LOUISIANA DEPARTMENT OF WILDLIFE & FISHERIES

OFFICE OF FISHERIES
INLAND FISHERIES SECTION

PART VI -B

WATERBODY MANAGEMENT PLAN SERIES

RACCOURCI OLD RIVER

WATERBODY EVALUATION & RECOMMENDATIONS

CHRONOLOGY

September 2013 – Prepared by
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Table of Contents

WATERBODY EVALUATION

STRATEGY STATEMENT

Recreational

Recreational species are managed to provide a sustainable population, while providing anglers the opportunity to catch or harvest numbers of fish.

Commercial

Commercial species of fish are managed to provide a sustainable population.

Species of Greatest Conservation Need

Species of greatest conservation need are managed to ensure sustaining populations.

EXISTING HARVEST REGULATIONS

Recreational

All statewide regulations apply to game fish species, see link below: http://www.wlf.louisiana.gov/regulations

Commercial

All statewide regulations apply to commercial fish species, see link below: http://www.wlf.louisiana.gov/regulations

Species of Greatest Conservation Need

Paddlefish (*Polyodon spathula*) are inhabitants of the lake. Pallid Sturgeon (*Scaphirhynchus albus*) and Shovelnose Sturgeon (*Scaphirhynchus platyrhynchus*), two federally threatened and endangered species, inhabit the reach of the Mississippi River near the connectivity of Raccourci Old River. Gulf Pipefish (*Syngnathus scovelli*) is listed as a species of concern in the 2015 Louisiana Comprehensive Wildlife Action Plan.
https://www.wlf.louisiana.gov/assets/Resources/Publications/Wildlife_Action_Plans/Wildlife_Action_Plan_2015.pdf

SPECIES EVALUATION

Recreational

Largemouth Bass (*Micropterus salmoides*) are targeted for evaluation since they are a species indicative of the overall fish population due to their high position in the food chain and because they are highly sought after by anglers. Electrofishing is the best indicator of Largemouth Bass abundance and size distribution, with the exception of large fish.

Largemouth Bass Catch Per Unit Effort and Structural Indices

Electrofishing in Old River is conducted in the fall when water levels are at their lowest. Figure 1 represents the catch-per-unit-of-effort (CPUE = bass per hour) of Largemouth Bass (*Micropterus salmoides*) since 2007. The 2010 and 2016 electrofishing results of Largemouth

Bass (LMB) catch rates were the highest on record. In 2020, catch rates again exceeded long term averages (Figure 1). There was an overall decline in annual catches from 2011 to 2014, as indicated by the downward trend in fall electrofishing CPUE. The indicated decline in LMB relative abundance during this time period may have resulted from the prolonged elevated or low water levels in 2011 and 2012, respectively (**Appendix I**), impacting recruitment for those years. The rise in catch rate in the 2015, 2016, and 2020 samples is the result of larger sub-stock and stock-size abundance and quality recruitment of young in those years. As the 2015 and 2016 recruits have advanced, their abundance has led to increased catch rates of quality- and preferred-size fish in 2017-2020, as shown in Figure 2.

Proportional stock density (PSD) and relative stock density (RSD) are indices used to numerically describe length-frequency data. Proportional stock density compares the number of fish of quality-size (greater than 12 inches for Largemouth Bass) to the number of bass of stock-size (8 inches in length). The PSD is expressed as a percent. A fish population with a high PSD consists mainly of larger individuals, whereas a population with a low PSD consists mainly of smaller fish. For example, Figure 3 below indicates a PSD of 57 for 2011. The number indicates that 57% of the bass stock (fish over 8 inches) in the sample was at least 12 inches or longer.

$$\text{PSD}= \frac{\text{Number of bass>12 inches}}{\text{Number of bass>8 inches}} \text{ x100}$$

Relative stock density (RSD) is the proportion of Largemouth Bass in a stock (fish over 8 inches) that are 15 inches (preferred-size) or longer.

$$\text{RSD}= \frac{\text{Number of bass>15 inches}}{\text{Number of bass>8 inches}} \text{ x100}$$

Although one of the highest in the overall CPUE's was in 2016, size-structure indices were at their lowest in the proportion of quality-size fish and also low for preferred-size fish for that year (Figure 3). This is due to an increased abundance in that year of sub-stock and stock-size fish. In 2017, the PSD value exceeded long term averages, most likely due to the 2015/2016 recruits advancing to quality-size. This was followed by an increase in RSD values in 2019. Both indices showed a decreasing trend from 2019 to 2020. This is again the result of an increase in the number of stock-sized fish in 2020. While the number of quality-and preferred-size fish were nearly identical in 2019 and 2020, the number of stock-sized fish nearly doubled in the same time period. Length distributions from all years of fall electrofishing data combined show that there were more sub-stock size fish (<8 inches) present in 2010, 2016, and 2020 than in other years (Figure 4). Length distribution results also show that there were more quality-size fish (>12 inches) present in recent years.

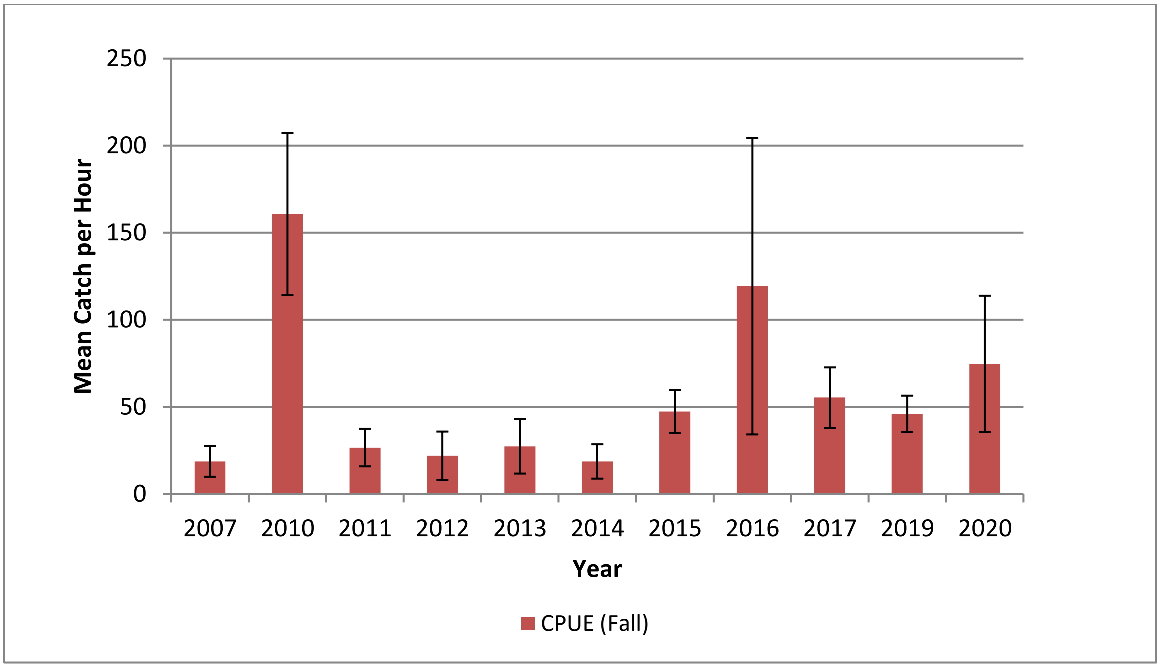


Figure 1. The mean CPUE number per hour for Largemouth Bass from Raccourci Old River, LA, in fall electrofishing results from 2007 to 2020. Error bars represent 95% confidence limits of the mean CPUE.

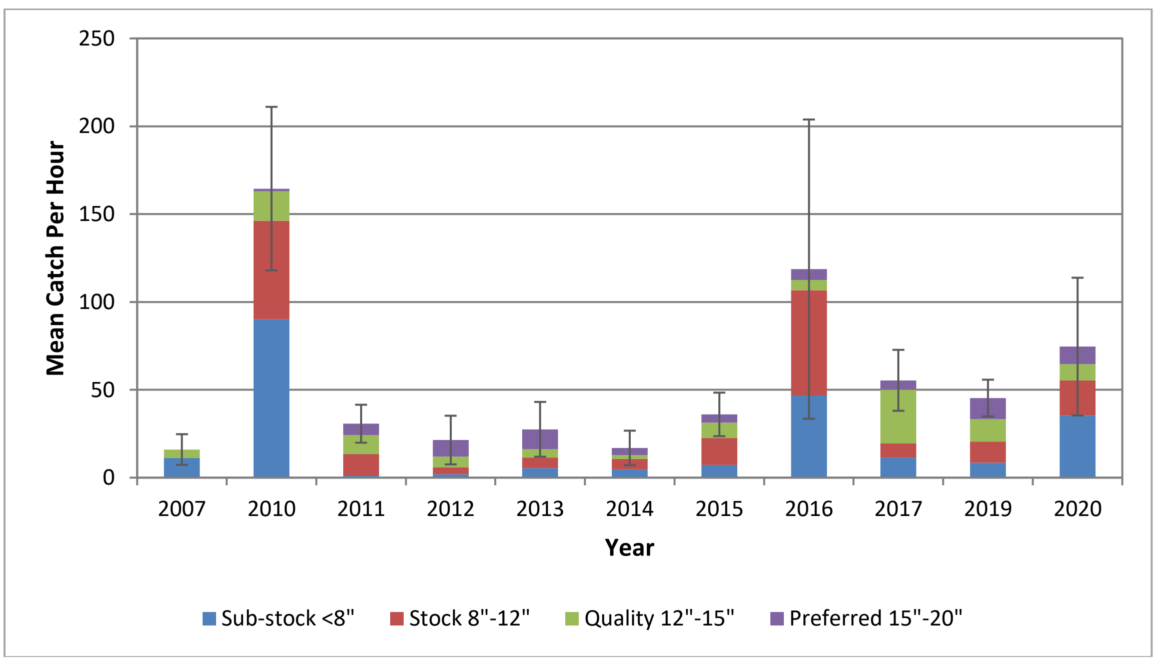


Figure 2. The mean CPUE for sub-stock- (<8"), stock- (8"-12"), quality- (12"-15") and preferred-size (15"-20") Largemouth Bass from Raccourci Old River, LA, for spring electrofishing results from 2007 to 2020. Error bars represent 95% confidence limits of the mean total CPUE.

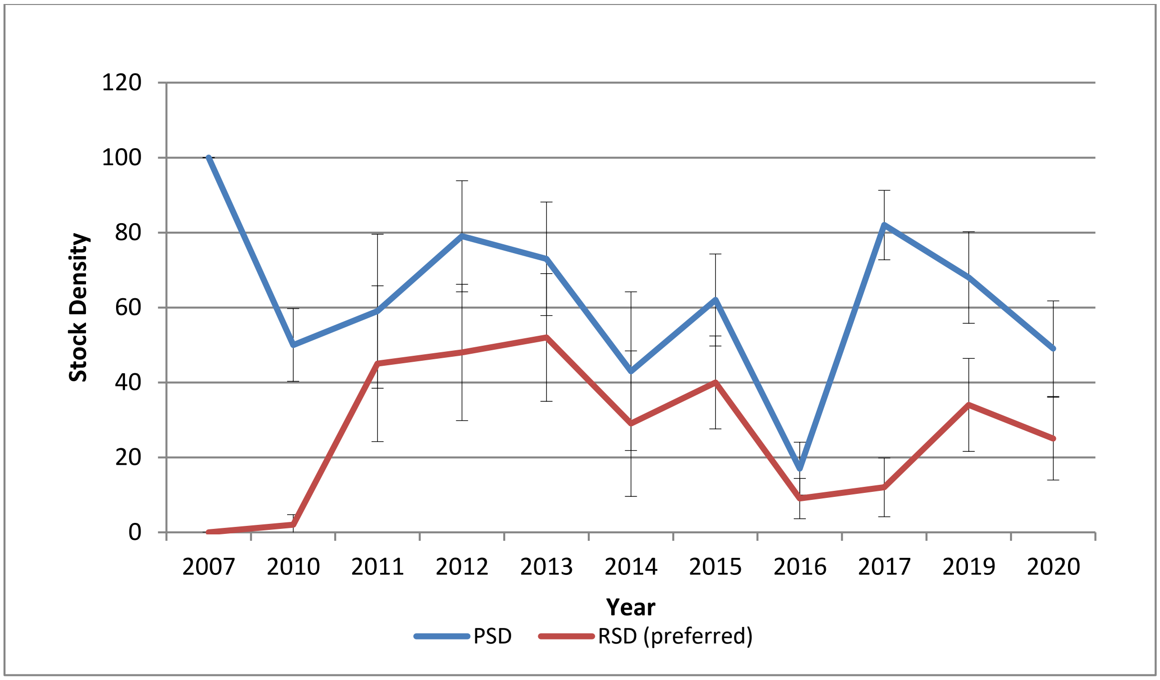


Figure 3. The mean size-structure indices (PSD and RSDp) for Largemouth Bass from fall electrofishing in Raccourci Old River, LA, from 2007 to 2020. Error bars represent 95% confidence limits of the mean size-structure indices.

