fish species collected at the Emiquon Preserve in 2013; * represents non-native species.

<u>Common name</u>	<u>Scientific name</u>	<u>Family</u>	<u>No.</u>	<u>%</u>
gizzard shad	<i>Dorosoma cepedianum</i>	Clupeidae	7442	48.0
black crappie	<i>Pomoxis nigromaculatus</i>	Centrarchidae	2894	18.7
unidentified <i>Lepomis</i> spp.	<i>Lepomis</i> spp.	Centrarchidae	2128	13.7
bluegill	<i>Lepomis macrochirus</i>	Centrarchidae	1658	10.7
golden shiner	<i>Notemigonus crysoleucas</i>	Cyprinidae	473	3.1
largemouth bass	<i>Micropterus salmoides</i>	Centrarchidae	450	2.9
pumpkinseed	<i>L. gibbosus</i>	Centrarchidae	129	0.8
* common carp	<i>Cyprinus carpio</i>	Cyprinidae	92	0.6
bowfin	<i>Amia calva</i>	Amiidae	59	0.4
unidentified <i>Ameiurus</i> spp.	<i>Ameiurus</i> spp.	Ictaluridae	41	0.3
white crappie	<i>P. annularis</i>	Centrarchidae	36	0.2
black bullhead	<i>Ameiurus melas</i>	Ictaluridae	20	0.1
shortnose gar	<i>Lepisosteus platostomus</i>	Lepisostidae	18	0.1
starhead topminnow	<i>Fundulus dispar</i>	Fundulidae	16	0.1
spotted gar	<i>L. oculatus</i>	Lepisostidae	14	0.1
yellow bullhead	<i>A. natalis</i>	Ictaluridae	7	0.0
unidentified Catostomidae spp.	Catostomidae spp.	Catostomidae	3	0.0
warmouth	<i>L. gulosus</i>	Centrarchidae	3	0.0
brown bullhead	<i>A. nebulosus</i>	Ictaluridae	2	0.0
emerald shiner	<i>Notropis atherinoides</i>	Cyprinidae	1	0.0
mud darter	<i>Etheostoma asprigene</i>	Percidae	1	0.0
sauger	<i>Stizostedion canadense</i>	Percidae	1	0.0
bluegill x	<i>L. macrochirus x</i>	Centrarchidae	1	0.0
pumpkinseed	<i>L. gibbosus</i>			
Total Fish			15489	
Total Species			19	
Total Families			9	

Table 4 List showing total catch, percent composition of total catch, and mean catch per unit effort (No./Hr) of each fish species collected while electrofishing at the Merwin Preserve in 2013; * represents non-native species.

<u>Common name</u>	<u>Scientific name</u>	<u>Family</u>	<u>No.</u>	<u>%</u>	<u>No./Hr</u>
gizzard shad	<i>Dorosoma cepedianum</i>	Clupeidae	2301	63.08	575.25
unidentified <i>Ictiobus</i> spp.	<i>Ictiobus</i> spp.	Catostomidae	566	15.52	141.50
western mosquitofish	<i>Gambusia affinis</i>	Poeciliidae	181	4.96	45.25
* common carp	<i>Cyprinus carpio</i>	Cyprinidae	151	4.14	37.75
* silver carp	<i>Hypophthalmichthys molitrix</i>	Cyprinidae	86	2.36	21.50
bigmouth buffalo	<i>Ictiobus cyprinellus</i>	Catostomidae	56	1.54	14.00
unidentified <i>Ameiurus</i> spp.	<i>Ameiurus</i> spp.	Ictaluridae	54	1.48	13.50
smallmouth buffalo	<i>I. bubalus</i>	Catostomidae	44	1.21	11.00
black bullhead	<i>Ameiurus melas</i>	Ictaluridae	37	1.01	9.25
yellow bullhead	<i>A. natalus</i>	Ictaluridae	33	0.90	8.25
freshwater drum	<i>Aplodinotus grunniens</i>	Sciaenidae	32	0.88	8.00
bluegill	<i>Lepomis macrochirus</i>	Centrarchidae	22	0.60	5.50
unidentified <i>Lepomis</i> spp.	<i>Lepomis</i> spp.	Centrarchidae	18	0.49	4.50
black crappie	<i>Pomoxis nigromaculatus</i>	Centrarchidae	11	0.30	2.75
white crappie	<i>Pomoxis annularis</i>	Centrarchidae	11	0.30	2.75
shortnose gar	<i>Lepisosteus platostomus</i>	Lepisostidae	8	0.22	2.00
white bass	<i>Morone chrysops</i>	Moronidae	8	0.22	2.00
orangespotted sunfish	<i>L. humilis</i>	Centrarchidae	7	0.19	1.75
bowfin	<i>Amia calva</i>	Amiidae	6	0.16	1.50
warmouth	<i>L. gulosus</i>	Centrarchidae	5	0.14	1.25
* bighead carp	<i>H. nobilis</i>	Cyprinidae	2	0.05	0.50
green sunfish	<i>L. cyanellus</i>	Centrarchidae	2	0.05	0.50
bluegill x warmouth	<i>Lepomis macrochirus</i> x <i>L. gulosus</i>	Centrarchidae	1	0.03	0.25
emerald shiner	<i>Netropis atherinoides</i>	Cyprinidae	1	0.03	0.25
golden shiner	<i>Notemigonus crysoleucas</i>	Cyprinidae	1	0.03	0.25
logperch	<i>P. caprodes</i>	Percidae	1	0.03	0.25
largemouth bass	<i>Micropterus salmoides</i>	Centrarchidae	1	0.03	0.25
longnose gar	<i>L. osseus</i>	Lepisostidae	1	0.03	0.25
yellow bass	<i>M. mississippiensis</i>	Moronidae	1	0.03	0.25
Total Fish			3648		
Total Species			25		
Total Families			11		

Table 5 List showing total catch, percent composition of total catch, and mean catch per unit effort (No./Hr) of each fish species collected while electrofishing at the Emiquon Preserve in 2013; * represents non-native species.

