George Ross Lakes Fishery Survey Report

Texas A&M University Student Subunit of the American Fisheries Society
Department of Wildlife and Fisheries Sciences
Texas A&M University

Summary

Applied research experiences for students enrich educational programs and promote more competitive graduates ready to take-on career challenges. However, there is a shortage of such opportunities for students focusing on fisheries careers and there is a need for thinking beyond the classroom when it comes to training fisheries students. Field-based, hands-on learning opportunities in which students solve real-world problems improve critical thinking, promote collaborative work environments, and foster stronger connections between student academic experiences and on-the-job responsibilities. Here, we present a fishery assessment of the George Ross Lakes managed by stakeholders with the Circle D Civic Association Board as a means of bridging the gap between student education and applied fisheries management. The George Ross Lakes are impoundments on Spicer Creek in Bastrop County, Texas. On April 5-6, 2019, students sampled the fisheries in Upper George Ross Lake and Lower George Ross Lake using boat electrofishing. All fishes collected were measured, weighed, and returned to the water. From these measurements students developed length-frequency histograms, length-weight relationships, relative weight estimates, and proportional size distribution statistics. These fishery metrics were then used to provide potential management actions the Circle D Civic Association Board might consider in the future. These management actions are only suggestions and should be interpreted only after consideration of management goals and stakeholder interests are reviewed.

Background

Student training in science, technology, engineering, and math fields is increasingly moving towards greater emphasis on research experience (Russell et al. 2007). This is particularly true in the wildlife and fisheries disciplines where job duties routinely require field experience, independent critical thinking, and honed communication skills (Millspaugh and Millenbah 2004). It has long been recognized that introduction to foundations at the undergraduate level, and reinforcement of foundations with advanced techniques at the graduate level, yield the greatest professional growth for students (Oglesby and Krueger 1989). More recent works have shown that students with greater critical thinking and communication skills are most likely to succeed in their careers post-graduation (McMullin et al. 2016). Furthermore, students with diverse and management-based experiences are most successful in obtaining jobs and advancing within agencies (Dunmall and Cooke 2016). These patterns point to a need for greater hands-on experiences for fisheries students in a time when fisheries course offerings are shrinking (Jackson et al. 2016). To address this challenge, extra-curricular opportunities are needed to supplement classroom experiences, and fisheries students need to get out and interact with fishery resources and stakeholders (Lederman and Carlson 2016).

Engaging students in the fisheries management process is the best approach to improving their comprehension of principles and preparation for post-graduate work. Fisheries management is a field composed of a number of sub-disciplines focused on the biology and ecology of fishes (i.e., fishes), the creation and maintenance of waterbodies and their physical characteristics (i.e., habitat), and the people that manage, use, or otherwise invest in fishery resources (i.e., people). It is at the intersection of fish, habitat, and people that the process of fisheries management is conducted (Figure 1a). At this intersection, choices related to stakeholder values, technical knowledge, and policy implementation manifest as fisheries management decisions (Figure 1b). That is, fishery resources are managed to meet the goals of stakeholders in a manner that is technically possible and sound. Maintaining resources for future generations requires adherence to policies regulating fishery resource use. Once stakeholder goals are identified, fishery assessment and monitoring can be used to inform management that seeks to measure progress toward goals using a series of metrics particular to the field. For example, stakeholders might be interested in maintaining a "trophy fishery" characterized by few opportunities to catch large fishes, or a "panfish fishery" characterized by many opportunities to catch smaller fishes. Alternatively, "balanced fisheries" exist within the range between the trophy and panfish endpoints and are generally the goal when diverse stakeholder interests are involved. Characterizing a fishery as belonging to these or other classifications is possible with fishery metrics such as the proportional size distribution (PDS) in which the size and number of fishes within size classes are used to determine the status of a fishery. Other commonly used metrics include the relative weight metric used to determine if individual fishes are heavier (good condition) or lighter (poor condition) than the average weight of a typical individual at some length. These and other metrics provide insight into the current status of a fishery and how management actions might be tailored to reach stakeholder goals. Exposing students to these principles (Figure 1) and the techniques and metrics used to make empirically-based fisheries management decisions represents a clear path to training well-balanced fisheries professionals capable of solving real-world problems.

