Economic Impact of Recreational Angling on Reservoir and Tailrace Sections of Millers Ferry Reservoir, Alabama

by

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Abstract

Recreational fishing creates a large source of income within the state of Alabama through both direct sales for local communities and taxes. Knowing how much and where anglers spend money fishing specific destinations allows fisheries managers to better understand the economic impact of these fisheries to the local economy. This economic impact was evaluated for Millers Ferry (William “Bill” Dannelly) Reservoir, Alabama, a 7,006-ha impoundment of the Alabama River. The reservoir was divided into six sections covering 157.1 km to conduct a stratified, non-uniform probability sampling design. Instantaneous counts (N=188), on-site roving creel interviews (N=729), and follow-up telephone interviews (N=506) were conducted to obtain fishing effort and expenditure data from January to December 2015. Data were then extrapolated to estimate total fishing effort on the reservoir at 164,145 ± 36,184 hours. Over the one-year study period, recreational boat anglers were responsible for 89% of the effort while the remaining effort was from shore anglers for a total of 23,156 and 4,589 trip days, respectively. Recreational anglers who visited Millers Ferry Reservoir spent $2.5 million on their trips for resources (fuel, lodging, food, tournament fees, etc.). Fuel for boats and vehicles ($1.0 million) and food ($0.5 million) were the sources of the majority of the expenditures. Anglers targeting black bass *Micropterus* spp. spent $1.7 million on their trips with most of the effort concentrated in the sections directly above the dam. Anglers targeting crappie *Pomoxis* spp. ($0.33 million), catfish (family Ictaluridae; $0.27 million), sunfish *Lepomis* spp. ($0.06 million), and anything ($0.16 million) were responsible for the remaining expenditures. Total expenditures generated an estimated $161,951 in tax revenue for the state of

Alabama, Dallas and Wilcox Counties, and the four municipalities within these counties that apply taxes. Most tax revenue was generated for the state of Alabama ($108,516), Wilcox County ($35,296), and the city of Camden ($13,347). State and local managers can use these economic impact estimates to better understand a fishery and improve the opportunities for recreational anglers.

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List of Abbreviations

REC Act	Outdoor Recreation Jobs and Economic Impact Act
TCM	Travel cost method
WTP	Willingness-to-pay
CPE	Catch per effort; measure of catch rate
HPE	Harvest per effort; measure of harvest rate
RPE	Release per effort; measure of release rate
LPE	Livewell per effort; measure of catch rate for livewelled species
ANOVA	On-way Analysis of Variance
TM	Taxed municipalities
ADCNR	Alabama Department of Conservation and Natural Resources

Definitions of Note

Consumer Surplus	willingness-to-pay for a recreational visit above and beyond a person's actual expenditures and is the area below the recreational visit demand curve and above the equilibrium travel cost (price)
Local Angler	angler with residence in Dallas or Wilcox County, Alabama
Non-local Angler	angler with residency with residence in Alabama that isn't a local angler
Out-of-state Angler	angler with residency in a state other than Alabama
Opportunity Cost	measure in terms of value of the next best alternative forgone; in this study, a fraction of angler's wage Rate applied to the round trip travel time to the recreation site and substitute sites
Substitute Site	similar site that could replace the study site and in this study was used as part of a substitute site opportunity cost in the travel cost method
Travel Cost Method	method to estimate travel costs (opportunity cost of travel plus actual expenditures) and visit frequency to establish angler visitation demand
Trip	one angler fishing for a one day period
Visit	fishing expedition for one angler and can be multiple days from residence
Willingness-to-pay	maximum amount and angler is willing to pay for fish

I. INTRODUCTION

Outdoor recreation contributes immensely to local, state, and federal governments making it extremely important for managers of varying assets to understand the economic impact of their resources. The importance of understanding the value of these resources was highlighted by the signing of the Outdoor Recreation Jobs and Economic Impact Act of 2016 (REC Act) into law (Outdoor Recreation Jobs and Economic Impact Act of 2016). It directed the Bureau of Economic Analysis and Department of Commerce to assess and analyze the effects of outdoor recreation attributable to the overall U.S. economy. While the REC Act and other large scale assessments provide pivotal insight into the economic impact of larger entities, it is dually crucial to conduct these assessments on a state-wide scale to better understand within-state variation.

While the effort and expenditures related to a certain resource have been known to fluctuate yearly, expenditures related to angling have had an overall downward trend in recent years (U.S. Department of the Interior 2003–2014). Overall annual fishing effort in the state of Alabama since 2000 increased from 11.3 million days in 2001, to a high of 13.7 million days in 2006, and then to a low of 10.9 million days in 2011. While the amount of effort has fluctuated, there has been a noticeable decrease in expenditures over this time. In 2001, total angling expenditures in Alabama were estimated at $723 million followed by a slight decline to $700 million in 2006. However, over the next five year period, the decline was much more pronounced, down to a low of $456 million. While a state-wide estimate of angling expenditures can provide a snapshot of changing trends, it may provide an unclear representation to local fisheries and city managers. Thus, where reasonable, it may be even more important to understand a specific resources' impact on local economies rather than larger geographic areas to understand the intricate changes related to expenditures and address opportunities that may be present to revolutionize this downward trend.

Creel surveys are an excellent tool for fisheries managers to utilize when determining

the status of a single recreational fishery. Traditionally, they have been used to estimate angler effort (hours, days, trips) and harvest, but more recently their applications have been expanded to determine the economic impact of a local fishery or a fishing tournament on its surrounding communities (McKee 2013; Driscoll and Myers 2014; Lothrop et al. 2014), evaluate the response of a management decision on a water body (Henderson and Kirk 2002; Markham 2005), and estimate site-specific fish consumption rates (Finley et al. 2003). Recreational fishing creates a large source of income within the state of Alabama through both direct sales for local communities and taxes for local, state, and federal governments (McKee 2013; Lothrop et al. 2014; Snellings 2015). Knowing how much and where anglers spend money when fishing specific destinations allows fisheries managers to better understand the economic impact of these fisheries to the local economy as well as various levels of government. Economic values of fisheries vary among target species and waterbodies (McKee 2013; Lothrop et al. 2014), likely based on angler trip characteristics, demographics, and motivations (Ditton et al. 1990; Ditton and Hunt 1996; U.S. Fish and Wildlife Service 2000). All of these factors can additionally vary regionally (Brinson and Wallmo 2017). These data become vital when trying to understand a fishery and how to properly manage it.

Creel surveys can determine angler effort and harvest of target species, where anglers are coming from, and how much they spend when visiting a fishery. This is useful to natural resource agencies and local, county, and state officials in determining where funds, manpower, and other resources should be directed (Martin 1987). Results from these surveys can also be used to justify programs, seek higher operating budgets, and ultimately better serve their constituents. Historically, creel surveys have been widely used to provide an estimate of metrics such as total and mean harvest, catch, and effort, as well as trip information and angler demographics (Bernard et al. 1998). Creel surveys also have the advantage of being adaptably able to be used in a variety of systems to address multiple issues (Colle et al. 1987; Dolman 1991; Ditton and Hunt 2001; Markham 2005).

I.1. Angler Surveys

Two common types of on-site creel surveys exist in fisheries management to determine components of an angler's trip pertinent to study objectives (Pollock et al 1994; Pollock et al 1997; Lockwood 2000). In access point surveys, creel clerks have a pre-determined schedule and route of boat landings at which to interview anglers. Once they arrive at a boat landing, they remain there for a predetermined amount of time and interview anglers at the completion of their fishing trip. They may move between multiple boat landings and multiple bodies of water within the same day. The second type of on-site creel survey is a roving survey in which a creel clerk has a boat or similar mode of transportation and will move around on a body of water contacting anglers while they fish. Both types of surveys have advantages and disadvantages and the objectives of the study help determine which survey should be used.

Roving creel surveys are more desirable than an access-point creel survey when there are many access points to a fishery, making it difficult to interview a representative group of anglers, especially when a lot of fishing effort originates from private docks and landings. This allows for anglers to be enumerated and interviewed regardless of where their trip originated (Pollock et al. 1994; Lockwood 2000). The spatiotemporal frame of the roving survey is chosen sequentially in that the days to be sampled should be chosen first, followed by the time of day to sample, and then by the sections to be surveyed, where applicable. When stratifying a sampling regime, prior knowledge of the fishery effort is useful to maximize encounter rates (Newman et al. 1997; Lothrop et al. 2014). Pollock et al. (1994) illustrated the concept of the random non-uniform probability sampling design based on guidelines from Pfeiffer (1966) and Malvestuto et al. (1978) where fishing pressure is dependent upon the time, day of week, and location within the lake. Thus, sample times, sample days, and section selection are chosen with unequal probability with replacement to allow more sampling to be conducted when and where more anglers are typically fishing.

In a roving creel survey, effort (angler-h) is measured by an instantaneous count, where

the amount of people fishing in a specified area during the survey time block are enumerated (Hoenig et al. 1993). The instantaneous count should be done as quickly as possible to reduce the chance that anglers move into or out of the survey area in an effort to obtain more accurate estimates. Catch rate (fish/h) is estimated by determining when an angler began fishing and how many fish they have caught relative to the time of contact (Pollock et al. 1997). Total catch is then calculated as only part of the catch since the interviews only represent a portion of the fishing day. Additionally, anglers can be missed during the instantaneous count due to obscurity issues such as vegetation or islands; thus, effort estimated using this method is conservative. Two assumptions govern the determination of harvest/catch rates and fishing effort. The first is that the catch rate at the time of the interview will be consistent for the entire trip. It is also assumed that the catch rates of the anglers interviewed will be equal to those of the anglers not interviewed. Accuracy of the rates and calculated efforts relies heavily upon these assumptions (Pollock et al. 1994; McCormick et al. 2012; Alexiades et al. 2015).

Creel surveys are complex and must be carefully designed to conform to existing logistical constraints while providing the most robust data possible. Pollock et al. (1994) described the length-of-stay bias inherent in the roving creel survey, which arises from the fact that the probability of intercepting anglers is proportional to their trip length (Thomson 1991; Bernard et al. 1998). Thus, anglers who fish longer are more likely to be interviewed than those that only fish for a few hours, increasing the overall fishing effort. Also, successful anglers may fish for a longer amount of time, resulting in high catch rates; whereas, unsuccessful anglers may become frustrated and leave before an interview can be conducted. Conversely, in harvest-oriented fisheries, successful anglers may leave early once catching their creel limit, possibly resulting in an underestimate of the true catch rate. However, there is currently no way to correct for this bias. All creel survey designs can be affected by prestige bias, which occurs when anglers overestimate the numbers or sizes of fish they have caught to make them appear more successful (Pollock et al. 1994). Avidity bias also exists where multiple interviews with

people who fish constantly may saturate the sample giving inaccurate results.

However, on-site interviews cannot solely be used to calculate the economic impact of a reservoir on a local fishery, because the trip has not yet been completed. Thus, to avoid these biases, many on-site creel surveys now employ a follow-up interview via telephone or mail to obtain complete trip data (Pollock et al. 1994; Ditton and Hunt 2001; Chen et al. 2003). At the time of the on-site interview, it is hard for an angler to estimate their remaining expenditures, which may be related to trip length after encounters with creel clerks or due to unintended expenses, potentially resulting in an underestimation of expenses (Pollock et al. 1994). Follow-up interviews also allow more detail about the trip to be obtained than would be feasible during the on-site interview (Chen et al. 2003).

Pollock et al. (1994) noted that inaccurate responses may be given when a question lacks clarity, is misunderstood, or is vague; thus it is important to design questions to elicit accurate responses. Memory (i.e. recall bias) is also an important factor governing the accuracy of responses. For example, anglers are more likely to remember details of their fishing trip when surveyed three months rather than twelve months after the conclusion of their trip. Thus it is important to conduct a follow-up interview as soon as possible after the fishing trip has been completed to reduce the chance of accidental error (Ditton and Hunt 2001; Chen et al 2003). Questions should also be asked in a logical order for the convenience of the respondent, rather than the analyst (Pollock et al. 1994). This strategy helps the respondent focus on one thought while transitioning into the next suite of questions. Additionally, this helps maintain the interest of the respondent which, in turn, improves the likelihood that they will complete the survey.

I.2. Economic Valuation

Economic impact assessments of recreational angling have been conducted at the national level (DOI 2014), state level (Dalton et al. 1998), and local level (Chen et al. 2003; Henderson et al. 2003; Hutt et al. 2013) from data collected during creel surveys. They have

been used to determine the impact of a single species within a water body (Schorr et al. 1995; Ransom 2001; Lothrop et al. 2014), the impact of tournament angling on a reservoir (Snellings 2015), and to determine the influence of the reservoir as a whole to the surrounding communities (McKee 2013).

The Travel Cost Method (TCM) unites two common methods to estimate the recreational value of a resource (King and Mazzotta 2000). It can be used to observe economic value fluctuations of a resource based on the elimination of an existing site, addition of a new site, changes in the environmental quality of a site, and changes in access costs. The TCM is a demand-based model used to determine the value that anglers place on a resource, in this case, a fishing experience (Lothrop 2012, McKee 2013). It assumes that as the cost of a trip increases, the number of trips taken will decrease. This can be represented using a downward sloping linear relationship to create a demand curve (Figure 1).

The first step to determining the economic impact of a waterbody using the TCM is to estimate direct expenditures within a local economy. This assumes that direct expenditures spent on fishing through items such as food, lodging, transportation, and equipment directly affect regional business activity and also provide local employment opportunities within the community (Anderson et al. 1986). These expenditures create a ripple effect, where the services required to maintain these businesses will also benefit from the fishery (Anderson et al. 1986; Martin 1987; Ransom 2001). Some economic impact assessments estimate the total number of jobs created (known as induced impact) from a fishery, which have been known to have a noticeable impact on the job market (Schorr et al. 1995; Dalton et al. 1998; Chen et al. 2003; Hutt et al. 2013). When estimating the economic value of a fishery, money spent at a study location by anglers who live within the regional area (e.g., county) may simply involve the recycling of money. However, these expenditures are generally included within the analysis as this money might be spent outside the regional area if the resource was located, or if better angling opportunities were found, elsewhere (Loomis 2006; Hutt et al. 2013). The amount of

expenditures by anglers is generally directly related to the distance they travel to reach the fishing location (Chen et al. 2003; Henderson et al. 2003). This is intuitive, as non-local anglers incur more costs from the distance travelled and may stay for multiple days. By estimating angler direct expenditures, it is also possible to calculate the amount of tax revenue generated. However, these values are not a complete representation of the value of a fishery as they only portray the expenditures incurred to visit and use the resource. While direct expenditures can give an estimate of the value of a fishery resource, there are other factors that must be considered.

The second step helps estimate the economic impact of a resource by estimating benefits such as consumer surplus. Consumer surplus is a measure of the value that anglers place on the activity over and above their actual expenditures (Ransom 2001; Hutt et al. 2013). It is the difference between the actual expenditures incurred for a good or service and the maximum willingness-to-pay (WTP), which is the maximum amount anglers would be willing to pay to use a resource. The consumer surplus is derived from the collected data and is estimated based on the number of visits an angler would make to a certain site at varying travel costs.

