MONITORING DIETS AND GROWTH RATES OF NATIVE PREDATORY FISH STOCKED TO SUPPRESS NON-NATIVE TILAPIA

A Thesis

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ABSTRACT

Following efforts to eradicate invasive tilapia, *Oreochromis* spp., from a drainage canal in Port Sulphur, Louisiana, alligator gar, spotted gar, largemouth bass, and bullheads were stocked in January and February 2010 as a biological control of possible remnant tilapia. Fish were recaptured to monitor for tilapia in the diets. The objectives of the study were to compare diets among predatory fish and to determine primary diet items of alligator gar, largemouth bass, and bullheads. This study also allowed for data to be collected on two age classes of alligator gar that were produced in aquaculture and released into the Port Sulphur drainage canal. Fish were collected with monofilament gill nets (2.5, 4.4, and 5.1 cm bar mesh), measured, weighed and stomach contents were retrieved via gastric lavage. All fishes were tagged before being released alive into the canal. Each diet item was identified to the lowest possible taxon and was categorized as fish, crustacean, insect, mollusc, reptile, or unidentified. The percent of empty stomachs was 21.8% and did not differ among predatory fish. The overall diets among the three genera were not similar. Fish were more common in largemouth bass than in bullheads. Crustaceans were most common in alligator gar diets. The mean number of insects per stomach was similar among the predatory fish. Tilapia were not identified in the diets of any fish possibly due to the low abundance of tilapia in the canal or to advanced digestion of diet items. Fish was the dominant diet item found in both alligator gar and largemouth bass, thus if the abundance of tilapia does increase piscivorous fish are stocked. Between May and November 2010, alligator gar produced in 2009 grew faster than fish produced in 2010 suggesting that supplementing declining populations is beneficial because stocked alligator gar grow in the wild.

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Woundfin	*Plagopterus argentissimus*
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Yellow perch	*Perca flavescens*

LIST OF ABBREVIATIONS

Alligator gar	aligar
Catch per Unit Effort	CPUE
Celsius	C
Centimeters	cm
Green sunfish	green
Kilogram	kg
Kilometer	km
Largemouth bass	lmbass
Louisiana Department of Wildlife and Fisheries	LDWF
Millimeters	mm
Nicotinamide adenine dinucleotide	NADH
Parts per thousand	ppt
Polyvinyl chloride	PVC
Salinity	Sal
Temperature	Temp
Total length	TL
United States Dollars	USD
Weight	WT

INTRODUCTION

There are an estimated 50,000 nonnative species that have been introduced into the United States (Pimentel et al. 2005). Human population growth and subsequent globalization has increased the number of unintentional invasive species transported to the United States (Pimentel et al. 2005; Stanton 2005; Meyerson and Mooney 2007). Some introduced species such as corn *Zea* spp. and cattle *Bos* spp. are economically valuable, but many other species alter ecosystem processes, causing ecological and economic damage (Vitousek et al. 1996; Pimentel et al. 2005). For example, nutria *Myocastor coypus* were released in Louisiana for their fur and weed control, but now contribute to marsh degradation and can destroy bald cypress *Taxodium distichum* seedlings (Conner and Toliver 1987; Conner and Toliver 1990; Carter et al. 1999). Water hyacinth *Eichhornia crassipes* form dense mats in freshwater that obstruct navigation, impede drainages, and increase flooding by hindering runoff (Penfound and Earle 1948; Center and Hill 2002). Invasive fish species alter ecosystems by reducing aquatic vegetation, modifying water quality, or reducing native populations sometimes to the point of extinction (Vitousek et al. 1996; Pimentel et al. 2005; Casal 2006). It is estimated that the economic loss due to invasive fish in the United States is 5.4 billion USD a year (Pimentel et al. 2005). Unfortunately, an established nonnative tilapia population was recently discovered in southern Louisiana.

Tilapia are teleost fish in the family Cichlidae (Coward and Little 2001; Canonico et al. 2005) and are grouped into three genera (*Oreochromis*, *Tilapia*, or *Sarotherdon*) based on geographic range, feeding habits, and reproductive strategies (Trewavas 1982; Coward and Little 2001). Native to Africa and southern Asia, tilapia have been imported into the Americas primarily for aquaculture, but also for aquatic vegetation control, the aquarium trade, and sport fishing (Stauffer et al. 1998; Canonico 2005; Zambrano 2006). A short generation time and a long breeding season characterized by multiple spawning events, allow tilapia to quickly establish a population when introduced to a favorable habitat (Peterson et al. 2005). Most species reach sexual maturity in six months (McKaye et al. 1995) and blue tilapia *Oreochromis aureus* can spawn every 4-6 weeks (Stauffer et al. 1988). A 29 month study on Nile tilapia *Oreochromis niloticus* reproduction determined that the population did not have a specific breeding season, but rather breed throughout the year with peak reproductive periods (Komolafe and Arawomo 2007). High reproductive output due to parental care also facilitates establishment of new populations (Coward and Bromage 2000; Canonico et al. 2005). *Oreochromis* spp. are maternal mouth brooders and females protect the eggs and young fry in their buccal cavity (Trewavas 1982; Coward and Bromage 2000). Mouth brooding does not require a specific substrate for reproduction, therefore *Oreochromis* spp. can maintain a population in a wide range of habitats (McKaye et al. 1995).

Tilapia can be detrimental to an ecosystem by affecting habitats, nutrient cycles, food webs, and energy budgets (Khan and Panikkar 2009). In the Lake Mead Basin, predation by blue tilapia on endangered woundfin *Plagopterus argentissimus* and Virgin River chub *Gila seminude* further reduced the numbers of both species (Canonico et al. 2005). Competition with Nile tilapia led to a decline in native largemouth bass *Micropterus salmoides* and bluegill *Lepomis macrochirus* populations in Mississippi (Canonico et al. 2005). Similarly, native cichlid populations in Lake Nicaragua have declined since the introduction of tilapia (McKaye et al. 1995). Aggressive territorial behavior of spotted tilapia *Tilapia mariae* displaced native Centrarchids in southern Florida from preferred spawning sites (King and Etim 2004; Moyle and Marchetti 2006; Brooks and Jordan 2010).

Many species of tilapia tolerate a wide range of salinity and temperature, allowing populations to establish in a variety of ecosystems (Schofield et al. 2010). Blue tilapia can survive salinities ranging from 0-50 ppt (Stauffer et al. 1988) and Nile tilapia have been observed spawning in salinities from 0-32 ppt (Watanabe and Kuo 1985). Despite being classified as a warm water fish, mortality of juvenile Nile tilapia does not occur until 13.7°C with total mortality at 8.7°C (Charo-Karisa et al. 2005). Mozambique tilapia *Oreochromis mossambicus* can not withstand being exposed to water temperatures of 12.8°C and below for extended periods (Childers and Bennett 1967) and blue tilapia that appeared dead when exposed to 8°C for six hours revived when transferred to water that was 20°C (Stauffer et al. 1988). Because extended periods of low temperatures typically kill tilapia, they have been used as vegetation control in the United States where winter temperatures are sustained enough to cause 100% mortality (Childers and Bennett 1967). However, winters in southern Louisiana do not sustain cold enough temperatures to kill every species of tilapia.

The potential for tilapia to alter the Louisiana marsh ecosystem influenced the decision of the Louisiana Department of Wildlife and Fisheries (LDWF) to attempt eradication. Because the Port Sulphur drainage canal is a small and relatively closed system, LDWF used rotenone to eradicate the tilapia. Rotenone is a chemical produced by plants in the legume family and is highly toxic to fish, insects, and other invertebrates (Chandler and Marking 1982; Chadderton et al. 2003; Robertson and Smith-Vaniz 2008;

Nanda et al. 2009). Rotenone inhibits the respiratory enzyme NADH-dehydrogenase killing fish through oxygen deprivation (Ernster et al. 1963; Fukami et al. 1969; Chandler and Marking 1982). Rotenone was traditionally used by fisheries managers to assess native communities, but is also used to eradicate unwanted species (Ackerman and Bellwood 2000; Chadderton et al. 2003; Robertson and Smith-Vaniz 2008). Plans were implemented to continue monitoring for tilapia and native piscivore fish species were restocked in high numbers as a biocontrol for possible remaining tilapia.

The use of biocontrols can be a sustainable management technique for controlling invasive species and a good alternative to releasing potentially harmful chemicals into the environment. Biocontrols have been successful in Africa where invasive water hyacinth had become resistant to herbicides (Center and Hill 2002). Similarly, stocking predatory fish species in rice fields reduces pests such as the rice caseworm *Nymphula depunctalis* without the use of chemicals (Vromant et al. 1998; Vromant et al. 2002). Redbelly tilapia *Tilapia zilli* have been used as a biocontrol for mosquitoes *Culex* spp. by preying on immature life stages of the mosquito and destroying mosquito habitat by consuming vegetation used by mosquitoes (Legner 1978). Introduced with good intentions, many nonnative biocontrols become established and threaten the diversity of native species or become an economic pest (Hatherly et al. 2005; Roy and Wajnberg 2008). For example, ladybirds *Harmonia axyridis* were introduced to many countries to control insect populations and are now considered a pest in the United States because they consume fruit and economically impact the wine and fruit industries (Roy and Wajnberg 2008). Use of fishes such as alligator gar *Atractosteus spatula*, spotted gar *Lepisosteus oculatus*, bullheads *Ameiurus* spp., and largemouth bass as a biocontrol for an established invasive like tilapia in the Port Sulphur drainage canal is beneficial because they are native to south Louisiana.

Alligator gar, spotted gar, and largemouth bass are opportunistic feeders, and usually consume the most abundant or vulnerable prey item (Godinho et al. 1997; Ostrand et al. 2004; Buckmeier 2008), which is beneficial if the tilapia population increases after rotenone treatments. Typical diets of alligator gar, spotted gar, and largemouth bass largely contain fish (Goodyear 1967; Godinho et al. 1997; García de León et al. 2001). Although bullheads usually feed heavily on invertebrates (Raney and Webster 1940; Rickett 1976), they can be piscivorous (Moore 1972). In Lockhart Pond in Ontario, Canada, fish was the most abundant diet item identified in 21.5-26.5 cm TL bullheads (Moore 1972). The most frequent diet item of alligator gar collected in Biloxi Bay and the Mississippi sound were hardhead catfish *Galeichthys felis* (Goodyear 1967). Predation by largemouth bass in an Illinois pond reduced the abundance of Mozambique tilapia from 10,828 per acre to 11 per acre (Childers and Bennett 1967). Even though both largemouth bass and alligator gar are considered top predators, largemouth bass were the most common species identified in alligator gar stomachs from the Vicente Guerrero Reservoir in Mexico (García de León et al. 2001).

Stocked native predatory fish can be an effective biocontrol for tilapia if the stocked predators thrive in the new environment and the targeted prey item is a large component of the predator's diet. High growth rates of the stocked predators can indicate favorable environmental parameters (Stone and Modde 1982). Low turbidity allows predators to see prey and varied prey size allows many ages of fish to feed (Fessler 1950; Stone and Modde 1982). Growth rates of largemouth bass stocked in South Dakota ponds were most affected by geographical growing season, water turbidity, and prey stocked (Stone and Modde 1982). Fast growth rates of recaptured predators indicate effective feeding activity and suitability of environmental conditions for the stocked species.

If tilapia are observed as a large part of a predators diet, the predator may be able to control the targeted prey. Although sacrificing individual predators provides all stomach contents, each sacrificed predator can no longer consume the targeted prey. Also, sacrificing fish can be harmful to a small population or cause bad public relations due to objects to sacrificing fish (Light et al. 1983). Gastric lavage is a technique used to collect stomach contents of fish by pumping water into the fish's stomach to flush out the contents. After the stomach contents are collected, the fish can be released alive. For example, sturgeons (Acipenseridae) are classified as legally threatened and cannot be sacrificed (Brosse et al. 2002), but gastric lavage enables scientists to study the diet of sturgeons without harming the fish. Gastric lavage is a beneficial technique because it is inexpensive and does not require sacrificing the fish to retrieve stomach contents.

Gastric lavage is effective at removing most of the stomach contents of many fish species. Light et al. (1983) sacrificed 198 brook trout *Salvelinus fontinalis* and 60 slimy sculpins *Cottus cognatus* after lavage and found that 98% of stomach contents in brook trout were removed and 100% of stomach contents in slimy sculpins were removed by gastric lavage. Similarly, all stomachs examined from 43 sacrificed grass pickerel *Esox americanus vermiculatus* had no remaining diet items after gastric lavage and 40 out of 41 largemouth bass stomachs were completely emptied through gastric lavage (Foster 1977). The gastric lavage technique can be altered to fit the fish's digestive tract.

Different fittings and tube sizes can be used to ensure survival of the fish post gastric lavage. Survival of 21 slimy sculpins and 14 brook trout was 100% five days after gastric lavage and was 100% sixteen days after a second gastric lavage (Light et al. 1983). Brosse et al. (2002) reported no mortality of sturgeon 60 days post gastric lavage.

Habitat loss is a major factor that has caused populations of alligator gar to decline throughout their historical range (Robinson and Buchanan 1988; Ferrara 2001; Buckmeier 2008). From 1953 to 2005 the number of alligator gar collected in Lake Pontchartrain, LA with beach seines decreased by 98.6% (O'Connell et al. 2007). Due to low numbers of alligator gar throughout their distribution several states have stocked hatchery-produced alligator gar to enhance wild populations (Buckmeier 2008). However, there are no published data that reports growth and survival of hatchery-reared alligator gar that have been released into the wild. Most species of fish grow fastest the first year of life (Viosca 1943; Edsall 1960; Netsch and Witt 1962). The length of white fish *Coregonus clupeajormis* increased by the greatest annual increment the first year of life and annual growth rates decreased as the fish increased in age (Edsall 1960). Sixty-eight percent of total length of yellow bass *Morone mississippiensis* was achieved by age 2 (Schoffman 1958). Besides being a possible biocontrol, stocked alligator gar can be assessed to determine diets and growth rates post release to evaluate growth of hatchery produced alligator gar released into the wild.

The purpose of the study was to monitor for tilapia in the diets of predatory fish stocked in the Port Sulphur drainage canal. It was hypothesized that if tilapia did survive rotenone treatments, they would be consumed by largemouth bass and alligator gar due to the piscivorous nature of these species. The goal was to identify the diets of stocked predatory fishes into the Port Sulphur drainage canal and to measure the growth rates of recaptured alligator gar. The objectives included:

1. Quantify removal efficiency of gastric lavage in spotted gar and largemouth bass;
2. Quantify percent survival of spotted gar and largemouth bass post gastric lavage;
3. Compare the diet composition among alligator gar, largemouth bass, and bullheads;
4. Compare diet item categories within alligator gar, largemouth bass, and bullheads; and
5. Determine growth rates of recaptured alligator gar produced in 2008 and 2009.

STUDY SITE

In the spring of 2009 tilapia (*Oreochromis* hybrid) were identified in a drainage canal in Port Sulphur, Louisiana (Figure 1) and was the first wild population of tilapia found in Louisiana. The canal, which provides drainage to prevent flooding of urbanized areas of Port Sulphur during heavy precipitation, has little vegetation, is approximately 12 km long, averages 1.2 m deep, and salinity typically remains below 3 ppt. The drainage canal is parallel to a marsh levee that protects the Port Sulphur community from the adjacent marsh waters. The water level in the canal is regulated by two pumps that transfer water from the canal, over the levee, and into the adjacent marsh. Because introduced tilapia can negatively impact a native community, their discovery was a cause of concern that was exacerbated by local environmental conditions that are favorable to tilapia and the proximity of the Port Sulphur drainage canal to local marshes. Invasive tilapia have established populations that have caused detrimental effects on native fish population in Florida, Texas, Arizona, and California (Stauffer et al. 1988; McKaye et al. 2005; Peterson et al. 2005; Brooks and Jordan 2010). In the case of a hurricane, flooding, or transport through the pump system, tilapia could be transferred from the Port Sulphur drainage canal into the marsh, giving tilapia access to all of southern Louisiana waterways.

Between 9 June 2009 and 13 July 2009 four rotenone treatments totaling 8,555 L were applied to the drainage system (Melissa Kaintz, LDWF, personal communication). Although approximately 1,039,518 tilapia were killed and collected from the canal post rotenone treatments, it was possible not all tilapia were destroyed. On 14 December 2009 electrofishing in the canal post rotenone treatments revealed 2 tilapia and 2 Rio Grande

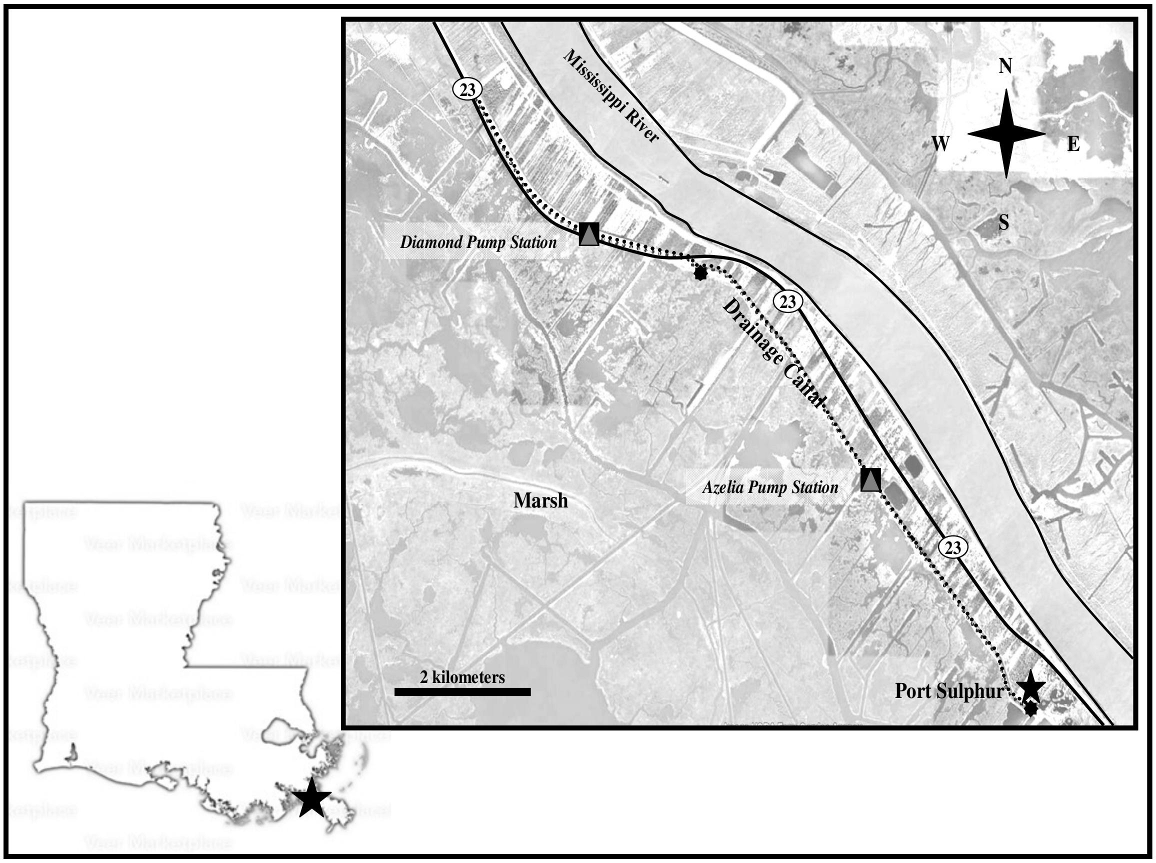

Figure 1. The location of the Port Sulphur drainage canal (dotted line). Stocking locations are marked with an eight point start (✸) and pumping stations are marked with a triangle(▲).

cichlids *Herichthys cyanoguttatum*, a nonnative relative of tilapia (Melissa Kaintz, LDWF, personal communication).