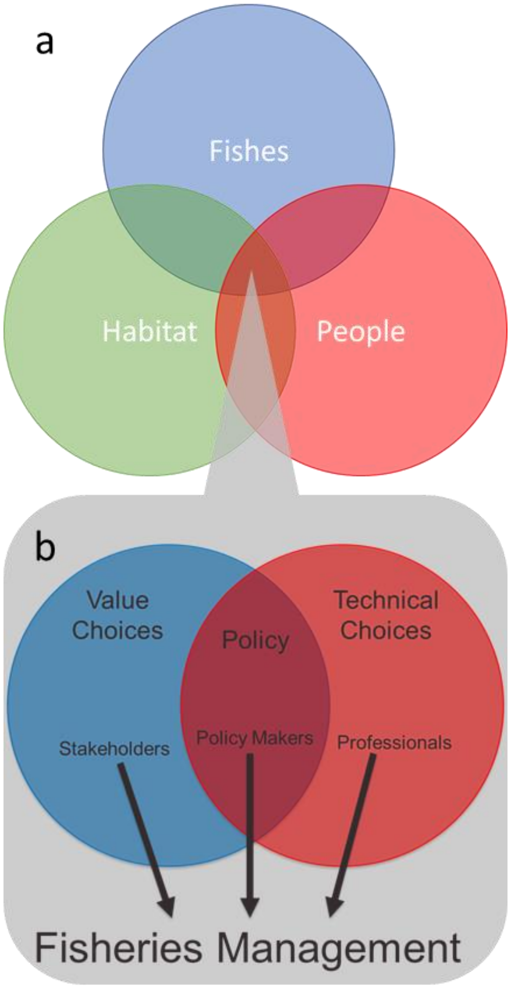

Figure 1. Conceptual diagrams illustrating (a) the major foci of fisheries management and (b) the process of using stakeholder goals and technical knowledge to create policies to maintain a fishery.

This work mixed fisheries investigations and student hands-on experience with science to simultaneously promote the development of superior fisheries students while solving real-world needs related to fisheries management technical information. This goal was accomplished by bringing students to the George Ross lakes in Bastrop County, Texas to assess the current status and future management options for two small impoundments. The objectives of this work included (1) surveying fishes within two impoundments, (2) using data collected during surveys to calculate fishery metrics useful for establishing the current condition of the fisheries, and (3) using analysis results to develop management recommendations.

Study Area

This work was conducted on two small impoundments located in Bastrop County, Texas. These impoundments include Upper George Ross Lake (UGRL) and Lower George Ross Lake (LGRL). The surface area for UGRL is 12.36 acres and LGRL is 10.13 acres (Table 1), and UGRL is nested within the watershed of LGRL (Figure 2).

Table 1. Waterbody names, surface area, and watershed size.

Waterbody name	Surface area	Watershed size
Upper George Ross Lake (UGRL)	12.36 acres (0.05 km^2)	588.11 acres (2.38 km^2)
Lower George Ross Lake (LGRL)	10.13 acres (0.041 km^2)	711.66 acres (2.88 km^2)

Figure 2. George Ross lakes illustrating upper (UGRL) and lower (LGRL) impoundments on Spicer Creek in Bastrop Country, Texas. The upper impoundment is nested within the watershed of the lower impoundment, and the shared upstream watershed is composed of mostly forested land with development in the areas around each impoundment.

Methods

Surveys. – The fisheries investigation included commonly employed fisheries techniques. Fish surveys were conducted using a boat-mounted, direct-current electrofishing around the perimeter of the impoundments at night. Nighttime, boat-mounted electrofishing is an efficient method for collecting a diversity of fishes and size classes at a time when fishes are most active in shallow, littoral zones. Studies of standardized methods in fisheries management suggest electrofishing surveys should be conducted in spring (Pope et al. 2009), thus work was conducted on the evening of April 5 through the early morning hours of April 6, 2019. All fishes collected during electrofishing were identified to species, weighed, measured for length, and returned to the water. Two gillnets were deployed, one in each impoundment, and soaked overnight to assess pelagic fish assemblages. These gillnets yielded no catch and were therefore removed from analyses. Shoreline seining was planned for the morning of April 6, but inclement weather prevented seining surveys.

