Evaluating Tradeoffs Between Fishing Quality and Economic Performance in a Reservoir Black Bass Fishery with High Tournament Effort

by

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Abstract

Black bass *Micropterus sp.* populations are subject to high catch-and-release angling effort and higher post-release mortality partly attributable to the popularity of fishing tournaments. Increasing stakeholder conflicts between tournament and non-tournament angler groups dispute the appropriate use of a fishery, public resource crowding, and possible decreases in fishing quality. However, tournaments provide economic benefits through increased expenditures and support engagement of fisheries. Despite tournaments social, biological, and economic impacts, documentation of these events is largely unregulated, and their tradeoffs are not fully understood by management agencies. My research objectives were to identify the social, biological, and economic tradeoffs of the tournament and non-tournament black bass fishery at Neely Henry Reservoir in northeast Alabama. Specifically, my study collected socioeconomic data from tournament and non-tournament angler effort using a mixed-methods survey design with contingent behavior questions to understand covariates that influence angler behavior and priorities. This information was paired with an equilibrium age-structured simulation model to determine how varying amounts of angler effort affect black bass size structure and abundance, incorporating an economic sub-model to assess the impact of angler effort on the economy.

This study reinforces the socioeconomic disparities between tournament and non-tournament angler effort and highlights the quantitative tradeoffs of angler effort interactions among stakeholder groups. Specifically, an increase in tournament effort corresponded to a decrease in non-tournament effort, irrespective of tournament participation. My survey revealed fishing quality to be a significant priority to anglers, surpassing their desire for additional tournament opportunities. My model indicated that the relationship between fishing quality and the collective economic performance produced by the fishery was relatively linear. Therefore, the fishing quality and economic tradeoffs of this study pertain to the management goals of the agency as well as tournament organizers. Understanding angler behaviors and priorities are vital for managers to accurately evaluate fishery demands and the biological and economic tradeoffs in a dynamic environment. Collectively, my study results provide the required information for agencies to develop proactive management strategies that maximize the benefits of the tournament fishing industry while supporting a high-quality fishery with desirable catch rates and size structure for all stakeholders.

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Chapter I: Introduction

Black bass *Micropterus* spp. are an ecologically and economically important sportfish across much of North America and represent the most sought-after fish by U.S. freshwater anglers (USDI 2016). In one of the most recent National Surveys of Fishing, Hunting, and Wildlife-Associated Recreation, there were an estimated 9.6 million black bass anglers who helped generate nearly $30 billion dollars in economic activity (USDI 2016). Due to the ubiquity and economic importance of black bass, they have been the subject of numerous studies examining their growth (Pope and Wilde 2004), mortality, population structure, and economic value across a large spatial and temporal range.

Competitive Fishing

Being a widely dispersed, naturally aggressive predator, black bass are sought after for their size and exciting recreationally angling experience; so much that anglers have created a community around these angling experiences. Organized competitive fishing for black bass originated in the 1960s and was proceeded with the formation of the Bass Anglers Sportsman Society (B.A.S.S) in 1968 by Ray Scott in Montgomery, Alabama (Long et al. 2015). As of 2023, B.A.S.S has accumulated over 600,000 members. As tournaments began to grow in popularity, Scott began to advertise the phrase of “Don’t Kill Your Catch” in 1972 in order to promote voluntary catch and release fishing for black bass species. Today, organized tournaments can range from one-time fundraisers for a charity cause to million-dollar cash prize tournaments that anglers must qualify to participate in, such as the Bass Pro Shop US Open tournament.

Increasing tournament coverage over social media has added to the growing audience. In 2023, the B.A.S.S organization has 4 million magazine readers, 918,000 Facebook members (Bassmaster Facebook 2023), and 705,000 Instagram followers (Bass_nation Instagram 2023). Friends and family follow anglers to tournaments weigh-ins to partake. The 2023 Academy Sports + Outdoors Bassmaster Classic hosted in Knoxville, Tennessee was deemed the largest classic to date with nearly 164,000 attendees over a weekend of events and 4.5 million viewers on FOX and FS1 television coverage (Bassmaster.com 2023). Schram and Hunt (2007) predict that the commercial aspects of tournament fishing will continue to grow substantially if current media trends continue. Tournament fishing has the potential to occupy a place in American culture similar to that of other professional sports.

As live-release fishing tournaments for black bass increase, fishery managers have been concerned with how fishing tournaments could impact black bass fisheries (Allen et al. 2004). Schramm et al. (2007) reported that 62% of state agencies reported tournament or private organizations had attempted to influence fishery management decisions to make fishery resources more attractive to tournaments. Driscoll et al. (2012) assessed the trends in fishery agency assessments of black bass tournaments in the southeast United States, identifying benefits but also persistent issues include resource overuse, user-group conflicts, and a lack of documentation, monitoring and registration programs.

Population-level effects associated with Tournament Fishing

As tournaments continue to grow in popularity and are conducted year-round in the southern United States, where average August water temperatures can exceed 80 degrees Fahrenheit; agencies have expressed the need for further information regarding the survival of tournament-captured black bass. Various studies have quantified the sources of black bass mortality as well as estimated the population level effects on the fishery (Kerns at al. 2012). Although, conclusions from studies have been variable: some having no overarching effect on black bass population abundance (Kwak and Henry 1995; Neal and Lopez-Clayton 2001), while Hayes et al. (1995) simulated the impacts of tournament fishing on Largemouth bass and concluded that tournament-associated post-release mortality could affect population size structure. Sylvia and Weber (2022) identified simulation scenarios that suggest tournaments have little effect on black bass population size structure, but size structure could be reduced with higher tournament capture probabilities and lower post-tournament survival than was observed in the small Iowa lake that they evaluated. This variability in conclusions furthers the need for additional research and system-specific assessment and management.

Economic Impact

Pollock et al. (1994) and Schorr et al. (1995) explained that many legislative decisions that affect fisheries are largely constrained by financial and budgetary considerations, therefore, it is important for resource managers to know the economic value of a fishery. Anglers can contribute significantly to the municipalities surrounding popular fishing destinations when they come to participate. Angler expenditures include boat and vehicle fuel, lodging, charters, fishing gear, groceries, etc.

Black bass tournament anglers can often be distinctive for their specialty gear on the water and the amount of fishing expenditures invested compared to non-tournament anglers. In 2017, Plauger documented tournament black bass anglers to spend $435 per day while non-tournament black bass anglers spent $182 per angler per day at Lake Eufaula (Plauger 2018). Organized black bass tournament trails specially produce a large economic impact to towns surrounding water bodies. Driscoll et al. (2010) documented $31.8 million worth of expenditures produced by tournament and non-tournament black bass anglers surrounding Sam Rayburn Reservoir in Texas in 2007. As tournament popularity continues to grow, cities surrounding bodies of water are attracted to hosting black bass anglers to provide a boost to their own economy. Alabama Bass Trail (ABT) Chairman of the Board, Hugh Stump recalls "when anglers aren't on the water, participants and spectators often explore the city surrounding the waterbody spending money in the local economy. Spectators often produce enough of an economic impact that additional cities show interest in hosting tournaments" (ABT 2017). This event produced more than $2.85 million in state and local tax revenue (Bassmaster.com 2023).

Economic impact studies are typically the preferred methodology to determine a fisheries potential impact to regional economies. Knowledge of the value of these fisheries can not only provide incentive for investment in public resources but also provide proper mitigation estimates should these municipalities suffer a loss in revenue due to destruction of a fishery or water resource. Quantitative economic data on sport fisheries can provide conservation agencies with more political influence on state and municipal projects that involve the use of water and fishery resources (Schorr et al. 1995).

Angler Surveys

Quantitative economic data is often a limiting factor and necessary in supporting the research of a fishery including the construction or maintenance of public entities such as boat launches, facilities, and fishing piers. Collecting information from anglers utilizing the fishery allows management to estimate the value of resources such as a tournament-oriented black bass fishery. Managers can also interpolate possible economic loss if a resource is altered. If a fishery is damaged, threatened, or overexploited, consumers may frequent the fishery less, therefore, lessening the economic value of the resource and decreasing the economic impact that the fishery provides for the surrounding economy.

Creel surveys have been used to collect a wide variety of information from anglers. Traditionally, surveys are used to estimate angler effort, catch, and harvest of a fishery, however, their purpose has been broadened to gather socioeconomic information more recently. Socioeconomic data can include ethnicity, residence, household income, and distance traveled amongst other information (Pollock et al. 1994). Another valuable technique utilized in surveys is the inclusion of contingent behavior questions. The contingent behavior technique uses questions to elicit an individual’s intentions about their behavior in measurable quantities or frequencies under hypothetical scenarios. Contingent behavior questions can be applied to high-effort sport fisheries to understand how anglers may respond to management actions or fluctuations in the fishery.

While surveys are common for traditional harvest fisheries, and sociodemographic data have been described for anglers in general, research is limited regarding the economic or sociodemographic data of black bass tournament anglers that encompasses the variety of tournaments and their participating anglers (Maceina et al. 2019). Along with being incredibly diverse events, attracting varying sized groups ranging from a dozen to hundreds of in state and out of state anglers of all ages, black bass tournaments in the United States continue to be largely unregulated. The majority of state agencies do not have a solution to document black bass tournament activity and therefore have a broad perception of the angling pressure being enacted on black bass populations.

Black bass tournament structure provides a small window for researchers to obtain data. Anglers are on the water far before sunrise. Anglers come off the water for the weigh-in period during a designated window of time that has been characterized as “frenzied” and “chaotic”. Lastly, anglers are ready to exit after a long day of fishing, making traditional survey methods impractical (Snellings 2015; Maceina et al. 2019). A lack of documentation of this large of a proportion of angler effort being enacted on a fishery poses for population, economic, and research uncertainties. Further documentation of tournament and non-tournament black bass anglers will aid in analyzing the overall impact made by this influential group of anglers on popular fisheries.

One of the goals of fisheries management agencies is to provide a quality fishing experience to the users of a public waterbody and this cannot be accomplished without the input from anglers. Frequent surveys are needed due to the fluid demographics of human and fish populations, as well as the respective changes in the attitudes and opinions of anglers (Ditton and Hunt 1996). Additionally, fostering a transparent and informative relationship with the stakeholders of the fishery can lead to increased angler support for research and buy-in to management regulations for agencies.

Evaluating Tradeoffs

A tradeoff is defined as a situational decision that necessitates accepting lesser achievement of one objective in the interest of better fulfillment of a competing objective. Some examples of tradeoffs in natural resource management are (a) economic performance vs. environmental protection, (b) short term fishery yield vs. long term sustainability, and (c) maximizing long term yield vs. achieving stable yields. From year to year the management of black bass tournaments presents a potential trade-off between economic performance and fishing quality. Per-trip expenditures are typically higher for tournament than non-tournament fishing, therefore, tournaments have the potential to provide higher expenditures than an equal amount of non-tournament fishing. However, a tradeoff arises because fish released from tournaments experience higher post-release mortality rates thereby having a larger potential negative impact on fish mortality, abundance, and fishing quality (catch rates and size structure) (Wilde et al. 1998; Suski et al. 2004; Lewin et al. 2006; Siepker et al. 2007; Schramm and Hunt 2007; Sylvia and Weber 2022; Melstrom et al. 2023).

As the demand for tournaments has steadily increased, there have been various responses from agencies regarding how to balance the fluctuating tradeoffs of modern-day black bass management as discussed in Driscoll et al. (2012). Tournament events and anglers continue to provide large economic benefits to economies surrounding popular sportfish waterbodies and encourage the public's involvement in fisheries resources and agency programs by attracting tourism revenue such as lodging and restaurants where the tournament takes place as well as displaying the activity of fishing over social media platforms. Unfortunately, an equal amount of attention and research is identifying variable population impacts including size-selective mortality, declines in fishing quality, and continued user conflict between tournament and non-tournament angler effort.

The potential for both positive and negative impacts from tournaments is particularly of concern for fisheries agencies in the southeast United States. Alabama is considered one of the best places in the United States for black bass fishing with Lake Guntersville, Pickwick, Eufaula, and the Coosa River chain of lakes receiving national attention. With most of the angler effort in the state focusing on black bass, the importance of evaluating the economic and fishing quality tradeoffs of black bass tournaments is imperative for proper mitigation by management agencies. Thus, it would be beneficial for managers to have quantitative predictions regarding how many tournaments must be sacrificed to achieve their fishing quality objectives, for example. Or conversely, how much does fishing quality have to suffer to satisfy the demand for competitive fishing events and their subsequent positive economic impacts?

Managers need information on the current effects, benefits, and costs, of black bass tournaments on reservoir fisheries in the southeast United States to properly apply traditional fisheries management techniques to a rapidly evolving fishery. Therefore, the goal of my thesis is to identify the social, biological, and economic tradeoffs of the tournament and non-tournament Largemouth bass *Micropterus nigricans* (LMB) and Alabama bass *Micropterus henshalli* (ALB) fishery at Neely Henry Reservoir in northeast Alabama. Specifically, my study aimed to first collect socioeconomic data from tournament and non-tournament angler effort to add to the baseline understanding of the covariates that influence black bass angler behavior. Identifying angler contingent behavior can inform managers regarding current angler priorities for black bass fisheries and tournament opportunities. However, formulating appropriate fisheries management actions are incomplete without quantifying how various stakeholders' priorities may affect the fishery involved. Therefore, my second objective was to develop an age-structured simulation model with sector-specific (tournament and non-tournament) angler effort to determine how varying amounts of angler effort affect black bass size structure and abundance. I incorporated an economic sub-model to assess the economic impact of angler effort on the local economy.

Using this mixed methods approach, I was able to observe drivers of sector specific angler effort and behavior as well as assess the fishing quality and economic tradeoffs of the black bass sport fishery at Neely Henry Reservoir. Collectively, my study results will provide the required information for agencies to develop proactive management strategies that maximize the benefits of the tournament fishing industry while supporting a high-quality fishery with desirable catch rates and size structure for all stakeholders.

Study Area

Neely Henry Reservoir is a 4,546-hectare storage reservoir within the Coosa River Basin in northeast Alabama (Figure 1) lying between Weiss Lake to the northeast and Logan Martin Reservoir to the southwest. With the completion of Neely Henry dam in 1966, the reservoir was filled and is operated by the Alabama Power Company for hydroelectric power and recreation. As the reservoir progresses downstream, it transitions from a lotic, river system with a few back bays to a wider, lentic system, with large branches reaching off the main waterbody before moving through Neely Henry Dam and rejoining the Coosa River. Neely Henry has eight primary public boat launches dispersed across the reservoir that were utilized during the project.

According to a study conducted by Jacksonville State University in 2018, 44% of lake residents identified fishing as the most important recreational activity (Boozer 2019). Neely Henry is primarily managed for Largemouth Bass *Micropterus salmoides* (LMB) and Alabama Bass *Micropterus henshalli* (ALB) by the Alabama Department of Conservation and Natural Resources (ADCNR). The reservoir also supports other popular game species such as Crappie (genus *Pomoxis*) and Catfish (genus *Ictalurus*).

The reservoir is surrounded by four major metropolitan areas within 200 miles including Birmingham, Alabama, Atlanta, Georgia, and Nashville and Chatanooga, Tennessee. During 2017 there were 143 black bass tournaments and 8,490 anglers on Neely Henry Reservoir (Boozer 2019). The Reservoir's primary boat launch, "Coosa Landing" is located in the middle of downtown Gadsden and is easily accessible to the surrounding community. This launch hosts a majority of the black bass tournaments on the reservoir. Neely Henry's black bass fishery attracts many out of state anglers with several large tournament trails and accredited fishing leagues including the Bassmaster Elite series in 2021, the Phoenix Bass Fishing league, and the American Bass Anglers Top 150 in 2023.

Neely Henry Reservoir was selected for this study by the Alabama Department of Conservation and Natural Resources due to the need for additional knowledge of the black bass fishery in response to a perceived decrease in fishing quality in the Coosa River Chain from the public. Neely Henry Reservoir's surface area, public access, and bathymetry proved conducive to the agencies overall objectives to quantify post-release movement and mortality, the current magnitude of tournament and non-tournament capture rates, and population-level life history parameters such as length at age-specific vulnerability to capture, harvest, and release, using a mass reward tag and telemetry system.

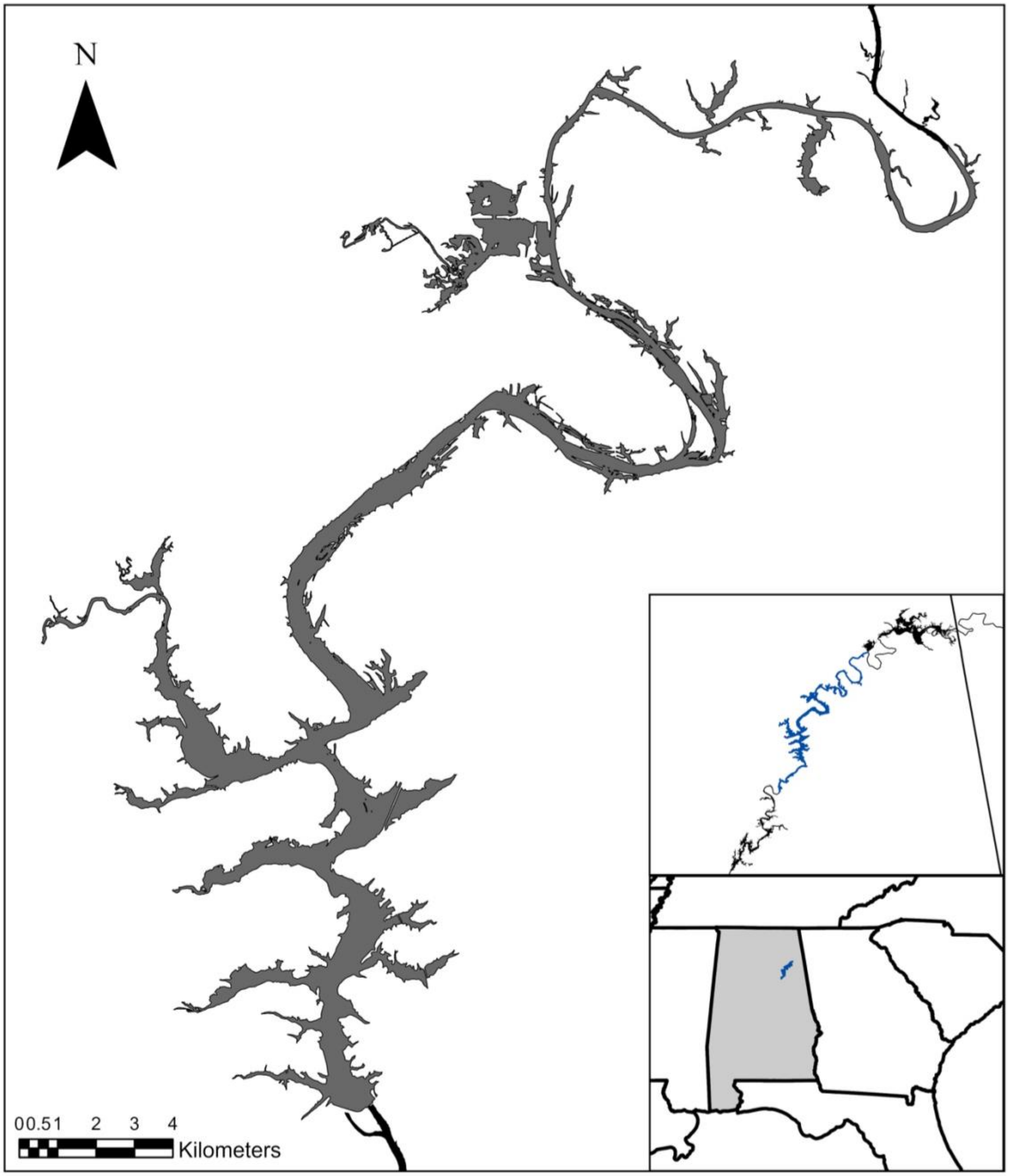

Figure 1: Neely Henry Reservoir in Northeast Alabama. The Coosa River connects Neely Henry to Weiss Lake to the North and flows South through the hydroelectric dam to Logan Martin Reservoir.

Chapter II: Intended behavioral responses of tournament and nontournament black bass anglers to variable fishing quality and tournament effort.

Introduction

Black bass *Micropterus* spp. are an ecologically and economically important sportfish across much of North America and represent the most sought-after fish by U.S. freshwater anglers (USDI 2016). In the most recent National Survey of Fishing, Hunting and Wildlife-Associated Recreation, there were an estimated 9.6 million black bass anglers who helped generate nearly $30 billion dollars in economic activity (USDI 2016). Due to the ubiquity and economic importance of black bass, they have been the subject of numerous studies examining their growth, mortality, population structure, and economic value across a large spatial and temporal range (Beamesderfer and North 1995, Pope and Wilde 2004, Suski et al. 2004, Siepker et al. 2007).

Competitive Fishing

Competitive fishing events or "tournaments" are defined as organized fishing competitions amongst anglers on a designated body of water for incentives such as awards, prizes, or public recognition (Schramm et al. 1991). Snellings (2015) identified eight different types of tournament groups separated by various characteristics including cost of entry fee, number of participants, organization membership, and if a set schedule existed, among other factors. The eight different types of tournaments included Professional, Semiprofessional, Large Open, Small Open, Trail, Non-Local Club, Local Club, and Wildcat. Organized tournaments can range from one-time fundraisers for a charity cause to million-dollar cash prize tournaments that anglers must qualify to participate in such as the Bass Pro Shop US Open tournament.

Since the 1960s, black bass tournament groups have been organized at the local, state, regional, and national level across the continental United States. In 2005, the United States was estimated to host over 32,000 tournaments annually (Schramm and Hunt 2007). Increasing tournament coverage over social media has added to the growing audience. The 2023 Bassmaster Classic hosted in Knoxville, Tennessee was deemed the largest classic to date with nearly 164,000 attendees over a weekend of events and 4.5 million viewers on FOX and FS1 television coverage (Bassmaster.com 2023). Tournament fishing has the potential to occupy a place in American culture similar to that of other professional sports.

Economic Impact

Pollock et al. (1994) and Schorr et al. (1995) explained that many legislative decisions that affect fisheries are largely constrained by financial and budgetary considerations, therefore, it is important for resource managers to know the economic value of a fishery. Anglers can contribute significantly to the municipalities surrounding popular fishing destinations when they come to participate. Black bass tournament anglers can be distinctive for their specialty gear on the water and the amount of fishing expenditures invested compared to non-tournament anglers. Plauger (2017) documented tournament black bass anglers to spend $435 per day while non-tournament black bass anglers spent $182 per angler per day at Lake Eufaula (Plauger 2018). The 2023 Academy Sports + Outdoors Bassmaster Classic produced an economic impact of over $35 million in just one weekend.

Economic impact studies are typically the preferred methodology to determine a fisheries potential impact to regional economies. Knowledge of the value of these fisheries can not only provide incentive for investment in public resources but also provide proper mitigation estimates should these municipalities suffer a loss in revenue due to destruction of a fishery or water resource. Quantitative economic data on sport fisheries can provide conservation agencies with more political influence on state and municipal projects that involve the use of fisheries (Schorr et al. 1995).

Angler Surveys

Traditionally, fisheries managers use surveys to estimate angler effort, catch, and harvest of a fishery, however, their purpose has been broadened to gather socioeconomic information including the use of contingent behavior scenarios, more recently. Contingent behavior questions can be applied to high-effort sport fisheries to understand how anglers may respond to management actions or fluctuations in the fishery that are important to the valuation of a fishery.

There are two main designs used to conduct on-site angler surveys including access point and roving creel methods (Robson and Jones 1989). Access point surveys are typically utilized on bodies of water with limited access, funneling anglers to specific launches at the lake. At these access points, a creel clerk waits and intercepts anglers as they leave the waterbody to collect completed trip data. Roving creel surveys are utilized when there are too many access points to the fishery or if the waterbody is too large to obtain a representative sample by access point means. A roving creel survey consists of a team of creel clerks intercepting anglers on the water while they are actively fishing.