METHODS

Stocking Native Fishes

The Louisiana Department of Wildlife and Fisheries began stocking native fish into the Port Sulphur drainage canal in July 2009 (Table 1). Most fish came from the Bonnet Carré Spillway and the Atchafalaya River Basin. The final stocking took place on 11 February 2010 with 4500 bullheads from the Lacombe Fish Hatchery in Lacombe, Louisiana.

Alligator gar produced at Golden Ranch Plantation in Gheens, Louisiana, and Private John Allen National Fish Hatchery in Tupelo, Mississippi, in the spring of 2008 and 2009 (Clay 2009) were stocked into the Port Sulphur drainage canal. Alligator gar were stocked at either the northern portion (N 29° 31.466'; W 89°44.759') or the southern portion (N 29°28.474'; W 89°41.829') of the canal (Figure 1). Stocking was completed in 5 trips from 16 December 2009 to 23 January 2010. Eighteen wild collected adults of unknown ages, 159 1+ year, and 183 young-of-the-year alligator gar were weighed (kg), measured (TL; mm), and tagged before release into the canal (Table 2). Adult and 1+ year alligator gar were tagged with both an individually numbered T-bar tag and a passive integrated transponder (PIT-tag). Due to small size, the young-of-the-year alligator gar were only PIT-tagged

Sampling Stomach Contents-Gastric Lavage

From 29 March 2010 to 12 November 2010 (N= 59 samples) monofilament gill nets (2.5, 3.5, or 5.1 cm bar mesh) were used to collect fish for gastric lavage. Nets were deployed at sunrise for two hours or two hours before sunset to maintain consistency

Table 1. Total number of each native fish species stocked in 2009 and 2010 by the Louisiana Department of Wildlife and Fisheries into the Port Sulphur drainage canal post rotenone treatments.

Common Name	**Species**	**N**
Catfish	*Pylodictis olivaris,* *Ictalurus furcatus,* *Ictalurus punctatus*	32
Bowfin	*Amia calva*	41
Largemouth Bass	*Micropterus salmoides*	115
Spotted Gar	*Lepisosteus oculatus*	306
Sunfish	*Lepomis* spp.	762
Bullhead	*Ameiurus* spp.	4500

Table 2. Mean (±SE), minimum, and maximum total length (mm) and weight (kg) for adult and juvenile alligator gar stocked into the Port Sulphur drainage canal. The 1+ year old fish were hatched in May 2008 and the young-of-the-year fish were hatched in May 2009. Adult alligator gar were wild caught and were of unknown ages.

Year Class	**N**	**Measurement**	**Mean (± SE)**	**Min**	**Max**
Adult	18	TL	1156.4 ± 39.2	815	1465
		WT	11.5 ± 1.2	4	23
2008	159	TL	624.8 ± 5.0	482	785
		WT	1.5 ± 0.04	0.6	3
2009	183	TL	373.1 ± 2.14	310	470
		WT	0.23 ± 0.004	0.1	0.5

among samples and because gar and largemouth bass are most active during sunrise and sunset (Echelle and Riggs 1972; McMahon and Holanov 1995). During each two-hour sampling period nets were examined every 20-45 minutes to retrieve collected fish to reduce stress and retrieve stomach contents prior to digestion. Salinity (ppt) and water temperature (ºC) were measured for each sample period with a handheld temperature-oxygen-conductivity-salinity meter (YSI Model 85; Yellow Springs, Ohio).

Gastric lavage was used to retrieve stomach contents from each fish with a large enough throat for the tube to fit into without force. Gastric lavage was performed using a modified Chapin 20010 Sure Spray One Gallon Poly Sprayer. Modifications included replacing the sprayer nozzle with a vinyl tube attached with a metal tube clamp. Fish were held anterior end down over a Miroil Oil Polishing Filter Model 85F (Allentown, PA) resting on a bucket to collect stomach contents. Based on species and size of fish, an appropriately sized polyvinyl chloride (PVC) pipe was used to hold the fish's mouth open to facilitate insertion of the sprayer tube into the gastric system. Pressurized water was pumped into the stomach of the fish to flush stomach contents into the filter. Each stomach was flushed until contents returned clear of debris. Stomach contents were labeled and transferred to individual cloth bags for storage in 70% ethanol.

After gastric lavage each fish was weighed (kg), measured (TL; mm), and was returned to the canal. No mortalities were observed when fish were released. If an untagged fish was collected, it was issued a T-bar tag with an individual number. Each time a tagged fish was recaptured, the increase in total length since time of initial release was calculated and used to determine the growth rate with linear regression. Analysis of covariance was used to compare growth rates between the 2008 and 2009 alligator gar year classes.

Stomach contents were examined using an illuminated magnification lense and a dissecting microscope, identified to the lowest possible taxon, then categorized as either fish, crustacean, insect, mollusc, reptile, or unknown. Items placed in the unknown category were typically too digested to identify. Unknown items were found in stomachs that contained other identifiable items or were the only item in a stomach.

Percent of empty stomachs was calculated for alligator gar, largemouthbass, and bullheads, and Chi Square analysis was used to determine if there was a difference in percent empty stomachs among the three fishes. Multivariate analysis of variance (Wilk's Lambda) was used to compare the overall diet among alligator gar, largemouth bass, and bullheads. Analysis of variance, followed by Tukey's *post hoc* analysis was used to compare the abundance of fish, crustacean, insect, mollusc, reptile, or unknown itmes among alligator gar, largemouth bass, and bullhead. Analysis of variance, followed by Tukey's *post hoc* analysis was used to compare the abundance of fish, crustacean, insect, mollusc, reptile, or unknown diet item categories within the predatory fish diets.

Removal Efficiency of Gastric Lavage Technique

To quantify the portion of the stomach contents retrieved via gastric lavage, fish must be sacrificed after gastric. It was important to maintain potential tilapia predators in the canal, so this portion of the study was conducted using spotted gar from Bayou Chevreuil, St. James Parish, Louisiana (Figure 2).

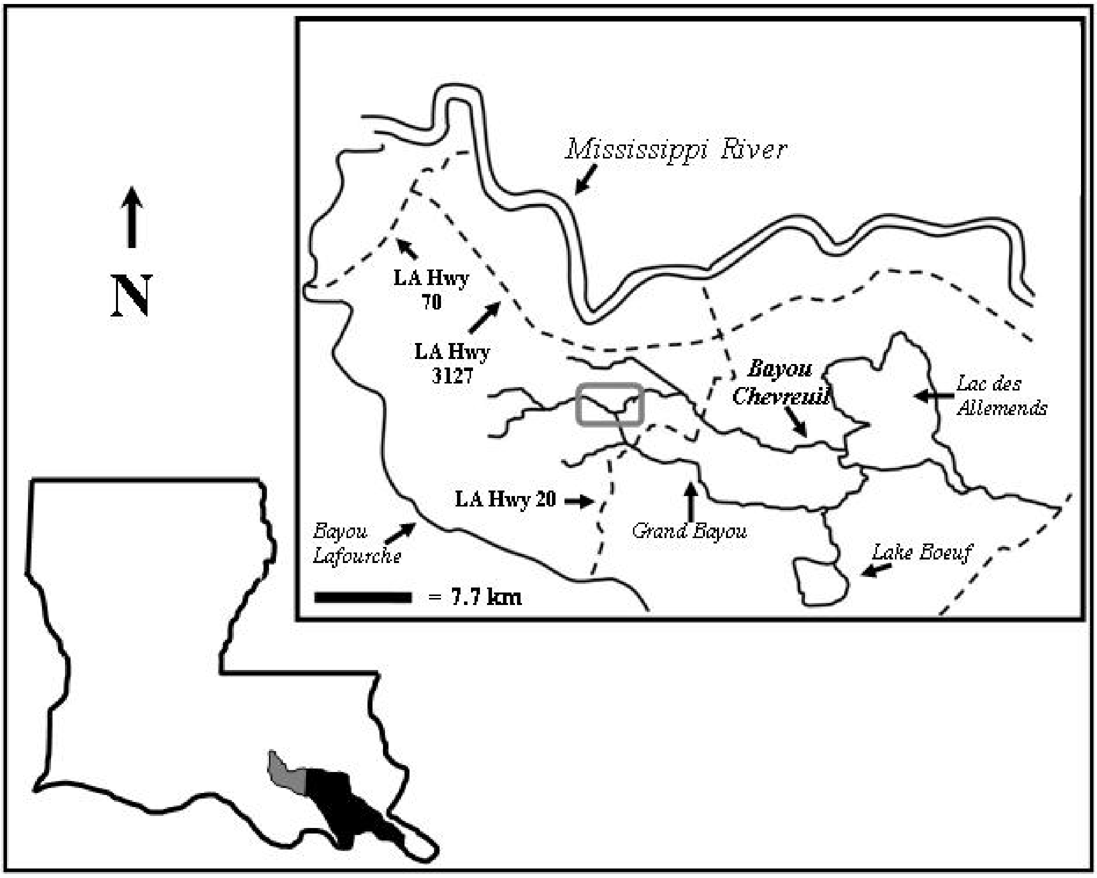

Figure 2. Location of Bayou Chevreuil in southern Louisiana. Rectangle (▭) marks approximate locations where nets were deployed. Fish were collected from Bayou Chevreuil for mortality and efficiency of gastric lavage studies (Modified from Smith 2008).

On 13 July 2010 and 16 August 2010 monofilament gill nets (2.5, 3.5, and 5.1 cm bar mesh) were deployed in Bayou Chevreuil (Figure 2) either at sunrise or two hours prior to sunset for a total of two hours. Nets were examined every 15-20 minutes for captured fish and each fish collected was weighed (kg), measured (TL; mm), and T-bar tagged. Gastic lavage was performed on each spotted gar (N=19) and stomach contents were stored in 70% ethanol until identified to lowest possible taxon. Following gastric lavage each fish was sacrificed and cut on the ventral side from the vent to the ismuthus and stored on ice until further processing.

Stomachs were removed from each spotted gar and remaining contents were identified. All stomach contents from both the gastric lavage and the dissected stomachs were categorized as fish, crustacean, insect, reptile, amphibian, or unknown. Total stomach contents for each spotted gar were determined by combining the stomach contents removed during gastric lavage and stomach contents removed directly from the dissected stomachs of sacrificed fish. Stomach contents removed by gastric lavage were compared to total stomach contents using analysis of similarity (Primer version 6.1.6) to determine if the gastric lavage stomach contents were similar to total stomach contents. Percent empty stomachs as determined for all spotted gar.

Mortality Associated With Gastric Lavage

To quantify mortality associated with the gastric lavage technique, survival of lavaged fish was compared to survival of similarly captured fish not exposed to gastric lavage. Spotted gar (N=4) and largemouth bass (N=13) were collected from Bayou Chevreuil (Figure 2) as to not remove potential predators from the Port Sulphur drainage canal. Four monofilament gillnets (2.5, 3.5, and 5.1 cm bar mesh) were deployed on 9 September 2010, 21 September 2010, 30 September 2010, 7 October 2010, and 16 October 2010 for a total of three hours on each date. Catch per unit effort (CPUE) for each species was calculated by dividing the total number of hours all nets were deployed by the number of fish collected. During sampling, nets were inspected every 20-45 minutes to reduce stress of captured fish and to stop digestion of stomach contents. Gastric lavage was performed on half of the fish collected (N=2 spotted gar; N=6 largemouth bass) and the remaining fish were not lavaged and used as a control (N=2 spotted gar; N=7 largemouth bass). Each fish collected was weighed (kg), measured (TL; mm), and T-bar tagged with an individual number and transported in live wells to a 3.6 m diameter recirculating tank at the Nicholls State University Farm. Fish were not fed for the two week monitoring period and dead fish were identified and removed daily. At the end of the two week observational period, all live fish were returned to Bayou Chevreuil.

RESULTS

Sample Site Data

Gillnets were deployed for 59 sample periods in the Port Sulphur drainage canal. During the sample period, salinity ranged from 1 to 3.1 ppt and temperature ranged from 18.9 to 33.8°C (Figure 3). A total of 307 fish were collected using gillnets (Table 3). Alligator gar (N=87) and bullheads (N=85) were the most abundant fish collected. No adult alligator gar were recaptured. One tilapia (TL=193 mm) was collected on 19 September 2010.

Diet Data

Gastric lavage was performed on 198 fish (Table 4) and alligator gar (N=86), largemouth bass (N=54), and bullheads (N=48) were the most frequently lavaged fish. Diets consisted of various species of fish, crustaceans, insects, reptiles, and a mollusc (Table 5). One hundred fifty-one stomachs contained at least one diet item and were categorized as not empty. Twenty-four percent of alligator gar stomachs, 18.5% of largemouth bass stomachs, and 20.8% of bullhead stomachs were empty (Figure 4.) Based on Chi Square analysis, there was no difference in percent empty stomachs among alligator gar, largemouth bass, and bullheads (X^2(df=2, N=43)=2.78, p=0.249).

Based on multivariate analysis of variance, the frequency of diet items was not similar among alligator gar, largemouth bass, and bullheads (Wilk's Lambda = 0.6008; $F_{12,278} = 6.72$; $P < 0.0001$; Figure 5). Largemouth bass and alligator gar contained more fish in their diet than bullheads (P=0.0392; Figure 6). The mean number of crustaceans

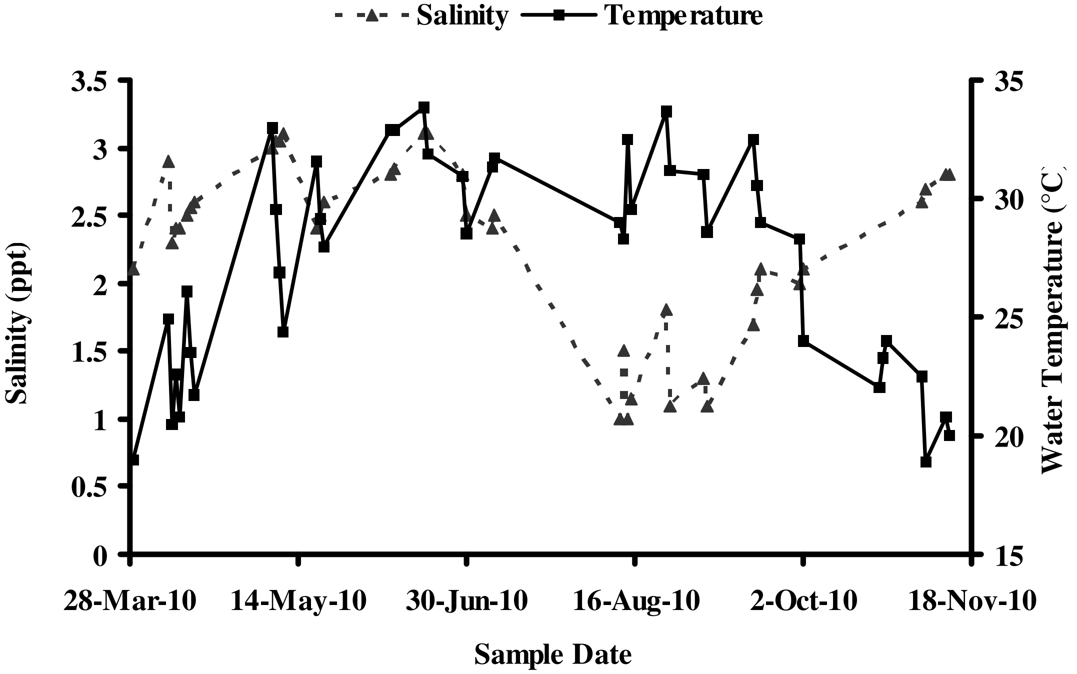

Figure 3. Mean salinity (▲, dashed line; N=55) and temperature (■, solid line; N=59) recorded at approximately sunrise and sunset in the Port Sulphur drainage canal on each sample day (N=59) between 29 March 2010 and 12 November 2010.

Table 3. The total number of each fish species collected using gillnets in the Port Sulphur drainage canal during 59 samples from 29 March 2010 to 12 November 2010.

Common Name	**Species**	**N**
Alligator Gar	*Atractosteus spatula*	87
Bullhead	*Ameiurus* spp.	85
Largemouth Bass	*Micropterus salmoides*	54
Warmouth	*Chaenobryttus gulosus*	51
Green Sunfish	*Lepomis cyannelus*	15
Spotted Gar	*Lepisosteus oculatus*	10
Bluegill	*Lepomis macrochirus*	4
Tilapia	*Oreochromis* spp.	1

Table 4. The number of fish recaptured, number of empty stomachs, and mean (±SE) total length and weight of each species that underwent gastric lavage. The information in parenthesis next to alligator gar indicated the fish was produced in 2008, 2009, or did not contain a tag when collected.

Species	**N**	**Empty Stomachs**	**Total Length (mm)**	**Weight (kg)**
Alligator Gar (2008)	19	10	671 ± 33.0	1.82 ± 0.327
Alligator Gar (2009)	57	11	509 ± 21.0	0.90 ± 0.153
Alligator Gar (No Tag)	10	0	580 ± 26.4	0.85 ± 0.119
Largemouth Bass	54	10	235 ± 7.8	0.22 ± 0.032
Bullhead	48	10	252 ± 2.7	0.24 ± 0.007
Spotted Gar	10	6	591 ± 23.7	0.88 ± 0.133

Table 5. Diet items of alligator gar, largemouth bass, bullheads, and spotted gar identified to the lowest possible taxon.