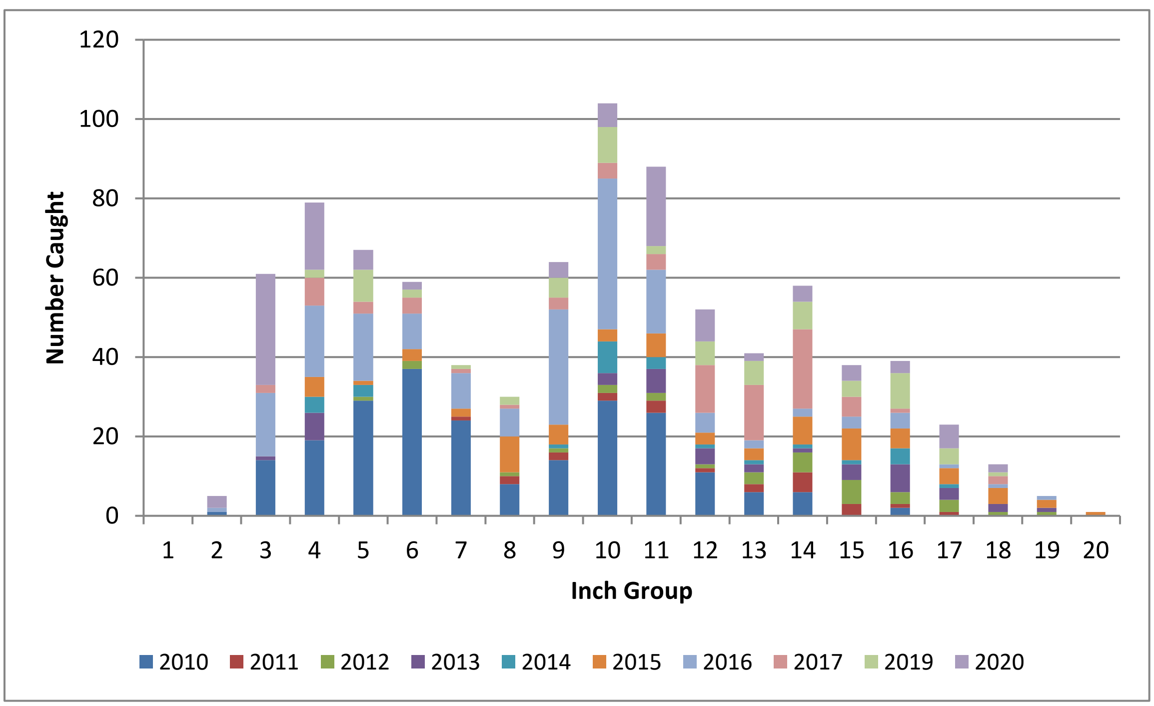


Figure 4. The size distribution (length frequencies) for Largemouth Bass from fall electrofishing results in Raccourci Old River, LA, from 2010 to 2020. N=865.

Largemouth Bass Stocking and Genetics

Largemouth Bass have been tested for the Florida allele, post stocking efforts. Results have indicated that the Florida gene is not assimilating into the Largemouth Bass population. Due to the resistance of the Florida gene to integrate into the native population, as well as the open connection with the Mississippi River, the lake is not a candidate for the continued stocking of Florida Bass. Genetic analysis was conducted on Largemouth Bass samples collected in Raccourci Old River during 2015, 2016, and 2017 electrofishing samples (Table 1). Allozyme starch gel electrophoresis analyses were conducted at the Louisiana State University School of Renewable Natural Resources.

Table 1. Genetic analyses of Largemouth Bass populations from Raccourci Old River, LA.

GENETICS					
Year	Number	Northern	Florida	Hybrid	Florida Influence
1992	42	100%	0%	0%	0%
2015	81	100%	0%	0%	0%
2016	154	100%	0%	0%	0%
2017	140	100%	0%	0%	0%

As shown in Table 2, Raccourci Old River has been stocked with 104,902 Florida Largemouth Bass and 71,781 Hybrid Striped Bass since 2007.

Table 2. Stocking history of Raccourci Old River, LA from 2007 – 2009.

YEAR	FLORIDA LARGEMOUTH BASS (fingerlings)	FLORIDA LARGEMOUTH BASS (phase II)	HYBRID STRIPED BASS
2007	32,156	-	-
2008	41,446	-	-
2009	30,582	718	71,781
Total	**104,184**	**718**	**71,781**

Recreational / Other Species

Crappie Catch Per Unit Effort and Length Frequencies

Both Black and White Crappies (*Pomoxis nigromaculatus* and *P. annularis*) are present in the lake. Black Crappie are far more prevalent in the lake than White Crappie. Fall lead net catches for 2010 and 2011 were 1.0 and 1.1 fish per net hour, respectively. Those for 2012 to 2014 were far less with an average of 0.09 fish per hour. CPUE's rebounded to 0.6 and 1.1 fish per net hour in 2015 and 2016, respectively, with increased abundance of stock-sized fish (Figure 5). While the number of quality-, preferred-, and memorable-sized fish have met or exceeded long term averages in recent years, the number of stock-sized fish has been declining over the same time period. The increase in abundance of stock- and quality- sized fish in 2015 and 2016 may have resulted from increased stability in water levels during the spring and early summer months in those years (Appendix I). This likely positively influenced recruitment and survival of sub-stock-sized fish. The opposite may hold true in recent years, as the number of stock-sized fish has shown to be decreasing. Potentially, this could be caused by the increased magnitude and duration of flooding caused by record water levels in the Mississippi River during this timeframe, thus having a negative impact on recruitment and survival of sub-stock-sized fish. Fall lead net samples indicate the majority of fish sampled in 2020 were quality- (8-10 inches) and preferred-size (10-12 inches) fish, with a majority of fish caught being in the 7 through 11 inch groups (Figure 6).

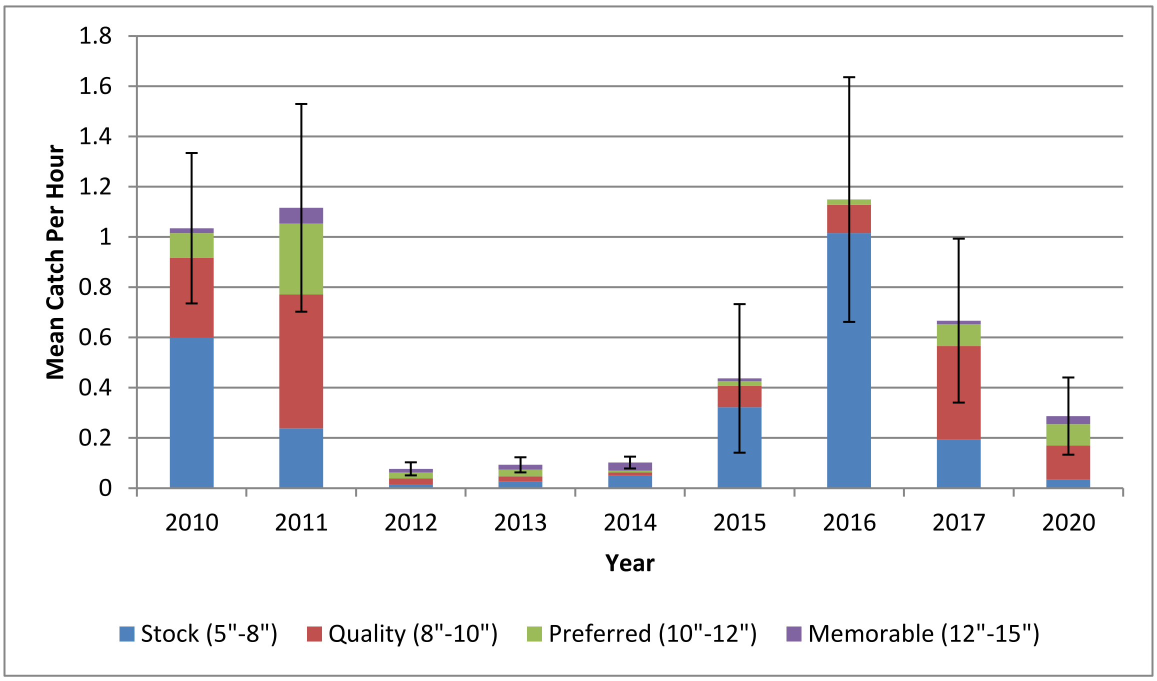


Figure 5. The mean CPUE (± 95% CI) for stock-, quality-, and preferred-size Black Crappie from lead net catch results for 2010 to 2016 from Raccourci Old River, LA.

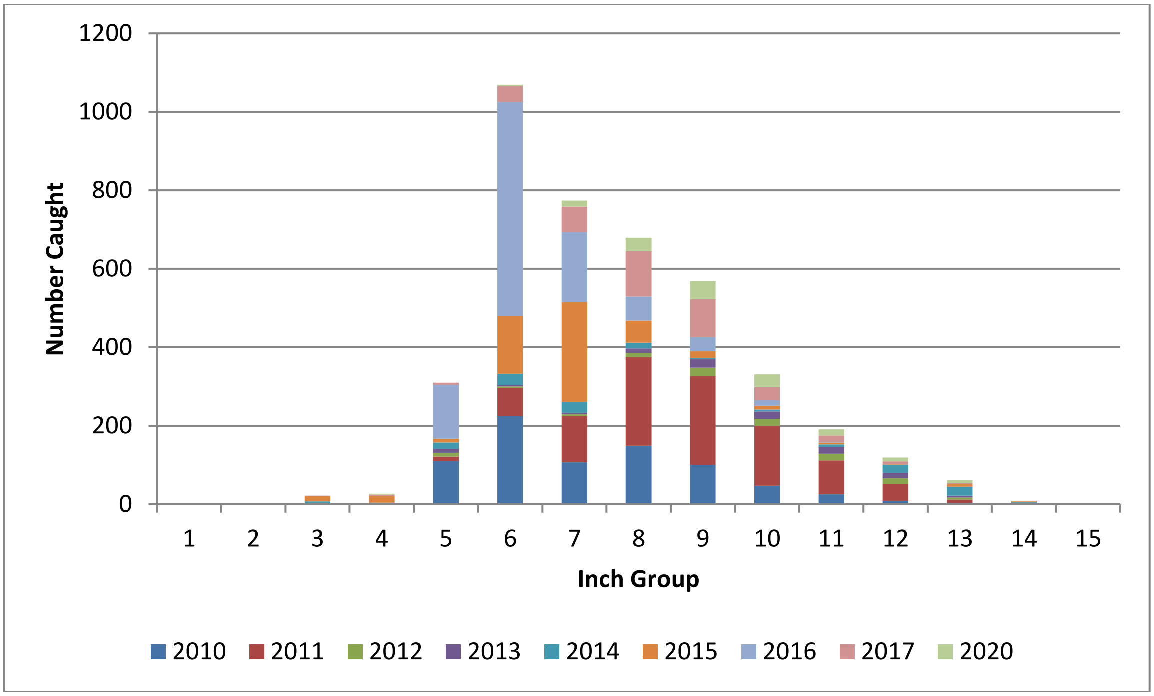


Figure 6. The size distribution (length frequencies) for Black Crappie from lead net catch results in Raccourci Old River, LA, from 2010 to 2020. N = 4,246.

Crappie Population Characteristics Study

A stock assessment of crappie was conducted on Old River Raccourci from 2010 – 2013. The purpose of the study was to obtain accurate and precise estimates of vital rate functions including growth, mortality, and recruitment of the Old River Raccourci crappie population. The age structure of the crappie population is shown in Figure 7. The population is dominated by one and two-year-old crappie. These data were obtained by analyzing the otoliths of the crappie sampled during the study. These age estimates, along with estimates of mortality rates, were analyzed to determine if alternative regulations (i.e., minimum length limits) would have any significant impact on the population. It was determined that any length limit implementation would likely result in decreased yield and substantially increase the numbers of crappie that would need to be released. The full report, prepared by the LDWF Fisheries Management Section (West and Beck 2014), is found in **Appendix II**.

