# Phase I: Historical Summary of Seismic Impacts on Biotic and Abiotic Conditions of Lake Maurepas

**Prepared by:**

**Kyle Piller, Chris Murray, and Gary Shaffer**

**Submitted December 31, 2022**

Introduction

## Executive Summary

The overall goal of this project was to develop a historical report on the impacts of seismic surveys in Lake Maurepas. We surveyed the scientific literature and available databases for historical fisheries, herpetofauna, and wetland data for Lake Maurepas. Little pre-seismic activity data was available for comparison and despite the existence of multiple seismic surveys, no single study has been devoted to investigating the potential biotic or abiotic impacts of any of these seismic surveys in Lake Maurepas. For fisheries, broad comparisons, encompassing different degrees of sampling effort and gears (1970, 1987, and 2000-2003), resulted in the detection of nearly the same top five numerically dominant species across the two most comprehensive surveys in 1970 and 1987, despite five intervening seismic surveys in 1972, 1977, 1979, 1981, and 1982. The most recent survey (2000-2003) also resulted in the detection of four of the same top five numerically abundant species. These results suggest little to no seismic survey impacts on the fish assemblage in Lake Maurepas. For the herpetofauna, again, minimal pre-seismic survey data was available for comparison. Therefore, one can presume that seismic surveys did not result in local extirpation of species because only two species were detected prior to the last seismic test that were not observed afterwards with minimal sampling prior to and after testing. Rather, the literature presented here suggests that stochastic events affect amphibian and reptile assemblage dynamics both inter- and intraspecifically and likely have had a greater impact on the herpetofauana than any of the seismic activities in Lake Maurepas. Finally, in regards to wetland data, no swamp data exists from the time of last seismic activity in 1985. Approximately, 87% of the Maurepas swamp is in varying states of degradation and three factors are roughly equally responsible for the degradation process in Lake Maurepas, namely nutrient limitation, near-permanent flooding, and saltwater intrusion.

## General Scope of Work

Southeastern Louisiana University will gather historical biological and abiotic data for Lake Maurepas to determine any previous seismic survey impacts (if any) on the biological and environmental aspects of Lake Maurepas. Any available data will be obtained and summarized from published scientific papers and state & federal reports and databases.

**Fishes of Lake Maurepas**

Kyle R. Piller, PhD
Southeastern Louisiana University

The fish fauna of Louisiana was comprehensively surveyed in the 1960s-1970s and ultimately summarized by Douglas (1974). At the time, 148 species of freshwater fishes were documented from Louisiana's waters. In 2002, an update to Douglas (1974) augmented the known freshwater fish diversity in Louisiana to 170 species (Douglas and Jordan 2002). Most recently, Doosey et al. (2021) reported the occurrence of 224 species in Louisiana's freshwaters, including 165 primarily freshwater, 28 primarily marine, and 31 euryhaline or diadromous fish species.

Within Louisiana, the Lake Pontchartrain Basin fish assemblage is arguably one of the most interesting assemblages due to the dynamic nature of the salinity gradient within the Lake Pontchartrain complex (Lake Borgne-Lake Pontchartrain-Lake Maurepas). As stated earlier, the Basin contains a natural salinity gradient from Lake Borgne in the east with high salinities to the freshwater Lake Maurepas in the west. The Lake Pontchartrain estuarine fish assemblage in between these areas is highly variable with at least 97 species known from the lake (Suttkus et al. 1954, Thompson and Fitzhugh 1985, O'Connell et al. 2004, O'Connell et al. 2014). An abundance of fish diversity data is available for Lake Pontchartrain.

## Fish Diversity in Lake Maurepas

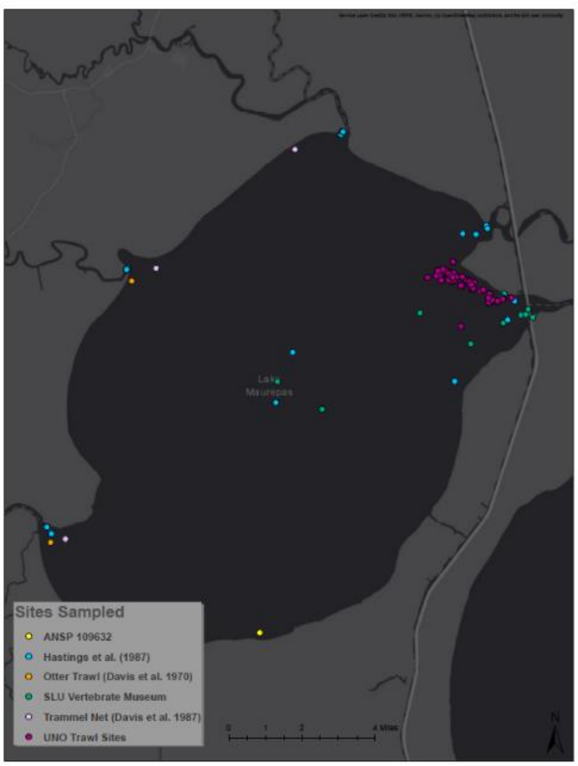


**Figure 1.** Historic collection localities of fishes from Lake Maurepas based on published manuscripts and vouchered museum records.

Lake Maurepas, a system in which the fish community has generally been poorly studied, lies on the western edge of the Lake Pontchartrain Basin. Historic museum records (vouchered museum specimens) from Lake Maurepas are rare. In fact, outside of Southeastern's Vertebrate Museum, there is only a single collection record housed at another institution/museum, a specimen of the Naked Goby (*Gobiosoma bosc*) from 1968, archived at the Academy of Natural Sciences in Philadelphia (ANSP 109632). The bulk of the vouchered museum records are at Southeastern Louisiana University, with the earliest specimens from 1968. There are 279 records from 46 species, representing 9,905 specimensin the Southeastern collection from 1968. The fish diversity of Lake Maurepas is summarized in the Supplemental Table (**Table S1**).

**Davis et al. (1970)**

The first detailed study of the Lake Maurepas fish community was conducted by Davis et al. (1970), who utilized trammel nets and trawling to sample five localities in Lake Maurepas (**Fig. 2**). Their fieldwork took place from January 1967 through June 1969 and they surveyed fishes using an otter trawls (N=20) at two stations near the mouths of the Amite and Blind rivers. Fifteen fish species were captured using otter trawls. These surveys were dominated by Bay Anchovy (*Anchoa mitchilli*), with Atlantic Croaker (*Micropterus undulatus*) and Blue (*Icatalurus furcatus*) and Channel (*Ictalurus punctatus*) catfishes being the next most abundant species. Salinities during their otter trawl surveys ranged from 0-4ppt.


**Figure 2**. Collection localities from Davis et al. (1970). The study was conducted from 1967-1969.

Davis et al. (1970) also used trammel nets (200 yds in length), which preferentially target large-bodied species, to survey three localities in Lake Maurepas from July 1967 through June 1968. Twenty-two species were captured in total although there was variation across seasons. From the November to Feburary, Spotted Gar (*Lepisosteus oculatus*) and Longnose Gar (*Lepisosteus osseus*) were the dominant species, whereas from March to June, Gizzard Shad (*Dorosoma cepedianum*), Spotted Seatrout (*Cynoscion nebulosus*), and Striped Mullet (*Mugil cephalus*) dominated the catch.