<u>Common name</u>	<u>Scientific name</u>	<u>Family</u>	<u>No.</u>	<u>%</u>	<u>No./Hr</u>
gizzard shad	<i>Dorosoma cepedianum</i>	Clupeidae	7307	87.51	1217.83
largemouth bass	<i>Micropterus salmoides</i>	Centrarchidae	367	4.40	61.17
golden shiner	<i>Notemigonus crysoleucas</i>	Cyprinidae	295	3.53	49.17
unidentified <i>Lepomis</i> spp.	<i>Lepomis</i> spp.	Centrarchidae	181	2.17	30.17
bluegill	<i>Lepomis macrochirus</i>	Centrarchidae	103	1.23	17.17
black crappie	<i>Pomoxis nigromaculatus</i>	Centrarchidae	54	0.65	9.00
* common carp	<i>Cyprinus carpio</i>	Cyprinidae	18	0.22	3.00
bowfin	<i>Amia calva</i>	Amiidae	10	0.12	1.67
spotted gar	<i>L. oculatus</i>	Lepisostidae	5	0.06	0.83
white crappie	<i>P. annularis</i>	Centrarchidae	3	0.04	0.50
pumpkinseed	<i>L. gibbosus</i>	Centrarchidae	2	0.02	0.33
starhead topminnow	<i>Fundulus dispar</i>	Fundulidae	2	0.02	0.33
brown bullhead	<i>A. nebulosus</i>	Ictaluridae	1	0.01	0.17
shortnose gar	<i>Lepisosteus platostomus</i>	Lepisostidae	1	0.01	0.17
warmouth	<i>L. gulosus</i>	Centrarchidae	1	0.01	0.17
Total Fish			8350		
Total Species			14		
Total Families			7		

Table 6 List showing total catch, percent composition of total catch, and mean catch per unit effort (No./24 Hrs) of each fish species collected with fyke nets at the Merwin Preserve in 2013; * represents non-native species.

<u>Common name</u>	<u>Scientific name</u>	<u>Family</u>	<u>No.</u>	<u>%</u>	<u>No./24 Hrs</u>
white bass	<i>Morone chrysops</i>	Moronidae	150	17.90	9.38
* common carp	<i>Cyprinus carpio</i>	Cyprinidae	135	16.11	8.44
shortnose gar	<i>Lepisosteus platostomus</i>	Lepisostidae	104	12.41	6.50
white crappie	<i>Pomoxis annularis</i>	Centrarchidae	93	11.10	5.81
bluegill	<i>Lepomis macrochirus</i>	Centrarchidae	91	10.86	5.69
* silver carp	<i>Hypophthalmichthys molitrix</i>	Cyprinidae	63	7.52	3.94
black bullhead	<i>Ameiurus melas</i>	Ictaluridae	60	7.16	3.75
gizzard shad	<i>Dorosoma cepedianum</i>	Clupeidae	33	3.94	2.06
bigmouth buffalo	<i>Ictiobus cyprinellus</i>	Catostomidae	18	2.15	1.13
black crappie	<i>P. nigromaculatus</i>	Centrarchidae	14	1.67	0.88
unidentified <i>Ameiurus</i> spp.	<i>Ameiurus</i> spp.	Ictaluridae	14	1.67	0.88
freshwater drum	<i>Aplodinotus grunniens</i>	Sciaenidae	11	1.31	0.69
unidentified <i>Ictiobus</i> spp.	<i>Ictiobus</i> spp.	Catostomidae	11	1.31	0.69
green sunfish	<i>L. cyanellus</i>	Centrarchidae	9	1.07	0.56
orangespotted sunfish	<i>L. humilus</i>	Centrarchidae	6	0.72	0.38
smallmouth buffalo	<i>I. bubalus</i>	Catostomidae	6	0.72	0.38
spotted gar	<i>L. oculatus</i>	Lepisostidae	6	0.72	0.38
yellow bullhead	<i>A. natalus</i>	Ictaluridae	6	0.72	0.38
river carpsucker	<i>Carpoides carpio</i>	Cyprinidae	3	0.36	0.19
bowfin	<i>Amia calva</i>	Amiidae	2	0.24	0.13
longnose gar	<i>L. osseus</i>	Lepisostidae	1	0.12	0.06
pumpkinseed	<i>L. gibbosus</i>	Centrarchidae	1	0.12	0.06
yellow bass	<i>M. mississippiensis</i>	Moronidae	1	0.12	0.06
Total Fish			838		
Total Species			21		
Total Families			9		

Table 7 List showing total catch, percent composition of total catch, and mean catch per unit effort (No./24 Hrs) of each fish species collected with fyke nets at the Emiquon Preserve in 2013; * represents non-native species.