Data Analysis. – Data collected during fieldwork were analyzed by students under the direction of Dr. Joshuah Perkin. Length and weight data for the most common species were used to construct length-frequency histograms, length-weight regressions, relative weights, and proportional stock densities for each pond. Length-frequency plots illustrate the size distribution of all fishes captured and provide insight into the range of sizes included in a population. Length-frequency plots were created for Bluegill, Largemouth Bass, and Redear Sunfish. Length-weight regressions provide insight into "robustness" of fishes, or how they add weight as they grow. Length-weight regressions fit to Largemouth Bass allowed for determining if there was any difference in robustness of fishes between the two lakes. Robust fishes indicate suitable conditions exist for growth and maintenance of mass. Relative weight metrics allow for comparing the weight-at-length for all individuals to determine if fish conditions are average, heavier, or lighted than expected for the species. Relative weight results for Largemouth Bass provide a second measure of fish condition that gives insight into management needs. A relative weight value of 100 means that the conditions within the impoundments are sufficient for fish to maintain a body mass consistent with the average weight for the species. However, if values are below 95-100, then corrective management might be required. Examples of corrective management include reducing density of fishes to relieve crowding or supplementing the forage base to stimulate growth. The number of fish at particular sizes were used to develop proportional size distribution (PSD) metrics for Largemouth Bass and Bluegill. The PSD is a useful tool for determining if overcrowding, stunting, or optimum conditions exist within the impoundments, and the ratio of PSDs for Largemouth Bass and Bluegill can provide guidance for management actions.

Management Options. – Information on management options based on the methods used here are provided. These options represent actions that might be taken to improve the fisheries according to stakeholder interests. The ultimate decisions regarding management will dependent on well-defined goals of the managing entity after consultation with stakeholders (see Figure 1 above).

Results

Five species of fish were encountered during electrofishing surveys during 0.85 hours of sampling on UGRL and 0.62 hours of sampling on LGRL (Table 2). In UGRL the most abundant species was Bluegill, followed by Largemouth Bass, Redear Sunfish, Green sunfish, and Blacknose Crappie. In LGRL the most abundant species was Bluegill, followed by Largemouth Bass, Redear Sunfish, and Green Sunfish. Blacknose Crappie was not collected from LGRL. After accounting for differences in effort caused by differences in lake size, the CPUE for Bluegill, Largemouth Bass, Redear Sunfish, and Green Sunfish was higher in LGRL.

Table 2. Fish species encountered during electrofishing surveys, including the total number of individuals captured and catch per unit effort (CPUE). The CPUE metric was calculated by dividing the total number of fish collected by the total number of hours electrofishing was conducted on each lake.

	Upper George Ross Lake		Lower George Ross Lake	
Fish species	Total captured	CPUE	Total captured	CPUE
Blacknose Crappie	4	4.7	0	0
Bluegill	109	128.2	116	187.1
Green Sunfish	11	12.9	9	14.5
Largemouth Bass	60	70.6	82	132.3
Redear Sunfish	39	45.9	40	64.5

Length frequency plots illustrated differences in sizes between the two lakes for the three most abundant species, Bluegill, Largemouth Bass, and Redear Sunfish (Figure 3). Bluegill size structure was very consistent between UGRL and LGRL, except that a greater number of larger individuals (>180 mm total length, TL) was collected in LGRL. Largemouth Bass size structure differed between UGRL and LGRL in that two size groups were clear in each lake. In UGRL, a small size group ranging 80-100 mm TL was present and second group ranging 240-480 mm TL was present. In LGRL, a small group ranging 120-240 mm TL was present and a second group ranging 280-340 mm TL was present. Only three Largemouth Bass >320 mm TL were collected from LGRL, whereas 23 individuals >320 mm TL were collected from UGRL. Redear Sunfish size structure was consistent between UGRL and LGRL.