The Davis et al. (1970) study represents the majority of the available fish data that pre-dates any of the previous seismic surveys. Unfortunately, it is difficult to determine any seismic survey impacts on the fishes of Lake Maurepas (if any at all) based on these data due to the limited amount of biological sampling conducted during this time-period.

### *Millican et al. (1984)*

Millican et al. (1984) sampled seven localities in Lake Maurepas using gill nets and otter trawls near the mouths of the Tickfaw, Blind, and Amite rivers, as well as near the western edge of Pass Manchac, and two open water habitats. However, no specific locality information was provided. They reported 39 species, including 18 of the 29 species reported by Davis et al (1970). No information was provided in regard to the number and duration of gill net sets or otter trawl pulls. Furthermore, no abiotic data or fish abundance data was reported.

### *Hastings et al. (1987)*


**Figure 3.** Collection localities for Hastings et al (1987).

The most comprehensive survey of Lake Pontchartrain fishes was conducted by Hastings et al. (1987) who conducted six bimonthly gill net and otter trawl (N=126) surveys from September 1983 through October 1984. They surveyed 7 sites in Lake Maurepas (**Fig. 3**), including five nearshore and two mid-lake sites. The five nearshore sites were also surveyed using rotenone. Over 74,000 specimens were collected from 67 species representing 28 families across the study. The Bay Anchovy (*Anchoa mitchilli)* was the most abundant species, comprising more than 70% of the total catch. Other numerically dominant species include the Gulf Menhaden, Channel Catfish, Blue Catfish, Naked Goby, and Atlantic Croaker. These abundant species were also similar to the results of Davis et al. (1970). Of the 67 species, 55% were primarily freshwater species. The authors attributed this, in part, to the low salinity encountered in the study, which ranged from 0.0 to 2.5ppt (mean=0.4ppt).

### *University of New Orleans (2000-2003)*

Finally, an unpublished trawl data set (16ft trawl), provided by Dr. Martin O'Connell (University of New Orleans), reported the collection of 14,687 fish specimens from 24 species from the same mid-lake region of Lake Maurepas, due west of the Interstate 55 bridge at Manchac (**Fig. 4, Table 1**). This data set is based on 55 individual trawls from 2000-2003. The most abundant species was the Bay Anchovy (*Anchoa mitchilli*), followed by the Atlantic Croaker (*Micropogonias undulatus*) and Blue Catfish (*Ictalurus furcatus*).

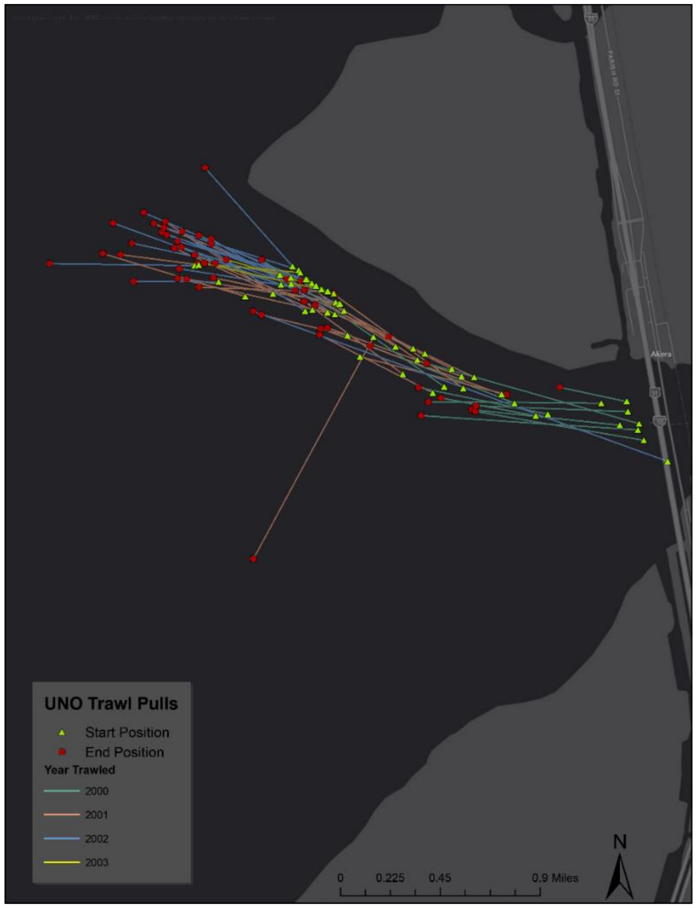


**Figure 4**. Location of trawls from Lake Maurepas (2000-2003) conducted by University of New Orleans researchers (2000-2003) from near mid-lake, west of I-55 near Pass Manchac.

### Other Studies

Several other unpublished studies of Lake Maurepas fishes have been conducted by Price and Kuckyr (1974), Saul (1974), and Tarver and Savoie (1976). These studies were mentioned by Hastings et al. (1987), but were not available for examination or summarization as these data were reported in unpublished reports.

### Historic Fisheries Data (Commercial and Recreational Fisheries)

Intensive effort was put forth to acquire historic fisheries data from Lake Maurepas. Prior to 1999, all commercial fisheries data was managed by NOAA (National Ocean and Atmospheric Administration) and landing data was collected from 1968-1999. In order to protect the business information of those engaged in commercial fishing, NOAA treats data as confidential when fewer than the requisite number of vessels, fishermen and/or dealers have reported. In most jurisdictions this is three of each, but it varies. Commercial fisheries data from Lake Maurepas from the requested seismic survey time periods are deemed confidential and are therefore unavailable for analysis due to the limited number of commercial fishermen reporting their catches (see email correspondence with NOAA and Gulf States Marine Fisheries Commission).

**Michael Lewis - NOAA Federal** <michael.t.lewis@noaa.gov> Oct 31, 2022, 9:32 AM
to me, Donna

Hi Kyle

I'm afraid I don't have access to data at that level of granularity. I can only see what I present on FOSS, which is year/state/species. Anything more specific than that requires help from one of our regional data partners or the state. Since I don't have state contacts, I'll first send you to Donna Bellais at GulfFIN. If she doesn't have the data you need she should be able to direct you to the appropriate state agency. I've CC'd her here.

Thanks,
Mike Lewis

I am looking to obtain historical fisheries data for Lake Maurepas (Lake Pontchartrain Basin) in Louisiana.

I am interested in blue crab and commercial fish landings/catches. I am most interested in the data from 1964 through 1995.

How can I get this data?
Send by: kyle.piller@selu.edu
--
Michael Lewis
Fishery Biologist
NOAA Fisheries, Office of Science and Technology
1315 East-West Highway
Silver Spring, MD 20910
301-426-8147

NOAA FISHERIES

**Kyle Piller** <kyle.piller@selu.edu> Oct 31, 2022, 9:53 AM
to Donna.Bellais

Donna:

Michael Lewis from NOAA Fisheries provided me with your contact information.

I am looking to obtain some historical fisheries data for Lake Maurepas (In Louisiana, part of the Lake Pontchartrain Basin). I am most interested in getting historical catch data of blue crabs and blue catfish (or commercial and recreational fisheries data in general) from Lake Maurepas. I would like to get from as far back as possible up to the present day.

I first contacted LdWF and was told that LDWF does not have any of this data prior to 1999 because they did not collect commercial data prior to the creation of the trip ticket program in 1999. Also, some of the LDWF data is "confidential" because of the low number of individuals reporting catch data.

Does NOAA have any recreational or commercial fisheries data from Maurepas? If you are not the correct contact, is there someone else at LDWF who can provide this data?

