LOUISIANA DEPARTMENT
OF WILDLIFE & FISHERIES

OFFICE OF FISHERIES
INLAND FISHERIES SECTION

PART VI -B

WATERBODY MANAGEMENT PLAN SERIES

ANACOCO LAKE

WATERBODY EVALUATION & RECOMMENDATIONS

CHRONOLOGY

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WATERBODY EVALUATION

STRATEGY STATEMENT

Recreational

Black basses, crappies and catfishes in Anacoco Lake are managed to provide anglers the greatest opportunity to catch and harvest a limit of fish. Sunfishes are managed to provide a sustainable population while providing anglers the opportunity to catch and harvest numbers of fish.

Commercial

The physical characteristics of Anacoco Reservoir do not support the large rough fish species that normally comprise a commercial fishery. Therefore, a commercial fishery is limited to catfish species including channel catfish (*Ictalurus punctatus*), blue catfish (*I. furcatus)*, flathead catfish (*Pylodictis olivaris*), bullhead catfishes (*Ameiurus* spp.), and common carp (*Cyprinus carpio*). The existing prohibition on commercial fishing gear follows the recreational strategy chosen for many of our popular inland reservoirs; emphasizing recreational fisheries for bass and crappies. Catfish are managed to provide a sustainable population while providing anglers and commercial fishers the opportunity to harvest numbers of fish.

Species of Special Concern

No threatened or endangered fish species are found in this waterbody.

EXISTING HARVEST REGULATIONS

Recreational

Statewide regulations apply to all fish species, the recreational fishing regulations may be viewed at the link below:
http://www.wlf.louisiana.gov/fishing/regulations

Trot lines, yo-yos, and set hooks are legal gear.

Commercial

State regulations apply except that the use of gill nets, trammel nets, fish seines and hoop nets are prohibited in Anacoco Lake as per Louisiana RS 76:103.

The commercial fishing regulations may be viewed at the link below:
http://www.wlf.louisiana.gov/fishing/regulations

SPECIES EVALUATION

Recreational

Electrofishing is the most commonly used sampling technique to assess largemouth bass relative abundance (catch per unit effort = CPUE), size distribution and relative weight (physical body condition). Data collected during spring and fall electrofishing is used to describe population trends, age composition, growth rate, mortality rate and the genetic composition of a largemouth bass population.

Relative abundance, size distribution and relative weight

Largemouth bass (LMB) make up 80-85% of the black bass population in Anacoco Lake. Size distribution of the LMB population (length frequencies) generated from standardized sampling results from 1990-1998 (Figure 1) and 2000-2010 (Figure 2) show normally distributed population structures with 58.7% and 52.4% of largemouth bass between 8 and 16 inches total length (TL), respectively. The majority (96.7%) of LMB captured from 2013 to 2015 were less than 12" TL, likely attributable to increased recruitment following the 2012 drawdown (Figure 3). The effects of the 1999-2000 renovation can be seen in the overall increase in actual abundance (Figures 1 and 2) and relative abundance (Figures 4 and 5) from 1990's to 2000's sampling results. While these increases may be partially attributed to the increased number of samples taken during the 2000's vs. the 1990's, 2000-2003 LMB captures alone almost equal total captures for the entire decade of the 90's (688 and 869 respectively). This indicates that the objective of the renovation to increase LMB abundance was successful.

Mean relative weight (Wr) for each inch group is also shown in Figures 1 through 3. This measurement is obtained from fall samples only and is defined as the ratio of fish weight to the weight of a ''standard'' fish of the same length. The Wr index is calculated by dividing the weight of a fish by the standard weight for its length, and multiplying the quotient by 100. Largemouth bass relative weights well below 100 may indicate a problem of insufficient or unavailable forage, whereas relative weights closer to 100 indicate sufficient forage is available (Neumann et al. 2012). A description of the forage species and sampling methods is described below. When mean Wr values from pre-renovation (1990's) are compared to post renovation (2000's), we see an overall increase of 7.9, from 90.2 to 98.1 (Figures 1 and 2). Because relative weight factors provide an indirect measure of forage availability, this increase is again indicative of the success of the renovation at temporarily increasing the productivity in Anacoco Lake. The latest samples (Figure 3) show all Wr values are above 85 with the average for all inch groups at 93.

As described in part A of this management plan, increased turbidity from 2003 to 2008 (Figure 15) resulted in reduced primary productivity and reduced LMB forage availability (Figure 10). LMB abundance was reduced as a result. The effects of this turbidity are also evidenced in Wr from that time period with 2004 and 2006 annual mean Wr values (85.4 and 84.7, respectively) near record lows for Anacoco Lake (Figure 4). While 2007 also fell within this timeframe, high catch rates and Wr values were observed in fall sampling for this year (Figures 5 and 4). This is likely attributable to the 2006 drawdown that temporarily improved water clarity and allowed LMB populations to increase rapidly as seen by comparing 2007 spring (0.0) and fall (99.1) sub-stock size CPUE's (Figures 5 and 6). This large increase in relative abundance was likely due to increased recruitment in response to improved habitat conditions after several years of reduced LMB numbers prior to 2007. The same pattern can be seen in 2013 sampling results following the 2012 drawdown with improved sub-stock catch rates from spring (1.0) to fall (91.4; Figures 5 and 6). This pattern indicates that significant drawdowns have short term, beneficial effects on habitat, recruitment, and fish body condition in Anacoco Lake.

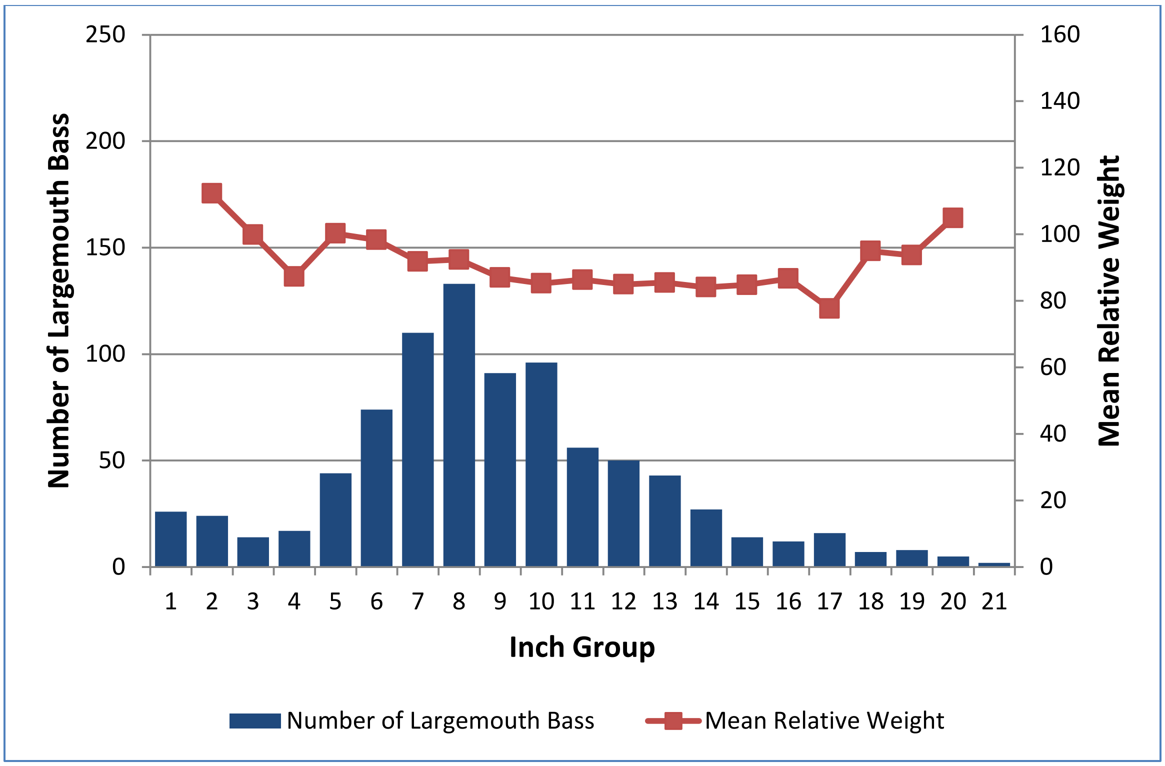

Figure 1. LMB size distribution results for all gear types for all seasons, 1990-1998 (n=869). Wr values from fall electrofishing samples only (n=219).

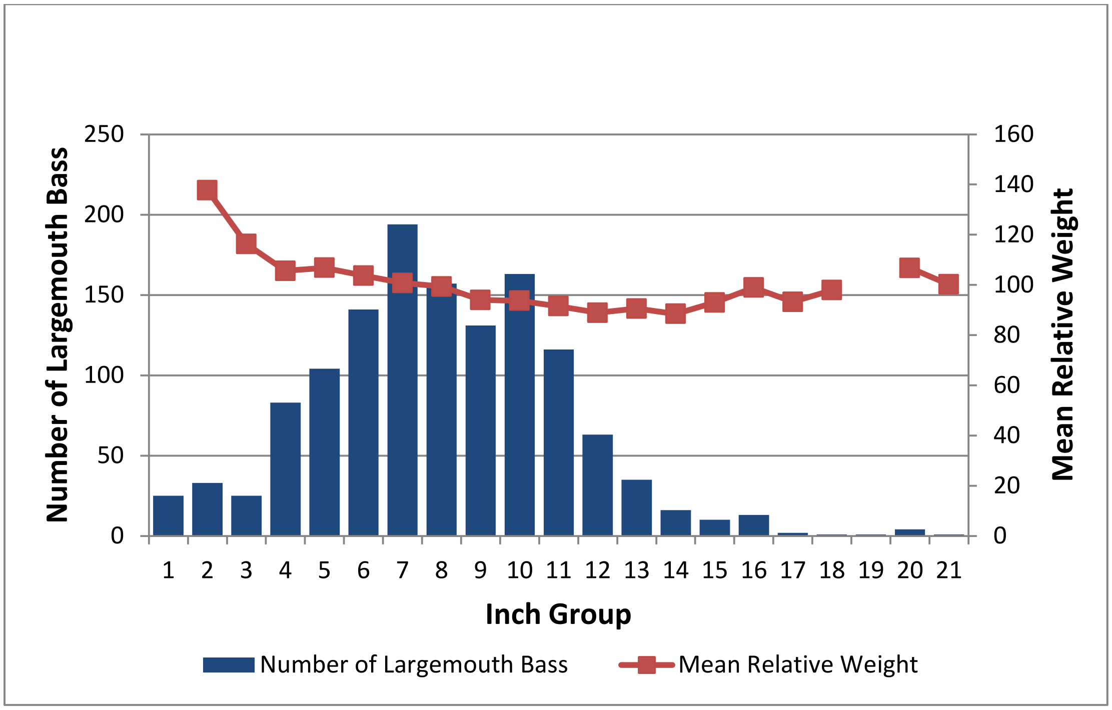

Figure 2. LMB size distribution results for all gear types for all seasons, 2000 - 2010 (n=1,318). Wr values from fall electrofishing samples only (n=701).