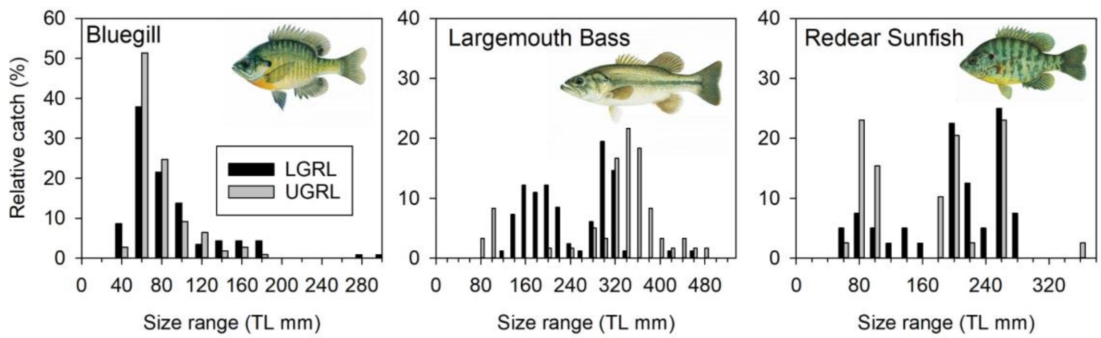

Figure 3. Relative length frequency plots for Bluegill, Largemouth Bass, and Redear Sunfish collected from Upper George Ross Lake (UGRL) and Lower George Ross Lake (LGRL) during April 5-6, 2019.

Length-weight regressions for Largemouth Bass in the two lakes revealed greater robustness of smaller fish in Lower George Ross Lake compared to Upper George Ross Lake (Figure 4A). Note that the red line for LGRL in Figure 4A is higher for fish <Log_{10}(2.4) mm TL, meaning smaller fish tended to weight more at a given length compared with UGRL. Relationships between length and relative weight showed that the current fisheries exist on the border of a "balanced fishery" and "panfish fishery" (Figure 4B).