Kye Piller

**Bellais, Donna B.** Oct 31, 2022, 11:00 AM
to me

Kyle,

The states in the Gulf have the final say in their commercial data being released. What Louisiana has told you is correct in regard to the year and confidential data. Gulf States Marine Fisheries Commission cannot release any Louisiana confidential commercial data if they (Louisiana) will not. The only data you would be able to access, is the non-confidential data at a high level…Year/State/Species as Mike Lewis from NOAA stated before. Commercial data containing any further detail such as gear, fishing area, grade, etc. becomes confidential. Also on a side note, any data that is confidential is removed from the non-confidential view.

The non-confidential data may be accessed from Gulf States Marine Fisheries Commission or FOSS's web sites but only goes back to 1985 for historical data.

However, I can tell you after pulling the criteria you specified - Blue Crab and Blue Catfish in Louisiana for Lake Maurepas 1985-1995 (I can only go back to 1985)…..there are no commercial landings.

Thanks,
*Donna Bellais*
**ComFIN Programmer**
**Gulf States Marine Fisheries Commission**
**2404 Government Street**
**Ocean Springs, MS 39564**
**DBellais@gsmfc.org**
**(228) 875-5912**

In 1999, LDWF (Louisiana Department of Wildlife and Fisheries) initiated a trip ticket program requiring commercial fisherman to report collection of commercially valuable species. The confidentiality clause also corresponds to LDWF fisheries data. Therefore, like NOAA data, commercial fisheries data from Lake Maurepas from the requested seismic survey time periods are deemed confidential by LDWF and are therefore unavailable for analysis due to the limited number of commercial fishermen reporting their catches (see email correspondence with LDWF).

Historical Fisheries Data External Inbox

**Kyle Piller** <kyle.piller@selu.edu> Thu, Sep 1, 9:11 AM
to pcagle

Peyton:

I am not sure if you are the correct individual to contact, but I am looking to obtain some historical fisheries data for Lake Maurepas. I am most interested in getting historical catch data of blue crabs and blue catfish (or commercial and recreational fisheries in general) from Lake Maurepas. There isn't much data in the scientific literature, so I am coming to LDWF to see what is available. At a minimum, I would like to get the data from the 1950s (if available) to the present day.

Can you provide this or is there someone else at LDWF who can provide this data?

Kye Piller

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Kyle R. Piller, PhD
Duane and Catherine Shafer Endowed Professor, Curator of Vertebrates,
and Graduate Coordinator, Southeastern Louisiana University, Dept. of
Biological Sciences,Hammond, LA 70402
Voice: 985-549-2191,website: www.kylepiller.com

**Peyton Cagle** <pcagle@wlf.la.gov> Thu, Sep 1, 9:23 AM
to me

I'm going to have to forward this request. Commercial landings data pre-2000 was collected and reported by NOAA port agents. We may have all those records on file somewhere, but I personally do not. Let me see what I can do.

**Peyton Cagle**
**LA Department of Wildlife and Fisheries**
peyton.cagle@la.gov
www.wlf.louisiana.gov
1213 N. Lakeshore Dr.
Lake Charles LA 70601
(o) 337-491-2575 Ext. 3017
(f) 337-491-2009

Peyton Cagle <pcagle@wlf.la.gov>
to me
Wed, Sep 14, 3:12 PM

Please see the response from our Data Management section below. One concern is the waterbody code that contains Lake Maurepas also contains the swamp areas north and south of the lake. This means that we can't determine if fishing took place in the lake or surrounding areas. Additionally, most of the data is confidential.

We definitely don't have anything commercial prior to 1999. I ran the area associated with Maurepas (406) and annual by species landings are 60% confidential and that's without looking at those numbers vs basin wide for additional confidentiality concerns. Since it's seismic, is he after species of concern and not necessarily landings? We can definitely give a list of species captured. If he needs more than the 60% confidential landings the only choice there would be to go to species groupings (saltwater fish, freshwater fish, etc). I can provide anything independent in that area.

Peyton Cagle
LA Department of Wildlife and Fisheries
peyton.cagle@la.gov
www.wlf.louisiana.gov
1213 N. Lakeshore Dr.
Lake Charles LA 70601
(o) 337-491-2213
(f) 337-491-2009

Peyton Cagle <pcagle@wlf.la.gov>
to me
Thu, Sep 15, 6:36 AM

See https://www.doa.la.gov/media/dw0asdgl/76.pdf page 16, Subchapter F, Section 319. Also, Title 56 sections 301.4, 306.5, and 306.6. This should explain it.

To sum it up, we are bound by law to not share or provide any commercially reported data where there are less than three individuals reporting. The number of fishers reporting landings is below three when you neck down the data to a single waterbody that is not heavily fished, so you cannot report that data in any fashion that the individual records could then be interpreted.

Peyton Cagle <pcagle@wlf.la.gov>
to me
Sep 15, 2022, 1:04 PM

Answers below in red. I'm checking to see if there is any other route. Possibly grouping years in 2, 3, or 5 year intervals, etc.

Peyton Cagle
LA Department of Wildlife and Fisheries
peyton.cagle@la.gov
www.wlf.louisiana.gov
1213 N. Lakeshore Dr.
Lake Charles LA 70601
(o) 337-491-2213
(f) 337-491-2009

**From:** Kyle Piller <kyle.piller@selu.edu>
**Sent:** Thursday, September 15, 2022 11:15 AM
**To:** Peyton Cagle <pcagle@wlf.la.gov>
**Subject:** Re: Historical Fisheries Data

**EXTERNAL EMAIL:** Please do not click on links or attachments unless you know the content is safe.

Thanks for the clarification.

1. I am fine if we expand the study area to include the swamps north and south of the lake, especially if it gives us more data. The only information we could provide would already be expanded into this area, but the data is confidential.

2. Also, ideally I would like species lists and abundances, but if the best option is by groupings, then that will have to do. We can provide species lists through any independent sampling data that exists, but you will be very limited to dependent data.

3. Are you saying that there is NO commercial data in the region prior to 1999? For fishes? Crabs? Anything? We did not collect the commercial data prior to the creation of the trip ticket program in 1999. Data prior to 1999 would have to be requested through NOAA.

4. At this point, I am willing to take any harvest/catch data from that region as far back as I can get it.
Again, we only have data through 1999, but what you are requesting is mostly confidential and cannot be provided. You would need to determine a different route of looking at the data. We can provide you with any of our independent sampling data from the area, but I'm not sure what exists because that is within the freshwater boundary.
Kyle Piller

## Fish Diversity in Relation to Seismic Surveys

Multiple seismic surveys (airgun and dynamite) have been conducted in Lake Maurepas with the earliest survey conducted in 1967 and the most recent survey in 1985. No previous study has been dedicated to understanding the potential impacts of any of the historic seismic surveys on the fish assemblage in Lake Maurepas and the lack of available recreational or commercial fisheries data make it challenging to address this directly.

Three targeted trawl surveys were conducted, with two of these studies (Davis et al. 1970, Hastings et al. 1987) surveying multiple sites within the lake, while the third study focused on a single station in the lake (UNO, unpublished). There were also substantial differences in sampling effort, with the greatest number of individual trawl pulls of 126 for Hastings et al. (1987) to 55 (UNO study) to 20 for Davis et al (1970) (**Table 1**). Species richness values were also variable, ranging from 14 to 27 species.