Consumer surplus is estimated using a wide array of variables such as expenditures incurred to reach a site, the cost to visit an alternative site if the aforementioned resource was unavailable, and household income. Many other demographic and trip characteristics can be used to describe consumer surplus (Ward and Beal 2000; Parsons 2003). Overdispersion occurs due to the tendency of many resource users making a limited number of trips to use a resource while more avid users, make numerous trips. This tendency can lead to error in the consumer surplus model and less precisely estimate the value of a resource. Opportunity cost (i.e. the cost of an anglers' time spent traveling to and from the use of a resource), is an important consideration when determining consumer surplus. This is determined by considering an individual's household income in relation to a standard number of hours worked per year

(40-h work week for 50 weeks per year) to estimate their hourly rate. The time spent travelling to use a resource is valued at 1/3 of their hourly rate and this ratio is subsequently multiplied by the time spent travelling to use the resource with a standard speed of 55 mph.

Many factors may affect the economic value of a fishery. Fluctuating water levels can influence angler access and water quality, which may impact economic value (Anderson et al. 1986; Bradle et al. 2006; Hutt et al. 2013; Daugherty et al. 2015). Seasonal patterns in expenditures also exist, with anglers spending more money on fishing in the summer than in the winter, presumably due to longer trips in the summer (Anderson et al. 1996). Angler effort at Lake Fork, Texas, increased after a state record Largemouth Bass *Micropterus salmoides* was caught from the reservoir (Chen et al. 2003) while Colle et al. (1987) noticed a 90% loss in revenue from the Orange Lake, Florida fishery after an infestation of Hydrilla *verticillata* restricted fishing access during summer and fall. In contrast, aquatic vegetation in amounts that do not inhibit access can increase the economic value of reservoirs (Henderson and Kirk 2002; Henderson et al. 2003).

In 2011, there were 473,000 and 210,000 resident and nonresident anglers, respectively, that participated in recreational fishing in Alabama, comprising 10.9 million fishing days, most of which (9.9 million) were by residents. These anglers collectively spent an average of 16 days fishing in Alabama with total expenditures of approximately $456.5 million. These expenditures were 69% trip-related ($317 million) and spent on things such as food, lodging (collectively $122 million), and transportation ($79 million). Equipment expenditures comprised $128 million of total fishing expenditures, 84% of which were for fishing equipment (such as rods, reels, and lines). Auxiliary equipment expenditures such as tents and special fishing clothing comprised the remaining 16% ($20 million). Each angler (freshwater and saltwater combined) spent an average of $635 annually on fishing in Alabama. The average freshwater angler spent $412 that year on trip-related expenses (excluding equipment and other costs) and $25 in trip expenditures per day (DOI 2014).

Thus, fishing creates a large source of revenue for the state of Alabama, which stimulates the economy and creates employment opportunities. Out of the estimated 683,000 people fishing in Alabama in 2011, 598,000 participated in freshwater fishing activities. Many of the anglers that fish in Alabama also came from out of state which attests to the many fishing opportunities available. The main target species include catfish (family Ictaluridae; 245,000 anglers), black bass *Micropterus* spp. (215,000 anglers), crappie *Pomoxis* spp. (207,000 anglers), temperate basses *Morone* spp. (186,000 anglers), and sunfish *Lepomis* spp. (126,000 anglers). McKee (2013) valued the Lake Guntersville, Alabama, fishery at $45.2 million, with direct expenditures estimated at $13.4 million. Black bass tournaments at Lake Guntersville, Alabama, generated $4.6 million in revenue in a single year (Snellings 2015). Lothrop et al. (2014) found that the Striped Bass *Morone saxatilis* fishery in Lewis Smith Reservoir, Alabama generated $0.7 million annually in direct expenditures. Similar analyses have not been conducted for reservoirs in more rural areas of Alabama. Results from creel surveys can be used to determine economic impacts and trip characteristics of anglers to aid in implementing best management practices, which can help increase revenue within a reservoir (Loomis 2006).

I.3. Site Description and Study Objectives

My study site, Millers Ferry (William “Bill” Dannelly) Reservoir, is a main-stem impoundment located on the Alabama River in Dallas and Wilcox Counties, Alabama. Construction of the lock and dam began in 1963 and was completed in 1974. The impoundment was created for recreational purposes, flood control, and for the generation of hydropower. The reservoir has a surface area of 7,000 ha and a shoreline distance of 800 km at normal pool elevation of 24.38 m (USAED 1974). Additionally, it has a mean depth of 5.88 m and a maximum depth of 18.29 m. The reservoir is 169 km long from Millers Ferry Lock and Dam near Camden, Alabama, upstream to the R.F. Henry Lock and Dam, east of Selma, Alabama. It is

managed to have a mean annual fluctuation of only 0.30 m. Hydraulic retention time of Millers Ferry Reservoir is 5.6 days at normal discharge, equating to 65 complete exchanges per year.

Recreational anglers have a wide array of species to target on the reservoir, including Largemouth Bass, Alabama Bass *M. henshalli*, crappie, catfish, and sunfish. Additionally, a commercial fishery for Paddlefish *Polyodon spathula* exists in Millers Ferry Reservoir. Numerous tournaments are held on the reservoir each year, mainly targeting black bass and crappie (Ricks et al. 2006). In 2013, self-reported fishing results from bass tournaments on 28 water bodies in Alabama ranked Millers Ferry Reservoir third (64.7%) in percentage of tournament anglers with a limit of fish and eighth in average bass weight (0.95 kg; Abernethy 2014). Millers Ferry Reservoir was also ranked second in kg/per angler-day (4.26) of bass; based on the overall quality of the fishery, it ranked second in the state of Alabama.

This study location, in the Black Belt Region of Alabama, was chosen because it is a poor region in the state and little is known about the economic impacts of recreational fishing in the area. The counties in which Millers Ferry Reservoir is located, Dallas and Wilcox, had a population of 43,820 and 11,670 people, respectively, according to the 2010 census, a decrease of 5.5% and 11.5%, respectively, from the 2000 census (Blackbelt Economic Development Alliance 2010). Dallas County residents had a median income of $26,029 while those in Wilcox County had a median income of $23,491, a decrease of 3.8% and an increase of 16.6%, respectively from the estimated 2007 median income (U.S. Census Bureau 2010). Racial demographics of Dallas and Wilcox County populations were 32.0% and 27.7% Caucasian and 67.0% and 71.8% of African-American descent, respectively. Additionally, 27.6% and 29.6% of the population in Dallas and Wilcox County, respectively, was under the age of 18. Gender, household income, ethnic and racial composition, and urbanization may all impact the participation of individuals in recreational fishing activities (Hunt et al. 2017). The

goal of this study was to estimate the economic impact of a large reservoir to the surrounding communities in the Black Belt region.

The specific goals of this two-year study on Millers Ferry Reservoir, tailrace and river section were to:

1. Quantify the recreational fishing effort for bass, crappie, catfish and sunfish species and from where angler travel trips originated;
2. Quantify the total expenditures, demand and consumer surplus associated with these recreational and tournament fisheries on Millers Ferry reservoir and tailrace;
3. Partition total recreational expenditures into the local cities and counties in which they occurred;
4. Determine the proportion of recreational fishing trip expenditures that go toward local taxes by applying local city and county tax rates to these fishery expenditures; and
5. Describe the socio-economics of the recreational anglers to understand better how efforts can be directed to improve angling experiences and increasing expenditures in the region.

II. METHODS

II.1. Roving Creel Survey

A roving creel was used to survey recreational anglers from January to December 2015; this type of survey was chosen because of the large study area and multitude of access points including multiple private residences. Millers Ferry Reservoir and its tailrace were divided into six different sections totaling 157.1 km and 7,006 ha of the Alabama River. Section 6 was the tailrace section of the lock and dam and sections 1 through 5 were all above the lock and dam and span from that point upstream to the International Paper Plant, just upstream of Selma, Alabama (Figure 2). The area between the International Paper Plant and the next lock and dam,

R. F. Henry Lock and Dam, was not included after consultation with Alabama Department of Conservation and Natural Resources (ADCNR) biologists determined that this area has little access and is underutilized by anglers. Sections were chosen to include roughly equal linear lengths within the reservoir and were surveyed in fall 2014 by driving a vessel along the main channel of the reservoir for approximately thirty minutes, i.e. the expected duration of instantaneous boat counts. Section boundaries from downstream to upstream and their corresponding channel lengths are:

Section 6 - Alabama Highway 10 bridge to the Millers Ferry Lock and Dam (22.7 km)

Section 1 – Millers Ferry Lock and Dam to Gee's Bend (26.1 km)

Section 2 – Gee's Bend to Gee's Creek (22.9 km)

Section 3 – Gee's Creek to Calhoun Bend (27.3 km)

Section 4 – Calhoun Bend to Little Miami Public Use Area (25.5 km)

Section 5 – Little Miami Public Use Area to the International Paper Plant (32.6 km)

Sample days, times, and sections of the reservoir were selected using a non-uniform, stratified sampling design and a random number generator (Malvestuto et al. 1978). A random-number generator was used to determine the sampling regime. Each month, there were two, 4-day sampling events, encompassing either Thursday through Sunday or Saturday through Tuesday, following the sampling design used by Lothrop et al. (2014), for a total of 96 sampling days. Days to sample were all given an equal likelihood of being chosen. The random-number generator chose two sample days each month that occurred on one of the six possible survey days (i.e. Thursday – Tuesday). If the day of the month selected fell on a Thursday or Friday, sampling for that given week occurred from Thursday through Sunday. Conversely, if the day of the month selected fell on a Monday or Tuesday, sampling days were from Saturday through Tuesday. In the event that a day chosen fell on a Saturday or Sunday, a coin flip determined the outcome, with 'heads' denoting sampling Thursday – Sunday and 'tails' denoting sampling Saturday – Tuesday.

Each sampling day was divided into three time slots – morning (AM – 6 to 10 AM), noon/midday (NN – 10 AM to 2 PM), and afternoon (PM – 2 to 6 PM). From these three time slots, two were chosen at random for each day to sample. Because Millers Ferry Reservoir is located approximately 3 h from Auburn University, the first sampling times of each 4-day event were always the NN and PM time slots and the last sampling times were always the AM and NN time slots. Sections sampled each day were determined randomly as described above, weighted by expected angler use derived by consultation with ADCNR biologists working on Millers Ferry Reservoir (Table 1).

Each 4-h survey period began with an instantaneous count. Basic data (Appendix 1) were recorded as well as physiochemical properties, including wind speed (estimated km/h), air temperature (°C), water temperature (°C), and the presence or absence of precipitation. The entire length of the section was traversed by boat and the number of boats and people per boat were recorded (see notes in Appendix 1). The number of shore anglers observed fishing within a section was additionally recorded. Because the study was concerned with the economic impact of recreational fishermen, anglers were enumerated separately from people not fishing. Many backwaters exist on Millers Ferry Reservoir, therefore, the same route was driven each time a count was conducted in the same section to avoid biases that may arise from deviating from the standard path of travel. Boats that were operating via use of a gas motor when observed were not counted because it was impossible to determine origin, destination, or purpose of their trip.

Directly following the instantaneous count, all anglers within the section were approached and asked to participate in the survey. The entire section was searched for anglers, including backwaters and areas that were not feasible to inspect during the instantaneous count due to time constraints. Once an angler was encountered, they were approached at idle speed and the trolling motor was lowered into the water so their responses could easily be heard and parallel movement along with their boat was possible to provide minimal disturbance to their

fishing trip. Once they agreed to participate, anglers were then asked questions from the on-site survey (Appendix 2).

Previous creel surveys conducted on Lake Guntersville and Lewis Smith Lake, Alabama, were used as the basis to design the survey used in this study (Lothrop 2012, McKee 2013). I used the same seasonal month distributions (spring [March – May], summer [June – September], fall [October – November], and winter [December – February]) as McKee (2013). Minor deviances were made from the previous survey designs to increase usefulness of the survey for this study. The questions were arranged to promote a continuous flow to a conversation and allow for a less-pressured environment to the angler. The goal was to make the interviewee feel as though they were having a typical conversation with a fellow angler. Chi-squared tests were used to determine difference between target species group and time period of interview, reservoir section of interview, and season of interview. Significance was determined at a value of $P \leq 0.05$.

The questions were designed to determine anglers' target species, effort, and harvest. Information about their trip, such as tournament relatedness, boat launch site, current hometown, and their length of stay were also included in the survey (Appendix 2). Questions about their total estimated trip expenditures and estimated local expenditures, indicated as money spent within 20 miles of the study site, were asked and some basic demographic information was collected. Because demographic questions tend to be more sensitive, these questions were asked at the end to deter people from not completing the survey (Pollock 1994). At the conclusion of the survey, anglers were asked to participate in a follow-up phone interview to obtain more detailed information about their trip. If they agreed to participate, contact information was obtained and the interview was then terminated. This process was continued until the end of the time period or until all anglers within a section had been interviewed.

II.2. Follow-up Telephone Survey

Recreational anglers that agreed to participate in the off-site telephone interview were contacted within one day after returning from each 4-day trip to reduce memory recall bias. People were called in the order in which they were encountered on the reservoir, unless surveyors were told by the anglers during the on-site survey that their visit would not be complete when phone interviews were to be conducted. In these cases, the individual was contacted within 2-3 days after the time they indicated that they would have returned to their place of residence. Three attempts were made to contact each person, all within the week immediately following the end of the sampling trip. Upon successful contact with an angler via telephone, questions regarding the purpose of their trip, their fishing experience, and total time fishing were determined (Appendix 3). Information regarding their lodging accommodations (for overnight trips), previous tournament involvement at Millers Ferry Reservoir, and trip expenditure data were additionally recorded. Trip expenditures were separated into categories, such as gas (truck and boat), lodging, and grocery expenses, and expenditure categories were divided into the city or county in which the money was spent. Interviewees were also able to make any additional comments regarding the reservoir or their experience.

Due to the accidental exclusion of certain questions regarding their alternate site if fishing was unavailable at Millers Ferry Reservoir from the follow-up telephone interview, an attempt was made to contact all anglers with a previously successful follow-up telephone interview a second time from May – September, 2016 (Appendix 4). Questions were asked regarding their alternate fishing site if fishing were unavailable on Millers Ferry Reservoir, the distance of this waterbody to their house, and which one they would rather visit. Questions were also asked regarding other lakes or reservoirs in which they fished in 2015, their estimated cost of boat gas per day (not shown), and if they stated that they rented or leased land along or near the reservoir, the cost for such. Recall bias was not a concern since these answers were

assumed to not vary with increasing time between the on-site interview and the second follow-up telephone interview. Four attempts were made to contact these anglers (two times each before and after 5 PM). After a successful interview, they were removed from the list. The additional attempt to contact these anglers compared to the first follow-up telephone interview was to ensure a sufficient sample size. This was a result of the sample size being reduced from all angling parties contacted during the on-site roving creel survey, to those agreeing to a follow-up telephone survey, and thus being further reduced to those that had successful follow-up telephone surveys.

