George Ross Lakes FISHES: Fisheries Investigations and Student Hands-on Experience with Science

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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, I propose to merge fisheries investigations and student hands-on experience with science (FISHES) to simultaneously train students and produce fisheries management recommendations for two ~10-acre ponds in Bastrop, Texas. The George Ross Lakes are impoundments on Spicer Creek in Bastrop County, Texas and are managed by stakeholders with the Circle D Civic Association Board. The Board has invited student-based research lead by faculty to serve as both a student training opportunity and a process for developing fishery assessments with subsequent management recommendations. This proposal outlines the major components of the FISHES framework, including fieldwork to be conducted, analyses of collected data, and the resulting recommendations that will be developed.

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 weigh metric used to determine if individual fishes are heavier (good condition) or lighter (poor condition) than the average weight of an 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.

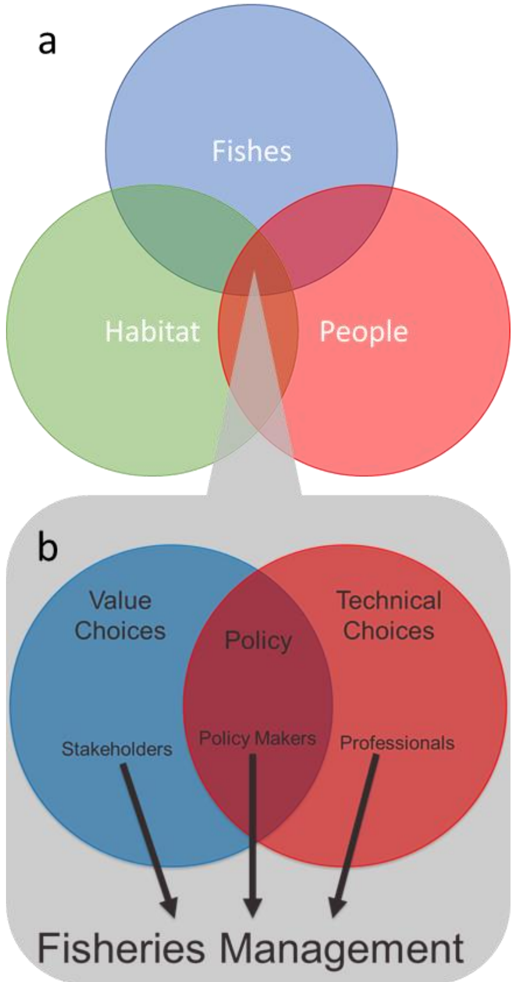

Figure 1. Conceptual diagrams illustrating (a) the major foci of fisheries management and (b) the process of using stakeholder goals and technical knowledge to create policies to maintain a fishery.

I propose to mix fisheries investigations and student hands-on experience with science (FISHES) to simultaneously promote the development of superior fisheries students while solving real-world needs related to fisheries management technical information. This goal will be 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 include (1) surveying habitats and 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 will be 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)