**Table 1.** Summary of sites sampled, collection effort, and number of captured species in Lake Maurepas based on Davis et al (1970), Hastings et al. (1987), and UNO trawl survey (unpublished).

| Trawl Study | # Sites Sampled | # Trawls | # Species |
|---|---|---|---|
| Davis et al. (1970) | 2 | 20 | 14 |
| Hastings et al (1987) | 6 | 126 | 27 |
| UNO Trawl Surveys (2000-2003) | 1 | 55 | 24 |

Despite substantial differences in sampling effort among the three studies, the top five numerically dominant species were nearly identical (**Table 2**) across studies despite five intervening seismic surveys in 1972, 1977, 1979, 1981, and 1982 between the Davis et al. (1970) and Hastings et al. (1987) studies. The Davis et al. (1970) and Hastings et al (1987) studies shared 4 of the 5 top species. A sixth seismic survey conducted in 1985 and occurred between the Hastings et al. (1987) and the UNO trawl studies. Again, 4 of the top 5 numerically dominant species were recovered between these time periods. The earliest and most recent studies shared the same 5 numerically dominant species.

**Table 2**. Top numerically dominant species based on three trawl surveys in Lake Maurepas.

| Davis et al. (1970) (Study conducted 1967-1969) | Seismic Surveys (N=5), 1971,1972,1977, 1979,1981 | Hastings et al. (1987) (Data collected in 1984/85) | Seismic Survey (N=1) 1985 | UNO Trawl Surveys (2000-2003) |
|---|---|---|---|---|
| *1. Anchoa mitchilli* | | *1. Anchoa mitchilli* | | *1. Anchoa mitchilli* |
| *2. Micropterus undulatus* | | *2. Brevoortia patronus* | | *2. Brevoortia patronus* |
| *3. Ictalurus furcatus* | | *3. Ictalurus furcatus* | | *3. Ictalurus furcatus* |
| *4. Ictalurus punctatus* | | *4. Ictalurus punctatus* | | *4. Micropogonias undulatus* |
| *5. Brevoortia patronus* | | *5. Gobiosoma bosc* | | *5. Ictalurus punctatus* |

**Supplemental Tables**

**Table S1.** Summary of fish diversity across multiple fish surveys in Lake Maurepas.

| Common Name | Species | Family | Davis et al. (1970) | Millican et al. (1984) | Hastings et al. (1987) | UNO Trawls (2000-2003) | Other Records |
|---|---|---|---|---|---|---|---|
| Atlantic Stingray | *Dasyatis sabina* | Dasyatidae | | | X | | |
| Paddlefish | *Polyodon spathua* | Polyodontidae | | X | X | | |
| Spotted Gar | *Leisosteus oculatus* | Lepisosteidae | X | X | X | | |
| Longnose Gar | *Lepsosteus osseus* | Lepisosteidae | X | X | X | | |
| Alligator Gar | *Atractosteus spatula* | Lepisosteidae | X | X | X | X | |
| Bowfin | *Amia calva* | Amiidae | X | | X | | |
| Ladyfish | *Elops saurus* | Elopide | | X | X | | |
| American Eel | *Anguilla rostrata* | Anguillidae | | X | X | | |
| Speckled Worm Eel | *Myrophls punctatus* | Ophichthidae | | | X | | |
| Alabama Shad | *Alosa alabamae* | Clupeidae | | X | X | | |
| Skipjack Herring | *Alosa chrysolochloris* | Clupeidae | | X | X | | |
| Gulf Menhaden | *Bevoortia patronus* | Clupeidae | X | X | X | X | |
| Gizzard Shad | *Dorosoma cepedianum* | Clupeidae | X | X | X | | |
| Threadfin Shad | *Dorosoma petenense* | Clupeidae | | X | X | X | |
| Bay Anchovy | *Anchoa mitchilli* | Engraulidae | | X | X | X | |
| Striped Anchovy | *Anchoa hepsetus* | Engraulidae | X | | | X | |
| Common Carp | *Cyprinus carpio* | Cyprinidae | | X | X | | |
| Grass Carp | *Ctenopharyngdon idella* | Xenocyprinidae | | | | | K. R. Piller (pers. obs) |
| Golden Shiner | *Notemigonus crysoleucas* | Leuciscidae | | | X | | |
| Pugnose Minnow | *Opsopeodus emiliae* | Leuciscidae | | | X | | |
| Rover Carpsucker | *Carpiodes carpio* | Catosotmidae | | | X | | |
| Smallmouth Buffalo | *Ictiobus bubalus* | Catosotmidae | X | X | X | | |
| Black Bullhead | *Ameiurus melas* | Ictaluridae | | X | X | | |
| Yellow Bullhead | *Ameriurus natalis* | Ictaluridae | | | X | | |
| Blue Catfish | *Ictalurus furcatus* | Ictaluridae | X | X | X | X | |
| Channel Catfish | *Ictaurus punctatus* | Ictaluridae | X | X | X | X | |
| Tadpole Madtom | *Noturus gyrinus* | Ictaluridae | | | X | | |
| Flathead Catfish | *Pylodictus olivarus* | Ictaluridae | | X | X | X | |
| Hardhead Catfish | *Ariopsis felis* | Ariidae | | | X | | |
| Gafftopsail Catfish | *Bagre marinus* | Ariidae | | | X | | |
| Ladyfish | *Elops saurus* | Elopidae | | | | X | |
| Pirate Perch | *Aphredoderus sayanus* | Aphredoderidae | | X | X | | |
| Atlantic Needlefish | *Strongylura marina* | Belonidae | | X | X | | |
| Sheepshead Minnow | *Cyprinodon variegatus* | Cyprinodontidae | | | X | | |
| Golden Topminnow | *Fundulus chrysotus* | Fundulidae | | | X | | |
| Gulf Killifish | *Fundulus grandis* | Fundulidae | | | X | | |
| Bayou Killifish | *Fundulus pulverus* | Fundulidae | | | X | | |
| Rainwater Killifish | *Lucania parva* | Fundulidae | | | X | | |
| Western Mosquitofish | *Gambusia affinis* | Poeciliidae | | | X | | |
| Least Killifish | *Heterandria formosa* | Poeciliidae | | | X | | |
| Inland Silverside | *Menidia beryllina* | Atherinopsidae | | X | X | X | |
| Brook Silverside | *Labidesthes sicculus* | Atherinopsidae | X | | X | | |
| Chain Pipefish | *Sygnathus louisianae* | Sygnathidae | | | | | |
| Gulf Pipefish | *Sygnathus scovelli* | Sygnathidae | | X | X | X | |