<u>Common name</u>	<u>Scientific name</u>	<u>Family</u>	<u>No.</u>	<u>%</u>	<u>No./24 Hrs</u>
black crappie	<i>Pomoxis nigromaculatus</i>	Centrarchidae	988	50.18	35.29
bluegill	<i>Lepomis macrochirus</i>	Centrarchidae	658	33.42	23.50
pumpkinseed	<i>L. gibbosus</i>	Centrarchidae	87	4.42	3.11
golden shiner	<i>Notemigonus crysoleucas</i>	Cyprinidae	49	2.49	1.75
bowfin	<i>Amia calva</i>	Amiidae	43	2.18	1.54
gizzard shad	<i>Dorosoma cepedianum</i>	Clupeidae	37	1.88	1.32
largemouth bass	<i>Micropterus salmoides</i>	Centrarchidae	34	1.73	1.21
* common carp	<i>Cyprinus carpio</i>	Cyprinidae	29	1.47	1.04
shortnose gar	<i>Lepisosteus platostomus</i>	Lepisostidae	14	0.71	0.50
white crappie	<i>P. annularis</i>	Centrarchidae	14	0.71	0.50
spotted gar	<i>L. oculatus</i>	Lepisostidae	8	0.41	0.29
black bullhead	<i>Ameiurus melas</i>	Ictaluridae	5	0.25	0.18
brown bullhead	<i>A. nebulosus</i>	Ictaluridae	1	0.05	0.04
sauger	<i>Stizostedion canadense</i>	Percidae	1	0.05	0.04
unidentified <i>Lepomis</i> spp.	<i>Lepomis</i> spp.	Centrarchidae	1	0.05	0.04
Total Fish			1969		
Total Species			15		
Total Families			7		

Table 8 List showing total catch, percent composition of total catch, and mean catch per unit effort (No./24 Hrs) of each fish species collected with mini-fyke nets at the Merwin Preserve in 2013; * represents non-native species.

<u>Common name</u>	<u>Scientific name</u>	<u>Family</u>	<u>No.</u>	<u>%</u>	<u>No./24 Hrs</u>
unidentified <i>Ameiurus</i> spp.	<i>Ameiurus</i> spp.	Ictaluridae	2612	55.53	163.25
western mosquitofish	<i>Gambusia affinis</i>	Poeciliidae	913	19.41	57.06
yellow bullhead	<i>Ameiurus natalus</i>	Ictaluridae	271	5.76	16.94
unidentified <i>Ictiobus</i> spp.	<i>Ictiobus</i> spp.	Catostomidae	178	3.78	11.13
gizzard shad	<i>Dorosoma cepedianum</i>	Clupeidae	145	3.08	9.06
unidentified <i>Lepomis</i> spp.	<i>Lepomis</i> spp.	Centrarchidae	141	3.00	8.81
black crappie	<i>Pomoxis nigromaculatus</i>	Centrarchidae	102	2.17	6.38
black bullhead	<i>A. melas</i>	Ictaluridae	68	1.45	4.25
* common carp	<i>Cyprinus carpio</i>	Cyprinidae	52	1.11	3.25
white crappie	<i>P. annularis</i>	Centrarchidae	28	0.60	1.75
shortnose gar	<i>Lepisosteus platostomus</i>	Lepisostidae	25	0.53	1.56
bullhead minnow	<i>Pimephales vigilax</i>	Cyprinidae	24	0.51	1.50
freshwater drum	<i>Aplodinotus grunniens</i>	Sciaenidae	20	0.43	1.25
emerald shiner	<i>Netropis atherinoides</i>	Cyprinidae	19	0.40	1.19
bluegill	<i>Lepomis macrochirus</i>	Centrarchidae	17	0.36	1.06
orangespotted sunfish	<i>L. humilus</i>	Centrarchidae	15	0.32	0.94
green sunfish	<i>L. cyanellus</i>	Centrarchidae	11	0.23	0.69
white bass	<i>Morone chrysops</i>	Moronidae	10	0.21	0.63
bigmouth buffalo	<i>Ictiobus cyprinellus</i>	Catostomidae	7	0.15	0.44
slenderhead darter	<i>Percina phoxocephala</i>	Percidae	6	0.13	0.38
blackspotted topminnow	<i>Fundulus olivaceus</i>	Fundulidae	4	0.09	0.25
blackstriped topminnow	<i>F. notatus</i>	Fundulidae	4	0.09	0.25
logperch	<i>P. caprodes</i>	Percidae	4	0.09	0.25
largemouth bass	<i>Micropterus salmoides</i>	Centrarchidae	4	0.09	0.25
smallmouth buffalo	<i>I. bubalus</i>	Catostomidae	4	0.09	0.25
mud darter	<i>Etheostoma asprigene</i>	Percidae	3	0.06	0.19
red shiner	<i>Cyprinella lutrensis</i>	Cyprinidae	3	0.06	0.19
blackside darter	<i>P. maculata</i>	Percidae	2	0.04	0.13
bowfin	<i>Amia calva</i>	Amiidae	2	0.04	0.13
* silver carp	<i>Hypophthalmichthys molitrix</i>	Cyprinidae	2	0.04	0.13
warmouth	<i>L. gulosus</i>	Centrarchidae	2	0.04	0.13
bluegill x warmouth	<i>Lepomis macrochirus</i> x <i>L. gulosus</i>	Centrarchidae	1	0.02	0.06
golden shiner	<i>Notemigonus crysoleucas</i>	Cyprinidae	1	0.02	0.06
johnny darter	<i>E. nigrum</i>	Percidae	1	0.02	0.06
longnose gar	<i>L. osseus</i>	Lepisostidae	1	0.02	0.06
unidentified <i>Etheostoma</i> spp.	<i>Etheostoma</i> spp.	Percidae	1	0.02	0.06
yellow bass	<i>M. mississippiensis</i>	Moronidae	1	0.02	0.06
Total Fish			4704		
Total Species			32		
Total Families			12		

Table 9 List showing total catch, percent composition of total catch, and mean catch per unit effort (No./24 Hrs) of each fish species collected with mini-fyke nets at the Emiquon Preserve in 2013; * represents non-native species.