Creel survey methods are often combined in order to maximize efficiency and pair with the characteristics of the waterbody or targeted group of anglers. Additional variation of creel surveys include the bus-route access point, aerial boat count, abbreviated on-site, mail, email, and telephone surveys. VanDeValk et al. (2023) paired an abbreviated summer access point creel with a full roving-creel survey on Oneida Lake in New York in 2022 to document angler effort. Mckee (2013) combined traditional roving creel methodology with aerial boat counts and a follow-up telephone survey to collect economic data from recreational black bass anglers on Lake Guntersville.

Previous survey literature has shown low angler response rates and minimal documentation or regulation of tournaments across the country, leading to uncertainty about angler pressure and group interactions in this popular sport fishery. The diversity of tournament angler motives and attitudes further complicate this understanding. To address this, frequent surveys are essential to assess demographic changes in both human and fish populations, as well as shifts in angler attitudes and opinions (Ditton and Hunt, 1996).

Stakeholder Conflict

As fishing tournaments for black bass increase, fishery managers have been concerned with how tournaments could impact black bass fisheries (Allen et al. 2004). Schramm et al. (2007) reported that 62% of state agencies reported tournament or private organizations had attempted to influence fishery management decisions to make fishery resources more attractive to tournaments. A factor analysis performed by Schram et al. (2007) identified six primary factors associated with inland fishing tournaments that adversely impact fisheries management agencies including resource overuse, user-group conflicts, cost to agency, non-traditional management model, fish introductions and fish population impacts. Driscoll et al. (2012) assessed the trends in fishery agency assessments of black bass tournaments in the southeast United States. They found tournaments to generally benefit fisheries management by promoting fishing, specific fisheries, and agency programs. Although, persistent issues include resource overuse, user-group conflicts, and a lack of documentation, monitoring, and registration programs.

Managers often must balance different stakeholder preferences such as wanting a harvest, quantity, or trophy-oriented fishery. All management practices have their own economic value, management requirements, and tradeoffs. If a fishery is damaged, threatened, or overexploited, consumers may frequent the fishery less, therefore, lessening the economic value of the resource and decreasing the economic impact that the fishery provides for the surrounding economy.

Despite the economic benefits of tournaments, the tournament fishing community can make up anywhere from 20-80% of the total black bass angler effort on reservoirs and still shares the same waterways with other stakeholder groups. Stakeholder conflict pertaining to the use of the fishery, overall fish population health, and resource congestion have been observed across the country as non-tournament anglers can't find parking spots on Saturday mornings and have observed dead bass at boat launches. Several surveys suggest that tournament and non-tournament black bass anglers differ in opinions pertaining to what a quality fishing experience entails as well as their motives for fishing, suggesting continued potential for asymmetric conflict among stakeholders (Ditton and Hunt 1996; Gilliland 1998; Wilde et al. 1998; Arlinghaus 2005; Arlinghaus and Cooke 2009; Poudyal 2022). Surveys in Oklahoma showed that over 65% of fishing license holders favored regulating black bass tournaments (Summers 1995). Despite this sentiment, reservoir systems have documented tournament activity increases of 275% from 2006 to 2020, on the Harris Chain of lakes, for example (Hamm et al. 2022).

Ditton (1996) explained that almost 80% of agencies viewed information on angler attitudes and opinions for management activities as "very or extremely important". More recent research has called for studies to determine the ways tournament anglers impact the fisheries resource and experience of non-tournament anglers (Poudyal 2022). As black bass fishery stakeholders continue to change, agencies lack information regarding the current interactions, priorities and socioeconomic data pertaining to black bass angler groups on reservoir fisheries in the southeast United States that are necessary to properly apply traditional fisheries management techniques to a rapidly evolving fishery.

Understanding the behavior and priorities of stakeholders is important to acknowledge when evaluating the tradeoffs associated with implementing management plans for sport fisheries. Failure to acknowledge stakeholder priorities may result in unintentional fisheries management and economic consequences. Therefore, my objective was to document socioeconomic characteristics and contingent behavioral responses of tournament and nontournament black bass angler groups at Neely Henry Reservoir to variable fishing quality and the amount of tournament activity at the reservoir using a mixed methods angler survey.

Methods

Survey Design

Survey administration was conducted using a mixed methods approach combining an access-point creel survey design for anglers who participate in tournaments and a roving creel survey design for anglers who do not participate in tournaments as often or at all. An access-point survey approach was selected due to tournaments utilizing boat ramps at a designated period of time. Tournament anglers are characteristically less willing to complete a survey while actively fishing in the event, therefore, anglers were approached in the boat launch parking lot during the weigh-in period of tournaments and prior to departure. Non-tournament anglers were approached on the water while they were actively fishing using traditional roving creel methodology outlined in (Malvestuto et al. 1978). Not all bass anglers utilize designated boat ramps, therefore, these combined methods will reach our target audience of a representative sample of the bass angling community in an efficient and minimally biased manner.

All anglers, regardless of trip type (tournament or non-tournament), were verbally asked the same series of questions (Table 1). Interview questions took no longer than 10 minutes to complete and were recorded on an electronic tablet using Qualtrics software. Survey questions were posed to gather information on trip frequency, tournament participation, angler effort, trip origin, trip expenditures, contingent behavior, and general angler socio-economic demographics. Contingent behavior questions pertained to changes in angler effort in the event of a hypothetical increase or decrease in tournament fishing opportunities and black bass fishing quality at Neely Henry. Specifically, anglers were asked if their fishing effort would fluctuate/change if there were half or double the number of tournaments present every month or if they caught twice or half the amount of 2–4-pound bass every fishing trip. Socioeconomic demographics such as monthly participation in tournament and nontournament bass angling, distance traveled, employment, age, and household income were included to allow me to explain angler variability in my analysis. All survey methods and questions were approved by the Auburn University Office of Research Compliance under IRB protocol #23-099 EX 2302 (Appendix A-1).

Access-Point Survey Distribution

Access-point surveys were conducted to encounter tournament anglers. Access-point surveys began March 2023 and were completed at the end of December 2023. Two weekend trips and one weekday trip were randomly selected each month of the study period for surveying. Access-point surveying at tournaments was primarily conducted on weekends due to data found by Mckee (2013) on Lake Guntersville stating that approximately 90% of tournaments occurred between the days of Saturday and Sunday. After collecting initial tournament information for Neely Henry Reservoir, few Sunday tournament events were formally documented compared to Saturday tournament events (M. Holley, unpublished data) therefore, Saturday tournaments were given priority over Sunday tournaments. I assume that angler demographics are similar among Saturday and Sunday tournament participants. I attempted to survey 10-15 anglers at each tournament. Three total tournament days (each day may consist of more than one tournament if events happen concurrently) were attended each month therefore, our expected sample size was 300 tournament interviews in 2023.

Access-point surveys took place at public boat launches including Coosa Landing/City Docks boat launch located in Gadsden, Canoe Creek boat launch located on the west side of the reservoir, as well as Rainbow Landing, Southside, and Ten Islands boat launches located south of Gadsden, AL (Figure 1). On each randomly selected day/time, I randomly selected a boat launch to conduct surveys. Ramps were selected with unequal probability according to a priori knowledge from regional biologists pertaining to angler use (M.Holley, unpublished data). Half of the survey days were allocated to Coosa Landing Boat Launch because it is known to receive 50% of the total angler activity at Neely Henry (M. Holley, unpublished data) while the rest of the boat launches (Canoe Creek, Southside/Rainbow Landing, and Ten Islands) received the remaining 50% of angler effort combined. Weekend tournaments were selected by randomly selecting one tournament at Coosa Landing every month, and randomly selecting one tournament at the remaining boat launches with the following unequal probability: Canoe Creek: 40%, Southside/Rainbow Landing: 40%, and Ten Islands receiving 20% surveying probability (Table 2).

Tournament organizers and fishing clubs were contacted to determine where tournaments were being held and when the weigh-in took place. A tournament director was called to be informed of our research intentions and to clarify that a tournament is occurring at that boat launch prior to attendance. Organized, weekday, “wildcat”, tournaments only occurred on

Tuesdays and Wednesdays at Coosa Landing, and Thursdays at Canoe Creek, therefore, one random weekday tournament was randomly selected across the three weekdays. I went to the boat launch associated with the randomly selected day of the week. This unequal sampling probability reflects the angler effort that was distributed to the different boat launches across the reservoir and guaranteed I sampled every dynamic group of anglers that were necessary to achieving a representative sample.

During access point surveys, a surveyor waits at a boat ramp at a predetermined time and intercepts anglers during or as they complete their fishing trip (Robson and Jones 1989). The fast-paced nature of bass tournaments where anglers depart from a single ramp and return at a scheduled time to "weigh-in", made it necessary to use an access point survey method as opposed to a roving creel survey method. Due to the chaotic nature of the weigh-in period with anglers weighing in bass, loading, and securing their boats and gear in a short amount of time, a full conventional interview was not practical.

I arrived at the tournament location 30-45 minutes prior to the formal weigh-in period in attempt to capture any early arriving anglers. I stayed at the weigh-in until all available anglers had been surveyed or I ran out of anglers/time. Upon arrival of the tournament, I documented initial tournament data including date, boat launch, tournament name, number of boats and/or participating anglers, start time, weigh-in time, entry fee, and how often the tournament frequents Neely Henry every year (Appendix A-2). For each tournament surveyed, this information was determined by talking to a tournament director, organizer, or participant in the event. Anglers and tournament administrators who agreed to participate were provided an information letter and received verbal explanation on the purpose of the research, how the data will be used, and the voluntary nature of their participation (Appendix A-1).

Tournament anglers were identified as any angler participating in the tournament above 18 years of age. Anglers were randomly/opportunistically contacted once they removed their boat from the water and while preparing their boat for trailering, departure, or getting ready for the weigh-in. I only contacted anglers in the boat launch parking lot area to avoid bias towards anglers who did or did not catch fish during the tournament. Upon approaching the angler(s) I identified my affiliation, stated my purpose, and asked for permission to administer a verbal survey. With the angler's permission, a survey was performed. Anglers who wished to not be surveyed were tallied. Anglers were not repeated/surveyed twice.

Tournament angler interviews were completed trip interviews obtained as the angler prepares to exit the reservoir. One angler from each boat was interviewed regardless of how many anglers were present. If more than one angler was partaking in the verbal interview, one anglers' response was recorded. When more than one weekend tournament occurred at the same boat ramp on the same day, both tournaments were simultaneously surveyed.

Roving Creel Survey Distribution

Roving creel surveys were conducted to encounter non-tournament anglers. Roving creel surveys began in March 2023 and were completed at the end of December 2023. Two randomly selected weekend trips and one weekday trip were conducted each month in conjunction with tournament surveys. I surveyed non-tournament bass anglers using a roving creel methodology. Roving creel surveys operate under similar principles as the access-point method with a few notable differences. A roving creel survey requires the creel clerk to actively seek out interviews on the water body via boat (Rohrer 1986; Pollock et al. 1994). The surveyor then identifies and interviews anglers while they are still engaged in fishing.

Weekend roving creel surveys were randomly selected for a Saturday or Sunday first. If it was a Saturday survey, I randomly selected a morning or evening survey. If a Sunday was drawn, a morning survey was conducted. I assumed there was no significant sociodemographic difference between non-tournament bass anglers who fish on Saturday or Sunday evenings, therefore only surveying Saturday evening anglers would be sufficient for the sake of sampling efficiency. Weekend roving creel surveys coincided with our tournament survey schedule when possible, for efficiency. For example, if a Sunday morning non-tournament survey is randomly selected it was scheduled on a weekend that the surveyor is attending a tournament. When a Saturday morning or evening non-tournament survey was randomly selected in conjunction with a Saturday tournament survey, a 30-minute buffer was put in place before and after the tournament weigh-in to ensure timeliness of both surveys.

Roving creel weekday surveys were randomly selected across all Monday through Friday weekdays in a month. If a Tuesday, Wednesday, or Thursday non-tournament weekday survey was drawn, survey scheduling was combined with a Tuesday, Wednesday, or Thursday "wildcat" tournament survey for sampling efficiency while randomly selected Monday and Friday surveys remained independent to maintain a representative sample of weekday anglers.

Neely Henry Reservoir was broken up into two survey sections for the roving creel survey. Section 1 was 2105 hectares while Section 2 was 2038 hectares (Figure 2). For each non-tournament survey, one of the two sections was randomly selected without replacement. A four-hour survey circuit was performed in the randomly selected section in a randomly selected direction for either traveling left or right of the boat launch. A morning circuit took place from approximately 7:30am to 11:30am. An evening circuit took place from approximately 3:30 pm to 7:30pm or until light conditions were unsurveyable. Survey timing did vary slightly with available light as the year progressed. Upon arrival to the boat launch, I documented initial non-tournament data including, date, boat launch used, morning, or evening survey, start time, and section surveyed. The team of two, consisting of the boat driver and the surveyor would exit the launch in either the left or right direction and began to identify any relatively stationary (not moving at a high speed), actively fishing watercraft along the circuit.

Non-tournament bass anglers were identified as any angler who was recreationally targeting bass (confirmed upon approach) above 18 years of age. Upon approaching the angler(s) I identified my affiliation, stated my purpose, and asked for permission to administer a verbal survey. With the angler's permission, a survey was verbally administered. Anglers who agree to participate received a verbal explanation of the purpose of the research, how the data was used, and the voluntary nature of their participation. One angler from each boat was interviewed. If more than one angler was partaking in the verbal survey, one anglers' response was recorded. Anglers who wished to not be surveyed were tallied. Anglers were not repeated.

Every actively fishing watercraft that is identified along the circuit was approached and identified. Purpose of trip and target species was documented for every watercraft regardless of if they were targeting black bass or not. A progressive count of all actively fishing boats was conducted during the circuit. If a tournament angler was identified during a non-tournament survey, a survey was not administered unless the angler was willing to do so. If the circuit was not completed within the four-hour survey period, the surveying team stopped actively surveying anglers but continued to tally/record a progressive count of all actively fishing boats until the circuit is complete- verbally inquiring or visually identifying target species if possible. Tournament bass boats that were encountered but not surveyed were tallied. Pre-fishing and repeat angler (an angler that was previously surveyed) boats were tallied as well.

Data Storage and Protection

While in the field, survey data was stored in an AU issued, passcode protected, electronic tablet device and maintained in my possession. Data was collected using Auburn University approved *Qualtrics* software. Upon returning to the office, data was stored on a password protected computer and uploaded to the online *Qualtrics* database on a secured Auburn University network. Data was exported onto csv. files for additional data storage after every field day. This method of data collection and storage was used for both tournament and non-tournament surveys.

At no point were survey respondents asked to identify themselves uniquely. Respondents were notified that they can opt out of the survey at any point. They were also able to refuse to answer any questions they did not wish to answer. The survey questions and sample size also made it impossible to identify any respondent based on simple demographic data (age, gender, etc.). The angler's completion of the single, on-site survey served as their de facto consent to the use of their responses in the research analysis. Participants were not compensated for their participation and were verbally informed. See approved IRB Information sheet (Appendix A-1).

Statistical Analyses

Boat launch sampling proportions were determined by dividing the number of access point survey events specific to each boat launch by the total surveys conducted (Table 2). Interviews were categorized into three trip types: tournament, non-tournament, and pre-fishing, then further subdivided into weekend and weekday strata based on survey dates. Additionally, interviews were organized into seasonal categories (Spring, Summer, Fall, Winter) to analyze seasonal and day-type distributions. Pre-fishing interviews, totaling 26, were included in the tournament survey trip types for subsequent analysis (Table 3). Further, interviews were categorized into two trip types (tournament and non-tournament) and organized by the indicated boat launch. Launch-specific interviews were then divided by the total number of interviews to determine the proportional survey distribution based on boat launch (Table 4).

Angler interviews were categorized into two sectors: tournament and non-tournament based on trip and day type strata, with an overall average computed for both trip types. One-way distance traveled (miles), trip duration (hours), and expenditures were determined by calculating the mean values within specific strata (e.g., tournament interviews during weekends). Individual trip expenditures were calculated by halving the total team expenditures (assuming teams consisted of two anglers) and recording the mean individual expenditures per trip for each survey stratum. Additionally, anglers indicated the proportion of their expenditures within a 20-mile radius of Neely Henry Reservoir, and mean values were computed for each survey stratum (Table 5).

Throughout the roving creel survey, I documented all relatively slow-moving (surveyable) boats encountered along the circuit, facilitating the computation of a weighted average fishing population. As angler survey data captures only those observed on survey days, applying a weighted average accounts for estimated angler activity on unsurveyed calendar days, ensuring representative variables reflecting the Neely Henry fishing population are utilized. To address variation in weekend and weekday effort, I segregated the data into weekend and weekday strata during calculations.

Weighted tournament trip length was computed using the mean values from tournament and pre-fishing angler interviews conducted on weekends and weekdays. This average was then multiplied by the total number of weekend and weekday days between March and December 2023 to encompass all potential fishing days. Subsequently, the resulting figure for each effort sector (tournament and pre-fishing) was divided by the sum of all tournament-related effort across day types to derive a weighted average for tournament and pre-fishing effort on both weekends and weekdays. The average trip hours for tournament and pre-fishing trips on weekends and weekdays were then multiplied by the sum of the weighted angler effort for tournament and pre-fishing across day types to determine the weighted average trip length for tournament-related effort. This process was repeated for weighted non-tournament trip length, and these trip length values were subsequently applied to annual angler effort calculations in Chapter 3.

A similar procedure was followed to accommodate variation in trip expenditures among weekend and weekday tournament and non-tournament angler trips. The weighted angler effort was multiplied by the average individual trip expenditures across different effort sectors (tournament, non-tournament, and pre-fishing) and day types (weekend and weekday). Subsequently, the weighted average tournament trip expenditures were computed by aggregating the weighted tournament and pre-fishing expenditures across day types. Similarly, the weighted average non-tournament trip expenditures were determined by summing the weighted non-tournament expenditures across day types. These weighted trip expenditures were then utilized in the annual angler effort calculations outlined in Chapter 3 to derive the annual direct expenditures for the Neely Henry tournament and non-tournament black bass fishery (Table 5).

During angler interviews, I documented anglers' baseline monthly tournament and non-tournament trips to Neely Henry, as well as their hypothetical changes in effort in response to contingent scenarios involving alterations in fishing quality and tournament activity on the reservoir. Anglers provided one of four responses: maintaining their current effort, leaving the system, or specifying an increase or decrease in trips per month in each scenario. Responses were analyzed across three groups: tournament interviews, non-tournament interviews, and the combined dataset. Within each trip type, an angler's tournament and non-tournament trips were assessed for changes from their baseline effort. Responses were categorized and the number of interviews in each category was divided by the total number of interviews to identify overall trends in angler effort in response to the presented contingent scenarios (Tables 6 and 7).

All angler interviews were organized into bins relative to the proportion of their total effort that is spent on tournament-related trips to Neely Henry Reservoir to understand tournament angler avidity and angler effort priorities. Angler's annual tournament trips to NH was divided by their annual effort (trips) to achieve tournament effort proportion (Figure 3). To further understand annual tournament effort among anglers, all interviews annual tournament related trips were organized into histogram bins to understand how many anglers are taking how many tournaments related trips per year (Figure 4).

Intended behavioral responses of angler effort to variation in fishing quality and the number of tournaments at the reservoir were assessed through contingent behavior questions during roving creel and access point surveys. I organized anglers' monthly tournament and non-tournament effort across three fishing quality scenarios: a 50% decrease, baseline effort, and a 100% increase in fishing quality at Neely Henry Reservoir. Baseline monthly effort served as a reference, with adjustments made based on anglers' responses to each scenario to determine their new monthly effort. This monthly estimate was multiplied by 12 to evaluate annual effort changes, providing insights into potential economic and fishing quality implications. Subsequently, a linear mixed effects model was employed to analyze the percent change from baseline effort and determine statistical significance. While all interviews were analyzed collectively, tournament and non-tournament trips were examined separately (Figures 5 and 6).

I replicated the analysis for tournament effort contingent behavior scenarios, applying all survey responses to the same linear mixed effects model. Data was then plotted across three tournament effort scenarios: a 50% decrease, baseline angler effort, and a 100% increase in tournament effort at Neely Henry. By utilizing contingent behavior questions, this approach provides valuable insights into angler priorities and behaviors regarding their fishing experiences, while also offering insight to potential economic and fishing quality implications under various management and biological scenarios (Figure 7 and 8).

Results

Descriptive Survey Statistics

On-site sampling at Neely Henry Reservoir comprised 28 roving creel and 28 access point surveys, yielding 136 non-tournament trip interviews and 223 tournament-related trip interviews between March and December 2023. The total sample size consisted of 356 individual angler interviews, with a 100% response rate for both roving and access-point creel surveys. Among these, 86 interviews were conducted in Section 1, while 50 interviews were conducted in Section 2 (Figure 2). Despite the survey objectives, there were two Saturdays, one in August and one in December when no tournaments occurred at any of the boat launches at Neely Henry Reservoir. There were two weekday roving creel surveys where no bass anglers were encountered- typically due to weather.

Weekday wildcat tournaments concluded at the end of October, which decreased my sample size. Although Ten Islands boat launch was included in the schedule, no substantial tournaments were documented from this launch. According to Snelling's (2015) classifications, of the 28 tournaments attended, 2 were semiprofessional, 4 were high-school events, 1 was a charity event, 10 were trails, and 11 were wildcat tournaments across five different boat launches

(Table 2). Additionally, 54% of access point interviews were conducted during the Spring, 14% in the summer, 26% in the fall, and 6% of interviews occurred during Winter (Table 3).

Each access point creel survey averaged 7.96 interviews. In comparison, Snellings reported an average of 5.7 interviews per tournament at Guntersville Lake in 2014. Throughout the access point surveys, 43 repeat anglers were identified over the year, although, given the fast-paced environment, repeat encounters may have been underestimated. Four pre-fishing boats were encountered during access point surveys, and interviews were conducted as well. Notably, my capacity was maximized at every tournament attended, conducting interviews until most boats had departed, typically within a 1-1.5-hour timeframe from entry to weigh-in. Access point interviews were predominantly collected from Coosa Landing (73%), followed by Canoe Creek (12.2%), Southside (12.7%), and Rainbow Landing (1.5%) (Table 4).

Each roving creel survey averaged 4.85 interviews, similar to Mckee's (2013) average of 4.8. Throughout the surveys, 17 repeat boats, 63 non-bass boats, and 22 progressive boat counts were recorded. Despite encountering 46 bass tournament boats, they were not surveyed. The maximum angler interview recorded during one survey period was 13 interviews in July. Seasonally, 40% of roving creel interviews occurred in spring, 26% in summer, 31% in fall, and 2% in winter (Table 3). Southside was the most frequently used boat launch by anglers interviewed on the water, used by 30% of interviews, followed by Canoe Creek (22.8%), Coosa Landing (15%), and other launches such as Lakeshore, Ten Islands, Greensport, Tillisons Bend, and Shoal Creek (Table 4).

Over 150 anglers (41.7% of all interviews) reported that 90-100% of their annual effort was dedicated to tournaments, while nearly 100 (27.8% of all interviews) interviews indicated that 0-10% of their annual effort involved tournament fishing trips. Approximately 75 angler interviews reflected varying levels of tournament participation, with efforts ranging from 10-50% of their annual total (Figure 3). Despite some angler's avidity for tournaments, my data showed that the vast majority of anglers engaged in 0-10 tournament trips annually. Specifically, only 24% of all interviews reported more than 12 tournament trips per year. While tournament effort constitutes a significant portion of some anglers' overall fishing effort, the majority participate in a relatively small number of trips, except for a minority engaging in up to 150 tournament-related trips per year (Figure 4).