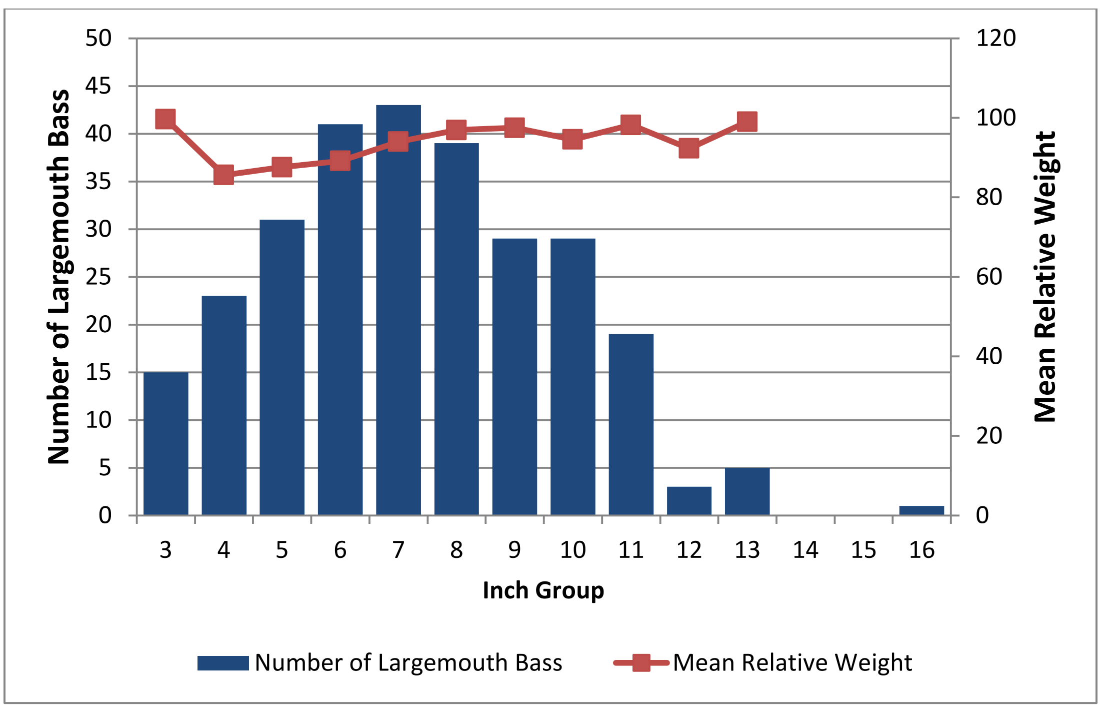

Figure 3. LMB size distribution results for all gear types for all seasons, 2013-2015 (n=277). Wr values from fall electrofishing samples only (n=229).

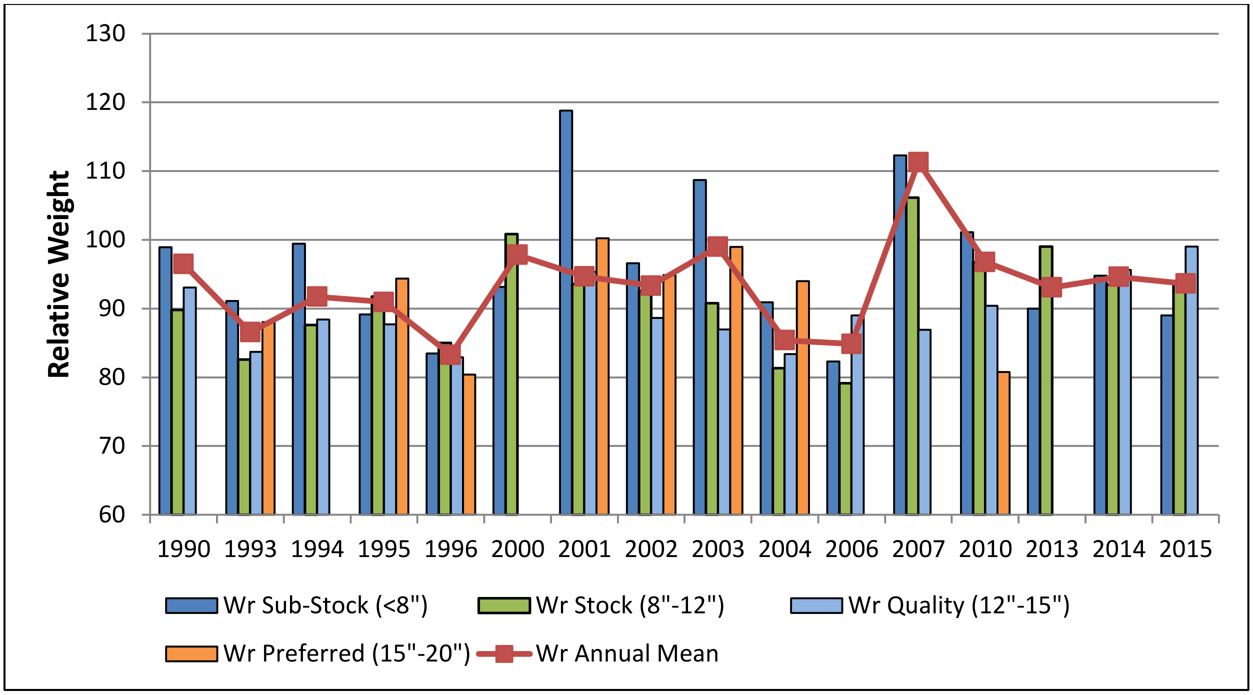

Figure 4. The mean relative weights for largemouth bass by length category and combined annual mean from fall electrofishing samples 1990-2015 (n=1,154).

Standardized electrofishing results from pre-renovation fall sampling, with the exception of 1994, show very little variablity in catch rates. While this indicates population stability, relative abundance was low with total CPUE less than 30 LMB/hour captured in four out of five years sampled (Figure 5). These results indicate low annual recruitment and low LMB numbers for most years during this time period. Post renovation fall electrofishing samples showed significantly increased catch rates through 2003, with total CPUE greater than 50 for each of these years (Figure 5). Fall catch rates, after this time period, show increased variability with low (2004 and 2006) and high catch rates (2007 and 2010) among years.

These results collectively illustrate: 1) the success of the renovation at increasing LMB abundance; 2) the negative impacts degraded habitat conditions (high turbidity) had on LMB abundance; 3) and the rapid population response (increase) to improved habitat conditions. The rapid decline in fall catch rates from 2000-2004 indicate that the beneficial effects of the renovation were relatively short lived (approximately 3 years), but it is uncertain how much of this decline is attributable to normal, decreasing productivity or decreased productivity due to high turbidity. The Fall 2013 total CPUE (138.1 bass/hour) was the second highest fall catch rate on record for Anacoco Lake, behind only post renovation sampling in 2000 (Figure 5). This illustrates that the 2012 drawdown was successful at improving aquatic habitat (water clarity) which lead to increased LMB recruitment. Results similar to the 2000 renovation can be achieved at much lower monetary costs by allowing terrestrial vegetation to naturally grow on the dry lake bed rather than planting and fertilizing. The fall 2014 total

CPUE (67.9 bass/hour) was significantly lower than 2013 fall total CPUE. This is possibly attributable to declining productivity after the 2012 drawdown and decreased abundance in association with increased proportion of larger fish.

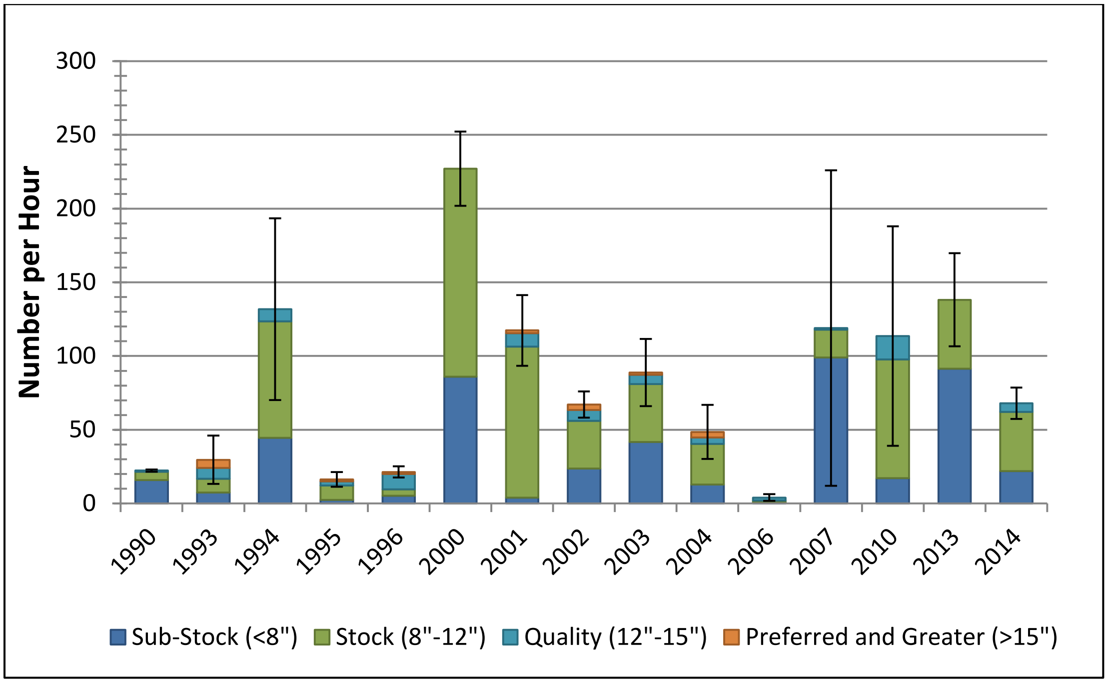

Figure 5. Mean CPUE (+ SE) for LMB by size class from standardized fall electrofishing samples for 1990-2014. Error bars represent standard error of total mean CPUE.

The differences between pre and post-renovation are less readily apparent in standardized spring electrofishing results (Figure 6). While 2001 showed the highest total spring CPUE on record for Anacoco Lake (170.3 LMB/hour), total spring catch rates rapidly returned to pre-renovation levels (<50 LMB/hour, Figure 6). The high catch rate in 2001 is likely a direct result of the renovation, but the rapid decline in catch rates after that year is indicate that the beneficial effects were short lived. Mean CPUE for 1996-1998 and 2001-2003 showed a slight increase for stock-size and larger (≥8”) LMB from 32.4 to 36.0 bass/hour. It is unclear whether this increase is an effect of the renovation, natural size structure fluctuation, or sampling variability. The negative effects of increased turbidity are readily apparent from 2005-2008. While 2007 spring catch rates were depressed from the drawdown in Fall 2006 (Part A, Table 1), 2005 and 2008 total largemouth bass CPUE’s were significantly lower than most spring samples taken during normal (no drawdown during the previous year) habitat conditions from 1992-2004 (Figure 6).