<u>Common name</u>	<u>Scientific name</u>	<u>Family</u>	<u>No.</u>	<u>%</u>	<u>No./24 Hrs</u>
unidentified <i>Lepomis</i> spp.	<i>Lepomis</i> spp.	Centrarchidae	1941	44.92	69.32
black crappie	<i>Pomoxis nigromaculatus</i>	Centrarchidae	1348	31.20	48.14
bluegill	<i>Lepomis macrochirus</i>	Centrarchidae	650	15.04	23.21
golden shiner	<i>Notemigonus crysoleucas</i>	Cyprinidae	122	2.82	4.36
gizzard shad	<i>Dorosoma cepedianum</i>	Clupeidae	81	1.87	2.89
unidentified <i>Ameiurus</i> spp.	<i>Ameiurus</i> spp.	Ictaluridae	36	0.83	1.29
* common carp	<i>Cyprinus carpio</i>	Cyprinidae	32	0.74	1.14
largemouth bass	<i>Micropterus salmoides</i>	Centrarchidae	28	0.65	1.00
pumpkinseed	<i>L. gibbosus</i>	Centrarchidae	28	0.65	1.00
starhead topminnow	<i>Fundulus dispar</i>	Fundulidae	14	0.32	0.50
white crappie	<i>P. annularis</i>	Centrarchidae	11	0.25	0.39
black bullhead	<i>Ameiurus melas</i>	Ictaluridae	10	0.23	0.36
yellow bullhead	<i>A. natalis</i>	Ictaluridae	5	0.12	0.18
bowfin	<i>Amia calva</i>	Amiidae	4	0.09	0.14
unidentified Catostomidae spp.	Catostomidae spp.	Catostomidae	3	0.07	0.11
shortnose gar	<i>Lepisosteus platostomus</i>	Lepisostidae	2	0.05	0.07
warmouth	<i>L. gulosus</i>	Centrarchidae	2	0.05	0.07
emerald shiner	<i>Notropis atherinoides</i>	Cyprinidae	1	0.02	0.04
mud darter	<i>Etheostoma asprigene</i>	Percidae	1	0.02	0.04
spotted gar	<i>L. oculatus</i>	Lepisostidae	1	0.02	0.04
bluegill x	<i>L. macrochirus x</i>	Centrarchidae	1	0.02	0.04
pumpkinseed	<i>L. gibbosus</i>				
Total Fish			4321		
Total Species			17		
Total Families			9		

Table 10 List showing total catch, percent composition of total catch, and mean catch per unit effort (No./24 Hrs) of each fish species collected with tandem fyke nets at the Merwin Preserve in 2013; * represents non-native species.

<u>Common name</u>	<u>Scientific name</u>	<u>Family</u>	<u>No.</u>	<u>%</u>	<u>No./24 Hrs</u>
white crappie	<i>Pomoxis annularis</i>	Centrarchidae	39	20.63	9.75
white bass	<i>Morone chrysops</i>	Moronidae	34	17.99	8.50
bluegill	<i>Lepomis macrochirus</i>	Centrarchidae	28	14.81	7.00
black bullhead	<i>Ameiurus melas</i>	Ictaluridae	26	13.76	6.50
* common carp	<i>Cyprinus carpio</i>	Cyprinidae	25	13.23	6.25
yellow bullhead	<i>A. natalus</i>	Ictaluridae	9	4.76	2.25
black crappie	<i>P. nigromaculatus</i>	Centrarchidae	7	3.70	1.75
shortnose gar	<i>Lepisosteus platostomus</i>	Lepisostidae	6	3.17	1.50
gizzard shad	<i>Dorosoma cepedianum</i>	Clupeidae	4	2.12	1.00
* silver carp	<i>Hypophthalmichthys molitrix</i>	Cyprinidae	4	2.12	1.00
smallmouth buffalo	<i>Ictiobus bubalus</i>	Catostomidae	2	1.06	0.50
* bighead carp	<i>H. nobilis</i>	Cyprinidae	1	0.53	0.25
channel catfish	<i>Ictalurus punctatus</i>	Ictaluridae	1	0.53	0.25
longnose gar	<i>L. osseus</i>	Lepisostidae	1	0.53	0.25
pumpkinseed	<i>L. gibbosus</i>	Centrarchidae	1	0.53	0.25
spotted gar	<i>L. oculatus</i>	Lepisostidae	1	0.53	0.25
Total Fish			189		
Total Species			16		
Total Families			7		

Table 11 List showing total catch, percent composition of total catch, and mean catch per unit effort (No./24 Hrs) of each fish species collected with tandem fyke nets at the Emiquon Preserve in 2013; * represents non-native species.