On average, tournament trip interviews exhibited longer travel distances, longer fishing durations, and higher expenditures on gas, food, tackle, and lodging compared to non-tournament trip interviews (Table 5). Tournament trip interviews reported higher values for all variables on weekends compared to weekdays, whereas non-tournament trip interviews showed relatively consistent values across day types. After weighting all survey data to adjust for differences in sample size between day type and tournament and non-tournament interviews, the weighted individual expenditures per trip were $204 and $78 for tournament and non-tournament trips, respectively. The weighted trip length for both survey groups was 5.7 and 5.4 hours for tournament and non-tournament trips.

Contingent Behavior Scenarios

Contingent behavior questions pertaining to fluctuations in fishing quality revealed notable trends in angler preferences. Specifically, 75% of all interviews expressed a positive impact on their non-tournament trips if fishing quality were to double. Specially, 80% of tournament interviews indicated a positive effect on their tournament trips under the same scenario. However, when faced with a 50% decrease in fishing quality, 25% of tournament interviews stated they would refrain from visiting the reservoir, while 20% of all interviews expressed intentions to leave the system entirely in this scenario. Notably, 71% of all interviews indicated no change in their tournament effort if fishing quality declined by 50%, with non-tournament interviews being the most affected group (14% reported a negative impact). Furthermore, 63% of tournament interviews anticipated no change in their tournament trips under decreasing fishing quality. Similarly, 69% of non-tournament interviews stated their non-tournament trips would remain unaffected if fishing quality declined by 50% (Table 6).

The linear mixed effects model revealed a 22.5% (P=4.90E-7) decrease in non-tournament trips and a 24.35% (P=1.34E-5) decrease in tournament trips when fishing quality declined by 50%. Conversely, when fishing quality increased by 100%, anglers indicated significant increases of 81% (P=1.91E-61) and 52% (P=5.57E-20) in non-tournament and tournament trips, respectively. These findings were significantly different from the baseline estimate of tournament and non-tournament angler effort (Figures 5 & 6).

Contingent behavior questions regarding tournament effort at Neely Henry Reservoir revealed 6% of all interviews would opt to leave the system if tournament effort increased by 100%, a lower proportion compared to responses regarding a decrease in fishing quality. Specifically, 20% of tournament interviews noted a negative effect on their tournament effort with a 100% increase in tournament activity, while 33% of non-tournament interviews anticipated a decrease in their non-tournament trips under the same scenario. Conversely, only 16% of all interviews anticipated a positive impact on their tournament effort with increased tournaments. Interestingly, 64.7% of all interviews indicated no change in their angler effort (tournament or non-tournament) in response to an increase in tournaments at Neely Henry reservoir. Lastly, when tournament effort decreased by 50%, 92% of all interviews reported no change to their tournament effort, with many anglers verbally expressing their commitment to continue fishing tournaments. Additionally, 25% of all interviews indicated an increase in their non-tournament angler effort in response to reduced tournaments, with non-tournament interviews showing stronger opinions than tournament interviews, with 29% versus 23%, respectively (Table 7).

The linear mixed effects model estimated a 21.5% increase (P=1.50E-11) and 5% decrease (P=0.206) in annual non-tournament and tournament trips, respectively, when tournament effort declined by 50%. Notably, the change in non-tournament trips was statistically significant, while tournament trips did not significantly differ from the baseline effort. Conversely, when tournament effort increased by 100%, anglers indicated a 22.5% decrease (P=1.54E-12) and a 4.5% decrease (P=0.27) in non-tournament and tournament trips, respectively. Changes in non-tournament angler effort were statistically significant from the baseline effort estimate in both tournament effort scenarios, while changes in tournament effort were not statistically significant (Figure 7 and 8).

Discussion

Sampling Techniques

My findings align with prior research on the socioeconomic dynamics of tournament versus non-tournament anglers (Wilde et al. 1998; McKee 2013; Snellings 2015; Gratz 2017). Tournament participants exhibit higher fishing frequency, travel longer distances, and allocate more expenditures across day-types compared to non-tournament anglers. These patterns suggest consistent behaviors, motivations, and preferences among tournament anglers, regardless of the specific reservoir. While previous studies have acknowledged diversity among tournament anglers, indicating a range of stakeholders within the black bass tournament fishing community, their motivations and preferences remain distinct from those of non-tournament anglers (Wilde et al. 1998).

Through a mixed methods survey approach, I captured diverse fishing behaviors among bass anglers, including avid weekend tournament participants and weekday wildcat tournament anglers, via on-site access point creel surveys. Utilizing nonuniform probability sampling of boat launches on the reservoir provided a relatively representative sample of tournament angler usage patterns. While there were instances where tournaments were not held at the intended location, adjustments to the survey schedule allowed for random selection of alternative boat launches to ensure comprehensive coverage. Similar to findings by Gratz (2017) and McKee (2013), the refusal rate among anglers for on-site surveys at Neely Henry was low.

The majority of tournaments at Neely Henry originated from Coosa Landing. During sampling at this ramp, it was frequent to encounter previously unknown tournaments coinciding with documented tournaments. Conversely, due to constrained parking capacity, limited space, and competing stakeholder activities, hosting tournaments at Ten Islands boat launch seemed unfeasible for events with more than ten boats and no tournament was documented at this boat launch throughout the year. This launch site is widely frequented by stakeholders for recreational activities such as swimming, camping, and grilling, often experiencing crowding even in the absence of tournaments.

Angler activity peaked during the spring, predominantly driven by weekend angling, regardless of the season (Table 3). The majority of tournament-related interviews were collected at Coosa Landing reflecting my unequal probability sampling. Non-tournament interviews were distributed across various boat launches and private properties, with Southside being the most common launch site, representing 30% of non-tournament interviews compared to only 12.7% of tournament interviews (Table 4). Roving creel interviews were evenly distributed between sections 1 and 2 of the reservoir, totaling 86 and 50 interviews, respectively. However, variation in the day of the week may have influenced this difference. Section 1 of the reservoir features a more lentic habitat with larger arms, providing anglers with calm fishing areas, while the upper end is narrower with fewer and smaller back bays (Figure 2).

The number of interviews conducted at each access point survey varied significantly, influenced by factors such as the duration of conversations with tournament anglers beyond the standard 'ten-minute survey' and the length of the weigh-in period. Weekday wildcat tournaments, which typically involved fewer boats, often concluded their weigh-ins quickly, leaving a limited window for conducting interviews. Additionally, documenting wildcat tournaments held in the evenings posed challenges as anglers were less receptive to being approached in the dark at boat launches.

In the fall of 2023, Alabama Power conducted dam maintenance, resulting in a two-week period during which the reservoir water level was substantially lowered. Signs were posted at every boat launch advising anglers to 'launch at your own risk' due to the reduced river channel size, limiting access to many back bays off the main channel. Despite efforts to sample during this period, encounters with anglers significantly decreased over at least two survey outings, which may have affected my sample size.

Descriptive Survey Statistics

The histogram depicted in Figure 3 showed distinct groups of anglers based on the proportion of their annual effort that is spent in tournaments. Despite anglers’ avidity for tournaments show in Figure 3, the data showed that less than a quarter of interviewee’s take more than 12 tournament trips every year. Comparably, black bass anglers on Lake Guntersville in 2013 averaged 6 bass tournaments and 49 total bass fishing trips in the previous 12 months (Mckee 2013). Although some anglers allocate a significant portion of their total effort to tournaments, the volume of annual fishing trips remains relatively modest compared to non-tournament angler effort (Figure 4). These proportional differences in tournament effort among anglers may suggest that there may be significant differences in motives and attitudes towards the management and resource use of the Neely Henry bass fishery that align with how each group prefers to prioritize their fishing trips. These angler trends are supported by previous literature that has divided anglers by their participation in tournaments and evaluated the differences between each groups stated motives and attitudinal statements for fishing (Wilde et al. 1998, Poudyal 2022).

The socioeconomic data, including distance traveled, trip length, and trip expenditures, aligned with findings from previous studies. While weekend tournament anglers traveled notably farther than non-tournament anglers, weekday tournament anglers demonstrated a local pattern, averaging 13 miles for evening wildcat tournaments. Non-tournament anglers maintained consistency in distance traveled across day types. By weighting our survey data, we addressed the absence of anglers on non-survey days and accounted for variation in sample size between tournament and non-tournament trips. This approach enabled us to extrapolate our findings to a broader, representative population of the black bass fishery at Neely Henry. Estimating sector-specific expenditures per trip and trip length from this data will play a crucial role in informing the simulation model in Chapter Three, facilitating an understanding of large-scale population effects on fishing quality and economic performance (Table 5).

Contingent Behavior Scenarios

Contingent behavior questions regarding fishing quality showed that an increase in fishing quality would increase angler effort across all interviews on average. Conversely, a decline in fishing quality elicited strong negative reactions from angler interviews, with a notable portion opting to leave the system rather than reduce their fishing effort. When faced with a 50% decrease in fishing quality, most anglers indicated no change in their effort or chose to exit the system entirely. Particularly regarding non-tournament interviews, anglers often expressed their intention to continue fishing, despite diminished enjoyment (Table 6). Tournament interviews had a higher proportion of interviews that would leave the system than non-tournament interviews, although everyone's tournament trips were more likely to stay the same in comparison to non-tournament trips regarding a decrease in fishing quality. Anglers often elicited that they would still attempt the tournament as it would be more difficult for everyone.

The linear mixed effects model enabled me to analyze anglers' opinions and intended behavior to assess potential changes to annual angler effort and it's subsequent effect on the fishery. I was able to quantitatively document a direct relationship between fishing quality and angler effort, showing statistically significant fluctuations, both positive and negative, in tournament and non-tournament trip effort across all interviews with non-tournament trips yielding the highest increase in annual effort when fishing quality increased (Figure 6).

Contingent behavior questions pertaining to changes in tournament effort revealed diverse preferences among interviews. When tournament effort hypothetically decreased, annual tournament fishing effort showed no significant shift (Figure 7) across all interviews. Tournament trip interviews indicated a lack of interest in any increase in tournaments at Neely Henry, preferring to maintain their current tournament frequency with many expressing concerns about overcrowding and its effects on their experience and the fishery (Table 7). Related to overcrowding, Mckee (2013) used contingent behavior questions to assess the impact of boat ramp access on anglers' trips, revealing that 25% of interviews indicated their effort would increase if guaranteed a parking space at Lake Guntersville in 2013. Lastly, contingent behavior questions identified a negative correlation between tournament effort and non-tournament angler effort with the majority of interviews suggesting no change or a decline to their non-tournament trips. The linear mixed effects model illustrated that their qualitative responses translated to a statistically significant average decrease in annual non-tournament angler trips when tournament effort increased across all interviews, regardless of whether they primarily engaged in tournaments or not. Non-tournament effort increased in response to declining tournament effort scenarios as well (Figure 8). This data substantiates literature's qualitative suggestion that tournament effort inversely affects non-tournament effort by providing quantitative statistics in support of these assertions (Gilliland 1998; Wilde et al. 1998; Poudyal 2022).

I documented an inverse relationship between tournament and non-tournament angler effort, although, the linear mixed model revealed that anglers appear more sensitive to changes in fishing quality compared to tournament activity. Increases in fishing quality had a stronger correlation for increasing tournament and non-tournament fishing trips across all interviews possibly identifying increasing fishing quality as a higher priority to anglers than increased tournament opportunities at Neely Henry. While all fishing trips were positively associated with increasing fishing quality, non-tournament trips increased more compared to tournament trips in this scenario. Poudyal (2022) identified comparative and interesting trends amongst tournament and non-tournament anglers where both groups wanted to catch many fish, but tournament anglers prioritized their desire to catch big fish, exceeding non-tournament anglers. This suggests that although increasing fishing quality hypothetically increased all anglers fishing trips; it is important to note that angler groups perspectives of what a quality fishing experience entails may differ.

When evaluating angler priorities and motives, it is crucial to consider that the comprehensive behavioral data revealed less than a fifth of interviews would enjoy an increase in tournaments (Table 7). In contrast, a substantial portion of stakeholders interviewed expressed strong positive changes in angler effort if fishing quality improved at Neely Henry Reservoir (Table 6). These findings suggest that when agencies evaluate fishery management strategies, enhancing fishing quality should possibly take precedence over providing additional tournament opportunities.

Implications

Understanding angler behavior and priorities is vital for managers to evaluate fishery demand and tradeoffs in a dynamic environment. This study reinforces the socioeconomic disparities between tournament and non-tournament angler effort, as previously documented, and highlights the quantitative tradeoffs in angler effort interactions among stakeholder groups. Specifically, an increase in tournament effort corresponds to a decrease in non-tournament effort, irrespective of angler group and tournament participation level.

The challenges involved in researching tournament events are concerning, given their substantial impacts on public resources managed by agencies, both socially, biologically, and economically. A lack of documentation in a growing sport fishery may result in inadequate management of a high-pressure fishery and ongoing stakeholder conflict. Enhanced structure and communication from tournament directors could mitigate stakeholder conflict and reduce public perception of tournament impacts on public resources. Improved communication may also alleviate the decline in non-tournament trips observed in this study and facilitate enhanced agency research, ultimately leading to improved fisheries management and enhanced fishing quality over time.

The Michigan and Minnesota Departments of Natural Resources have implemented straightforward regulations to document bass tournaments. In Minnesota, regulations limit the number of tournaments on specific bodies of water based on tournament size and timing, prohibiting tournaments on national holidays like Memorial Day to mitigate stakeholder conflicts (Minnesota DNR 2023). Since 2019, Michigan mandates online registration for all bass tournaments, requiring organizers to document event details such as date, time, location, and participating boats, along with biological data like the largest fish caught. This system facilitates self-management among stakeholders by enabling organizers to search for conflicting events, ensuring transparent communication, and allowing non-tournament stakeholders to check for ongoing tournaments before heading to a launch site. Michigan's approach minimizes the need for state intervention and law enforcement efforts (Goneia 2022).

Prior to this study, the quantitative impact of tournament activities on non-tournament effort had not been fully understood. This information is crucial as the popularity of tournament fishing grows and conflicts among angler groups persist. Poudyal (2022) highlighted the importance of assessing how tournament effort influences the fisheries resource and the experience of non-tournament anglers. By utilizing contingent behavior questions, I was able to systematically measure variation in angler effort under realistic scenarios, providing valuable insights for agencies to consider.

Understanding this relationship enables researchers to simulate more accurate fishery scenarios and comprehend their biological impacts, particularly when considering variation in catchability and post-release mortality among different types of angler effort. In Chapter 3, I leveraged the observed relationship between tournament and non-tournament angler effort outlined in this chapter to develop scenarios of annual sector-specific angler effort for use in a simulated fishery. This allowed for an examination of how changes in angler effort would influence the fishing quality and economic performance of the black bass fishery at Neely Henry Reservoir.

There is a wealth of research exploring the economic and biological aspects of black bass tournament fishing, alongside investigations into the social and behavioral differences between tournament and non-tournament anglers. However, many studies lack quantitative variables directly impacting fisheries. The long-term social and economic effects of tournaments on other stakeholders remain uncertain. Future studies should further quantify the economic and social implications of contrasting angler dynamics observed here and assess the lasting impacts of bass tournaments on stakeholders accessing black bass fisheries.

The sociological dynamics and priorities in the black bass angler communities in the southeast United States may be shifting and stakeholder conflict continues to increase while license and boating sales continue to decrease. As the black bass angling population continues to diversify, the findings presented here will aid agencies in recognizing the quantitative implications of distinct stakeholder group demands.

Table 1: Description of variables recorded during access point and roving creel angler surveys. Values at the beginning of each variable coincide with the survey question in Appendix A-3.

Variable	Response
1) Target species	Anything, Crappie, Bass, Catfish, Bream, other
2) Current tournament participation	Yes, no
3) Boat launch utilized today	Name of boat launch, private slip, or resident launch
4) *n* hours spent fishing today	Number of intended or completed fishing trip hours
5) One-way distance traveled (mi)	One-way distance traveled to boat launch (miles)
6) Tend to fish on the weekend, weekday, or both	Weekend, weekday, both
7) Fishing trip expenditures ($US)	$US currency separated into gas, lodging, food, fishing gear, other
8) Monthly participation in bass tournaments	Yes, no, and/or number of average tournaments participated in per month
9) Monthly participation in non-tournament bass fishing	Number of average non-tournament fishing trips per month
10) Contingent behavior scenarios	Number of fishing trips taken per month in response to each scenario
11) Age	Age of angler in years
12) Employment	Retired, semi-retired, or employed
13) Zip code	Residential zip code
14) Capture of "yellow-tagged bass”	Yes, no, and if applicable: number caught

Table 2: Intended and actual unequal probability survey sampling schedule for access point surveys at Neely Henry Reservoir in 2023.

Boat Launch	Intended tournament trips	Intended sampling proportion	Actual tournament trips	Actual sampling proportion
Coosa Landing	16	0.53	19	0.68
Canoe Creek	7	0.23	6	0.21
Southside / Rainbow Landing	5	0.17	3	0.11
Ten Islands	2	0.07	0	0.00
Total	30	1.00	28	1.00

Table 3: Seasonal and day-type distribution of tournament, non-tournament and pre-fishing trip type interviews recorded during roving creel and access point surveys on Neely Henry Reservoir in 2023.

Trip Type	Spring	Summer	Fall	Winter	Total
Non-tournament					
Weekend	40	31	30	3	104
Weekday	15	5	12	0	32
Total	55	36	42	3	136
Tournament					
Weekend	87	21	48	13	169
Weekday	20	5	3	0	28
Total	107	26	51	13	197
Pre-fishing					
Weekend	3	5	3	1	12
Weekday	10	0	4	0	14
Total	13	5	7	1	26
Seasonal Total	175	67	100	17	359

Table 4: Proportion of sector specific interviews that utilized specific boat launches for their fishing trip, obtained by access point and roving creel surveys at Neely Henry Reservoir, Alabama from March 2023 through December 2023.

Trip Type	Coosa Landing	Canoe Creek	South-side	Ten Islands	Rainbow landing	Personal property	Greens-port	Tillson’s bend	Lake-shore	Shoal Creek
Tournament	0.736	0.122	0.127	0	0.015	0	0	0	0	0
Non-tournament	0.147	0.228	0.301	0.103	0	0.066	0.022	0.015	0.11	0.007

Table 5: Summary of trip and day type strata of angler variable means including: one way distance traveled (miles), trip length (hours), and expenditures ($U.S) obtained by access point and roving creel surveys at Neely Henry Reservoir, Alabama from March 2023 through December 2023. Standard error from the mean in parathesis. Weighted trip length expands survey data to the general bass fishing population at Neely Henry and were applied in Chapter 3.

	Trip Type					
	Tournament (N=223)			Non-tournament (N=136)		
	Weekend	Weekday	Average	Weekend	Weekday	Average
One-way distance traveled (miles)	67.4 (9.23)	13.4 (1.89)	60.3 (8.33)	24.4 (2.55)	29.7 (6.89)	25.6 (2.51)
Trip length (hours)	8.3 (0.048)	4.0 (0.319)	7.6 (0.14)	5.7 (0.22)	5.1 (0.37)	5.6 (0.19)
Boat and vehicle fuel ($)	134.9 (7.95)	61.4 (7.87)	124.6 (7.46)	55.7 (4.84)	58.7 (10.45)	56.4 (4.41)
Food ($)	39.4 (4.31)	9.7 (3.43)	35.9 (3.94)	11.6 (1.45)	10.8 (4.02)	11.4 (1.44)
Tackle ($)	60.7 (7.34)	24.7 (6.88)	55.7 (6.67)	13.0 (5.25)	12.8 (6.75)	12.9 (4.33)
Lodging ($)	40.5 (7.91)	0.0 (0)	36.4 (7.16)	4.8 (3.41)	0.6 (0.64)	3.8 (2.64)
Total individual expenditures per trip ($)	224.4 (19.44)	91.0 (12.48)	207.0 (17.83)	74.4 (6.60)	80.7 (16.02)	75.8 (6.24)
Total individual expenditures per trip within 20 miles ($)	186.0 (18.35)	87.9 (11.64)	175.7 (16.7)	63.6 (6.33)	62.8 (16.7)	63.4 (6.16)
Weighted expenditures per trip ($)			204.1			78.1
Weighted trip length (hours)			5.7			5.4

Table 6: Summary of survey responses (tournament: N=223, non-tournament: N=136, total: N=359) regarding angler's contingent behavior to **changes in fishing quality** at Neely Henry Reservoir, Alabama, from March to December 2023. Values are expressed as a proportion of the total sample size. Participants indicated potential changes in angler effort (tournament and non-tournament) in response to 100% increases and 50% decreases in fishing quality during access point and roving creel surveys. Some anglers expressed intent not to return to the reservoir under each scenario, while any deviation from baseline effort was considered as an increase or decrease. "T and NT" trips refers to tournament and non-tournament trips.

	100% Increase						50% Decrease					
	Tournament Interviews		Non-Tournament Interviews		All Survey Interviews		Tournament Interviews		Non-Tournament Interviews		All Survey Interviews	
	T trips	NT trips	T trips	NT trips	T trips	NT trips	T trips	NT trips	T trips	NT trips	T trips	NT trips
"Would not come back"	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.26	0.13	0.15	0.19	0.21
Decrease in baseline effort	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.10	0.04	0.14	0.09	0.13
No change	0.19	0.27	0.63	0.20	0.37	0.25	0.63	0.63	0.83	0.70	0.72	0.66
Increase in baseline effort	0.81	0.73	0.38	0.80	0.64	0.75	0.01	0.00	0.01	0.01	0.01	0.00

Table 7: Summary of survey responses (tournament: N=223, non-tournament: N=136, total: N=359) regarding angler's contingent behavior to **changes in tournament effort** at Neely Henry Reservoir, Alabama, from March to December 2023. Values are expressed as a proportion of the total sample size. Participants indicated potential changes in angler effort (tournament and non-tournament) in response to 100% increases and 50% decreases in tournament effort during access point and roving creel surveys. Some anglers expressed intent not to return to the reservoir under each scenario, while any deviation from baseline effort was considered as an increase or decrease. "T and NT" trips refers to tournament and non-tournament trips.