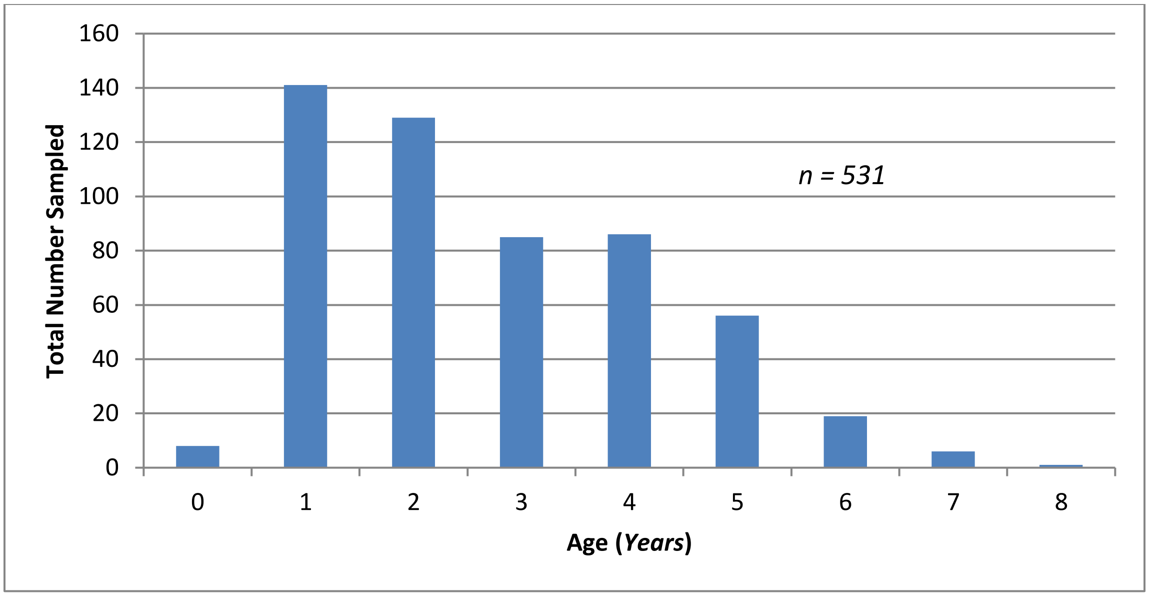


Figure 7. Age structure of Old River Raccourci crappie from 2010 – 2013.

The crappie stock assessment study revealed that Old River Raccourci has a moderately slow growth rate. Table 3 shows the length of time in years for crappie to reach 8, 10, and 12 inches. These rates are considered slower than average for Louisiana waterbodies.

Table 3. The average age for Old River Raccourci crappie to reach 8, 10, and 12 inches.

AGE (years)	LENGTH (inches)
2.0	8.0
2.9	10.0
4.4	12.0

Forage

Forage availability is typically measured directly through electrofishing and shoreline seine sampling, and indirectly through measurement of largemouth bass body condition or relative weight. Relative weight (Wr) is the ratio of a fish's weight to the weight of a ''standard'' fish of the same length. The 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 Wr below 80 indicate a potential problem with forage availability. Relative weights for Largemouth Bass are determined from fall electrofishing results. Figure 8 indicates weight has generally remained at a healthy level of above 90 since 2007.

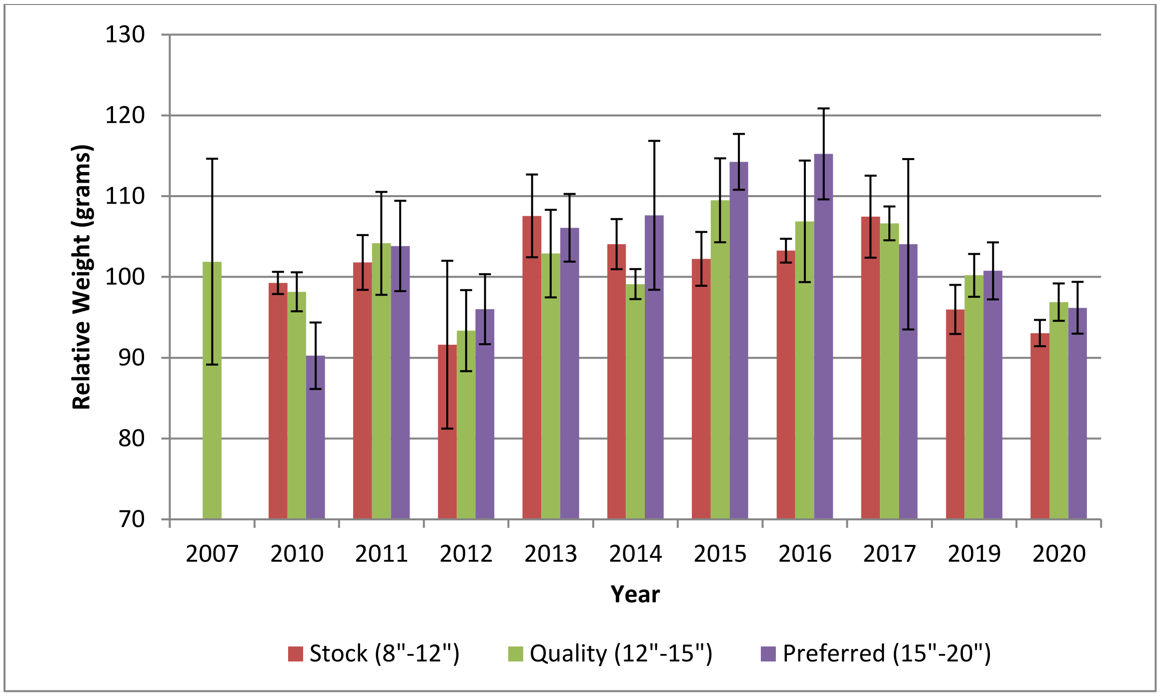


Figure 8. The mean relative weights (±95% CI) for stock- (>8"), quality- (>12") and preferred-size (>15") Largemouth Bass collected from Raccourci Old River, LA, during fall electrofishing from 2007 to 2020.

Forage in Raccourci Old River is comprised mainly of Threadfin Shad (*Dorosoma petenense*), Bluegill, and Gizzard Shad (*Dorosoma cepedianum*). Forage composition in total numbers by species collected in fall electrofishing samples from 2013 to 2020 are presented in Figure 9.

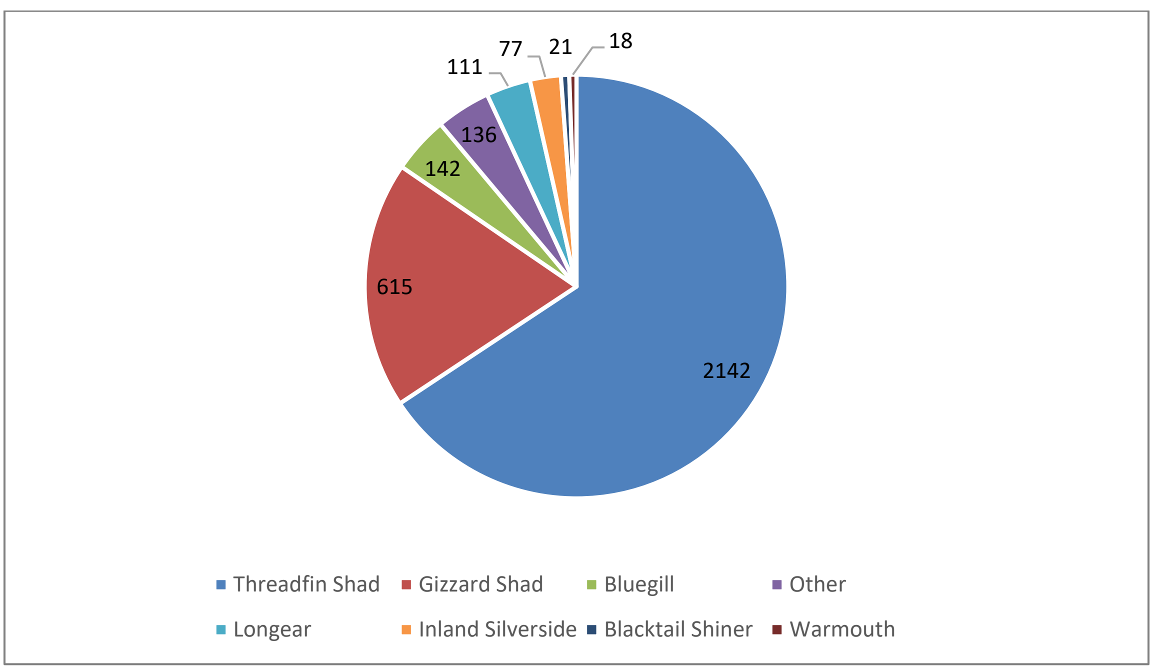


Figure 9. The mean CPUE for forage fish by species for Raccourci Old River, LA, from fall electrofishing results from 2013 to 2020.

Commercial

Currently, commercial fish species are sampled by the use of gill nets. Bowfin, carp species and Smallmouth Buffalo are the most represented species in terms of poundage captured from 2011 to 2017 (Figure 10).

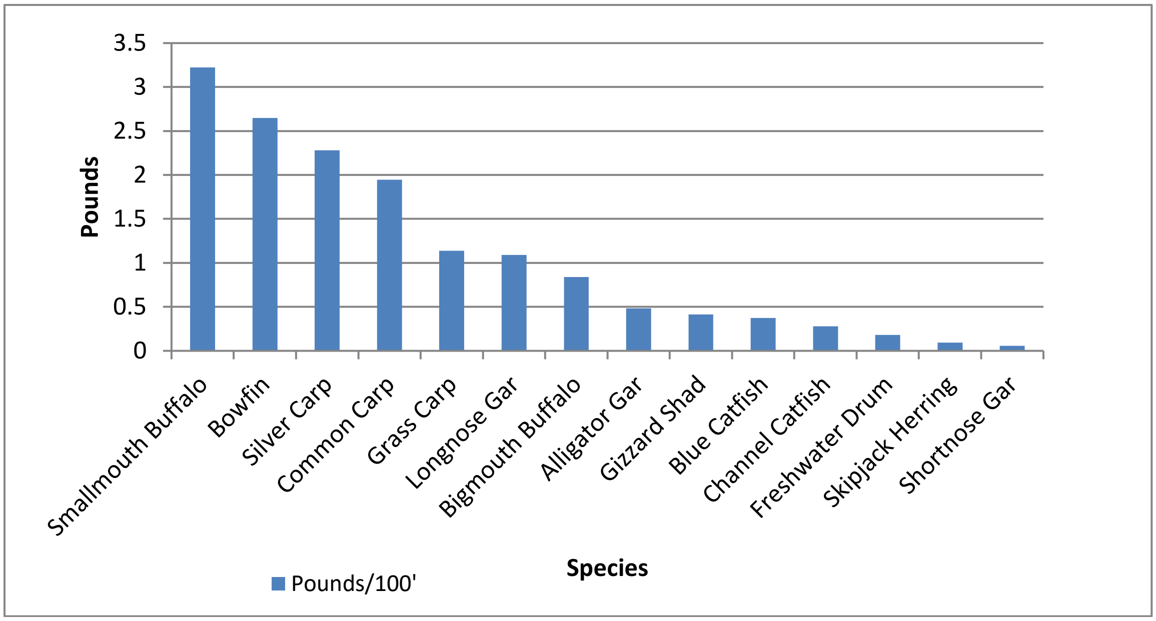


Figure 10. Mean gill net catch results per net night (100 feet of net fished for one night) in pounds for selected commercial fish species in 2011, 2014, and 2017 from Raccourci Old River, LA.

Aquatic Invasive Species

Common Carp (*Cyprinus carpio*), Grass Carp (*Ctenopharyngodon idella*), Bighead Carp (*Hypophthalmichthys nobilis*) and Silver Carp (*Hypophthalmichthys molitrix*) are present in Old River Raccourci. Zebra Mussel (*Dreissena polymorpha*) shell fragments have also been observed along the lakeshore.

HABITAT EVALUATION

Aquatic Vegetation

Due to large seasonal water fluctuations, nuisance aquatic vegetation does not occur in any significant amount. There are no records of treatments or vegetation complaints.

Water Quality

The 2018 Water Quality Integrated Report from the Louisiana Department of Environmental Quality, Water Permits Division listed Old River having the presence of a non-native aquatic plant (water hyacinth – *Pontederia crassipes*) as the lake's only impairment.

Substrate

Areas of the lake that are seasonally flooded are timbered and have Tunica, Sharkey, and Fausse clay soils (frequently flooded, very poorly drained) that are typical of the natural Mississippi River levee. This area contains low ridges and swampy treed sloughs formed by the frequent annual erosion pattern by the Mississippi River. The substrate of the permanently flooded portion of the lake is soft river sediment. Another significant component of the substrate is the numerous cypress trees adjacent to the tree line. This combination of structure and substrate near the shore has contributed to the persistent existence of the sunfish and crappie populations that the lake is known for producing.

CONDITION IMBALANCE / PROBLEM

Raccourci Old River is subject to infestations of nuisance aquatic organisms that are present in the Mississippi River, especially Asian carp and Common Carp. Because of the volume of river water that enters the lake annually, it is not feasible to exclude such infestations.

CORRECTIVE ACTION NEEDED

Control Asian carp and Common Carp populations.