II.3. Effort and Catch

Effort ($\hat{E}_{\text{species}}$), trip length, trips, catch rate (CPE), harvest rate (HPE), and harvest per target species on Millers Ferry Reservoir were calculated from the data collected during the on-site interview and extrapolated to the population of anglers (Bernard et al. 1998; Hoenig et al. 1997; Lockwood et al. 1999). For purposes of clarification, a “trip” was defined as an angler fishing for a one-day period where the trip length for an angler varies depending on the target species and a “visit” was defined as on entire fishing expedition which could be comprised of one or more trip days. The target species groups for which these estimates were determined were black bass, crappie, catfish, sunfish, and anything or other, which were combined for analyses. These values were estimated using calculations from Malvestuto et al. (1978) for each fishing method (i.e. boat, shore, and all anglers) separately as well as by target species groups.

Probabilities were assigned to determine the total weekday and weekend effort (E) per sampling period for recreational anglers using:

$$E = (I * A * t)/\rho_1 \quad (1)$$

where *I* is the instantaneous count of boats or shore angling parties, *A* is the average number of people per boat/shore angling party, *t* is the length of time block in hours, and ρ_1 is the probability of sampling an angler within that period and is determined by multiplying the probability of sampling that section by the weighted probability of sampling during that time period. Annual effort was estimated by multiplying the mean weekend effort during the year by the number of weekend days in the year. The mean weekend day effort was multiplied by 106, as opposed to 104 because Memorial Day and Labor Day would have similar effort to a typical weekend day. Because the Fourth of July holiday fell on a Saturday, this remained as a weekend day resulting in the mean weekday effort being calculated from 259 days in 2015. The two values were summed to determine total recreational fishing effort for the year on Millers Ferry Reservoir.

Trip length was estimated from averaging the angler-estimated hours of effort from the on-site survey (McKee 2013; Lothrop 2014). Estimates from the on-site survey were used rather than the off-site telephone survey because the estimated time spent fishing for bass and crappie were very similar, likely due to a large amount of tournament bass anglers which have a predetermined begin and end time and these anglers were predominantly fishing from a boat. Using the on-site estimated fishing time for anglers targeting sunfish, catfish, and anything allowed for larger sample sizes in estimating mean daily fishing effort. People that typically stayed for a shorter duration were commonly shore anglers and did not have a telephone, as determined during the on-site survey, so a follow-up telephone interview was impossible resulting in inflated estimates of trip length from the follow-up telephone interview for anglers targeting sunfish, catfish, and anything. If an angler was unsure of their estimated start and/or end time, these data were omitted from analyses. Trip days for boat, shore, and all anglers was determined by dividing the total effort ($\hat{E}_{\text{species}}$) for each method and target species combination by their respective trip length.

Harvest-per-effort (HPE), release-per-effort (RPE), and total catch-per-effort (CPE) were estimated for each fishing method and by target species group for each day sampled. Effort was estimated by multiplying the number of hours a fishing party spent fishing by the total number of anglers in the party to calculate the total number of fishing effort hours per angling party. The calculated hours were summed for the day to determine total effort for all anglers ($\hat{E}_{\text{species}}$). The total number of target species caught per day was also summed to determine total catch for all anglers ($\hat{C}_{\text{species}}$). The mean among all days was calculated to determine yearly CPE by:

$$CPE_{\text{species}} = \hat{C}_{\text{species}}/\hat{E}_{\text{species}} \quad (2)$$

The same process was conducted for HPE and RPE; both were estimated for each target species group within each fishing method. The $\hat{C}_{\text{species}}$ estimated for HPE calculation resulted from harvested fish and from released fish for RPE estimates. Catch rates for black bass anglers fishing from boat that kept black bass in livewells (LPE) was additionally estimated using the same method. Due to many of the bass anglers participating in tournaments where the fish would subsequently be released at the end of the day, LPE values were included in estimated CPE for bass anglers fishing from boats, but not HPE estimates. Estimated harvest of each targeted species for each fishing method was estimated by multiplying the HPE estimates by their respective total effort.

Percent effort by section ($\hat{E}_{\text{section}}$) was also calculated. The effort for each section for the summation of all weekdays was determined by:

$$\hat{E}_{\text{section,weekdays}} = \left(\frac{\Sigma I * A}{n}\right) X\ 259 \quad (3)$$

where I is the instantaneous count of boat and shore angling parties, A is the average number of people per boat/shore angling party, n is the number of times that section was sampled, and 259 is the number of weekdays in 2015. Using the same reasoning for weekend and weekend

days as was used for $\hat{E}_{\text{species}}$, this value was calculated for weekend days as well where instead of multiplying the parenthesized value by 259, it was multiplied by 106. The percent effort by section was then estimated by:

$$\hat{E}_{section} = \frac{\hat{E}_{section,weekdays} + \hat{E}_{section,weekend-days}}{\sum (\hat{E}_{section,weekdays} + \hat{E}_{section,weekend-days})} \text{ X } 100 \quad (4)$$

This calculation was conducted for boat, shore, and all recreational anglers in each reservoir section within the study area.

II.4. Angler Socioeconomic Characteristics

Socioeconomic characteristics were evaluated across target species groups. These characteristics included party size, total estimated trip expenditures, and total estimated local trip expenditures, and were evaluated using a One-Way Analysis of Variance (ANOVA) with a Tukey's Post-Hoc test. Results were considered significant across target species groups at $P < 0.05$. One-way distance travelled (km), alternate site distance (km), trip length (days), number of days and tournaments fished at Millers Ferry Reservoir in the 12 months prior to the interview, angler rating of the fishing quality (1 = poor, 5 = excellent), mean age, years of fishing experience, and mean household income were also determined. Whether or not they were a resident of the reservoir, their trip was related to a tournament, or they were a member of a fishing club was additionally determined. A resident of the reservoir was defined as someone that owned, rented, or leased waterfront property whether it was a permanent residence or a residence used sporadically throughout the year. Trips related to a tournament were individuals that stated that they were either prefishing for a tournament or currently fishing in a tournament. The spatial distribution of trip originations of anglers with permanent residences in Alabama was observed through use of geographic information systems (GIS) software. The distribution of all

anglers' permanent residence was determined and by summation among states, Alabama counties, and target species groups.

II.5. Expenditures and Tax Revenue

Anglers were asked to estimate the direct expenditure cost of their entire trip during the on-site roving creel survey. The anglers that agreed to a follow-up telephone interview were asked about the costs incurred in varying categories in more detail than during the on-site roving creel interview. These categories included lodging, groceries, restaurant meals, tournament fees, and boat ramp fees split into the city or county in which this money was spent. Expenditures estimated by anglers are often different between the on-site interview and the follow-up telephone interview estimates; however, the follow-up telephone interview estimates are thought to be more accurate, due to unplanned expenses and/or the trip being completed and no more expenses being incurred (McKee 2013; Lothrop et al. 2014; Snellings 2015). To assess whether this was true for my data, I compared expenditures within each category between survey types for each target species group using a paired t-test. Completed trip expenditures from the follow-up telephone survey were used to compute total reservoir expenditures and resulting taxes.

Recreational anglers participating in follow-up telephone interviews were asked to estimate their final trip expenditures across the different categories in different cities and counties in which the money was spent (Appendix 3). For example, if an angler spent money on fuel in two locations during the trip, they were asked the names of the two cities or counties and how much was spent in each one. Since anglers may buy gas in one location and not use all of the gas on a given trip, automobile and truck gas were determined separately from the other expenditures. The cost of automobile fuel was determined by dividing the average price of regular unleaded gas in Alabama in 2015 ($2.42; U.S. Energy Information Administration 2015)

by the average miles per gallon of trucks (17.5 mpg; MPGGuide 2016) to determine the average cost of gas per mile. The fuel efficiency of trucks was determined by averaging the combined city and highway mpg of standard and small (2- and 4-wheel drive) pick-up trucks made from 2010 to 2015. It was thought that since most anglers trailered boats, they would be using pick-up trucks. The resulting value was multiplied by the round-trip distance travelled in miles to determine expenditures incurred from gas to operate a truck for the trip. Boat gas was determined during the second follow-up telephone interview where anglers were asked to estimate their total gas expenditures per day for their boat. These values were averaged to determine that bass, crappie, and sunfish anglers spent $36.81, $17.76, and $19.67, respectively, on boat fuel per day. Recreational anglers targeting catfish, anything, or other we found to spend $17.37 on boat fuel per day. These recalculated truck and boat fuel expenditures were used in the remaining analyses.

Expenditures per day were determined for each target species group. They were determined by analyzing all anglers by target species group together, anglers indicating they were only there for the day, and those stating that they were staying overnight. The cost per day for anglers staying overnight was determined by dividing the costs incurred in each expenditure category by the number of days the angler spent at the reservoir to find the average cost per day. These average daily costs were determined separately for anglers fishing from boats and those fishing from shore. The summation of daily costs incurred by target species group and by either trip type (day or overnight) or method (boat or shore) resulted in the total cost per day fishing at Millers Ferry Reservoir for varying trip types and methods within each expenditure category. The average daily expenditures ($X_{Species}$) in each expenditure categories were extrapolated to the entire fishing effort at Millers Ferry Reservoir in 2015 for each target species group by multiplying the species-specific daily costs in each category by the total number of trip days for all anglers by species using:

$$X_{Species} = Mean(TC_{Species}/Days) \times (E_{Species}/t_{Species}) \quad (5)$$

In this equation, $TC_{Species}$ is an individual angling party's trip cost and Days is the number of days in the trip where the mean of the divisor of these numbers determines the average cost per day. $E_{Species}$ is the total bass fishing effort in hours and $t_{Species}$ is the average time in hours bass anglers spent fishing per day. The divisor of these two determines the total number of trip days. These expenditures were additionally calculated for all anglers by fishing method (boat or shore) and by expenditure category.

The contribution from recreational anglers to sales tax revenue was estimated for the state of Alabama, the counties in which Millers Ferry Reservoir is located (Dallas and Wilcox), and the main cities within those counties which administer taxes (Selma in Dallas County and Camden, Pinehill, and Yellow Bluff in Wilcox County; Palm and Malvestuto 1983; Alabama Department of Revenue(2) 2015). The state of Alabama and the counties and cities mentioned above will hereafter be referred to as taxed municipalities (TM). The proportion of money spent in each TM was determined using expenditure data generated during the follow-up telephone interview. If money was spent in a city within the two counties, then that cost was also included in the proportion of money spent in the respective county. These were then applied to the extrapolated expenditure estimates to determine the estimated expenditures in each TM by targeted species and expenditure category. Tax rates in 2015 for each TM were obtained from each municipality through personal communication with either city or county clerks, Revenue Discovery Systems, or by the Alabama Department of Revenue resources (Alabama Department of Revenue 2015, Alabama Department of Revenue (2) 2015). Revenue Discovery Systems handles the administration of tax revenue to contracted cities and counties.

General sales tax was applied in each TM as a percentage of total costs. The resulting money spent in each general sales expenditure category (food, meals, bait, and other) was

summed for each target species group and TM combination and multiplied by the respective tax rate. Fuel tax is applied on a cents per gallon basis, thus, total fuel expenditures in each TM were divided by the average price per gallon of gas in Alabama in 2015 ($2.42) to determine the total gallons bought in each TM. The resulting value was multiplied by the cents of tax applied per gallon in each TM. Lodging tax is applied across TMs as a percentage of cost, flat rate per night, or a combination of both. If it was a percentage, this tax rate was multiplied by the expenditure for lodging in those TMs. Selma (in combination with a tax percentage) and Wilcox County both apply a flat dollar tax rate per night. For these two TM, the average price per night of a room in each location was determined by dividing the cost of lodging obtained during the follow-up telephone interview divided by one minus the number of trip days, as I assumed anglers spending more than one day would leave on the last day. Total lodging expenditures in each of these two TM were then divided by the average cost per night of a room to determine the number of nights a room was used and then multiplied by the flat dollar amount to determine the tax revenue generated from lodging. This tax calculation procedure was conducted for all anglers collectively and for anglers targeting different species. Tax revenue was not calculated for out of state expenditures of the counties and cities in the state of Alabama outside of our study area.

II.6. Travel Cost Model

Information from the on-site roving creel and follow-up telephone interviews was applied to the travel cost method (TCM) to relate the time and travel cost people incur to visit and fish at Millers Ferry Reservoir (Parsons 2003; Ward and Beal 2000; Ecosystem Valuation). A regression analysis was used to describe the relationship between the annual number of visits and independent variables, such as the cost of travel, duration of trip, and tournament participation (McKee 2013; Lothrop 2014; Snellings 2015). An angler's opportunity cost (O_a) for

their trip, the value of an angler's time to travel to and from Millers Ferry Reservoir, was determined from the wages obtained during the on-site roving creel survey using the equation:

$$O_a = ((H_a/2{,}000) * 0.33) \times (D_a/55 \text{ mph}) \quad (6)$$

where H_a is the annual household income for an angler which was divided by a standard 2,000 hours worked per year (40 hours per week multiplied by 50 weeks per year) to obtain an hourly pay wage. This was multiplied by 0.33 since an angler's travel time was valued at 1/3 of their hourly pay wage. D_a is the roundtrip distance traveled by an angler and was divided by 55, the estimated average miles per hour during travel, to obtain the number of hours spent travelling to fish at Millers Ferry Reservoir (Prado 2006; Ojumu 2009). One-way distance travelled from an anglers' residence to Millers Ferry Reservoir, determined from the on-site roving creel survey, and from their residence to their alternative site, determined during the second follow-up telephone survey, were doubled to determine round-trip distance.

The travel cost for an individual angler (T_a) was estimated using:

$$T_a = O_a + X_a \quad (7)$$

where X_a is the summation of an angler's expenditures incurred on their visit, including the cost of vehicle operation, boat fuel (if applicable), lodging, groceries, and equipment and bait. The cost of vehicle operation was estimated by multiplying the Federal mileage reimbursement rate of ($0.575) in 2015 by the roundtrip travel distance to fish at Millers Ferry Reservoir (Internal Revenue Service 2015). If fishing was not the sole reason for visiting Miller's Ferry Reservoir, that angler's data was not used to estimate the travel cost since the TCM is not well suited for multi-purpose visits (Ward and Beal 2000; Parsons 2003; Prado 2006).

The demand curve for the quantity of fishing visits taken (Q) at varying visitation costs (P) on Millers Ferry Reservoir was estimated using:

$$Q = \beta_0 + \beta_1 T + \beta_2 S + \beta_3 H + \beta_4 V + \varepsilon_i \quad (8)$$

where β_n are coefficient estimates for the regression, T is travel cost, S is opportunity cost of travelling to an alternative substitute site, H is household income, V is a matrix of socio-demographic variables that can affect fishing demand (i.e. age, gender, target species, years of fishing experience, whether or not they own waterfront property, etc.), and ε_i is random model error (Ojumu et al. 2009). It is expected that the demand curve would have an inverse relationship between the travel cost and number of trips demanded such that as visit costs increase with increasing distance to the reservoir, the number of angler trips to Millers Ferry Reservoir should decrease.