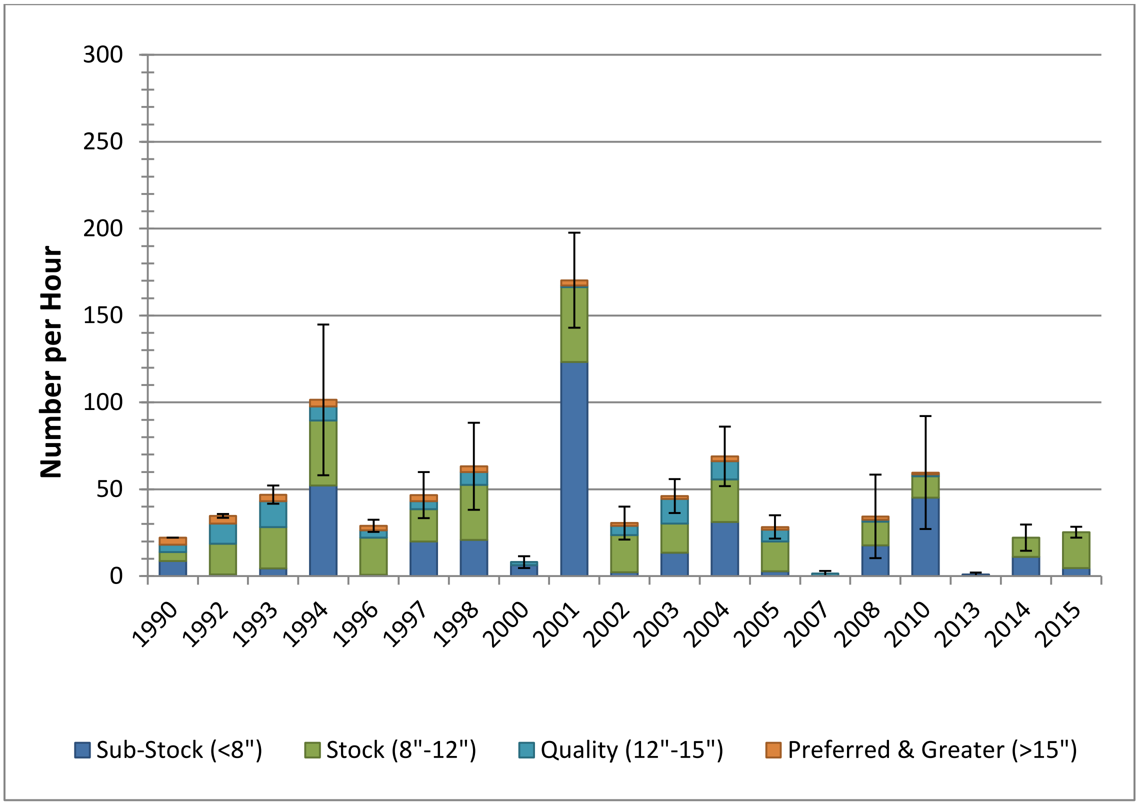

Figure 6. Mean CPUE (+ SE) of largemouth bass by size class from standardized spring electrofishing samples for 1990-2015. Error bars represent standard error of total mean CPUE.

Size structure indices

Proportional stock density (PSD) and relative stock density (RSD) are indices used to numerically describe length-frequency data (Anderson and Neumann 1996). Proportional stock density compares the number of fish of quality size ($\geq$ 12 inches for largemouth bass) to the number of bass of stock size ($\geq$ 8 inches in length), and is calculated by the formula:

$$\text{PSD} = \frac{\text{Number of bass} \geq 12 \text{ inches}}{\text{Number of bass} \geq 8 \text{ inches}}$$

PSD is expressed as a percentage. A fish population with a high PSD consists mainly of larger individuals, whereas a population with a low PSD consists mainly of smaller fish. A value between 40 and 70 generally indicates a balanced bass population. In Anacoco Lake, fall PSD values show a great degree of variability which is attributable to highly variable catch rates of young-of-the-year (YOY) depending upon spawning success and recruitment (Figures 7 and 9). Fall PSD values from 2000 to 2002 increased from 0 to 33%, and spring PSD values from 2001 to 2003 increased from 9 to 50% (Figure 7 and 8). These increases illustrate the population reaching balance after the 1999-2000 renovation stimulated production in the fishery. Both spring and fall PSD values from 2005-2010 show large amounts of variability, which is likely attributable to habitat impacts (turbidity) and measures taken to attempt to correct those impacts (drawdowns) which caused shifts in the population size structure. The 2013 electrofishing data analysis resulted in PSD values of 0% in both fall and spring (Figures 7 and 8). This illustrates that in 2013, no fish larger than 12” TL were captured and that the LMB population is out of balance with an over-abundance of smaller fish. The most recent electrofishing data analysis (2014 fall and 2015 spring) resulted in PSD values of 14% in the fall and 18% in the spring (Figures 7 and 8). These results describe a LMB population consisting primarily of small individuals. Strong recruitment following the 2012 drawdown is attributed. However, the size structure is now returning to pre-drawdown levels.

Relative stock density (preferred, RSD_{15}) is the percentage of largemouth bass in a stock (fish over 8 inches) that are also 15 inches TL or longer, and is calculated by the formula:

$$RSD_{15} = \frac{\text{Number of bass} \geq 15 \text{ inches}}{\text{Number of bass} \geq 8 \text{ inches}}$$

An RSD_{15} value between 10 and 40 indicates a balanced bass population, while values between 30 and 60 indicate a higher abundance of larger fish. RSD_{15} values from both spring and fall sampling range from 0 to 25% with most years falling below 15% (Figures 7 and 8)). This indicates Anacoco Lake has not had an abundance of larger bass. Moreover, the size structure of Anacoco Lake bass has been more typically skewed toward smaller fish (Figure 7 and 8).

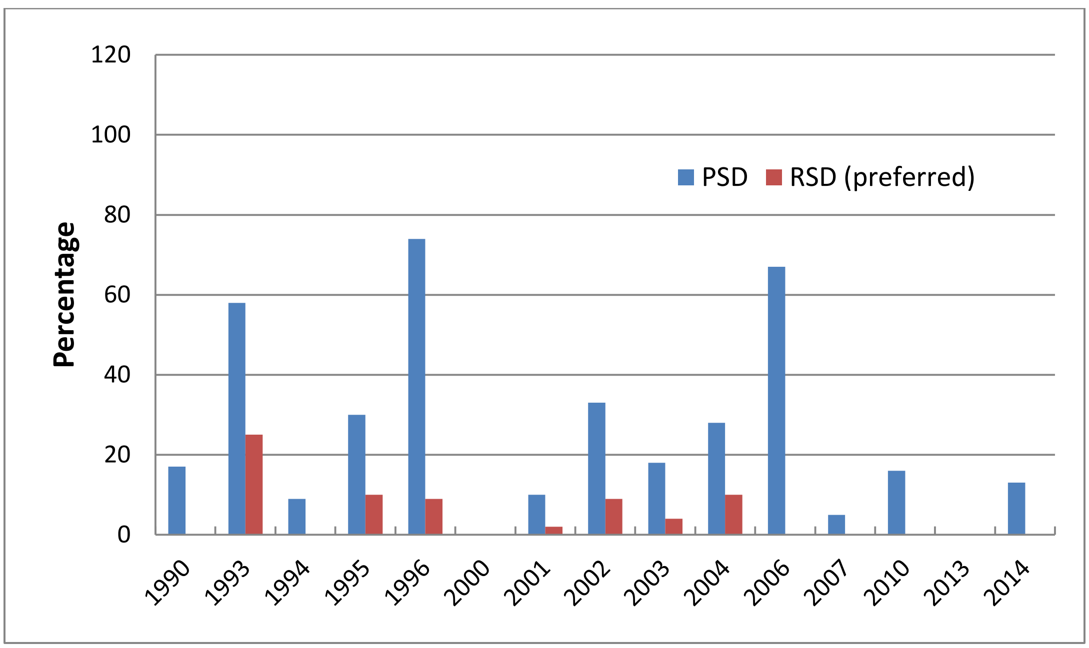

Figure 7. Proportional stock density (PSD) and relative stock density ($RSD_{preferred}$) for largemouth bass on Anacoco Lake, LA from fall electrofishing results, 1990 – 2014.

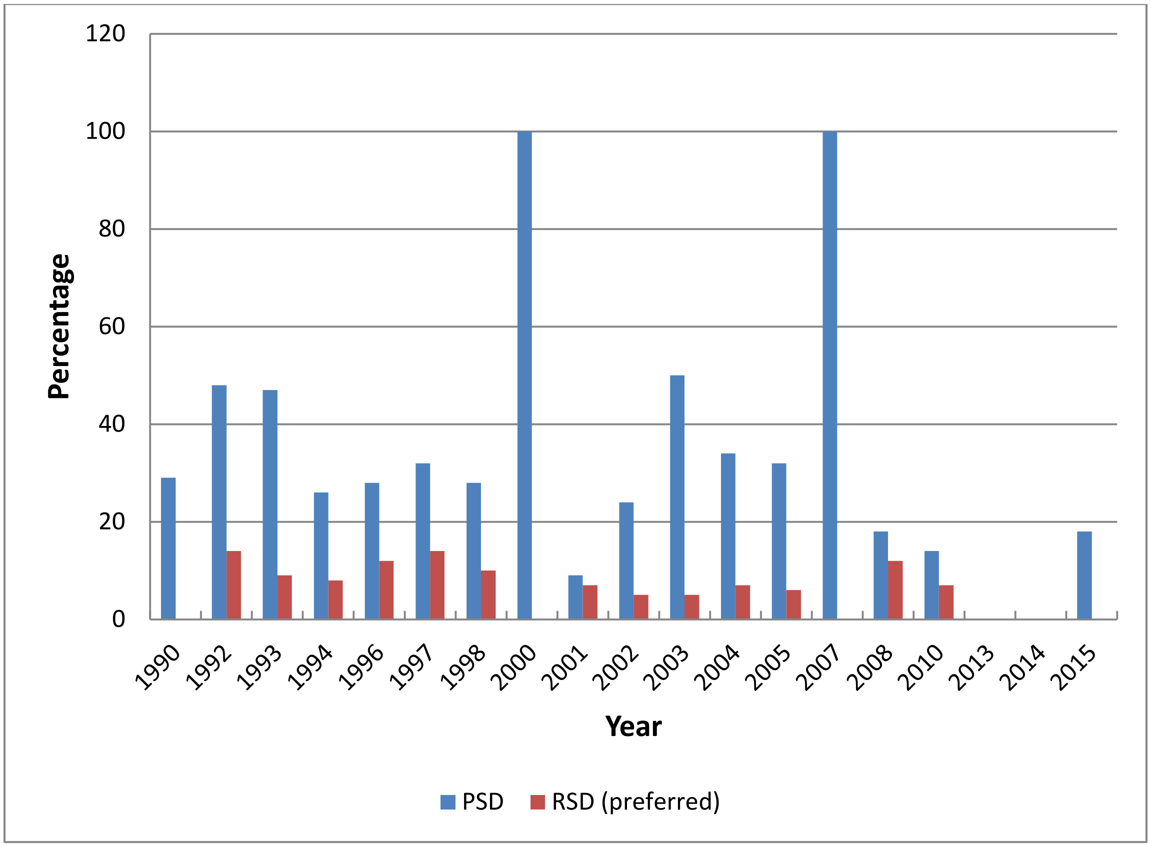

Figure 8. Proportional stock density (PSD) and relative stock density (RSD_{15}) for largemouth bass on Anacoco Lake, LA from spring electrofishing results, 1990 –2015.