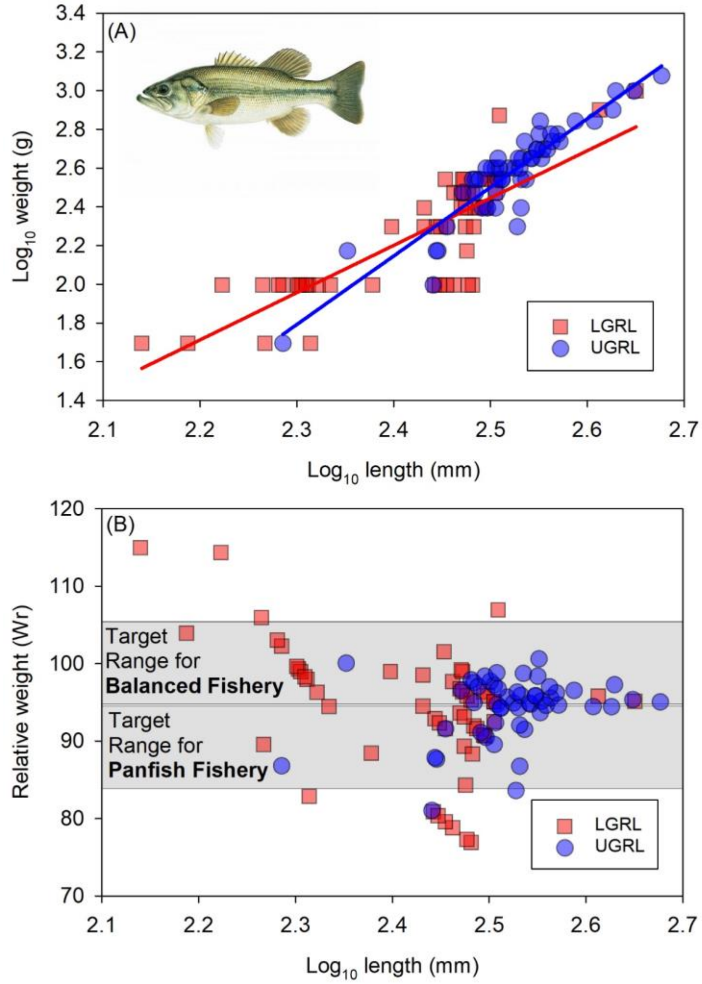

Figure 4. (A) Length-weight relationship for Largemouth Bass in Upper George Ross Lake (UGRL, blue circles and line) and Lower George Ross Lake (LGRL, red circles and line). Smaller fish weighed more in LGRL compared to UGRL, suggesting better conditions for small fish to gain weight in that lake. (B) Length-relative weight relationship for Largemouth bass in UGRL and LGRL (colors are the same as panel A). The relative weight metric compared fish from the surveyed lakes to average values for the species, such that values <100 are below average and values >100 are above average. The target range of relative weight values differs according to the goal of the fishery. If a "balanced fishery" with equal numbers of large and small fish is desired, then relative weight values ranging 95-105 are desirable. If a "panfish fishery" dominated by many small fish is desired, then relative weights ranging 85-95 are desired.

Proportional size distribution (PSD) results for the two lakes revealed contrasting management actions might be necessary. The PSD values for Largemouth Bass were 88.4% in UGRL and 32.6% in LGRL, while PSD values for Bluegill were 4.3% in UGRL and 21.6% in LGRL. When plotted on the conceptual diagram of Higginbotham (2010), potential management actions for each lake were revealed (Figure 5). Ratios of Bluegill and Largemouth Bass PSD revealed that in UGRL, small Largemouth Bass are likely being outcompeted by a stunted Bluegill population. Management recommendations from Neal and Willis (2012) include either ceasing harvest of Largemouth Bass from the Upper Lake or stocking grown-out fish that, once stocked, would not be consumed by the existing bass. For LGRL, an opposite issue of too many smaller bass exists and Largemouth Bass <12" should be selectively harvested.