Diet Item	**Alligator Gar**	**Largemouth Bass**	**Bullheads**	**Spotted Gar**
<u>Fish</u>				
Poecilidae				
Unknown Poecilidae	4	27	0	0
Poecilia latipinna	28	6	0	0
Gambusia affinis	38	42	1	0
Cyprinodontidae				
Cyprinodon variegatus	8	8	0	0
Centrarchidae				
Lepomis spp.	4	2	0	0
Lepisosteidae				
Lepisosteus oculatus	1	0	0	0
Unidentifiable	57	46	8	5
<u>Crustaceans</u>				
Cambaridae				
Procambarus clarkii	9	3	1	0
Palaemonidae	0	1	0	0
Unidentifiable	16	3	2	0
<u>Insects</u>				
Odonata	3	0	0	0
Diptera	1	0	0	0
Culicidae	0	0	389	0
Formicidae	0	1	1	0
Unidentifiable	8	6	43	0
<u>Molluscs</u>				
Gastropoda	0	0	1	0
<u>Reptiles</u>				
Emydidae	1	0	0	0
Colubridae				
Nerodia rhombifer	1	0	0	0
<u>Unknown</u>	14	9	25	0

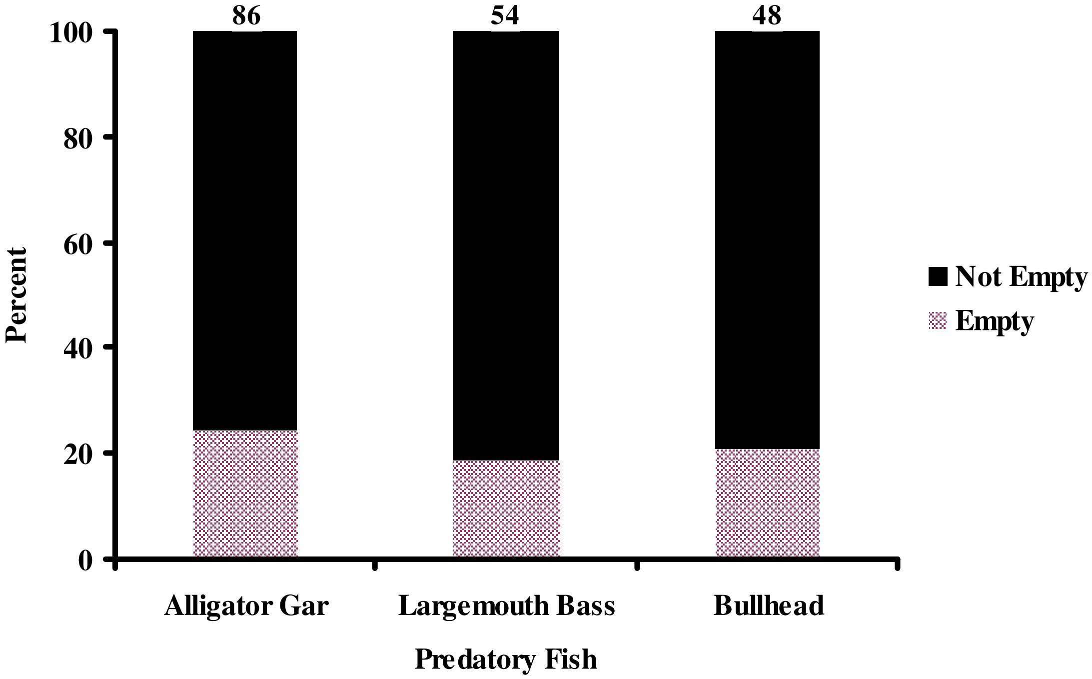

Figure 4. The percent of empty and not empty stomachs for alligator gar, largemouth bass, and bullheads collected between 29 March 2010 and 12 November 2010 from the Port Sulphur drainage canal. The number on top of each bar represents the sample size.

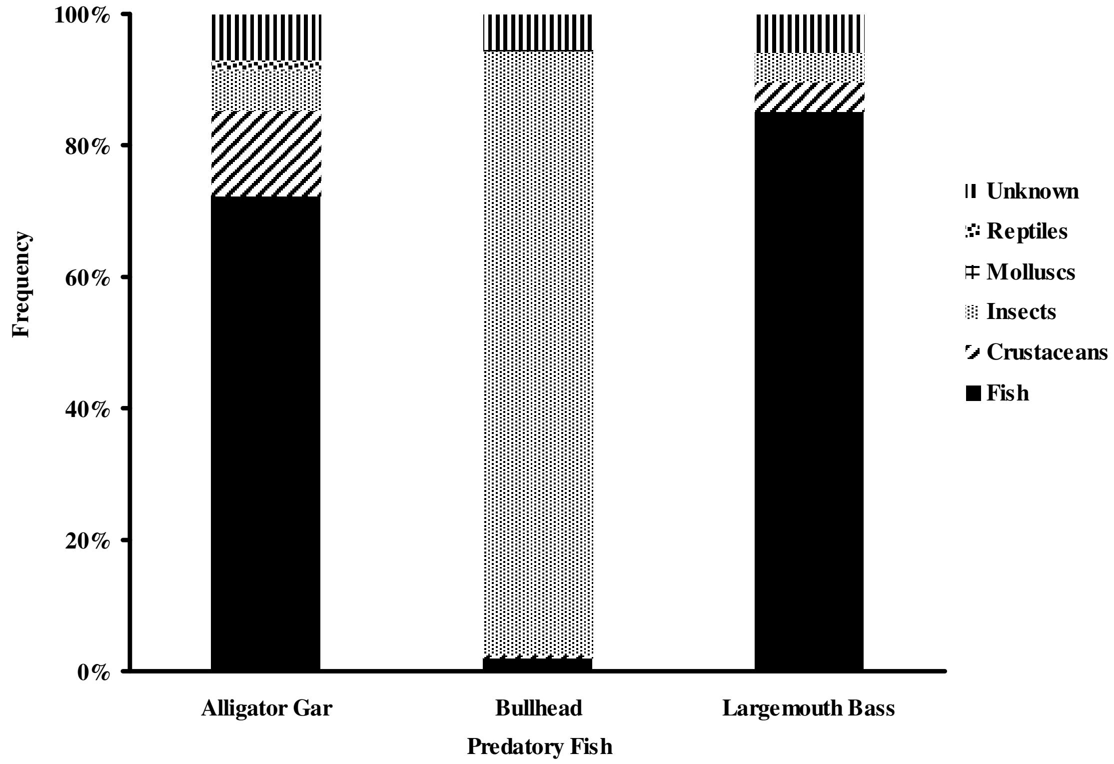

Figure 5. The frequency of fish, crustaceans, insects, molluscs, reptiles, and unknown items in the diets of alligator gar, bullheads, and largemouth bass collected between 29 March 2010 and 12 November 2010.

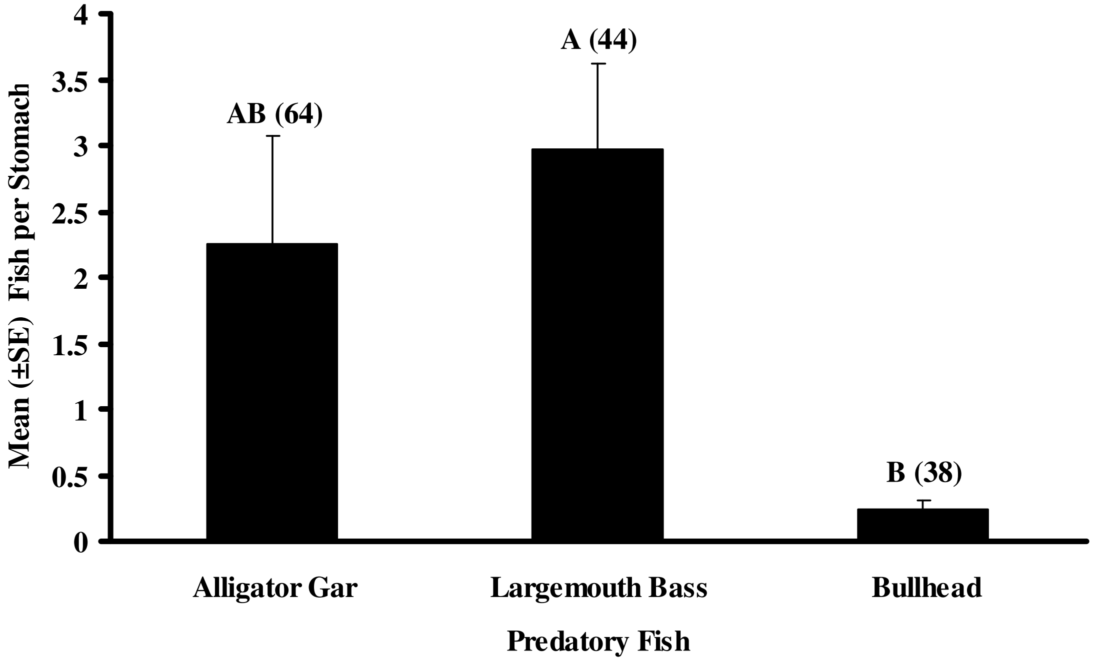

Figure 6. Mean (±SE) number of fish per stomach in the diets of alligator gar, largemouth bass, and bullheads collected in the Port Sulphur drainage canal between 29 March and 12 November 2010. Number in parenthesis represents sample size. Letters above bars represent Tukey groupings and denote differences among predatory fish.

was higher in alligator gar (0.41 ± 0.062) than largemouth bass (0.16 ± 0.044) or bullheads (0.08 ± 0.056; P=0.0002; Figure 7). The mean number of insects per stomach in alligator gar, largemouth bass, and bullheads was similar (P=0.1706; Figure 8). The amount of unknown diet items per stomach in bullheads was greater than in largemouth bass and in alligator gar (P<0.0001; Figure 9). Analysis of variance was not used to compare mollusc and reptile diet item categories because only two reptiles, a diamondback watersnake *Nerodia rhombifer* and a turtle in the family Emydidae and only one mollusc, a gastropod shell were identified (Table 5).

Diet categories were compared within each predatory fish group using analysis of variance. Fish were the most abundant diet item in alligator gar (P<0.0001; Figure 10) and largemouth bass (P<0.0001; Figure 11). Insects had a more variable diet. The mean number of each diet item category in bullheads was similar (P=0.2958; Figure 12).

Removal Efficiency of Gastric Lavage

Zero out of 19 spotted gar stomachs were classified as empty. Based on analysis of similarity there was no difference between diet item composition collected via gastric lavage and total diet composition (P=0.088). Reptiles (100%) and amphibians (100%) had the highest removal efficiency followed by fish (87%; Table 6.)

Survival of Fish Post Gastric Lavage

Nets were deployed for a total of 15 hours. Four spotted gar (CPUE=0.067) and 13 largemouth (CPUE=0.217) bass were collected. All spotted gar were alive two weeks after gastric lavage (N=2). Two out of 6 largemouth bass that underwent gastric lavage

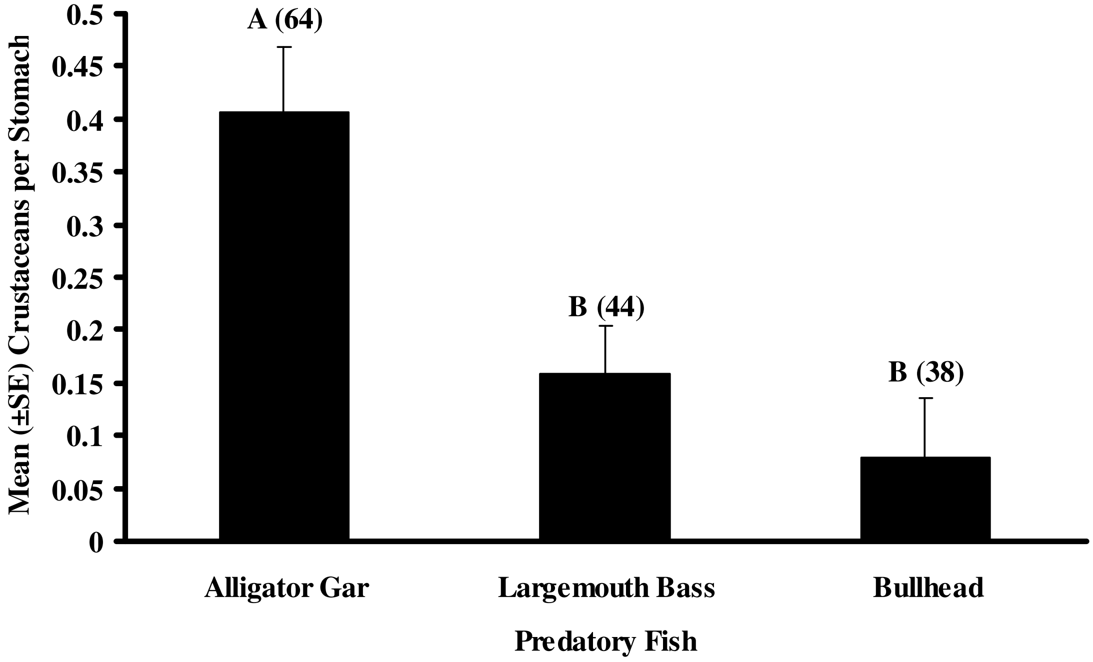

Figure 7. Mean (±SE) number of crustaceans per stomach in the diets of alligator gar, largemouth bass, and bullheads collected in the Port Sulphur drainage canal between 29 March and 12 November 2010. Number in parenthesis represents sample size. Letters above bars represent Tukey groupings and denote differences among predatory fish.

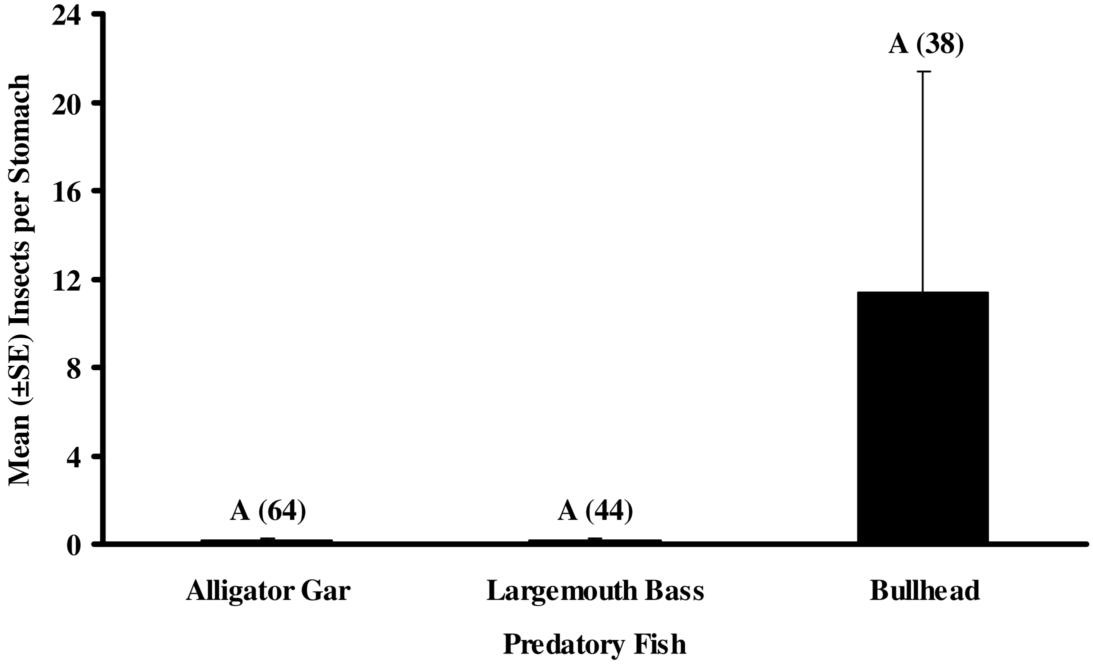

Figure 8. Mean (±SE) number of insects per stomach in the diets of alligator gar, largemouth bass, and bullheads collected in the Port Sulphur drainage canal between 29 March and 12 November 2010. Number in parenthesis represents sample size. Letters above samples represent Tukey groupings and denote differences among predatory fish.

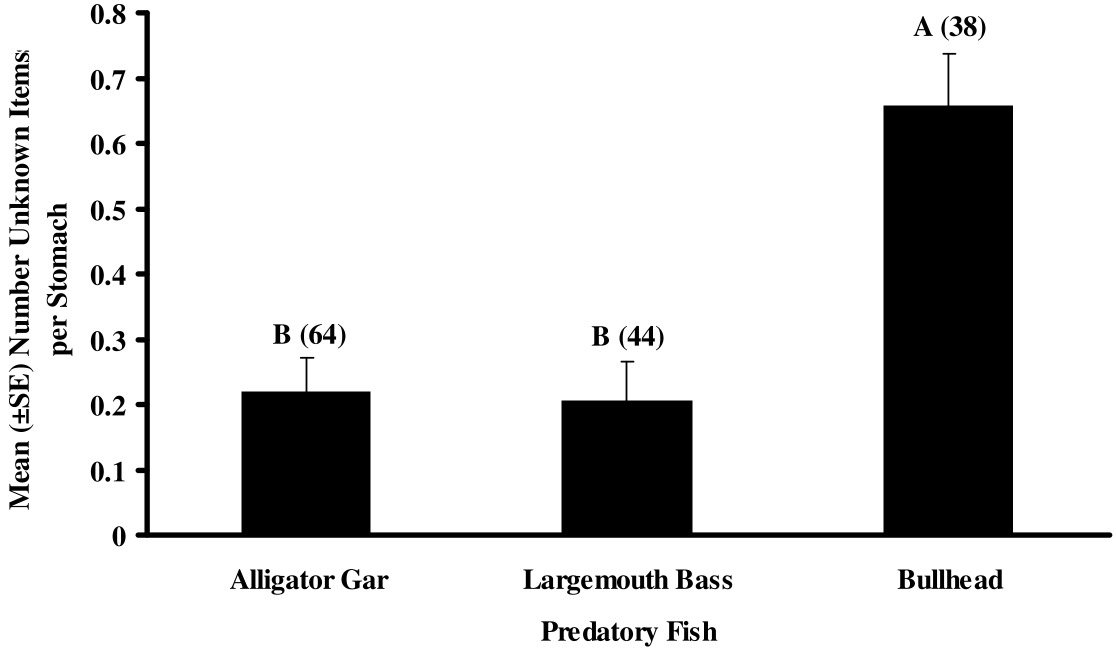

Figure 9. Mean (±SE) number of unknown items per stomach in the diet of alligator gar, largemouth bass, and bullheads collected in the Port Sulphur drainage canal between 29 March and 12 November 2010. Number in parenthesis represents sample size. Letters above bars represent Tukey groupings and denote differences among predatory fish.