RECOMMENDATIONS

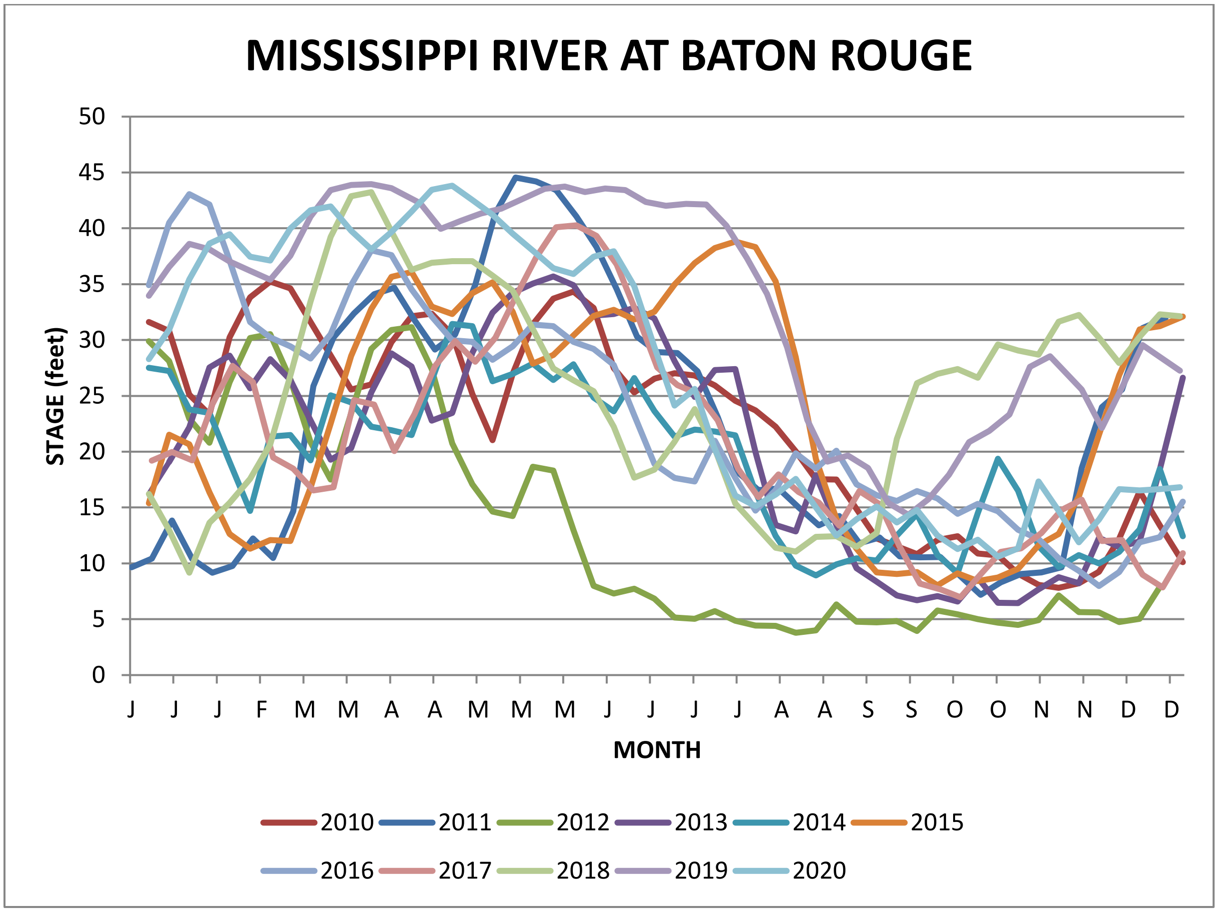
1. Continue standardized sampling of fish populations to evaluate the condition of the stocks.

2. Continue with existing regulations for both recreational and commercial species.

3. Continue to evaluate the presence and influence of invasive aquatic organisms.

APPENDIX I
(return to [recreation](#)**)**

Mississippi River Hydrograph



APPENDIX II

(return to crappie)

Old River Raccourci Crappie:
Population Characteristics with Size Regulation Simulations
2014 Report

Steve Beck and Joe West
Fisheries Management Section
Louisiana Department of Wildlife of Fisheries

Introduction:
Given the popularity of crappie (sac au lait, white perch, *Pomoxis* spp.) angling in Louisiana (LA), it is necessary to regularly assess management strategies. Before the efficacy of waterbody-specific harvest regulations can be determined, accurate and precise estimates of the present fishery and population are needed. The primary goal of this project was to develop a statewide database of crappie population and fishery characteristics to inform and evaluate future management decisions.

The success of crappie harvest regulation depends on the vital rate functions, i.e. growth, mortality, and recruitment, of the populations in question. The goal of most crappie anglers is to maximize the amount of meat harvested (i.e., yield) as opposed to catching trophy size fish, and therefore the goal of crappie management is often to maximize yield. Crappie population models indicate that minimum length limits have the potential to increase yield if a population demonstrates fast growth and low natural mortality (Allen and Miranda 1995). In practice, implementing a minimum length limit can result in reduced yields if conditions are not appropriate (Boxrucker 2002). The Old River Raccourci crappie fishery is currently managed with a 50 fish creel limit and no minimum length limit.

This report presents Old River Raccourci crappie population characteristics and compares these results to other LA waterbodies included in this project that completed sampling by 2013. Additionally, an equilibrium age and sex structured population model was constructed to simulate effects of multiple size regulations on the Old River Raccourci crappie fishery. White crappie (*Pomoxis annularis*) and black crappie (*Pomoxis nigromaculatus*) are not independently managed; therefore, most population characteristics presented in this report are not separated by species.

Methods:
Fishery Independent Collections:

Crappie were sampled with standardized LA Department of Wildlife and Fisheries (LDWF) fall lead net surveys from 2010 to 2013. The overall sampling objective was the collection of a minimum of 500 individuals to represent the current size/age distribution of the crappie population in question.

Age Determination:
A random sub-sample of up to 10 individuals per species per inch group <12 inches were sacrificed from each annual lead net survey for age determination. Due to larger variation in length-at-age of older crappie, all individuals collected ≥12 inches were sacrificed. Sagittal otoliths were removed, cleaned, and stored in glycerin for processing at the LDWF Office of Fisheries Age and Growth Lab.

Biological ages were assigned to individual fish by assuming a March 1st hatch date and adjusting ages to correspond with sample collection dates relative to this hatch date (e.g., young-of-the-year collected on September 1st would be 0.5 years old). Due to temporal variation in LA crappie annulus formation, biological ages were also adjusted to ensure individual fish were assigned to the correct cohort. For example, biological ages of fall collected crappie with evidence of annuli formation on the otolith margin were reduced by one year; fall collected crappie without evidence of annuli formation on the otolith margin were not adjusted. Biological ages were then used to estimate both sex and non-sex-specific von Bertalanffy growth parameters (see *Growth* section for details).

Annual length at age sample matrices were then converted to age-length-keys, where each matrix cell of annual length at age samples was normalized by the sum of its row to generate empirical probabilities of age given length. These age-length-keys were then used to assign ages to the non-sacrificed crappie collected from each annual lead net survey.

Population Characteristics:
Growth: The von Bertalanffy (1938) growth function (VBGF) was used to model length at age of the combined crappie population. The function is configured as:

$$L_t = L_\infty\left(1 - e^{-K(t-t_0)}\right) \quad [1]$$

where L_t is mean total length (TL) at age in years, L_∞ is the asymptotic average maximum TL, K is the rate at which length approaches L_∞, and t_0 is the theoretical age when TL=0. The model was fit to the four year dataset using the SAS nonlinear approximation procedure (PROC NLIN; SAS 1996). Statistical outliers (i.e, absolute studentized residuals >2.5) were then removed and the model refit. Due to size selectivity of the lead net sampling gear resulting in only the fastest growing young-of-the-year fish represented in the samples, and to prevent unrelasitic parameter estimates, the t_0 parameter was fixed at 0. The average times to reach stock, quality, and preferred sizes were then estimated by inverting equation [1] and solving for time.

Size Structure Indices: Proportional size distribution indices (PSD-X) were calculated over the sampling period following methods given in Neumann et al. (2012) as:

$$PSD - X = \frac{Number\ of\ fish \geq length\ of\ interest}{Number\ of\ fish \geq minimum\ stock\ length} \times 100 \quad [2]$$

where X indicates the length category of interest (i.e., quality [Q], preferred [P], or memorable [M] sizes; 8, 10, and 12 inches total length, respectively).

Length/Weight Relationship: Weight-length regressions were estimated for the combined crappie population following methods given in Neumann et al. (2012). The relationship between weight and length can be described with the power function:

$$W = aL^b \quad [3]$$

where W is weight, L is total length, a is the weight-length constant and b is the allometric exponent. The model, after common logarithmic transformation, was fit to the three-year dataset with the SAS linear regression procedure (PROC REG; SAS 1996). Statistical outliers (i.e., absolute studentized residuals > 2.5) were then removed and the model refit.

Condition: Condition indices provide a measure of the relative 'plumpness' of fish (Neumann et al. 2012). Mean relative weights of quality, preferred, memorable, and trophy size fish (i.e., 8, 10, 12, and 15 inches respectively) over the four-year sampling period were calculated separately for black and white crappie following methods given in Neumann et al. (2012). Relative weights (W_r) for individual fish were calculated from:

$$W_r = (W/W_s) \times 100 \quad [4]$$

where W is the weight of an individual fish and W_s is a length-specific standard weight reported by Neumann and Murphy (1991).

Recruitment: Mean annual catch rates of age-1 crappie collected from lead net surveys were used to calculate a coefficient of variation (CV; standard deviation/mean×100) representing the inter-annual variability in recruitment over the four year sampling period. Waterbody-specific mean annual age-1 catch rates were also compared to the mean annual age-1 catch rates for all waterbodies included in the study.

Mortality: Total instantaneous mortality (Z) was estimated with catch curve analysis (Ricker 1975). The model describing the exponential reduction in abundance at age is configured as:

$$N_{t+1} = N_t e^{-Z_t} \quad [5]$$

where N_t is the number of individuals alive at time t, N_{t+1} is the number alive the following time interval, and Z_t is the instantaneous total mortality rate at time t. Equation [5] is linearized by taking the natural logarithm of both sides to obtain:

$$log_e(N_{t+1}) = log_e(N_t) - Z(t) \quad [6]$$

which was solved with the SAS linear regression procedure (PROC REG; SAS 1996). The interval (i.e., annual in this case) total mortality rate A is then calculated from:

$$A = 1 - e^{-Z} \quad [7]$$

Assumptions of catch curve analysis are: 1) mortality is constant across ages, 2) recruitment is constant, and 3) samples are representative of the true age structure of the population. To reduce the possibility of violating assumption (2) and concerns with inadequacies in sample size, samples over the four-year sampling period were used to create a single pseudo-cohort. Because sampling occurred in successive years with unequal sampling efforts, age-specific mean catch per unit effort over the four year sampling period was substituted for the age-specific number of individuals (N_t) in Equation [6]. Additionally, only age classes considered fully-recruited to the lead net gear and containing more than three individuals from the sampling period were included in the catch curve. Instantaneous natural mortality (M) was approximated following the approach recommended by Hewitt and Hoenig (2005) as:

$$M = \frac{4.22}{t_{max}} \quad [8]$$

where t_{max} represents the maximum age in the population. This estimation assumes that the stock is unexploited and approximently1.5% of the stock survives to t_{max}. Because populations in this study are exploited, the maximum observed age of crappie from each waterbodies leadnet samples are unlikely to represent the true maximum age of the unexploited population. Therefore, the maximum observed age was increased by one, two, and three years to approximate high, medium, and low natural mortality scenarios. Instantaneous fishing mortalities (F) corresponding to the low, medium, and high natural mortality scenarios were then approximated by difference, i.e. $Z - M$.

LA crappie fisheries can be categorized as Type 2 fisheries, where natural and fishing mortality occur simultaneously. Interval natural (v) and fishing (u) mortality rates for Type 2 fisheries are calculated from:

$$v = \frac{MA}{Z} \ , \ u = \frac{FA}{Z} \quad [9, 10]$$

where Z, F, and M are instantaneous total, fishing, and natural mortality rates respectively, and A is the interval total mortality rate.

Population Simulations:

An equilibrium age and sex structured population model was constructed to compare the effects of implementing size-specific harvest regulations (i.e., 10 and 12-inch minimum length limits) on Old River Raccourci crappie fishery performance compared to the present regulation (no length limit).

Model Configuration: Abundance at age a and sex s was modeled as:

$$N_{a,s} = R_s S_{a,s} \quad [11]$$

where R_s is equilibrium sex-specific constant recruitment calculated from $R \times 0.5$. Sex-specific survivorship-at-age ($S_{a,s}$) was calculated recursively from $S_{a,s-1}e^{-Z_{a,s}}, S_{1,s} = 1$ where $Z_{a,s}$ are age and sex-specific total instantaneous mortality rates. Separated into additive components this becomes:

$$Z_{a,s} = M + H_{a,s} + D_{a,s} \quad [12]$$

where M is the constant non-sex-specific instantaneous natural mortality rate. Three natural mortality scenarios were used to model each size regulation (see *Methods: Population Characteristics: Mortality* section).