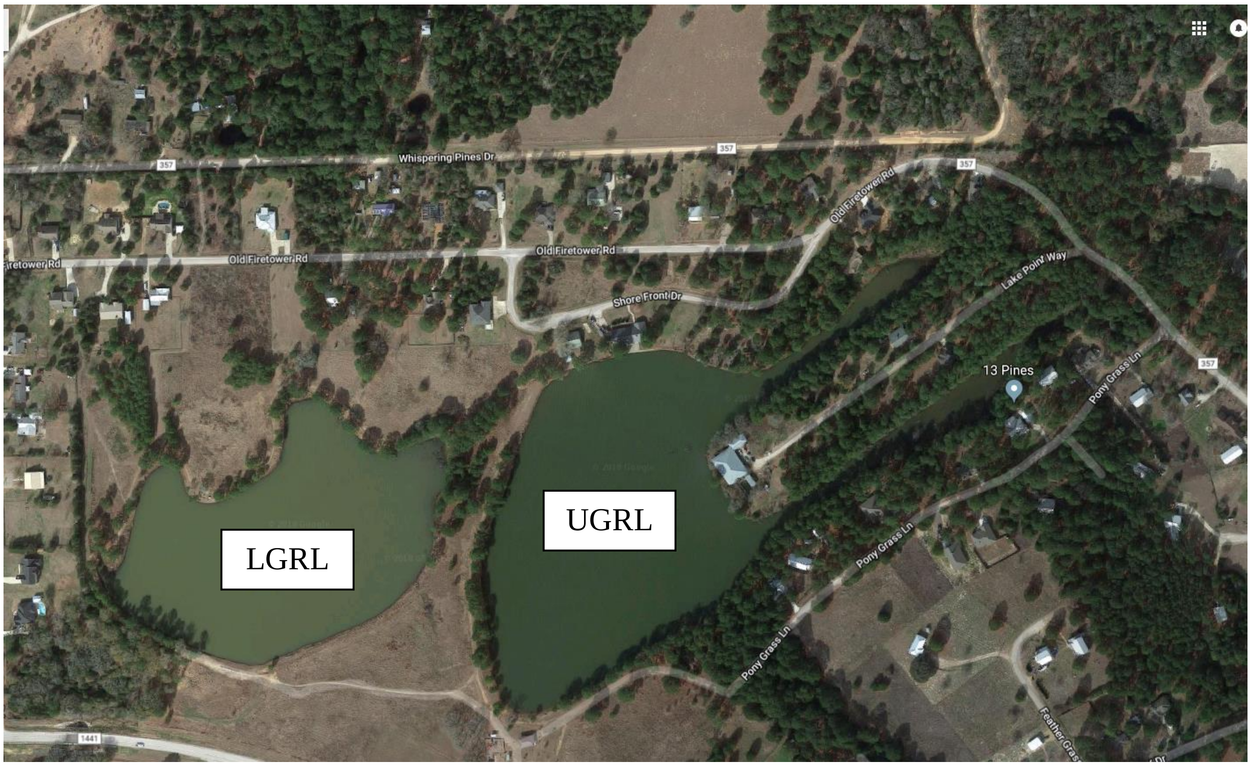

Figure 2. George Ross lakes illustrating upper (UGRL) and lower (LGRL) impoundments on Spicer Creek in Bastrop Country, Texas. The upper impoundment is nested within the watershed of the lower impoundment, and the shared upstream watershed is composed of mostly forested land with development in the areas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

Student Involvement and Broader Impacts

This work will be conducted by students under the direction of Dr. Perkin. Students involved with this work will range from undergraduate to graduate students, including Master of Science and Doctor of Philosophy students. Students from the Principles of Fisheries Management (WFSC410) class taught during fall semesters will be invited to attend on a voluntary basis (i.e., not a required fieldtrip). Additionally, student members of the Texas A&M University Student Subunit of the American Fisheries Society will be encouraged to participate. Students directly involved with the work, under the encouragement of Dr. Perkin, will develop poster presentations of the work to share at university, state, regional, and national conferences. The impact of this work will extend beyond the students directly involved because data will be made available to all future WFSC410 classes as a case study. Lastly, it is hopeful that this project can be extended into a long-term monitoring program where annual surveys are used to update stakeholders on the status of the fishery as well as involve an indeterminate number of future fisheries professionals.