<u>Largemouth bass reproduction</u>

Largemouth bass reproduction based on seine haul captures of YOY was variable, but usually two or less LMB/haul from 1990-1998 (Figure 9). Reproduction peaked in 2000, immediately after the renovation; however, seine captures of YOY were very low (0.67 LMB/haul) the following year (2001). While this would normally indicate poor reproduction in 2001, analysis of 2001 spring electrofishing results (Figure 6) show record high catch rates (123.2 LMB/hour) of sub stock-size (<8" TL) fish from May of that year. This may indicate that an early spawn occurred in 2001 causing the fish to be larger than normal during standardized seine sampling. Research shows that LMB are less susceptible to seining gear once they reach 70mm (2.75") TL (Jackson and Noble 1995). If this was the case, the fish would have been less susceptible to the gear and the resulting gear bias could have caused an artificially low catch rate in standardized seine samples. Conversely, the strong year class documented in 2000 fall electrofishing results (Figure 5) may have negatively impacted 2001 reproduction through density dependent predation/competition attributable to already high LMB relative abundance.

The effects of high turbidity and drawdowns on LMB reproduction are clearly illustrated by seine results from 2005 and 2007, respectively (Figure 9). While high turbidity levels led to low seine catch rates in 2005 (0.0 LMB/haul), the 2006 drawdown temporarily improved water quality and stimulated reproduction in 2007 (5.7 /haul, Figures 15 and 9).

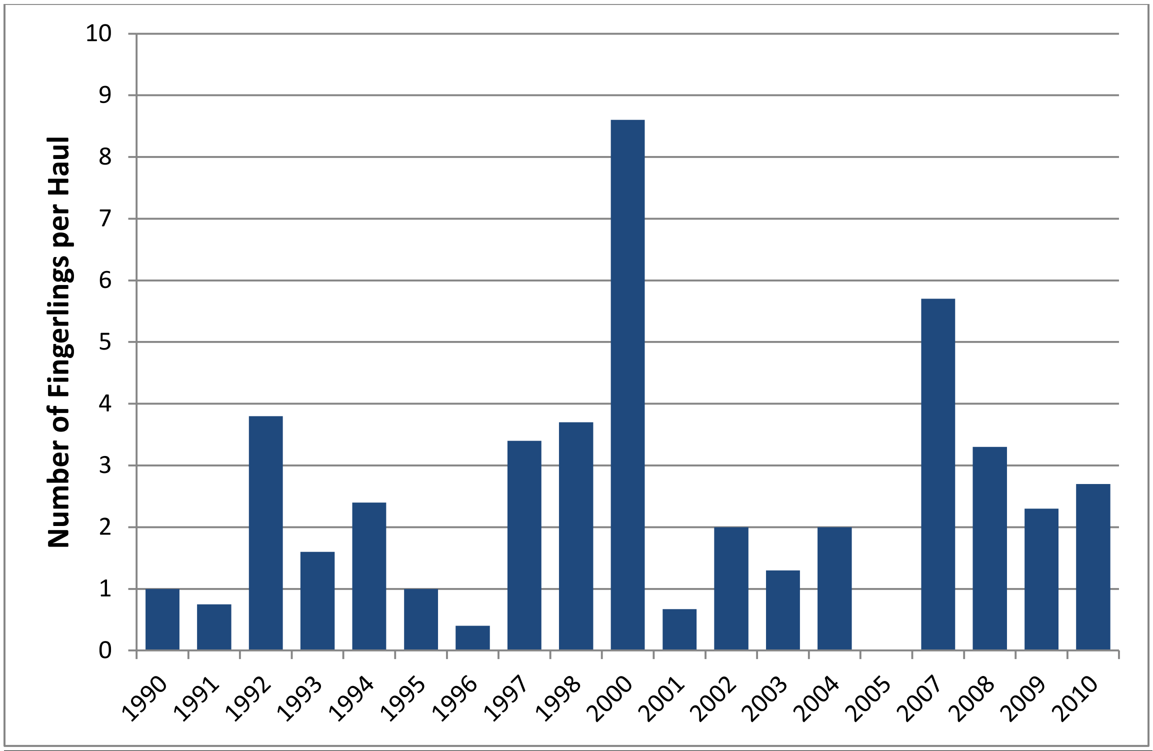

Figure 9. Number of largemouth bass YOY captured per-seine-haul from 1990-2010 in standardized summer seine sampling results.

In 2011, LDWF discontinued the use of seine samples to collect YOY abundance estimates. By examining sub-stock relative abundance changes from spring to fall of a given year, we are given a relative indicator of recruitment success. In 2013, sub-stock catch rates increased from 1.0 bass/hour (spring) to 91.4 bass/hour (fall) indicating a very successful recruitment year (Figures 5 and 6). In 2014 sub-stock catch rates declined overall to 11.1 in the spring and 22 in the fall.

Largemouth bass genetics

Genetic analyses through electrophoresis of liver tissues from largemouth bass show a range of 13 to 33% total Florida largemouth bass (FLMB) influence from 2001-2013 (Table 1). A total of 1,022,369 FLMB were stocked in the lake from 2000-2013 after the renovation (Part A, Table 6). Only two of the years analyzed (2002 and 2013) had greater than 0% pure FLMB influence. The highest total FLMB influence (33%) was recorded in 2013, with 6% pure FLMB collected in that year (Table 1). LDWF stocked only pure FLMB in 2013 following the 2012 drawdown, and assuming all sub-stock fish captured were YOY, stocked fish provided a total contribution of 5.9% (4 FLMB/68 total LMB x 100) to year class strength. Hybrid crosses between northern LMB and FLMB increased by roughly 10% for every year sampled through 2004, with the most recent sample (2013) showing 27% hybrid influence. These combined results indicate that while FLMB stockings are successful at introducing the Florida genome into Anacoco Lake, the large majority of this influence is achieved through interbreeding of stocked and resident fish. This also indicates that the preponderance of fish observed after drawdowns are the result of natural reproduction and not directly attributable to stocking.

Table 1. Genetic analysis of largemouth bass samples from Anacoco Lake taken in 2001– 2013.

Year	Number	Northern	Florida	Hybrid	Florida Influence
2001	31	87%	0%	13%	13%
2002	31	74%	6%	20%	26%
2004	23	70%	0%	30%	30%
2013	98	67%	6%	27%	33%

Spotted bass

Spotted bass comprise 10% to 15% of the total population of black bass found in Anacoco Lake. They are found most commonly in the lower reaches of the reservoir along the face of the dam, where the predominant habitat is gravel and rip-rap.

Forage and Biomass

According to standardized electrofishing sampling of community assemblage, the most commonly available forage for largemouth bass in Anacoco Lake are bluegill (*Lepomis macrochirus*), threadfin shad (*Dorosoma petenense*), and gizzard shad (*D. cepedianum*, Figure 10). While all other forage species collectively comprise a significant portion of the total forage base, no other species exhibits the same abundance individually. Prior to the renovation, bluegills were the predominant forage (Figure 10). Bluegill made up the majority (64% and 66%) of the total (449 and 397) forage specimens captured in 2014 and 2015, respectively (Figure 10). Abundance of all forage species increased from 2001-2003 and again in 2014, indicating the success of the past renovations at increasing productivity in Anacoco Lake. Effects of turbidity were again apparent in 2006, with only three forage fish captured in standardized forage sampling that year (Figure 10). LDWF forage sampling is not specifically designed to capture shad species, therefore shad abundance may actually be under-represented in some years.

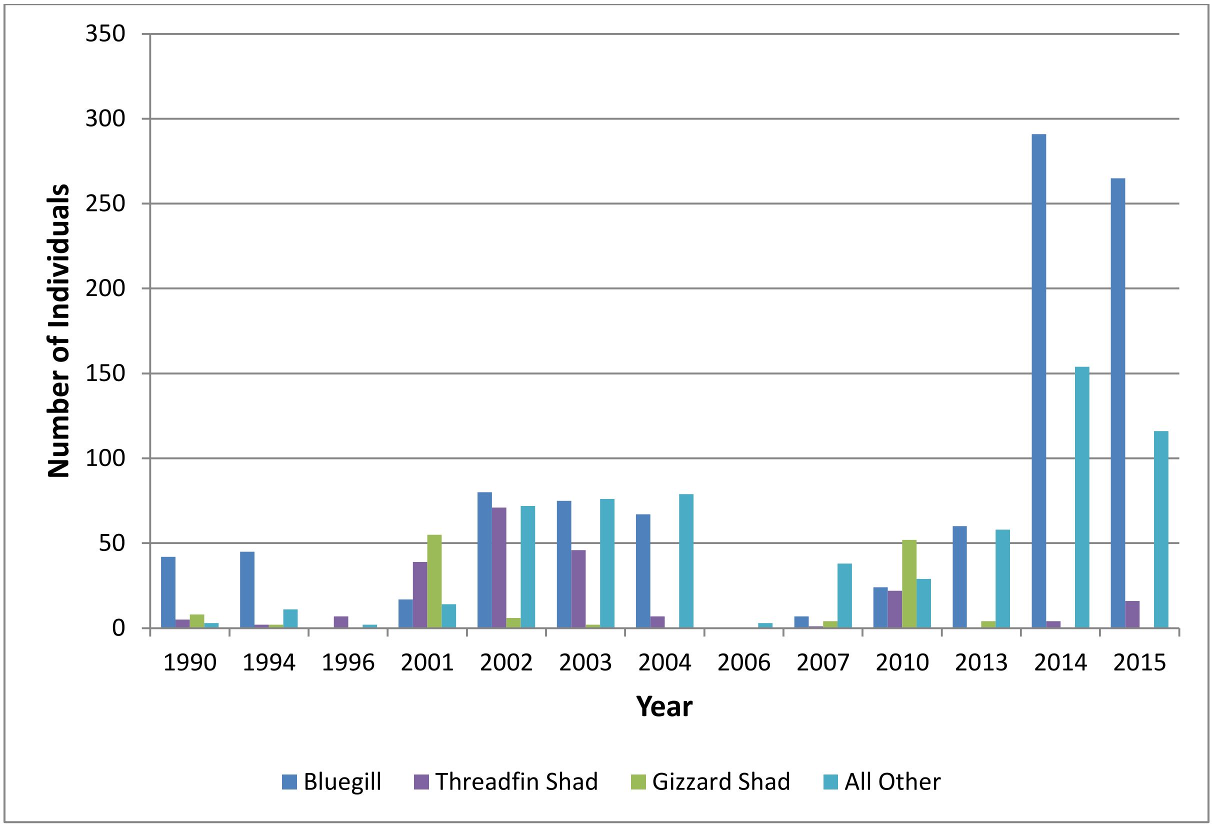

Figure 10. The number of bluegill, threadfin shad, gizzard shad, and all other forage species less than 6 inches TL captured in standardized fall forage samples from 1990-2015.