Since the dependent variable, visits, is a nonnegative integer, a count data model was used to estimate consumer surplus. Endogenous stratification, overdispersion, and truncation were corrected via use of a negative binomial model. Cook's Distance tests were used to determine common outliers in the dataset for variables in the model and influential entry observations were removed where Cook's distance was greater than four over the sample size (Bollen and Jackman 1990; SAS 2009). Weighting each observation prior to the parameter estimation within the model corrected for these factors. The dependent variable, visits, was weighted by the number of days and angler fished at Millers Ferry Reservoir in the 12 months previous to their on-site interview. By adding the additional parameter to include the missing heterogeneity (*α*), we were able to correct for overdispersion results from neglected or unobserved heterogeneity in the dependent variable. The negative binomial model used the equation:

$$\lambda = \exp(\beta_0 + \beta_1 T + \beta_2 S + \beta_3 H + \beta_4 V + \alpha) \quad (9)$$

where λ is the number of trips a typical angler will take and is defined as a function of variables that affect the demand. The betas (*β*) are coefficients for the independent variables, *T*, *H*, *S*, and *V* where *T* is the travel cost, *H* is household income, *S* is the alternative site opportunity cost, *V*

is a matrix of socio-demographic variables that can affect fishing demand, and α identifies the degree of dispersion in the predictions (Parsons 2003; Martinez-Espiñeira and Amoako-Tuffour 2008). To estimate consumer surplus accurately using the TCM, the variables travel cost, income, and substitute site opportunity cost must be included in the model (Kling 1989; Parsons 2003). Other variables selected to be used in the model were found to be statistically significant at P ≤ 0.05 and collinear variables were removed (Ward and Beal 2000).

II.7 Consumer Surplus

Willingness to pay was estimated from the survey data and a regression analysis was performed between the number of visits and the travel cost to determine the consumer surplus. Consumer surplus gives the value between an anglers' actual trip expenditures and WTP which is the estimated amount that anglers are willing to pay to use a resource. Consumer surplus (*CS*) per angler trip on Millers Ferry Reservoir was estimated using:

$$CS = \frac{(\hat{\lambda}/-\hat{\beta}_1)}{\hat{\lambda}} = \frac{1}{-\hat{\beta}_1} \quad (10)$$

where $\hat{\lambda}$ is the estimated number of angler trips and $\hat{\beta}_1$ is the estimated travel cost coefficient from the TCM (Equation 9; Parsons 2003). To estimate aggregate consumer surplus for the entire fishery, consumer surplus was multiplied by the estimated total number of trips on Millers Ferry Reservoir. The second-order Taylor series approximation was used to calculate the standard error for the consumer surplus per angler trip and was estimated using:

$$Var\left(\frac{1}{-\hat{\beta}_1}\right) = \left(\frac{\Upsilon^2}{-\hat{\beta}_1{}^4}\right) + 2\left(\frac{\Upsilon^4}{-\hat{\beta}_1{}^6}\right) \quad (11)$$

where Υ is the standard error of $\hat{\beta}_1$ (Englin and Shonkwiler 1995).

III. RESULTS

III.1. Descriptive Survey Statistics

Instantaneous boat counts were conducted on Millers Ferry Reservoir on 96 separate sampling days for a total of 188 successful counts. Four of the scheduled instantaneous counts were not conducted. Two of these were due to heavy rain and lightning, one was due to the boat ramps in the section being covered by a thick layer of mud following a high water event, and the fourth was due to various other weather conditions. A total of 1,062 recreational fishing boats was counted throughout the year with a mean of 5.6 boats per instantaneous count. A total of 1,878 people was observed fishing on these boats resulting in a mean of 1.77 people per boat. A total of 192 people were observed fishing from shore during these same instantaneous counts resulting in a total of 2,070 recreational anglers observed during the instantaneous counts. The AM, NN, and PM time periods were sampled 50, 84, and 54 times, respectively, throughout the study.

A total of 729 interviews was conducted during the on-site roving creel survey of which 118 (16%) were parties that had previously been contacted. Of the 729 total interviews, 656 (90%) were with anglers fishing from a boat while the remaining 73 (10%) interviews were with anglers fishing from shore. Boat anglers comprised 94.1 – 100.0% of the interviews in sections 1 – 4; whereas, only 47.5% and 53.5% of anglers interviewed were fishing from boats in sections 5 and 6, respectively (Table 2). Nearly half (49%) of the on-site interviews were conducted during the NN time period followed by the AM (32%) and PM (19%) time periods (Table 3). Anglers were most commonly interviewed in the spring (41%; March - May), followed by the summer (34%; June - September), fall (13%; October - November), and winter (12%; December - February) seasons (Table 4).

A majority of the angling parties interviews were targeting bass (53%), with crappie (20%) and catfish (15%) the next most popular, while a smaller number of parties were targeting

anything (8%) or sunfish (3%; Table 3). The percent of anglers targeting specific species was fairly constant across different time periods during the day (Table 3). The two exceptions are that bass anglers seemed to select fishing the AM period over the PM period (χ^2 = 30.2, df = 2, p = <0.0001) and crappie anglers opted to fish the NN period more than the PM period (χ^2 = 11.8, df = 2, p = <0.0027). Season was statistically significant factor determining when anglers selected to fish for bass (χ^2 = 73.5, df = 3, p = <0.0001), crappie (χ^2 = 38.0, df = 3, p = <0.0001), catfish (χ^2 = 24.4, df = 3, p = <0.0001), sunfish (χ^2 = 14.0, df = 3, p = 0.0029), and anything (χ^2 = 16.7, df = 3, p = 0.0008). Bass was the most commonly targeted species in all seasons, followed by crappie, catfish, anything, and sunfish (Table 4). The only observed difference to this trend within season was when more catfish anglers were interviewed in the winter months than crappie anglers. The proportion of recreational anglers targeting bass was fairly constant within the seasons, ranging from 50.3 – 58.5%, but a slight decrease (43.7%) was observed in the winter months (Table 5). A slight decrease in proportion of crappie anglers interviewed was observed within the summer months followed by a slight increase in the fall while the spring and winter months had relatively average targeted pressure. The proportion of recreational anglers targeting catfish was greatest within winter (26.4%) and then gradually decreased as the year progressed to a low of 9.8% of the interviews in the fall. The proportion of anglers targeting sunfish during the summer months (6.5%), more than twice that in spring and fall, and there were no interviews on sunfish anglers during the winter months. In contrast, the proportion of anglers targeting anything remained fairly constant within each season throughout the year, ranging from 6.5 – 9.3% of total interviews.

Due to the non-uniform probability sampling regime implemented, the proportions of interviewed anglers targeting specific species within each river section were observed (Table 6). It was observed that bass was the most sought after species in sections one through four with approximately 54 – 63% of the anglers in these sections indicating bass as their target species.

Anglers targeting crappie additionally showed the same trend with most of the anglers targeting them in sections one through four (12.5 – 25.6%). However, there was a large increase in anglers targeting catfish or anything in sections five (35.6% and 28.8%, respectively) and six (37.2% and 16.3%, respectively), the uppermost and lowermost sections, while the amount of anglers targeting sunfish remained fairly low (<6.5%) through the entire study area.

While sections 1 and 2 had the most overall interviews, they also had the largest surface areas (2,732 ha and 1,951 ha, respectively) while section 3 was the next largest section with a surface area of 714 ha (Table 7). The number of on-site angler interviews conducted during the roving creel survey from January to December, 2015 per 100 hectares of reservoir surface area enabled encounter rates to be observed. This allowed us to look at the relative density of anglers targeting different species by reservoir section (Table 8). Bass had the highest encounter rates in every section except for section 6, where it was the same at catfish (3.8) encounter rates and in section 5 where catfish (3.5) had the highest encounter rates. The highest encounter rates were observed in sections one and two for recreational anglers targeting bass with rates of 5.8 and 8.6, respectively. The third highest encounter rate was 4.1 and was for anglers targeting crappie in section 2, which was more than double the next highest encounter rate for crappie anglers – 1.9 in section 1. Section 2 had the highest encounter rate at 16 interviews per 100 hectares while sections six, one, and five had similar encounter rates around 10 interviews per 100 hectares in 2015. Sections three and four had very low encounter rates at less than 5 interviews per 100 hectares, likely due to the lack of reservoir access.

III.2. Effort and Catch

Total angling effort during 2015 was estimated at 164,145 h (SE, 36,184 h) with an estimated 27,416 annual trips for boat and shore anglers combined , comprised mostly of boat anglers (Table 9). Estimated mean daily effort for recreational boat anglers was 231 h on a weekday and 806 h on a weekend-day. Estimated mean daily effort on a weekday for

recreational shore anglers was 45 h on a weekday and 59 h on a weekend-day. Most of the annual effort (146,732 h; SE, 31,112 h) was by boat anglers while the remaining 17,412 h (SE, 5,073) of effort was from shore anglers. Boat and shore anglers made an estimated 23,156 and 4,589 number of trips, respectively, in 2015.

A majority (65%) of the boat angling effort was from anglers targeting bass, followed by crappie (20%), catfish (8%), anything (4%), and sunfish (2%; Table 9). Bass anglers made the most fishing trips (13,484) and had the longest trip length (7.1 h), resulting in the largest fishing effort (95,764 h) on Millers Ferry Reservoir. Boat anglers targeting crappie had a total of 29,345 h of fishing effort with a mean trip length of 5.8 h and a total of 5,048 trips, while catfish anglers contributed a total of 12,075 h effort over 2,683 trips with a mean of 4.5 h per trip. The remaining 6% of boat effort was from anglers targeting sunfish or anything.

About half of the annual shore angling effort (9,005 h) was directed towards targeting catfish resulting in an estimated 2,263 trips with a mean of nearly 4.0 h per trip (Table 9). Shore anglers fishing for anything additionally comprised approximately a third (5,783 h) of annual shore angling effort resulting in 2,695 trips with a mean duration of 3.4 h per trip. The remaining 15% of shore effort targeted bass, crappie, and sunfish; sample sizes for shore anglers targeting these species were low, and estimates may be unreliable.

While bass were the most targeted species, crappie and catfish comprised the majority of the annual harvest (Table 9). Boat anglers harvested an estimated 30,519 crappie and 15,818 catfish from Millers Ferry Reservoir in 2015. Bass were the third most harvested species (9,576). This is the result of low harvest rates (13%) which is the bass HPE (0.10) divided by total bass CPE (0.76). Crappie had a CPE of 1.67 and a HPE of 1.04 resulting in approximately 62% of the fish caught being harvested while catfish had the highest harvest rate of 94% resulting from a CPE of 1.40 and a HPE of 1.31. Anglers targeting sunfish and anything also had high harvest rates of 46% and 87%, respectively.

Shore anglers harvested significantly less fish than boat anglers, due to large differences

in fishing effort (Table 9). A minimal amount of bass and crappie (<30) were harvested by these anglers as a result of an extremely low CPE. The largest CPE among both boat and shore anglers were from shore anglers targeting sunfish, which had a CPE of 3.48 and a high HPE of 2.00 resulting in 1,696 individuals being harvested. Approximately 991 catfish were harvested by shore anglers as well resulting from a CPE of 0.12 and HPE of 0.11. Shore anglers targeting anything harvested all captured fish (2,718) resulting from an equal CPE and HPE of 0.47.

It was estimated that 37.9% of boat angling effort was in section 2 followed by 23.6% in section 1 (Table 10). This was followed by 14.3%, 10.6%, 8.3%, and 5.3% in sections 3, 4, 6, and 5, respectively. Conversely, 39.9% and 37.5% of the shore angling effort was directed in sections 5 and 6, respectively, likely due to better shore access. Overall, an estimated 32.9% and 21.8% of fishing effort by all methods is directed in sections 2 and 1, respectively. The remaining four sections comprised 9.6 – 12.9% of the overall effort on Millers Ferry Reservoir in 2015. However, it should be noted that it appears that the fishing effort in sections 3, 4, and 6 is greater than originally assumed by the district biologist and supervisor when compared to Table 1.

III.3. Angler Socioeconomic Characteristics

Angler party size was largest for anglers targeting sunfish (2.24; N=25) and smallest for anglers targeting bass (1.71; N=386; Table 11). A One-way ANOVA ($F=4.28$, $df=724$, $P=0.001981$) with a Tukey Post-hoc test found party size for anglers targeting bass, crappie, or catfish were not statistically significantly different ($P < 0.05$) while party size for sunfish was significantly different from these anglers. Party size for anglers targeting anything was intermediate and similar to the other target species groups. The overall mean party size for all anglers contacted during the on-site roving creel survey was 1.77.

Average estimated trip expenditures collected during the on-site roving creel survey were highest for bass anglers ($215.44) followed by crappie ($190.64), sunfish ($135.60),

anything ($110.35), and catfish ($97.44) anglers; however, standard deviations were high for all target species groups (Table 11). The average trip expenditure for all anglers was $180.82. A One-way ANOVA (F=5.6, df=719, P=0.0002) with a Tukey's Post-hoc test revealed total trip expenditures were significant between bass and catfish anglers (P=0.00046), bass and anything anglers (P=0.037), and crappie and catfish anglers (P=0.049). Similarly, recreational anglers targeting bass had the highest mean local total trip expenditures of $139.79. Crappie anglers spent the second most locally per trip ($116.42) followed by sunfish ($95.08), catfish ($79.67), and anglers targeting anything ($69.08). None of these values were statistically significantly from one another (F=2.1, df=717, P=0.083). Mean local trip expenditures for all anglers was $118.41. The percentage of expenditures incurred locally was highest for catfish and sunfish anglers (82 and 70, respectively); whereas bass, crappie, and anglers targeting anything incurred between 61% and 65% of their expenditures locally.

Total estimated expenditures were similar between the on-site and follow-up survey for each target species group (P≥0.05; Table 12). However, more expenditures were estimated in the follow-up survey when considering all anglers collectively (t=-2.64, df=503, P=0.009). The largest value difference in means between these values was observed for sunfish anglers ($120; N=16). Crappie ($10; N=101), catfish ($17; N=76), bass ($34; N=279), and recreational anglers targeting anything ($41; N=34) had a difference in means considerably lower than sunfish anglers. The overall difference in means was $30 (N=506). Sunfish anglers additionally had the largest difference in means (78.4%) between on-site roving creel total trip estimated expenditures and follow-up telephone completed trip expenditures. Crappie (5.9%), catfish (14.8%), bass (16.4%), and anglers targeting anything (30.8%) had a noticeably lower difference in means. The overall difference in means for all anglers was 16.8%.

Only 30% of the anglers interviewed during the on-site roving creel survey were residents of the two counties (Wilcox and Dallas) in which Millers Ferry Reservoir is located (Table 13). Ten percent of all angler interviews were conducted on recreational anglers from

each of Mobile and Clarke County. Less than 5% of all interviewed anglers were from any other individual county in Alabama. While approximately 1/3 of the anglers were residents of the two counties in which the study site was located, a majority of the interviewees outside of local counties were from areas to the southwest of the reservoir and around Birmingham, Alabama, located in Jefferson County (Figure 3). Anglers interviewed during the study were residents of 33 out of the 67 Alabama counties. Most interviewees were from Alabama (89.6%); whereas 6.5% were from Florida, 3.2% from Mississippi, and Georgia, Iowa, Michigan, Nebraska, and Tennessee were represented by one angler each. No resident information was obtained for six of the anglers interviewed.