Fisheries Investigation

Proposed fieldwork. – The fisheries investigation aspect will include assessments using a mix of commonly employed techniques. Impoundment depths will be mapped to create bathymetry maps using a boat-mounted Humminbird Helix 10 sidescan sonar unit. This work will be conducted ahead of fish collections (see timeline below) so that the remainder of sampling can be planned. Maps of depth topographies will be generated and delivered to the Circle D Civic Association Board (the Board hereafter). Fish surveys will be conducted using 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). All fishes collected during electrofishing will be identified to species, weighed, measured for length, and returned to the water. Low sampling mortality rates are expected with boat electrofishing. Pelagic fishes in the deeper water and in the middle of impoundments will be sampled using overnight gillnet sets. Depending on depths, standard experimental gillnets will be deployed if depths are >8 feet or mini-gillnets will be deployed if depths are shallower. Two gillnets will be deployed in each impoundment and soaked overnight to assess pelagic fish assemblages. All fishes collected by gillnet will be weighed and measured and released if alive. Some mortality is expected with gillnets (particularly for shad), and any individuals experiencing mortality will be retained for deposition in the Texas A&M University Biodiversity Research and Teaching Collections. Gillnetting surveys can be conducted on the same visit as nighttime electrofishing in the spring (see timeline below). Finally, shoreline seining will be conducted if water depths are appropriate for seining. A bag seines measuring 15’ by 6’ with ¼-inch mesh will be pulled at up to three locations in each impoundment where water depths allow for seining.

Data Analysis. – Data collected during fieldwork will be analyzed by students under the direction of Dr. Perkin. Bathymetry maps will be developed using ArcGIS and exported as PDF files for Board consideration. Fish length-weight data will be used to generate length-weight regressions and relative weights. Length-weight regressions provide insight into "robustness" of fishes, or how they add weight as they grow. Similarly, 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. The number of fish at particular sizes will be used to develop proportional size distribution (PSD) metrics. The PSD is a useful tool for determining if overcrowding, stunting, or optimum conditions exist within the impoundments. Seine haul data will be interpreted using the guidelines developed by Swingle (1956) to determine if recruitment is occurring within each of the impoundments.

Expected results. – The results from fieldwork and data analysis will be useful for developing management recommendations for consideration by the Board. Bathymetry maps can be used to direct placement of any future structures in appropriate depths. Furthermore, maps can be used to assess the distribution of deep water where fishes might seek refuge during periods of low water or drought. Figure 3 below provides an example of what a bathymetric map looks like.

Figure 3. Example bathymetric map illustrating contour lines that define depth changes in a small pond. Here, cooler colors towards the center of the pond represent deeper water, while warmer colors towards the edges represent shallower water. Topographic features such as humps, points, or rises are shown areas where topographic lines form ovals or otherwise circular shapes.

Length-weight regressions will allow for determining if there is any difference in robustness of fishes between the impoundments being studied as well as other waterbodies. Robust fishes indicate suitable conditions exist for growth and maintenance of mass. Relative weight results provide a second measure of fish condition that gives insight into management needs. Figure 4 below provides an example of this concept. 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, supplementing the forage base to stimulate growth, or fertilizing to stimulate increased primary production.