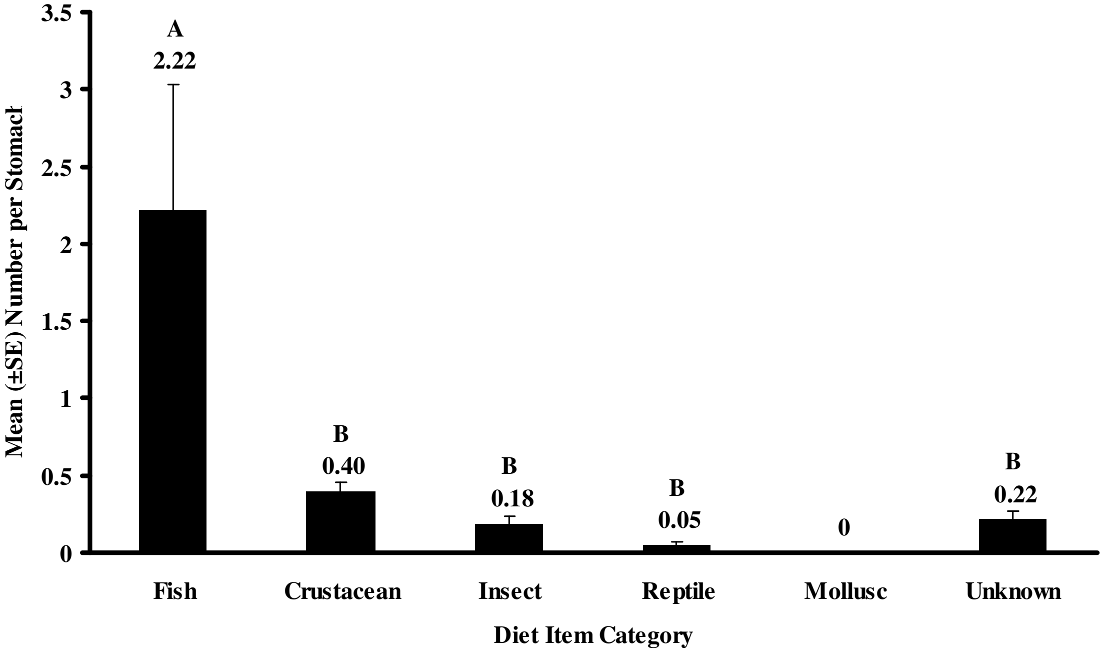

Figure 10. Mean (± SE) number per stomach of each diet item in alligator gar. Letters above bars represent Tukey groupings and denote differences among diet items. No molluscs were consumed by alligator gar.

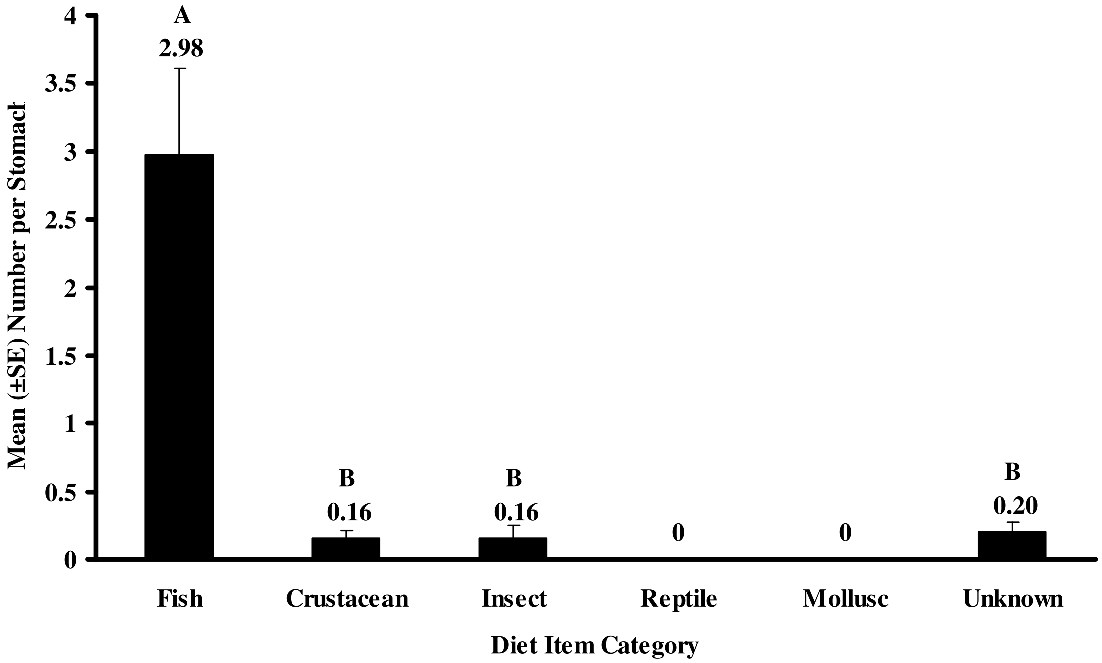

Figure 11. Mean (± SE) number per stomach of each diet item in largemouth bass. Letters above bars represent Tukey groupings and denote differences among diet items. No molluscs or reptiles were consumed by largemouth bass.

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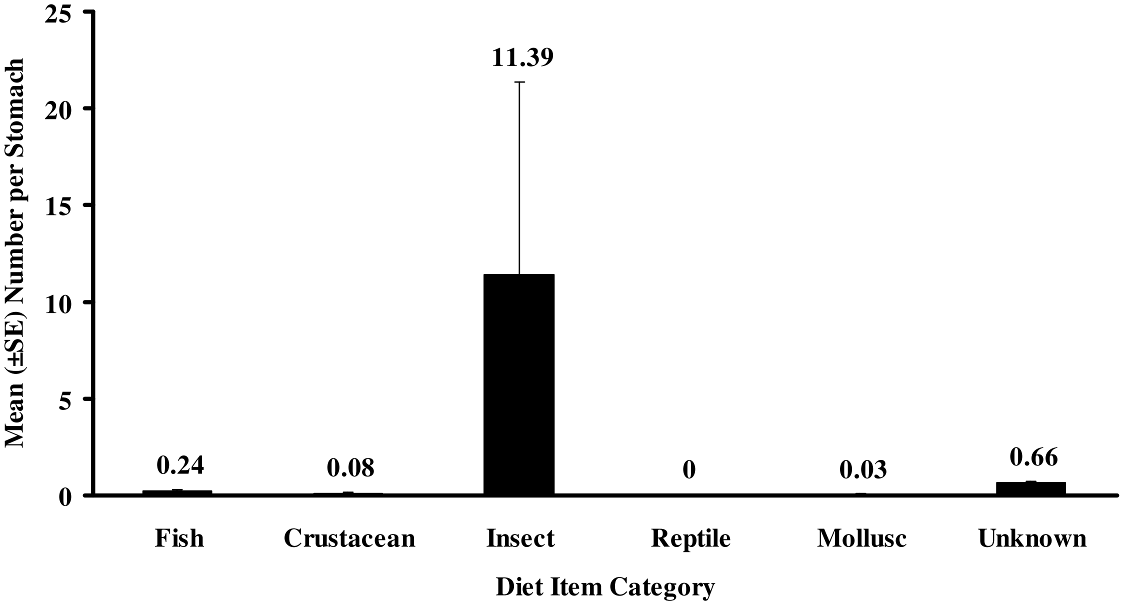

Figure 12. Mean (± SE) number of each diet item in bullheads. There was no statistical difference among diet item categories. No reptiles were consumed by bullheads.

Table 6. The number of diet items removed by gastric lavage, total number of diet items, and removal efficiency for each diet item category.

	Fish	**Crustaceans**	**Insects**	**Reptiles**	**Amphibians**	**Unidentifiable**
Gastric Lavage Diet Items	20	30	5	3	2	2
Total Diet Items	23	50	8	3	2	16
Removal Efficiency (%)	87.0	60.0	62.5	100.0	100.0	12.5

died within the two week observation period, but no control fish died (Figure 13). Raw data is presented and no statistical analysis was performed due to low sample size.

Alligator Gar Growth Rates

Fifty-six alligator gar were captured at least once. Ten alligator gar were recaptured twice, four were recaptured three times, two were recaptured four times, and one fish was recaptured on five different days. Growth rates were determined by calculating the increase in total length divided by the number of days since stocking. Although alligator gar were measured on 13, 14, 15, 21, 22, 23 of January 2010 and released on 18, 20, 21, 22, 23 January 2010, 13 January 2010 was the used as the standard stocking day to calculate days since release. Temperature in the canal during stocking on 22 and 23 January 2010 ranged from 16-18° C. Alligator gar growth for approximately the first 100 days in the canal was minimal (Figure 14). The temperature in the canal on 15 April 2010 (92 days since stocking) was 21.7° C. The next sampling period took place on 7 May 2010 (114 days since stocking) and the water temperature had risen to 33° C. Alligator gar produced in 2009 grew 2.7 mm per day and alligator gar produced in 2008 grew 1.4 mm per day between May and November 2010 once the water warmed (Figure 15; $t=-11.04$, $P<0.0001$).

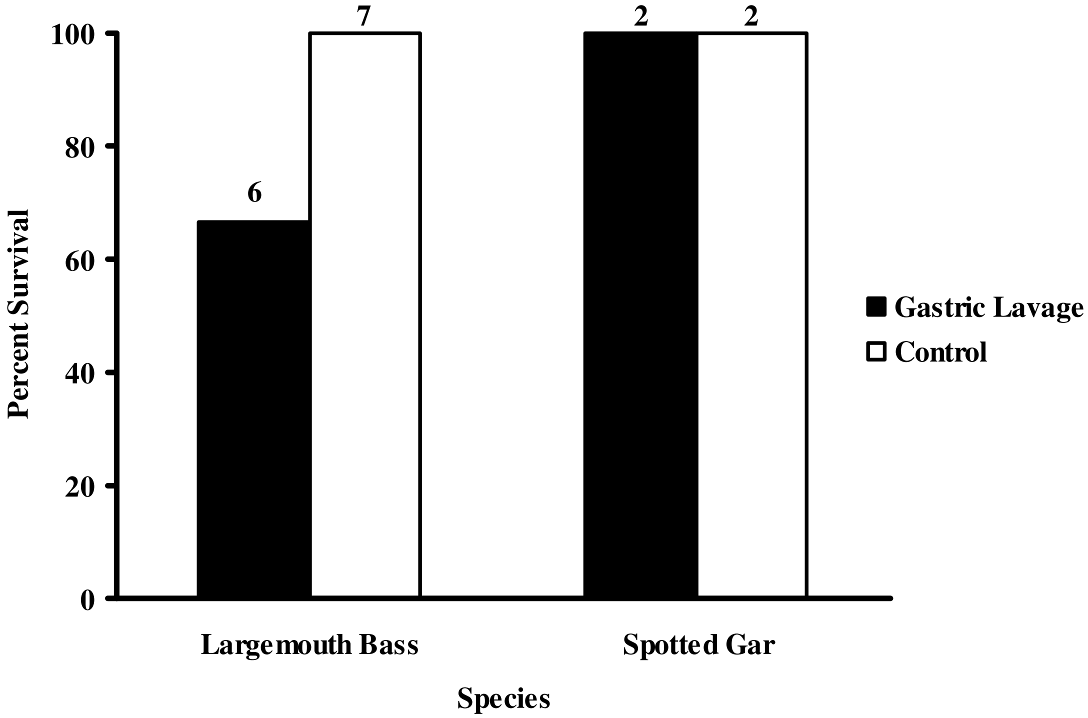

Figure 13. Percent survival of largemouth bass (TL=250 ± 36 mm; WT=0.24 ± 0.13 kg) and spotted gar (TL=533 ± 32 mm; WT=0.87 ± 0.49 kg) that were gastric lavaged (solid bar) or not gastric lavaged (open bar). The number on top of bars represents sample size.

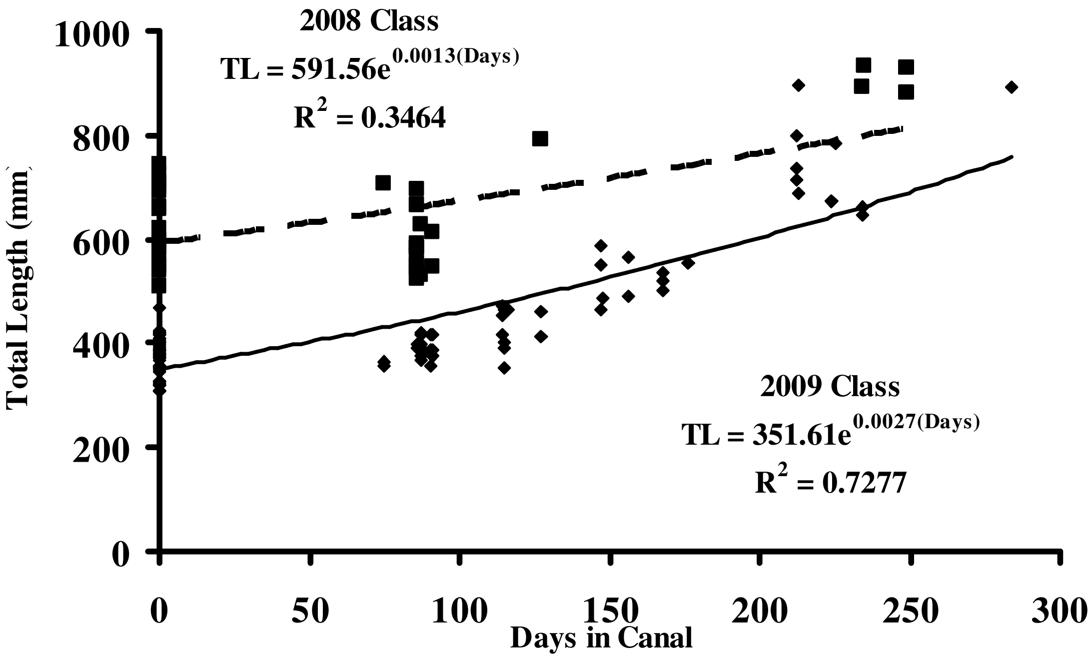

Figure 14. The total length (mm) of each alligator gar stocked in the canal and the total length (mm) for each recaptured alligator gar. Lengths at day zero represent initial stocking lengths. Lines represents a growth rate for alligator gar produced in either 2008 (dashed line, squares) or 2009 (solid line, diamonds).

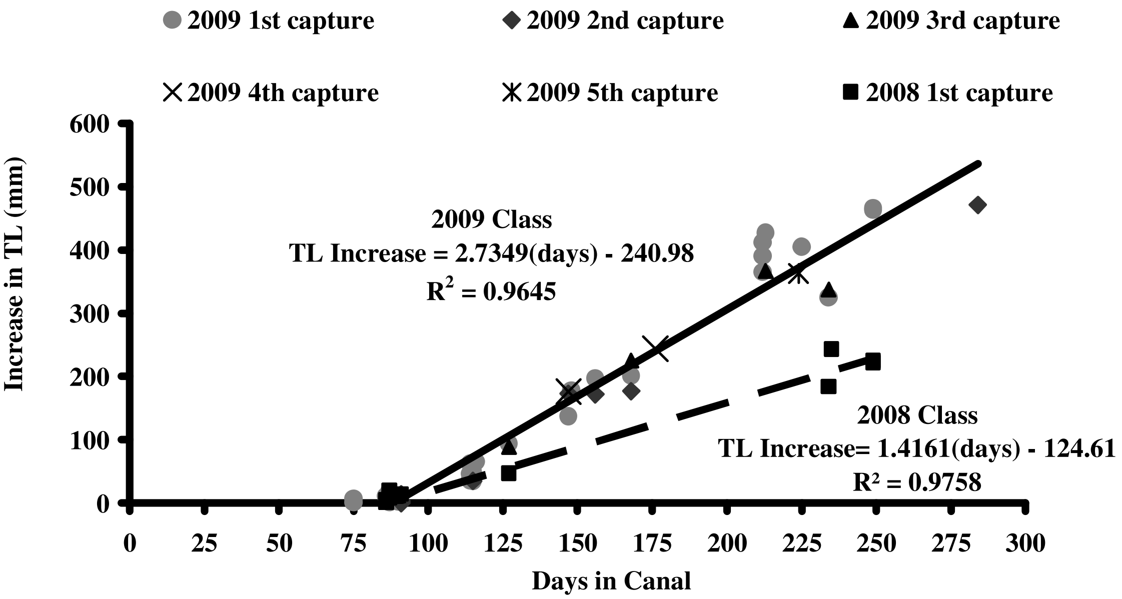

Figure 15. The change in total length since initial stocking date (13 January 2010) for each alligator gar. Lines represents a growth rate for alligator gar produced in either 2008(dashed line) or 2009 (solid line). Symbols represent recapture events.

DISCUSSION

The fish community in the Port Sulphur drainage canal has changed since the rotenone treatments. Besides tilapia, striped mullet *Mugil cephalus*, silversides *Menidia beryllina*, killifish *Fundulus* spp., sailfin mollies *Poecilia latipinna*, and mosquito fish *Gambusia affinis*, were the most abundant fish collected during the rotenone treatments (Melissa Kaintz, LDWF, personal communication). The fish collected in gillnets during this study reflect the species stocked post rotenone treatments. Alligator gar, bullheads, largemouth bass, and warmouths were the most frequently captured fish and except for spotted gar, they were the most abundant species stocked. Although fish species identified in the diets of alligator gar and largemouth bass such as mosquito fish and sailfin mollies were not stocked, they were present in the canal post rotenone treatments. Also, one striped mullet was collected by electrofishing on 18 November 2010, which suggests that the fish species that were in the canal prior to rotenone treatments are returning.

No tilapia were identified as a part of any stomach contents. This could be because the predators did not consume tilapia, tilapia were not a frequent enough diet item to be identified, or tilapia could not be identified due to advanced digestion. Previous studies have described largemouth bass that depleted populations of fish by predation (Childers and Bennett 1967; Bonar et al. 2005). Largemouth bass in Pacific northwest lakes were responsible for 98% of all predation on coho salmon (Bonar et al. 2005). Both largemouth bass and alligator gar are considered opportunistic feeders, consuming the most abundant diet items (Godinho et al. 1997; García de León et al. 2001; Buckmeier 2008). If tilapia were the most abundant prey available in the canal, they probably would have been identified in diets. Although two small tilapia were collected in December 2009, additional tilapia were not found in the canal by electrofishing, gillnets, or trawls until 19 September 2010. After tilapia were found in the canal in 2010, the water temperature in the canal decreased making it difficult to capture fish with gillnets and collect diet samples.

The overall percent of empty stomachs among alligator gar, largemouth bass, and bullheads was 21.8%. This is similar to a diet study in Mississippi where 22.2% of alligator gar stomachs were empty (Goodyear 1967). Howick and O'Brien (1983) generalized that most diet studies on largemouth bass result in approximately 50% empty stomachs. Other studies find that habitat, especially the amount and type of vegetation, affects diets by contributing to prey vulnerability (Stein and Magnuson 1976; Savino and Stein 1982; Dibble and Harrel 1997). Decreased plant cover increases piscivory due to reduced prey refuge (Dibble and Harrel 1997). Low vegetation density in the Port Sulphur drainage canal may have left prey vulnerable resulting in a low percent of empty stomachs in predators.

In this study, diet composition was not similar among predatory fish. The main component of both largemouth bass and alligator gar diets was fish, while bullheads diet was more variable. Although results of this study are typical for the species analyzed, the diets can vary due to geographic location and prey availability (Raney and Webster 1940; Seaburg and Moyle 1964; Keast and Webb 1966; Goodyear 1967). The bullheads in this study consumed prey items from all diet item categories. In another study brown bullhead *Ameriurus nebulosus* diets consisted of 60% Crustacea and 25% Diptera (Raney and Webster 1940). Brown bullheads in Ontario, Canada consumed mainly fish (Moore

1972). Diets of the forty-eight bullheads that underwent gastric lavage in this study contained a total of three crustaceans and nine fish.