	100% Increase						50% Decrease					
	Tournament Interviews		Non-Tournament Interviews		All Survey Interviews		Tournament Interviews		Non-Tournament Interviews		All Survey Interviews	
	T trips	NT trips	T trips	NT trips	T trips	NT trips	T trips	NT trips	T trips	NT trips	T trips	NT trips
Would not come back	0.066	0.051	0.059	0.059	0.061	0.056	0.015	0.015	0.007	0.000	0.011	0.008
Decrease in baseline effort	0.203	0.223	0.052	0.331	0.148	0.270	0.041	0.030	0.015	0.007	0.031	0.022
No change	0.538	0.726	0.779	0.603	0.624	0.671	0.899	0.726	0.963	0.699	0.928	0.719
Increase in baseline effort	0.193	0.000	0.110	0.007	0.167	0.003	0.046	0.228	0.015	0.294	0.031	0.251

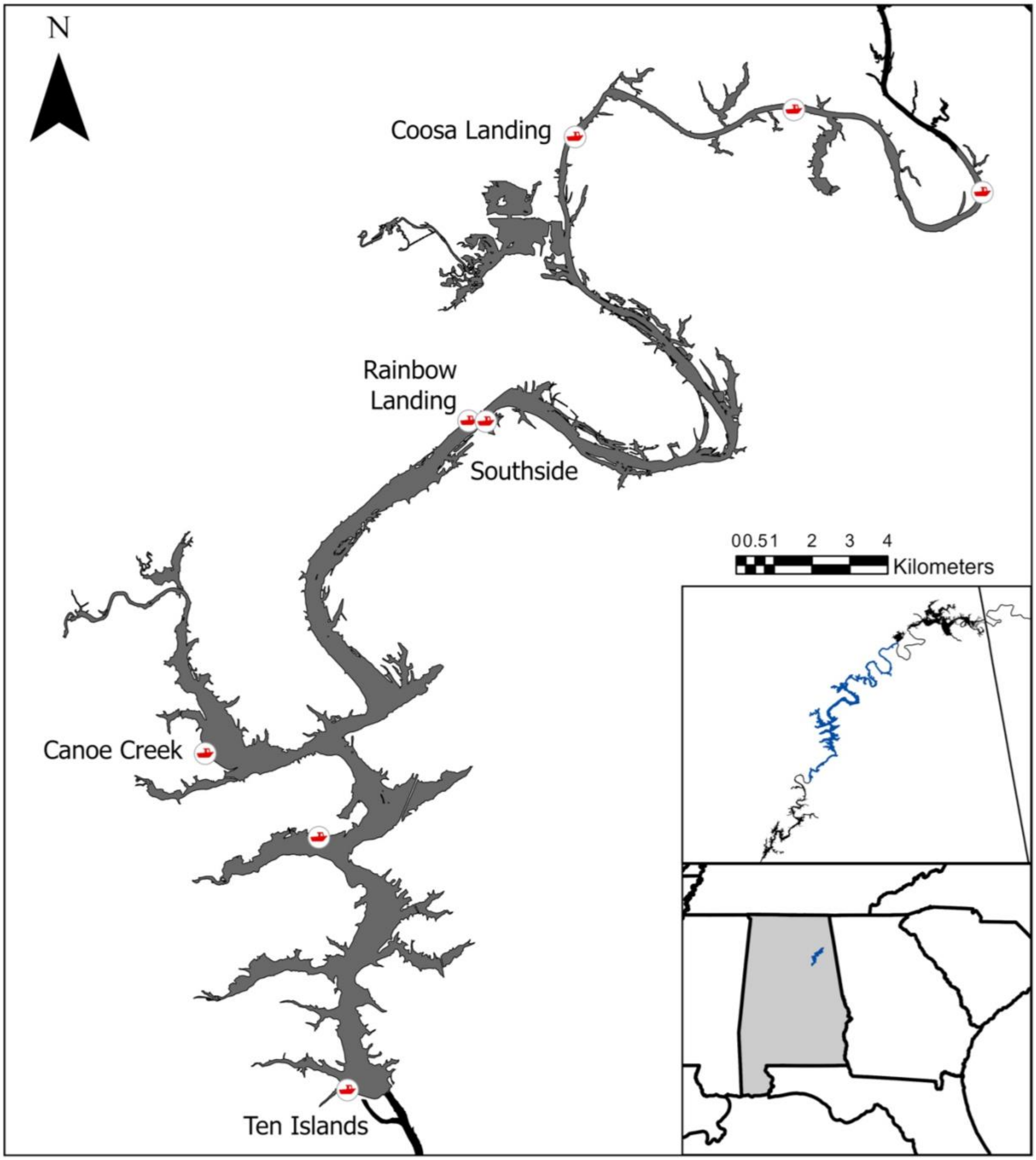

Figure 1: Boat launches included in the 2023 access point surveys at Neely Henry Reservoir, AL. Boat launches that were not surveyed due to insignificant angler use are shown but not labeled.

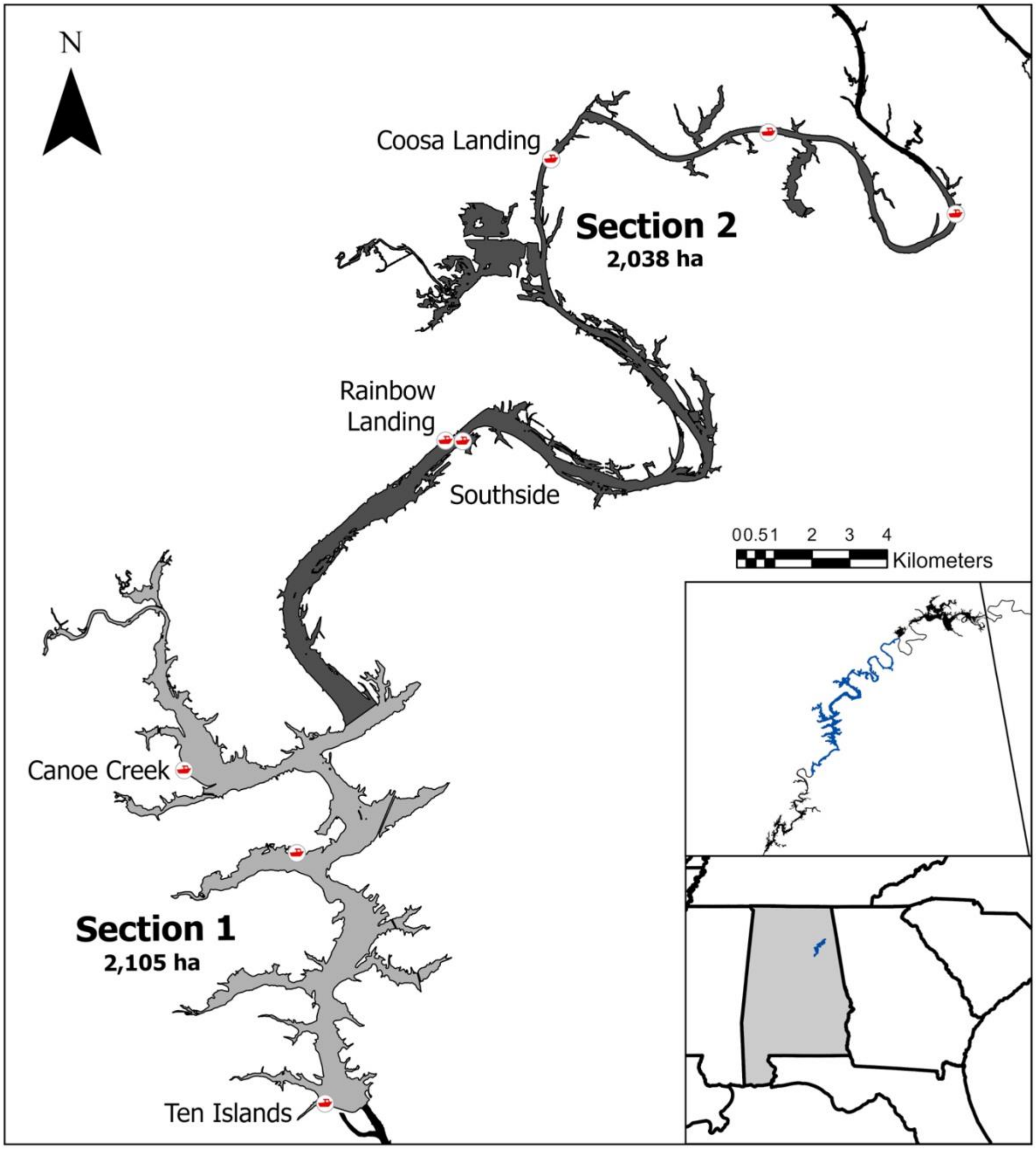

Figure 2: 2023 roving creel survey sections at Neely Henry Reservoir, AL.

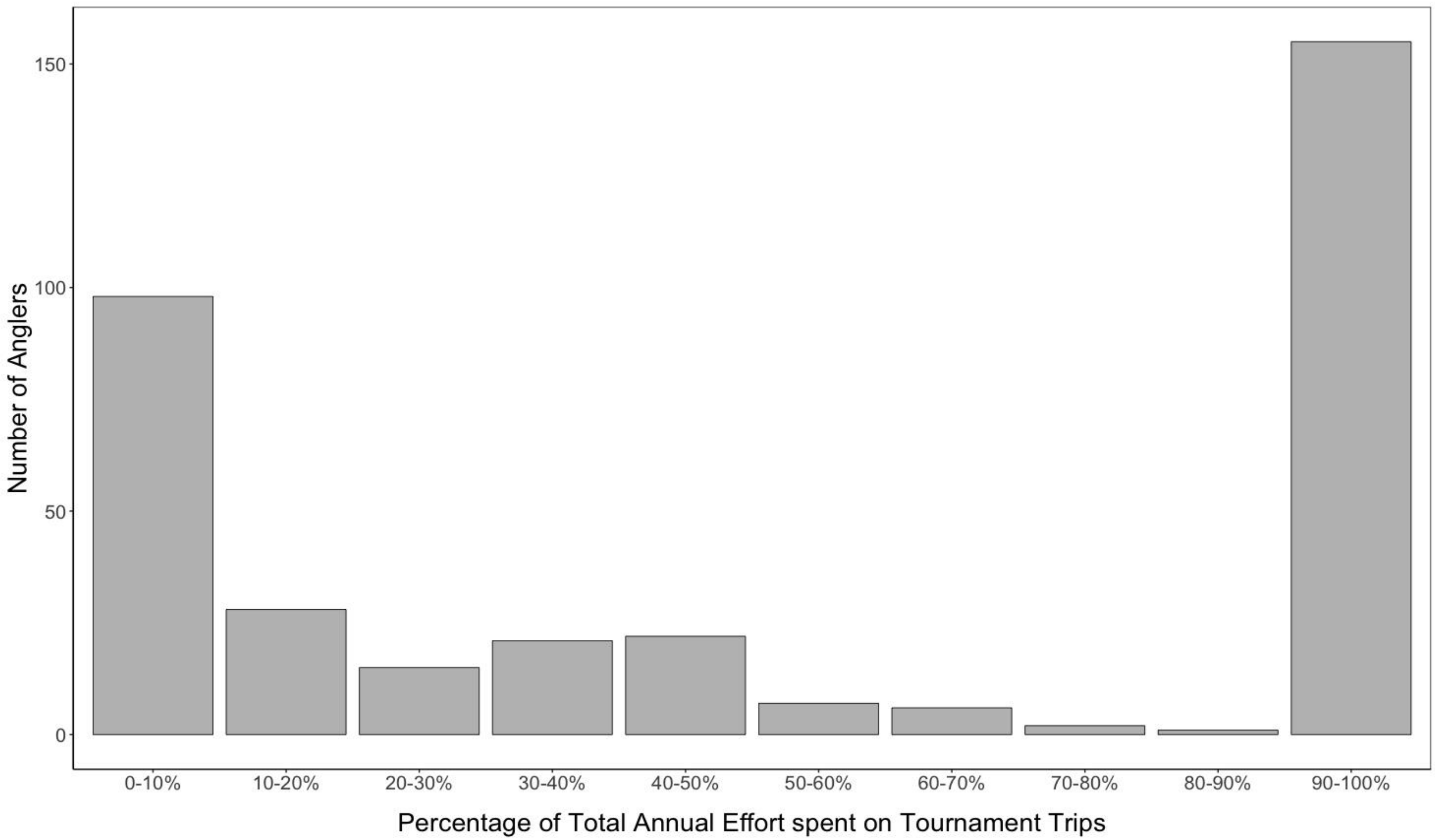

Figure 3: Histogram depicting the distribution of total annual effort allocated to tournament-related trips derived from all access point and roving creel angler interviews at Neely Henry Reservoir between March- December 2023.

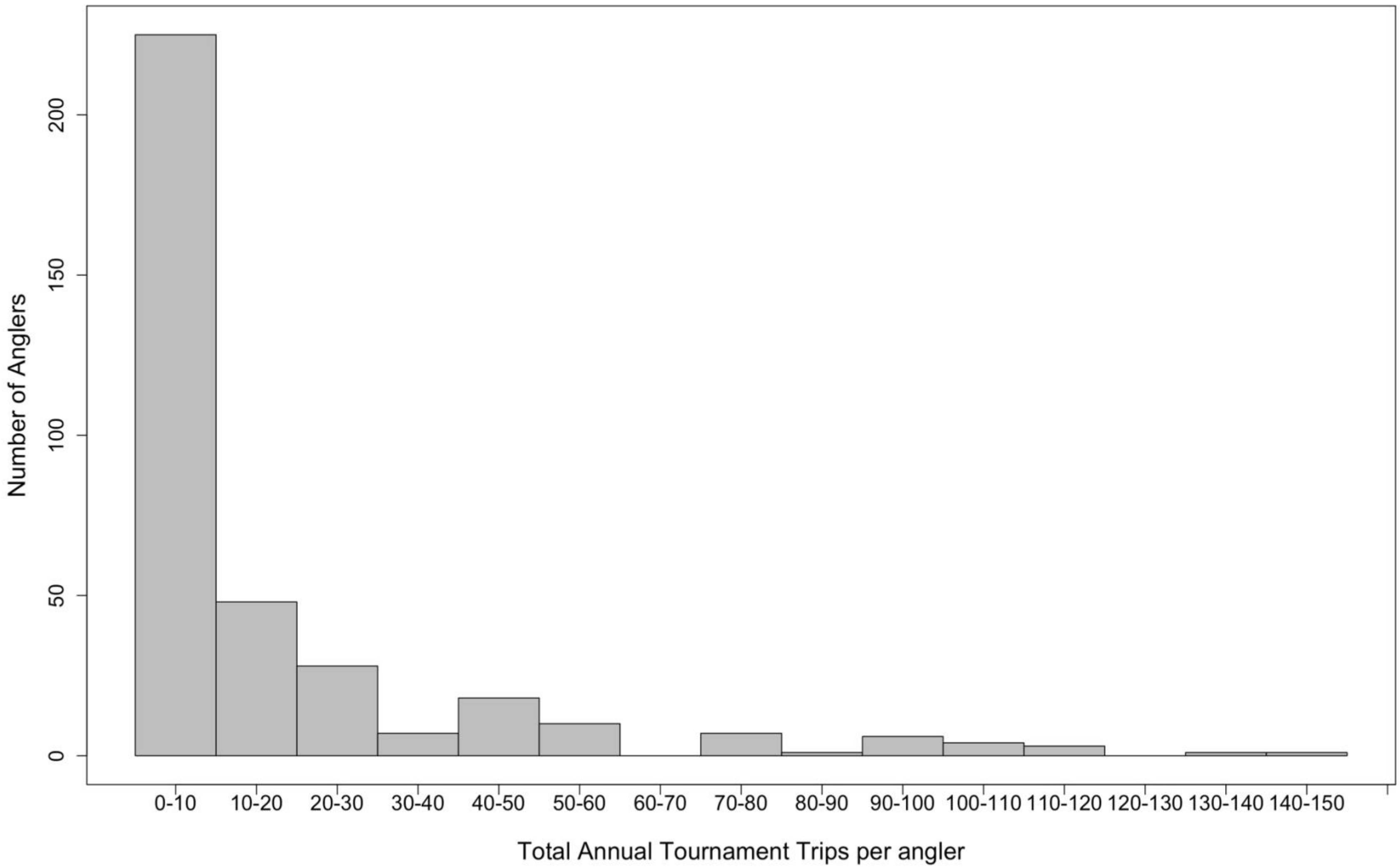

Figure 4: Histogram depicting the annual distribution of tournament-related trips derived from all access point and roving creel angler interviews at Neely Henry Reservoir between March- December 2023.

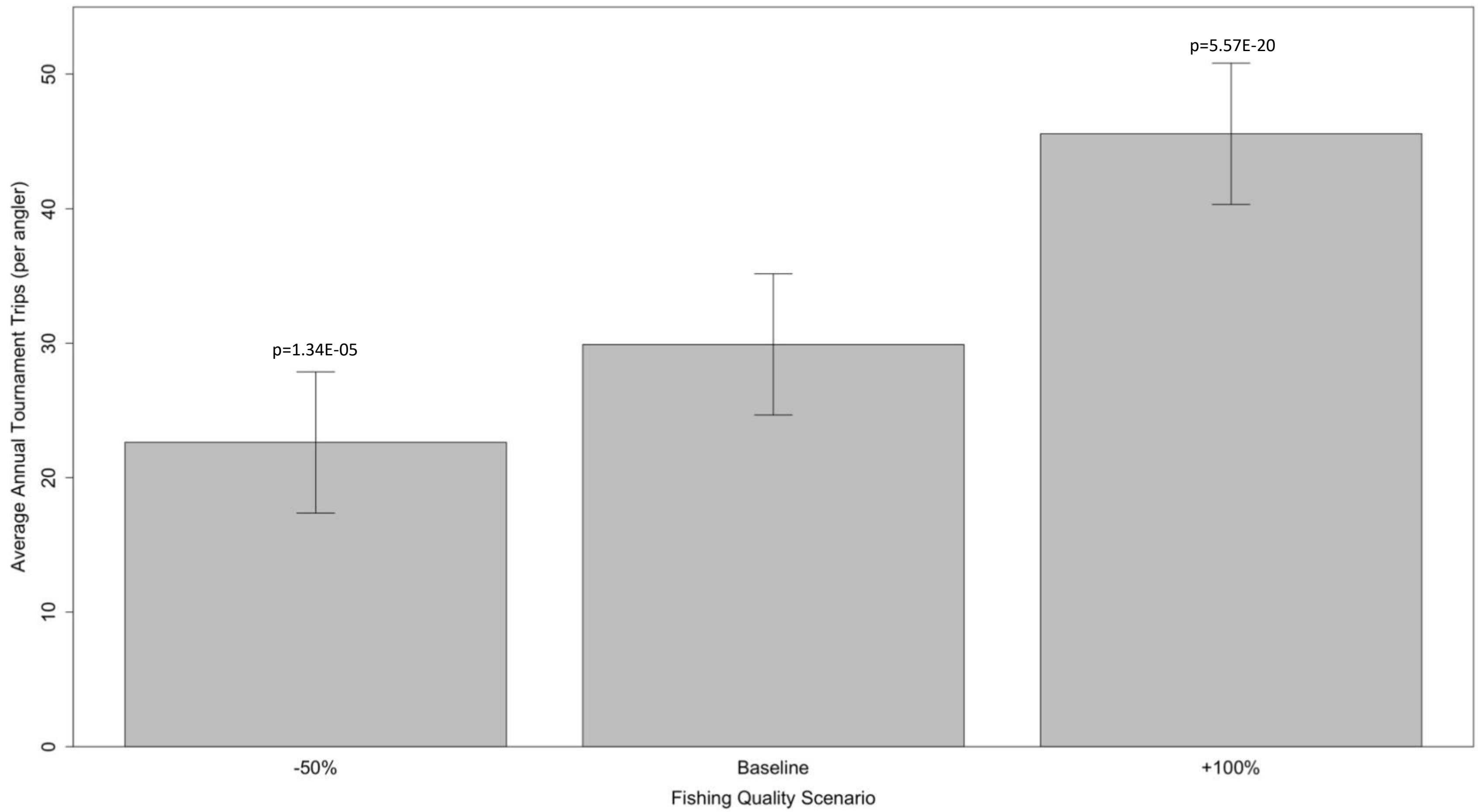

Figure 5: Pair-wise comparison examining changes in mean annual tournament trips for all angler interviews across three fishing quality scenarios (50% decrease, baseline, and 100% increase) at Neely Henry Reservoir, AL. Effort changes were assessed through fishing quality contingent behavior questions during roving creel and access point surveys conducted from March to December 2023. p-values indicate differences relative to the baseline scenario.

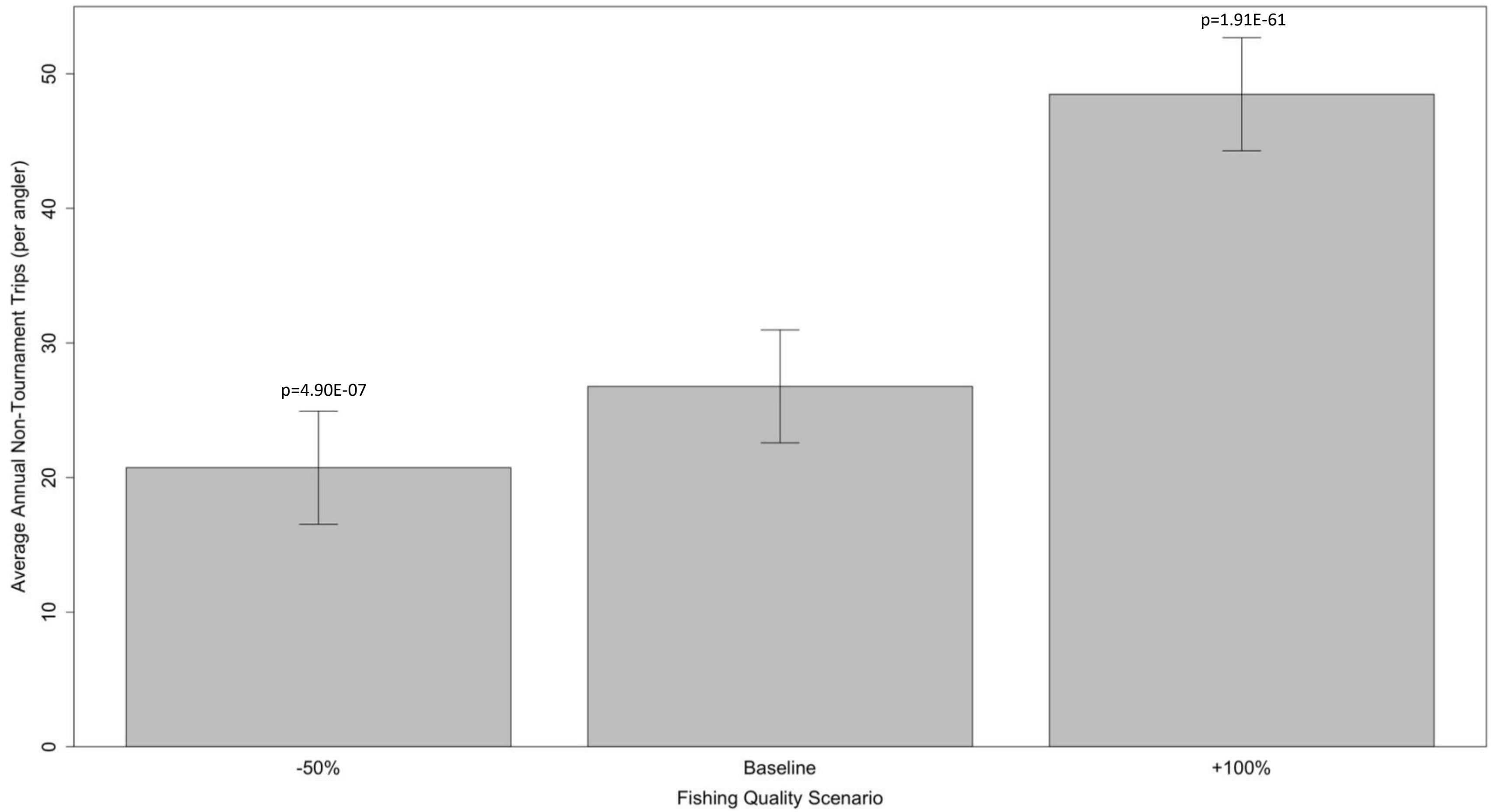

Figure 6: Pair-wise comparison examining changes in mean annual non-tournament trips for all angler interviews across three fishing quality scenarios (50% decrease, baseline, and 100% increase) at Neely Henry Reservoir, AL. Effort changes were assessed through fishing quality contingent behavior questions during roving creel and access point surveys conducted from March to December 2023. p-values indicate differences relative to the baseline scenario.