## Table S1 (continued)

| Common Name | Species | Family | Davis et al. (1970) | Millican et al. (1984) | Hastings et al. (1987) | UNO Trawls (2000-2003) | Other Records |
|---|---|---|---|---|---|---|---|
| White Bass | *Morone chrysops* | Moronidae | | X | X | | |
| Yellow Bass | *Morone mississippiensis* | Moronidae | X | X | X | X | |
| Striped Bass | *Morone saxatilus* | Moronidae | | X | X | | |
| Banded Pygmy Sunfish | *Elassoma zonatum* | Elassomatidae | | | X | | |
| Warmouth | *Lepomis gulosus* | Centrarchidae | | | X | | |
| Bluegill | *Lepomis macrochirus* | Centrachidae | X | X | X | X | |
| Longear Sunfish | *Lepomis megalotis* | Centrachidae | | X | X | | |
| Redear Sunfish | *Lepomis microlophus* | Centrachidae | X | X | X | | |
| Redspotted Sunfish | *Lepomis miniatus* | Centrarchidae | | | X | | |
| Banded Sunfish | *Lepomis symmetricus* | Centrarchidae | | | X | | |
| Largemouth Bass | *Micropterus salmoides* | Centrarchidae | X | | X | | |
| White Crappie | *Pomoxis annularis* | Centrachidae | | X | X | | |
| Black Crappie | *Pomoxis nigromaculatus* | Centrarchidae | X | | X | | |
| Crevalle Jack | *Caranx hippos* | Carangidae | X | X | X | | |
| Spanish Mackeral | *Scomberomorus maculatus* | Scomberidae | | | X | | |
| Sheepshead | *Archosargus probatocehalus* | Sparidae | X | X | X | X | |
| Pinfish | *Lagodon rhomboides* | Sparidae | | | X | | |
| Freshwater Drum | *Aplodinotus grunniens* | Sciaenidae | X | X | X | X | |
| American Silver Perch | Bairdiella chrysoura | Sciaenidae | | | | X | |
| Sand Seatrout | *Cynoscion arenarius* | Sciaenidae | X | | X | X | |
| Spotted Seatrout | *Cynoscion nebulosus* | Sciaenidae | X | | | X | |
| Spot | *Leiostomus xanthurus* | Sciaenidae | X | | X | X | |
| Atlantic Croaker | *Micropogonias undulatus* | Sciaenidae | X | X | X | X | |
| Red Drum | *Sciaenops ocellatus* | Sciaenidae | X | | | | |
| Black Drum | *Pogonias cromis* | Sciaenidae | | | X | | |
| Striped Mullet | *Mugil cephalus* | Mugilidae | X | X | X | X | |
| Freshwater Goby | *Ctenogobius shufeldti* | Gobiidae | | X | X | | |
| Naked Goby | *Gobiosoma bosc* | Gobiidae | | X | X | X | |
| Clown Goby | *Microgobius gulosus* | Gobiidae | | | X | | |
| Bay Whiff | *Citharichthys spilopterus* | Paralichthyidae | | X | X | | |
| Southern Flounder | *Paralichthys lethostigma* | Paralichthyidae | X | X | X | X | |
| Hogchoker | *Trinectes maculatus* | Achiridae | X | X | X | X | |
| | | | | | | | |
| **Number of Species** | ***Species=*** | | **29** | **39** | **67** | **24** | |
| | | | **Trammel nets, trawling** | **Gill nets, trawling** | **Gill nets, trawling, rotenone** | **Trawling** | |

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## Reptiles and Amphibians of Lake Maurepas: History of Study and Trends in Relation to Seismic Surveys

Christopher M. Murray, Ph.D.
Southeastern Louisiana University

The herpetofauna of Lake Maurepas, Louisiana has never been directly comprehensively surveyed within the water body specifically. However, data for the basin indirectly exists from reptile and amphibian surveys in response to perturbation (Schriever et al. 2009), when characterizing the herpetofaunal assemblage at a broader spatial scale (Platt et al. 1989), as a result of long-term road cruising surveys between Lake Maurepas and Lake Pontchartrain (McCardle and Fontenot, 2016; Lutterschmidt et al. 2019; McCardle et al. 2022), and managed recreational alligator harvest. These works elucidate the assemblage of reptiles and amphibians expected in the Lake Maurepas Basin and provide ecological trends for snakes and alligators, but are not in direct correlation with previous seismic surveys. The lack of data relating seismic testing to herpetofauna responses exists for two reasons; a remarkably small amount of work assesses Lake Maurepas herpetofauna, and seismic surveys occurred before ecological data was recorded for such groups.

Within Louisiana, Lake Maurepas occupies the western-most lentic extent of the Lake Pontchartrain basin. This habitat is interesting and dynamic, receiving freshwater from numerous rivers, yet being seasonally inundated with salinity from the east (Keddy et al. 2007). Lake Maurepas represents the freshest extent of the salinity gradient from west to east (Lake Maurepas to Lake Borgne). This salinity gradient, in combination with historical logging, has resulted in a terrestrial gradient as well, leaving degraded habitat on the east side of the lake. Both of these gradients in Lake Maurepas create a dynamic landscape for the interesting and woefully understudied herpetofauna assemblage.

### Herpetofauna Diversity in Lake Maurepas

*VertNet Records*

VertNet is a digital repository for natural history museum collections and contains only 9 records of amphibians and 20 records of reptiles that reference Lake Maurepas in the locality. Records indicate one Eastern coral snake (*Micrurus fulvius;* J. M. McLain) from 1973 and one Eastern newt (*Notophthalmus viridescens;* B. Comish) from 1974 that are not in surveys referenced below beginning is 1989.

*Schriever et al. (2009); Crother and Fontenot (2006); Platt et al. (1989).*

Lake Maurepas is a system in which the herpetofauna assemblage has been poorly studied. Only a couple studies specifically survey the amphibian and reptile assemblages in Lake Maurepas in an effort to provide baseline-monitoring data for the group in response to hurricane saltwater inundation (Schriever et al. 2009). This study expands upon Platt et al. (1989) that provided a preliminary survey of herpetofauna in the area. Methodologically, Schriever et al. (2009) utilized a standard transect design on Alligator Island to the far west end of Lake Maurepas that was operable for the 4 years leading up to report publication.

Additionally, they used a road cruising transect along Hwy 51 from the NE of Lake Maurepas to the SE of Lake Maurepas for 18 months from 2004 to 2005. In summary, and in combination with Platt et al. (1989), the species of amphibian and reptiles observed are summarized in **Table 1.** The objective of Schriever et al. (2009) however, was to provide baseline assemblage data in the context of saltwater perturbation and did recover drastic turnover in assemblage dynamics as a result of successive hurricane impacts, elucidating shifts in dominant species, ecological evenness, abundance and habitat-specific turnover. Overall, the work provides a thorough picture of herpetofauna assemblage dynamics in response to perturbation at the appropriate scale for predictions concerning Lake Maurepas.

**Table 1:** Lake Maurepas reptile and amphibian assemblage using data from Platt et al. (1989), Crother and Fontenot (2006) and Schriever et al. (2009).