Differences in diets between this study and previous studies could be due to differences in prey abundance and habitat (Lewis et al. 1961; Savino and Stein 1982; Dibble and Harrel 1997; Godinho et al. 1997). Diets of largemouth bass feeding in common pondweed *Potamogeton nodosus* were composed of 86% macro invertebrates and 14% fish as opposed to largemouth bass feeding in Eurasain watermilfoil *Myriophyllum spicatum* that had diets composed of 25% macroinvertebrates and 75% fish (Dibble and Harrel 1997). Quantifying the vegetation density in the Port Sulphur canal may help to explain the composition of diet items for each species.

The diet composition of spotted gar acquired by gastric lavage was similar to the total diet composition of spotted gar. Foster (1977) reported similar results showing that stomqachs of sacrificed yellow perch *Perca flavescens*, largemouth bass, pumpkinseed *Lepomis gibbosus*, and white perch *Morone americana* were empty post gastric lavage (Foster 1977). The current study determined the efficiency of gastric lavage through direct quantification of diet items from sacrificed fish. Prey identification becomes increasingly difficult the longer an item remains in the stomach and is digested. After only 60 minutes, 3% of razorback sucker larva *Xyrauchen texanus* fed to green sunfish, bluegills, and yellow bullheads fed in the lab could be identified (Schooley et al. 2008). A majority of diet items remaining in the stomachs of sacrificed spotted gar were unidentifiable items retrieved from the posterior end of the stomach. Using a different method such as comparing weight of remaining diet items may produce higher percent removal efficiency. Light et al. (1983) weighed diet items remaining in the stomachs of brook trout and slimy sculpins post gastric lavage resulting in 98% and 100% removal efficiency, respectively.

It is important to determine the percent mortality and removal efficiency of gastric lavage to perfect a nonlethal technique for diet studies because endangered species, small or sensitive populations, and public relations can benefit from a technique that does not involve sacrificing individuals (Light et al. 1983). Low mortality of fish post gastric lavage has been reported in previous studies (Foster 1977; Light et al. 1983; Hartleb and Moring 1995; Brosse et al. 2002; Hakala and Johnson 2004). Largemouth bass, pumpkinseed, and yellow perch were recaptured with full stomachs after the initial gastric lavage (Hartleb and Moring 1995). No Siberian sturgeons *Acipenser baeri* died during a six week observation period post gastric lavage (Brosse et al. 2002). Although the sample size in this study was too small to determine the mortality rate associated with gastric lavage, raw data and the number of recaptures of alligator gar (N=76) in the canal suggest low mortality rate for this study. After gastric lavage, no spotted gar died during the two week observation period and only 2 largemouth bass died post gastric lavage. Both largemouth bass that died were caught on 9 September 2010 when the water temperature was 28.6°C. Largemouth bass have a better chance for survival after catch and release in colder water temperatures (Plumb et al. 1988). Although no control largemouth bass died, largemouth bass mortalities may have been confounded by the stress of the gillnet collection and transport from Bayou Chevreuil to the recirculating tanks. Hakala and Johnson (2004) reported no difference in mortality among control largemouth bass and largemouth bass 7 days post gastric lavage. A larger sample size in this study may have yielded similar results.

In this study the growth rate of alligator gar produced in 2009 (2.7 mm/day) was faster than the growth rate of alligator gar produced in 2008 (1.4 mm/day). This is typical of many species of fish, such as the yellow bass that grow fastest in the first year of life (Viosca 1943; Schoffman 1958; Edsall 1960; Netsch and Witt 1962). Rapid growth of juvenile fish is critical to survival to avoid predation (Sogard 1992). Long body shape, sedentary lifestyle, and low food conversion factor allow gar to grow faster than other species of fish (Netsch and Witt 1962). The growth rates of the juvenile alligator gar in this study compare to other species of gar. Young-of-the-year longnose gar *Lepisosteus osseus* were observed growing an average of 2.95 mm/day (Netsch and Witt 1962) and juvenile spotted gar range from 1.4-2.1 mm/day (Riggs and Moore 1960).

Determining the growth rates of hatchery-reared fish released into the wild helps to evaluate stocking efforts for managing populations. Many stocking efforts that supplement depleted wild populations result in poor survival of stocked species due to increases in susceptibility to predation or competition with established populations for food and habitats (Reimers 1979; Hume and Parkinson 1988; Bates and McKeown 2003). This study provides the first growth rates of hatchery reared juvenile alligator gar released into the wild. Growth rate data of alligator gar stocked in the Port Sulphur drainage canal can be referenced when stocking alligator gar to replenish wild populations that are depleted due to habitat loss and overfishing (Buckmeier 2008; Mendoza et al. 2008). Hatchery reared alligator gar that were released as young-of-the-year and 1+ year successfully survived and grew when stocked into the drainage canal.

Diet studies explain part of the basic biology of fish and in this case attempt to determine if a certain fish species is an effective biocontrol. High numbers of fish considered to be top predators were stocked in the Port Sulphur canal as a biocontrol for remnant tilapia. Even though no tilapia were identified in the diets, fish was the dominant diet item in largemouth bass and alligator gar. Alligator gar and largemouth bass are beneficial to stock because of their different life histories. Largemouth bass mature at a younger age than alligator gar allowing the population of largemouth bass to thrive and different life stages of largemouth bass to consume different sized tilapia. Alligator gar are long lived and grow to a larger size which requires consumption of a lot of prey.

LITERATURE CITED

Ackerman, J. L. and D. R. Bellwood. 2000. Reef fish assemblages: a re-evaluation using enclosed rotenone stations. Marine Ecology Progress Series 206:227-237.

Bates, D. J. and B. A. McKeown. 2003. Growth in stream-stocked juvenile hatchery-reared coastal cutthroat trout (*Oncorhynchus clarki clarki*) and the implications for wild populations. Aquaculture 222:215-228.

Bonar, S. A., B. D. Bolding, M. Divens, and W. Meyer. 2005. Effects of introduced fishes on wild juvenile Coho salmon in three shallow Pacific Northwest lakes. Transactions of the American Fisheries Society 134:641-652.

Brooks, W. R. and R. C. Jordan. 2010. Enhanced interspecific territoriality and the invasion success of the spotted tilapia (*Tilapia mariae*) in south Florida. Biological Invasions 12:865-874.

Brosse, L., P. Dumont, M. Lepage, and E. Rochard. 2002. Evaluation of a gastric lavage method for sturgeons. North American Journal of Fisheries Management 22:955-960.

Buckmeier, D. L. 2008. Life history and status of alligator gar *Atractosteus spatula*, with recommendations for management. Heart of the Hills Fisheries Science Center, Texas Parks and Wildlife Department, Inland Fisheries Division. pp.1-13.

Canonico, G. C., A. Arthington, J. K. McCrary, and M. L. Thieme. 2005. The effect of introduced tilapias on native biodiversity. Aquatic Conservation: Marine Freshwater Ecosystems 15:463-483.

Carter, J., A. L. Foote, and A. J. Johnson-Randall. 1999. Modeling the effects of nutria (*Mycocaster coypus*) on wetland loss. Wetlands 19(1):209-219.

Casal, C. M. V. 2006. Global documentation of fish introductions: the growing crisis and recommendations for action. Biological Invasions 8:3-11.

Center, T. D. and M. P. Hill. 2002. Field efficacy and predicted host range of the pickerelweed borer, *Bellura densa*, a potential biological control agent of water hyacinth. BioControl 47:231-243.

Chadderton, L., S. Kelleher, A. Brow, T. Shaw, B. Studholme, and R. Barrier. 2003. Testing the efficacy of rotenone as a piscicide for New Zealand pest fish species *in*: Managing Invasive Freshwater Fish in New Zealand. Proceedings of a workshop hosted by the Department of Conservation, 10-12 May 2001 in Hamilton. Department of Conservation, Hamilton, New Zealand.

Chandler Jr., J. H. and L. L. Marking. 1982. Toxicity of rotenone to selected aquatic invertebrates and frog larvae. The Progressive Fish-Culturist. 44(2):78-80.

Charo-Karisa, H., M. A. Rezk, H. Bovenhuis, H. Komen. 2005. Heritability of cold tolerance in Nile tilapia, *Oreochromis niloticus*, juveniles. Aquaculture 249:115-123.

Childers, W. F. and G. W. Bennett. 1967. Experimental vegetation control by largemouth bass-tilapia combinations. Journal of Wildlife Management 31(3):401-407.

Clay, T. A. 2009. Growth, survival, and cannibalism rates of alligator gar *Atractosteus spatula* in recirculating aquaculture systems. Thesis. Nicholls State University, Thibodaux, Louisiana.

Conner, W. H. and J. R. Toliver. 1987.The problem of planting Louisiana swamplands when nutria (*Mycocastor coypu*) are present. Eastern Wildlife Damage Control Conferences Third Eastern Wildlife Damage Control Conference. University of Nebraska-Lincoln pp.42-29.

Conner, W. H. and J. R. Toliver. 1990. Long-term trends in bald-cypress (*Taxodium distichum*) resource in Louisiana (U.S.A.). Forest Ecology and Management 33/34:543-557.

Coward, K. and N. R. Bromage. 2000. Reproductive physiology of female tilapia broodstock. Reviews in Fish Biology and Fisheries 10:1-25.

Coward, K. and D. Little. 2001. Culture of the "aquatic chicken": present concerns and future prospects. Biologist 48:12-16.

Dibble, E. C. and S. L. Harrel. 1997. Largemouth bass diets in two aquatic plant communities. Journal of Aquatic Plant Management 35:74-78.

Echelle, A. A. and C. D. Riggs. 1972. Aspects of the early life history of gars (*Lepisosteus*) in Lake Texoma. Transactions of the American Fisheries Society 101:106-112.

Edsall, T. A. 1960. Age and growth of the whitefish, *Coregonus clupeaformis*, of Munising Bay, Lake Superior. Transactions of the American Fisheries Society 89(4):323-332.

Ernster, L., G. Dallner, and G. F. Azzone. 1963. Differential effects of rotenone and amytal on mitochondrial electron and energy transfer. The Journal of Biological Chemistry 238(3):1124-1131.

Ferrara, A. M. 2001. Life-history strategy of Lepisosteidae: implications for the conservation and management of alligator gar. Doctoral dissertation. Auburn University, Alabama.

Fessler, F. R. 1950. Fish populations in some Iowa farm ponds: A survey based upon two methods of population analysis. The Progressive Fish-Culturist 12(1):3-11.

Foster, J. R. 1977. Pulsed gastric lavage: an efficient method of removing the stomach contents of live fish. The Progressive Fish-Culturist 39(4):166-169.

Fukami, J., T. Shishido, K. Fukunaga, and J. E. Casida. 1969. Oxidative metabolism of rotenone in mammals, fish, and insects, and its relation to selective toxicity. Journal of Agriculture and Food Chemistry 17(6): 1217-1226.

García de León, F. J., L. González-García, J. M. Herrera-Castillo, K. O. Winemiller, and A. Banda-Valdés. 2001. Ecology of the alligator gar, *Atractosteus spatula*, in the Vincente Guerrero Reservoir, Tamaulipas, México. The Southwest Naturalist 46(2):151-157.

Godinho, F. N., M. T. Ferreira, and R. V. Cortes. 1997. The environmental basis of diet variation in pumpkinseed sunfish, *Lepomis gibbosus,* and largemouth bass, *Micropterus salmoides*, along an Iberian river basin. Environmental Biology of Fishes 50:105-115.

Goodyear, C. P., 1967. Feeding habits of three species of gars, *Lepisosteus*, along the Mississippi gulf coast. Transactions of the American Fisheries Society 96:297-300.

Hakala, J. P. and F. D. Johnson. 2004. Evaluation of a gastric lavage method for use on largemouth bass. North American Journal of Fisheries Management 24:1398-1403.

Hatherly, I. S., A. J. Hart, A. G. Tullett, and J. S. Bale. 2005. Use of thermal data as a screen for the establishment potential of non-native biological control agents in the UK. BioControl 50:687-698.

Hartleb, C. F. and J. R. Moring. 1995. An improved gastric lavage device for removing stomach contents from live fish. Fisheries Research 24:261-265.

Howick, G. L. and W. J. O'Brien. 1983. Piscivorous feeding behavior of largemouth bass: An experimental analysis. Transactions of the American Fisheries Society 112:508-516.

Hume J. M. B. and E. A. Parkinson. 1988. Effects of size and time of release on the survival and growth of steelhead fry stocked in streams. North American Journal of Fisheries Management 8:50-57.

Keast, A. and D. Webb. 1966. Mouth and body form relative to feeding ecology in the fish fauna of a small lake, Lake Opinicon Ontario. Journal of the Fisheries Research Board of Canada 33:1945-1974.

Khan, M. F. and P. Panikkar. 2009. Assessment of impacts of invasive fishes on the food web structure and ecosystem properties of a tropical reservoir in India. Ecological Modeling 220:2281-2290.

King, R. P. and L. Etim. 2004. Reproduction, growth, mortality and yield of *Tilapia mariae* Boulenger 1899 (Cichlidae) in a Nigerian rainforest wetland stream. Journal of Applied Ichthyology 20: 502-510.

Komolafe, O. O. and G. A. O. Arawomo. 2007. Reproductive strategy of *Oreochromis niloticus* (Pisces: Cichlidae) in Opa reservoir, Ile-Ife, Nigeria. Revista de Biología Tropical International Journal of Tropical Biology and Conservation 55(2): 595-602.

Legner, E. F. 1978. Mass culture of *Tilapia zillii* (Cichlidae) in pond ecosystems. Entomophaga 23(1):51-55.

Lewis, W. M., G. E. Gunning, E. Lyles, and W. L. Bridges. 1961. Food choice of largemouth bass as a function of availability and vulnerability of food items. Transactions of the American Fisheries Society 90:277-280.

Light, R. W., P. H. Adler, and D. E. Arnold. 1983. Evaluation of gastric lavage for stomach analyses. North American Journal of Fisheries Management 3:81-85.

McKaye, K. R., J. D. Ryan, J. R. Stauffer Jr., L. J. Lopez Perez, G. I. Vega, and E. P. van den Berghe. 1995. African tilapia in Lake Nicaragua. Bioscience 45(6):406-411.

McMahon, T. E. and S. H. Holanov. 1995. Foraging success of largemouth bass at different light intensities: implications for time and depth of feeding. Journal of Fish Biology 46:759-767.

Mendoza, R., C. Aquilera, and A. M. Ferrara. 2008. Gar biology and culture: status and prospects. Aquaculture Research 39:748-763.

Meyerson, L. A. and H. A. Mooney. 2007. Invasive alien speices in an era of globalization. Frontiers in Ecology and the Environment 5(4):199-208.

Moore, J. W. 1972. Piscivorous activities of brown bullheads in Lockhart Pond, Ontario, Canada. The Progressive Fish-Culturist 34(3):141-142.

Moyle, P. B. and M. P. Marchetti. 2006. Predicting invasion success: freshwater fishes in California as a model. Bioscience 56(6):515-524.

Nanda, N. B. P., P. C. Das, and J. Jena. 2009. Use of rotenone as piscicide: toxicity levels in a few common freshwater predatory and weed fishes. Journal of Applied Aquaculture 21:241-249.

Netsch, N. F. and A. Witt Jr. 1962. Contributions to the life history of the longnose gar (*Lepisosteus osseus*) in Missouri. Transactions of the American Fisheries Society 91:251-262.

O'Connell, M. T., T. D. Shepherd, A. M. U. O'Connell, and R. A. Myers. 2007. Long-term declines in two apex predators, bull sharks (*Carcharhinus leucas*) and alligator gar (*Atractosteus spatula*), in Lake Pontchartrain, and oligohaline estuary in southern Louisiana. Estuaries and Coasts 30(4):567-574.

Ostrand, K.G., B. J. Braeutigam, and D. H. Wahl. 2004. Consequences of vegetation density and prey species on spotted gar foraging. Transactions of the American Fisheries Society 133:794-800.

Penfound, W.T. and T.T. Earle. 1948. The biology of the water hyacinth. Ecological Monographs 18:448-472.

Peterson, M. S., W. T. Slack, and C.M. Woodley. 2005. The occurrence of non-indigenous Nile tilapia, *Oreochromis niloticus* (Linnaeus) in coastal Mississippi, USA: Ties to aquaculture and thermal effluent. Wetlands 25(1):112-121.

Pimentel, D., R. Zuniga, and D. Morrison. 2005. Update on the environmental and economic costs associated with alien-invasive species in the United States. Ecological Economics 52:273-288.

Plumb, J. A., J. M. Grizzle, and W. A. Rogers. 1988. Survival of caught and released largemouth bass after containment in live wells. North American Journal of Fisheries Management 8:325-328.

Raney, E. C. and D. A. Webster. 1940. The food and growth of the young of the common bullhead, *Ameiurus nebulosus nebulosus* (LeSueur), in Cayuga Lake, New York. Transactions of the American Fisheries Society 69:205-209.

Reimers, P. E. 1979. Success in a hatchery program with fall Chinook salmon by simulating the natural life history of the stock. The Progressive Fish-Culturist 41(4):192-195.

Rickett, J. D. 1976. Growth and reproduction of largemouth bass and black bullheads cultured together. The Progressive Fish-Culturist 38(2):82-85.

Riggs, C. D. and G. A. Moore. 1960. Growth of young gar (Lepisosteus) in aquaria. Proceedings of the Oklahoma Academy of Science for 1959 40:44-46.

Robertson, D. R. and W. F. Smith-Vaniz. 2008. Rotenone: an essential but demonized tool for assessing marine fish diversity. BioScience 58(2):165-170.

Robinson, H. W. and T. M. Buchanan. 1988. Fishes of Arkansas. University of Arkansas Press, Fayetteville, Ankansas.

Roy, H. and E. Wajnberg. 2008. From biological control to invasion: the ladybird *Harmonia axyridis* as a model species. BioControl 53:1-4.

Savino, J. F., and R. A. Stein. 1982. Predator-prey interaction between largemouth bass and bluegills as influenced by simulated, submersed vegetation. Transactions of the American Fisheries Society 111:255-266.

Schofield, P. J., W. F. Loftus, R. M. Kobza, M. I. Cook, and D. H. Slone. 2010. Tolerance of nonindigenous cichlid fishes (*Cichlasoma urophthalmus*, *Hemichromis letourneuxi*) to low temperature: laboratory and field experiments in south Florida. Biological Invasivions 12:2441-2457.

Schoffman, R. J. 1958. Age and rate of growth of the yellow bass in Reelfoot Lake, Tennessee for 1955 and 1957. Journal of the Tennessee Academy of Science 33(1):101-105.

Schooley, J. D., A. P. Karam, B. R. Kesner, P. C. Marsh, C. A. Pacey, and D. J. Thornbrugh. 2008. Detection of larval remains after consumption by fishes. Transactions of the American Fisheries Society 137:1044-1049.

Seaburg, K. G. and J. B. Moyle. 1964. Feeding habits, digestive rates, and growth of some Minnesota warmwater fishes. Transactions of the American Fisheries Society 93(3):269-285.

Smith, O. 2008. Reproductive potential and life history of spotted gar *Lepisosteus oculatus* in the upper Barataria Estuary. Thesis. Nicholls State University, Thibodaux, Louisiana.