Eighty-five percent of anglers targeting bass were from Alabama with the counties with the highest representation being Mobile and Clarke County, each with 13% of anglers indicating they were residents of those counties (Table 13). Escambia (10%), Dallas (9%), and Covington (7%) also had large numbers of bass anglers travelling to fish at Millers Ferry Reservoir. Ninety-two percent of crappie anglers indicated that they were residents of Alabama with Wilcox (25%) and Clarke County (15%) being the most represented. Nearly all (96.4%) of anglers targeting catfish were residents of Alabama with 65% of them indicating they were residents of the two counties in which the study site is located. While 96% of the sunfish anglers were residents of Alabama, no county had more than six interviewees making it difficult to make inferences. Similar to catfish, 98% of anglers targeting anything were from Alabama with Dallas (38%) and Wilcox County (25%) being the most represented of Alabama counties.

Anglers targeting bass and crappie both travelled a mean of 134 km one-way to fish at Millers Ferry Reservoir (Table 14). Sunfish (97 km), anything (66 km), and catfish anglers (59 km) travelled a shorter distance to fish at Millers Ferry Reservoir. The overall mean one-way travel distance for all anglers was 115.2 km. When contacted during the roving creel survey, sunfish anglers had the longest average trip length at 7.3 days total, followed by crappie (3.6), anything (3.0), bass (2.9) and catfish (2.1) anglers. However, anglers targeting crappie and

catfish angled for their respective species about 49 days in the 12 months prior to their on-site interview. Anglers targeting anything fished at Millers Ferry Reservoir a mean of 43 days in the 12 months prior to their on-site interview followed by bass and sunfish anglers at 32 and 29 days, respectively.

Forty-five percent of bass anglers indicated that their trip was directly related to a tournament, either by pre-fishing for a future tournament or actively fishing in a tournament at the time of their interview (Table 14). Of these, 31% of the anglers were prefishing for a tournament while the remaining 69% were actively fishing in a tournament. Spring was the season in which most (45%) of the bass anglers mentioned their trip was related to a tournament were fishing, followed by summer (30%), fall (16%), and winter (9%). Only two (0.01%) crappie anglers indicated their trip was related to a tournament; anglers targeting other species groups did not mention that their trip was related to a tournament. Similarly, anglers that were targeting bass fished a mean of 3.5 tournaments on Millers Ferry Reservoir in the 12 months prior to their on-site interview. Anglers targeting any other species besides bass fished a mean on 0.3 or fewer tournaments on the reservoir in this same time frame. Bass anglers were also the most likely to be a member of a fishing club (41%); less than 3% of all other anglers were members of a fishing club. On a quality of fishing scale from 1 (poor) to 5 (excellent), bass anglers were the most satisfied with the quality of fishing at 2.5 followed by sunfish (2.3), crappie and anything (each at 2.1), and catfish (1.9) anglers. The one-way distance to travel to an alternate fishing site was largest for sunfish, bass, and crappie anglers at 140, 113, and 100 km, respectively (Table 14). Anglers targeting catfish (71 km) and anything (58 km) mentioned they would travel shorter distances.

The age distribution of anglers fishing at Millers Ferry Reservoir in 2015 was represented by a normal distribution (Figure 4). On average, crappie anglers were the oldest anglers with a mean age of 57 years old (Table 14). Sunfish, catfish, and anglers targeting anything all had a mean age of 50 or above; bass anglers were the only anglers with an

average age below 50. Sunfish anglers had the fewest years of fishing experience targeting any species (33), followed by bass (35) and anything anglers (35) and crappie (43) and catfish (43) anglers (Table 14). The mean yearly household income varied considerably among target species groups with a high of $94,490 for bass anglers and a low of $42,858 for anglers targeting anything. Most anglers had a mean annual household income of less than $150,000 per year while most anglers targeting catfish or anything had a mean annual household income of less than $100,000 per year (Figure 5). Overall, mean annual household income across all anglers was $80,830.

III.4. Expenditures and Tax Revenue

From the second follow-up telephone survey, it was estimated that bass, crappie, and sunfish anglers spent $36.81, $17.76, and $19.67, respectively, on boat fuel per day. Recreational anglers targeting catfish, anything, or other spent $17.37 on boat fuel per day. Among all anglers, the largest percentage of expenditures (35.9%) were incurred from fuel costs, followed by groceries (24.7%), equipment and bait (14.0%), and lodging (9.0%; Table 15). Restaurant meals (6.8%), tournament fees (5.2%), repairs or other (3.3%), and boat launch fees (1.1%) comprised the remainder of expenditures. A similar pattern was observed for all anglers in each target species group except bass, in which equal amounts of money were spent on tournament fees and groceries. Bass anglers spent the most per trip day ($125), while anglers targeting any other target species spent approximately half as much per trip day (Table 15).

Anglers fishing for one day spent less per day than anglers fishing for multiple consecutive days (Table 15). Bass anglers spent the most per day of day trip anglers with a mean of $122 in expenditures, followed by crappie ($48), catfish ($44), anything ($43), and sunfish ($38) anglers. Similar to day trip anglers, bass anglers staying overnight spent $127 per trip day, more than any other targeted species (Table 15). Overnight anglers fishing for anything

spent the second most per trip day ($90); anglers targeting other species groups each spent less than $80 per day. Day trip anglers targeting bass spent 96% of the amount of the expenditures per day that bass anglers staying overnight spent; whereas those targeting any other species only spent between 48 – 62% of the amount per day that their overnight counterparts spent.

Anglers fishing from boat generally spent more per day than those fishing from shore for all targeted species except for sunfish (Table 16). However, low sample sizes for shore anglers have affected these results. Boat anglers targeting bass spent the most with $125 in mean daily expenditures, followed by those targeting anything ($78), catfish ($69), crappie ($64), and sunfish ($58). Part of the difference in expenditures among target species groups was due to bass anglers spending roughly twice as much as anglers targeting other species on fuel costs, especially for boats. However, anglers in all target species groups spent the largest percentage of total trip expenditures on fuel (32 – 43%), followed by groceries (15 – 30%; Table 16). Catfish and anything shore anglers spent $20 and $38 per trip day, respectively, mostly for equipment and bait (Table 16). Too few shore anglers targeting other species groups were encountered to make inferences about their expenditures.

Out-of-state angling parties spent $405 per trip with an average trip length of 4.7 days. Their cost per trip was higher than for local anglers ($58) and non-local anglers ($319), anglers from Alabama outside of the two aforementioned counties. However, non-local and local anglers had shorter average trip lengths (3.5 and 1.1 days, respectively).

Over 90% of all expenditures were incurred within the state of Alabama for all target species groups and expenditure category (excluding boat ramp and tournament fees) combination except for grocery expenditures incurred by sunfish anglers (74%; Table 17). All expenditures were incurred in Alabama for 18 of these 30 target species-expenditure category combinations. Wilcox County was the location of between 34 and 100% of all expenditures for each target species-expenditure category combinations, excluding other (Table 17). Most

lodging expenses for all anglers were incurred within Wilcox County as well as approximately 40% of all fuel expenses. Food, meal, and equipment and bait expenditure percentages within Wilcox County were much more variable among target species groups. The cities of Camden, Pine Hill, and Yellow Bluff are all located within Wilcox County. The percentage of total expenditures incurred in Camden for each target species group-expenditure category combination varied between 16 and 93%. Minimal amount of expenditures were incurred in Pine Hill and Yellow Bluff. Dallas County was the location of between 0 and 22% of all expenditures for each target species group-expenditure category combination (Table 17). Fewer expenditures were incurred in Dallas County in relation to Wilcox County. Only fuel for crappie anglers (11%), food for anything anglers (19%), and bait and equipment for crappie and catfish anglers (22 and 21%, respectively) had more than 10% of total expenditures in each target species-expenditure category occur in Dallas County.

Total extrapolated expenditures for all anglers fishing at Millers Ferry Reservoir in 2015 were estimated at $2.53 million (Table 18). Expenditures by bass anglers comprised 68% of the total followed by crappie (13%), catfish (11%), anything (6%), and sunfish anglers (2%). Fuel and grocery comprised more than half of all estimated expenditures, followed by equipment and bait (12%), tournament fees (11%); expenditures in other categories collectively comprised less than 20% of the total.

Based off of total extrapolated expenditures (Table 18), percent of expenditures by expenditure category, targeted species, and location (Table 17), and tax rates for all TMs, a total summation of $161,951 in tax revenue was generated for these TMs by all recreational anglers (Table 19). Approximately 45% of this tax revenue was generated from general sales, 39% from fuel, and 16% from lodging expenditures. An estimated $108,516 in tax revenue was generated for the State of Alabama compared to $35,296 and $1,780 in tax revenue for Wilcox and Dallas County, respectively. Camden, Pine Hill, and Yellow Bluff collected an estimated $13,347, $76, and $119, respectively, in generated taxes from anglers fishing at Millers Ferry

Reservoir. Angler expenditures resulted in an estimated $2,817 in generated tax revenue for Selma.

Most (62%) total estimated tax revenue was generated by recreational bass anglers for all TMs (Table 20). Across TMs, bass anglers generated an estimated $40,699 in general sales, $44,395 in fuel, and $15,677 in lodging tax revenue. The State of Alabama collected the most tax revenue (69%) from these anglers, followed by Wilcox County (21%) and Camden (8%); other TMs accounted for less than 2% of total tax revenue generated. Anglers targeting crappie generated $22661 in tax revenue across TMs, mostly from general sales (48%) and fuel (39%; Table 21). Distribution of tax revenue across TMs was similar to that described for bass anglers. Catfish anglers generated similar amounts of tax revenue as crappie anglers, with a similar distribution across expenditure categories and TMs (Table 22). Tax revenue generated by anglers for the other two target species groups combined for less than 11% of total tax revenue (Tables 23 and 24).

III.5. Travel Cost Model and Consumer Surplus

I do not currently have results to present on these parts due to time constraints and issues that arose within the model. We are working to get these issues resolved as quickly as possible to allow TCM and consumer surplus results to be presented in the future. However, I expect the same inverse relationship to hold true such that an angler will make less visits to a destination as the cost associated with this trip increases. I would expect the travel cost, opportunity cost to travel to an alternative site, and anglers' household income, and various other socio-demographic variables, realized through the analysis, to be significant in these results. Based on these values, I would have been able to estimate the number of trips an anglers would be willing to take based on these variables.

IV. DISCUSSION

IV.1. Roving Creel Survey

An average of 3.9 on-site interviews were conducted during each roving creel survey which was intermediate to similar surveys on Lewis Smith Lake, Alabama (1.9; Lothrop 2012) and Lake Guntersville, Alabama (4.8; McKee 2013) Similar to these surveys, few anglers refused to participate in the on-site survey on Millers Ferry Reservoir. Low rejection rates could result from each researcher learning from the previous ones on how to appropriately ask questions in a non-threatening manner and could result from anglers understanding that the results of the surveys can benefit their angling experience and would not harm it. These surveys were conducted in a manner to minimize interference with the angler's fishing experience. Use of a trolling motor which allowed us to easily hold position or move alongside anglers also using trolling motors permitted minimal disturbance to their fishing trip. However, avoiding disturbance to a trip is much more difficult where other fishing methods, such as trolling and down-rigging, are more prevalent (Lothrop 2012).

Anglers that frequent waterbodies multiple times throughout the year are more likely to be interviewed than a one-time visitor, leading to endogenous stratification or avidity bias (Englin and Shonkwiler 1995). This would make our results more similar to those found with the avid anglers. Endogenous stratification was corrected by applying a non-uniform probability sampling regime and obtaining a large sample size. Thomson (1991) found that expenditure estimates per trip were not affected by avidity and that using a non-uniform probability sampling design, similar to the one used in this study, was effective at correcting avidity bias. Further, only 16% of interviews were with parties who had been interviewed previously during the study. Thus, endogenous stratification likely had little impact on study results.

IV.2. Follow-up Telephone Survey

Follow-up telephone interviews were conducted to minimize the length of the on-site

interviews and to compile completed trip information including expenditures. It has been found that on-site roving creel estimated trip expenditures underestimate completed trip expenditures (Lothrop 2012; McKee 2013). Anglers may have also experienced unintended expenditures after initial contact. Angling success or changes in weather may additionally alter the amount of effort applied by an angler than originally anticipated. Overall follow-up telephone response rate was 69% with anglers targeting anything having the lowest response rate (56%) and bass anglers having the highest response rate (72%). An adjusted response rate of 72% was observed when wrong numbers were removed and a response rate of 81% was observed for people who agreed to the follow-up telephone interview with a valid telephone number. The overall response rate was 16% higher than that observed for a similarly designed study on Lake Guntersville (McKee 2013). These values were much higher than mail-in response rates found on Alabama waterbodies by Quintana (25%; 2015) and Snellings (26%; 2015). Similarly, Schroeder et al. (2008) had a successful mail-in survey response rate of 39.3% for Minneapolis-St. Paul, Minnesota from metropolitan residents while Criddle et al. (2001) observed a mail-in survey response rate of 70%. Our adjusted response rate was slightly higher than that observed by Hutt et al. (2013) who obtained a response rate of 78% and 74% for two recruited mail-in surveys on Mississippi reservoirs. These above average response rates for a mail-in survey found by Hutt et al. (2013) may highlight the importance of informing anglers about the survey and not randomly targeting anglers based on licensure status or simply handing them a survey packet at a fishing event. Varying degrees of response rates can be observed partially due to a temporal variation in participation and due to sociodemographic differences of anglers among targeted species and waterbodies (Wallen et al. 2016).

My second follow-up telephone survey reported a response rate, compared to the original sample size, of only 48%. This 24% discrepancy between follow-up calls. This may be a result of building credibility with the angler and second interviews being conducted approximately one year after first contacting the anglers at Millers Ferry Reservoir. Many

anglers, when answering my attempt the first time, mentioned that they answered the call from an unknown number, because they were expecting a follow-up call. When conducting the second follow-up calls, they may have been less likely to answer since they did not anticipate the additional contact attempt. Telephone surveys make the angler-researcher interaction more personable and does not require the angler to keep track of a tangible, affecting the success rate.

IV.3. Effort and Catch

The distribution of anglers across target species groups differed between this study and an access point survey conducted by ADCNR biologists in March – June, 2014. The ADCNR survey found that 79% of anglers were targeting bass while the present survey found that 55% of anglers were targeting bass during the same time period. Compared to my study, the access point survey at Millers Ferry Reservoir slightly underestimated the percent of anglers targeting crappie (17%) and severely underestimated the percent of anglers targeting catfish at 1% as compared to 14% during my study over the same time period. The slight underestimation of crappie anglers may be due to these anglers having a higher probability of owning waterfront property on Millers Ferry Reservoir. Thus, these anglers do not regularly use the boat ramps and exposes one of the limitations of an access point survey (Pollock 1994). The severe underestimation of the remaining targeted species may be the result of another limitation of access point surveys. While they primarily focus around boat launches, they may not proportionally sample shore anglers since they often utilized areas not located around boat ramps at Millers Ferry Reservoir. Approximately half of the effort for catfish and anything anglers was by shore, thus eliminating most of these people from possible inclusion in reporting. Sampling at major access areas may contribute to the difference in proportions as major bass tournaments prefer to use larger ramps accommodating more boats while other anglers may tend to avoid these ramps and the congestion associated with them. This same trend was

observed by McKee (2013) for roving creel surveys and ADCNR access point surveys conducted on Lake Guntersville in 2010 and spring 2011, respectively.