<u>Common name</u>	<u>Scientific name</u>	<u>Family</u>	<u>No.</u>	<u>%</u>	<u>No./24 Hrs</u>
black crappie	<i>Pomoxis nigromaculatus</i>	Centrarchidae	470	63.43	67.14
bluegill	<i>Lepomis macrochirus</i>	Centrarchidae	204	27.53	29.14
largemouth bass	<i>Micropterus salmoides</i>	Centrarchidae	21	2.83	3.00
* common carp	<i>Cyprinus carpio</i>	Cyprinidae	13	1.75	1.86
gizzard shad	<i>Dorosoma cepedianum</i>	Clupeidae	9	1.21	1.29
pumpkinseed	<i>L. gibbosus</i>	Centrarchidae	8	1.08	1.14
white crappie	<i>P. annularis</i>	Centrarchidae	6	0.81	0.86
black bullhead	<i>Ameiurus melas</i>	Ictaluridae	5	0.67	0.71
bowfin	<i>Amia calva</i>	Amiidae	2	0.27	0.29
golden shiner	<i>Notemigonus crysoleucas</i>	Cyprinidae	1	0.13	0.14
shortnose gar	<i>Lepisosteus platostomus</i>	Lepisostidae	1	0.13	0.14
yellow bullhead	<i>A. natalis</i>	Ictaluridae	1	0.13	0.14
Total Fish			741		
Total Species			12		
Total Families			6		

Table 12 List showing total catch, percent composition of total catch, and mean catch per unit effort (No./24 Hrs) of each fish species collected with tandem mini-fyke nets at the Merwin Preserve in 2013; * represents non-native species.

<u>Common name</u>	<u>Scientific name</u>	<u>Family</u>	<u>No.</u>	<u>%</u>	<u>No./24 Hrs</u>
black bullhead	<i>Ameiurus melas</i>	Ictaluridae	14	35.00	3.50
unidentified <i>Ameiurus</i> spp.	<i>Ameiurus</i> spp.	Ictaluridae	12	30.00	3.00
* common carp	<i>Cyprinus carpio</i>	Cyprinidae	4	10.00	1.00
* silver carp	<i>Hypophthalmichthys molitrix</i>	Cyprinidae	4	10.00	1.00
bigmouth buffalo	<i>Ictiobus cyprinellus</i>	Catostomidae	2	5.00	0.50
freshwater drum	<i>Aplodinotus grunniens</i>	Sciaenidae	2	5.00	0.50
western mosquitofish	<i>Gambusia affinis</i>	Poeciliidae	1	2.50	0.25
shortnose gar	<i>Lepisosteus platostomus</i>	Lepisostidae	1	2.50	0.25
Total Fish			40		
Total Species			7		
Total Families			6		

Table 13 List showing total catch, percent composition of total catch, and mean catch per unit effort (No./24 Hrs) of each fish species collected with tandem mini-fyke nets at the Emiquon Preserve in 2013; * represents non-native species.

<u>Common name</u>	<u>Scientific name</u>	<u>Family</u>	<u>No.</u>	<u>%</u>	<u>No./24 Hrs</u>
bluegill	<i>Lepomis macrochirus</i>	Centrarchidae	43	39.81	6.14
black crappie	<i>Pomoxis nigromaculatus</i>	Centrarchidae	34	31.48	4.86
gizzard shad	<i>Dorosoma cepedianum</i>	Clupeidae	8	7.41	1.14
golden shiner	<i>Notemigonus crysoleucas</i>	Cyprinidae	6	5.56	0.86
unidentified <i>Ameiurus</i> spp.	<i>Ameiurus</i> spp.	Ictaluridae	5	4.63	0.71
unidentified <i>Lepomis</i> spp.	<i>Lepomis</i> spp.	Centrarchidae	5	4.63	0.71
pumpkinseed	<i>L. gibbosus</i>	Centrarchidae	4	3.70	0.57
white crappie	<i>P. annularis</i>	Centrarchidae	2	1.85	0.29
yellow bullhead	<i>A. natalis</i>	Ictaluridae	1	0.93	0.14
Total Fish			108		
Total Species			7		
Total Families			4		



Figure 1 Map of The Nature Conservancy's Merwin Preserve in 2013.



Figure 2 Map of The Nature Conservancy's Emiquon Preserve in 2013.



Figure 3 Map of The Nature Conservancy's Merwin Preserve displaying all locations where American lotus *Nelumbo lutea* was observed in July 2013.