| **Group** | **Species** | **Source** |
|---|---|---|
| Amphibians | *Acris crepitans* | Platt et al. 1989; Schriever et al. 2009 |
| | *Pseudacris crucifer* | Schriever et al. 2009 |
| | *Amphiuma sp.* | Schriever et al. 2009 |
| | *Ollotis nebulifer* | Platt et al. 1989; Schriever et al. 2009 |
| | *Gastrophryne carolinensis* | Platt et al. 1989; Schriever et al. 2009 |
| | *Hyla avivoca* | Schriever et al. 2009 |
| | *Hyla cinerea* | Platt et al. 1989; Schriever et al. 2009 |
| | *Hyla squirella* | Schriever et al. 2009 |
| | *Lithobates catesbeianus* | Platt et al. 1989; Schriever et al. 2009 |
| | *Lithobates clamitans* | Schriever et al. 2009 |
| | *Lithobates grylio* | Platt et al. 1989; Schriever et al. 2009 |
| | *Lithobates sphenocephalus* | Platt et al. 1989; Schriever et al. 2009 |
| Snakes | *Agkistrodon piscivorous* | Platt et al. 1989; Schriever et al. 2009 |
| | *Coluber constrictor* | Platt et al. 1989; Schriever et al. 2009 |
| | *Pantherophis obsoletus* | Platt et al. 1989; Schriever et al. 2009 |
| | *Farancia abacura* | Crother and Fontenot, 2006 |
| | *Lampropeltus getula* | Platt et al. 1989; Schriever et al. 2009 |
| | *Nerodia cyclopion* | Platt et al. 1989; Schriever et al. 2009 |
| | *Nerodia erythrogaster* | Platt et al. 1989; Crother & Fontenot 2006 |
| | *Nerodia fasciata* | Platt et al. 1989; Schriever et al. 2009 |
| | *Nerodia rhombifer* | Platt et al. 1989; Schriever et al. 2009 |
| | *Storeria dekayi* | Platt et al. 1989; Schriever et al. 2009 |
| | *Thamnophis proximus* | Platt et al. 1989; Schriever et al. 2009 |
| | *Thamnophis sirtalis* | Crother and Fontenot, 2006 |
| | *Regina rigida* | Platt et al. 1989; Schriever et al. 2009 |
| | Opheodrys aestivus | Platt et al. 1989; Schriever et al. 2009 |
| Crocodilians | *Alligator mississippiensis* | Platt et al. 1989; Schriever et al. 2009 |
| Turtles | *Trachemys scripta* | Platt et al. 1989; Schriever et al. 2009 |
| | *Chelydra serpentina* | Platt et al. 1989 |
| | *Kinosternon subrubrum* | Platt et al. 1989; Schriever et al. 2009 |
| | *Macrochelys temminckii* | Platt et al. 1989 |
| | *Sternotherus odoratus* | Platt et al. 1989 |

| | | |
|---|---|---|
| Lizards | *Anolis carolinensis* | Platt et al. 1989; Schriever et al. 2009 |
| | *Plestiodon fasciatus* | Platt et al. 1989; Schriever et al. 2009 |
| | *Plestiodon laticeps* | Platt et al. 1989; Schriever et al. 2009 |
| | *Scincella lateralis* | Schriever et al. 2009 |

**Trends in Herpetofauna Ecology**

**Snakes**

*McCardle and Fontenot, 2016*

Snake surveys (n = 657) from September 2003 to December 2014 on a 37 km stretch of road within the Manchac Land Bridge were performed. The Manchac Land Bridge borders the eastern side of Lake Maurepas, providing the terrestrial barrier between Lake Maurepas and Lake Pontchartrain. Here, detection, species, sex and mortality were considered in response to ambient temperature, road surface temperature and the difference between those two variables. Nine species were detected (all of which are listed in Table 1). Species detection, sex and mortality all varied by ambient temperature and the difference between ambient and road surface temperature.

*Lutterschmidt et al. 2019*

This study conducted 78 snake surveys within one calendar year along the same Manchac Land Bridge transect as Mccardle and Fontenot (2016) in an attempt to identify seasonal times and specific regions in which higher morality may occur. The conservation-based initiative here identified times of year and specific locations in which the snake assemblage is more sensitive to perturbation. Results indicate that road mortality in late spring and early summer is highest, corresponding to breeding-associated movements. Across space, results identify species-specific “hot spots” in which detections were significantly higher for 9 species. When combined, data indicate that the extreme northeast section of Lake Maurepas, immediate east and far southeast, harbor more snake traffic than other sections of the eastern shore.

*Mccardle et al. 2022*

This study investigated nearly 13 years of snake road-cruising data along the Manchac Land Bridge to investigate numerous intraspecific trends in snake detection and mortality. In summary, data incorporating the previous two studies inferred that season, sex, cohort, life history strategy and stochastic weather events all influence activity patterns of snakes surrounding Lake Maurepas. In summary, this manuscript elucidates that snake demography and assemblage structure are valuable response variables when monitoring the effects of anthropogenic perturbation.

**Alligators**

Historic recreational harvest data was obtained from the Louisiana Department of Wildlife and Fisheries. Available data exists annually from 2002 to 2021. Recreational harvest seasons in Lake Maurepas begin in late August and stay open for 60 days annually. Harvest data is a good indicator of population recruitment and sustainable management (Pers. Comm. C. Nix) Commercial data was not available due to the proprietary nature of such information. Three parishes (Livingston, Tangipahoa and St. John's) border Lake Maurepas and harvest data for each parish exists, however, it is unknown how many of the harvested individuals came from Lake Maurepas as opposed to elsewhere in the Parish. Maurepas Swamp Wildlife Management Area, however, is a protected area along the southeast margin of the lake and harvest data specific to this area is available. It is important to note that the number of tags allotted to the region is standardized, but interest and effort in harvest may vary year to year. Data for Maurepas Swamp WMA alligator harvest are displayed in Figure 1. While Livingston and St. John's Parishes show recent decline in the number of alligators harvested, Tangipahoa Parish is remarkably stable (Figure 2) and Maurepas Swamp WMA exhibits an increase in alligator harvest since 2010.

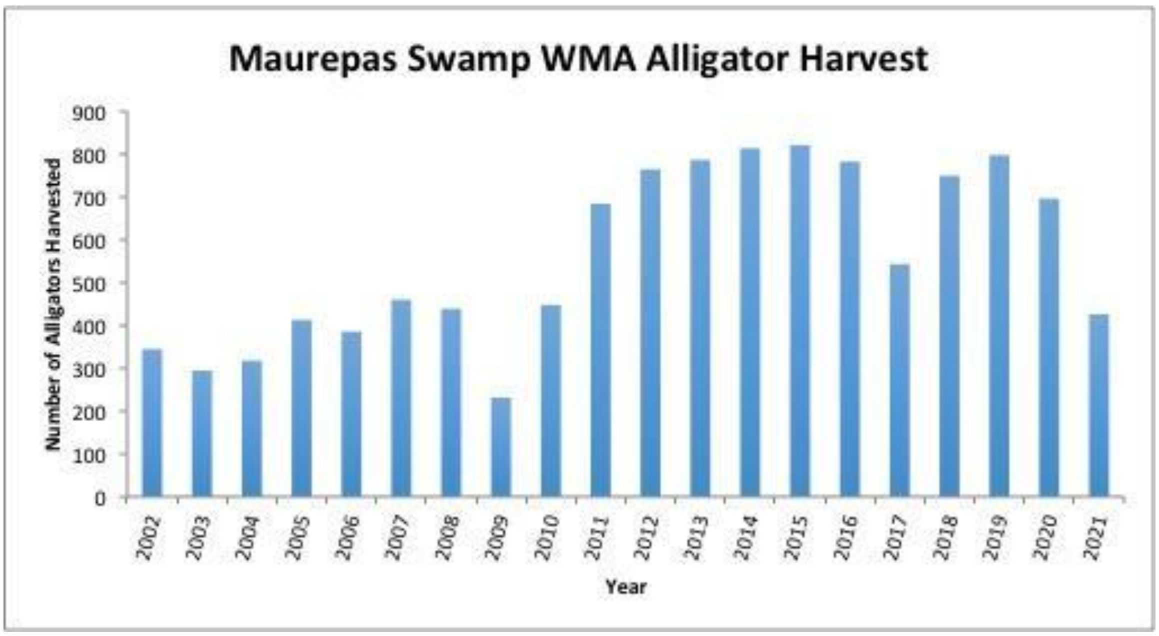

**Figure 1.** Alligator harvest data from Maurepas Swamp Wildlife Management Area from 2002 to 2021 showing an increase in harvest from 2011 to 2020.