Sogard, S. M. 1992. Variability in growth rates of juvenile fishes in different estuarine habitats. Marine Ecology Progress Series 85:35-53.

Stanton, L. E. 2005. The establishment, expansion and ecosystem effects of *Phragmites australis* an invasive species in coastal Louisiana. Doctoral Dissertation. Louisiana State Univeristy, Baton Rouge, Louisiana.

Stauffer, J. R. Jr., S.E. Boltz, and J.M. Boltz. 1988. Cold shock susceptibility of blue tilapia from the Susquehanna River, Pennsylvania. North American Journal of Fisheries Management 8:329-332.

Stein, R. A. and J. J. Magnuson. 1976. Behavioral response of crayfish to a fish predator. Ecology 57:751-761.

Stone, C. C. and T. Modde. 1982. Growth and survival of largemouth bass in newly stocked South Dakota ponds. North American Journal of Fisheries Management 4:326-333.

Trewavas, E. 1982. Genetic groupings of Tilapiini used in aquaculture. Aquaculture 27(1):79-81.

Viosca, P. Jr. 1943. Phenomenal growth rates of largemouth black bass in Louisiana waters. Transactions of the American Fisheries Society 72:68-71.

Vitousek, P. M., C. M. D'Antonio, L. L. Loope, and R. Westbrooks. 1996. Biological invasions as global environmental change. American Scientist 84(5):468-479.

Vromant, N., A. J. Rothuis, N. T. T. Cuc, and F. Ollevier. 1998. The effect of fish abundance of the rice caseworm *Nymphula depunctalis* (Guenée) (Lepidoptera: Pyralidae) in direct seeded, concurrent rice-fish fields. Biocontrol Science and Technology 8:539-546.

Vromant, N., D. K. Khan, N. T. H. Chau, and F. Ollevier. 2002. Can fish control planthopper and leafhopper populations in intensive rice culture? Biocontrol Science and Technology 12: 695-703.

Watanabe, W. O. and C. Kuo. 1985. Observations on the reproductive performance of Nile tilapia (*Oreochromis niloticus*) in laboratory aquaria at various salinities. Aquaculture 49:315-323.

Zambrano, L., E. Martinez-Meyer, N. Menezes, and A. T. Peterson. 2006. Invasive potential of common carp (*Cyprinus carpio*) and Nile tilapia (*Oreochromis niloticus*) in American freshwater systems. Canadian Journal of Aquatic Science. 63:1903-1910.

Appendix I. The identification numbers, total length (TL; mm), weight (WT; kg), and year class of the alligator gar stocked in the Port Sulphur drainage canal. The year classes of adult alligator gar were unknown.

PIT-tag	T-bar tag	TL (mm)	WT (kg)	Year
470C4D424F	2635	1315	15.5	Adult
470C5040SB	1761	985	6	Adult
467B7D6DSF	2100	1325	14.5	Adult
464C762032	1762	1140	12	Adult
4804347AOE	2634	1040	6.5	Adult
470C56216A	1636	1240	12	Adult
470A3C6673	2632	1245	14.5	Adult
470D25395F	1754	1130	11.5	Adult
470AZA7EHC	1764	1150	10.5	Adult
467C12727B	1768	1130	9	Adult
467B74713E	1763	1225	12.5	Adult
467BSE1274	1765	1465	23	Adult
4709691445	2070	995	6.5	Adult
470C3D3372	2069	975	6	Adult
47OA4C2C62	1770	995	6.5	Adult
4AOB1A423B	2633	1335	20	Adult
467D140167	1753	1310	17	Adult
4A73536606	2631	815	4	Adult
4A75035247	2665	702	2.0	2008
4B02601602	2132	555	0.9	2008
467C6D4F4B	2621	645	1.5	2008
467C386638	2646	590	1.0	2008
4A73536432	2130	578	1.1	2008
4A0B28364B	2696	660	1.6	2008
467D0B5233	2623	745	2.3	2008
4A0B6D563A	2312	550	0.8	2008
4A0C240F35	2319	605	1.0	2008
4A0C1B5E42	2659	670	1.5	2008
4B032B7D08	2639	625	1.3	2008
4A0A774448	2611	534	0.9	2008
4B033A1C29	2090	524	0.9	2008
4B1A672967	2135	595	1.1	2008
4A0B280149	2638	742	2.2	2008
4B04224D79	2139	617	1.3	2008
4A7323035F	2126	585	1.1	2008
4A7178425B	2149	558	1.0	2008
4A0C1B221A	2618	613	1.5	2008

PIT-tag	T-bar tag	TL (mm)	WT (kg)	Year
4A0A674507	2604	776	2.8	2008
4A0B2D0917	2146	606	1.2	2008
4A0B0E5011	2694	532	0.8	2008
4A73460212	2655	602	1.2	2008
4B1A6C181D	2302	541	1.0	2008
4A0C114C38	2301	565	1.2	2008
4A0A672802	2150	659	1.7	2008
4B04131557	2642	668	1.9	2008
4A0C160256	2321	546	1.0	2008
4A0B2C1F53	2096	515	0.8	2008
4B1B0E1C72	2314	601	1.2	2008
4A0B1D6364	2323	648	1.7	2008
4A732B3824	2325	502	0.7	2008
467C507B18	2647	583	1.0	2008
4B19154A64	2637	600	1.3	2008
4A720F3D62	2125	620	1.5	2008
4A0C2254083	2684	560	1.0	2008
4B1A716537	2700	530	1.0	2008
470A56385A	2648	700	2.0	2008
A4720E2154	2644	620	1.5	2008
4A0B03660D	2687	640	1.5	2008
4A0A783C22	2322	510	0.9	2008
4A0C123304	2681	640	1.5	2008
4A0B21202A	2607	550	1.0	2008
467C627F1E	2650	700	2.0	2008
4A720E746A	2148	600	1.7	2008
4B1A6D0031	2324	530	1.0	2008
4A73502D5D	2147	620	1.4	2008
4B1B0C4C12	2095	560	1.0	2008
4B1A687C71	2140	650	1.5	2008
4B1A7A3F14	2307	620	1.4	2008
4A0B0E1F23	2128	650	1.6	2008
4A72027B7A	2645	690	1.7	2008
4A0C143E10	2601	670	1.6	2008
4A0A761E29	2679	690	1.6	2008
4A730F691B	2229	490	0.6	2008
470C557613	2624	680	1.6	2008

PIT-tag	T-bar tag	TL (mm)	WT (kg)	Year
4B0415462C	2678	700	1.9	2008
4A720A591A	2078	750	2.6	2008
4A0B0D3636	2310	600	1.0	2008
470A583020	2622	690	2.4	2008
4A734A6C5B	2633	580	1.0	2008
4A0B0C0A03	2693	560	1.8	2008
4A0C192744	2138	550	1.0	2008
470D0D0007	2625	590	1.7	2008
4B1B050E1C	2641	610	1.3	2008
4B1A711B29	2247	530	1.0	2008
4A0B2F7E79	2236	560	1.3	2008
470A670319	2649	710	2.1	2008
4B0324343C	2643	570	1.1	2008
4B0409450C	2580	560	1.1	2008
4A73142C13	2664	570	1.0	2008
4A0B746D39	2235	630	1.5	2008
4A732B2B4D	2636	650	1.4	2008
4A0B163173	2304	630	1.9	2008
4A0B21233D	2127	540	0.9	2008
4A0A7F4126	2089	730	2.7	2008
4A0C227225	2629	570	1.1	2008
4A0B2B3E0C	2691	550	0.9	2008
4A0B34372D	2378	662	1.7	2008
4A0A636F7A	2379	641	1.4	2008
4A7310045A	2380	754	2.6	2008
4B032D0A64	2381	748	2.5	2008
4A0B2E262C	2382	585	1.2	2008
4A0C230F4A	2383	655	1.8	2008
4A0A7D3F2D	2384	618	1.4	2008
4A0B0A0523	2385	608	1.4	2008
4A0A7E352C	2386	599	1.3	2008
4A0B1D2E62	2387	595	1.1	2008
4A0C144A0E	2388	591	1.2	2008
4B04192A51	2389	658	1.8	2008
4B0A24271A	3290	621	1.4	2008
4B0403736F	2391	648	1.8	2008
4B1B026D0E	2392	652	1.6	2008
4A0C1D4A4D	2393	658	1.6	2008

PIT-tag	T-bar tag	TL (mm)	WT (kg)	Year
4A0A72061D	2394	612	1.3	2008
4B03364724	2395	576	1.2	2008
4A73465D5E	2396	640	1.6	2008
4A751E075A	2397	581	0.9	2008
4B1B105D78	2398	553	0.9	2008
4A0B02216D	2399	622	1.4	2008
4A0A6C301E	2400	682	2.0	2008
4A0A7F641C	2501	732	2.5	2008
4B03326E4E	2502	631	1.6	2008
4B1B014D73	2503	667	1.8	2008
4A0A696A73	2504	725	2.3	2008
4A751B442C	2505	482	1.1	2008
4B0270020A	2506	775	3.0	2008
4A75062C33	2507	650	1.8	2008
4A0C1D632B	2508	609	1.4	2008
4A716D0B33	2509	675	2.1	2008
4A74035223	2510	661	1.8	2008
4B1B417633	2511	575	1.2	2008
4A0A761578	2512	605	1.4	2008
4A73127946	2513	705	2.0	2008
4A06115A68	2514	658	1.8	2008
4B1B026F3A	2515	555	1.1	2008
4B03273E3D	2516	661	1.1	2008
4A75112545	2517	685	2.0	2008
4A0B27311C	2518	572	1.1	2008
4A0A6C613A	2519	785	2.8	2008
4B0340072C	2520	661	1.7	2008
4A0B375433	2521	645	1.7	2008
4A0B193A0A	2522	696	2.1	2008
4A0B730E2B	2523	709	2.2	2008
4B0273716A	2524	610	1.5	2008
4B1B196734	2525	619	1.5	2008
4A0C141F30	2002	596	1.3	2008
4B02703277	2003	610	1.4	2008
4B02350047	2005	615	1.4	2008
4B024C0F55	2006	743	2.3	2008
4A0C10477D	2007	584	1.3	2008

PIT-tag	T-bar tag	TL (mm)	WT (kg)	Year
4A0C142125	2008	641	1.4	2008
4A0C207076	2009	599	1.4	2008
470A785961	2010	688	1.8	2008
4A0C222D69	2011	660	1.8	2008
4A0C15314F	2012	632	1.6	2008
4A0C200917	2014	575	1.2	2008
4A0B202B6F	2016	728	2.4	2008
4B18721A0E	2640	628	1.5	2008
4A0B737922	2017	663	1.9	2008
4A716E0A63	2018	685	1.9	2008
4A0C136F4B	2019	611	1.4	2008
4A0A791F22	2020	612	1.2	2008
4A737E3154	2021	644	1.7	2008
4A0B2B513D	2022	685	2.1	2008
4A0C11501A	2023	628	1.5	2008
4B1A69295B	2024	662	1.8	2008
4B02735B1B	2025	614	1.4	2008
4A0C1F6E33	2201	625	1.3	2008
4A73557958	2202	598	1.0	2008
4B1B091C0D	2203	597	1.1	2008
4A71787F59	2204	545	0.9	2008
4A7505585E	2205	634	1.4	2008
4B03276C0E	2206	630	1.4	2008
4A0B1E1230	2207	545	1.0	2008
4A0A7C2D73	2208	576	1.0	2008
4A3236A40	2209	649	1.6	2008
4A0C1C5930	2210	771	2.9	2008
4A0B227A2C	2211	582	1.1	2008
4B19172532	.	419	0.27	2009
4A0B323D34	.	390	0.23	2009
4A0B7D3E6A	.	395	0.27	2009
4A0B267E3A	.	354	0.18	2009
4B1A6B6214	.	402	0.31	2009
4B02414606	.	381	0.23	2009
4A0A674329	.	355	0.21	2009
4B02601949	.	321	0.17	2009
4B026F5E15	.	316	0.12	2009
not recorded	.	326	0.15	2009

PIT-tag	T-bar tag	TL (mm)	WT (kg)	Year
4A740A421E	.	354	0.18	2009
4A0C142232	.	326	0.14	2009
4B031A4C39	.	365	0.20	2009
4B19174A03	.	392	0.27	2009
4A7162661E	.	356	0.20	2009
4A0B1B3712	.	398	0.29	2009
4B04157839	.	384	0.24	2009
4A7521624A	.	361	0.18	2009
4A0B35292F	.	409	0.30	2009
4A0C1F1C03	.	371	0.21	2009
4B19084116	.	367	0.22	2009
4B19160D63	.	369	0.22	2009
4A0C1B6811	.	360	0.19	2009
4A0B00510E	.	354	0.17	2009
4A73040C7C	.	359	0.22	2009
4A0C1C1A53	.	380	0.24	2009
4A71720B77	.	390	0.25	2009
4A0B2F563C	.	380	0.24	2009
4A0B215517	.	470	0.51	2009
4A71543B76	.	340	0.20	2009
4B030C3D19	.	358	0.23	2009
4A0B2F7011	.	364	0.18	2009
4B1A657375	.	310	0.16	2009
4A0B1D5319	.	344	0.17	2009
4A0C23636C	.	428	0.34	2009
4A73404323	.	399	0.30	2009
4A0B7B3473	.	360	0.19	2009
4A0C22190E	.	364	0.21	2009
4B02453020	.	335	0.17	2009
4A73097766	.	346	0.19	2009
470C32192B	.	385	0.28	2009
4709695608	.	370	0.21	2009
470C7A5A73	.	416	0.30	2009
467D1A0462	.	319	0.15	2009
467D10650B	.	379	0.25	2009
470A597A3F	.	365	0.23	2009
467C044035	.	385	0.28	2009
467C176E41	.	373	0.24	2009

PIT-tag	T-bar tag	TL (mm)	WT (kg)	Year
467D01316E	.	409	0.29	2009
467B7A3442	.	357	0.19	2009
467C611446	.	333	0.14	2009
467C2A3B4B	.	416	0.30	2009
467C277E44	.	350	0.19	2009
467C6D591B	.	410	0.27	2009
467C2C346B	.	374	0.23	2009
467C37432A	.	373	0.25	2009
470C577D25	.	355	0.19	2009
467C7F2914	.	360	0.20	2009
467C52233E	.	410	0.30	2009
47096B2803	.	380	0.24	2009
467C1E5A65	.	376	0.23	2009
467C547748	.	356	0.18	2009
470A48127B	.	336	0.15	2009
467C1B4A03	.	385	0.25	2009
470C2B7B4A	.	325	0.13	2009
47096A186A	.	395	0.24	2009
470C774030	.	378	0.23	2009
467C477C06	.	364	0.20	2009
470A037E18	.	356	0.20	2009
470C382419	.	399	0.27	2009
467D00405D	.	385	0.23	2009
470A422002	.	384	0.26	2009
470A29775A	.	377	0.25	2009
470C414103	.	345	0.17	2009
467C78723D	.	357	0.17	2009
467C120746	.	371	0.23	2009
467B7E1811	.	380	0.27	2009
467C6A2843	.	350	0.19	2009
467C2A5DIF	.	323	0.15	2009
47096B6F77	.	364	0.19	2009
467C7F1701	.	368	0.23	2009
470A4D4F1B	.	400	0.29	2009
467C6C1013	.	365	0.23	2009
467C7B1060	.	339	0.17	2009
470C5A7970	.	332	0.15	2009
470A4B5B14	.	336	0.17	2009

PIT-tag	T-bar tag	TL (mm)	WT (kg)	Year
467C705F16	.	319	0.17	2009
4709723137	.	390	0.28	2009
470C58396E	.	417	0.36	2009
470D066443	.	354	0.20	2009
470C1C7377	.	390	0.28	2009
470C213171	.	320	0.14	2009
470D487543	.	399	0.24	2009
467C164424	.	412	0.30	2009
470A4C0427	.	341	0.18	2009
467C391232	.	390	0.24	2009
4A742C6176	.	410	0.28	2009
4A0C230964	.	360	0.19	2009
4B04260469	.	388	0.26	2009
AB02324667	.	377	0.24	2009
4A0A69215B	.	348	0.19	2009
4A0C1C7678	.	351	0.17	2009
4A0A75461B	.	327	0.16	2009
4A0C11730E	.	392	0.25	2009
4A733BOB22	.	372	0.22	2009
4A0C123409	.	342	0.16	2009
4A732D5469	.	386	0.23	2009
4B1AGC134C	.	379	0.24	2009
4A717D3F38	.	386	0.24	2009
4B03435C09	.	380	0.21	2009
4A0C20684E	.	425	0.32	2009
4A0A654059	.	371	0.22	2009
4B187D710D	.	423	0.32	2009
4A0C240773	.	441	0.33	2009
4A7337233C	.	358	0.18	2009
4A0A7F3122	.	349	0.16	2009
4A72076457	.	401	0.29	2009
4A0C1C2568	.	406	0.25	2009
4A0B196A0D	.	423	0.29	2009
4A0B5E513F	.	365	0.20	2009
4A730F5A71	.	387	0.23	2009
4A7343374E	.	416	0.33	2009
4A0B764B73	.	375	0.22	2009
4A0B73557D	.	403	0.28	2009

PIT-tag	T-bar tag	TL (mm)	WT (kg)	Year
4B18730E7E	.	355	0.19	2009
4B1A742E75	.	453	0.40	2009
4A737C1855	.	420	0.30	2009
4A7508602A	.	376	0.23	2009
4A0A6E762E	.	366	0.21	2009
4A0C017A07	.	373	0.25	2009
4A0C1F0A53	.	322	0.15	2009
4A0A657F6F	.	350	0.19	2009
4A0B757D53	.	339	0.16	2009
4A0B363A35	.	383	0.27	2009
4A0B300934	.	398	0.15	2009
4A0B221107	.	422	0.32	2009
4A0C243C5F	.	373	0.24	2009
4A0B374174	.	363	0.21	2009
4B1B141246	.	380	0.22	2009
4A750E5C60	.	323	0.16	2009
4B1B105233	.	355	0.18	2009
4B03214B6B	.	375	0.22	2009
4A0C213635	.	412	0.31	2009
4A736D271B	.	372	0.24	2009
4A0B18540C	.	330	0.15	2009
4B187A2810	.	347	0.17	2009
4A0C182269	.	383	0.25	2009
4A0B755B7E	.	387	0.26	2009
4B1A697423	.	370	0.21	2009
4A0B1C522E	.	410	0.30	2009
4A0B7C5C30	.	372	0.20	2009
4A73505F6D	.	335	0.16	2009
4B032F2D03	.	369	0.19	2009
4B031B3362	.	396	0.30	2009
A4A0A6C401A	.	407	0.29	2009
4B1A710963	.	361	0.22	2009
4A0B197316	.	350	0.18	2009
4A0B36666E	.	348	0.18	2009
4A731D6075	.	398	0.28	2009
4A717E3846	.	370	0.23	2009
4A7343666A	.	398	0.29	2009
4B0320775E	.	373	0.21	2009

PIT-tag	**T-bar tag**	**TL (mm)**	**WT (kg)**	**Year**
4A0C1B6E3F	.	334	0.18	2009
4A0A6E324D	.	401	0.28	2009
4B1B127479	.	383	0.22	2009
4A0B046D23	.	354	0.18	2009
4B0321111E	.	388	0.25	2009
4B0420655B	.	398	0.30	2009
4B04003C2E	.	419	0.31	2009
4A0C150306	.	394	0.27	2009
4A0B27566B	.	332	0.16	2009
4A73105801	.	352	0.18	2009
4A0B021033	.	343	0.17	2009
4B04000B53	.	368	0.17	2009
4A71492460	.	364	0.20	2009
4A0B0C412B	.	395	0.26	2009
4B031D322A	.	369	0.21	2009
4A0C13370A	.	370	0.23	2009
4A0A7D5F57	.	344	0.19	2009
4A0C1D1735	.	382	0.28	2009
4A0B210A5B	.	440	0.36	2009
4A73564324	.	376	0.23	2009
4A0B7D791E	.	362	0.19	2009

Appendix II. The salinity (ppt) and temperature (ºC) during each sample period. AM indicates a sunrise sample and PM denotes a sunset samples.