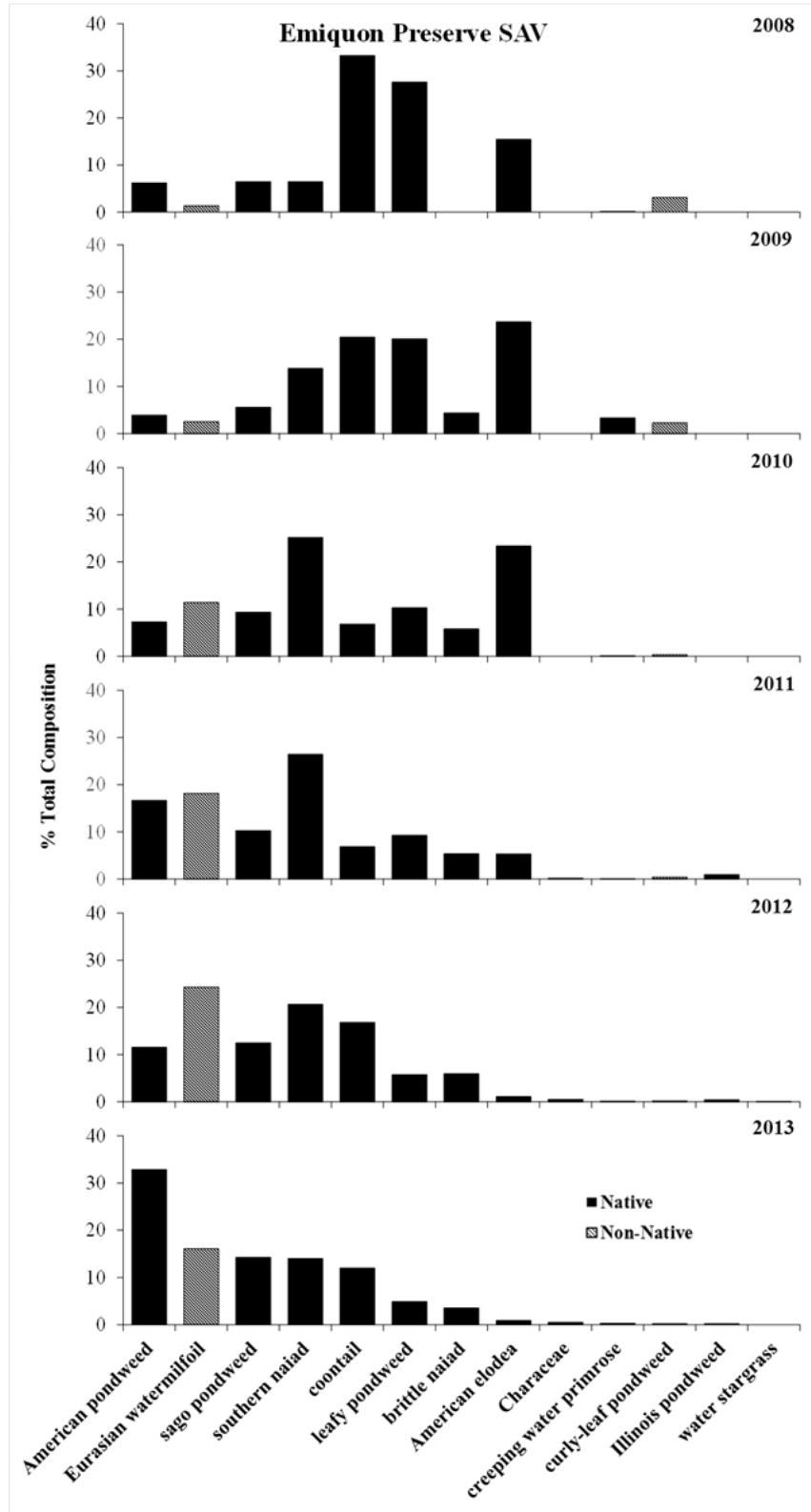


Figure 4 Percent total composition of all native and non-native submersed aquatic vegetation (SAV) species collected at the Emiquon Preserve during 2008-2013.

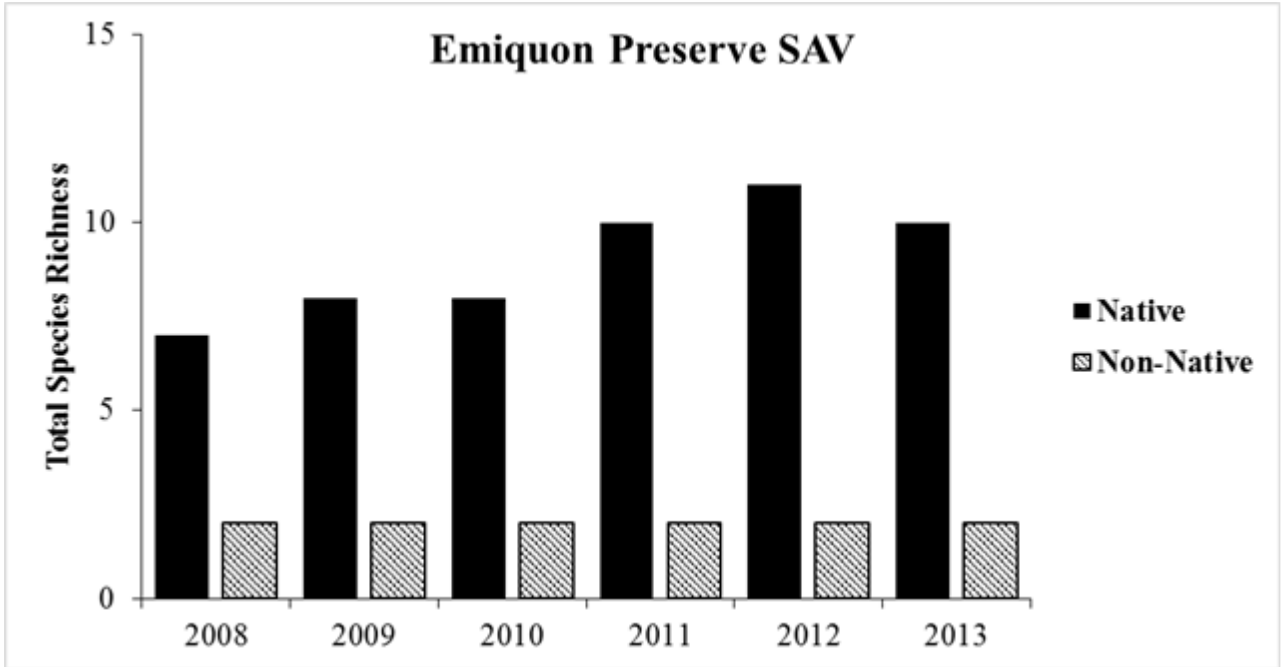


Figure 5 Total number of all native and non-native submersed aquatic vegetation (SAV) species collected at the Emiquon Preserve during 2008-2013.