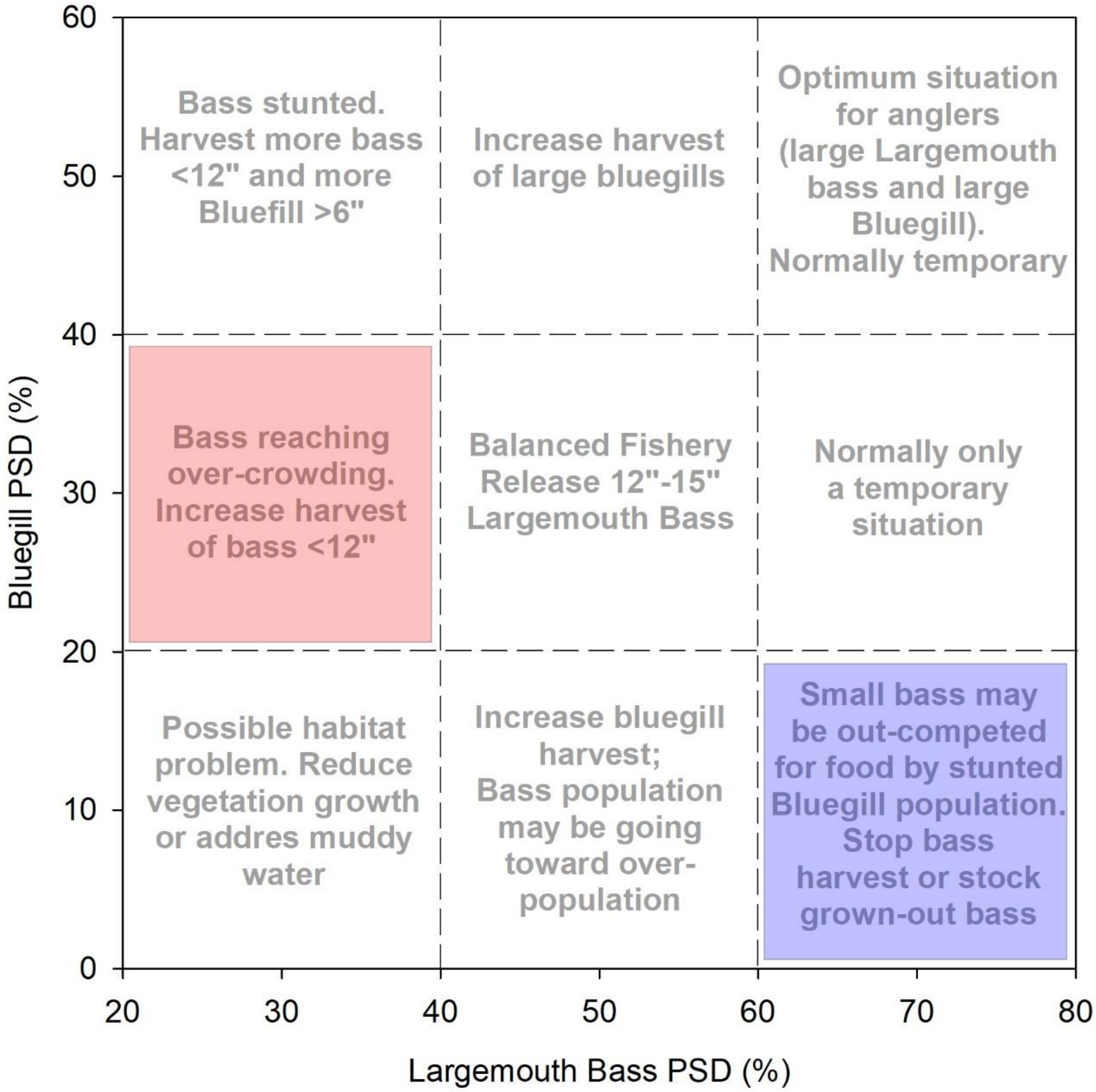

Figure 5. Relationship between Largemouth Bass and Bluegill proportional size distribution (PSD) values illustrating the current conditions and management suggestions for UGRL (blue area) and LGRL (red area).

Wright and Kraft (2012) suggested additional research should be conducted for fisheries where Redear Sunfish were used as a replacement for Bluegill. Given the abundance of Redear Sunfish in the George Ross lakes, this fishery option could be explored. The PSD values for Redear were 82.6% in UGRL and 87.9% in LGRL. When Redear Sunfish were plotted in place of Bluegill on the conceptual diagram of Higginbotham (2010), potential alternative management actions for each lake were revealed (Figure 6). Ratios of Redear Sunfish and Largemouth Bass PSD revealed that in UGRL, an optimal situation of large Largemouth Bass and large Redear Sunfish currently exists. This makes for excellent angling opportunities for anglers interested in catching either species. For LGRL, the issue of stunting of Largemouth Bass is further exaggerated by the presence of many large Redear Sunfish, and management options include the selective harvest of small Largemouth Bass (<12" length) and large Redear Sunfish (>6" length).