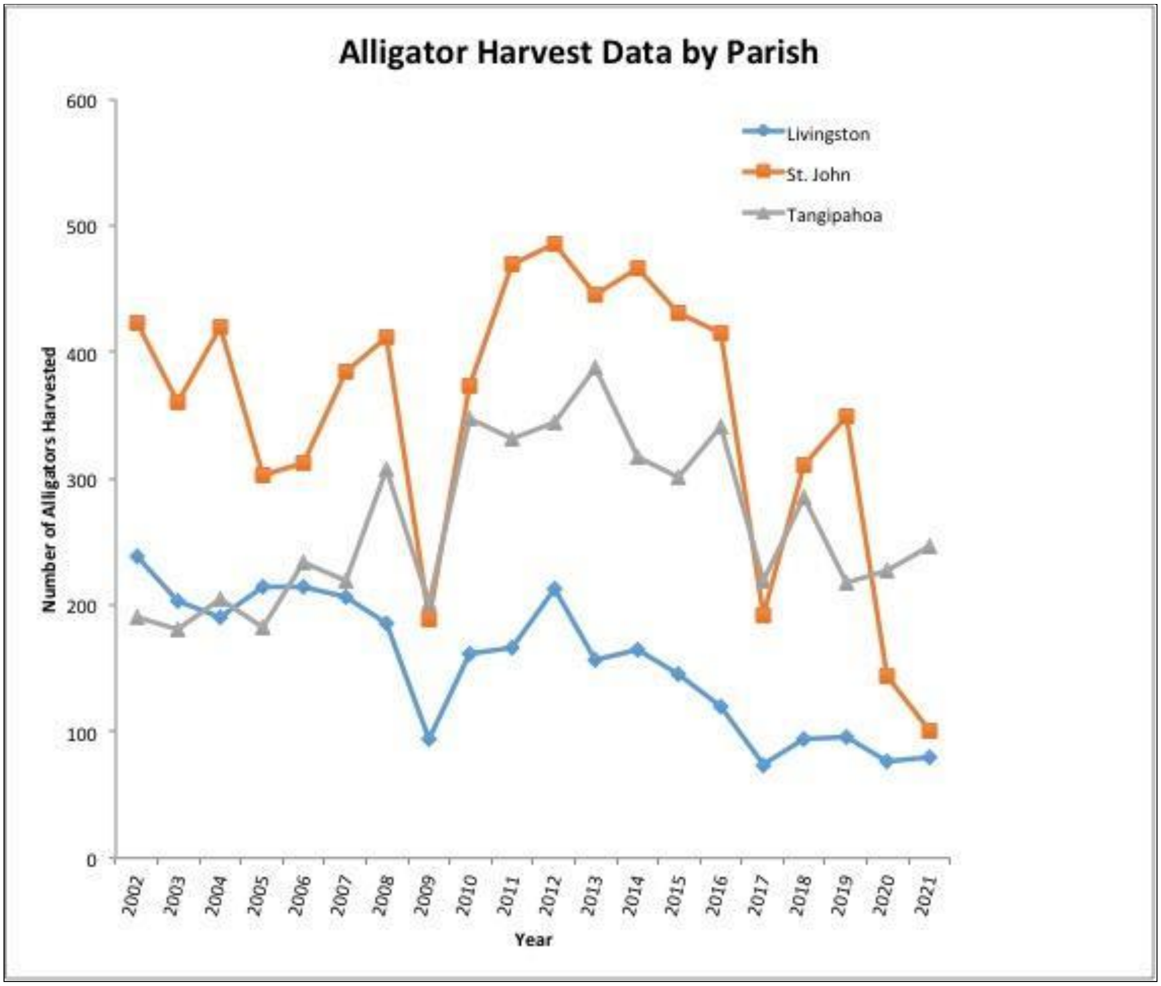


**Figure 2**. Alligator harvest data for Livingston, St. John and Tangipahoa Parish from 2002 to 2021.

**Herpetofauna in Relation to Seismic Surveys**

Temporally, no extensive herpetofauna surveys or monitoring efforts predate seismic surveys, last occurring in Lake Maurepas in 1985. Hence, no data to test the hypothesis that such surveys impact amphibians and reptile ecology and diversity exists. One can, however, presume that seismic surveys did not result in much local extirpation of species because only two species were detected prior to the last seismic test that were not observed after with minimal sampling prior to and after testing. Further, new species were more recently observed after testing (i.e. *Hyla squirella*). Repatriation of reptiles and amphibians to Lake Maurepas via dispersal is inherently possible, however no gaps in species observations exist in any data, albeit sparse. Further, no data exists to speculate on the effects of seismic surveys on the ecology of herpetofauna, a much more conceivable response to such perturbation. Abundance, spatial movements and other interactions with the environment driven by stress physiology may have been altered in response to seismic testing, but no data exists to that effect.

Relevant however, is the proposition of appropriate response variables for seismic bio-monitoring. The literature presented here suggests that stochastic events affect amphibian and reptile assemblage dynamics both inter- and intraspecifically. As such, reptiles and amphibians are likely relevant bioindicators for seismic testing perturbation.

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**Forested Wetlands of Lake Maurepas**

Gary P. Shaffer
Southeastern Louisiana University

No swamp data exists from the time of last seismic activity in 1985, but it is inconceivable that said would cause swamp degradation. About 87% of the Maurepas swamp is in varying states of degradation and three factors are roughly equally responsible for the degradation process in Lake Maurepas, namely nutrient limitation, near-permanent flooding, and saltwater intrusion (Shaffer et al. 2016).

The most detailed studies of the Maurepas swamp were initiated in 2000 (Shaffer et al. 2003, 2009). They established 20 paired monitoring stations, each 625 $m^2$, that characterized three different hydrologic regimes. Completely degraded areas were characterized by dead trees, broken marsh and open water habitats. These areas dominate the eastern portion of the Maurepas swamp as well as the Manchac land bridge between Lakes Maurepas and Pontchartrain (Figure 1). In contrast, interior swamp was dominated by forests with broken canopies, few midstory species and a well-developed herbaceous community. Finally, throughput swamp that receives reliable sources of non-point source freshwater runoff was characterized by mature canopy trees of *Taxodium distichum* (baldcypress) and *Nyssa aquatica* (water tupelo), a well-established midstory stand and a poorly established herbaceous layer. These monitored habitats characterized an area of roughly 80 $km^2$ and were replicated to consistently represent relative proportions of each habitat type. In addition, four additional paired sites were established in 2004 to provide baseline data for a levee-gapping project on the Amite River Diversion Canal. This project was completed in 2016 and has since resulted in restoration of roughly 12,000 acres of relict and degraded swamp.

From 2000 through 2010, net primary production (NPP) of more than 2,000 canopy and midstory trees and nearly 200 herbaceous subplots was measured annually, as well as a number of abiotic variables, such as soil bulk density (i.e., soil strength) and percent organic matter, interstitial soil salinity, and light penetration. Shaffer (2009) provided methods for the 2000–2006 portion of the study. The methods remained the same through 2010 (Shaffer et al. 2016). These data accompanied periods of severe drought (2000 and 2006), normal weather, and the hurricanes of 2002, 2005, and 2008.