Mean total standing crop of fish taken from biomass samples in Anacoco Lake from 1966-1975, 1977-1984, and 1993-2006 was 73.7, 48.2, and 67.2 lbs/acre respectively (Figure 11). The peak production year for total standing crop was in 1966 (93.4 lbs./acre) and the minimum production year was 1975 (16.21 lbs./acre). Peak game fish production occurred in 1969 (41.0 lbs./acre) and 1979 (42.4 lbs./acre). Negative impacts of high turbidity are evident in 2006 rotenone samples, with record low game fish production (0.85 lbs./acre) recorded for that year (Figure 11).

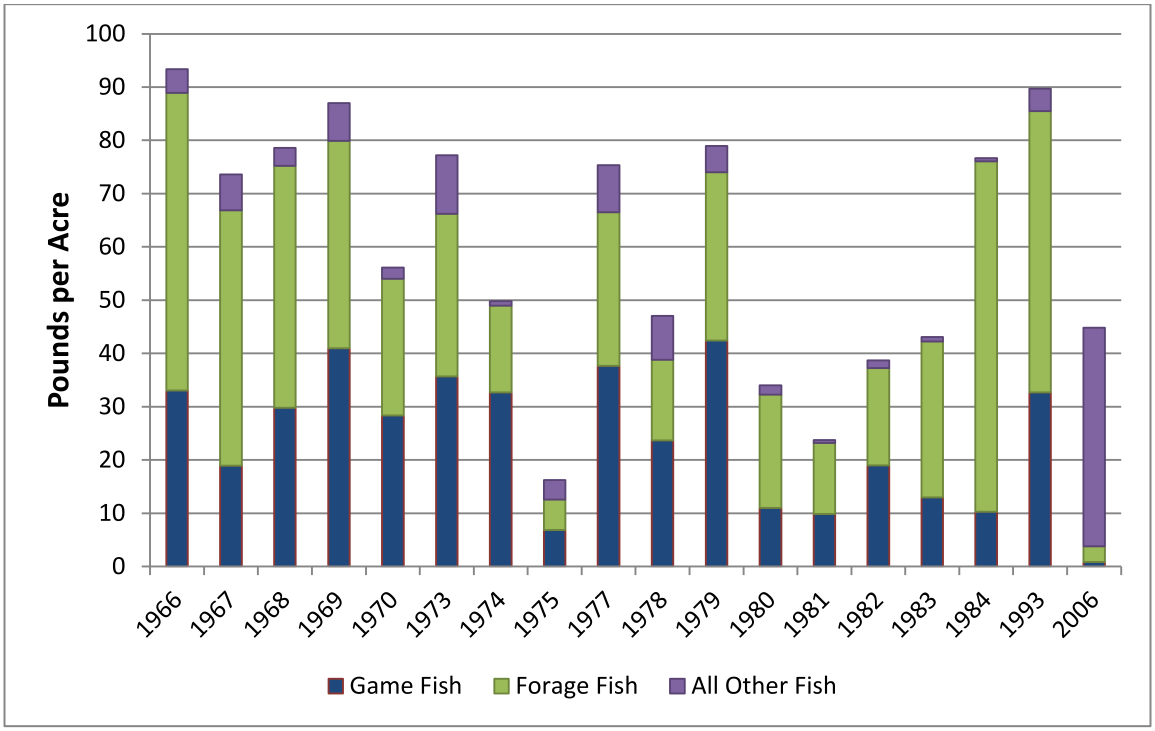

Figure 11. The total standing crop estimates (biomass) in pounds per acre for game fish, forage fish, and all other fish from 1966-2006.

Gill Net Results—Gill net sampling is used to determine the status of large bass and other large fish species. Results are reported in pounds per net-night with a net-night defined as 100’ of net fished for 12 hours. Increases in relative abundance of blue and flathead catfish were observed post renovation through 2004, but neither of these species were captured in 2005 and 2006 (Figure 12). This indicates that the renovation had an overall beneficial effect on catfish production in Anacoco Lake, but abundance of large catfish may have been reduced during high turbidity years. While large catfish abundace was reduced during this time period, rotenone results from 2006 showed an abundance of small blue and channel catfish, possibly indicative of over-population and associated reduced growth rates. Results in Figure 12 from 2013-2016 show increases in gill net samples of channel, blue, and flathead catfish.

Common carp were first captured in gill nets on Anacoco Lake in 1997. Dramatic increases in carp abundance were observed post renovation with this species being the most abundant by weight from 2001-2007 (Figure 12). The effects of common carp on water quality are well documented with high carp numbers associated with high turbidity as these fish disturb bottom sediments during feeding activity. While the presence of carp is an obvious contributing factor to high turbidity observed in Anacoco Lake, carp abundance was high during low turbidity years (2001-2004), but showed a dramatic decrease during peak turbidity years (2005 and 2006, Figures 12 and 15). These results indicate it is unlikely that high turbidities observed on Anacoco Lake can be solely attributed to the presence of common carp in the lake.

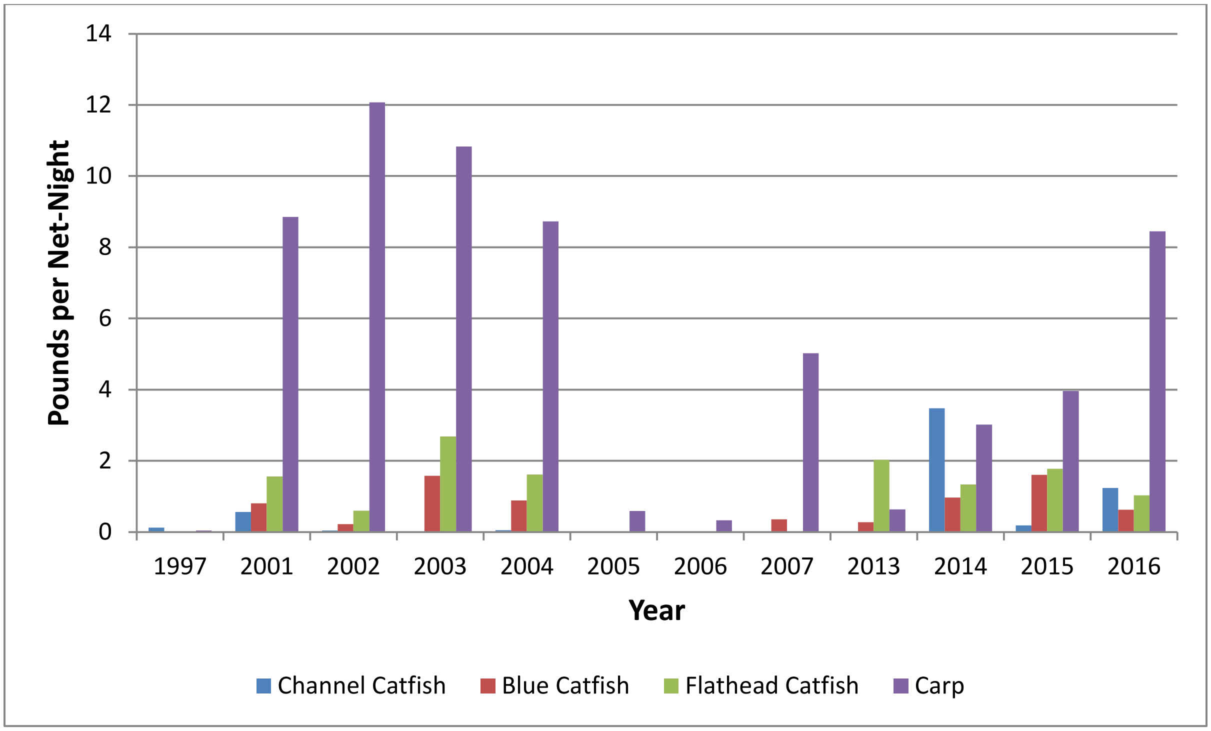

Figure 12. Annual catch per unit effort (pounds per net-night) of channel catfish, blue catfish, flathead catfish and common carp captured in LDWF standardized gill net sampling in Anacoco Lake, LA, from 1997-2016.

Crappie

While both white and black crappies are found in Anacoco Lake, black crappies historically have been more abundant. In recent years, the crappie population has shifted to predominantly white crappie, likely attributable to increased turbidity, a habitat condition which favors white crappie abundance. Standardized lead net samples specifically targeting crappie in fall 2007 yielded a total catch of five crappies (white) from 6 samples for a catch rate of 0.2 crappie/net night. Part of this low catch rate is attributable to gear selectivity since most of the crappie captured in fall electrofishing from 2007 were less than 6” TL and therefore would not be effectively sampled by lead nets. Relatively high catch rates of small crappie in standardized electrofishing (7.7 sub-stock crappies/hour) combined with low catch rates in lead nets, indicate that while overall crappie abundance was low, reproduction in 2007 was high in response to the 2006 fall drawdown.

Creel Surveys

Results of the 2001 creel survey indicate that fishing trips were from 1.25 to 3.5 hours in duration with 6,509 anglers traveling an average of 23 miles to fish the reservoir (Table 2). Largemouth bass anglers were the largest angler group accounting for 60% of the total fishermen sampled, followed by crappie anglers (16%), non-specific anglers (14%), and catfish anglers (6%).

Largemouth bass anglers

Angler creel survey results from 2001 indicated a total angler effort of 21,591 hours. Bass anglers accounted for the most effort (13,818 hours) followed by crappie anglers (3,495 hours), non-specific anglers (3,104), and catfish anglers (597 hours). With an estimated 1,600 acres of LMB habitat in Anacoco Lake, angler effort equates to 8.6 bass angler hours/acre/year. The amount of angler effort required to effect change in population size structure is more than three times that value (Eder 1984). Approximately 88% of all bass caught were captured by bass anglers. An estimated 73% of those bass (5,883) were released (Table 4). Of the estimated 2,137 LMB harvested, 83.3% were between 9" and 11" TL (Table 4 and Figure 13). Bass anglers were eight times more likely to release their catch (3.13 released/trip) than harvest their catch (0.39 harvested/trip, Table 3). The combination of low angler effort and a high release rate negate any potential benefit of future harvest restrictions to the Anacoco Lake LMB population.