Shore anglers comprised 10% of all anglers' on-site interviews at Millers Ferry Reservoir comparable to what McKee (2013) found at Lake Guntersville. However, the majority of shore anglers at Lake Guntersville were targeting crappie; whereas catfish and anything anglers comprised 86% of shore angler interviews at Millers Ferry Reservoir. Target species of shore anglers could be influenced by their demographics, the location and availability of shore access, and the spatial distribution of habitat in each waterbody. The proximity to populated areas and availability of shore access at Millers Ferry Reservoir resulted in a noticeable difference in distribution of shore anglers across sample sections. Over 90% of anglers interviewed in sections 1 through 4 were fishing from a boat, whereas only about half of the anglers in sections 5 and 6 were fishing from a boat. Section 5 was located within the city limits of Selma which resulted in the large shore fishery since anglers could easily drive to the marina where most of the effort was located and had uninhibited shoreline devoid of trees. However, access to this area was minimal with less than 100 meters of unobstructed shoreline which created a congested fishery. However, much more shore access was available near the lower portions of the reservoir in sections 1 and 6. Section 6, the tailrace of Millers Ferry Reservoir, experienced increased shore fishing effort due to the city of Camden nearby, the availability of close parking, and large amount of optimal shore access (>500 m). However, section 1 also had many opportunities for shore access directly above the lock and dam, but an angler was required to walk much longer distances from the parking areas to access waters more than 7 feet deep. Thus, the presence of deep water near a parking lot may help entice shore anglers to fish in a particular area over another.

We observed most of the fishing effort in the spring and summer months with nearly equal amount during the fall and winter. Lothrop (2012) observed this same decrease from spring through the winter months on Lewis Smith Lake, Alabama, but McKee (2013) observed a

similar decrease in angling effort from the spring through fall on Lake Guntersville, Alabama. Part of this discrepancy could be explained by differences in weather and yearly distribution of fishing tournaments. However, it could also be a result of other recreational hobbies. Throughout personal conversation with anglers during the earlier months in 2015, they mentioned that fishing effort would decline in the fall and winter months at our study site due to the availability of hunting in the area.

Differences in the proportion of times a time block was sampled relative to the number of interviews per target species group were observed. Most of the proportions were fairly consistent among time block and targeted species. However, it was observed that bass anglers were more likely to be observed during the AM time block rather than the PM time block and crappie anglers were proportionally more likely to be interviewed during the NN time block rather than the PM time block. The difference in bass anglers could be explained by the excess of tournament anglers fishing at Millers Ferry Reservoir. Tournaments typically began at or before 7 am, the approximate time when interviews commenced. Thus, anglers were available for interview for the whole duration of the AM time block. However, anglers were often interviewed during the PM time block from 3 to 6 pm. Due to the linearity of the reservoir, instantaneous counts often began at boat ramps utilized by the bass anglers. Most of these bass tournaments would require their participants to be out of the water by 3 or 4 pm. By the time I would return to the beginning of the section, nearly all of the bass tournament anglers would be removed from the reservoir. While multiple factors may contribute to the difference in fishing time preference for crappie anglers, it is likely due to the extreme afternoon heat present where the study site is located. Overall, anglers at Millers Ferry Reservoir fishing for any targeted species were more likely to be fishing during the NN time block than the rate that each time block sampled would suggest. This same trend was also observed on Lake Guntersville, Alabama for all target species groups except for catfish anglers which preferred the PM time block (McKee 2013). Lothrop (2014) found that Striped Bass anglers preferred fishing in the

morning periods in a similarly designed study on Lewis Smith Lake, Alabama. As is often assumed, effort targeting a specific species can vary spatially and temporally depending on perceived fish movement and anglers' preferences.

After the amount of effort by section was calculated based off counts from the instantaneous count, results indicated the district biologist and supervisor slightly overestimated how often anglers would be encountered in the two most frequented sections. They estimated that at any given time, 29% and 39% of the anglers were fishing in sections 1 and 2, respectively, while these effort percentages were determined to be 22% and 33%, respectively. They also overestimated the utilization of section 5 by 6%. While percent use estimates for section 6 were similar, the use of sections 3 and 4 was underestimated by about three fold. Since the district in which the study site is located is responsible for managing fish populations in multiple Alabama counties including the Mobile Bay which experiences tremendous fishing pressure, it is often difficult to obtain accurate estimates ahead of time. Limited access in sections 3 and 4 likely limit these estimates as well since many of the anglers fishing in these sections launch in other sections.

The amount of effort (97,257 h) put forth targeting bass at Millers Ferry Reservoir in 2015 comprised 59% of the total effort and was very respectable, but it was much less than that observed at the trophy bass fishery of Lake Guntersville, Alabama (968,800 h; McKee 2013). A bass angler's average trip day was 7.1 h in length at Millers Ferry Reservoir and was similar to that at Lake Guntersville, Alabama (McKee 2013), but longer than that found by Lothrop (2014) on Lewis Smith Lake, Alabama (5.2 h). Contrasting results were observed between the catch rates of bass at Millers Ferry Reservoir and the ADCNR survey, on the same reservoir, in 2014 (ADCNR, unpublished data). During my study, a CPE of 0.75 and a HPE of 0.10 were calculated, and the ADCNR survey observed a CPE of 0.64 and HPE of 0.01 which coincide more closely with those found by McKee (2013) at Lake Guntersville, Alabama. Lothrop (2014) also found bass catch and harvest rates on Lewis Smith Lake, Alabama similar to at Millers

Ferry Reservoir of 0.76 and 0.20, respectively. These discrepancies may arise between the surveys based on seasonal patterns which fluctuate from year to year among and within waterbodies, which can make it more difficult to make these comparisons (ADCNR, unpublished data). Lake Guntersville, Alabama also receives much more fishing effort which may allow for the bass to become accustomed to the presence of anglers and resulting in lure avoidance and decreases in catch rates (Hessenauer 2016).

Observed crappie catch rates at Millers Ferry Reservoir (1.64) were lower than that found on Lake Guntersville, Alabama (2.47; McKee 2013). Lothrop (2014) also observed higher CPE of crappie at Lewis Smith Lake, Alabama with 2.63 fish caught per hour. Accordingly, Lake Guntersville and Lewis Smith Lake also had higher harvest rates. However, the catch and harvest rates observed at Millers Ferry Reservoir for crappie during my study were about three times higher than found during the ADCNR survey (ADCNR, unpublished data). Consequently, crappie anglers angled for a longer time period where the higher CPE and HPE estimates were observed. However, the CPE at Millers Ferry Reservoir (1.11) was much greater than that observed at Lake Guntersville (0.33) as well as the harvest rate. Observed CPE and HPE on Millers Ferry Reservoir were higher during my study in 2015 than was found during an ADCNR survey in 2014 but remained consistent for anglers targeting catfish (ADCNR, unpublished data). Mallison and Cichra (2004), Alexiades et al. (2015), and McCormick et al. (2012) all found differences in catch estimates from incomplete and complete catch rate estimates where the amount of error depends on the model used. There is additionally error in these estimates resulting from uncertainty due to human behavior, fish behavior, and environmental factors – all of which influence measurement and variation. There is also the assumption that catchability is constant and fish foraging and behavior is random. With all of these varying factors to consider, it is not uncommon for catch rates to fluctuate spatially and temporally.

IV.4. Angler Socioeconomic Characteristics

The mean party size for all target species groups at Millers Ferry Reservoir was 1.77 where all target species groups besides bass had a mean party size above the overall mean indicating that the large number of bass anglers strongly influenced this value. These party sizes are similar to other findings where McKee (2013) observed an average party size of 1.84 on Lake Guntersville, Alabama with a mean bass party size below the average. The repeated finding that bass anglers' party sizes are below the overall mean may suggest that they participate in fishing more for sport and relaxation than for social reasons. Anglers partake in the sport for varying reasons depending on the avidity of an angler (Quintana 2015). Metropolitan anglers that fish near metropolitan complexes do so for health (reducing stress and tension), appreciation (escaping nature and escaping the crowds and noise), and affiliation with family and friends (Schroeder et al. 2008). Anglers also prefer to catch targeted species, know that trophy size fish are available, have well-maintained and natural setting, and adequate boat access (Quintana 2015).

Thirty-three percent of the anglers from Alabama interviewed during the roving creel survey were from the two counties in which the study site was located. Conversely, 63% of the Alabama anglers interviewed at Lake Guntersville, Alabama were from the three counties in which that waterbody is located (McKee 2013) suggesting that Alabama anglers travelled at higher rates to visit Millers Ferry Reservoir than Lake Guntersville. However, this may partially be due to the locality of the waterbodies such that many Alabama anglers visiting Millers Ferry Reservoir travelled from around Mobile Bay where they are restricted by the Gulf of Mexico to the south possibly limiting their freshwater fishing destination opportunities. Contrary to this observation, most anglers fishing at Millers Ferry Reservoir in 2015 were from the state of Alabama while less (71%) of all angler fishing at Lake Guntersville, Alabama were from Alabama suggesting that the latter acts more as a destination fishery. Chen et al. (2003) and Driscoll et al. (2010) found that intermediate percentages of anglers fishing Lake Fork and Sam

Rayburn Reservoir, Texas were residents of that state. While Lake Fork Reservoir, Sam Rayburn Reservoir, and Lake Guntersville are all trophy largemouth bass destinations, it is evident that out of state angler participation can vary regionally. When comparing an anglers' targeted species to their county or state of residence, it was found that in both my study and the similar study on Lake Guntersville, Alabama, anglers targeting catfish or anything were more likely to be residents of the surrounding counties while bass anglers have a much higher probability of travelling from out of state. The residence of anglers fishing a certain waterbody can vary spatially, but these ratios may be influenced by other factors (Colle et al. 1987). Anglers are oftentimes more willing to travel farther distances to fish well-known reservoirs (Martin et al. 2015). While bass anglers travel from further distances, bass are often assumed more of a prized fish whereas seeking, i.e. catfish, is typically a more urban fishery.

The average distance travelled one way for all anglers was 115 km while bass and crappie anglers both travelled an average of 134 km one-way to fish at Millers Ferry Reservoir; whereas, catfish and anything anglers travelled shorter distances, similar to that found by McKee (2013). These larger distances travelled by bass and crappie anglers may be explained by a few different findings. First, 45% of bass anglers' contacted at Millers Ferry Reservoir indicated that their trip was related to a tournament creating greater incentive (i.e. tournament winnings) to travel farther distances. Secondly, the probability of a crappie angler owning waterfront property was higher than for any other target species group suggesting that crappie anglers may be willing to travel longer distances if they owned waterfront property lessening the expenses incurred on their trip. Depending on the spatial distribution of reservoirs within the state in relation to proximity of metropolitan areas and popularity of nearby waterbodies, reservoirs may be experiencing overlapping areas of influence (Martin et al. 2015).

Sunfish anglers had the longest trip duration (7.3 days) at Millers Ferry Reservoir while the remaining target species groups had a similar average. However, it should be noted that the sample size for trips taken by sunfish angler was low (N=16) and was largely driven by an

outlier staying 60 days. With this individual removed from this calculation, the average trip length for sunfish anglers is more consistent with the other target species groups. Length of trip seemed to have no relation to the quality of fishing, whether or not their trip was related to a tournament, whether they owned waterfront property, or the number of days spent fishing at Millers Ferry Reservoir in the 12 months prior to their contact.

Similar to that found by McKee (2013), bass anglers were, on average, the youngest target species group. We additionally noticed a similar trend of household incomes among target species groups as McKee (2013), where bass anglers had the highest household income, followed by sunfish and crappie anglers. This was followed by a significant decrease in household income for anglers targeting catfish and anything. These results are not surprising as catfish and anything anglers are more likely to be local anglers, travelling to Millers Ferry Reservoir from the local area. According to the 2010 census, Dallas and Wilcox County had annual household incomes of $26,029 and $23,491, respectively and ranked as the 5th and 2nd poorest counties, respectively, in Alabama (U.S. Census Bureau 2010).

A large discrepancy was noticed between the race of anglers located within Dallas and Wilcox County and the ratio of anglers utilizing the resource. The Blackbelt Economic Development Alliance (2010) noted that approximately 70% of the population in each of the counties was of African American descent. However, I found that 88% of the anglers interviewed were of white/Caucasian descent. This is similar to the findings of a trout economic study conducted on the Canyon Reservoir tailrace in Texas where 87% of anglers were white/Caucasian (Bradle et al. 2006). They also observed that 98% of the anglers interviewed were males while 81% of anglers in our interviewed parties were male. Since about 1/3 of the people in each of these two counties are also under the age of 18 and less than 10% of anglers we interviewed were under this age, it is apparent that there is underrepresentation from the African American and younger individuals partaking in this pastime. However, the low annual household income in combination with expenses incurred to fish may contribute to these

differences. It is a general conclusion that there is often less participation by females, poorer and unemployed individuals, individuals from ethnic and racial minorities, and urban residents (Hunt et al. 2017).

IV.5. Expenditures and Tax Revenue

These projects have been conducted at varying reservoirs in Alabama since 2010 and have resulted in varying differences between on-site incomplete trip estimated expenditures and follow-up completed trip expenditures. At my study site, anglers underestimated their completed trip expenditures by 17% when asked to estimate total expenses incurred during the on-site survey. The same trend was observed by McKee (2013) and Lothrop (2012) where underestimates of 12% and 28%, respectively, were observed. When anglers were asked for a single number, total trip expenditure estimate during the on-site survey, they may answer the question without considering all possible expenditures. During the follow-up survey, asking anglers about expenditures in specific categories (i.e. fuel, lodging, groceries, tournament fees, etc.) may help illicit more accurate responses as they do not need to quickly sum all possible expenditures and can instead consider expenses in each category individually. Asking these questions during the follow-up telephone interview also allows more clarification from the researcher (Pollock et al. 1994). However, it remains important to ask these questions during the on-site survey so that correction factors can be realized.

Among all target species, anglers spent the most on automotive and boat fuel, where applicable and bass anglers spent approximately twice as much as any other targeted species group on fuel. Bass anglers had shorter trip lengths causing their fuel expenditures to be spread out among fewer days and many were participating in tournaments. Differences in daily expenditures between bass anglers and all other target species groups is mainly driven by the difference in boat fuel costs. The higher expenditures trend from bass anglers has dually been noted by Long and Melstrom (2016) where anglers fishing for black bass and trout spent more

than those fishing for catfish and sunfish. Through observation, it was noticed that many of the tournament bass anglers used larger boats and were willing to travel further distances via boat in search of larger fish. Depending on the boat launch site of the tournament, some of these anglers would travel over 60 km by water to fish in a certain area. This trend was also observed by McKee (2013) on Lake Guntersville, Alabama, where bass anglers spent at least three times as much per trip on gas than any other targeted species group except for sunfish.