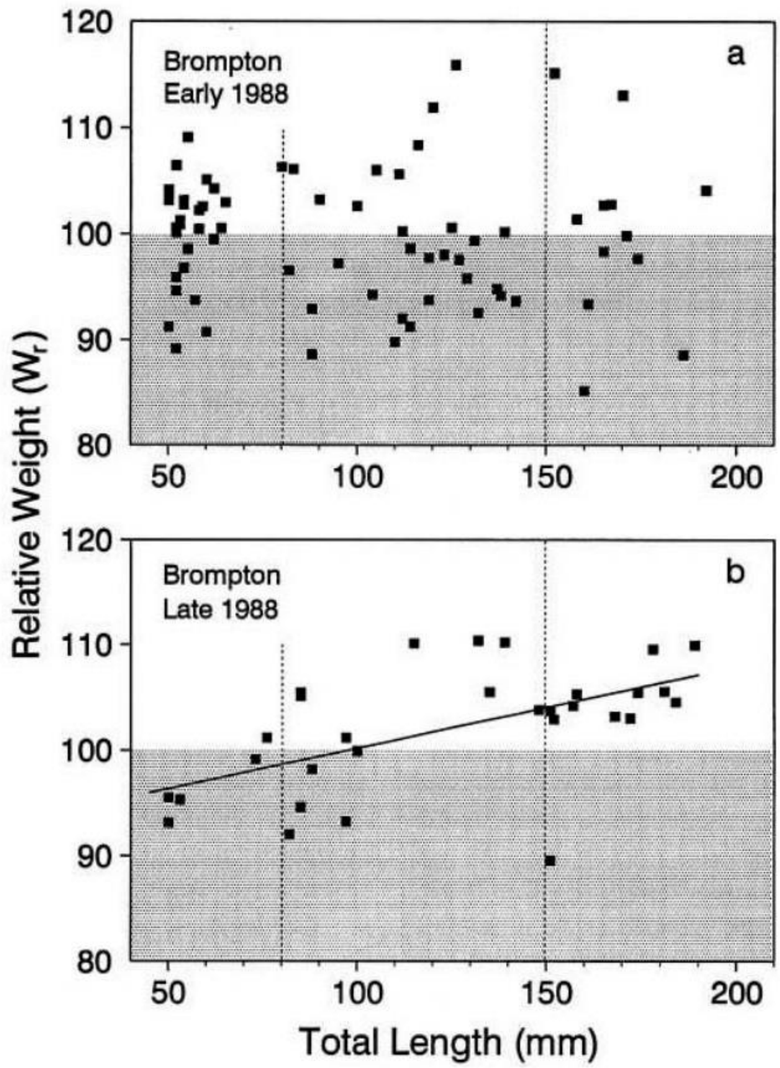

Figure 4. Example plot of relative weight values across a range of fish sizes. The gray shaded area illustrates fish with relative weights below average for the species, while those above the gray shaded area are heavier than average.

If the primary fishes in the impoundments are Bluegill and Largemouth Bass (common in impoundment of this size in Texas; Bonds et al. 2005), then PSD metric relationships between these two species are useful for diagnosing management activities (see Figure 5). If a "balanced fishery" is the desired goal, then PSD values for Bluegill should be 20-40 and Largemouth Bass should be 40-60 (center box in Figure 5). Deviations from these values in any direction can be used to determine the most appropriate management action(s).