Table 2. The estimates for the number of total anglers, average angler party size, average duration of fishing trip, and average distance traveled from residence to boat ramp for Anacoco Lake from the 2001 creel survey.

Target Species	Total # of anglers	Mean # of anglers in party	Mean length of fishing trip (hrs.)	Mean one-way distance traveled to ramp
Largemouth Bass	3913	1.72	3.48	26
Crappie	1033	2.1	3.36	22
Anything	916	1.91	2.95	14
Catfish	401	1.52	1.24	13

Table 3. The estimated largemouth bass caught per trip, released per trip, harvested per trip, and mean weight of harvested bass for bass anglers fishing Anacoco Lake in 2001.

Target Species	# LMB caught per trip	#LMB released per trip	# LMB harvested per trip	Average weight of harvested LMB (lbs.)
Largemouth Bass	3.52	3.13	0.39	0.68

Table 4. Estimated number of largemouth bass harvested, released, released below 12 inches, and released above 12 inches by largemouth bass anglers fishing Anacoco Lake in 2001.

Target Species	Total #LMB harvested	Total #LMB released	#LMB released below 12"	#LMB released above 12"
Largemouth Bass	2137	5883	5393	490

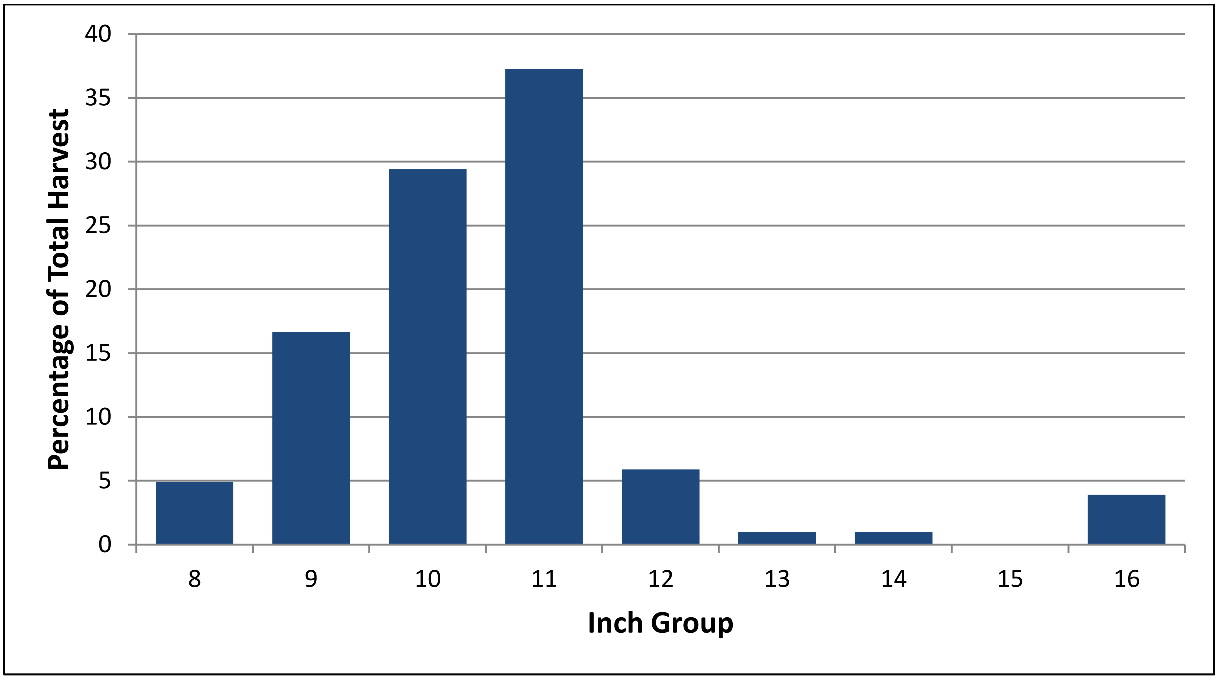

Figure 13. The percentage of total largemouth bass harvested per inch group on Anacoco Lake, LA, during the 2001 creel survey. (n=102 actual interviews).

Crappie anglers

The 2001 Anacoco Lake creel survey results indicate peak crappie fishing occurs in March and October with sporadic effort occurring outside of these two months. The majority of crappie harvested (60.7%) were between 7" and 9" in total length (Figure 14). Thirty percent of the total harvest was 11" to 13" in TL. An estimated total of 1,641 crappies were harvested with an average weight of 1.19 lbs. (Table 5). All creel estimates, charts, and figures are for black and white crappie species combined.

Table 5. Total crappie harvested, number harvested per trip, and average weight of crappie harvested by crappie anglers fishing Anacoco Lake in 2001.

Target Species	Total # Crappie harvested	# Crappie harvested per trip	Average weight of harvested Crappie (lbs)
Crappie	1641	1.21	1.19

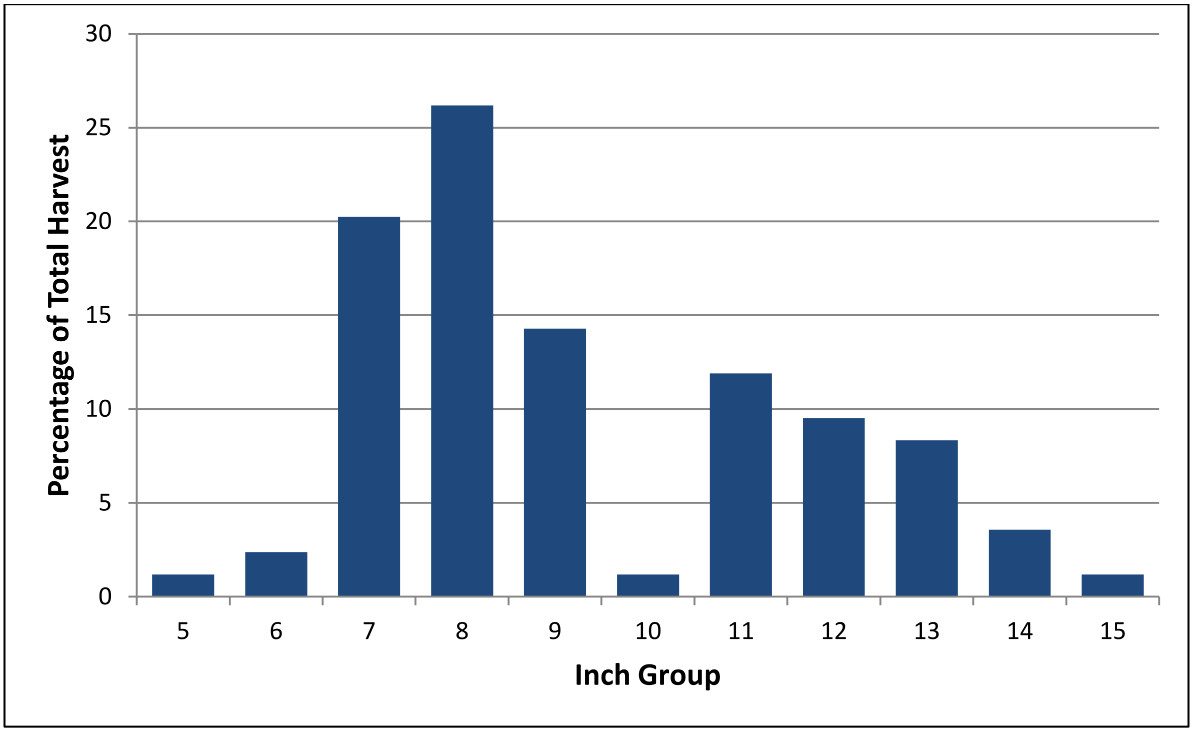

Figure 14. The percentages of crappies harvested by inch group on Anacoco Lake, LA, from the 2001 creel survey (n=84 actual interviews).

Commercial

TITLE 76

Chapter 1. Freshwater Sports and Commercial Fishing

103. Anacoco Lake, Lake Vernon and Anacoco Bayou

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B. Therefore, be it resolved, the Louisiana Wildlife and Fisheries Commission hereby prohibits the use of fish nets (gill nets, trammel nets, hoop nets, fish seines) in Anacoco Lake, Lake Vernon and that portion of Anacoco Bayou between the two lakes, Vernon Parish, LA.

AUTHORITY NOTE: Promulgated in accordance with R.S. 56:22.

HISTORICAL NOTE: Promulgated by the Department of Wildlife and Fisheries, Wildlife and Fisheries Commission, LR 4:57 (February 1978), amended LR 7:356 (July 1981), LR 12:843 (December 1986).

The statewide commercial fishing regulations may be viewed at the link below:
http://www.wlf.louisiana.gov/fishing/regulations

HABITAT EVALUATION

Turbidity

Excessive turbidity has been the primary habitat impairment on Anacoco Lake for the past decade. While the lake has historically experienced brief periods of high turbidity (usually in association with rainfall events), water clarity would increase naturally as particles settled out of suspension. This contrasts starkly with observed water clarity from 2004-2008, where water clarity remained poor for several consecutive years (Figure 15). In 2006, a summer/fall drawdown was conducted in an attempt to correct this problem. While this action temporarily improved water clarity, high turbidity returned by fall of 2007 (Figure 15). In 2008, the lake was lowered significantly (14’ to 18’ below pool elevation) to conduct emergency repairs on the drawdown structure. This event led to improved water clarity in 2009-2010 (Figure 15). This improvement in water quality from a significant summer drawdown was the basis for LDWF’s 2012 growing season drawdown, when high turbidity levels returned in 2011 after a partial dewatering in the fall of 2010. Following the 2012 drawdown, Anacoco Lake exhibited high water clarity values (60”) through 2013 (Figure 15). The benefits experienced in 2013 were short lived with water clarity dropping to 15” in 2014 through 2015 (Figure 15).