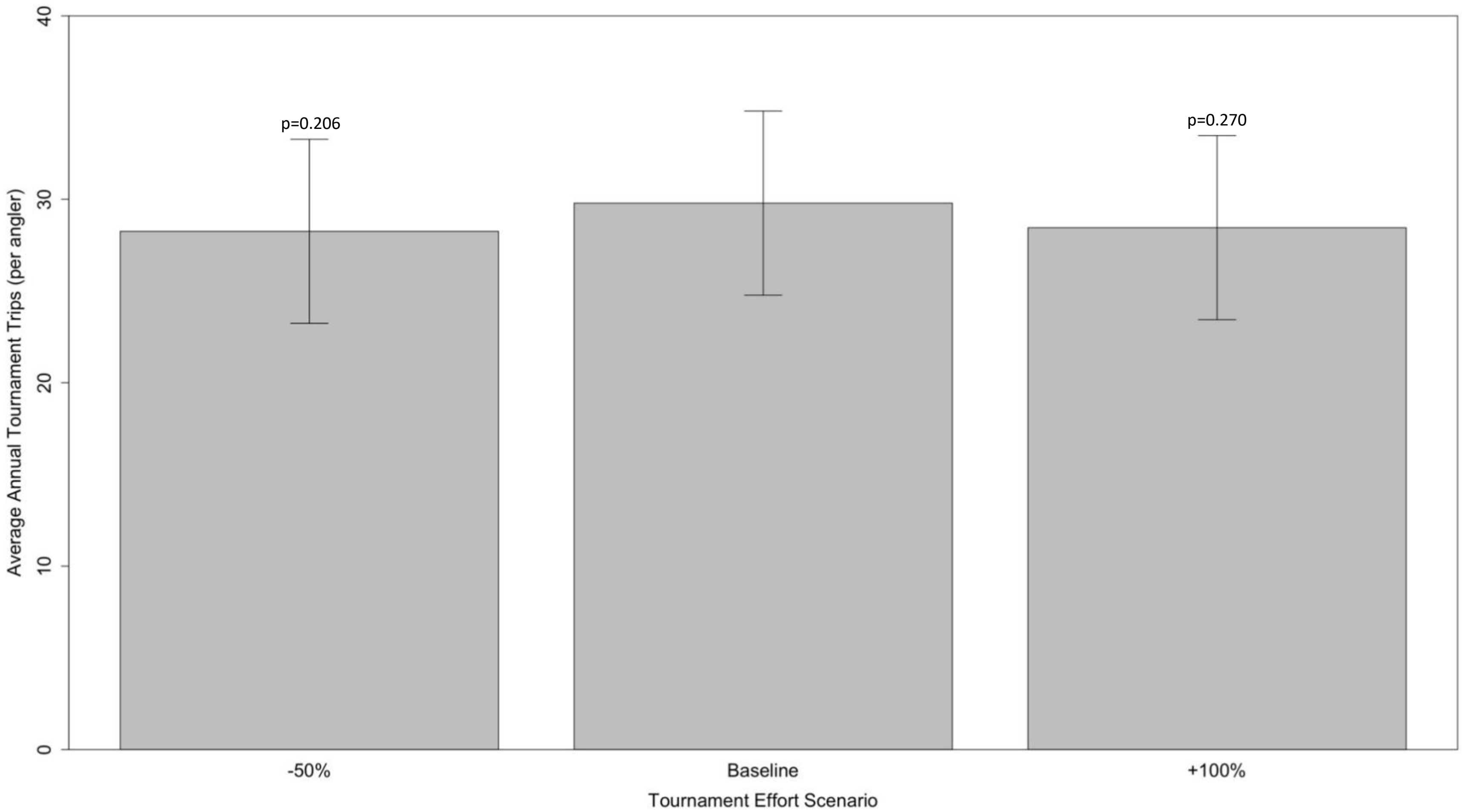

Figure 7: Pair-wise comparison examining changes in mean annual tournament trips for all angler interviews across three tournament effort scenarios (50% decrease, baseline, and 100% increase) at Neely Henry Reservoir, AL. Effort changes were assessed through tournament effort contingent behavior questions during roving creel and access point surveys conducted from March to December 2023. p-values indicate differences relative to the baseline scenario.

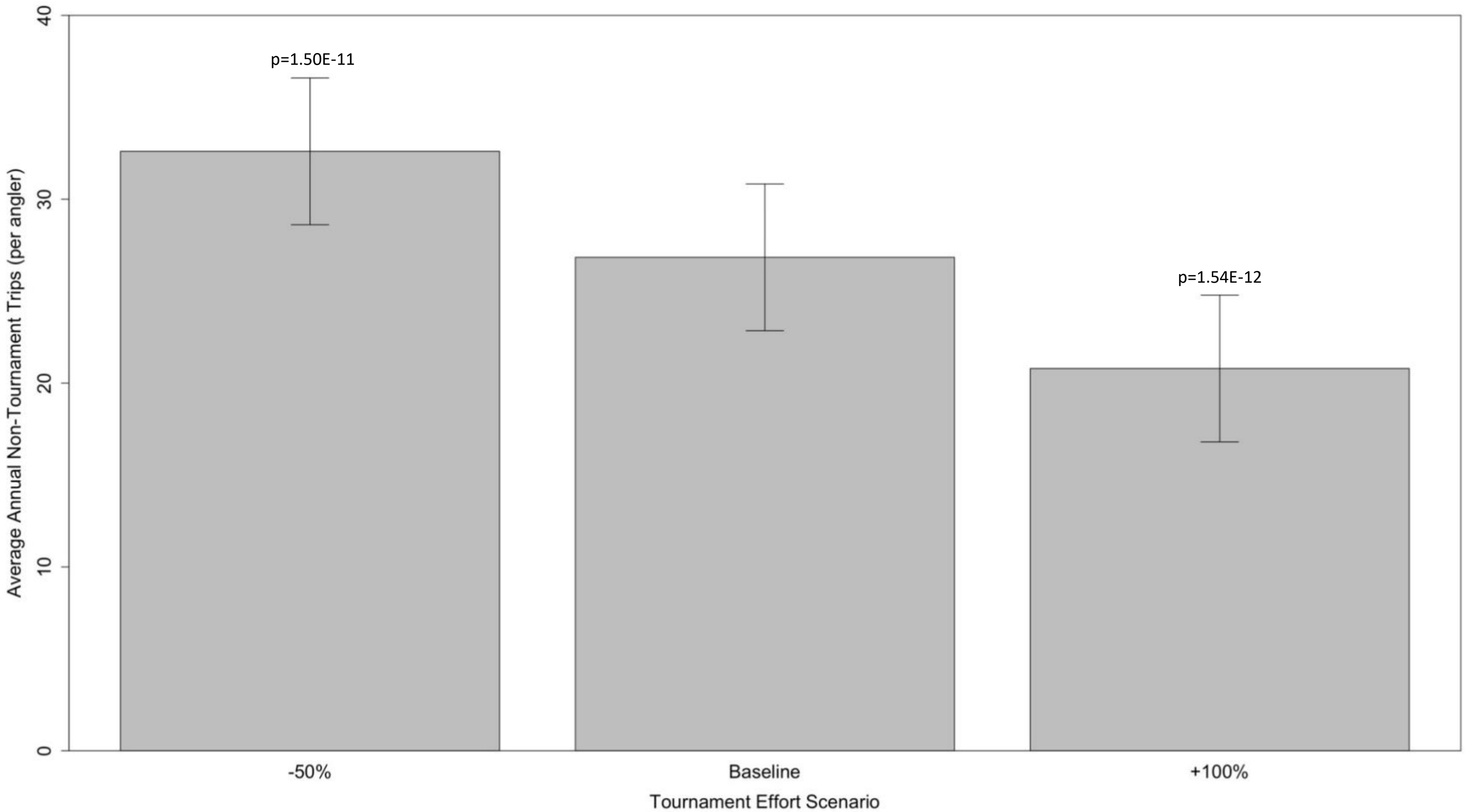

Figure 8: Pair-wise comparison, examining changes in mean annual non-tournament trips for all angler interviews across three tournament effort scenarios (50% decrease, baseline, and 100% increase) at Neely Henry Reservoir, AL. Effort changes were assessed through tournament effort contingent behavior questions during roving creel and access point surveys conducted from March to December 2023. p-values indicate differences relative to the baseline scenario.

Chapter III: Simulating tradeoffs between fishing quality and economic performance in a black bass fishery with high tournament effort

Introduction

Competitive Fishing

Organized, competitive, sport fishing is one of the largest and fastest growing aspects of inland fisheries resources with 78% of angler effort being directed towards black bass, *Micropterus* species (Allen et al. 2008; Schramm et al. 1991). Tournaments can range in size from a few anglers in a local, Tuesday night, club to several thousand. In 2023, the Academy Sports + Outdoors Bassmaster Classic was hosted in Knoxville, Tennessee and was deemed the largest classic to date with nearly 164,000 attendees over a weekend of events and 4.5 million viewers on FOX and FS1 television coverage (Bassmaster.com 2023). Schram and Hunt (2007) predict that the commercial aspects of tournament fishing will continue to grow substantially if current media trends continue. Tournament fishing has the potential to occupy a place in American culture similar to that of other professional sports.

As live-release fishing tournaments for black bass increase, fishery managers have been concerned with how fishing tournaments could impact black bass fisheries (Allen et al. 2004). Schramm and Hunt (2007) reported that 62% of state agencies reported tournament or private organizations had attempted to influence fishery management decisions to make fishery resources more attractive to tournaments. A factor analysis performed by Schramm and Hunt (2007) identified six primary factors associated with inland fishing tournaments that adversely impacted fisheries management agencies including resource overuse, user-group conflicts, cost to agency, non-traditional management model, fish introductions and fish population impacts.

Although, Driscoll et al. (2012) assessed the trends in agency assessments of black bass tournaments in the southeast United States and found tournaments to generally benefit fisheries management by promoting fishing, specific fisheries, and agency programs, although, persistent issues included resource overuse, user-group conflicts, and a lack of documentation, monitoring, and registration programs.

Some state agencies have moved to regulating the number of tournaments per month based on the size of the waterbody and size of the tournament including denying any tournaments to be held on popular holidays such as Memorial or Labor Day to minimize user conflict (Minnesota DNR 2023). Several studies express the difficulties of collecting data from bass tournament anglers exclaiming the "chaotic" and "frenzied" nature of the weigh-in period making traditional fisheries research techniques "impractical" (Snellings 2015; Maceina et al. 2019). Further research is needed to document this growing endeavor and its implications on fisheries resources and management.

Population-level effects associated with fishing

Due to the ubiquity and economic importance of black bass, they have been the subject of numerous studies examining their growth, mortality, and population structure, across a large spatial and temporal range (Pope and Wilde 2004; Kerns at al. 2012). Because of tournaments, catch and release fishing has increased substantially. As harvest decreases, traditional methods of black bass management including bag and length limits have become a less effective tool for structuring bass populations for fisheries managers (Long et al. 2015). While abiding to any slot, bag, or minimum length limit regulations, normal harvest practices tend to retain a variety of sized fish from the population. In contrast, fishery managers are concerned that tournament-associated mortality concentrates on the largest, fastest growing fish in the population. In some cases, mortality from tournaments can exceed harvest mortality at the population level (Myers et al. 2008) and can lead to significant shifts in population structure and fishing quality.

Tournament mortality occurring before or during the weigh-in process is relatively simple to document while delayed or post-release mortality is more challenging to estimate. Tournament-associated mortality has been a concern of management agencies because fish brought to weighing stations may incur relatively higher rates of mortality even if they are released alive (Wilde et al. 1998). During tournaments, bass can be exposed to various stressors including air exposure, live well anoxia or hypoxia, fish crowding, disease, displacement, etc. (Cooke et al. 2020; Suski et al. 2005). A culmination of these stressors can result in injury, excess energy expenditure, and initial or post release mortality at a higher rate than non-tournament catch and release fishing. As tournaments continue to grow in popularity and are conducted year-round in the southern United States, where average August water temperatures can exceed 80 degrees Fahrenheit, agencies have expressed the need for further information regarding the survival of tournament-captured bass.

Various studies have quantified the sources of black bass mortality as well as estimated the population level effects on the fishery (Kerns at al. 2012). Although, conclusions from studies have been variable: some having no overarching effect on bass population abundance (Kwak and Henry 1995; Neal and Lopez-Clayton 2001), while Hayes et al. (1995) simulated the impacts of tournament fishing on Largemouth bass and concluded that tournament-associated post-release mortality could affect population size structure. Sylvia and Weber (2022) identified simulation scenarios that suggest tournaments have little effect on bass population size structure, but size structure could be reduced with higher tournament capture probabilities and lower post-tournament survival. On top of this variation, Snellings (2015) identified eight different types of tournament groups and every black bass fishery can have its own largely unregulated proportion of diverse tournaments. This variability in conclusions furthers the need for additional research and system-specific assessment and management.

Economic Impact

Pollock et al. (1994) and Schorr et al. (1995) explained that many legislative decisions that affect fisheries are largely constrained by financial and budgetary considerations, therefore, it is important for resource managers to understand the economic value of a fishery. In the most recent National Survey of Fishing, Hunting and Wildlife-Associated Recreation, there were an estimated 9.6 million black bass anglers who helped generate nearly $30 billion dollars in economic activity (USDI 2016).

Recreational fishing is a major source of revenue for state and local communities across the United States as well as the state of Alabama. Angler expenditures include boat and vehicle fuel, lodging, charters, fishing gear, groceries for fishing trips, etc. (Chen et al. 2003). The 2023 Bassmaster Classic held in Knoxville, Tennessee produced more than $2.85 million in state and local tax revenue as well as supported over 12,000 jobs in the local community (Bassmaster.com 2023).

Black bass tournament anglers can be distinctive for their specialty gear on the water and the amount of fishing expenditures invested compared to non-tournament anglers. In 2017, Plauger documented tournament bass anglers to spend $435 per day while non-tournament bass anglers spent $182 per angler per day at Lake Eufaula (Plauger 2018). Driscoll (2010) documented tournament and non-tournament bass fishing expenditures on Sam Rayburn in 2007 and 2008 totaling $23.7 million and $8.6 million respectively for both groups of anglers. As tournament popularity continues to grow, cities surrounding bodies of water are attracted to hosting black bass anglers to provide a boost to their own economy. The 2023 Academy Sports + Outdoors Bassmaster Classic produced an economic impact of over $35 million in just one weekend. Driscoll et al. (2010) documented $31.8 million worth of expenditures produced by tournament and non-tournament black bass anglers surrounding Sam Rayburn Reservoir in Texas in 2007.

Economic impact studies are typically the preferred methodology to determine a fisheries potential impact to regional economies (Propst and Gavrilis 1987). Knowledge of the value of these fisheries can not only provide incentive for investment in public resources but also provide proper mitigation estimates should these municipalities suffer a loss in revenue due to destruction of a fishery or water resource. By estimating impacts such as changes in fishing quality or tournament quantity, economic impact assessments (EIAs) can help fisheries managers, elected officials, administrators, and interest groups describe the effects of regulations, policy, and investment decisions (Propst and Gavrilis 1987). Quantitative economic data on sport fisheries can provide conservation agencies with more political influence on state and municipal projects that involve the use of water and fishery resources (Schorr et al. 1995).

Evaluating Tradeoffs

A tradeoff is defined as a situational decision that necessitates accepting lesser achievement of one objective in the interest of enhanced fulfillment of a competing objective. Some examples of tradeoffs in natural resource management are (a) economic performance vs. environmental protection, (b) short term fishery yield vs. long term sustainability, and (c) maximizing long term yield vs. achieving stable yields. From year to year the management of black bass tournaments presents a potential trade-off between economic performance and fishing quality. Per-trip expenditures tend to be higher for tournament than non-tournament fishing, therefore, tournaments have the potential to provide higher expenditures than an equal amount of non-tournament fishing. However, a tradeoff arises because fish released from tournaments experience higher post-release mortality rates thereby having a larger potential negative impact on fish mortality, abundance, and fishing quality (Sylvia and Weber 2022; Suski et al. 2004; Siepker et al. 2007; Schramm and Hunt 2007; Lewin et al. 2006; Melstrom et al. 2023; Wilde et al. 1998).

As the demand for tournaments has increased, there have been various responses from agencies regarding how to balance the tradeoffs of modern-day black bass management as discussed in Driscoll et al. (2012). Tournaments have also encouraged the public's involvement in fisheries resources and agency programs. Unfortunately, creel surveys and management plans have identified continued user conflict between tournament and non-tournament anglers differing in opinions regarding the "proper use of the fishery", competing for boat launch parking, and access to the fishery, especially on weekends (Wild et al.1998, Hamm et al. 2022).

The potential for both positive and negative impacts from tournaments is particularly of concern for fisheries agencies in the southeast United States. Schramm and Hunt (2007) estimated 51% of nationwide competitive fishing events in 2005 occurred in this region with most of the effort focused on black bass species (Allen et al. 2008; Schramm et al. 1991). The state of Alabama, the birthplace of competitive bass fishing, spent over $218 million on freshwater fishing retail sales in 2020 (Southwick Associates 2020). Alabama is considered one of the best places in the United States for bass fishing with Lake Guntersville, Pickwick, Eufaula, and the Coosa River Chain receiving national attention.

With most of the angler effort in the state focusing on black bass, the importance of evaluating the economic and fishing quality tradeoffs of black bass tournaments is imperative for proper fisheries management by state agencies such as ADCNR. Thus, it would be beneficial for managers to have quantitative predictions regarding how many tournaments must be sacrificed to achieve their fishing quality objectives. Or conversely, how much does fishing quality possibly have to suffer to satisfy the demand for competitive fishing events and their positive economic impacts?

To fully understand the current effects, benefits, and costs of black bass tournaments in the southeast United States, my second study objective was to evaluate the tradeoffs between fishing quality and economic expenditures of the black bass fishery at Neely Henry Reservoir in northeast Alabama. Specifically, I examined the relationships between tournament and non-tournament angler effort with the size structure and abundance of both species using an equilibrium age-structured simulation model and used an economic sub-model to evaluate the annual direct expenditures produced by both sectors of angler effort.

Methods

I developed an equilibrium age-structured simulation model to assess the tradeoffs between fishing quality and economic expenditures as a function of sector-specific (tournament and non-tournament) angler effort. Indicators of fishing quality consisted of predictions of the abundance of the preferred (381 mm) and memorable (508mm) size classes of ALB and LMB in the simulated bass population. Lastly, an economic sub-model was incorporated to predict the economic impact of angler effort using the average direct expenditures from tournament and non-tournament trips collected in Chapter 2.

To understand how sector-specific angler effort could affect the fishery and economy I executed the simulation across five different scenarios representing a range of tournament effort where non-tournament effort was allowed to vary in response to tournament effort. This relationship between tournament and non-tournament effort was documented in Chapter 2 and was used to inform the five scenarios including Neely Henry's current estimated tournament and non-tournament angler effort. A sensitivity analysis was executed to assess the performance of the fishery under several recruitment, natural mortality, and tournament mortality variables across all scenarios.

Model Structure and Parameter Values

The model simulated age-structured LMB and ALB fish stocks, both with their own corresponding life history parameters. Life history parameters that were incorporated in the simulation include longevity, natural mortality, growth, maturity, and recruitment. Fish growth parameters included asymptotic length (mm, $L\infty$), the growth/metabolic coefficient (K), time at which length is theoretically zero ($t0$), and age (a), were obtained from the ADCNR Neely Henry management reports (Holley et al. 2022). The model included ages 1 through 12 for both species with the oldest age class serving as an accumulator group for fish 12 years and older. Equilibrium recruitment to the first age class (age 1) was generated as a function of spawning stock biomass using the Ricker stock-recruitment model. The average unfished recruitment (R0) for LMB was set to 1.0 as an arbitrary population-scaling factor. The R0 for ALB was 0.8 with to achieve the desired species ratio that reflected the average ratios observed from annual ADCNR standard electrofishing surveys since 2013. The functional form of the spawner-recruit relationship is uncertain for these species; thus, both the Ricker and Beverton-Holt stock recruitment models were included in our sensitivity analysis. The maximum reproductive rate (alpha_hat) of the stock recruitment model that determines per capita recruitment rates at low population size was taken from a published metanalysis of spawner-recruitment analyses (Myers et al. 1999) (Table 1).

Spawning stock biomass was calculated as the product of age-specific abundance and mature body mass. The probability of maturity was estimated as a logistic function of fish length. Length at 50% maturity (L50_mat), and the steepness parameter of the maturity curve (h_mat) was derived from published literature values. Body mass was predicted as a function of mean length at each age class via a standard length-weight regression. Mean length was obtained as a function of age using the von Bertalanffy growth model.

Equilibrium abundance of each species was obtained by applying natural and fishing mortality rates to each age class. Total instantaneous mortality was modeled as the sum of instantaneous fishing and natural mortality rates. Fishing mortality was partitioned into tournament and non-tournament mortality. Non-tournament mortality was partitioned into harvest mortality and catch-and-release mortality. Harvest mortality was modeled as the product of an instantaneous non-tournament capture rate and the probability that a captured fish would be retained for harvest (i.e., retention rate). non-tournament catch-and-release mortality was obtained as the product of the non-tournament capture rate, the voluntary release rate (1 – retention rate), and a non-tournament post-release mortality rate. The instantaneous tournament mortality rate was obtained as the product of the tournament capture rate, and the tournament post-release mortality rate. Post-release mortality was assumed to consist of direct mortality due to capture and any delayed mortality that may occur after release.

The instantaneous fully vulnerable capture rates were modeled as the product of sector-specific fishing effort (trips), a sector specific effort multiplier, and species-specific catchability. Sector-specific fishing effort was a user-specified quantity that was used to generate different fishing/management scenarios. The sector-specific effort multiplier term was included to account for the fact that tournament trips are longer on average than non-tournament trips and therefore impose more captures upon the population per angler trip. Finally, species-specific catchability was included to scale fishing effort to the instantaneous capture rates. This catchability term was tuned such that under target baseline fishing effort levels, model-predicted capture rates for each species reflected the observation from our tagging study that ALB experience higher capture rates than LMB at Neely Henry Reservoir.

Age-specific capture rates for each sector were calculated as the product of the sector-specific fully vulnerable capture rate and an age-based vulnerability to capture. tournament and non-tournament capture rates varied across different age classes using a length-based vulnerability function. I assumed that vulnerability of each species to capture, weigh-in, and harvest were determined solely by their respective length relative to a target size threshold and not by any other inherent characteristic of the species. Fish were assumed vulnerable to capture at 150mm, vulnerable to non-tournament mandatory release and tournament release between 150 and 304 mm, and vulnerable to harvest, voluntary non-tournament release, or tournament weigh-in at 305mm or above. By incorporating age-specific vulnerability to capture, the simulation model allowed fishing mortality to vary across age classes. The model protected fish from harvest if they were under the simulated minimum length at first capture.

Populations of both species were modeled separately over time but exposed to the same tournament and non-tournament fishing effort. Fishing effort determined the annual capture and mortality rate of each species in each sector (tournament or non-tournament effort). The sector specific capture and mortality rates account for differences in fish handling and subsequent post-release mortality. For example: tournament capture and mortality rates account for a bass being held in a live well, transported in a weigh-in bag, handled, weighed in at a tournament station, and released at the boat launch. non-tournament capture and mortality rates account for being angled and promptly released or harvested. Some fraction of non-tournament releases will die according to a post-release mortality rate that was lower than the tournament post release mortality rate (Allen et al. 2004). Natural, tournament and non-tournament mortality estimates used in our simulation were informed by our current reward/radio tagging study being conducted and corresponded to length-at-age specific capture and vulnerability rates.

Stochastic variation was not introduced into the model because interannual variability is not of interest in this study. The age-structured simulation model was constructed and executed in the statistical computing software R (Version 4.3.2 2(023-10-31)).

Performance Indicators

Fishing quality and direct expenditures were used as performance indicators with which to assess the outcomes of tournament effort scenarios and evaluate tradeoffs. Fishing quality was chosen as an indicator of overall fishery performance because stakeholders are primarily concerned about the abundance of black bass in the Preferred (381mm) to Memorable (508 mm) size classes relative to a baseline abundance estimate after annual angler effort and mortality were applied. The abundance of preferred and memorable black bass was obtained by summing over age classes. This was the product of age specific abundance and the proportion of each fish's age class that exceeds each size threshold (381mm and 508mm. The proportions were predicted from a cumulative normal distribution with mean length taken from the von Bertallanfy growth model predictions and assuming a coefficient of variation in length given age of 10%, which matches the observed variation in length given age for these species (Holley et al. 2022).