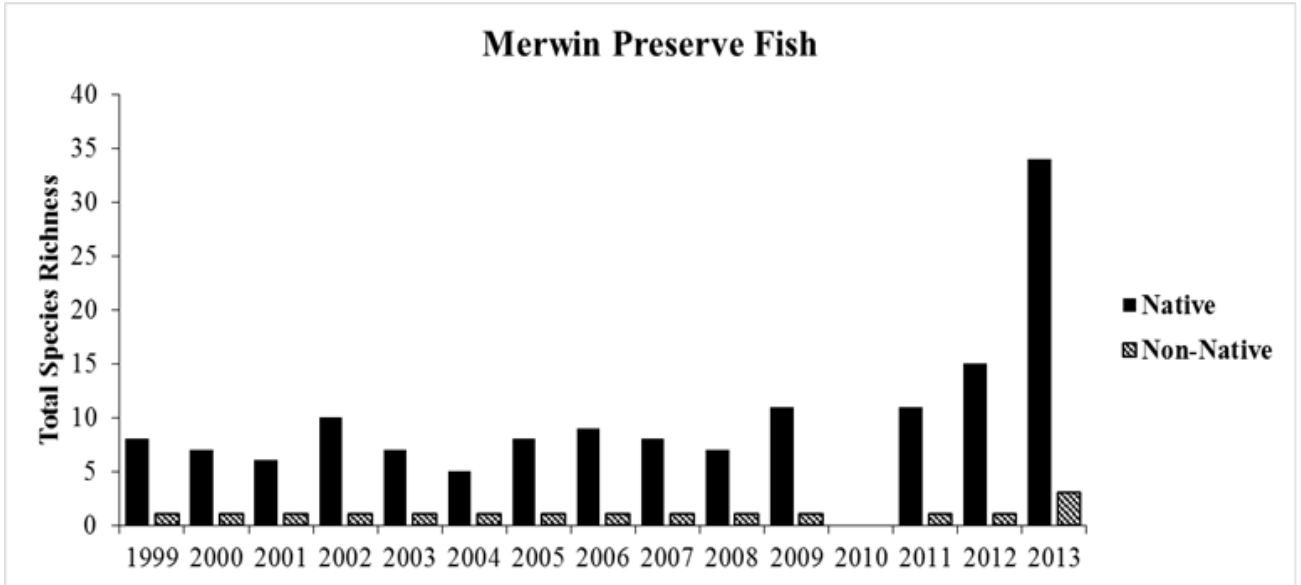


Figure 6 Total number of all native and non-native fish species collected at the Merwin Preserve during 1999-2013.

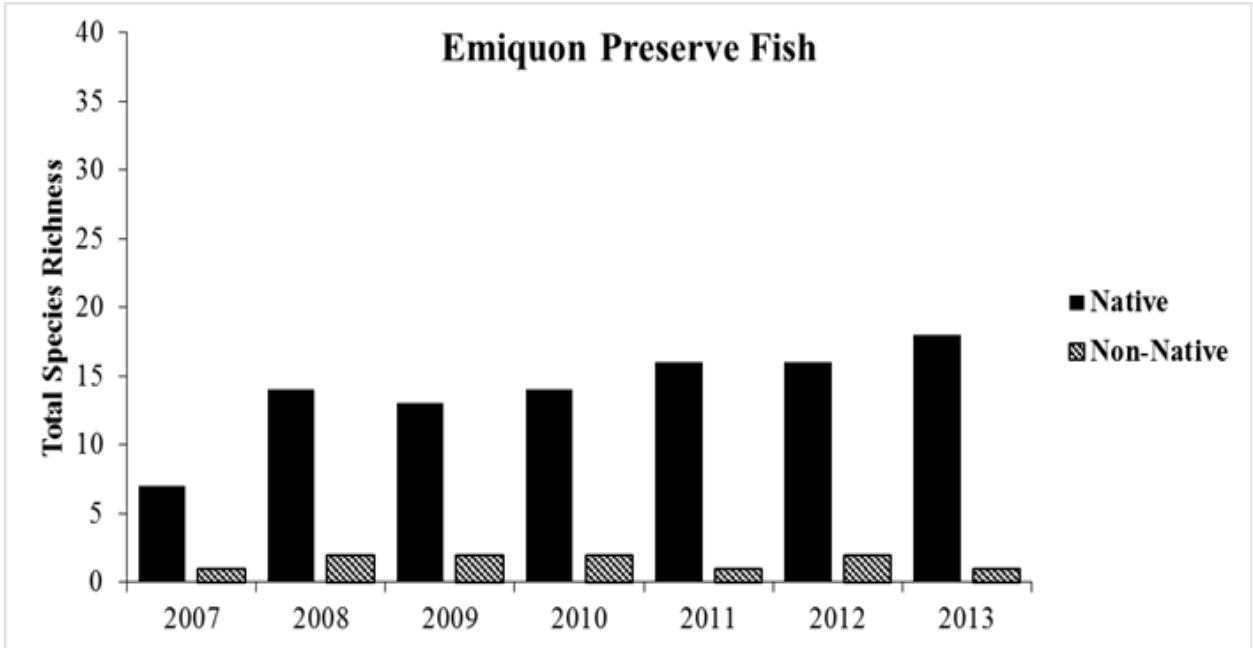


Figure 7 Total number of all native and non-native fish species collected at the Emiquon Preserve during 2007-2013.