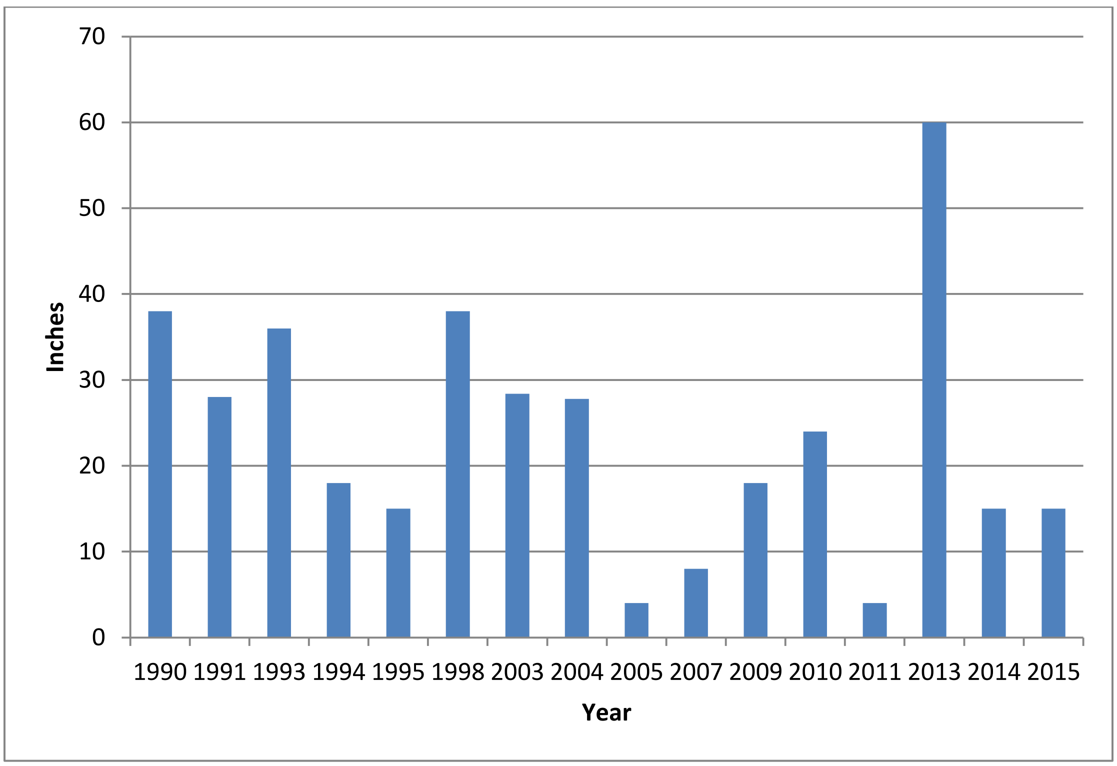

Figure 15. Secchi disk transparency measurements (clarity in inches) taken during vegetative type mapping surveys for Anacoco Lake, LA from 1990-2015.

Aquatic Vegetation
Anacoco Lake, in Vernon Parish, was surveyed for the presence of aquatic vegetation on September 2, 2015. On the day of the survey, water clarity was 38.1 cm as measured by secchi disk, and turbidity was measured at 18.8 ntu (Nephelometric Turbidity Units).

Plant densities were designated as “Low,” “Medium,” and “High.” The heaviest densities of plants were in the northern portions of the lake, and most notably in the northeastern end, though earlier spray efforts had been effective in the areas that are perennial problems. The most common species of concern in these areas were alligator weed (*Alternanthera philoxeroides*) and primrose (*Ludwigia* spp.). These two species made up the majority of plants in heavily infested areas. Common salvinia (*Salvinia minima*) was observed sheltered in a southeastern cove and in the cypress trees on the northern end of the lake. *Phragmites* spp. was observed in one small stand on the eastern end of the lake. Much of the 2’-4’ contour of the lake was occupied by light to medium densities of spikerush (*Eleocharis* spp.), pondweed (*Potamogeton* spp.), coontail (*Ceratophyllum demersum*) and stonewort (*Nitella* spp.).

In the winter and spring of 2013, LDWF planted bulrush (*Schoenoplectus californicus*), white water lily (*Nymphaea odorata*), and tape grass (*Vallisneria americana*) throughout the lake. So far, bulrush survival has been high, water lilies were observed mostly in the northern and western portions of the lake with a few large stands present, and no surviving tape grass was observed.

Fish Spawning Habitat
Anacoco Lake exhibits a wide range of bottom substrates (see below) with varying degrees of utilization by nest builders (centrarchids) for spawning. Firm bottoms with little organic accumulation provide nest building fish with ample spawning substrate in the lake. The abundance of inundated and fallen riparian timber also provides cavity nesters (catfishes) with sufficient areas for reproduction. Spawning habitat is not a limiting factor in Anacoco Lake.

Juvenile fish habitat
Anacoco Lake has scarce protective cover for juvenile fish in the form of submersed aquatic vegetation (SAV). Predominant SAV species include bladderwort, muskgrass, and stonewort. Alligator weed can reach high densities on the flats in the northern part of the lake, displacing more beneficial aquatic plants in these areas. Overall, juvenile fish habitat is currently a limiting factor to sport fish species in Anacoco Lake. In 2012-2013, LDWF partnered with the Vernon Parish Game and Fish Commission to conduct an aquatic plant restoration effort (Appendix I). Assessment of the success of this effort is ongoing quarterly through 2014. The most recent planting assessment (March 2014) resulted in the following: approximately 80% total survival of bullwhips (*Scirpus californicus*), water lilies *(Nymphaea odorata)* observed at 25% of the planting sites, and no tape-grass (*Vallisneria americana*) observed at any site.

Adult fish habitat
While all of the lake may be used by different species at certain times of the year, a

thermocline is normally present in the lower portion of the lake during warmer months. The 1,600 acres (62%) of lake surface area that does not exhibit thermal stratification is considered to be bass habitat. Because almost half the lake is only seasonally used by centrarchids, adult habitat is a limiting factor for these species.

Water fertility

Overall fertility has declined since inundation due to the natural aging process of the reservoir. While Anacoco Lake has a relatively large watershed (50:1), the soils in this area are relatively nutrient poor. Additionally, approximately half of this total watershed drains into Vernon Lake (upstream of Anacoco), which utilizes watershed nutrient inputs before they reach Anacoco Lake. The aging process and the addition of Vernon Lake have been detrimental to overall fisheries production in Anacoco by reducing primary productivity. Overall, water fertility is the primary limiting factor in Anacoco Lake.

Problem vegetation

Unlike many of our inland reservoirs, Anacoco Lake has scarce coverage of submersed or emergent aquatic vegetation. In fact, the absence of submersed plants has reduced the fisheries potential of Anacoco Lake. Aquatic vegetation is primarily located in the northern end of the lake and includes alligator weed (*Alternanthera philoxeroides*) and water primrose (*Ludwigia* spp.). These plants may negatively impact habitat (by displacement) of more desirable species. Common salvinia (*Salvinia minima*) has also been observed in backwaters on the western half of the lake. Fortunately, the invasive species has not reached concentrations high enough to warrant corrective action.

<u>Substrate</u>

Bottom substrates of Anacoco Lake range from sand to clay. The majority of the lake bottom consists of loam soils (sandy, silty, and clay loam) with a concentration of clay on the southern end of the lake (NRCS Technical Soils Investigation, Appendix II).

<u>Artificial Structure</u>

Many of the artificial structures found in Anacoco Lake consist of wharves, piers, and duck blinds. Private property owners commonly place woody brush adjacent to shorelines and piers as fish attractants.

CONDITION IMBALANCE / PROBLEM

Complex cover is lacking for sport fish production. Complex cover in Anacoco Lake is approximately 10%. Increased aquatic vegetation coverage would increase fisheries production and possibly provide improved water clarity.

CORRECTIVE ACTION NEEDED

Sediment contributions into Anacoco Lake should be minimized.

Native aquatic vegetation should be re-established to provide increased invertebrate forage, improved water clarity and increased fisheries productivity.

RECOMMENDATIONS

1. Work with Vernon Parish Police Jury, NRCS, LADA, and others to identify and stabilize exposed soil areas that may be sources of non-point runoff turbidity, and enact BMP's for shoreline development, bridge crossings, and roadside drainages.

2. Continue monitoring the success of aquatic plant introductions (Appendix I).

3. To accurately assess effects of the 2012 drawdown on fisheries and water quality, and provide time for aquatic plant establishment, no drawdowns are recommended through 2017. In early 2016' LDWF and the VPGFC agreed to put Anacoco on a drawdown schedule. The first is scheduled in September of 2019 and every 7 years thereafter unless unforeseen circumstances arise.

4. Conduct two treatments (one spring, one late summer) with imazapyr (0.5 gal/acre) and Turbulence surfactant (0.25 gal/acre) for alligator weed and water primrose control. An imazamox treatment at the same rate may be substituted depending on the proximity of camps/homes to the treatment area. All herbicide applications will be conducted in accordance with the LDWF Aquatic Herbicide Application Procedure to facilitate public access.

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APPENDIX I

Restoration Plan for Native Aquatic Plants in Anacoco Reservoir

The objective of these plantings will be to establish/restore beneficial, native, aquatic plants in both Anacoco and Vernon Lakes. This will consist of a multi-tiered approach with different plants combining effects and benefits to provide overall enhancement to fisheries habitat within the lakes. Plants will be divided between Anacoco and Vernon Lakes based on need, with the bulk of the plantings occurring on Anacoco Lake as per the 2012 LDWF drawdown plan.

Plant	Quantity	Benefits
Bullwhip (*Scirpus californicus*)	3000	Shoreline protection, fisheries habitat
Fragrant water lily (*Nymphaea odorata*)	7500	Break up wind action, bottom stabilization, fisheries habitat
Eel grass (*Vallisneria americana*)	15000	Complex cover for fish (habitat), bottom stabilization
Total:	28500	

The Vernon Parish Police Jury will provide funds through the Vernon Parish Game and Fish Commission to purchase plants. Labor and installation will be provided jointly by Vernon Parish and LDWF.

<u>Schedule:</u>
Fall 2012: Prior to conclusion of 2012 drawdown, plant bullwhips around margins of the lake (accomplished).

Spring 2013: Purchase water lily and eel grass from Wildlife Nurseries Inc. Disperse pre-weighted plants into designated target areas (accomplished). Exclosures will be constructed on some plots to test for herbivory.

Summer 2013 through winter 2014: Plant establishment will be assessed quarterly.

APPENDIX II

NRCS Technical Soil Services Investigation 2012

Natural Resources Conservation Service
State Office – Soils Section
3737 Government Street
Alexandria, LA 71302
Phone: (318) 473-7757
Cell: (318) 623-9512

Subject: Technical Soil Services Investigation Date: 11/19/2012
Vernon Parish
Anacoco Lake Turbidity Investigation
To: Eric Shanks
cc: Charles Guillory, Rebecca Fox, Mitch Mouton, Dr. Brian LeBlanc

Problem summary: Anacoco Lake is located in west central Vernon Parish Louisiana. The lake has a documented history of sustained turbidity in recent years due to high levels of suspended sediments. The sustained turbidity has resulted in reduced aesthetic value and impaired fisheries biological function of the lake.

Possible causes/factors: Among the several potential factors contributing to the turbidity problem that have been considered and discussed include: a) introduction of suspended sediments via feeder streams from adjacent watersheds due to cultural activities; b) exposure of lake bed sediments with natural dispersive chemical characteristics; c) wave action induced erosion of lake shoreline soils due to minimal shoreline vegetation; d) wave action induced suspension of unconsolidated lake sediments in shallow areas due to minimal aquatic and shoreline vegetation; e) natural accumulation of sediment in this low energy water body resulting in progressively larger areas of shallow water which are susceptible to wave action induced suspension of unconsolidated sediments. The primary factor(s) contributing to the turbidity problem have not been definitively identified.

Initial remedial actions: During the summer and early fall of 2012 the lake water level was drawn down in an effort to promote consolidation of bottom sediments and establishment of grassy vegetation which tends to minimize turbidity for some expected time period after re-establishing normal lake water levels.