Direct expenditures were chosen as an indicator of economic performance because it could be collected from all bass anglers during our survey and correlated with a range of tournament and non-tournament angler effort. In Chapter 2, I collected individual angler trip expenditure data for both tournament and non-tournament trips. The total trip expenditures comprised the average costs of boat and vehicle fuel, lodging, food, and tackle expenses. These data were incorporated into the simulation model as a weighted average, considering differences between weekend and weekday expenditures. Average individual pre-fishing trip expenditures were incorporated into a proportion of the annual tournament expenditures to reflect the pre-fishing effort and expenditures that coincides with tournament-related fishing. The economic sub-model generated annual direct expenditures by multiplying the quantity of annual tournament and non-tournament angler effort in each scenario by the average, weighted, tournament and non-tournament individual angler trip expenditures.

Simulation Scenarios

Neely Henry Reservoir had one partial creel survey conducted in 2013 by ADCNR, therefore, annual fishing effort is relatively unknown for this system. Due to the lack of reservoir-specific information, I obtained management plan/creel data from 16 reservoirs in four states (Table 2) to estimate Neely Henry's baseline angler effort. Reservoir surface area ranged from 897 ha (Coleto Creek, Texas) to 73491 ha (Toledo Bend, Texas-Louisiana). Reservoirs with a minimum of 30% of their annual fishing effort targeting black bass were considered for inclusion (Smith et al. 2024) therefore, these lakes represent popular black bass fisheries and thus were not a random sample of fisheries. Reservoirs included in the annual effort estimate were Amistad (TX), Choke Canyon (TX), Coleto Creek (TX), Conroe (TX), Dora/Beauclair (FL), Eufaula (AL/GA), Falcon (TX), Fork (TX), Graham (TX), Guntersville (AL), Millers Ferry (AL), O H Ivie (TX), Sam Rayburn (TX), Toledo Bend (TX), Travis (TX), and Watts Bar (TN).

These reports included the annual black bass angler effort (hours) and were divided by the reservoirs surface area (ha) to obtain angler effort per hectare per system. From these reservoirs, I calculated the mean value of angler hours per hectare and multiplied this value by the surface area (ha) of Neely Henry Reservoir to obtain a baseline estimate of annual black bass angler hours. In Chapter 2, I estimated NH to consist of 35% tournament and 65% non-tournament black bass angler effort based on my roving creel data and weighted average analysis for boat activity on the reservoir. Therefore, annual hours were divided into tournament and non-tournament angler effort by this proportion to produce sector specific annual angler effort. Lastly, tournament and non-tournament angler hours were divided by the weighted tournament (5.74 hours) and non-tournament trip (5.36 hours) length calculated in chapter 2 to obtain annual tournament and non-tournament black bass trips at Neely Henry Reservoir.

I tested five different fishing effort scenarios that represented a range of hypothetical tournament effort at Neely Henry Reservoir (Table 3). The middle scenario was the baseline scenario set to represent predictions of current tournament and non-tournament effort at Neely Henry Reservoir. The other four scenarios involved a 50% and 25% reduction in tournament effort from the baseline, and a 50% and 100% increase in tournament effort relative to the baseline. After fixing the tournament effort values for each scenario, non-tournament effort was allowed to vary in response to tournament effort based on the changes in non-tournament angler effort documented during contingent behavior questions in Chapter 2. For example, when tournament effort was hypothetically doubled, anglers indicated a 22% decrease in their non-tournament trips (Ch. 2, Figure 8). This percent change in non-tournament effort was applied to the baseline estimate of non-tournament angler effort to obtain the four combinations of angler effort for the four simulation scenarios around Neely Henry's estimated annual angler effort.

While survey questions asked how angler's non-tournament effort was specifically affected at a 100% increase and 50% decrease in tournament effort, I hypothesized a linear relationship between non-tournament angler effort at a 50% increase and 25% decrease in tournament effort. Specifically, I extrapolated non-tournament contingent behavior responses to predict non-tournament angler effort at a 50% increase and 25% decrease in tournament effort. By incorporating survey-informed angler effort scenarios (Table 3), which highlight the social interactions between tournament and non-tournament anglers, I was able to simulate realistic scenarios of angler effort that may be of interest to fisheries managers. Utilizing a range of angler effort allows us to evaluate the tradeoffs of our performance indicators in response to the angler effort scenarios.

Sensitivity Analyses

The functional form of the spawner-recruit relationship is uncertain for these species. Thus, I ran the model under two spawner-recruit models: the Beverton-Holt model and the Ricker model. The Ricker stock-recruitment model exhibits a dome-shaped, over-compensatory relationship (Ricker 1975), whereas The Beverton-Holt model is asymptotic. The baseline abundance estimates reported in the results utilize the Ricker stock recruitment model, but all effort scenarios were executed under both models. In addition to varying the functional form of the spawner-recruitment model, I allowed the maximum reproductive rate (alpha_hat) to vary by increasing and decreasing the value by fifty percent. Populations with a higher productivity parameter exhibit higher reproductive rates at low spawning stock and therefore are more resistant to higher fishing mortality rates.

A twenty percent increase and decrease in natural and tournament post-release mortality rates were applied to the simulated fishery to reflect the range of natural and tournament-associated post-release mortality documented for black bass species in the southern United States (Allen et al. 2008). Testing a variety of mortality estimates allowed me to understand their possible effects on the size structure and abundance of the simulated fishery.

Due to the variability in published social interactions among tournament and non-tournament fishing effort, I conducted five additional effort scenarios across the same range of tournament effort, but annual non-tournament effort remained constant using the baseline non-tournament effort estimate for Neely Henry (Table 4). I tested this to investigate the perception from stakeholders that non-tournament fishing effort may not be affected by any range of tournament effort despite what past literature and my survey suggests. This analysis assumes that changes in tournament effort on a reservoir do not impact non-tournament angler effort. Abundance of preferred and memorable black bass as well as annual direct expenditures were recorded for every sensitivity analysis across all effort scenarios.

Lastly, I evaluated the elasticity of preferred and memorable bass abundance to variation in tournament mortality (Tmort), natural mortality (Natmort), and maximum reproductive rate (alpha_hat). I focused on assessing these variables' elasticity under two of the five tournament effort scenarios: when tournament effort doubled (100%) and when it halved (-50%). The magnitude of the deviation from zero, either in the positive or negative direction, in Table 5 indicates the model parameter's elasticity in influencing bass abundance. A higher elasticity value signifies a more substantial impact on the performance indicator.

Results

Across reservoirs in my literature analysis, the average tournament and non-tournament angler hours per hectare were 4.90 and 10.46 hours, respectively (Table 2). Applying these values to Neely Henry Reservoir's surface area of 4546 ha, I calculated the annual tournament and non-tournament angler hours to be 24,432 and 45,374 hours for a sum of 69,807 annual hours. Weighted average tournament trip length was 5.74 hours which produced 4257 annual tournament trips at Neely Henry. Weighted average non-tournament trip length was 5.36 hours which produced 8465 annual non-tournament trips at Neely Henry. Total annual black bass effort was 12722 trips. These effort values were used as the baseline angler effort estimate that I applied to the simulation model (Table 3).

Fishing quality, represented by the abundance of both the preferred and memorable size classes were negatively related to fishing effort under both stock recruitment models (Figures 2 & 3). Under the Beverton-Holt stock recruitment model (Figure 2 & 3; bottom row), I observed similar abundance trends as the Ricker model (Figure 2 & 3; top row), although with wider fluctuations in size class abundance.

When non-tournament effort was held constant across tournament effort scenarios (Table 4), I found that lower tournament effort scenarios led to fewer total angler trips, as non-tournament anglers did not compensate in contrast to the survey results found in Chapter 2. Conversely, increased tournament effort scenarios resulted in more total annual angler trips, as non-tournament effort remained unchanged. This contrasted with previous scenarios where non-tournament effort decreased in response to tournament effort increases. Variation in total angler trips were reflected in the percent change in size class abundance in Figures 2 and 3; panels B and D, compared to panels A and C.

When comparing size class abundance responses with varying levels and no change in non-tournament effort across tournament effort scenarios, preferred abundance changed minimally, ranging from a 4.08% increase to a 9.03% decrease when non-tournament effort varied (Figure 2, A), and from a 5.86% increase to a 10.65% decrease when non-tournament effort was held constant across scenarios (Figure 2, B). Wider abundance variation was observed when non-tournament effort was held constant. Memorable abundance was more significantly affected compared to the preferred size class. In summary, both size classes demonstrated wider abundance distributions when non-tournament effort was held constant. This was attributed to larger annual decreases in total angler effort when tournament effort decreased and larger annual increases in total angler effort when tournament effort increased.

After running an elasticity assessment across three model parameters, fishing quality metrics, were most sensitive to changes in tournament mortality over all other model parameters tested across both Ricker and Beverton-Holt stock recruitment models and tournament effort scenarios. Under the Ricker model, the decline in preferred and memorable bass abundance under a 100% increase in tournament effort declined by 0.92% and 0.88% per percentage point change in tournament mortality rate, respectively. Under the Beverton-Holt model, the decline in both preferred and memorable bass abundance declined by 0.76% per percentage point change in tournament mortality rate when tournament effort increased by 100%. Changes in the natural mortality rate had the second highest elasticity for affecting size class abundance. Preferred bass abundance exhibited greater elasticity to natural mortality compared to memorable bass abundance across all tournament effort scenarios and recruitment models. However, a 50% increase in the maximum reproductive rate had a minimal impact on preferred and memorable bass abundance under both stock recruitment models and tournament effort scenarios. Elasticity values for preferred abundance were higher than memorable abundance suggesting that the preferred abundance was more sensitive to changes in the recruitment parameter than the memorable size class abundance (Table 5).

Annual direct expenditures increased with increasing annual angler effort across both non-tournament angler effort response scenarios (Figure 4). At the baseline estimate for Neely Henry, tournament effort generated $863,859.5 in direct expenditures, while non-tournament effort amounted to $663,030.8, totaling $1,526,890. When non-tournament effort was allowed to vary, A 50% decrease in tournament effort led to a 21% increase in non-tournament effort, resulting in $1,232,685 of total annual direct expenditures, a $294,205 annual decrease in total direct expenditures from the baseline. Conversely, doubling tournament effort caused a 22% reduction in non-tournament effort, leading to $2,247,749 in total annual direct expenditures, a $720,859 increase from the baseline (Figure 4).

When non-tournament effort remained constant in response to tournament effort scenarios, I recorded a broader range of total annual expenditures. This occurred because non-tournament effort didn't increase when tournament effort decreased, nor did it decline when tournament effort increased. Consequently, the scenario with the lowest tournament effort resulted in the lowest annual direct expenditures. Conversely, the scenario with a 100% increase in tournament effort yielded the highest direct expenditures, as non-tournament effort remained constant and contributed $663,030.8 consistently across all scenarios in this analysis (Figure 5).

I was able to directly compare both performance indicators simultaneously in Figure 6. Fishing quality and economic performance were inversely related. The figure illustrates the total annual expenditures generated and the percent change in size class abundance in response to each tournament effort scenario under the ricker stock recruitment model. For example: when tournament effort decreased by 25%, the fishery's economic value decreased by 9% or $136,794 and the abundance of preferred and memorable size classes increased by 1.87% and 4.62% respectively.

When non-tournament effort was held constant, expenditures and fishing quality varied more compared to when non-tournament effort was allowed to vary across tournament effort scenarios. Figure 7 illustrates the total annual expenditures generated and the percent change in size class abundance under the ricker stock recruitment model when non-tournament effort was held constant across tournament effort scenarios. When tournament effort decreased by 25%, the fishery's value dropped to $1,320,719 annually, reflecting an economic decrease of 13.51% or $206,171 as well as a fishing quality decline of 2.74% and 6.43% respectively for preferred and memorable size class abundance.

To further understand the fishing quality and economic trade-offs within the fishery, I assessed the percent change in the abundance of preferred and memorable bass caught per dollar annually. In this analysis, I transitioned the performance indicator from abundance to bass caught to align with the effort scale influencing direct expenditures. Moreover, I used bass caught divided by annual direct expenditures to obtain bass caught per dollar. As annual effort decreased, fishing quality increased while expenditures decreased. Conversely, as fishing effort increased, abundance of bass per dollar decreased, due to abundance decreasing and expenditures increasing (Figures 8 and 9, panels A and C). Additionally, I evaluated the percent change in the abundance of preferred and memorable fish caught per dollar across both recruitment models and both non-tournament angler effort response scenarios (Figures 8 & 9, panels B & D). I observed similar overall trends in bass per dollar under the Beverton-Holt as observed under the Ricker across angler effort response scenarios. Overall, memorable bass per dollar exhibited the widest range of values under the Beverton-Holt stock recruitment model when non-tournament effort remained constant (Figure 9, D), ranging from a 73.1% increase to a 51.6% decrease across tournament effort scenarios.

Discussion

The results from this research indicate that the relationship between fishing quality and the collective direct expenditures produced by the fishery are relatively linear. This finding suggests that there is likely not a “win-win” management scenario in which good economic performance and high fishing quality could be achieved simultaneously. The relationship between fishing quality and angler effort on the performance indicators was steeper for memorable bass than preferred due to relative abundance in the population. There are typically more preferred black bass in a population than memorable, therefore, changes in angler effort and related mortality was reflected more in the larger, less abundant, memorable size class. These trade-offs suggest that if the reservoir is to be managed for a high-quality black bass fishery, fishing related direct expenditures will have to be sacrificed and/or fish care will have to continue to improve to decrease post-release mortality and support larger age classes such as memorable fish (Allen et al. 2004, Schramm and Gilliland 2015, Kerns et al. 2016).

Conversely, if the reservoir is to be managed for improved economic performance, an increase in tournament effort will achieve this goal, but lower fishing quality would need to be tolerated. For example, the change in black bass abundance above 15 inches ranged from a 1.87% increase to an 11%, decrease under a 25% decrease or a 50% increase in tournament effort, respectively. It is worth entertaining whether changes in black bass abundance of this magnitude would be easily detected by anglers given the high variation in daily catch rates over time in these systems.

Understanding LMB and ALB recruitment life history would provide further confidence when taking a simulation approach to estimating the abundance and quality of black bass fisheries. Simulating both the Ricker and Beverton-Holt stock recruitment models revealed differences in estimates that could be significant to the quality of a fishery. For example, at a 50% decrease in tournament effort, preferred abundance increased by 4% under the Ricker model but 8.88% under the Beverton-Holt. Both models have differing baseline estimates, but this is a 117% difference between models in the same scenario (Figure 1, A & C). All analyses conducted under the Beverton-Holt stock recruitment model had higher variation in abundance across scenarios compared to the Ricker model. Unfortunately, no published studies have estimated stock-recruitment parameters for these two species. Nevertheless, my quantitative conclusions regarding the trade-offs held regardless of the functional form of the stock-recruitment relationship.

Black bass fisheries in the southern Unites States have transitioned to primarily catch and release where they may have influential impacts on the fishery, but creel data is only beginning to adapt to documenting this change in stakeholder priorities (Neiman et al 2021). Given these considerations, it may be practical for survey efforts to prioritize or incorporate the collection of effort and sociodemographic data from stakeholders of black bass fisheries, specifically in fisheries with high tournament effort. This approach could offer insight into anglers impacts on the fishery and modern-day priorities, as management agencies attempt to evolve with their participants. Notably, black bass tournament anglers have been notoriously difficult to document considering the unique framework of tournaments (early morning take-offs and fast-paced weigh-in events), as well as tend to be as socioeconomically diverse as the variety of tournaments available to participate in (Maceina et al. 2019). While acknowledging these limitation's impact on the other system's applicability, it's worth noting that the relative changes in abundance and expenditures remain consistent regardless of the recruitment model or literature-based estimates of baseline effort. However, for comprehensive economic assessments, the study's reliance on literature-based values for effort presents limitations.

Differences in simulated interactions between tournament and non-tournament angler effort affected model predictions of size class abundance and annual expenditures. Specifically, responses of size class abundance to changes in tournament effort were dampened in scenarios that included a negative interaction between T and NT effort. This finding resulted from simulated increases in non-tournament angler effort in response to decreases in tournament effort (and vice versa), which offset some of the improvement in size class abundance under lower tournament effort. I implemented this negative interaction between T and NT effort because it was consistent with angler survey responses from Chapter 2. However, this relationship depends on intended responses by anglers and not observed responses. This raises the question: Would stakeholders perceive a reduction in annual tournament events on the reservoir and subsequently increase their angler effort? What degree of decrease in tournament activity would be noticeable by non-tournament anglers, prompting them to utilize boat ramps more frequently on weekends, for example? Future studies should seek to conduct field studies to observe actual angler responses to variation in tournament effort if such opportunities arise from implementation of regulations that limit tournament activity.

Model predictions of expenditures and size class abundance do not consider shore anglers, anglers targeting other species, or anglers that are not currently visiting Neely Henry Reservoir. Mckee (2013) documented black bass shore angler effort to be minimal, making up 0.39% of all black bass angler effort at Lake Guntersville. Therefore, the lack of shore angler documentation is not concerning. Although, angler surveys from Chapter 2 likely missed anglers that have already left the black bass fishery at Neely Henry Reservoir due to either poor angling quality or the large amount of tournament activity. Recreational displacement refers to the ways in which stakeholders may modify their behavior in response to various perceived social and environmental pressures such as resource crowding and changes in resource conditions (fishing quality). In response to these pressures, anglers may change where, when and how much they fish (Hayes and Lovelock 2019). Consequently, the model may underestimate the increase in non-tournament effort under decreased tournament effort because I was not able to assess the potential number of latent non-tournament effort that may re-enter the fishery if conditions improved. However, model predictions could be improved by broadening the population of anglers surveyed in Chapter 2 to include anglers targeting other species at Neely Henry Reservoir or anglers that are not currently fishing the reservoir.

This study does not provide a comprehensive estimation of the economic impact on the economy surrounding Neely Henry Reservoir. Several studies including Boozer et al. (2019), Snellings (2015), and Myles and Swaim (2010) apply a multiplier effect to direct expenditure data to further interpolate the indirect and induced economic impact to the local economy surrounding the body of water as well as utilize economic assessments such as the travel cost model to formulate a broader impact of the tournament fishery. Regardless, direct expenditures are the foundation for further economic speculation and serve as an appropriate indicator of economic performance documented in many reservoir management plans and common economic analysis practices (Norman et al. 2021; Botta 2023).

Increasing the documentation requirements and/or registration of tournaments is becoming a more common in black bass fisheries with high tournament effort (Goniea 2022). As of 2019, the state of Michigan has required all fishing tournaments to register their event on an online database. This system has helped both tournament organizers, recreational anglers, and boaters avoid ramp conflicts as well as allows for tournament organizers to collaborate with each other and provide pertinent economic, social, and biological information to the state agency, with minimal law/state enforcement. For example: reporting compliance was estimated at 96% due to tournament directors regulating themselves by documenting unregistered tournaments observed at boat ramps (Goniea 2022). Minnesota has moved to regulating the number of tournaments per month based on the size of the waterbody and size of the tournament including denying any tournaments to be held on popular holidays such as Memorial or Labor Day to minimize user conflict (Minnesota DNR 2023). Several states continue to be unregulated and have a narrow idea of how many tournaments are taking place when and where on the waterbodies they manage, making managing the fishery a lot more difficult. Many legislative decisions that affect fisheries are largely constrained by financial and budgetary considerations, therefore, adequately documenting black bass tournaments, a major source of economic and fishery impact, may improve management outcomes.

Numerous economic and biological studies have examined the merits and drawbacks of tournament fishing (Fedler et al. 1991; Allen et al. 2004; Diggles et al. 2011; Driscoll et al. 2012; Poudyal 2022). Across the United States, especially in the southeast, shifts in social dynamics within black bass fishing communities are apparent, alongside persistent stakeholder conflicts, amidst declining license and boating sales (Cooke et al. 2016). This study identified the fishing quality and economic tradeoffs of the black bass tournament fishery at Neely Henry Reservoir that management agencies may need to consider when maximizing the benefits of the tournament fishing industry while also managing for a healthy population with desirable catch rates and size structure. Understanding these trade-offs may allow managers to more effectively communicate the potential risks and benefits of tournaments while considering a range of management options for sportfish populations in reservoirs.

Table 1: Parameter values used in the equilibrium age-structured simulation model to simulate Largemouth and Alabama Bass population at Neely Henry Reservoir.

	Parameter	LMB	ALB	Source
Fishery	Natural mortality	0.38	0.46	ADCNR literature
	Average unfished recruitment	1	0.8	ADCNR literature
	Asymptotic length	546	494	ADCNR literature
	Growth parameter	0.28	0.38	ADCNR literature
	Time at which length was zero	0.5	0.09	literature
	Length-weight parameter (a)	1.5e-5	1.5e-5	Beamesderfer 1995
	Length-weight exponent (b)	3	3	Beamesderfer 1995
	Length at 50% maturity of the population	300	300	literature
	Maturation rate (h_mat)	0.05	0.05	literature
Management	Total annual capture rate	0.8	0.96	2023 AU tagging/telemetry study
	Instantaneous capture rate	0.8	0.96	2023 AU tagging/telemetry study
	MLL capture (mm)	150	150	ADCNR literature
	MLL harvest (mm)	305	305	ADCNR literature
	MLL weigh-in (mm)	305	305	literature
	Tournament mortality rate	0.27	0.27	2023 AU tagging/telemetry study
	Non-tournament mortality rate	0.05	0.05	2023 AU tagging/telemetry study
	Proportion of voluntary release	0.97	0.97	2023 AU tagging/telemetry study
	Individual tournament trip direct expenditures ($U.S)	204.11		Chapter 2
	Individual non-tournament trip direct expenditures ($U.S)	78.05		Chapter 2
	Tournament trip length (hours)	5.74		Chapter 2
	Non-tournament trip length (hours)	5.36		Chapter 2

Table 2: Summary of reservoirs black bass angler effort (hours) included in the baseline annual angler effort estimate for Neely Henry Reservoir. 4.90 hours of tournament effort and 10.46 hours of non-tournament effort were applied to NH's surface area to obtain annual angler effort (hours). "T and NT" angler pertains to tournament and non-tournament angler effort.

Reservoir System	Years	Hectares	Tournament Effort	Non-tournament Effort	Total BB Effort	T Angler Hours per Hectare	NT Angler Hours per Hectare
Amistad (TX)	2018	26264	26794	179310	206104	1.02	6.83
Choke Canyon (TX)	2019	6939	26734	69919	96653	3.85	10.08
Coleto Creek (TX)	2020	897	1091	5958	7049	1.22	6.64
Conroe (TX)	2021	8141	18490	149605	168095	2.27	18.38
Dora/Beauclair (FL)	2020	2211	7669	19200	26869	3.47	8.68
Eufaula (AL/GA)	2017	18284	142941	116952	259893	7.82	6.40
Falcon (TX)	2016	33854	22186	88744	110930	0.66	2.62
Fork (TX)	2018	11033	174228	219379	393607	15.79	19.88
Graham (TX)	2021	970	6614	8166	14779	6.82	8.42
Guntersville (AL)	2012	27964	328100	636900	965000	11.73	22.78
Millers Ferry (AL)	2015	7006	49385	45269	94654	7.05	6.46
O H Ivie (TX)	2001	7749	27348	110268	137616	3.53	14.23
Sam Rayburn (TX)	2018	23363	209727	205226	414953	8.98	8.78
Toledo Bend (TX)	2019	73491	44443	203841	248284	0.60	2.77
Travis (TX)	2018	5067	10447	58832	69279	2.06	11.61
Watts Bar (TN)	2019	15819	23463	202139	225602	1.48	12.78
Mean						4.90	10.46

Table 3: Summary of the angler effort scenarios applied to the fishery in a sensitivity analysis ranging from a 100% increase to a 50% decrease in tournament effort. Non-tournament effort in each scenario is in response to contingent behavior data documented in chapter 2. “NT” refers to non-tournament.