Groceries and fishing equipment and bait were the next two largest expenditure categories on Millers Ferry Reservoir in 2015. Lothrop (2012) noticed this same trend in expenditures for anglers targeting Striped Bass on Lewis Smith Lake, Alabama; however, these anglers also incurred large guide service costs, which were not present at my study location. Tournament anglers have also been found to incur direct expenditures in different categories than non-tournament anglers (Snellings 2015). All target species groups spent similar amounts within most of the expenditure categories except for tournament fees. Bass anglers were the only target species group to incur direct expenditures related to tournament fees contributing to the difference in direct expenditures between target species groups. Overall, bass anglers spent approximately twice as much as any other target species group per angling party day, which is mainly attributable to the differences in fuel expenditures and the addition of tournament fee costs.

Angling parties staying overnight spent more per day than those only staying for only one day. All target species groups day trip anglers incurred direct expenditures totaling between 48% and 62% per day of their overnight counterparts except bass in which the expenditures per day were similar among day and overnight trip anglers. Angling parties staying overnight spent much more in the lodging, groceries, and restaurant categories per trip day while those fishing at Millers Ferry Reservoir for the day spent more in the equipment and bait and tournament fee categories per day. This trend is often expected as anglers fishing at a waterbody for only a single day will not normally incur lodging costs and they will typically eat breakfast at home

before leaving to fish for the day or wait to have dinner until they return to their residence. The large difference in tournament fees per angling day suggests that many of the bass tournament anglers only travelled to fish at the reservoir for the day, before returning to their residence that same day.

Boat anglers additionally spent more per day than shore anglers among anglers targeting catfish or anything. Shore anglers spent the most on equipment and bait and similar amounts in all other expenditure category. Most of these shore anglers travelled from short distances to fish at Millers Ferry Reservoir making it reasonable that they incurred little fuel costs. Shore anglers fishing for catfish and anything spent 29% and 49%, respectively, per trip day as their boat angling counterparts. Most of this discrepancy is attributed to fuel, lodging, and grocery costs since boat anglers were more likely to stay overnight. Similarly, Henderson et al. (2003) found that boat anglers staying overnight resulted in the highest trip expenditures. Hebdon et al. (2008) observed that urban pond anglers spent more on a trip than anglers fishing in nonurban fisheries showing the importance of these urban shore fisheries to the overall economic impact of a reservoir. Most of the shore effort at Millers Ferry Reservoir occurred in more urban areas and contributed more per angling day to the overall economic impact than the anglers fishing in nonurban areas. This makes it dually important to make these urban fisheries available as it provides affordable recreation which is especially important in the surrounding communities of Millers Ferry Reservoir are economically deprived (Blackbelt Economic Development Alliance 2010).

Using trip day averages observed during the follow-up telephone survey and mean differences observed between roving creel estimated trip expenditures and follow-up telephone completed trip expenditures, I was able to estimate the total trip costs for all anglers contacted during the on-site survey. Local anglers, those whose primary residence was in Dallas or Wilcox County, stayed an average of 1.1 days at Millers Ferry Reservoir resulting in trip expenditures totaling $58 per trip. Non-local anglers, those from Alabama outside of the two local counties,

and out-of-state anglers spent more per trip than local anglers with direct expenditures totaling $319 and $405, respectively, per trip; however, out-of-state anglers stayed at Millers Ferry Reservoir for a longer period (4.7 days) than non-local anglers (3.5 days), resulting in similar average daily expenditures. Similarly, Hutt et al. (2013) found on two Mississippi reservoirs, resident anglers stayed 1.2 days at each and nonresident anglers stayed 3.7 and 4.1 days. While a trophy bass fishery in Texas experienced a significantly higher fishing effort than was found in my study, higher expenditures per trip were found at Millers Ferry Reservoir (Chen et al. 2003). It is important to study the association between the effort and expenditures to better understand the relationship.

Recreational anglers spent an estimated $2.5 million in direct expenditures to fish at Millers Ferry Reservoir in 2015. This equates to 19% of the expenditures incurred to fish at Lake Guntersville, Alabama (McKee 2013) and 8% of that of Sam Rayburn Reservoir, Texas (Driscoll and Myers 2014), both well-known trophy bass fisheries. Most of the expenditures incurred to fish at Millers Ferry Reservoir and the largest amount of effort were a result of bass anglers. Following along the same trend, crappie accounted for the next highest expenditures ($0.33 million), followed by catfish ($0.27 million). Fuel was the highest expenditure category at $0.97 million, followed by groceries ($0.50 million) and equipment and bait ($0.31 million). Only 8% of direct expenditures incurred to fish at Millers Ferry Reservoir were for lodging compared to 23% at Lake Fork, Texas which may reflect the consequences of limited lodging opportunities in Dallas and Wilcox Counties to the overall economic impact (Chen et al. 2003). Boat anglers also accounted for 94% of all expenditures.

It was noticed that from all expenditures mentioned during the follow-up telephone interview that 90% of all expenditures to fish at Millers Ferry Reservoir, were done so in the state of Alabama while approximately 50% were incurred locally. McKee (2013) found that 88% of expenditures incurred to fish at Lake Guntersville were done so in the state of Alabama which is consistent with our findings; however, 80% of the expenditures in their study were incurred

locally, a difference of 30%. Similar to the findings at Lake Guntersville, Lothrop (2014) found that 84% of the direct expenditures were incurred locally. A lot of this discrepancy may be attributed to the limited resources in Wilcox County in which many of the anglers' destinations and launch sites were located suggesting that expenditures within the region could increase if more shopping opportunities were available. Other economic impact assessments have similarly found that a large proportion (>85%) of direct expenditures incurred to fish a waterbody are done so in the state where the waterbody is located (Driscoll et al. 2010). Further studies could be conducted with other user groups in the local area to discover and address deficiencies.

All TMs administered general sales tax which was applied to the sale of groceries, restaurant meals, equipment and bait, and other expenditure categories. General sales expenditures within the state of Alabama totaled $1.0 million for all anglers and at a tax rate of 4.0%, generated $41,219 for the state of Alabama in tax revenue. Collectively, all TMs benefited from $72,741 in generated tax revenue from applied general sales tax. However, only five of the seven TMs administered fuel tax. The state of Alabama administered the most aggressive fuel tax at $0.16 per gallon generating $59,339 in tax revenue from anglers visiting Millers Ferry Reservoir in 2015. Approximately 6.7% of the fuel tax revenue collected by the state of Alabama is returned directly to the counties (The Legislative Fiscal Office 2015). From this percentage, 55% is distributed based on population and the remaining 45% is distributed equally among the 67 Alabama counties. This dispersal of funds helps generate additional revenue for the local areas. Wilcox County, where $0.40 million in fuel was expended, benefited from $3,211 in tax revenue from fuel without the state apportioned funds. Camden did not apply fuel tax and an estimated $0.25 million in fuel expenditures was incurred in the city. If it had applied a fuel tax of $0.02, it would have benefited from an estimated $2,023 in fuel tax revenue from anglers visiting Millers Ferry Reservoir in 2015. Among all of the TMs, $63,771 was generated in fuel tax revenue by recreational anglers at this reservoir. Only four of the TMs additionally applied

lodging tax. Pine Hill and Yellow Bluff likely did not do so since lodging was not available in either of these TMs. Collectively, lodging tax generated $25,439 in tax revenue for the remaining TMs. Revenue generated from lodging tax can be very beneficial to surrounding communities (Chen et al. 2003).

IV.6. Travel Cost Model and Consumer Surplus

While I do not have results to discuss at the current time, there are estimates that can be made as to what the model may suggest. We would expect the results of our study to resemble those found by Lothrop (2012) on Lewis Smith Lake, Alabama. However, he only observed the TCM and resulting consumer surplus for Striped Bass anglers, but results in other categories (i.e. CPE, household income, etc.) for targeted species found in both reservoirs seemed similar. Snellings (2015) found that years of tournament experience and days spent practicing as statistically significant in determining the demand for trips taken for bass tournament anglers on Lake Guntersville, Alabama. This is not surprising as anglers that often participate in tournaments are often more dedicated anglers, have more years of fishing experience, and are willing to spend extra money to travel to and participate in tournaments. Since 45% of the bass anglers (approximately 25% overall) fishing Millers Ferry Reservoir in 2015 mentioned their trip was related to a tournament, I would expect to find similar results for bass anglers. Similarly, McKee (2013) found that for all bass anglers on Lake Guntersville, Alabama, the number of tournaments fished, years of angling experience, household income, their length of visit, residency status, and ethnicity were all important. Fewer significant variables were found during that study within other target species groups and residency groups making it difficult to make estimates. While the extent of the actual consumer surplus at Millers Ferry Reservoir has currently not been estimated, it is certain that it is present to some degree.

V. CONCLUSIONS AND MANAGEMENT IMPLICATIONS

While reservoir-wide aerial boat counts were not implemented during this study, it is recommended that they be used in future studies. These expenditure estimates are accurate for the anglers interviewed, but it is important to note that the total extrapolated expenditures and tax revenue generated from these expenditures in 2015 are conservative due to many backwaters being present throughout the reservoir. In the upper portions of the study area (sections 4 and 5) and below the lock and dam (section 6), the reservoir is more riverine and backwaters are more stream-like. However, in the three sections directly above the dam, the reservoir broadens and becomes more dendritic with islands present allowing anglers to conceal themselves behind these islands and in coves. Due to time constraints, I was not able to search all of these areas. McKee (2013) was able to accurately estimate angling effort and expenditures for the major fisheries on Lake Guntersville, Alabama by supplementing the roving creel survey with aerial boat counts and follow-up telephone surveys. Neglecting to use aerial boat counts on such reservoirs can significantly increase the error in estimating effort. Using aerial counts can also help researchers understand what areas anglers are utilizing and understand where to focus their efforts when conducting the roving creel surveys to maximize their effort.

Nonetheless, Millers Ferry Reservoir was responsible for an estimated $2.5 million in direct expenditures from recreational angling that benefit the local, county, and state governments. Among all target species groups, bass anglers contributed the most angling effort, travelled the farthest distance, and were responsible for 67% of direct expenditures incurred to fish at Millers Ferry Reservoir. Through the differences in daily expenditures between bass and all other target species, continuing to attract large bass tournaments such as the local McNider Tournament and the Alabama Bass Trail to the reservoir, can continue to stimulate the local economies. In addition to retaining these tournaments, it may also be beneficial to attract other large tournaments in addition to promoting the reservoir to local clubs. Driscoll et al. (2010)

estimated overall expenditures per tournament be $9,409 for club tournaments and $306,593 for open tournaments at Sam Rayburn Reservoir, Texas. Maintaining the current boat ramps and ensuring there is adequate parking at them will help facilitate the continuation of bass tournaments at the reservoir. The continuation of proper management of fish species on the reservoir is also important as an increase in catch or size of fish caught can increase the economic impact of a reservoir (Loomis 2006).

While anglers fishing from boat are responsible for a majority of these expenditures, it is also important to make the reservoir available to shore anglers. They contributed nearly $150,000 in total expenditures and as observed, by the boat-shore angler ratios in sections 5 and 6 where shore access is available, may be limited by the amount of shore access in the middle reaches of the reservoir. Making more of the area along the shoreline in Selma available to anglers may increase effort. Shroeder et al. (2008) found that reduced access to angling opportunities was a major determinant in whether anglers viewed fishing as a favorite activity. It is important to make public areas near prime fishing locations as well. It was noted multiple times by the shore anglers in Selma that fishing was not as productive as in previous years. Bradle et al. (2006) found that creating a short-term trout tailrace fishery via stocking resulting in a $3.93 return for every $1 spent on the local economy. The use of block nets in conjunction with stocking in county lakes in Alabama creates an excellent short-term fishery (Graves Lovell, personal communication). This may lead to increased catch rates, angler satisfaction, and could be used as a means to promote interest in fishing to the underrepresented African American and young individuals in Dallas and Wilcox Counties. Ninety percent of the anglers fishing from shore in sections 5 and 6, where shore access is possible, were local anglers highlighting the importance of these areas to local anglers.

Multiple public fishing sites were constructed with various amenities including parking lots, fishing piers, picnic areas, and restrooms at Lake Havasu, Arizona (Jacobson and Koch 2008). They were constructed in known productive fishing locations and artificial fish attractors

we submerged to provide a quality fishing experience for visitors. These facilities resulted in a 200% increase in fishing activity in the area. Properly constructed facilities could additionally provide children, novice anglers, and physically challenged individuals the opportunity to participate in fishing. Through availability of fishing to these and all people, expenditures and revenue created for the local, county, and state governments will increase and additionally promote the continuation of angling to younger generations. While increasing and maintaining facilities can require more resources, it has already been shown that given the opportunity, stakeholders of the resource are willing to assume this responsibility. The Portland boat ramp in section 3 of Millers Ferry Reservoir was in jeopardy of being closed due to maintenance costs, but a local bass club assumed the responsibility of maintaining the property allowing it to remain open for public use.

There is also no public shore access along the western shore of the reservoir between the Selma and the Bogue Chitto boat ramp near Orrville, Alabama. Acquiring land and creating shore access, either through land purchases or leases in this area, would enable anglers to access portions of the river which they may not normally be able to with a smaller boat. This would also afford people that may not have the ability to travel to the upper and lower reaches of the reservoir on the western side of the reservoir to partake in the sport. It has been documented that fishing license sales rates are higher in rural areas such that increased access could facilitate increased overall participation levels (Hunt et al. 2017). This could additionally increase the value of land along the reservoir and generate additional tax revenue through property taxes and maintenance. While this study focused solely on the value of recreational angling at Millers Ferry Reservoir, it does not reflect the value contributed by non-angling users. To fully understand the economic value of this resource, other users and factors should be considered.

It is also vital to make other resources on the reservoir available to all constituents and boater friendly. While it is often difficult to cater to the wants of all stakeholders, some recurring

complaints were observed. The first shows the complexity of managing a reservoir and the impossible feat of satisfying all stakeholders. The ADCNR sprayed vegetation a few years prior to my study and some of the anglers on the reservoir complained that too much of the vegetation was eradicated while others complained that not enough was eradicated. This is a testament to the difficulty that arises when trying to cater to not only the recreational anglers, but additionally to the people that use the reservoir for recreation or simply own waterfront property. There were also boat safety concerns from multiple boat anglers. Before Millers Ferry Reservoir was impounded, many trees were cut, but only to lie below the waterline. Anglers that had been visiting the reservoir since its impoundment had mentioned that buoys had marked the old stream channels. Most of these buoys are no longer present except for ones that some landowners deployed to mark submerged stumps. It is important to mark these channels to provide safe, navigable waters for all anglers, including those that may not be familiar with the waterbody. While modern technology can help tremendously with navigation, it should not solely be relied upon.

Recreational fishing creates a large source of revenue within the United States. The counties in which Millers Ferry Reservoir is located are two of the top five poorest in the state of Alabama, which makes it vital to promote this fishery to provide a supplemental source of revenue for this area. It is important that fishery managers continue to invest in understanding the economic impact of reservoirs as this allows them to understand how their resources should be directed in addition to understanding how to better cater to the desires of their constituents. This will additionally help guarantee that all improvements are worthwhile and a beneficial use of their resources, both manpower and funds. By properly improving a waterbody to meet these needs, it ensures the continuation of recreational angling and encourages the generation of revenue for local, county, and state governments.