Initial causal factor investigation: In addition to the beneficial effects of sediment consolidation and vegetation establishment, the lake draw down afforded an opportunity for a visual reconnaissance of the lake bed and to collect sediment samples for laboratory physical and chemical analysis. On October 10, 2012 Rebecca Fox (Soil Scientist _ NRCS) and I met with Eric Shanks (Biologist Manager _ LDWF) at Anacoco Lake to conduct a field evaluation of the lake bed and to collect sediment samples for a variety of soils analysis.
Prior to collection of sediment samples for lab analysis we conducted a cursory examination of sediment cores taken with a bucket auger across the extent of the dry lake bed at multiple landscape positions. Utilizing ATV's we traversed the lake bed starting at the south end near the dam structure and worked our way north to a location near the point of entry of Bayou Anacoco and Prairie Creek. We then worked our way south toward the dam collecting surface and subsurface sediment samples which we hope will yield the range of characteristic reflective of the lake bed sediments at different contour intervals. Three general physiographic regions were identified and sampled as the shallow flats on the extreme north end, intermediate depth flats in the middle lake area, and the deep flats and basin on the southern end. Samples were bagged and labeled and corresponding geo-coordinates recorded.
Samples were returned to the Opelousas Soil Survey Lab for processing and were subdivided. By arrangement with Dr. Brian LeBlanc (Professor, LSU Callegeri Environmental Center & Sea Grant) subsamples were hand delivered to the LSU Soil Fertility Lab in Sturgis Hall for chemical analysis using their 'Flood Test'. Flood Test analysis was developed after recent coastal inundation of soils by hurricane storm surge flood waters. The test evaluates for salts, conductivity sodium, calcium, magnesium, sulfur, chlorides and sodium adsorption ratio (SAR). SAR is used as a relative measure of sodium ion vs. calcium and magnesium. High sodium levels in relation to calcium and magnesium, particularly in conjunction with low conductivity tend to induce soil dispersion and a host of other

negative soil behaviors. The second subsample was used by the NRCS soil survey staff to determine soil texture analysis and evaluation for dispersive characteristics utilizing the crumb test and a smaller subset was analyzed using the double hydrometer dispersion evaluation method. The crumb test is a relatively quick field method to analyze samples for potential dispersive characteristics. Samples indicating potential dispersion were subsequently analyzed using the double hydrometer method. The double hydrometer evaluates the relative particle size settling rates of a sample using dispersant vs. sample using distilled water.

Lab Results and Initial Interpretations: Attachment 1 has a map indicating location of sediment sample sites overlaid on lake depth contours. Additionally, the attachment has a table with consolidated lab results from LSU and NRCS Soil Survey labs. Chemical analysis indicated that: a). sediment conductivities are all low (<1 dS/m); and b). SAR values are all very low. These results indicate that there should not be a high tendency for soil dispersion based on sodium chemistry which is the most common cause. When considering the results of the soil physical analysis, there were mixed results with the 1 hour and 4 hour crumb dispersion tests. Soils that have a 3 or 4 reaction in the crumb test are almost always dispersive in other tests and field performance. However, the crumb test is a field indicator test and samples testing positive should be examined with more decisive lab methods. Samples that showed the highest propensity for dispersion by the crumb test were subsequently analyzed using the double hydrometer method. Based on double hydrometer, none of the samples show significant tendency for inter-particle dispersion. Dispersion percentages >60 are indicative of dispersive soils whereas soils with <30 percent relative dispersion seldom have dispersive chemistry. Initial conclusions, based upon soil chemical analysis, crumb and double hydrometer analysis, are that suspended sediments in the lake water column are not likely due to soil chemistry. As such, other factors such as wave induced shoreline erosion and or wave induced sediment suspension in shallow water areas, or feeder stream introduction of suspended sediments should be evaluated further. Long-term in-stream water sampling should be a priority and will be necessary to calculate stream contribution of sediment load versus wave energy erosion and re-suspension in shallow water areas.

Future Actions: NRCS soil scientist plan to return to the lake site the first week of December to conduct a more aggressive evaluation of shoreline areas in an attempt to identify likely areas where wave action can cause erosion of exposed clayey shoreline. This site visit will coincide with shoreline bullwhip plantings conducted by LDWF.
We would especially like to thank Dr. Brian LeBlanc, LSU Callegeri Environmental Center & Sea Grant for soil chemical analysis conducted by LSU Soil Fertility Lab.

Sincerely,
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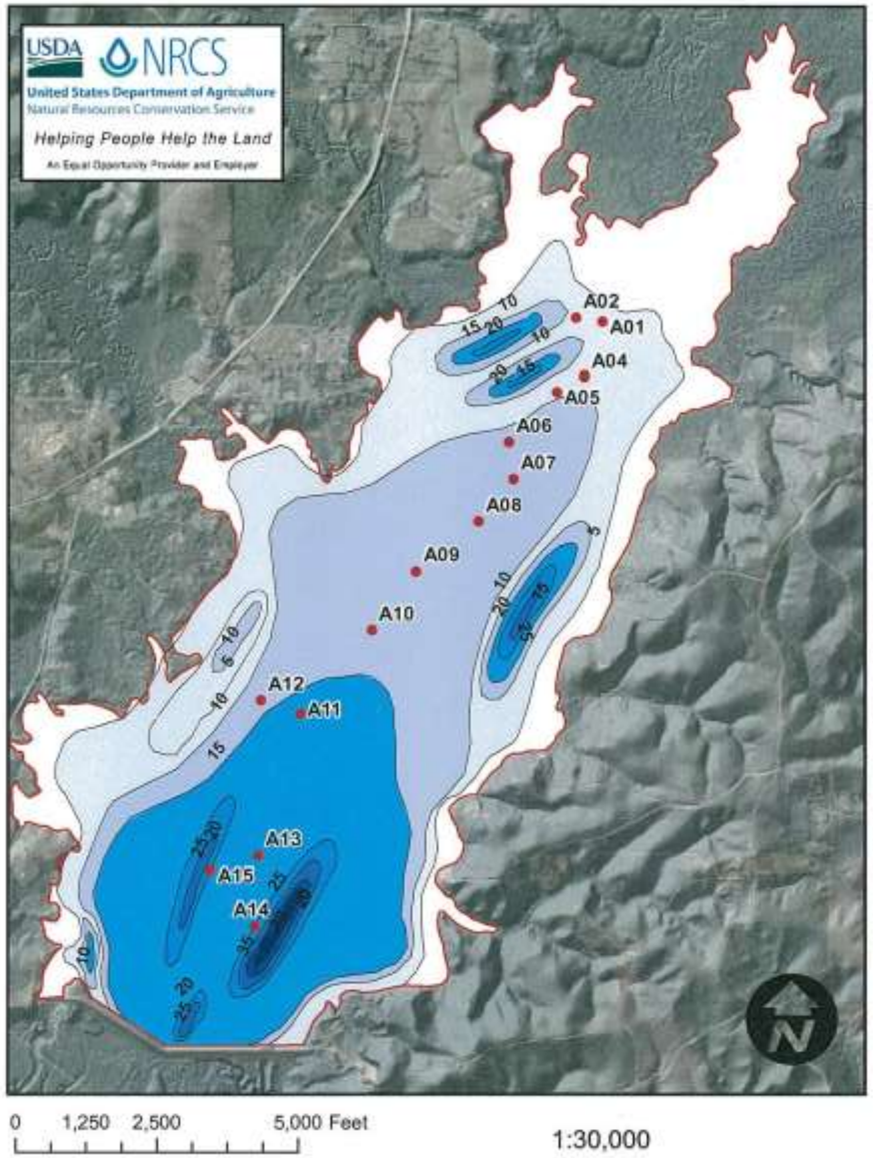

Anacoco Lake Soil Sampling Sites

Sample ID	Ca	Mg	Na	Cl	Salts	Conductivity	SAR	Crumb Test* 1 Hour		Crumb Test* 4 Hour		Double Hydrometer**	USDA Texture
	ppm	ppm	ppm	ppm	ppm	dS/m	_	Rep.1	Rep2	Rep.1	Rep2	% Disp.	
A01 Surface	30.1	4.9	5.7	61.7	113.5	0.18	0.25	1	1	1	1	12.8	Loam
A02 Surface	20.5	2.8	7.7	55.5	77.2	0.12	0.42	1	2	2	4	8.7	Clay Loam
A03 Surface	59.8	11.3	11.3	49.5	322.6	0.50	0.35	1	1	1	1		
A04 Surface	37.1	4.0	4.3	42.7	85.5	0.13	0.18	1	2	1	2		
A05 Surface	17.3	2.5	3.7	37.3	55.0	0.09	0.22	2	2	4	2	23.5	Fine Sandy Loam
A06 Surface	38.1	4.4	9.3	47.1	101.6	0.16	0.38	1	1	2	3		
A07 Surface	28.5	5.5	9.3	32.6	112.4	0.18	0.42	4	3	4	4	11.4	Loam
A07 Subsurface	10.4	7.0	5.4	29.4	50.0	0.08	0.32	1	1	1	1		
A08 Surface	31.9	4.5	6.6	35.2	53.5	0.08	0.29	1	1	1	1	15.9	Silty Clay Loam
A08 Subsurface	60.7	12.7	14.0	37.7	350.7	0.55	0.43	1	2	2	4		
A09 Surface	22.5	4.5	12.1	45.9	188.4	0.29	0.61	1	1	1	1		
A10 Surface	14.8	5.5	8.8	98.9	93.1	0.15	0.50	1	1	2	3	12.3	Silt Loam
A11 Surface	34.9	7.8	14.4	55.4	246.1	0.38	0.57	1	2	1	2		
A12 Surface	0.1	0.4	1.4	40.3	24.7	0.04	0.41	1	2	2	3		
A13 Surface	19.7	2.6	7.8	42.2	75.5	0.12	0.44	1	1	1	1		
A13 Subsurface	1.1	0.5	2.9	34.2	33.8	0.05	0.58	2	2	2	3		
A14 Surface	13.4	3.2	11.9	34.4	121.5	0.19	0.76	4	1	4	1	11.0	Clay
A14 Subsurface	19.0	4.2	7.4	30.3	53.9	0.08	0.40	4	4	4	4		
A14 SurfaceFrags	15.2	3.7	7.4	28.0	95.1	0.15	0.44	1	1	1	1		
A15 Surface	21.0	4.0	6.4	28.2	78.6	0.12	0.34	1	1	1	1		
A15 Adjacent	0.8	1.8	2.4	21.7	30.3	0.05	0.34	1	1	1	1		

**Soils that have a 3 or 4 reaction in this test almost always are dispersive in other test and field performance. However, soils that have a 1 or 2 crumb test reaction occasionally are shown to be dispersive in other tests or field performance (USDA-SCS, Engineering Division, Soil Mechanics Note No. 13)*

*** Soils with >60% is probably dispersive, <30% is probably not dispersive, between 30-60% other tests are needed to establish whether the sample is significantly dispersive*