Fixed Tournament Effort Scenario	-50%	-25%	Baseline Estimate	+50%	+100%
Percent change in NT effort	21%	11%	0	-11%	-22%
Tournament effort (trips)	2128	3192	4257	6385	8513
Non-tournament effort (trips)	10243	9354	8465	7534	6603
Total angler trips	12371	12547	12722	13919	15116
Total angler hours	67119	68463	69807	77032	84257

Table 4: Summary of angler effort scenarios applied to the fishery in the sensitivity analysis when non-tournament effort was held constant, ranging from a 100% increase to a 50% decrease in tournament effort. These effort scenarios are conducted under the assumption that tournament effort has no effect on non-tournament effort. “NT” refers to NT effort.

Fixed Tournament Effort Scenario	-50%	-25%	Baseline Estimate	+50%	+100%
Percent change in NT effort	0	0	0	0	0
Tournament effort	2128	3192	4257	6385	8513
Non-tournament effort	8465	8465	8465	8465	8465
Total angler trips	10594	11658	12722	14850	16978
Total angler hours	57591	63699	69807	82023	94239

Table 5: Summary of elasticity analysis conducted across simulation model parameters to analyze possible fluctuations in the preferred and memorable size class abundance of black bass at Neely Henry Reservoir. The performance indicator's elasticity to a 20% increase in tournament and natural mortality, as well as a 50% increase in the maximum reproductive rate (alpha_hat) was calculated across two of the five effort scenarios, a 100% increase in tournament effort and a 50% decrease in tournament effort.

Performance Indicator	Model Parameter	T Effort Scenario	Ricker	Beverton-Holt
Preferred Abundance	*Tmort*	100%	0.92	0.76
	Natmort	100%	-0.60	-0.57
	Alpha_hat	100%	-0.30	-0.10
	Tmort	-50%	1.24	1.20
	Natmort	-50%	-0.67	-0.70
	Alpha_hat	-50%	-0.31	-0.10
Memorable Abundance	*Tmort*	100%	0.88	0.76
	Natmort	100%	-0.35	-0.40
	Alpha_hat	100%	-0.12	-0.06
	Tmort	-50%	1.31	1.29
	Natmort	-50%	-0.42	-0.53
	Alpha_hat	-50%	-0.13	-0.06

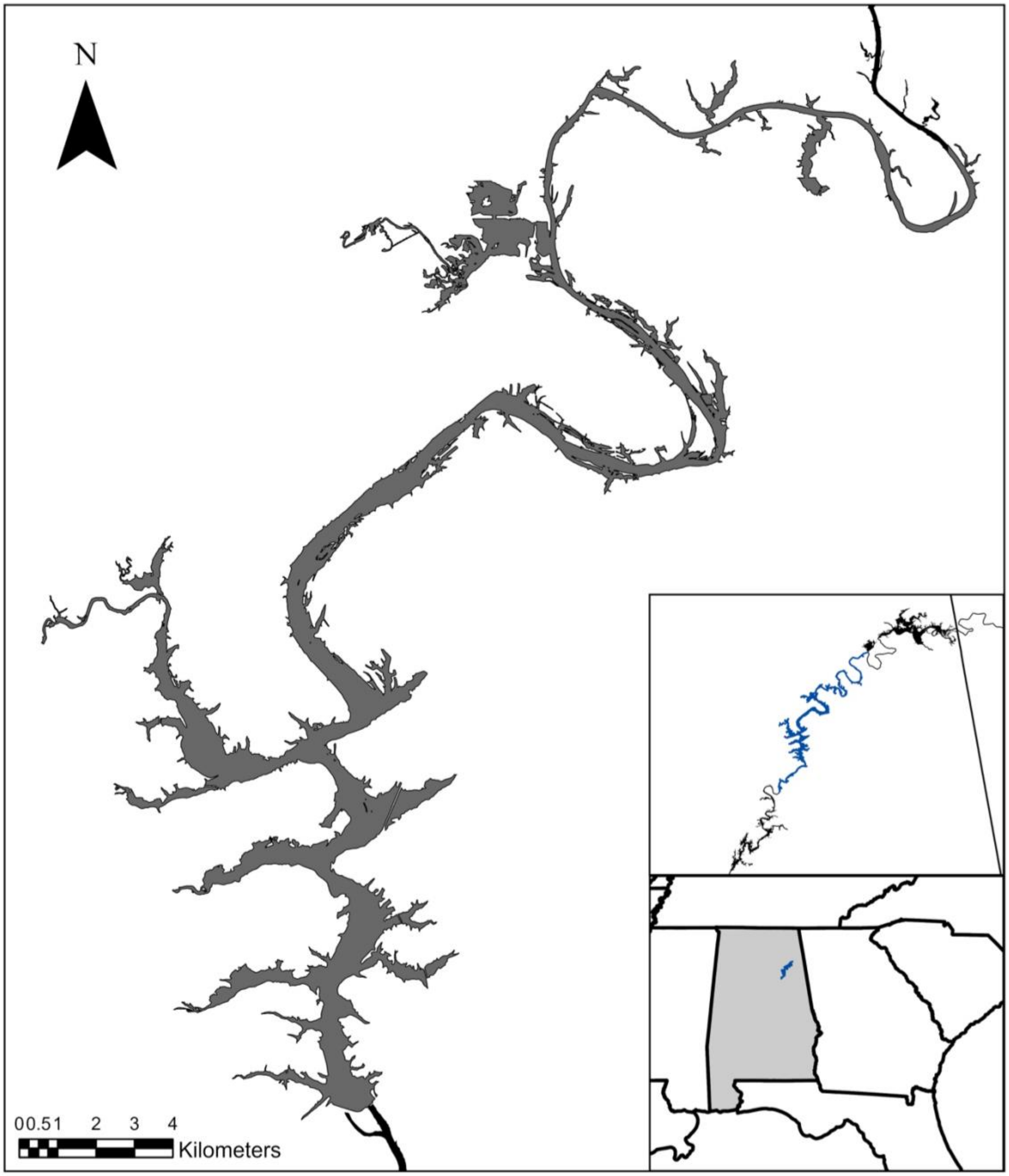

Figure 1: Neely Henry Reservoir in Northeast Alabama, U.S.A. The Coosa River connects Neely Henry to Weiss Lake to the North and flows South through the hydroelectric dam to Logan Martin Reservoir.

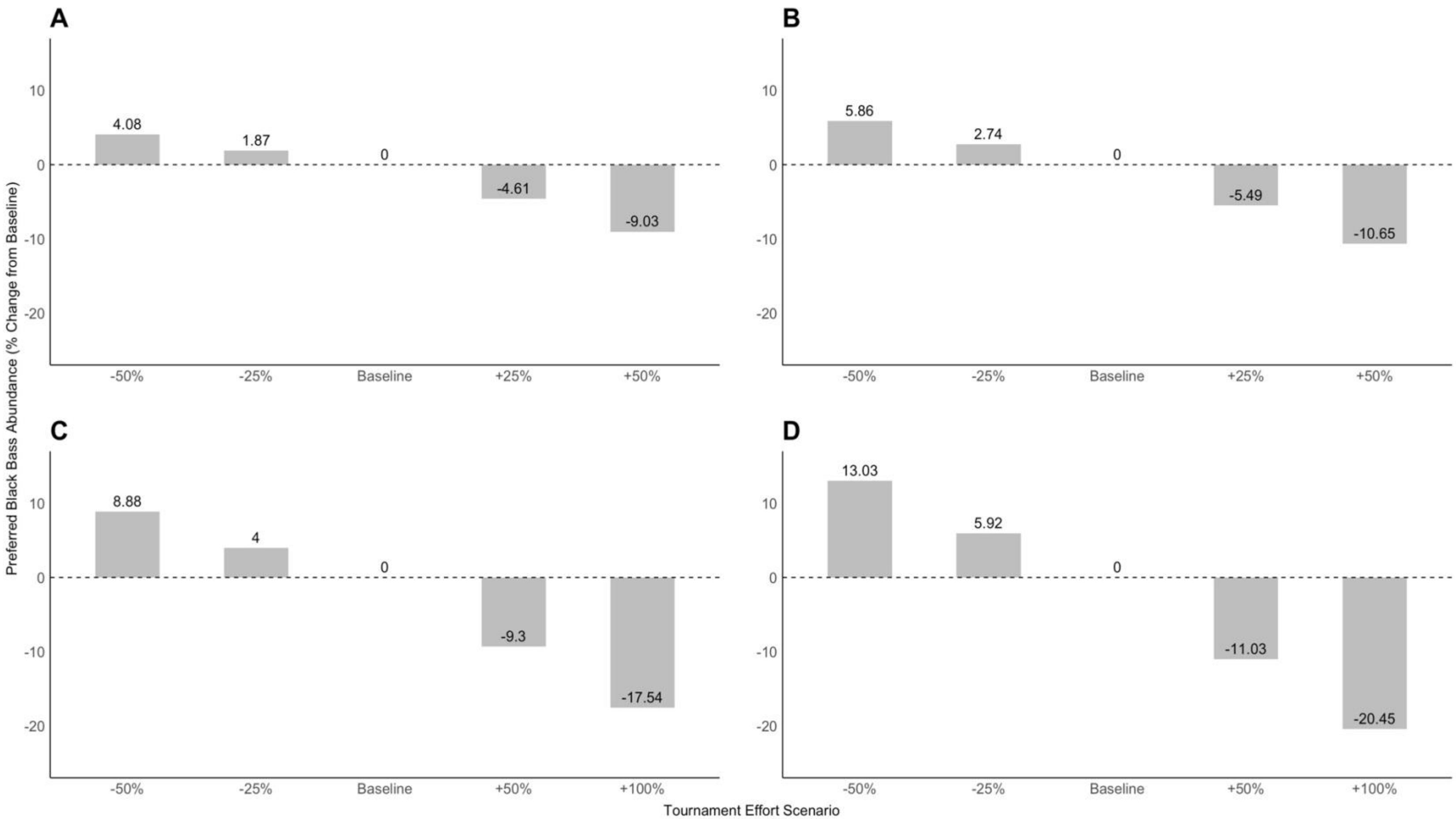

Figure 2: The percentage change in preferred black bass abundance at Neely Henry Reservoir relative to the baseline estimate under increasing or decreasing tournament angler effort scenarios (x axis). The four panels represent the results of running the model under all combinations of Ricker (top row; Panels A, B) or Beverton-Holt spawner-recruitment models (bottom row; Panels C, D), and allowing non-tournament effort to vary in response to tournament effort (left column; panels A, C), or holding non-tournament effort constant (right column; panels B, D).

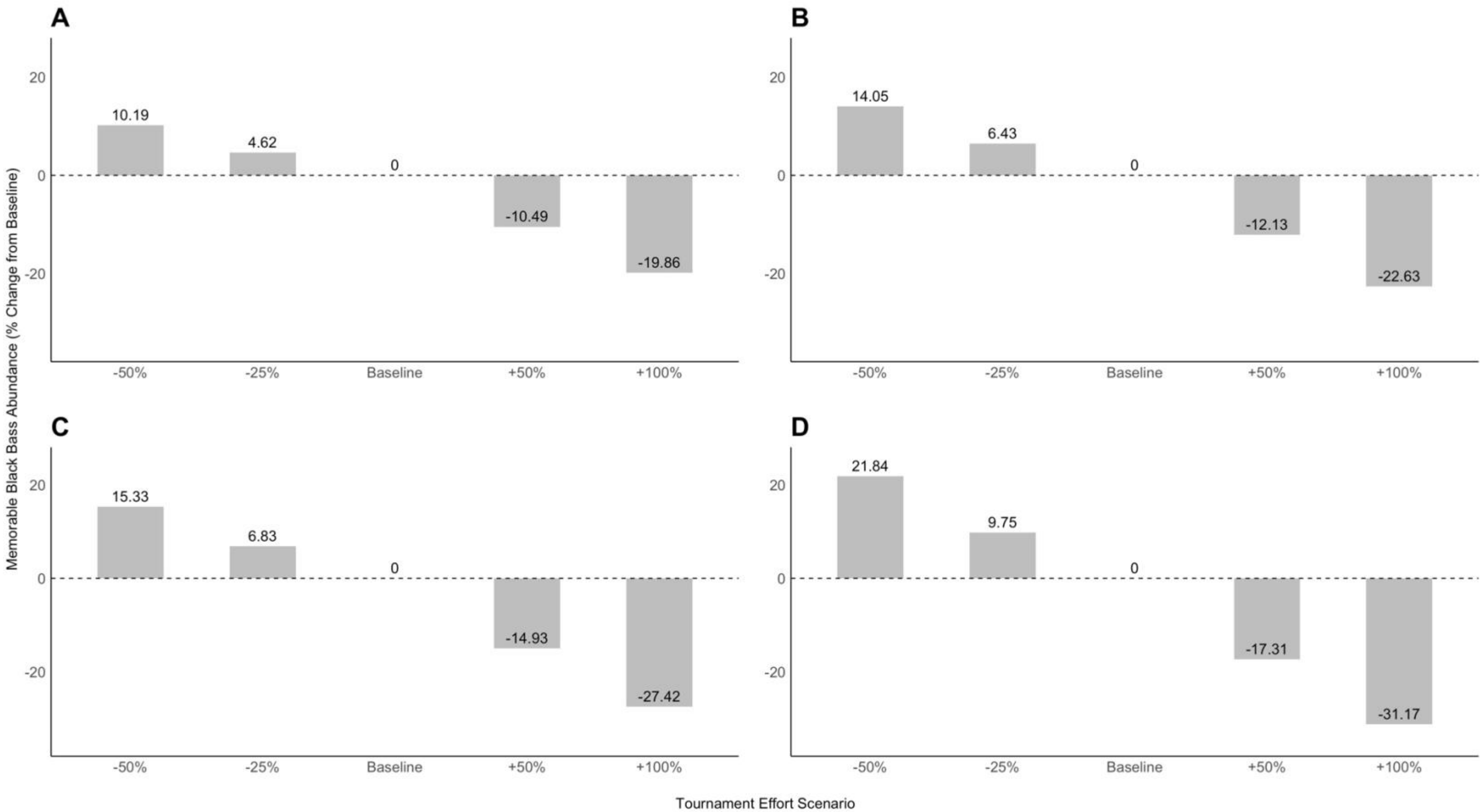

Figure 3: The percentage change in memorable black bass abundance at Neely Henry Reservoir relative to the baseline estimate under increasing or decreasing tournament angler effort scenarios (x axis). The four panels represent the results of running the model under all combinations of Ricker (top row; Panels A, B) or Beverton-Holt spawner-recruitment models (bottom row; Panels C, D), and allowing non-tournament effort to vary in response to tournament effort (left column; panels A, C), or holding non-tournament effort constant (right column; panels B, D).

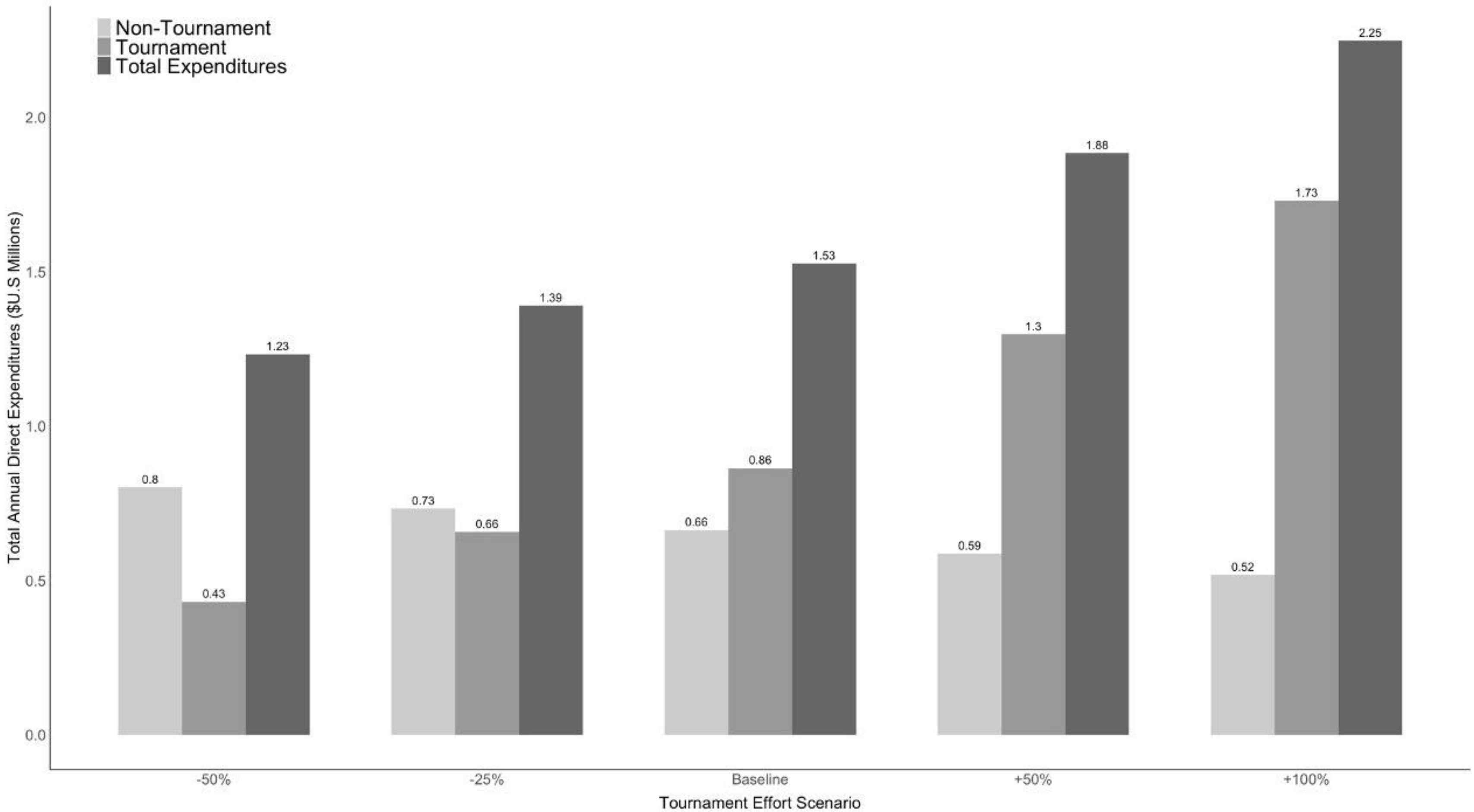

Figure 4: Non-tournament, tournament, and total annual direct expenditures across tournament effort scenarios when non-tournament effort was allowed to vary in response to tournament effort (Table 3). The baseline economic value of the Neely Henry black bass fishery is depicted in the middle, represented by "Baseline".

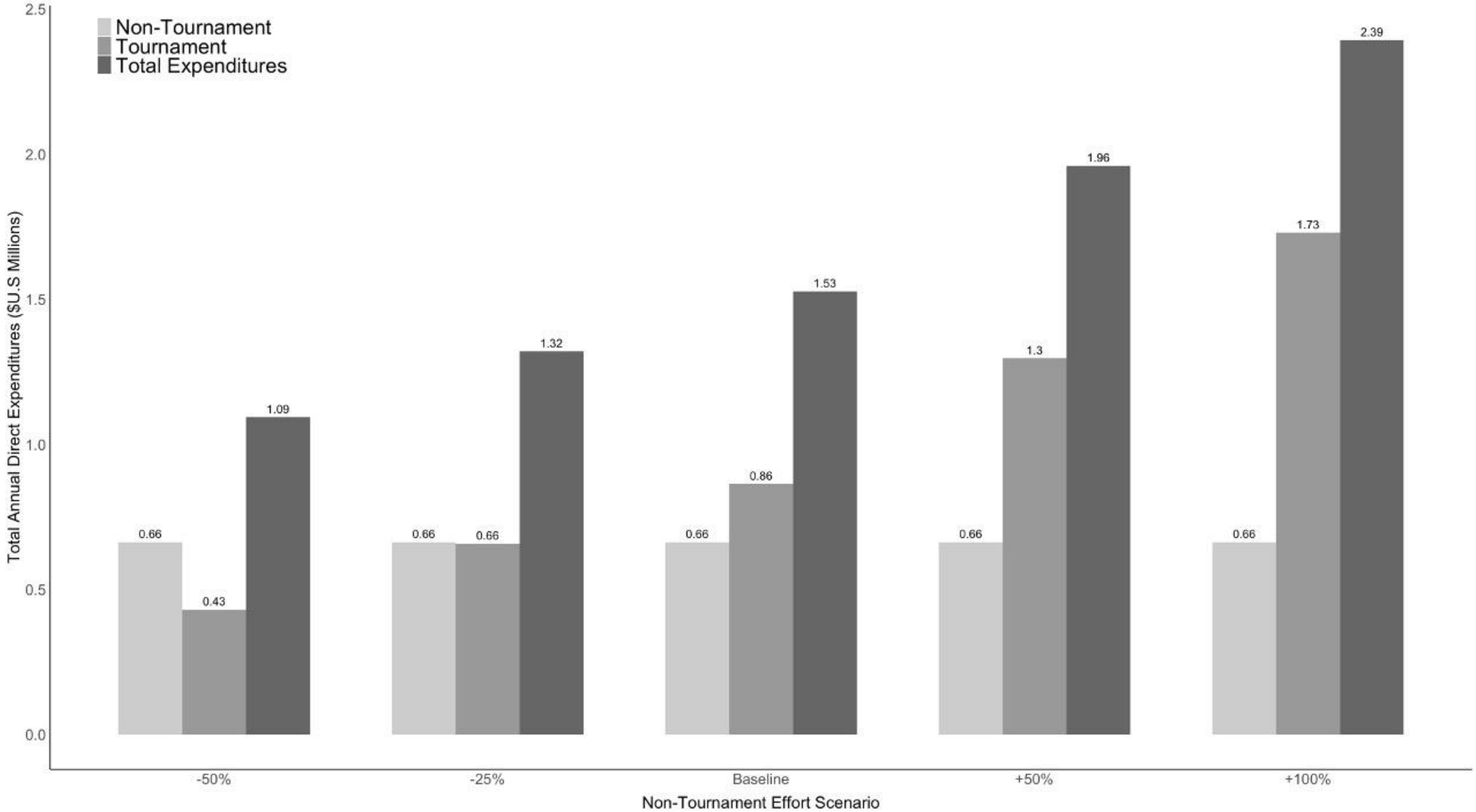

Figure 5: Non-tournament, tournament, and total annual direct expenditures across tournament effort scenarios when non-tournament effort was held constant (Table 4). The baseline economic value of the Neely Henry black bass fishery is depicted in the middle, represented by “Baseline”.