Date	Time	Temp	Sal
29-Mar-10	AM	19	2.1
8-Apr-10	PM	24.9	2.9
9-Apr-10	AM	20.5	2.3
9-Apr-10	PM	.	.
10-Apr-10	AM	21.1	2.4
10-Apr-10	PM	24	2.4
11-Apr-10	AM	20.8	2.4
13-Apr-10	PM	26.1	2.5
14-Apr-10	AM	22.2	2.5
14-Apr-10	PM	24.8	2.6
15-Apr-10	AM	21.7	2.6
7-May-10	PM	33	3
8-May-10	AM	27.7	3.1
8-May-10	PM	31.4	3
9-May-10	AM	25.2	3
9-May-10	PM	28.6	3.1
10-May-10	AM	24.4	3.1
19-May-10	PM	31.6	2.4
20-May-10	AM	27.9	2.5
20-May-10	PM	30.4	2.5
21-May-10	AM	28	2.6
9-Jun-10	PM	32.9	2.8
10-Jun-10	AM	30.2	2.9
10-Jun-10	PM	35.6	2.8
18-Jun-10	PM	33.8	3.1
19-Jun-10	AM	30.6	3.1
19-Jun-10	PM	33.1	3.1
29-Jun-10	PM	30.9	2.8
30-Jun-10	AM	28.7	2.9
30-Jun-10	PM	28.3	2.1
7-Jul-10	PM	31.3	2.4
8-Jul-10	AM	29.3	2.5
8-Jul-10	PM	34.2	2.5
12-Aug-10	PM	29	1
13-Aug-10	AM	28.3	1.5
14-Aug-10	PM	32.5	1
15-Aug-10	AM	31.2	2
15-Aug-10	PM	27.8	0.3
25-Aug-10	PM	33.7	1.8
26-Aug-10	AM	31.2	1.1
4-Sep-10	AM	29.1	1.4

Date	Time	Temp	Sal
5-Sep-10	AM	28.6	1.1
18-Sep-10	PM	32.5	1.7
19-Sep-10	AM	29.5	1.9
20-Sep-10	AM	29	2.1
1-Oct-10	PM	28.3	2
2-Oct-10	AM	24	2.1
23-Oct-10	PM	22	.
24-Oct-10	AM	21.5	.
24-Oct-10	PM	25	.
25-Oct-10	AM	24	.
4-Nov-10	PM	22.5	2.6
5-Nov-10	AM	17.8	2.9
5-Nov-10	PM	20	2.5
11-Nov-10	PM	20.8	2.8
12-Nov-10	AM	18.4	2.8
12-Nov-10	PM	21.6	2.8

Appendix III. Collection date, species, total length (TL; mm), weight (WT; kg), T-bar tag number, PIT-tag number, and number of diet items in each category.

Date	Species	TL	WT	T-Bar	PIT	Fish	Crustacean	Insect	Mollusc	Reptile	Unknown
29-Mar	aligar	357	0.2	.	467C547748	0	0	0	0	0	0
29-Mar	aligar	707	2	2504	4A0A696A73	0	0	0	0	0	0
29-Mar	aligar	365	0.2	.	4A7337233C	0	0	0	0	0	0
9-Apr	aligar	694	1.7	2648	470A56385A	0	0	0	0	0	0
9-Apr	aligar	541	0.8	2127	4A0B21233D	0	1	0	0	0	0
9-Apr	aligar	570	0.9	2211	4A0B2272C	0	1	0	0	0	0
9-Apr	aligar	524	0.7	2691	4A0B2B3E0C	0	0	0	0	0	0
9-Apr	aligar	590	1	2382	4A0B2E262C	0	0	0	0	0	0
9-Apr	aligar	391	0.1	.	4A0B2F563C	1	0	1	0	0	0
9-Apr	aligar	585	1	2007	4A0C10477D	1	1	0	0	0	0
9-Apr	aligar	551	0.7	2321	4A0C160256	0	0	0	0	0	0
9-Apr	aligar	664	1.5	2520	4B0340072C	0	0	0	0	0	0
9-Apr	aligar	399	0.3	.	4B04260469	0	0	0	0	0	0
9-Apr	aligar	582	0.9	2135	4B1A672967	0	1	1	0	0	0
10-Apr	aligar	376	0.1	.	470A29775A	0	0	0	0	0	0
10-Apr	aligar	398	0.2	.	470A4D4F1B	0	0	0	0	0	0
10-Apr	aligar	415	0.2	.	470C7A5A73	0	0	2	0	0	0
10-Apr	aligar	530	0.7	2322	4A0A783C22	0	0	0	0	0	0
10-Apr	aligar	386	0.15	.	4A0B7D3E6A	0	0	1	0	0	0
10-Apr	aligar	374	0.1	.	4A0C017A07	0	1	0	0	0	0
10-Apr	aligar	368	0.1	.	4A7337233C	0	0	0	0	0	0
10-Apr	aligar	415	0.2	.	4B04003C2E	0	0	0	0	0	0
10-Apr	aligar	392	0.15	.	4B04157839	1	1	0	0	0	0
10-Apr	aligar	420	0.2	.	4B1A6B6214	0	1	0	0	0	0
10-Apr	aligar	627	1.15	2525	4B1B196734	0	0	0	0	0	0
13-Apr	aligar	387	0.2	.	467C044035	1	0	1	0	0	0
13-Apr	aligar	388	0.2	.	467C391232	1	1	0	0	0	0

Date	Species	TL	WT	T-Bar	PIT	Fish	Crustacean	Insect	Mollusc	Reptile	Unknown
13-Apr	aligar	415	0.2	.	467C52233E	0	0	0	0	0	0
13-Apr	aligar	356	0.1	.	4A0B046D23	0	1	1	0	0	1
13-Apr	aligar	378	0.2	.	4B03214B6B	1	1	0	0	0	0
14-Apr	aligar	385	0.15	.	467C044035	2	1	0	0	0	0
14-Apr	aligar	376	0.15	.	4A0C017A07	1	0	0	0	0	0
14-Apr	aligar	545	0.7	2684	4A0C225408	0	0	0	0	0	0
14-Apr	aligar	614	1	2637	4B19154A64	0	0	0	0	0	0
14-Apr	aligar	416	0.2	.	4B1A6B6214	0	0	0	0	0	0
15-Apr	aligar	393	0.15	.	4B0232466F	2	0	0	0	0	0
7-May	aligar	472	0.453	.	467C6D591B	1	1	0	0	0	1
7-May	aligar	453	0.365	.	4A0A6C401A	0	1	0	0	0	0
7-May	aligar	416	2.79	.	4A0C1C1A5E	2	0	0	0	0	0
8-May	aligar	465	0.442	.	467C2A3B4B	1	1	0	0	0	1
8-May	aligar	354	0.178	.	467D1A0462	6	0	0	0	0	0
8-May	aligar	403	0.264	.	470D066443	6	0	0	0	0	0
8-May	aligar	389	0.23	.	4A0B046D23	6	0	1	0	1	0
9-May	aligar	464	0.418	.	470D487543	1	0	0	0	0	0
20-May	aligar	792	2.6	2623	467D0B5233	0	0	0	0	0	1
20-May	aligar	414	0.2725	.	470C213171	0	0	0	0	0	0
20-May	aligar	462	0.3955	.	4A0C017A07	1	0	0	0	0	0
9-Jun	aligar	589	0.88	.	467C2A3B4B	0	1	0	0	0	0
9-Jun	aligar	478	0.442	.	467C2A5D1F	1	1	0	0	0	0
9-Jun	aligar	549	0.651	.	4A0C017A07	1	1	0	0	0	0
9-Jun	aligar	463	0.3745	.	4A0C142232	1	0	0	0	0	0
10-Jun	aligar	488	0.494	.	4B1A657375	29	1	2	0	0	0
18-Jun	aligar	491	0.486	.	467D1A0462	2	0	0	0	0	0
18-Jun	aligar	566	0.7275	.	4B031D322A	0	1	1	0	0	0
29-Jun	aligar	459	0.7335	.	4B1A657375	0	0	0	0	0	0

Date	Species	TL	WT	T-Bar	PIT	Fish	Crustacean	Insect	Mollusc	Reptile	Unknown
30-Jun	aligar	520	0.5865	.	467C705F16	0	1	0	0	0	0
30-Jun	aligar	503	0.5595	.	4A0C142232	1	0	0	0	0	0
30-Jun	aligar	535	0.767	.	4B1A657375	1	0	0	0	0	1
8-Jul	aligar	384	0.16	.	.	.	.	.	.	.	.
8-Jul	aligar	554	0.824	.	4B1A657375	1	0	0	0	0	0
12-Aug	aligar	583	0.725	2471	.	0	0	0	0	0	1
13-Aug	aligar	577	0.83	2470	.	12	1	0	0	0	0
13-Aug	aligar	715	1.8	.	467C277E44	1	0	0	0	0	0
13-Aug	aligar	800	3	.	4B0321111E	44	0	0	0	0	0
13-Aug	aligar	737	2.1	.	4B187A2810	3	1	0	0	0	0
14-Aug	aligar	686	1.8	.	467D1A0462	1	0	0	0	0	1
14-Aug	aligar	897	4.1	.	4A0B215517	0	0	0	0	0	1
15-Aug	aligar	470	0.421	2457	.	1	0	0	0	0	0
15-Aug	aligar	609	0.893	2629	.	1	0	0	0	0	0
25-Aug	aligar	673	1.6	.	4B1A657375	1	0	0	0	0	0
26-Aug	aligar	640	1.1	2452	.	0	0	0	0	0	1
26-Aug	aligar	685	1.5	2713	.	0	0	0	0	0	1
26-Aug	aligar	786	2.7	.	4B02414606	1	0	0	0	1	0
4-Sep	aligar	730	2	.	467C2A5D1F	1	0	0	0	0	0
4-Sep	aligar	894	4.3	2649	470A670319	0	0	0	0	0	1
4-Sep	aligar	663	1.7	.	4A0C142232	1	0	0	0	0	1
4-Sep	aligar	648	1.2	.	4A750E5C60	1	0	0	0	0	0
5-Sep	aligar	681	1.3	2407	.	1	1	0	0	0	0
5-Sep	aligar	933	4.8	2679	4A0A761E29	0	1	0	0	0	0
19-Sep	aligar	886	4.2	.	4A0B196A0D	1	0	0	0	0	0
19-Sep	aligar	930	4.3	2513	4A73127946	0	1	1	0	0	0
19-Sep	aligar	886	4.1	.	4A737C1855	0	1	0	0	0	0

Date	Species	TL	WT	T-Bar	PIT	Fish	Crustacean	Insect	Mollusc	Reptile	Unknown
19-Sep	aligar	880	3.9	2386	4B04192A51	0	0	0	0	0	1
2-Oct	aligar	429	0.2815	3571	.	1	0	0	0	0	0
24-Oct	aligar	891	4.2	.	4A737C1855	0	0	0	0	0	0
12-Nov	aligar	535	0.6	3586	.	1	0	0	0	0	0
12-Nov	aligar	590	0.8	2345	.	0	0	0	0	0	1
8-May	bluegill	114	0.031	.	.	.	.	.	.	.	.
21-May	bluegill	115	0.028	.	.	.	.	.	.	.	.
8-Jul	bluegill	126	0.04	.	.	.	.	.	.	.	.
15-Aug	bluegill	122	0.032	.	.	.	.	.	.	.	.
8-Apr	bullhead	.	.	.	.	.	.	.	.	.	.
8-May	bullhead	218	0.198	2342	.	0	0	0	0	0	1
8-May	bullhead	229	0.2	2343	.	0	0	0	0	0	1
9-May	bullhead	235	0.2385	2339	.	0	0	0	0	0	0
9-May	bullhead	250	0.2545	2340	.	0	0	381	0	0	0
19-May	bullhead	237	0.248	2338	.	0	0	0	0	0	0
20-May	bullhead	234	0.205	2337	.	0	0	0	0	0	0
20-May	bullhead	252	0.369	2336	.	0	0	0	0	0	1
20-May	bullhead	239	0.2386	2335	.	0	0	1	0	0	1
20-May	bullhead	224	0.201	2124	.	0	0	2	0	0	1
20-May	bullhead	219	0.18	2123	.	0	0	8	0	0	0
21-May	bullhead	217	0.1945	2122	.	0	0	30	0	0	0
10-Jun	bullhead	259	0.187	2114	.	1	1	6	0	0	0
18-Jun	bullhead	263	0.2825	2111	.	0	0	0	0	0	0
18-Jun	bullhead	254	0.2585	2107	.	0	0	0	0	0	0
18-Jun	bullhead	249	0.2415	2338	.	0	0	0	0	0	1
18-Jun	bullhead	232	0.2245	2108	.	1	0	0	0	0	0
18-Jun	bullhead	250	0.216	2103	.	0	0	0	0	0	1
18-Jun	bullhead	239	0.1845	2110	.	0	0	0	0	0	1

Date	Species	TL	WT	T-Bar	PIT	Fish	Crustacean	Insect	Mollusc	Reptile	Unknown
18-Jun	bullhead	250	0.235	2109	.	0	0	0	1	0	1
19-Jun	bullhead	245	0.2035	2104	.	0	0	1	0	0	1
19-Jun	bullhead	255	0.249	2105	.	1	1	1	0	0	0
29-Jun	bullhead	269	0.2725	2497	.	0	0	0	0	0	0
29-Jun	bullhead	284	0.3145	2498	.	0	0	0	0	0	0
29-Jun	bullhead	285	0.3055	2499	.	0	0	1	0	0	0
29-Jun	bullhead	272	0.298	2500	.	0	0	0	0	0	1
30-Jun	bullhead	254	0.231	2493	.	0	0	0	0	0	0
7-Jul	bullhead	241	0.184	2123	.	0	0	0	0	0	1
7-Jul	bullhead	256	0.21	2492	.	0	0	1	0	0	0
8-Jul	bullhead	254	0.2325	2491	.	0	0	0	0	0	1
13-Aug	bullhead	293	0.3675	2469	.	1	0	0	0	0	0
13-Aug	bullhead	225	0.1755	2468	.	1	0	0	0	0	0
15-Aug	bullhead	264	0.2925	2627	.	0	0	0	0	0	1
26-Aug	bullhead	275	0.277	2453	.	1	1	0	0	0	0
4-Sep	bullhead	295	0.3205	2405	.	0	0	0	0	0	0
4-Sep	bullhead	175	0.0625	.	.	.	.	.	.	.	.
4-Sep	bullhead	165	0.0495	.	.	.	.	.	.	.	.
4-Sep	bullhead	174	0.0565	.	.	.	.	.	.	.	.
4-Sep	bullhead	170	0.0625	.	.	.	.	.	.	.	.
5-Sep	bullhead	255	0.2825	2408	.	1	0	1	0	0	1
18-Sep	bullhead	151	0.054	.	.	.	.	.	.	.	.
18-Sep	bullhead	170	0.0675	.	.	.	.	.	.	.	.
18-Sep	bullhead	150	0.0455	.	.	.	.	.	.	.	.
18-Sep	bullhead	164	0.0515	.	.	.	.	.	.	.	.
18-Sep	bullhead	154	0.05	.	.	.	.	.	.	.	.
18-Sep	bullhead	155	0.0475	.	.	.	.	.	.	.	.
18-Sep	bullhead	167	0.0555	.	.	.	.	.	.	.	.

Date	Species	TL	WT	T-Bar	PIT	Fish	Crustacean	Insect	Mollusc	Reptile	Unknown
18-Sep	bullhead	151	0.052	.	.	.	.	.	.	.	.
18-Sep	bullhead	157	0.052	.	.	.	.	.	.	.	.
19-Sep	bullhead	259	0.2245	2422	.	0	0	0	0	0	1
20-Sep	bullhead	238	0.1925	2424	.	1	0	0	0	0	0
20-Sep	bullhead	233	0.1745	2468	.	1	0	0	0	0	0
20-Sep	bullhead	265	0.2875	2425	.	0	0	0	0	0	1
1-Oct	bullhead	266	0.241	3575	.	0	0	0	0	0	1
1-Oct	bullhead	271	0.274	3573	.	0	0	0	0	0	1
2-Oct	bullhead	162	0.0555	.	.	.	.	.	.	.	.
2-Oct	bullhead	165	0.0615	.	.	.	.	.	.	.	.
2-Oct	bullhead	183	0.1095	.	.	.	.	.	.	.	.
2-Oct	bullhead	169	0.0595	.	.	.	.	.	.	.	.
23-Oct	bullhead	164	0.0685	.	.	.	.	.	.	.	.
24-Oct	bullhead	264	0.3095	3560	.	0	0	0	0	0	0
25-Oct	bullhead	195	0.097	.	.	.	.	.	.	.	.
25-Oct	bullhead	168	.	.	.	.	.	.	.	.	.
25-Oct	bullhead	200	.	.	.	.	.	.	.	.	.
4-Nov	bullhead	169	.	.	.	.	.	.	.	.	.
4-Nov	bullhead	167	.	.	.	.	.	.	.	.	.
4-Nov	bullhead	170	.	.	.	.	.	.	.	.	.
5-Nov	bullhead	182	.	.	.	.	.	.	.	.	.
5-Nov	bullhead	167	.	.	.	.	.	.	.	.	.
5-Nov	bullhead	200	.	.	.	.	.	.	.	.	.
5-Nov	bullhead	199	.	.	.	.	.	.	.	.	.
11-Nov	bullhead	271	206	3597	.	0	0	0	0	0	1
11-Nov	bullhead	273	254	3581	.	0	0	0	0	0	1
11-Nov	bullhead	259	196	3579	.	0	0	0	0	0	1
11-Nov	bullhead	156	52	.	.	.	.	.	.	.	.