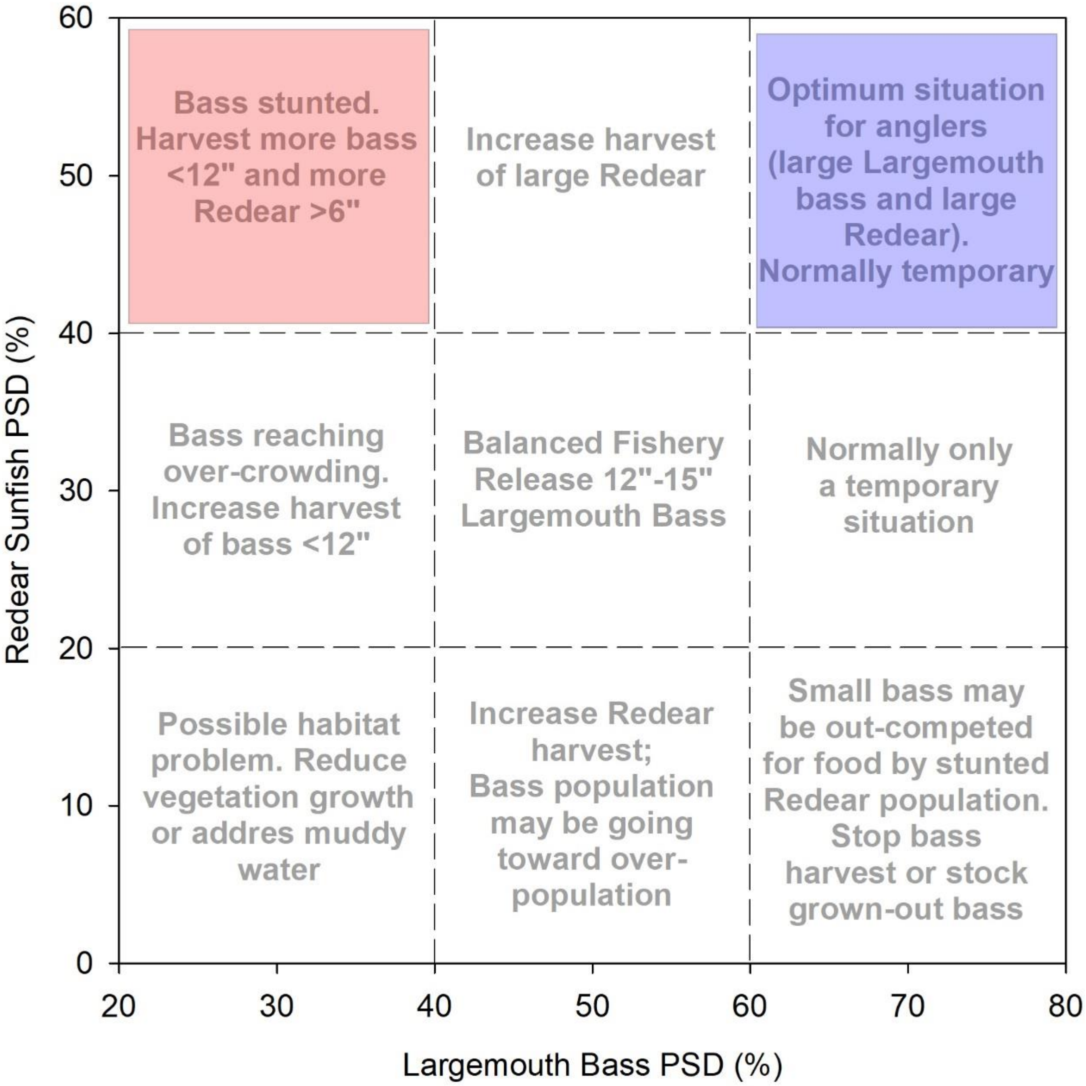

Figure 6. Relationship between Largemouth Bass and Redear Sunfish proportional size distribution (PSD) values illustrating the current conditions and management suggestions for UGRL (blue area) and LGRL (red area).

Management Actions and Recommendations

Data collected by students from the George Ross lakes provide insight into management actions that could that help to achieve stakeholder goals. It is critical that stakeholders determine the species and type of fisheries they wish to maintain before taking management actions. For example, fisheries that are commonly maintained in small impoundments such as the George Ross lakes are panfish, balanced, and trophy fisheries. Panfish fisheries are typically characterized by many small fish that are easy to catch, while a trophy fishery might contain few large fish that are difficult to catch. A balanced fishery exists between these two extremes and generally requires less management action to maintain. Across all of these fishery types, Largemouth Bass is treated as the target species while Bluegill or Redear Sunfish are treated as the forage base.

Catch rates (Table 2) and size distributions (Figure 3) of fishes pointed to a greater number of smaller Largemouth Bass in LGRL. These differences were evident in the length-weight regression as well (Figure 4A). Relative weights of fish in LGRL declined as their length increased, suggesting a crowing effect such that larger fishes competed with each other (Figure 4B). This same pattern was evident in PSD metrics for Largemouth Bass and Bluegill (Figure 5), which suggest management actions should be aimed at reducing overcrowding through removal of Largemouth Bass <12”. On the contrary, UGRL had few small Largemouth Bass (Figure 3), heaver weights for larger individuals (Figure 4A), relative weights indicative of a balanced fishery (Figure 4B), and a population in which small Largemouth Bass are likely outcompeted by Bluegill (Figure 5). One apparent mutually-beneficial management approach might involve the removal of small Largemouth Bass from LGRL followed by placement in UGRL. However, the number and frequency of such movements would have to be determined through repeated surveys of the fishery. This could be done through hook-and-line surveys in which anglers weigh and measure fish as they are released back into lakes (see suggestions by Bonds et al. 2005).