Instantaneous sex-specific harvest and discard mortalities ($H_{a,s}$, $D_{a,s}$) vary across ages. Age and sex-specific instantaneous harvest mortalities were calculated from:

$$H_{a,s} = FV_{h(a,s)} \quad [13]$$

where F is the overall instantaneous fishing mortality rate and $V_{h(a,s)}$ are the age and sex-specific vulnerabilities to harvest. Age and sex-specific instantaneous discard mortalities were calculated from:

$$D_{a,s} = FdV_{d(a,s)} \quad [14]$$

where d is the proportion of discards not surviving and $V_{d(a,s)}$ are the age and sex-specific vulnerabilities to discarding.

Age and sex-specific vulnerabilities to harvest and discard were developed as knife-edged vectors evaluated with predicted mean total lengths at age calculated from equation [1] using the sex-specific Old River Raccourci von Bertalanffy growth parameters. Crappie were considered vulnerable to harvest at a total length of 7 inches, which was the mean minimum size harvested across all lakes included this study that conducted creel surveys. Harvest vulnerabilities include the proportion of crappie of age a and sex s, evaluated with equation [1], for each simulated size regulation. Vulnerabilities to discard were calculated similarly, where the proportion of crappie of age a and sex s larger than the minimum size vulnerable to the fishery, but smaller than the minimum length limit, were vulnerable to discard. To approximate changes in growth through each age interval, TL at age was calculated using the age interval midpoints (i.e. $a + 0.5$).

Fishery Performance: Total catch (i.e., harvest + releases), percent of total catch released (i.e., releases/total catch), mean weight of harvested crappie and equilibrium yield (pounds harvested) were used to evaluate Old River Raccourci crappie fishery performance for each simulation.

Equilibrium harvest (i.e., number of individuals harvested) was calculated as:

$$C_H = \sum_a \sum_s N_{a,s} H_{a,s} \frac{(1-e^{-Z_{a,s}})}{Z_{a,s,}} \quad [15]$$

Equilibrium releases (i.e., number of individuals discarded) was calculated as:

$$C_R = \sum_a \sum_s \frac{N_{a,s} D_{a,s} \frac{(1-e^{-Z_{a,s}})}{Z_{a,s,}}}{d} \quad [16]$$

Equilibrium total catch (C_T; harvest + releases) was then calculated from $C_H + C_R$. Percent of total catch released was then calculated from C_R/C_T.

Mean weight of harvested crappie ($\bar{W}$), was calculated as:

$$\bar{W} = \left(\sum_a \sum_s W_{a,s} H_{a,s}\right) / \sum_a \sum_s H_{a,s} \quad [17]$$

where $W_{a,s}$is the sex-specific mean weight at age as derived from equations [1] and [3].

Equilibrium yield (i.e., pounds harvested) was calculated as:

$$Y = \sum_a \sum_s W_{a,s} H_{a,s} \quad [18]$$

Results:

Fishery-independent Collections:

Annual size frequency distributions of crappie collected from fall Old River Raccourci lead net surveys are presented in Figure 1 below.

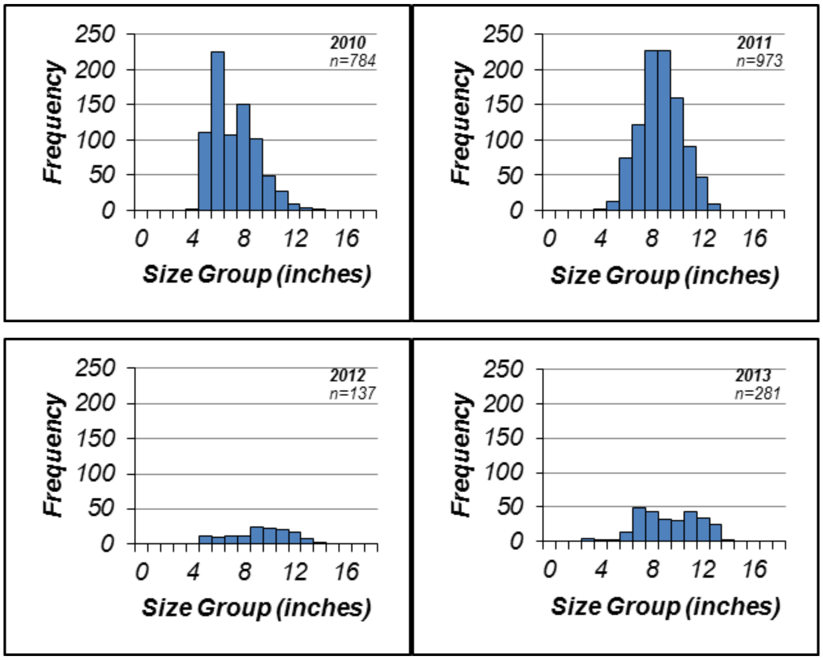


Figure 1: Annual size frequency distributions of Old River Raccourci crappie fall lead net surveys (2010-2013). Sample sizes (n) are presented in each graphic.

A summary of total crappie catches by species and year from fall Old River Raccourci lead net surveys is presented in Table 1 below.

Table 1: The contribution of black crappie and white crappie to total crappie catch by year for Old River Raccourci fall lead net surveys 2010-2013.

Year	*Black Crappie*	*White Crappie*	*Total*
2010	*776 (99%)*	*8 (1%)*	*784*
2011	*948 (97%)*	*25 (3%)*	*973*
2012	*103 (75%)*	*34 (25%)*	*137*
2013	*188 (67%)*	*93 (33%)*	*281*
Total	*2015 (93%)*	*160 (7%)*	*2175*

Age Determination:

Annual length at age sample matrices of crappie from fall Old River Raccourci lead net surveys are presented in Table 2 below.

Table 2: Annual length at age sample matrices of Old River Raccourci fall lead net surveys 2010-2013. Totals represent the sum across rows/columns.

2010

TL / Age	0	1	2	3	4	5	6	7	8	Totals
2										
3										
4		1								1
5		11								11
6		11								11
7		10								10
8		6	4	1						11
9		2	5	3						10
10			2	10						12
11			3	8						11
12				6	3					9
13					1	1	1			3
14							2			2
15										
16										
17										
18										
Totals	0	41	14	28	4	1	3			91

2011

TL / Age	0	1	2	3	4	5	6	7	8	Totals
2										
3										
4		1	1							2
5	1	10								11
6	1	10								11
7		7	5							12
8		2	11							13
9			8	1						9
10		2	11	4	2					19
11			2	6	4					12
12			1	5	36	2		3		47
13				1	6		1	1	1	10
14										
15										
16										
17										
18										
Totals	2	32	39	17	48	2	1	4	1	146

2012

TL / Age	0	1	2	3	4	5	6	7	8	Totals
2										
3										
4										
5		12								12
6		9								9
7		9	3							12
8		1	7	3						11
9			5	10						15
10		2	2	7	2	1				14
11			2	3	3	5				13
12				1	5	10		1		17
13					2	5	1			8
14				1						1
15										
16										
17										
18										
Totals		33	19	25	12	21	1	1		112

2013

TL / Age	0	1	2	3	4	5	6	7	8	Totals
2										
3	5									5
4	1									1
5		2								2
6		11								11
7		13	7							20
8		8	12							20
9		1	18	2						21
10			13	3	1	4				21
11			6	6	5	2	1			20
12			1	4	11	14	4			34
13					5	10	9	1		25
14						2				2
15										
16										
17										
18										
Totals	6	35	57	15	22	32	14	1		182

Population Characteristics:

Growth: Observed and predicted TL at age of crappie from Old River Raccourci fishery independent surveys are presented in Figure 2 below.

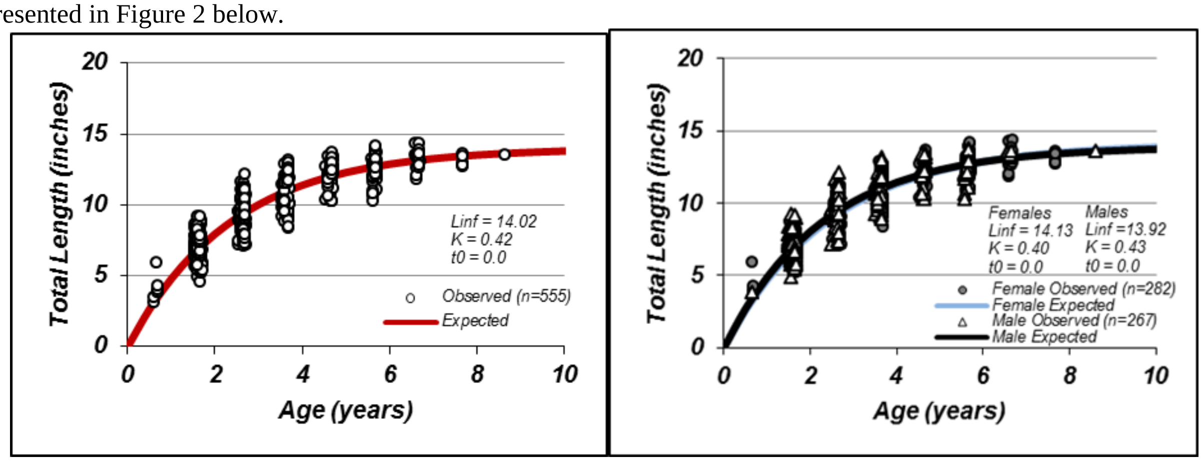


Figure 2: Observed and predicted total length at age of Old River Raccourci crappie (2010-2013). Von Bertalanffy parameter estimates and sample sizes (n) are presented in each graphic. Right graphic depicts sex-specific von Bertalanffy model fits and parameter estimates.

Average time in years for crappie (i.e., non-sex-specific) to reach quality (8 inch total length – TL), preferred (10 inch TL), and memorable (12 inch TL) sizes for waterbodies included in this project are presented in Table 3 below. This table illustrates variation in crappie growth rates among waterbodies.

Table 3: Average time in years for crappie to reach quality, preferred, and memorable sizes (Growth_type). Average times are sorted from lowest to highest with Old River Raccourci results highlighted.

Waterbody	Growth_type	Years	Time_yrs
Poverty	t_quality	2010-12	0.82
Caddo	t_quality	2011-13	1.23
Toledo Bend	t_quality	2009-11	1.44
Cross	t_quality	2010-12	1.45
D'Arbonne	t_quality	2009-12	1.84
Raccourci	t_quality	2010-13	1.97
Larto/Saline	t_quality	2009-12	2.02
Vernon	t_quality	2009-11	2.25

Waterbody	Growth_type	Years	Time_yrs
Poverty	t_preferred	2010-12	1.26
Caddo	t_preferred	2011-13	1.77
Cross	t_preferred	2010-12	2.09
Toledo Bend	t_preferred	2009-11	2.18
D'Arbonne	t_preferred	2009-12	2.62
Raccourci	t_preferred	2010-13	2.89
Larto/Saline	t_preferred	2009-12	2.95
Vernon	t_preferred	2009-11	3.27

Waterbody	Growth_type	Years	Time_yrs
Poverty	t_memorable	2010-12	2.19
Caddo	t_memorable	2011-13	2.58
Cross	t_memorable	2010-12	3.06
Toledo Bend	t_memorable	2009-11	3.61
D'Arbonne	t_memorable	2009-12	3.73
Raccourci	t_memorable	2010-13	4.41
Larto/Saline	t_memorable	2009-12	4.46
Vernon	t_memorable	2009-11	4.87

Size Structure Indices: Mean proportional size distribution indices (PSD-Q, PSD-P, and PSD-M) of crappie collected over the lead net sampling period for waterbodies included in this project are presented in Table 4 below. This table illustrates variation in PSD indices among LA crappie populations.

Table 4: LA crappie proportional size distribution indices (PSD-Q, PSD-P, and PSD-M), upper and lower 95% confidence intervals (CI), and years of lead net collections. Size structure indices are sorted from highest to lowest with Old River Raccourci results highlighted.

Waterbody	Years	PSD-Q	L95%CI	U95%CI
Poverty	2010-12	82.4	80.0	84.7
Toledo Bend	2009-11	75.3	74.1	76.6
Raccourci	2010-13	67.9	65.9	69.8
Vernon	2009-11	64.8	61.5	68.1
Caddo	2011-13	64.6	62.1	67.1
D'Arbonne	2009-12	53.2	50.4	55.9
Cross	2010-12	53.1	50.8	55.4
Larto/Saline	2009-12	38.4	36.0	40.7

Waterbody	Years	PSD-P	L95%CI	U95%CI
Poverty	2010-12	54.6	51.5	57.7
Caddo	2011-13	46.7	44.0	49.3
Raccourci	2010-13	30.0	28.0	31.9
Toledo Bend	2009-11	28.7	27.4	30.0
Vernon	2009-11	26.8	23.7	29.9
Cross	2010-12	24.0	22.0	25.9
D'Arbonne	2009-12	22.9	20.6	25.2
Larto/Saline	2009-12	14.3	12.5	16.0

Waterbody	Years	PSD-M	L95%CI	U95%CI
Caddo	2011-13	22.0	19.8	24.2
Poverty	2010-12	13.8	11.7	16.0
Raccourci	2010-13	8.9	7.7	10.1
Vernon	2009-11	8.8	6.8	10.7
Cross	2010-12	5.4	4.3	6.4
D'Arbonne	2009-12	5.4	4.1	6.6
Larto/Saline	2009-12	3.9	3.0	4.9
Toledo Bend	2009-11	3.6	3.0	4.1

Length/Weight Relationship: Observed and predicted weight at total length developed from Old River Raccourci fishery independent surveys are presented in Figure 3.