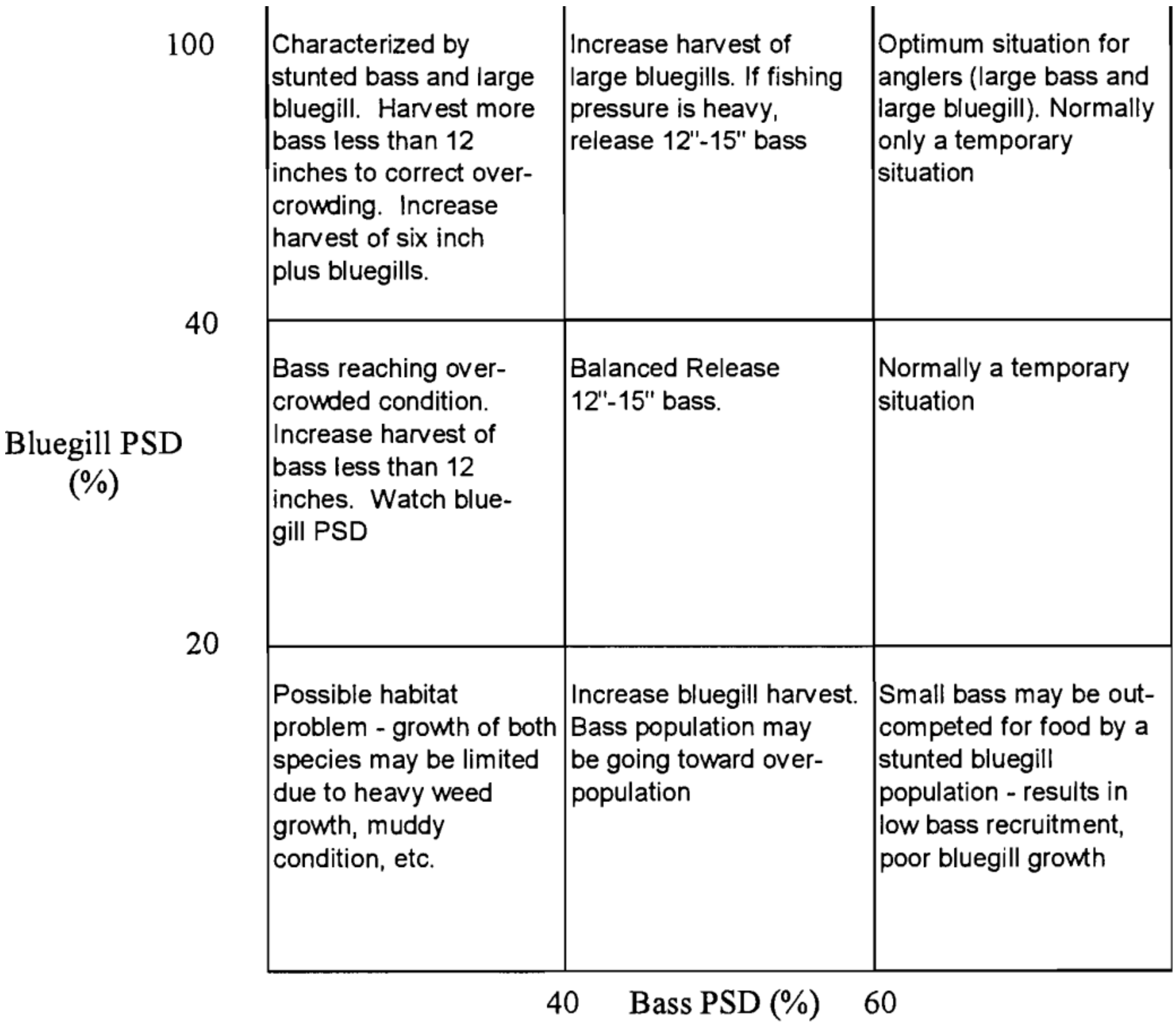

Figure 5. Diagnostic plot of PSD values for Largemouth Bass (x-axis) and Bluegill (y-axis) and the appropriate management actions for 9 scenarios. This figure is taken from Higginbotham (2010) and is a reflection details presented in Neal and Willis (2012).

Finally, results from shoreline seining can be used to assess the status of a fishery and guide management actions. If young Largemouth Bass and Bluegill are present, then the population is balanced. However, if no young Bluegill are detected then this could indicate low prey availability to bass. If no young Largemouth Bass are detected, then this could indicate an absence of bass or lack of recruitment. See Figure 6 below for status assessments and recommendations.

Table 1. Assessment of fish populations based on seining.

Seine Contents	Status	Recommendations
Young bass (less than 4 inches) present many recently hatched bluegills (less than 2 inches)	Population Balanced	Continue assessment using angler harvest records
Young bass (less than 4 inches) present no recently hatched bluegills	Bluegills absent or undesirable species competing with bluegills	Verify bluegill presence by angling
No young bass present many recently hatched bluegills (less than 2 inches)	Bluegills or bass crowded or bass not present in pond	Verify bass presence by angling.
No young bass present no recently hatched bluegills, undesirable species collected.	Overpopulation or absence of bluegills or undesirable fish species overpopulated.	Verify bass and/or bluegill presence by angling

Figure 6. Seine contents, status, and management recommendation relationships for small impoundments in which balanced Largemouth Bass and Bluegill populations are the management goal.

Timeline

Recommendations for sampling timelines for fishery assessments in the southern Great Plains include electrofishing and seining in late spring and seining assessments in the fall. Higginbotham (2010) recommends two electrofishing and gillnetting surveys, with the first one occurring in March-April and the second in September-October. If two samples are not possible, then either May-June or September-October. Pope et al. (2009) recommended electrofishing during the spring to maximize comparisons with other studies. Higginbotham (2010) suggests seining surveys be conducted during June-September.

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