From the perspective of the unique Largemouth Bass – Redear Sunfish fishery, conditions are optimal as they exist in UGRL but the issue of crowing persists for LGRL. An alternative to Largemouth Bass removal from LGRL could be the harvest of large Redear Sunfish from that lake. This could be done in series with Largemouth Bass relocations from LGRL to UGRL, except that Redear Sunfish would be harvested for consumption rather than relocation. All of these suggestions for potential management actions should be reviewed by stakeholders prior to actions being taken to ensure that the goals for the fishery are being addressed. Further fishery investigations should also be conducted to ensure that the patterns detected here are reflective of seasonal or annual variations in the fishery.

Student Involvement and Broader Impacts

This work was conducted by student members of the Texas A&M University Student Subunit of the American Fisheries Society under the direction of Dr. Joshuah Perkin. Students involved with this work ranged from undergraduate to graduate students, including Master of Science and Doctor of Philosophy students. Students from the Principles of Fisheries Management (WFSC410) class attended on a voluntary basis (i.e., not a required fieldtrip). Students directly involved with the work developed a short write-up for the Texas Chapter of the American

Fisheries Society newsletter and plan to share this report with the chapter. This case study will be incorporated into the curriculum for future WFSC410 classes.

References

Bonds, C., G. Conley, F. Gelwick, et al. (2005). Texas farm ponds: Stocking, assessment, and management recommendations. Special Publication Number 1, Texas Chapter of the American Fisheries Society. Available online: http://fisheries.tamu.edu/files/2013/10/Texas-Farm-Ponds-Stocking-Assessment-and-Management-Recommendations-.pdf

Dunmall, K. M., & Cooke, S. J. (2016). Narrow or Broad: Diverse Academic Pathways to a Career in Fisheries Science and Management. Fisheries 41:477-478.

Higginbotham, B. (2010). Fish population assessment and interpretation for private waters. Texas Cooperative Extension, Texas A&M University. Available online: https://agrilifecdn.tamu.edu/wildlife/files/2010/04/3_Fish_Popl_Assessment.pdf.

Lederman, N. J., & Carlson, A. K. (2016). Preparing the Next Generation of Fisheries Professionals: Insights from the Student Subsection of the Education Section. Fisheries 41:471-472.

McMullin, S. L., DiCenzo, V., Essig, R., Bonds, C., et al. (2016). Are We Preparing the Next Generation of Fisheries Professionals to Succeed in their Careers?: A Survey of AFS Members. Fisheries 41:436-449.

Millspaugh, J. J., & Millenbah, K. F. (2004). Value and structure of research experiences for undergraduate wildlife students. Wildlife Society Bulletin 32:1185-1194.

Neal, J. W., and D. W. Willis. (2012). Small Impoundment Management in North America. American Fisheries Society, Bethesda, Maryland, USA.

Oglesby, R. T., & Krueger, C. C. (1989). Undergraduate fisheries education: technical specialization or broad foundation?. Fisheries 14:17-21.

Pope, K. L., Neumann, R. M., & Bryan, S. D. (2009). Warmwater fish in small standing waters. Standard methods for sampling North American freshwater fishes. American Fisheries Society, Bethesda, Maryland, 13-27.

Russell, Susan H., Mary P. Hancock, and James McCullough. (2017). Benefits of undergraduate research experiences. Science 2007548-549.

Swingle, H. S. 1956. Appraisal of methods of fish population study. Part IV. Determination of balance in farm fish ponds. Transactions of the North American Wildlife Conference 21:298-322.

Wright, Russel A., and Clifford E. Kraft. (2012). Stocking strategies for recreational small impoundments. Chapter 6 In Neal, J. W., and D. W. Willis. (editors). Small Impoundment Management in North America. American Fisheries Society, Bethesda, Maryland, USA.