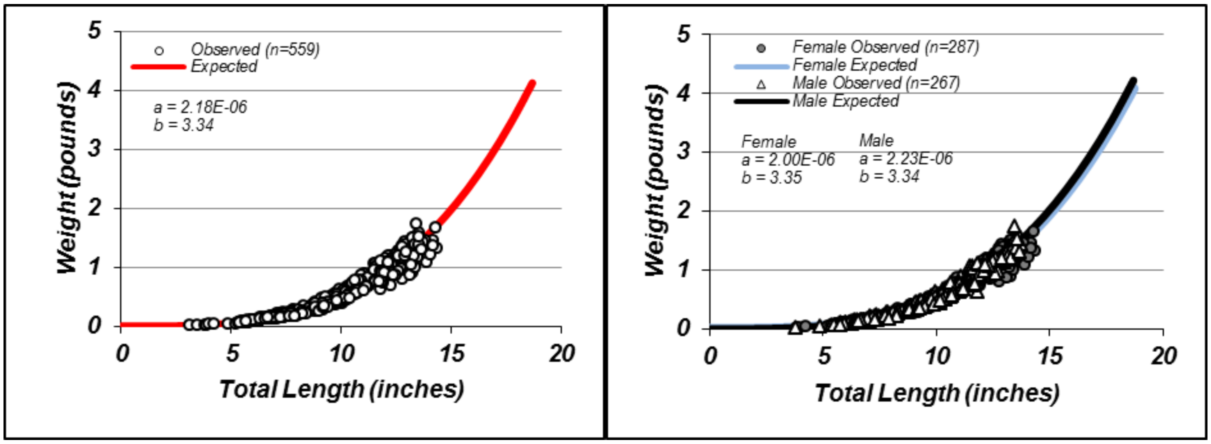


Figure 3: Observed and predicted weight at total length of Old River Raccourci crappie 2010-2013. Parameter estimates for the power function $W = aTL^b$ and sample sizes (n) used in model fitting are presented in each graphic. Right graphic depicts sex-specific weight-length relationships and parameter estimates.

Condition: Mean relative weights of quality, preferred, memorable, and trophy (15-inch TL) size black crappie and white crappie collected from lead net surveys for waterbodies included in this project are presented in Tables 5 and 6. This table illustrates variation in condition indices among LA crappie populations.

Table 5: Mean relative weights (W_r) of quality, preferred, memorable, and trophy size **black crappie**. Upper and lower 95% confidence intervals (CI), and years of lead net collections are also presented. Mean relative weights are sorted from highest to lowest with Old River Raccourci results highlighted. *NA* indicates that insufficient numbers of fish were collected to generate an estimate.

Quality Size

Waterbody	*Years*	*Wr*	*L95%CI*	*U95%CI*
Caddo	*2011-13*	*102.7*	*101.6*	*103.9*
Toledo	*2009-11*	*100.5*	*100.1*	*101.0*
Cross	*2010-12*	*96.3*	*95.3*	*97.3*
Raccourci	*2010-13*	*94.4*	*93.9*	*94.9*
Poverty	*2010-12*	*94.4*	*88.8*	*99.9*
Larto/Saline	*2009-12*	*92.8*	*91.8*	*93.7*
D'Arbonne	*2009-12*	*88.9*	*87.9*	*89.9*
Vernon	*2009-11*	*79.8*	*77.9*	*81.6*

Preferred Size

Waterbody	*Years*	*Wr*	*L95%CI*	*U95%CI*
Caddo	*2011-13*	*101.6*	*99.8*	*103.4*
Poverty	*2010-12*	*99.9*	*92.3*	*107.5*
Toledo	*2009-11*	*98.3*	*97.8*	*98.8*
Cross	*2010-12*	*98.3*	*97.3*	*99.2*
Larto/Saline	*2009-12*	*94.5*	*93.2*	*95.8*
Raccourci	*2010-13*	*94.4*	*93.7*	*95.1*
D'Arbonne	*2009-12*	*88.7*	*87.6*	*89.8*
Vernon	*2009-11*	*78.8*	*75.0*	*82.7*

Memorable Size

Waterbody	*Years*	*Wr*	*L95%CI*	*U95%CI*
Caddo	*2011-13*	*98.5*	*95.3*	*101.7*
Toledo	*2009-11*	*97.3*	*96.0*	*98.6*
Poverty	*2010-12*	*96.7*	*NA*	*NA*
Cross	*2010-12*	*96.0*	*88.9*	*103.1*
Larto/Saline	*2009-12*	*93.9*	*89.7*	*98.0*
D'Arbonne	*2009-12*	*92.7*	*88.1*	*97.3*
Raccourci	*2010-13*	*91.6*	*90.3*	*92.9*
Vernon	*2009-11*	*NA*	*NA*	*NA*

Trophy Size

Waterbody	*Years*	*Wr*	*L95%CI*	*U95%CI*
Cross	*2010-12*	*NA*	*NA*	*NA*
Poverty	*2010-12*	*NA*	*NA*	*NA*
Toledo	*2009-11*	*NA*	*NA*	*NA*
Vernon	*2009-11*	*NA*	*NA*	*NA*
D'Arbonne	*2009-12*	*NA*	*NA*	*NA*
Caddo	*2011-13*	*NA*	*NA*	*NA*
Larto/Saline	*2009-12*	*NA*	*NA*	*NA*
Raccourci	*2010-13*	*NA*	*NA*	*NA*

Table 6: Mean relative weights (W_r) of quality, preferred, memorable, and trophy size **white crappie**. Upper and lower 95% confidence intervals (CI), and years of lead net collections are also presented. Mean relative weights are sorted from highest to lowest with Old River Raccourci results highlighted. *NA* indicates that insufficient numbers of fish were collected to generate an estimate.

Quality Size

Waterbody	Years	Wr	L95%CI	U95%CI
Poverty	2010-12	105.7	104.6	106.8
Caddo	2011-13	105.0	103.6	106.4
Cross	2010-12	102.3	101.4	103.2
Larto/Saline	2009-12	101.1	99.5	102.7
Toledo	2009-11	96.1	94.9	97.2
D'Arbonne	2009-12	90.5	89.5	91.6
Raccourci	2010-13	83.3	80.6	86.0
Vernon	2009-11	76.2	75.4	77.0

Preferred Size

Waterbody	Years	Wr	L95%CI	U95%CI
Poverty	2010-12	108.3	107.5	109.2
Caddo	2011-13	106.5	105.7	107.3
Cross	2010-12	104.4	102.9	105.8
Larto/Saline	2009-12	97.7	95.5	100.0
Toledo	2009-11	96.6	94.8	98.3
D'Arbonne	2009-12	93.7	92.5	94.9
Raccourci	2010-13	90.1	87.9	92.4
Vernon	2009-11	75.1	73.9	76.4

Memorable Size

Waterbody	Years	Wr	L95%CI	U95%CI
Poverty	2010-12	111.3	109.7	112.9
Caddo	2011-13	102.9	101.8	104.0
Cross	2010-12	98.0	95.9	100.1
Toledo	2009-11	93.6	88.8	98.4
Larto/Saline	2009-12	92.6	89.1	96.1
D'Arbonne	2009-12	90.2	88.0	92.4
Raccourci	2010-13	85.3	81.9	88.7
Vernon	2009-11	73.5	71.8	75.1

Trophy Size

Waterbody	Years	Wr	L95%CI	U95%CI
Caddo	2011-13	100.5	98.8	102.2
Cross	2010-12	96.0	83.9	108.0
Toledo	2009-11	84.0	76.7	91.3
Larto/Saline	2009-12	83.5	-7.3	174.3
Poverty	2010-12	NA	NA	NA
Vernon	2009-11	NA	NA	NA
D'Arbonne	2009-12	NA	NA	NA
Raccourci	2010-13	NA	NA	NA

Recruitment: Annual mean age-1 crappie lead net catch per unit effort (CPUE) in Old River Raccourci compared to mean age-1 catch rates across all project lakes are shown Figure 4. Coefficients of variation describing the magnitude of variation in annual mean age-1 catch rates for waterbodies included in this project are presented in Table 7. This table illustrates variation in inter-annual recruitment among LA crappie populations.

Figure 4: Annual mean age-1 crappie catch rates from Old River Raccourci fall lead net surveys (2010-2013) compared to mean age-1 catch rates across all project lakes. Catch per unit effort (CPUE) is defined as lead net catch per hour.

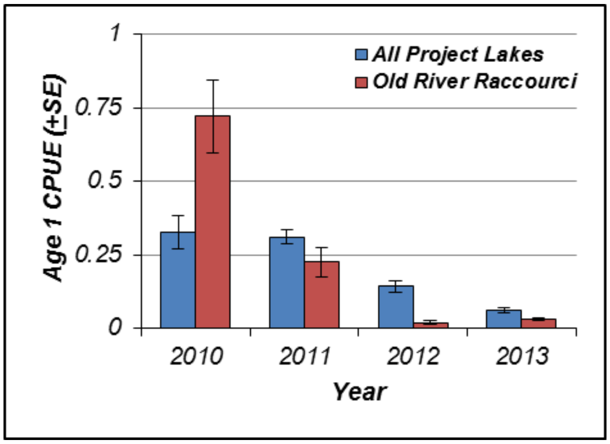


Table 7: Coefficients of variation (CV) describing the magnitude of variation in annual mean age-1 crappie catch per unit effort (CPUE) for Old River Raccourci crappie fall lead net surveys (2010-2013). CPUE is defined as lead net catch per hour. Also presented are years of crappie lead net surveys. Coefficients of variation are sorted from lowest to highest with Old River Raccourci results highlighted.

Waterbody	Years	CV

D'Arbonne	*2009-12*	*43*
Toledo Bend	*2009-10*	*54*
Cross	*2010-12*	*62*
Larto/Saline	*2009-12*	*68*
Poverty	*2010-12*	*75*
Vernon	*2009-11*	*82*
Caddo	*2011-13*	*85*
Raccourci	*2010-13*	*129*

Mortality: Total catch at age, mean CPUE at age, and corresponding 95% confidence intervals for the Old River Raccourci fall lead net survey are presented in Table 8. The shaded area identifies ages included in the catch curve analysis. Age-1 catches were considered not fully recruited to LDWF lead net sampling gear and excluded from model fitting.

Table 8: Total catch at age, and mean catch per unit effort (CPUE) at age for Old River Raccourci crappie fall lead net surveys (2010-2013). CPUE is defined as lead net catch per hour. Shaded area represents ages included in the catch curve analysis.

Age	*Catch*	*CPUE*	*L95%CI*	*U95%CI*
0	*14*	*0.003*	*0.001*	*0.004*
1	*848*	*0.181*	*0.107*	*0.254*
2	*804*	*0.160*	*0.094*	*0.226*
3	*282*	*0.057*	*0.038*	*0.076*
4	*136*	*0.027*	*0.015*	*0.038*
5	*63*	*0.012*	*0.008*	*0.015*
6	*20*	*0.004*	*0.003*	*0.006*
7	*6*	*0*	*0*	*0*
8	*1*	*0*	*0*	*0*

Observed mean CPUE at age and observed and predicted log_eCPUE at age of crappie collected from Old River Raccourci fall lead net surveys are presented in Figure 5.

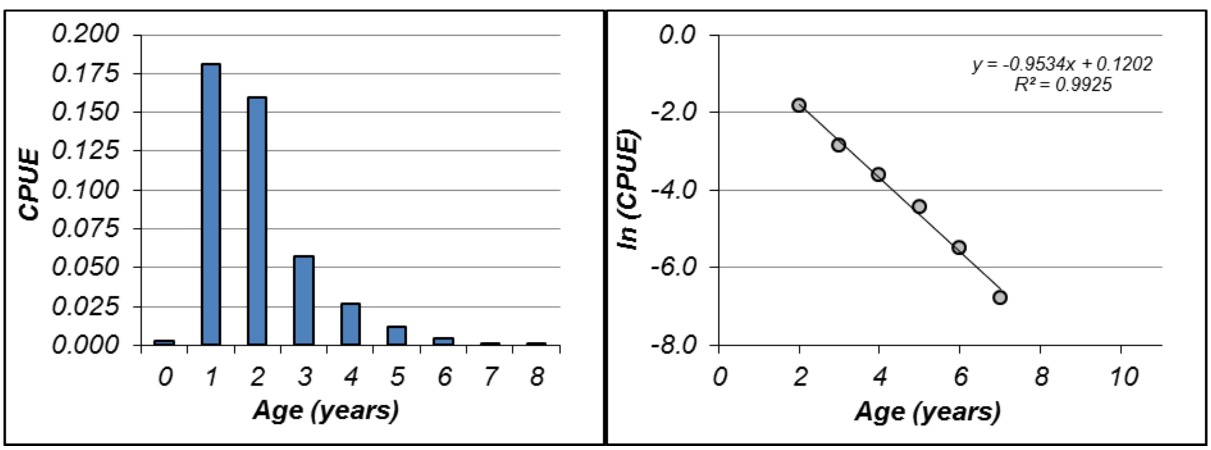


Figure 5: Observed catch rates by age of the Old River Raccourci crappie fall lead net surveys (2010-2013; left graphic). Right graphic depicts observed (circles) and predicted (line) mean log_e CPUE by age. The catch curve equation and coefficient of determination (R^2) are presented in graphic. Catch per unit effort (CPUE) is defined as lead net catch per hour.