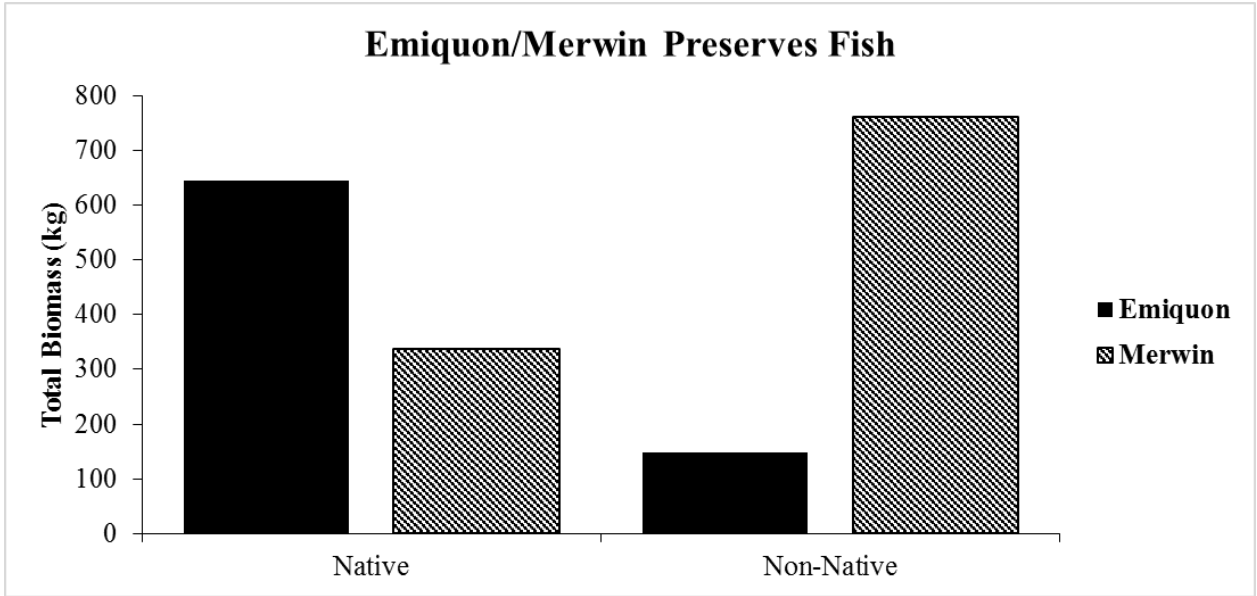


Figure 8 Total biomass (kg) of all native and non-native fish species collected at the Emiquon and Merwin Preserves in 2013.

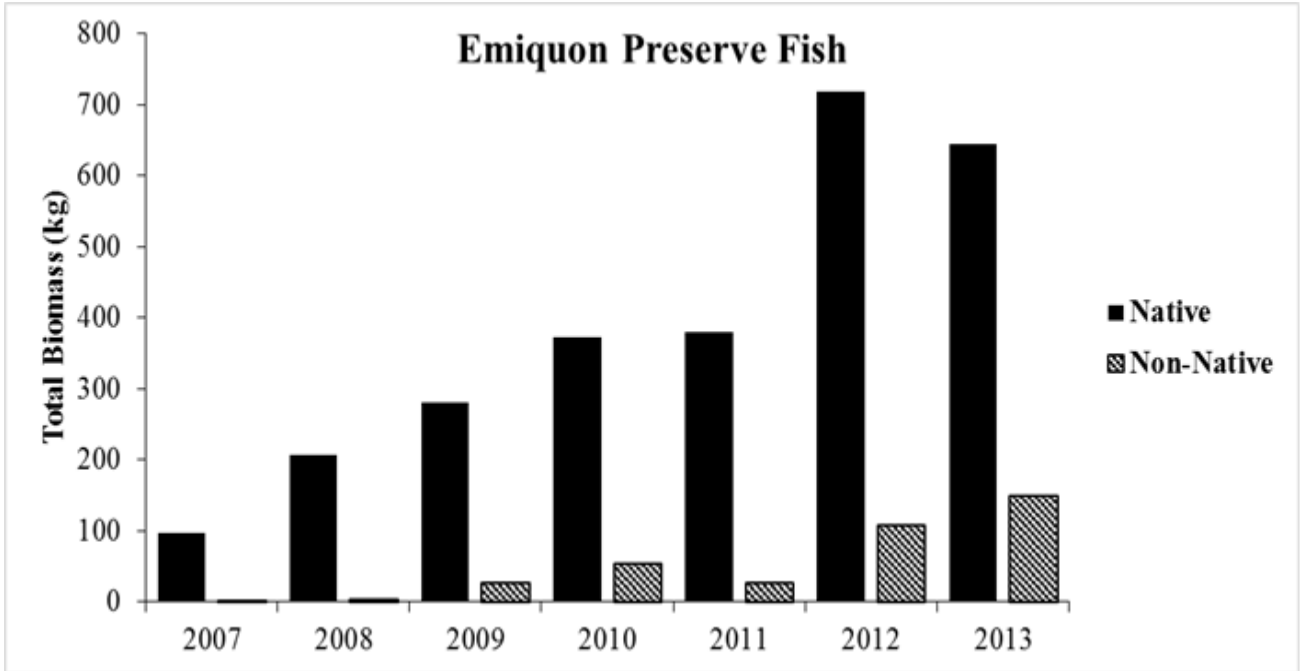


Figure 9 Total biomass (kg) of all native and non-native fish species collected at the Emiquon Preserve during 2007-2013.