## Primary Production

Net primary production (NPP) is the single best metric of ecosystem function. Other relevant metrics include natural regeneration which may require years for observation of any relevant change, such as what is observed in other baldcypress–water tupelo swamps (Shaffer et al. 2021).

Whole-habitat NPP was sampled including herbaceous biomass production (Shaffer et al. 2009, 2016) by taking four clip plots at each station during spring and late fall. The spring and fall clip plots were added together because a turnover study (Shaffer et al. 2009) indicated that two of the dominant species, *Sagittaria lancifolia* (bulltongue) and *Peltandra virginica* (arrow arum), replaced their original tissue only once during the year.  Restoration projects in the Maurepas swamp are needed to convert degraded/relict swamp to a sustainable, tree-dominated swamp. To accomplish this will require a substantial change from an herbaceous dominated to woody dominated habitat type. Therefore, herbaceous NPP will have little to no effect on total site NPP once the swamps recover.

In addition to swamp NPP, Shaffer et al. (2016) identified several other parameters that can be used to determine the degree of habitat restoration from open marsh or relict swamp to closed canopy forest. These include soil bulk density, canopy cover, stand density and basal area, as all separated cleanly by habitat type. In addition, habitat types can be isolated through changes in the signature of satellite and aerial photography (**Figure 1**).

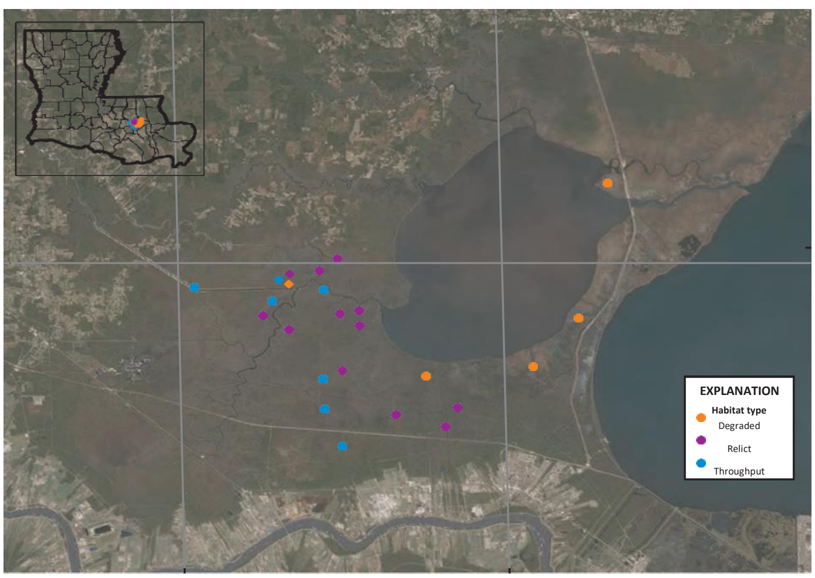


**Figure 1.** Location of the 24 sites, each with paired 625-m$^2$ stations (48 total), selected to represent the three major habitat types characterized by different hydrologic regimes in Maurepas swamp, Louisiana: namely degraded (orange), relict (purple), and throughput (blue). Image reproduced from Krauss et al. (2017).

Along with the 24 sites and 48 625-m$^2$ sampling stations, Maurepas swamp is also monitored via 25 Coastwide Reference Monitoring System (CRMS) stations (Steyer et al. 2003;

Folse et al. 2014). Measurements were made for the following variables at each CRMS station at the following time intervals:

- hourly: surface water salinity, temperature, and water stage;
- monthly: soil pore water (this collection varies and is done whenever each station is visited);
- biannually: surface elevation table (SET) and accretion plots where feasible (very limited in the Maurepas swamp);
- annually: herbaceous vegetation cover and height, canopy cover;
- every 3 years: diameter at breast height (DBH) of all living trees with DBH greater than 5 cm (trees are tagged with numbers), height and DBH of living shrubs and trees in the midstory with DBH less than 5 cm;
- every 5 years: soil cores for bulk density and percent organic matter along with soil salinity (actually 2008 and 2014) and percent land to water analysis if photography is available (actually 2008, 2012, and 2015).

All CRMS stations, however, in the Maurepas swamp are located along ecological edges. Edge habitat does not experience the same environmental conditions as non-edge swamp habitat. Nearly all edges in Maurepas swamp are considerably healthier than their corresponding interiors. None of the stations monitored in Shaffer et al. (2003, 2009, 2016) are on ecological edges.

The Maurepas swamp is in dire need of restoration. Shaffer et al. (2016) estimate that without restoration, most of the swamp will convert to marsh and open water within a few decades. At best, the healthiest swamps in Lake Maurepas are currently about half as productive as those in the Lac des Allemands swamp of Barataria Basin (Shaffer et al. 2021).

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**Water Quality Metrics (1943-1999)**

Kyle R. Piller, PhD
Southeastern Louisiana University

Water quality data from Lake Maurepas (1943-1995) were first summarized by Garrison (1999). This report includes sample information from two sites in Lake Maurepas. One site near the middle of the Lake, and another at the west end of Pass Manchac as it enters Lake Maurepas. A variety of relevant abiotic parameters were gathered and are summarized in this report and a subset of these values are re-summarized in this report.

**A. Specific Conductivity (SpC):** Specific conductivity is a measure used to quantify the conductivity of an aqueous solution. In particular, the USGS defines it as an indirect measure of the collective concentration of dissolved ions in solution. In Lake Maurepas, it ranged from 56 to nearly 4,420 (µS/cm), with a mean value of 628 (µS/cm). Values greater than 3,000 (µS/cm) are generally outside of the range observed for normal surface and groundwaters. Generally, these values fall within the range of normal surface and ground waters (USGS, 2019)

**B. pH:** The pH in Lake Maurepas ranges from 6.1 to 7.9 with a mean value of 7.1. Typically, groundwater and surface water is slightly basic, but can be affected by a variety of factors including carbon dioxide, local geology, carbon dioxide, and the presence of alkaline substances. The pH values in Lake Maurepas fall with the normal range. Based on the 1999 report, there were no pH readings outside of the normal range for freshwater aquatic life (6.5-9.0).

**C. Dissolved oxygen:** Dissolved oxygen levels represent one of the most important abiotic metrics for life in the aquatic environment. In Lake Maurepas, dissolved oxygen levels ranged from 5.4 to 13.2 mg/L with a mean of 8.2 mg/L. Most aquatic life-requires a minimum of 5-7 mg/L. The values in Lake Maurepas far exceed these levels.

**Table 1**. Maximum, minimum, and mean values for a select range of relevant parameters from Lake Maurepas (1943-1995).

| Metric | Min | Max | Mean | # of Measurements | Normal Range |
|---|---|---|---|---|---|
| Specific Conductance (µS/cm) | 56 | 4,420 | 628 | 139 | 30-3,200 (µS/cm) |
| pH | 6.1 | 7.9 | 7.1 | 140 | 6.6 -9.0 |
| Dissolved Oxygen (mg/L) | 5.4 | 13.2 | 8.2 | 134 | >5.0 mg/L |

The data presented in Garrison (1999) were not presented in a way to be able to analyze particular time periods before and after seismic surveys. Although the report provides means and ranges of measurements across the entire study period, nothing can be correlated to any particular seismic survey. Although some of these abiotic parameters were above “normal” ranges, all three of these abiotic parameters are subject to daily fluctuations, which, in turn are influenced by local weather conditions.

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