Total instantaneous and interval mortality rate estimates for crappie populations included in this project are presented in Table 9. This table illustrates variation in total mortality rate estimates among LA crappie populations.

Table 9: Total instantaneous (Z) and interval (A) mortality rates for waterbodies included in this project, ages included in each catch curve, 95% confidence intervals, years of lead net collections, and current size limit regulations. Estimates are sorted from highest to lowest with Old River Raccourci results highlighted. For *Regulation*, LL = length limit, CL = creel limit.

Waterbody	Years	Ages	Regulation	Z	L95%CI	U95%CI	A	L95%CI	U95%CI
Poverty	2010-12	1-3	No LL, 25 CL	-2.62	-4.21	-1.03	0.93	0.64	0.99
Larto/Saline	2009-12	2-5	No LL, 50 CL	-1.68	-2.30	-1.06	0.81	0.65	0.90
D'Arbonne	2009-12	2-5	No LL, 25 CL	-1.47	-2.53	-0.40	0.77	0.33	0.92
Toledo Bend	2009-10	2-6	No LL, 25 CL	-1.42	-1.74	-1.10	0.76	0.67	0.82
Cross	2010-12	2-5	No LL, 50 CL	-1.39	-2.10	-0.67	0.75	0.49	0.88
Vernon	2009-11	2-6	No LL, 50 CL	-1.27	-1.74	-0.80	0.72	0.55	0.82
Raccourci	2010-13	2-7	No LL, 50 CL	-0.95	-1.07	-0.85	0.61	0.57	0.66
Caddo	2011-13	2-8	No LL, 25 CL	-0.47	-0.64	-0.31	0.38	0.26	0.47

Maximum observed age of crappie populations included in this project and assumed longevities used in the low, medium, and high natural mortality scenarios are presented in Table 10.

Table 10: Maximum observed age of crappie and assumed maximum ages used for each natural mortality scenario for waterbodies included in this project. Also inlcuded are the years of lead net collections. Maximum observed ages are sorted from highest to lowest with Old River Raccourci results highlighted.

		Age_max			
			Natural Mortality Scenario		
Waterbody	Years	Observed	Low	Medium	High
Toledo Bend	2009-10	9	12	11	10
Cross	2010-12	8	11	10	9
Vernon	2009-11	8	11	10	9
Caddo	2011-13	8	11	10	9
Raccourci	2010-13	8	11	10	9
Larto/Saline	2009-12	7	10	9	8
D'Arbonne	2009-12	5	8	7	6
Poverty	2010-12	4	7	6	5

Instantaneous and interval fishing mortality rate estimates (F and u respectively) for each natural mortality scenario are presented in Table 11. This table illustrates variation in fishing mortality rate estimates among LA crappie populations.

Table 11: Instantaneous and interval crappie fishing mortality rate estimates ($F$and u) by natural mortality scenario and waterbody, ages included in each catch curve, years of lead net collections, and current size limit regulations. Estimates are sorted from highest to lowest with Old River Raccourci results highlighted. For *Regulation*, LL = length limit, CL = creel limit.

				Natural Mortality Scenario					
				Low		Medium		High	
Waterbody	Regulation	Years	Ages	F	u	F	u	F	u
Poverty	No LL, 25 CL	2011-13	2-8	-2.01	0.71	-1.91	0.68	-1.77	0.63
Larto/Saline	No LL, 50 CL	2009-11	2-6	-1.26	0.61	-1.21	0.59	-1.15	0.56
Toledo Bend	No LL, 25 CL	2010-12	1-3	-1.07	0.57	-1.04	0.55	-1.00	0.53
Cross	No LL, 50 CL	2009-12	2-5	-1.00	0.54	-0.97	0.52	-0.92	0.50
D'Arbonne	No LL, 50 CL	2010-13	2-7	-0.94	0.49	-0.86	0.45	-0.76	0.40
Vernon	No LL, 25 CL	2009-12	2-5	-0.88	0.50	-0.85	0.48	-0.80	0.45
Raccourci	No LL, 50 CL	2010-12	2-5	-0.57	0.37	-0.53	0.34	-0.48	0.31
Caddo	No LL, 25 CL	2009-10	2-6	-0.09	0.07	-0.05	0.04	0.00	0.00

Population Simulations:

Parameter values used in the Old River Raccourci crappie age and sex structured simulation model are presented in Table 13.

Table 13: Parameter values used in the Old River Raccourci age and sex structured crappie population simulations.

Parameter	Description	Values

	Low Natural Mortality Scenario	
Age_max	*Longevity (years)*	*11*
M	*Instantaneous natural mortality rate (years^{-1})*	*0.38*
F	*Instantaneous fishing mortality rate (years^{-1})*	*0.57*
	Medium Natural Mortality Scenario	
Age_max	*Longevity (years)*	*10*
M	*Instantaneous natural mortality rate (years^{-1})*	*0.42*
F	*Instantaneous fishing mortality rate (years^{-1})*	*0.53*
	High Natural Mortality Scenario	
Age_max	*Longevity (years)*	*9*
M	*Instantaneous natural mortality rate (years^{-1})*	*0.47*
F	*Instantaneous fishing mortality rate (years^{-1})*	*0.76*
	All Scenarios	
d	*Discard mortality rate (proportion not surviving)*	*0.1*
R	*Constant recruitment*	*10000*
Lvul	*Length at recruitment to fishery (inches)*	*7.0*
Linf_female	*Female asymptotic average maximum length*	*14.13*
K_female	*Female von Bertalanffy growth coefficient*	*0.40*
t0_female	*Female von Bertalanffy time at zero TL*	*0.00*
a_female	*Female length-weight constant*	*2.00E-0.06*
b_female	*Female length-weight allometric parameter*	*3.35*
Linf_male	*Male asymptotic average maximum length*	*13.92*
K_male	*Male von Bertalanffy growth coefficient*	*0.43*
t0_male	*Male von Bertalanffy time at zero TL*	*0.00*
a_male	*Male length-weight constant*	*2.23E-0.06*
b_male	*Male length-weight allometric parameter*	*3.34*

Simulation results illustrating the effect of two size regulations (10 and 12-inch minimum length limits) on total catch and catch per angler-trip relative to the current regulation (no length limit) for the three natural mortality scenarios are presented in Figures 7 and 8. The percent of crappie caught that would need to be released due to size regulations under each mortality scenario is shown in Figure 9. Simulation results illustrating the effects of size regulation implementation on mean weight of harvested crappie, the number of crappie harvested per trip, and yield relative to the "no length limit" regulation for three different natural mortality scenarios are presented in Figures 10, 11, and 12. Figure 13 illustrates the effect of each simulated size regulation on yield as a function of instantaneous fishing mortality for each natural mortality scenario.

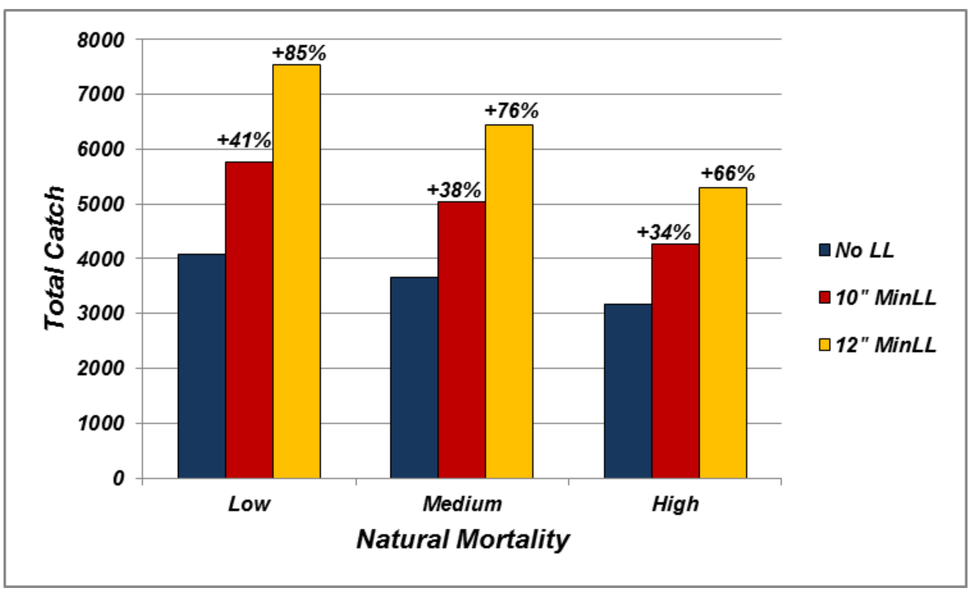


Figure 6: Model results illustrating the effect of two simulated size regulations (10 and 12-inch minimum length limits) on Old River Raccourci crappie total catch (numbers of fish), relative to the current regulation (no length limit) for three natural mortality scenarios. Units are relative to constant recruitment of 10,000 individuals.

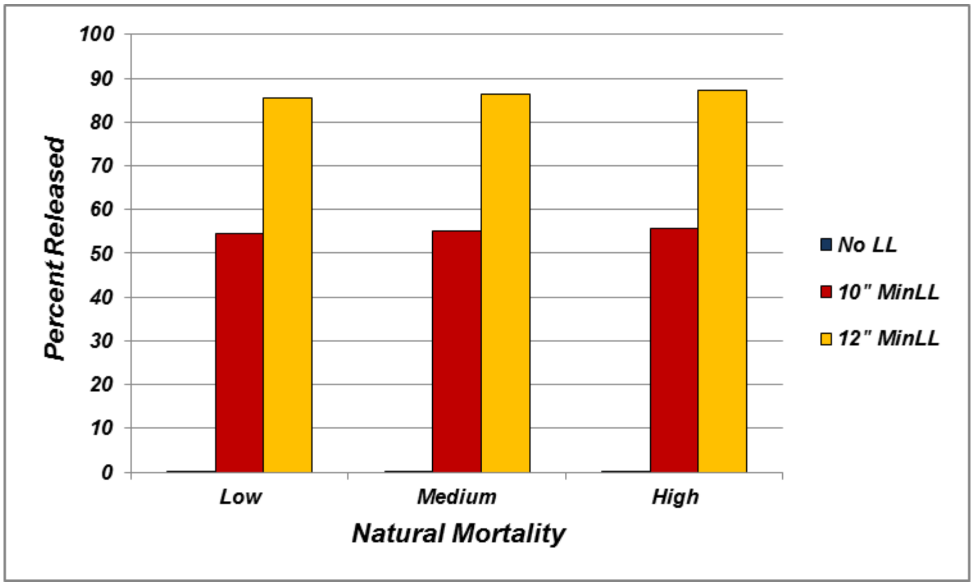


Figure 7: Model results illustrating the effect of two simulated size regulations (10 and 12-inch minimum length limits) on the number of crappie that would need to be released due to size regulations relative to the current regulation (no length limit) for three natural mortality scenarios in Old River Raccourci. We assumed zero fish are released for the "no length limit" regulation.

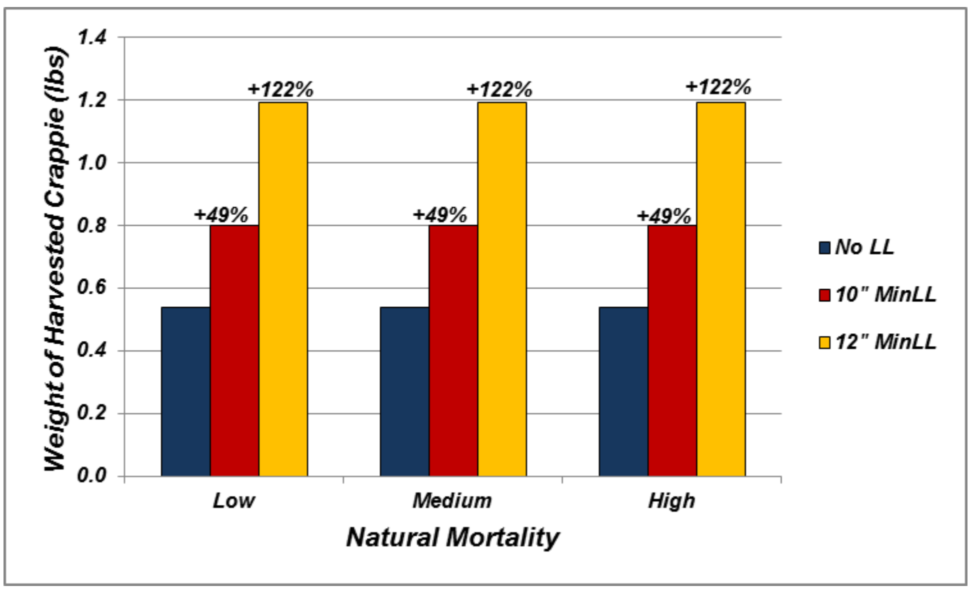


Figure 8: Model results illustrating the effect of two simulated size regulations (10 and 12-inch minimum length limits) on the mean weight of harvested crappie relative to the current regulation (no length limit) for three natural mortality scenarios in Old River Raccourci.