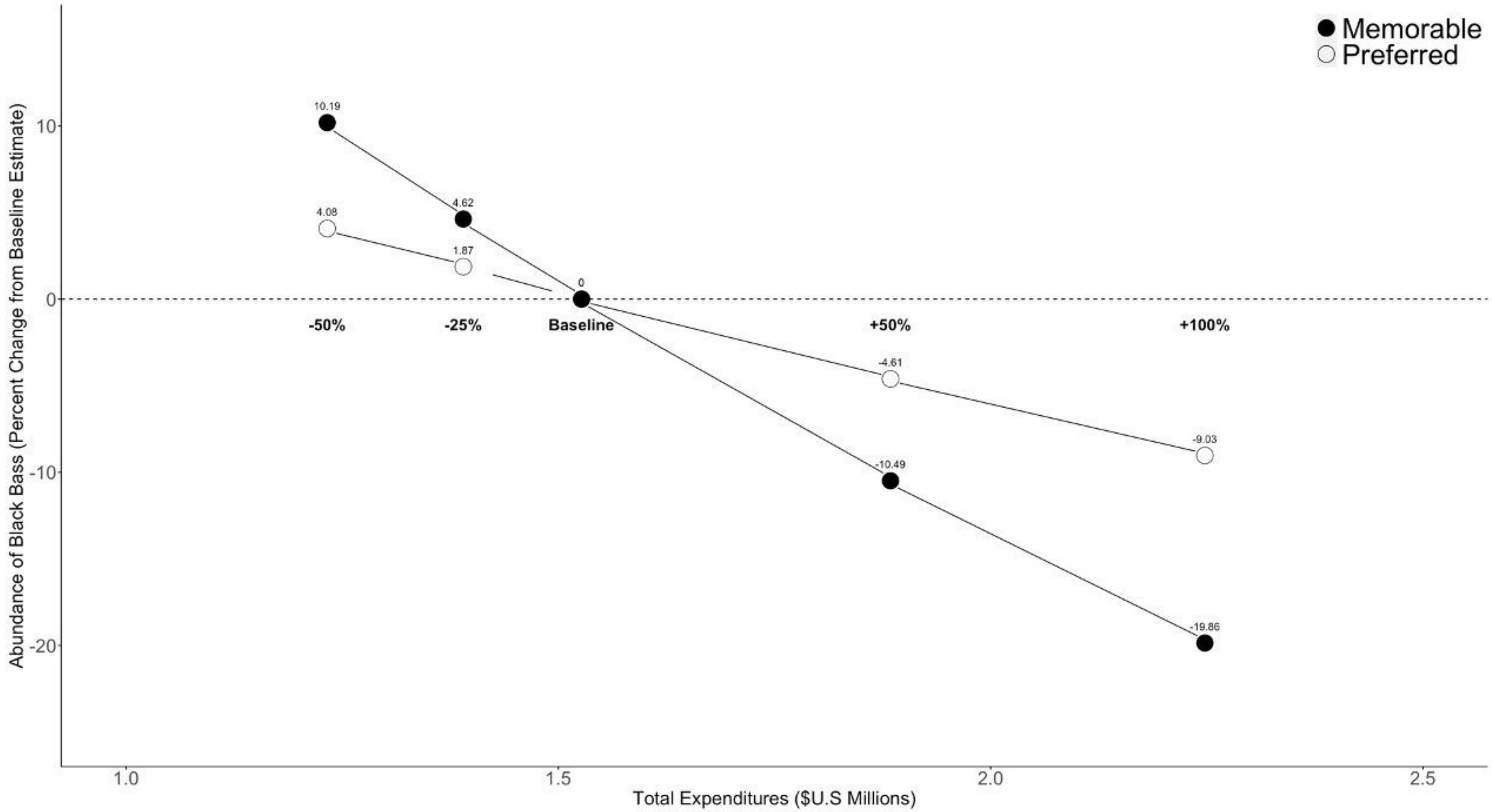

Figure 6: Plot compares total annual direct expenditures and the percentage change in size class abundance relative to the baseline estimate of abundance at Neely Henry Reservoir under the Ricker stock recruitment model. The tournament effort scenario is highlighted in bold across the plot and elaborated upon in Table 3. Non-tournament effort was allowed to vary in response to changes in tournament effort. Values next to the symbols specify the precise percent change in abundance at each scenario.

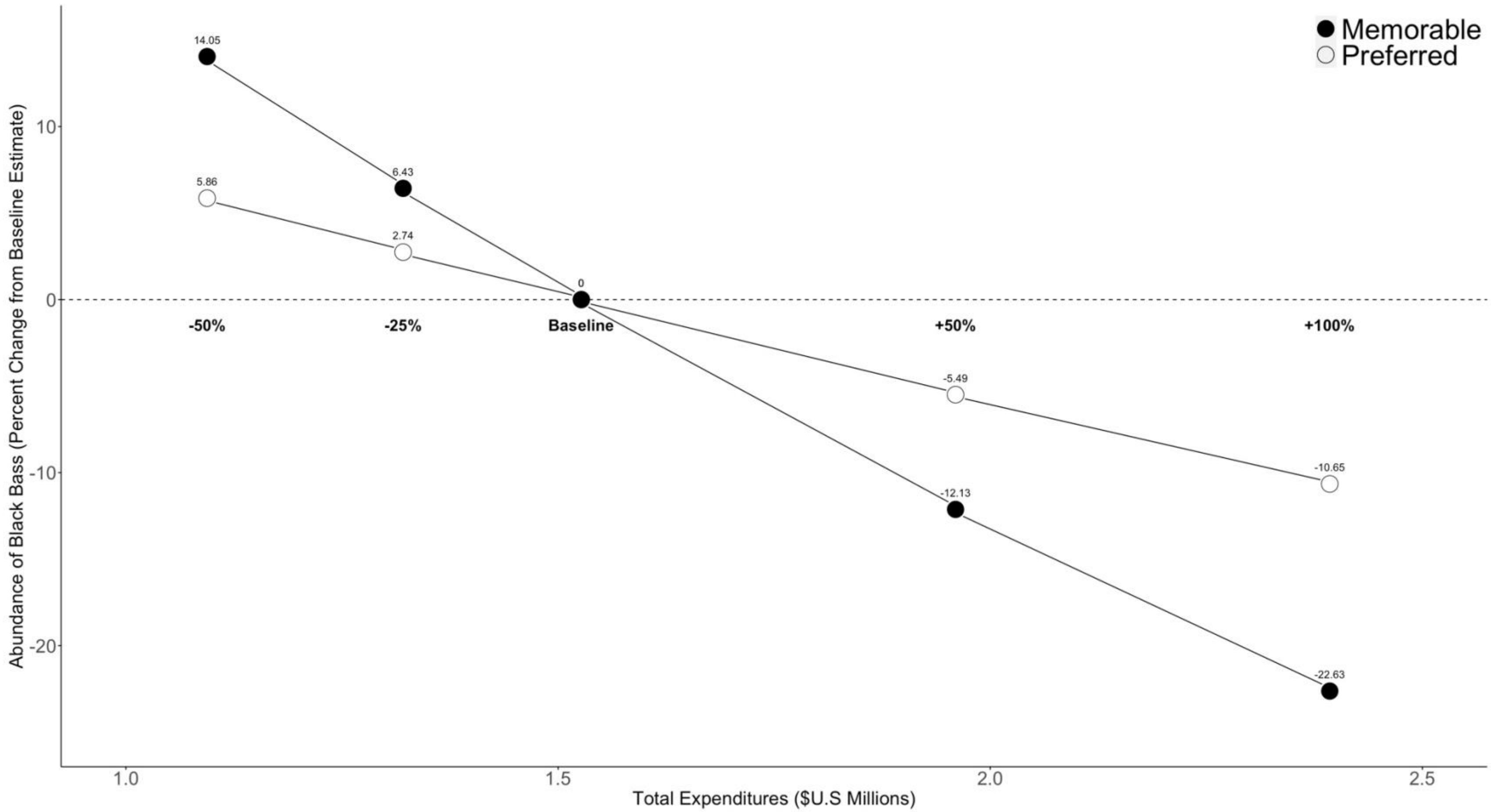

Figure 7: Plot compares total annual direct expenditures and the percent change in size class abundance relative to the baseline estimate of abundance at Neely Henry Reservoir under the Ricker stock recruitment model. The tournament effort scenario is highlighted in bold across the plot and elaborated upon in Table 4. Non-tournament effort was held constant in response to changes in tournament effort. Values next to the symbols specify the precise percent change in abundance at each scenario.

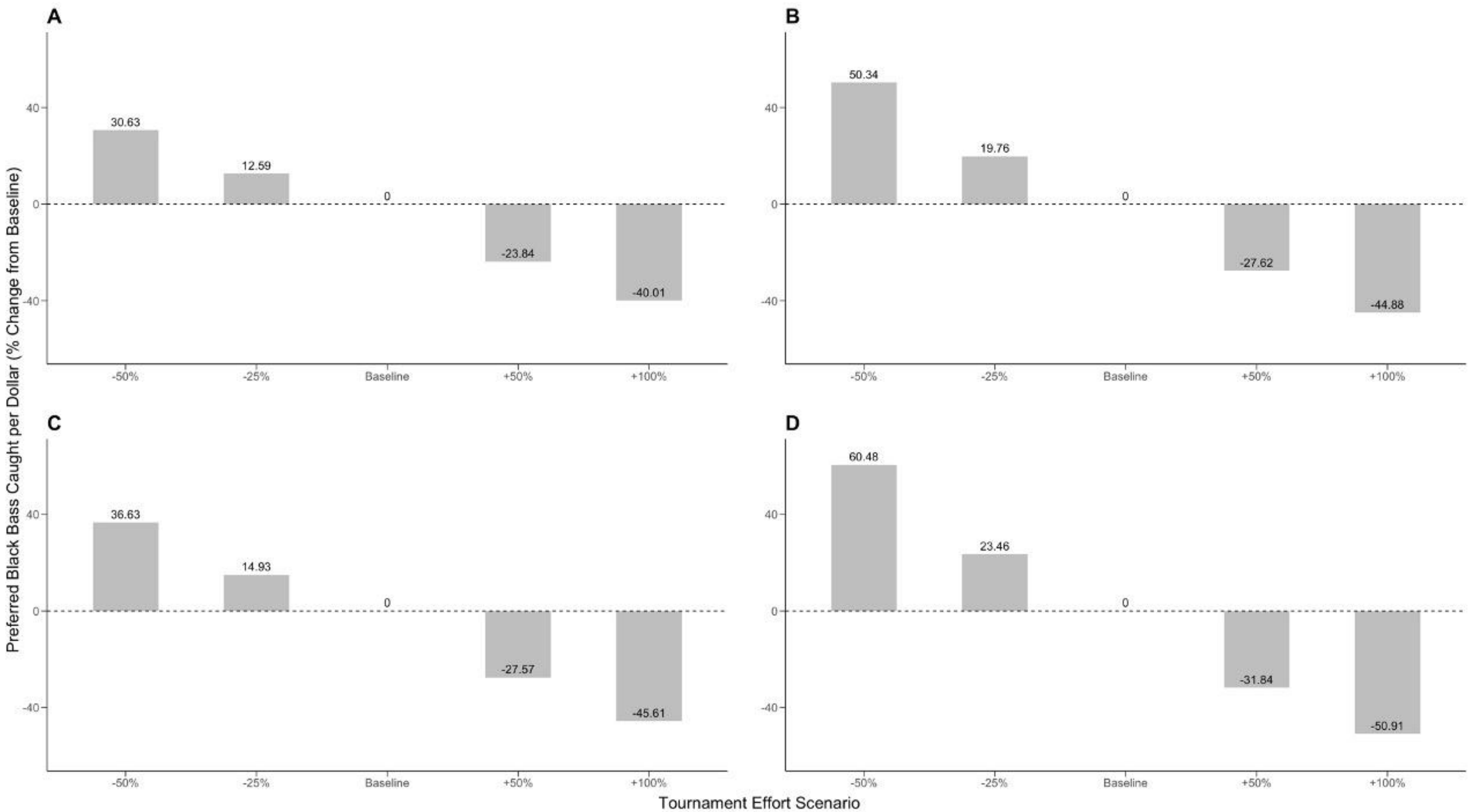

Figure 8: The percentage change in preferred black bass caught per U.S dollar relative to the baseline estimate under increasing or decreasing tournament angler effort scenarios (x axis). The four panels represent the results of running the model under all combinations of Ricker (top row; Panels A, B) or Beverton-Holt spawner-recruitment models (bottom row; Panels C, D), and allowing non-tournament effort to vary in response to tournament effort (left column; panels A, C), or holding non-tournament effort constant (right column; panels B, D).

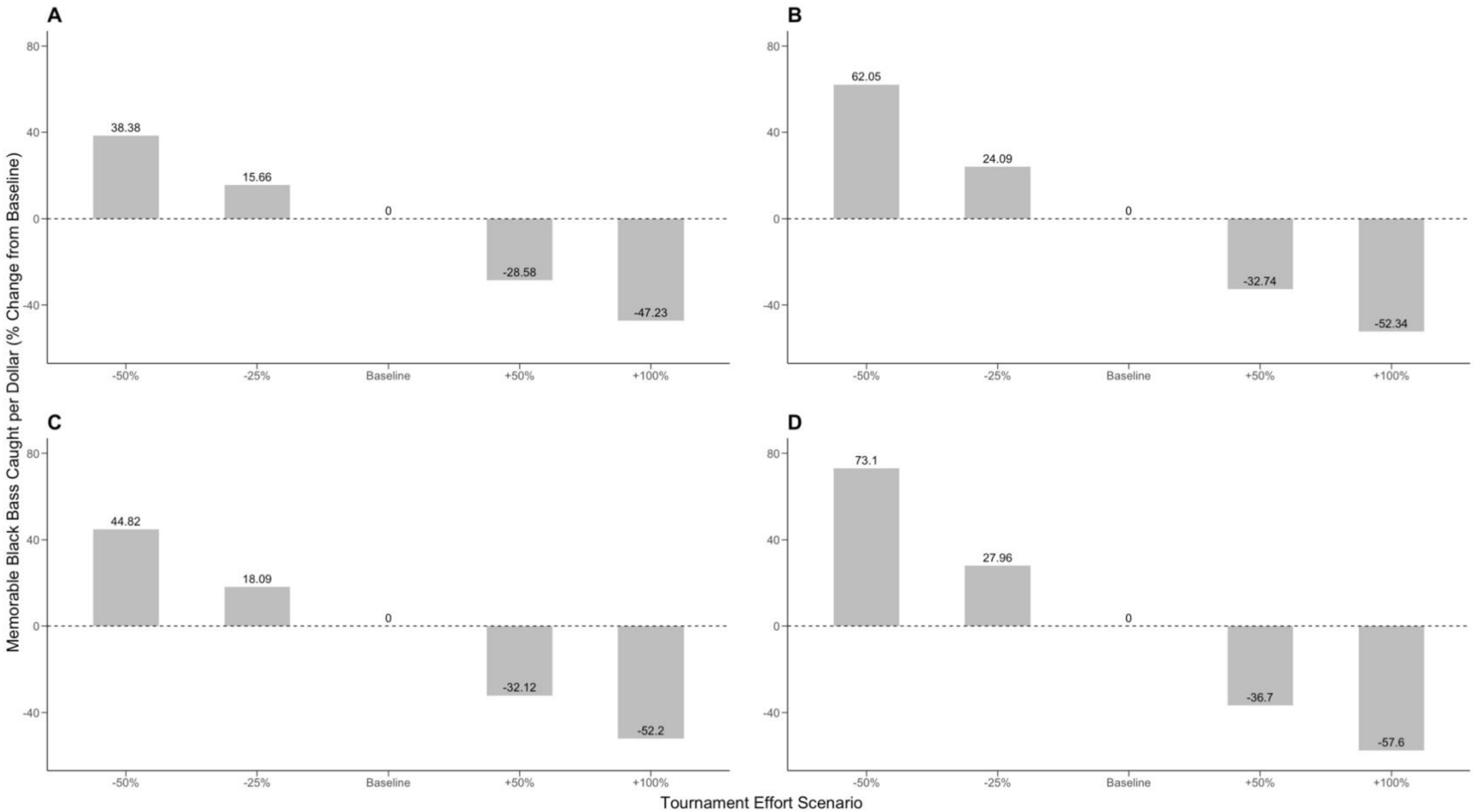

Figure 9: Percentage change in memorable black bass caught per U.S dollar relative to the baseline estimate under increasing or decreasing tournament angler effort scenarios (x axis). The four panels represent the results of executing the model under all combinations of Ricker (top row; Panels A, B) or Beverton-Holt spawner-recruitment models (bottom row; Panels C, D), and allowing non-tournament effort to vary in response to tournament effort (left column; panels A, C), or holding non-tournament effort constant (right column; panels B, D).

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Appendices

A-1: IRB Approved Information Sheet for access point and roving creel angler surveys at Neely Henry Reservoir between March- December 2023.

AUBURN UNIVERSITY

COLLEGE OF AGRICULTURE
SCHOOL OF FISHERIES, AQUACULTURE AND AQUATIC SCIENCES

(NOTE: DO NOT AGREE TO PARTICIPATE UNLESS IRB APPROVAL INFORMATION WITH CURRENT DATES HAS BEEN ADDED TO THIS DOCUMENT.)

INFORMATION LETTER
for a Research Study entitled
"Evaluating Tradeoffs Between Fishing Quality and Economic Performance with Increasing Tournament Effort in an Alabama Black Bass Fishery"
Sponsor: Alabama Department of Conservation and Natural Resources

You are invited to participate in a research study estimating angler use, effort, and economic value, of black bass recreational angling at Neely Henry Reservoir in Alabama. The purpose of this study is to (1) assess the intended behavioral responses of Black Bass anglers to variation in the availability of opportunities to participate in fishing tournaments, (2) estimate the intended behavioral responses of these anglers to variation in fishing quality, and (3) test for differences in average per-trip expenditures between tournament and non-tournament fishing trips. This will help us provide Alabama Department of Conservation and Natural Resources with a means of including fluctuations of black bass fishing quality and economic value to recreational bass angling on Alabama's reservoirs in the future. The study is being conducted by Natalie Coash, M.S. Student, under the direction of Matt Catalano, professor in the Auburn University School of Fisheries, Aquaculture, and Aquatic Sciences. You are invited to participate because you are a Neely Henry bass angler and are age 18 or older.

What will be involved if you participate? Your participation is completely voluntary. If you decide to participate in this research study, you will be asked a series of questions concerning your trip expenses, frequency of visits, and angling behavior in the event of fluctuating bass tournament opportunities and bass fishing quality. Your total time commitment will be approximately 10 minutes. We will record your verbal responses on our passcode protected tablet on a secure software.

Are there any risks or discomforts? The risks associated with participating in this study are disclosure of your opinions and individual trip expenditure data. You will be informed of the potential risk of exposure to COVID-19. To minimize these risks, we will keep your responses confidential, will only report them in aggregate form, and keep an appropriate distance during surveys for your safety.

Are there any benefits to yourself or others? If you participate in this study, you will be helping us provide ADCNR with enhanced understanding of bass angler use on Neely Henry Reservoir and improve ADCNR's ability to value recreational bass fishing opportunities. Participants will not receive any compensation or directly benefit from their participant.

Will you receive compensation for participating? There is no compensation for your participation, only our sincere appreciation.

203 Swingle Hall
382 Mel Street
Auburn, AL 36849-5419

Telephone:
616-375-1224

agriculture.auburn.edu/research/faas/quantitative-fisheries-lab/

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A-1: IRB Approved Information Sheet continued.

Are there any costs? If you decide to participate, there is no cost to you.

AUBURN UNIVERSITY

If you change your mind about participating, you can withdraw at any point during the interview. If you choose to withdraw, your data can be withdrawn as long as it is identifiable. Your decision about whether or not to participate or to stop participating will not jeopardize your future relations with Auburn University or the School of Fisheries, Aquaculture, and Aquatic Sciences.

Any data obtained in connection with this study will remain anonymous. We will protect your privacy and the data you provide by using the secured Qualtrics software database, which prevents sharing outside of those conducting the survey. Information collected through your participation may be used to fulfill M.S. thesis requirements, published in a professional journal, and/or presented at a professional meeting.

If you have questions about this study, please contact Natalie Coash at nsc0024@auburn.edu or Matt Catalano at mjc0028@auburn.edu.

If you have questions about your rights as a research participant, please ask them now you may contact the Auburn University Office of Research Compliance or the Institutional Review Board by phone (334) 844-5966 or e-mail at IRBadmin@auburn.edu or IRBChair@auburn.edu.

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HAVING READ THE INFORMATION ABOVE, YOU MUST DECIDE IF YOU WANT TO PARTICIPATE IN THIS RESEARCH PROJECT. IF YOU DECIDE TO PARTICIPATE, WE WILL PROCEED WITH THE INTERVIEW.

Natalie Coash 3/1/23

Investigator Date

Matt Catalano 3/1/23

Co-Investigator Date

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A-2: Tournament director information recorded during access point angler surveys at Neely Henry Reservoir between March- December 2023.

Tournament Director Information

Tournament name:

Start time:

Weigh-in time:

Number of boats:

Anglers per boat:

How many times does your trail/club compete at Neely Henry every year? (If applicable):

Entry fee:

A-3: Access point and roving creel survey question format for black bass anglers at Neely Henry between March- December 2023.

Access Point and Roving Creel Bass Angler Survey

Hello, we are working with Auburn University Fisheries Department… may we interview you? Y N

This survey will take less than 10 minutes of your time. All the information you give me today will remain confidential, anonymous, and no one will try to sell you anything. This information will be used to evaluate angler effort and fishing quality on Neely Henry Reservoir.

- Non-bass boat: What are you fishing for today? *Anything* *Crappie* *Bass* *Catfish* *Bream*

  *other*_________________

1. Are you targeting a specific species today? *Bass* *Crappie* *Catfish* *anything*

2. Are you participating in a bass tournament today? Y N ***(Y)***: T name: ____________________

   (N): Are you pre-fishing? Y N

3. What boat launch did you put in at today? _____________

4. Approximately, how long will you spend fishing today? _______________ hours **or** *Tourn. Hours*

5. How many miles did you travel one way to fish here today? _______ miles

6. Do you tend to fish more during the week or weekend? *Weekday* *Weekend* *Both*

7. Approximately how much money will you spend to -participate in this tournament/recreational fish- today including gas, lodging, food, drinks?

*Gas*______________ *Lodging*__________ *Food*__________ *Fishing gear*_____________
*other*__________

Circle one: *Ind.* *or* *Boat* ___________ *people*

Of the money you spent, how much was spent within "20" miles of Neely Henry Reservoir? *All of it* *None* *$*___________

8. Do you participate in any bass tournaments? Y N

   (YES) a) Approximately, how many bass tournaments do you participate in every month? _________ or **NA**

   b) How many of those are @ NH every month? _________ or **NA**

   c) Do you bass fish outside of tournaments/competition or pre-fishing? Y N

9. Approximately, how many days do you recreationally bass fish every month? Not including pre-fishing or tournaments. _______ Rec. days
   For example:
   15 days is every other day
   8 days is about twice a week
   4 days is about once a week

   How many of those days are fished at Neely Henry? ________ days

A-3: Access point and roving creel survey questions and format for black bass anglers at Neely Henry between March- December 2023.

10. How many more or less fishing trips would you take to **Neely Henry PER MONTH IF**:
Your amount trips can also stay the same.
Are those fishing trips for a tournament (T) or non-tournament (NT)? (Check or X a box for each scenario)

	Less fishing trips					No change	More fishing trips				
	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	5+
T TRIPS: Bass fishing quality **improved** "If you caught **twice** as many 3-4 lb. bass every trip"											
NT TRIPS: Bass fishing quality **improved** "If you caught **twice** as many 3-4 lb. bass every trip"											
T TRIPS: Bass fishing quality **declined** "If you caught **half** as many 3-4 lb. bass every trip"											
NT TRIPS: Bass fishing quality **declined** "If you caught **half** as many 3-4 lb. bass every trip"											
T TRIPS: **Increased** number of tournaments at NH "If there were **double** the number of tournaments at NH each month"											
NT TRIPS: **Increased** number of tournaments at NH "If there were **double** the number of tournaments at NH each month"											
T TRIPS: **Decreased** number of tournaments held at NH "If there were **half** the number of tournaments at NH each month"											
NT TRIPS: **Decreased** number of tournaments held at NH "If there were **half** the number of tournaments at NH each month"											

11. How old are you? ___________________ Male/Female

12. Are you retired? semi-retired? Employed? (Circle one)

13. Resident zip code? __________________

14. Have you caught any yellow, reward tagged bass? Y N **(Y)** # caught_____
(Y) How many of those have you called in? _________ or all tags
(Y) How many were caught during a tournament vs recreational fishing? Tourn: ________ Rec:_________
(Y) Did you release any bass with the tags still attached? Y N How many? _______

Thank you for taking the time to participate in this study. Your answers to this survey will provide useful information regarding the management and conservation of our natural resources here at Neely Henry.