Date	Species	Tl	WT	T-Bar	PIT	Fish	Crustacean	Insect	Mollusc	Reptile	Unknown
12-Nov	bullhead	243	142	3591	.	0	0	0	0	0	1
12-Nov	bullhead	244	180	3592	.	0	0	0	0	0	1
12-Nov	bullhead	257	236	3593	.	0	0	0	0	0	1
12-Nov	bullhead	173	74	.	.	.	.	.	.	.	.
12-Nov	bullhead	174	62	.	.	.	.	.	.	.	.
12-Nov	bullhead	192	76	.	.	.	.	.	.	.	.
12-Nov	bullhead	185	84	.	.	.	.	.	.	.	.
12-Nov	bullhead	171	74	.	.	.	.	.	.	.	.
12-Nov	bullhead	163	60	.	.	.	.	.	.	.	.
12-Nov	bullhead	185	66	.	.	.	.	.	.	.	.
9-Apr	green	.	.	.	.	.	.	.	.	.	.
10-Apr	green	.	.	.	.	.	.	.	.	.	.
10-Apr	green	.	.	.	.	.	.	.	.	.	.
10-Apr	green	.	.	.	.	.	.	.	.	.	.
10-Apr	green	.	.	.	.	.	.	.	.	.	.
14-Apr	green	142	.	.	.	.	.	.	.	.	.
15-Apr	green	.	.	.	.	.	.	.	.	.	.
7-May	green	141	0.051	.	.	.	.	.	.	.	.
9-May	green	127	0.0375	.	.	.	.	.	.	.	.
9-May	green	138	0.044	.	.	.	.	.	.	.	.
19-Jun	green	139	0.0495	.	.	.	.	.	.	.	.
29-Jun	green	129	0.0365	.	.	.	.	.	.	.	.
29-Jun	green	116	0.0355	.	.	.	.	.	.	.	.
30-Jun	green	146	0.0605	.	.	.	.	.	.	.	.
5-Nov	green	134	.	.	.	.	.	.	.	.	.
9-Apr	lmbass	269	0.2	2360	.	4	0	0	0	0	0
9-Apr	lmbass	286	0.3	2365	.	6	1	0	0	0	0
10-Apr	lmbass	266	0.2	2366	.	0	0	0	0	0	0

Date	Species	TL	WT	T-Bar	PIT	Fish	Crustacean	Insect	Mollusc	Reptile	Unknown
10-Apr	lmbass	265	0.1	2367	.	0	0	2	0	0	0
13-Apr	lmbass	251	0.2	2370	.	1	0	0	0	0	0
13-Apr	lmbass	273	0.25	2369	.	4	0	0	0	0	1
14-Apr	lmbass	270	0.2	2371	.	4	0	0	0	0	0
14-Apr	lmbass	287	0.2	2372	.	3	1	0	0	0	0
8-May	lmbass	268	0.289	2344	.	0	0	0	0	0	1
8-May	lmbass	257	0.213	2341	.	8	0	0	0	0	0
10-Jun	lmbass	294	0.3665	2113	.	0	0	0	0	0	0
10-Jun	lmbass	179	0.7715	2112	.	1	0	0	0	0	0
29-Jun	lmbass	353	0.702	2496	.	2	0	0	0	0	0
30-Jun	lmbass	311	0.4585	2495	.	0	0	0	0	0	0
7-Jul	lmbass	363	0.672	2496	.	1	0	0	0	0	0
8-Jul	lmbass	169	0.068	2489	.	6	0	0	0	0	0
14-Aug	lmbass	186	0.0825	2466	.	0	1	1	0	0	0
14-Aug	lmbass	185	0.083	2465	.	2	0	0	0	0	0
14-Aug	lmbass	185	0.0735	2467	.	5	0	0	0	0	0
25-Aug	lmbass	187	0.085	2455	.	1	0	0	0	0	0
25-Aug	lmbass	182	0.0805	2454	.	1	0	0	0	0	0
4-Sep	lmbass	224	0.1485	2725	.	0	0	0	0	0	0
4-Sep	lmbass	205	0.1125	2401	.	0	0	0	0	0	1
4-Sep	lmbass	209	0.111	2403	.	0	0	0	0	0	1
4-Sep	lmbass	185	0.0765	2404	.	0	0	0	0	0	1
4-Sep	lmbass	381	0.8295	2406	.	3	1	0	0	0	0
18-Sep	lmbass	185	0.08	2419	.	0	0	0	0	0	0
18-Sep	lmbass	188	0.0835	2418	.	0	0	1	0	0	1
19-Sep	lmbass	270	0.087	2421	.	4	0	0	0	0	0
19-Sep	lmbass	244	0.23	2420	.	8	0	0	0	0	0
20-Sep	lmbass	259	0.2535	2423	.	0	0	0	0	0	0

Date	Species	TL	WT	T-Bar	PIT	Fish	Crustacean	Insect	Mollusc	Reptile	Unknown
1-Oct	lmbass	181	0.068	2814	.	0	0	0	0	0	0
1-Oct	lmbass	172	0.0685	2813	.	0	0	0	0	0	0
1-Oct	lmbass	194	0.092	2815	.	0	0	0	0	0	1
1-Oct	lmbass	172	0.068	3574	.	1	0	0	0	0	0
2-Oct	lmbass	188	0.073	3570	.	0	0	0	0	0	1
2-Oct	lmbass	180	0.074	3569	.	1	0	0	0	0	0
2-Oct	lmbass	180	0.0735	3572	.	21	0	0	0	0	0
24-Oct	lmbass	250	0.214	3559	.	0	0	0	0	0	0
24-Oct	lmbass	411	1.1	3557	.	1	1	0	0	0	0
24-Oct	lmbass	274	0.3225	3556	.	11	0	0	0	0	0
24-Oct	lmbass	271	0.34	3558		5	0	0	0	0	0
25-Oct	lmbass	179	.	3555	.	2	0	0	0	0	0
4-Nov	lmbass	267	.	3576	.	1	0	0	0	0	0
4-Nov	lmbass	181	.	3577	.	1	0	0	0	0	0
5-Nov	lmbass	244	.	3578	.	15	0	3	0	0	0
11-Nov	lmbass	181	72	3596	.	0	0	0	0	0	0
11-Nov	lmbass	243	176	3598	.	0	1	0	0	0	0
12-Nov	lmbass	206	102	3588	.	0	0	0	0	0	1
12-Nov	lmbass	191	78	3589	.	1	0	0	0	0	0
12-Nov	lmbass	206	96	3590	.	1	0	0	0	0	0
12-Nov	lmbass	184	94	3594	.	2	0	0	0	0	0
12-Nov	lmbass	258	240	3595	.	1	1	0	0	0	0
12-Nov	lmbass	242	204	3587	.	3	0	0	0	0	0
29-Mar	spotted	652	1.2	2357	.	0	0	0	0	0	0
29-Mar	spotted	517	0.5	2358	.	0	0	0	0	0	0
29-Mar	spotted	542	0.6	2359	.	0	0	0	0	0	0
9-Apr	spotted	501	0.5	2361	.	0	0	0	0	0	0
10-Apr	spotted	516	0.5	2368	.	0	0	0	0	0	0

Date	Species	TL	WT	T-Bar	PIT	Fish	Crustacean	Insect	Mollusc	Reptile	Unknown
8-May	spotted	573	0.719	2345	.	2	0	0	0	0	0
19-Jun	spotted	725	1.7	2106	.	0	0	0	0	0	0
30-Jun	spotted	638	0.8795	2494	.	1	0	0	0	0	0
8-Jul	spotted	589	0.777	2488	.	1	0	0	0	0	0
15-Aug	spotted	660	1.4	2628	.	1	0	0	0	0	0
19-Sep	tilapia	193	0.159	.	.	.	.	.	.	.	.
9-Apr	warmouth	.	.	.	.	.	.	.	.	.	.
9-Apr	warmouth	.	.	.	.	.	.	.	.	.	.
10-Apr	warmouth	.	.	.	.	.	.	.	.	.	.
10-Apr	warmouth	.	.	.	.	.	.	.	.	.	.
10-Apr	warmouth	.	.	.	.	.	.	.	.	.	.
14-Apr	warmouth	130	.	.	.	.	.	.	.	.	.
8-May	warmouth	157	0.039	.	.	.	.	.	.	.	.
9-May	warmouth	134	0.046	.	.	.	.	.	.	.	.
9-May	warmouth	130	0.048	.	.	.	.	.	.	.	.
10-May	warmouth	137	0.0455	.	.	.	.	.	.	.	.
10-May	warmouth	136	0.052	.	.	.	.	.	.	.	.
19-May	warmouth	162	0.0905	.	.	.	.	.	.	.	.
19-May	warmouth	125	0.038	.	.	.	.	.	.	.	.
20-May	warmouth	129	0.0365	.	.	.	.	.	.	.	.
20-May	warmouth	170	0.1145	.	.	.	.	.	.	.	.
21-May	warmouth	134	0.047	.	.	.	.	.	.	.	.
21-May	warmouth	129	0.0455	.	.	.	.	.	.	.	.
21-May	warmouth	130	0.048	.	.	.	.	.	.	.	.
9-Jun	warmouth	147	0.076	.	.	.	.	.	.	.	.
9-Jun	warmouth	139	0.0515	.	.	.	.	.	.	.	.
10-Jun	warmouth	129	0.0375	.	.	.	.	.	.	.	.
10-Jun	warmouth	139	0.043	.	.	.	.	.	.	.	.

Date	Species	TL	WT	T-Bar	PIT	Fish	Crustacean	Insect	Mollusc	Reptile	Unknown
18-Jun	warmouth	135	0.0535	.	.	.	.	.	.	.	.
18-Jun	warmouth	151	0.0855	.	.	.	.	.	.	.	.
29-Jun	warmouth	135	0.057	.	.	.	.	.	.	.	.
29-Jun	warmouth	143	0.06	.	.	.	.	.	.	.	.
29-Jun	warmouth	109	0.0215	.	.	.	.	.	.	.	.
30-Jun	warmouth	132	0.0415	.	.	.	.	.	.	.	.
30-Jun	warmouth	140	0.0554	.	.	.	.	.	.	.	.
30-Jun	warmouth	144	0.059	.	.	.	.	.	.	.	.
30-Jun	warmouth	153	0.07	.	.	.	.	.	.	.	.
8-Jul	warmouth	209	0.217	2490	.	.	1	.	.	.	.
13-Aug	warmouth	149	0.071	.	.	.	.	.	.	.	.
14-Aug	warmouth	124	0.0375	.	.	.	.	.	.	.	.
15-Aug	warmouth	124	0.043	.	.	.	.	.	.	.	.
26-Aug	warmouth	131	0.0465	.	.	.	.	.	.	.	.
26-Aug	warmouth	137	0.0565	.	.	.	.	.	.	.	.
26-Aug	warmouth	165	0.1135	.	.	.	.	.	.	.	.
5-Sep	warmouth	137	0.0535	.	.	.	.	.	.	.	.
19-Sep	warmouth	134	0.0525	.	.	.	.	.	.	.	.
19-Sep	warmouth	129	0.045	.	.	.	.	.	.	.	.
20-Sep	warmouth	123	0.0405	.	.	.	.	.	.	.	.
20-Sep	warmouth	126	0.0385	.	.	.	.	.	.	.	.
20-Sep	warmouth	131	0.0425	.	.	.	.	.	.	.	.
2-Oct	warmouth	158	0.085	.	.	.	.	.	.	.	.
23-Oct	warmouth	155	0.0805	.	.	.	.	.	.	.	.
24-Oct	warmouth	130	0.044	.	.	.	.	.	.	.	.
24-Oct	warmouth	141	0.057	.	.	.	.	.	.	.	.
5-Nov	warmouth	130	.	.	.	.	.	.	.	.	.
5-Nov	warmouth	128	.	.	.	.	.	.	.	.	.
12-Nov	warmouth	136	48	.	.	.	.	.	.	.	.

BIOGRAPHICAL SKETCH

Rachel Cecilia Ianni was born on 23 June 1986 in Springfield, Ohio. Rachel graduated from Catholic Central High School in June of 2004. In 2008, she earned her Bachelor of Science degree in Biology from Wittenberg University. After graduation Rachel worked for the U.S. Forest Service and the Nevada Conservation Corps. In January 2010 Rachel enrolled in the Marine and Environmental Biology Master of Science program at Nicholls State University. Rachel plans to pursue a career in conservation and natural resource management after graduation in May 2011.

Rachel Cecilia Ianni

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EDUCATION

Nicholls State University
Thibodaux, LA
Master of Science- Expected May 2011
Marine and Environmental Biology

Wittenberg University
Springfield, Ohio
Bachelor of Science- May 2008
Major: Biology; Minor: Marine Science

Duke University Marine Laboratory
Beaufort, NC
Marine Biology Class - Summer 2005
Semester Abroad Program- Spring 2007

Bowling Green State University
Bowling Green, Ohio
Marine Biology Summer Program- June 2002

TEACHING EXPERIENCE

Teaching Assistant, December 2010
Nicholls State University, Thibodaux, Louisiana
- Assisted a combined biology/ humanity course which included a 2.5 week trip to Costa Rica

Intern, September 2009-December 2009
Newfound Harbor Marine Institute, Big Pine Key, Florida
- Trained in effective lesson plan development and teaching techniques
- Taught children 4th-12th grade hands on marine science using snorkeling and dissections

Concepts of Biology Tutor, January 2008-May 2008
Wittenberg University Biology Department
- Attended class, held office hours and review sessions

Tutor, June 2007-May 2008
Clark County Literacy Coalition, Springfield, Ohio
- Tutored a fifth grader twice a week in reading
- Tutored child whose second language is English

Lab Teaching Assistant, August 2005-May 2008
Wittenberg University Biology Department, Springfield, Ohio
- Selected by professors to assist in introductory biology labs of 15-25 students

Science Club Coordinator, September 2007-November 2007
Empowering Our Youth**,** Springfield, Ohio
- Planned, performed, and explained experiments for middle school children in an after school program

Classroom Assistant, August 2006-December 2006
Wittenberg University Biology Department, Springfield, Ohio
- Selected to assist in a freshman marine fisheries class
- Held office hours and review sessions

High School Chemistry Tutor, August 2005-May 2006
Springfield, Ohio
- Recommended by professor to serve as a chemistry tutor for local high school students

PROFESSIONAL EXPERIENCE

Intern, March 2011-May 2011
Louisiana Department of Natural Resources
Office of Coastal Protection and Restoration, Thibodaux, Louisiana

- Analyzed data and wrote reports for a coastal monitoring project

Graduate Assistant, January 2010-May 2011
Nicholls State University, Thibodaux, Louisiana

- Worked with Louisiana Department of Wildlife and Fisheries to monitor for invasive tilapia
- Performed gastric lavage on gar, bullheads, and bass to determine diets
- Determined growth rates of cultured alligator gar after being stocked in the wild
- Work at Nicholls farm to culture native plants

Volunteer, May 2010-November 2010
Institute for Marine Mammal Studies, Gulfport, MS

- Assisted with public outreach and education
- Performed monthly marine mammal and sea turtle stranding surveys
- Assisted in feeding and care of sea turtles

AmeriCorps Volunteer, August 2008-August 2009
Great Basin Institute, Reno, Nevada

- Member of the Nevada Conservation Corps; promoted to crew leader
- Successfully cut acres for fuels reduction, built trails, and removed invasive species

Biological Science Technician May 2008-August 2008
United States Forest Service, Mio, Michigan

- Performed botany and wildlife surveys

Peer Helper, August 2006-May 2008
Wittenberg University, Springfield, Ohio

- Selected based on leadership skills and ability to effectively communicate with peers
- Participated in decision-making, effective listening, and conflict resolution training

Volunteer, March 2008
Bridges to Community

- Spent spring break building houses in Nicaragua

Resident Advisor, Spring 2006 and 2007
Wittenberg University; Springfield, Ohio; Duke University, Beaufort, North Carolina

- Responsible for administrative tasks, upholding rules, and create a community in residence halls

Hurricane Katrina Relief Volunteer, March 2006
Pass Christian, Mississippi

- Spent a week cleaning up debris, gutting houses, and talking to residents about their experiences

Relay for Life Team Captain and Committee Member, Spring 2005 and 2006
American Cancer Society, Springfield, Ohio

- Participated in the planning and set up of Wittenberg's Relay for Life
- Recruited a successful team; planned and executed fundraisers

ORAL PRESENTATIONS

Ianni, R.C., Ferrara, A.M., and Fontenot, Q.C. March 2011. Diet and growth rates of cultured alligator gar *Atractosteus spatula* stocked into a Louisiana drainage canal. Aquaculture America, New Orleans Marriott, New Orleans, Louisiana.

Ianni, R.C., Ferrara, A.M., and Fontenot, Q.C. February 2011. Diet composition of predatory fish species in a canal in Port Sulphur, Louisiana. Louisiana Academy of Science, University of Louisana at Monroe, Monroe, Louisiana. Achieved **Best Graduate Oral Presentation** in Botany, Environmental Sciences, and Zoology.

Ianni, R.C., Ferrara, A.M., and Fontenot, Q.C. January 2011. Monitoring the diets of predatory fish: The use of predators to suppress non-native tilapia in Port Sulphur, Louisiana. Louisiana Chapter of the American Fisheries Society, Holiday Inn, Lafayette, Louisiana.

Ianni, R.C., Ferrara, A.M., and Fontenot, Q.C. May 2010. Preliminary analysis of alligator gar *Atractosteus spatula* and spotted gar *Lepisosteus oculatus* diets collected in a drainage canal in Port Sulphur, Louisiana. International Network for Lepisosteid Research, Nicholls State University, Thibodaux, Louisiana.

POSTER PRESENTATIONS

Ianni, R.C., A.M. Ferrara, and Q. Fontenot. 2011. Monitoring the diets of predatory fish in a Port Sulphur drainage canal. Nicholls State University Research Week, Nicholls State University, Thibodaux, Louisiana. Achieved **1st place** in graduate poster competition.

Ianni, R.C. and Kirby-Smith W.W. 2008. Fecal coliform bacteria concentrations do not depend on semi-diurnal tides in Carteret County, North Carolina. The Ohio Academy of Science, University of Toledo, Toledo, Ohio.

Ianni, R.C., Ark, J.T., Walton, A.C., and Reinsel, K.A. 2008. Effect of color variation on the shell selection process of the San Salvador hermit crab, *Clibanarius tricolor.* The Ohio Academy of Science, University of Toledo, Toledo, Ohio.

Ianni, R.C., Ark, J.T., Walton, A.C., and Reinsel, K.A. 2006. Effect of color variation on the shell selection process of the San Salvador hermit crab, *Clibanarius tricolor.* Wittenberg University Student Research Symposium, Springfield, Ohio.

PUBLICATIONS

Published Abstracts:

Ianni R.C. and Kirby-Smith W.W. 2008. Fecal coliform bacteria concentrations do not depend on semi-diurnal tides in Carteret County, North Carolina. The Ohio Journal of Science 108:A-23.

Ianni R.C., Ark J.T., Walton A.C., and Reinsel K.A. 2008. Effect of color variation on the shell selection process of the San Salvador hermit crab, *Clibanarius tricolor*. The Ohio Journal of Science 108:A-23.