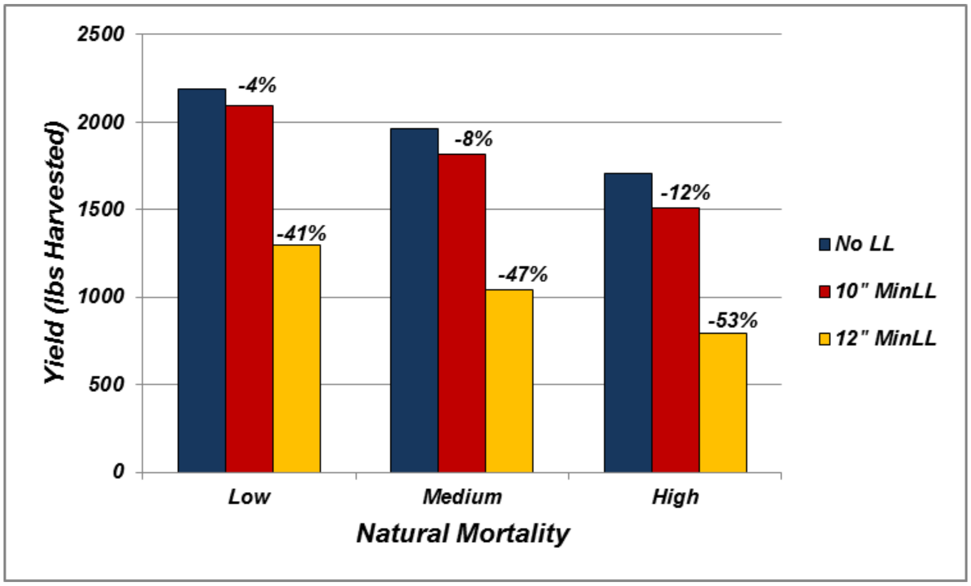


Figure 9: Model results illustrating the effect of two simulated size regulations (10 and 12-inch minimum length limits) on Old River Raccourci crappie yield (pounds harvested), relative to the current regulation (no length limit) for three natural mortality scenarios. Units are relative to constant recruitment of 10,000 individuals.

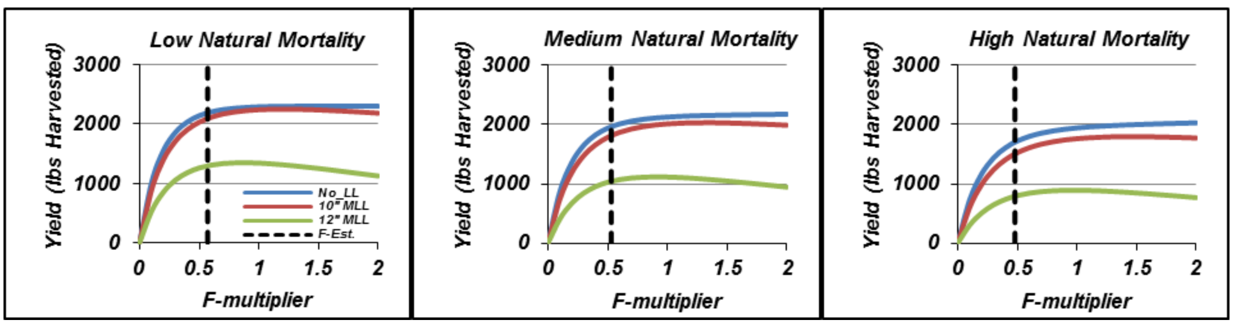


Figure 10: Model results illustrating the effect of three simulated size regulations (no length limit, 10 and 12-inch minimum length limits) on Old River Raccourci crappie yield (pounds harvested) versus instantaneous fishing mortality (*F*) for three natural mortality scenarios. Also shown is the estimate of *F* associated with each natural mortality scenario. Units are relative to constant recruitment of 10,000 individuals.

Discussion:

Population Characteristics:

Species Composition: Black crappie were the dominant crappie species observed during all four years of the study, comprising 93% of the total crappie catch (Table 1).

Growth: The Old River Raccourci crappie population has a moderately slow growth rate when compared to other waterbodies included in this project (Table 3). The time in years to reach quality (8-inch TL), preferred (10-inch TL), and memorable (12-inch TL) sizes for the Old River Raccourci crappie population (2.0, 2.9, and 4.4 years, respectively) are higher than the population exhibiting the fastest time to size (Poverty Point Reservoir; 0.8, 1.3, and 2.2 years respectively). The Larto/Saline Complex crappie population has the most similar growth rate (i.e., 2.0, 3.0, and 4.5 years respectively) when compared to the Old River Raccourci crappie population.

The method of von Bertalanffy model fitting used in this assessment assumed that the data are representative samples of lengths from each age-class. If this assumption fails (e.g., size-selective sampling and cumulative effects of fishing mortality), model parameters can only describe the current population available to harvest (Taylor et al. 2005). In other words, the current VBGF fitting methodology may underestimate growth when faster growing individuals are removed from the population disproportionaly due to size-selective fishing mortality. If determining potential growth rates under a no harvest scenario is of interest, then the methodology detailed in Taylor et al. (2005) could be used in future analyses.

Size Structure Indices: The Old River Raccourci crappie PSD indices are marginally higher than the other populations included in this project (Table 4). The Old River Raccourci PSD index for fish larger than quality size

(PSD-Q; 68) is less than the highest estimate (Poverty Point Reservoir; 82). The Old River Raccourci PSD index for fish larger than preferred size (PSD-P; 30) is also less than the highest estimate (Poverty Point Reservoir; 55). Caddo Lake had the highest PSD index for fish larger than memorable size (PSD-M; 22), which was substantially higher that the Old River Raccourci estimate (9.0). The Vernon Lake and Old River Raccourci crappie populations had very similar PSD indices.

Optimum ranges of PSD indices have been proposed for maintaining balanced crappie populations (Neumann et al. 2012). Old River Raccourci estimates for quality and preferred sized crappie are slightly higher than the recommended ranges (PSD-Q: 30-60, PSD-P: >10). Indices falling outside these ranges may indicate unstable crappie recruitment, growth, and mortality, or that population density is above optimum levels.

An important assumption in obtaining unbiased estimates of PSD indices is that samples are representative of the standing crappie population size structure. If this assumption fails, estimates will be biased low. This is an important limitation not only for unbiased estimates of population size structure, but also for obtaining accurate estimates of age-specific relative abundance and subsequent estimates of total mortality.

Condition: Tables 5 and 6 present species and size-specific mean relative weight estimates for waterbodies included in this project. For black crappie, Old River Raccourci mean W_r estimates of quality, preferred, and memorable sized fish are below the recommended range (95-105) of a balanced population (Neumann et al. 2012). Mean relative weights of black crappie were low when compared with estimates of other project waterbodies, and most similar to Bayou D'Arbonne Reservoir estimates. For white crappie Old River Raccourci mean W_r estimates fell just below the recommended range, and moderate compared to other waterbodies. Mean W_r estimates well below 100 may indicate a problem with prey availability or feeding conditions (Neumann et al. 2012).

Recruitment: Annual age-1 CPUE of Old River Raccourci crappie was generally lower than the state-wide average, with the exception occurring in 2010 (Figure 4). The Old River Raccourci population exhibited the largest variability in recruitment (CV=130), and recruitment steadily decreased from 2010-2013. Bayou D'Arbonne Reservoir crappie recruitment is the least variable (CV=44; Table 7) of all the waterbodies included in this project. The next lowest recruitment variability in annual age-1 CPUE estimates was for Toledo Bend Reservoir (CV=55). Future analyses incorporating annual age-1 CPUE data over a longer time-series will allow a more accurate assessment of recruitment in and among LA crappie populations.

Mortality: The Old River Raccourci crappie population had the second lowest estimate of total mortality (Z=-0.95/year; A=0.61/year) when compared to the other populations included in this project (Table 9). The lowest total mortality rate (Z=-0.47/year; A=0.38/year) was estimated for the Caddo Lake crappie population; the highest estimate (Z=-2.62/year; A=0.93/year) was for the Poverty Point Reservoir crappie population. The mortality estimates for Toledo Bend Reservoir, Caddo Lake, and Bayou D'Arbonne Reservoir represent transitional periods in each fishery due to crappie harvest regulation changes during the timeframe of this study.

To obtain unbiased estimates of total mortality rates via catch curve analysis, three assumptions must be met: 1) mortality is constant across ages, 2) recruitment is constant, and 3) samples are representative of the true age structure in the population. The first two assumptions are rarely met, and the impact of the second assumption is lessened in this assessment as described in *Methods*. If the third assumption of representative sampling is not met, mortality rate estimates will be biased.

The Old River Raccourci crappie population has an observed maximum age of 8 years, which was the most frequently observed maximum age across waterbodies (Table 10). The Toledo Bend population has the oldest age observed (9 years). The Poverty Point Reservoir population has the lowest observed maximum age (4 years). Given the approximation of M from equation [8], crappie populations with low maximum observed ages correspond to higher estimates of M; populations with high maximum observed ages correspond to lower estimates of M. Since exploitation of crappie populations is likely high, we developed multiple natural mortality scenarios to explicitly demonstrate uncertainty in M (see *Methods: Population Characteristics: Mortality* section).

The Old River Raccourci crappie population had a low rate of fishing mortality for each natural mortality scenario when compared to other crappie populations included in this project (Table 11). The lowest fishing mortality rate estimates were for the Caddo Lake crappie population, and the highest estimates were for the Poverty Point Reservoir crappie population (Table 11). Fishing mortality rate estimates presented in this report are approximated by difference (i.e. $Z - M$). If approximation of M from equation [8] is uncertain, fishing mortality estimates would also be considered uncertain.

<u>Population Simulations:</u>

Population simulations presented in this report are based on equilibrium conditions (i.e., long-term averages) and do not include more complex dynamics such as recruitment variability, density dependent growth, and environmental conditions.

Implementation of a minimum length limit on Old River Raccourci crappie would result in increased total catch

(Figure 6), but would increase the number of crappie that would need to be released (Figure 7). These effects increase as the minimum size limit increases, but are less pronounced with higher natural mortality scenarios. Length limit implementation would also increase the mean weight of crappie harvested (Figure 8), however the lower number of crappie harvested would result in decreased overall yield (Figure 9). These effects increase as the minimum size limit increases and are more pronounced with higher natural mortality. Figure 10 demonstrates that if natural mortality remains constant, there is no level of fishing mortality that would result in higher yields after implementing a minimum length limit. This is true for each natural mortality scenario.
Allen and Miranda (1995) suggest that estimates of M below 0.40 and fast growth rates are required for minimum length limits to increase yield. The estimates of M calculated for each scenario of this study (low = 0.38, medium = 0.42, high = 0.47) mostly exceed this level. While the M estimate for the low natural mortality scenario was below 0.40, it is likely that growth rates were insufficient to produce increased yield with the 10-inch minimum length limit. Our simulation results indicate that implementing a length limit would decrease yield and therefore support results of Allen and Miranda (1995).

<u>Conclusions:</u>

It is important to note that crappie populations and their fisheries are not only influenced by fishing effort, but also by anthropogenic and environmental factors. The type and degree of human activity within watersheds, riparian zones, and specific waterbodies can affect crappie populations by altering critical habitats. Additional factors influencing crappie populations include aquatic vegetation coverage, water level management, largemouth bass stocking programs, and habitat improvements. The frequency of floods, drought, and hurricanes can also influence crappie populations. While consideration of these factors is important in effective fisheries management, evaluating how these factors affect the Old River Raccourci crappie population and fishery is beyond the scope of this report.
The Old River Raccourci crappie population has a high maximum age, moderately slow growth rate, low mortality rate, with high recruitment variability when compared with the other crappie populations included in this project. The Old River Raccourci crappie fishery is currently managed with no size restrictions and a 50 fish per day harvest limit. Given the dynamics of the Old River Raccourci crappie population and fishery, size limit implementation would decrease yield and substantially increase the numbers of crappie that would need to be released.

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