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VII. TABLES

Table 1. Estimated percentage use of reservoir sections by district supervisor and biologist with estimated final weight and corresponding numbers used for the random number generator, Millers Ferry Reservoir, Alabama. Sections are ordered from most estimated use to least estimated use.

Section	Supervisor % Use Weight	Biologist % Use Weight	Range % Use Weight	Final Estimated % Use Weight	Number Drawn
2	40	30	30 - 40	39	1 - 39
1	30	30	30	29	40 - 68
5	20	15	15 - 20	17	69 - 85
6	5	15	5 - 15	8	86 - 93
3	3	5	3 - 5	4	94 - 97
4	2	5	2 - 5	3	98 - 100
Total	100	100	-	100	-

Table 2. Percent of interviews by fishing method (boat, shore) and by reservoir section contacted during the on-site roving creel survey, Millers Ferry Reservoir, Alabama, January – December 2015. Sections are ordered upstream to downstream; section 6 is the tailrace.

		Method	
Section	N	Boat	Shore
5	59	47.5	52.5
4	16	100.0	0.0
3	27	100.0	0.0
2	312	98.1	1.9
1	272	94.1	5.9
6	43	53.5	46.5

Table 3. Number of boat and shore angling parties contacted during the on-site roving creel survey by targeted species and by time block (morning [AM], noon [NN], and evening [PM]) and N is number of time blocks sampled, Millers Ferry Reservoir, Alabama, January – December, 2015.

Target Species	AM (N=50)	NN (N=84)	PM (N=54)	Total (N=188)
Bass	141	176	69	386
Crappie	37	83	25	145
Catfish	35	51	26	112
Sunfish	6	13	6	25
Anything	12	33	16	61
Total	231	356	142	729

Table 4. Number of recreational anglers targeting specific species by season (spring [March – May], summer [June – September], fall [October – November], and winter [December – February]) contacted during the on-site roving creel survey, Millers Ferry Reservoir, Alabama, January – December 2015. N is number of days sampled each season.

	Season				
Target Species	Spring (N=46)	Summer (N=64)	Fall (N=32)	Winter (N=46)	Total (N=188)
Bass	152	145	51	38	386
Crappie	66	37	24	18	145
Catfish	49	31	9	23	112
Sunfish	7	16	2	0	25
Anything	28	19	6	8	61
Total	302	248	92	87	729

Table 5. Percent of recreational anglers targeting specific species by season (spring [March – May], summer [June – September], fall [October – November], and winter [December – February]) contacted during the on-site roving creel survey, Millers Ferry Reservoir, Alabama, January – December 2015. N is number of days sampled each season.

	Season			
Target Species	Spring (N=46)	Summer (N=64)	Fall (N=32)	Winter (N=46)
Bass	50.3	58.5	55.4	43.7
Crappie	21.9	14.9	26.1	20.7
Catfish	16.2	12.5	9.8	26.4
Sunfish	2.3	6.5	2.2	0.0
Anything	9.3	7.7	6.5	9.2

Table 6. Percent of specific species targeted by recreational anglers by reservoir section contacted during the on-site roving creel survey, Millers Ferry Reservoir, Alabama, January – December 2015. Sections are ordered upstream to downstream; section 6 is the tailrace.

	Target Species					
Section	Bass	Crappie	Catfish	Sunfish	Anything	Total
5	30.5	1.7	35.6	3.4	28.8	100.0
4	62.5	12.5	18.8	6.3	0.0	100.0
3	59.3	25.9	3.7	0.0	11.1	100.0
2	53.8	25.6	11.2	2.6	6.7	100.0
1	58.1	19.5	13.2	4.4	4.8	100.0
6	37.2	4.7	37.2	4.7	16.3	100.0

Table 7. Number of recreational angling parties targeting specific species by reservoir section contacted during the on-site roving creel survey, Millers Ferry Reservoir, Alabama, January – December, 2015. River section area is in hectares with percent of total reservoir area per section. Sections are ordered upstream to downstream; section 6 is the tailrace.

	Section	Reservoir	Target Species					
Section	Area (ha)	Area (%)	Bass	Crappie	Catfish	Sunfish	Anything	Total
5	598	8.5	18	1	21	2	17	59
4	595	8.5	10	2	3	1	0	16
3	714	10.2	16	7	1	0	3	27
2	1,951	27.8	168	80	35	8	21	312
1	2,732	39.0	158	53	36	12	13	272
6	416	5.9	16	2	16	2	7	43
Total	7,006	-	386	145	112	25	61	729

Table 8. Number of recreational angling parties targeting specific species per 100 hectares of reservoir section with percent of reservoir area contacted during the on-site roving creel survey, Millers Ferry Reservoir, Alabama, January –December, 2015. Sections are ordered upstream to downstream; section 6 is the tailrace.

	Section	Reservoir	Target Species					
Section	Area (ha)	Area (%)	Bass	Crappie	Catfish	Sunfish	Anything	Total
5	598	8.5	3.0	0.2	3.5	0.3	2.8	9.9
4	595	8.5	1.7	0.3	0.5	0.2	0.0	2.7
3	714	10.2	2.2	1.0	0.1	0.0	0.4	3.8
2	1,951	27.8	8.6	4.1	1.8	0.4	1.1	16.0
1	2,732	39.0	5.8	1.9	1.3	0.4	0.5	10.0
6	416	5.9	3.8	0.5	3.8	0.5	1.7	10.3
All Anglers	7,006	-	5.5	2.1	1.6	0.4	0.9	10.4

Table 9. Angling effort (hours (SE)), mean trip length (hours), total trips (trip days), catch per effort (CPE), harvest per effort (HPE), and total estimated harvest by species and by angling method (boat, shore) obtained from the on-site roving creel survey, Millers Ferry Reservoir, Alabama, January – December 2015.

Method	Target Species	N	Effort	%	Trip Length	Trips	CPE	HPE	Harvest
Boat	Bass	381	95,764 (20,305)	65	7.10	13,484	0.76	0.10	9,576
	Crappie	141	29,345 (6,222)	20	5.81	5,048	1.67	1.04	30,519
	Catfish	73	12,075 (2,560)	8	4.50	2,683	1.40	1.31	15,818
	Sunfish	21	3,165 (671)	2	4.27	741	2.09	0.96	3,038
	Anything	34	6,383 (1,353)	4	5.32	1,200	1.00	0.87	5,553
	Boat Total	650	146,732 (31,112)	100	-	23,156	-	-	-
Shore	Bass[1]	4	1,493 (435)	8	5.94	251	0.02	0.02	30
	Crappie[1]	2	283 (82)	2	2.25	126	0	0	0
	Catfish	36	9,005 (2,624)	52	3.98	2,263	0.12	0.11	991
	Sunfish[1]	4	848 (247)	5	3.38	252	3.48	2.00	1,696
	Anything	27	5,783 (1,685)	33	3.41	1,697	0.47	0.47	2,718
	Shore Total	73	17,412 (5,073)	100	-	4,589	-	-	-

Table 9. Continued

Method	Target Species	N	Effort	%	Trip Length	Trips	CPE	HPE	Harvest
All Data	Bass	385	97,257 (20,740)	59	7.09	13,718	0.75	0.10	9,543
	Crappie	143	29,628 (6,304)	18	5.76	5,140	1.64	1.02	30,283
	Catfish	109	21,080 (5,184)	13	4.33	4,865	1.11	1.03	21,754
	Sunfish	25	4,014 (918)	2	4.13	973	2.03	0.98	3,935
	Anything	61	12,166 (3,038)	7	4.47	2,720	0.78	0.70	8,562
	Total	723	164,145 (36,184)	100	-	27,416	-	-	-

[1] Estimates may be unreliable due to small sample sizes

Table 10. Percent angling effort by reservoir section and fishing method observed during the instantaneous count, Millers Ferry Reservoir, Alabama, January – December 2015. Sections are ordered upstream to downstream; section 6 is the tailrace.

	Method		
Section	Boat	Shore	All
5	5.3	39.9	10.7
4	10.6	4.7	9.6
3	14.3	0.0	12.1
2	37.9	5.8	32.9
1	23.6	12.1	21.8
6	8.3	37.5	12.9

Table 11. Mean party size, total estimated angling party trip expenditures ($), angling party estimated local trip expenditures ($, Dallas and Wilcox Counties), and percent of total expenditures spent locally by targeted species per recreational party visit from the on-site roving creel survey. Means with the same superscript were similar (One-Way ANOVA with Tukey Post-hoc test; P > 0.05) and standard deviations in parenthesis, Millers Ferry Reservoir, Alabama, January – December 2015.

Target Species	N	Party Size	Total Expenditures[1]	Local Expenditures	% Local
Bass	386	1.71 [a] (0.58)	215.44 (297.67)	139.79 (290.03)	64.89
Crappie	145	1.83 [a] (0.73)	190.64 (286.43)	116.42 (218.10)	61.07
Catfish	112	1.74 [a] (0.81)	97.44 (190.36)	79.67 (181.05)	81.76
Sunfish	25	2.24 [b] (0.83)	135.60 (143.48)	95.08 (118.31)	70.12
Anything	61	1.89 [ab] (0.91)	110.35 (173.62)	69.08 (126.60)	62.60
All Anglers	729	1.77 (0.70)	180.82 (272.03)	118.41 (247.78)	65.49

[1]Significant p-values: Bass-Catfish = 0.00046; Bass-Anything = 0.037; Crappie-Catfish = 0.049

Table 12. Mean total expenditures ($) per party visit by targeted species reported in the on-site roving creel survey, compared to mean total expenditures ($) reported in the follow-up telephone survey, Millers Ferry Reservoir, Alabama, January – December 2015. A paired t-test was used to test for differences in means and standard deviations are in parenthesis.

Target Species	N	On-Site Expenditures	Follow-Up Expenditures	Difference in Means	%Different	Degrees of Freedom	t-Value	P-Value
Bass	279	207 (244)	241 (420)	34	16.4	278	-1.82	0.069
Crappie	101	170 (266)	180 (232)	10	5.9	99	-0.62	0.539
Catfish	76	115 (206)	132 (207)	17	14.8	74	-1.47	0.145
Sunfish	16	153 (133)	273 (317)	120	78.4	15	-1.75	0.101
Anything	34	133 (177)	174 (226)	41	30.8	33	-1.67	0.103
All Anglers	506	179 (239)	209 (350)	30	16.8	503	-2.64	0.009

Table 13. Number of recreational angling parties designated by county of residence in Alabama or out of state contacted during the on-site roving creel survey by targeted species, Millers Ferry Reservoir, Alabama, January – December 2015.

County	Bass	Crappie	Catfish	Sunfish	Anything	Total
Wilcox[1]	21	33	40	6	15	115
Dallas[1]	30	12	30	4	23	99
Mobile	41	12	8	4	8	73
Clarke	41	20	7	1	1	70
Baldwin	17	10	3	2	2	34
Escambia	31	1	1	0	0	33
Covington	24	0	0	1	2	27
Jefferson	9	11	2	0	2	24
Marengo	18	2	1	1	1	23
Monroe	17	1	3	1	0	22
Bibb	16	4	1	0	0	21
Tuscaloosa	17	3	0	1	0	21
Walker	3	9	0	0	0	12
Butler	3	2	6	0	0	11
Washington	7	2	0	1	0	10
Choctaw	7	0	2	0	0	9
Conecuh	0	1	3	1	2	7
Montgomery	3	0	0	0	3	6
Shelby	3	3	0	0	0	6
Autauga	3	0	0	0	1	4
Perry	2	1	0	1	0	4
Chilton	1	1	1	0	0	3
Hale	3	0	0	0	0	3
Coffee	2	0	0	0	0	2
Calhoun	1	0	0	0	0	1
Crenshaw	1	0	0	0	0	1
Elmore	1	0	0	0	0	1
Fayette	0	1	0	0	0	1
Greene	1	0	0	0	0	1
Houston	1	0	0	0	0	1
Lauderdale	1	0	0	0	0	1
Lee	1	0	0	0	0	1
Pickens	0	1	0	0	0	1
Alabama Total	326	130	108	24	60	648
Out of State[2]	57	12	4	1	1	75
Total	383	142	112	25	61	723

[1] Counties in which Millers Ferry Reservoir is located

[2] Includes Florida (N=47), Mississippi (N=23), Georgia (N=1), Iowa (N=1), Michigan (N=1), Nebraska (N=1), and Tennessee (N=1)

Table 14. Summary of angler variable means, SD in parenthesis, by species, collected during the on-site roving creel and follow-up telephone survey, Millers Ferry Reservoir, Alabama, January – December 2015. Including distance – one-way distance from trip origination site to reservoir access site, Trip Length - number of days in trip at time of interview, Days Fished – number of days fished at Millers Ferry Reservoir in 12 months prior to interview, River Resident – whether they owned property on Millers Ferry Reservoir (0=no, 1=yes), Tournament Related – whether their current trip was related to a tournament (0=no, 1=yes), Tournaments – number of tournaments fished at Millers Ferry Reservoir in 12 months prior to interview, Club Member – whether they were a member of a fishing club (0=no,1=yes), Quality – quality of fishing (1 = poor, 5 = excellent), Alternate Site Distance - one-way distance from residence to alternative site access, Age –age of angler in years, Years Fished – number of years angler has been fishing, and Household Income – annual household income ($).

Variable	Bass	Crappie	Catfish	Sunfish	Anything
Distance (km)	134 (105)	134 (184)	59 (69)	97 (81)	66 (76)
Trip Length	2.9 (8.0)	3.6 (5.4)	2.1 (1.9)	7.3 (14.4)	3.0 (3.7)
Days Fished	32 (40)	51 (62)	49 (62)	29 (35)	43 (59)
River Resident	0.23 (0.42)	0.41 (0.49)	0.23 (0.43)	0.24 (0.44)	0.18 (0.39)
Tournament Related	0.45 (0.50)	0.01 (0.12)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Tournaments	3.5 (5.1)	0.3 (0.9)	0.1 (0.6)	0.0 (0.0)	0.1 (0.3)
Club Member	0.41 (0.49)	0.02 (0.14)	0.03 (0.16)	0.00 (0.00)	0.03 (0.17)
Quality	2.5 (1.3)	2.1 (1.3)	1.9 (1.2)	2.3 (1.4)	2.1 (1.3)
Alternate Site Distance (km)	113 (144)	100 (139)	71 (77)	140 (174)	58 (64)
Age	47 (14)	57 (13)	54 (14)	55 (14)	50 (16)
Years Fished	35 (15)	43 (16)	43 (16)	33 (20)	35 (16)
Household Income	94,490 (51,408)	69,845 (40,815)	56,635 (48,394)	72,511 (37,201)	42,858 (45,919)

Table 15. Summary of angling party expenditures ($) by trip type and species per trip day, SD in parenthesis, obtained during the follow-up telephone survey, Millers Ferry Reservoir, Alabama, January – December 2015.

Trip Type	Category	Bass	Crappie	Catfish	Sunfish	Anything
Day		(N=154)	(N=48)	(N=50)	(N=6)	(N=21)
	Fuel	53 (10)	25 (9)	16 (11)	18 (12)	12 (13)
	Lodging	0 (2)	0 (0)	0 (0)	0 (0)	0 (0)
	Groceries	15 (17)	9 (10)	10 (15)	10 (6)	7 (8)
	Restaurant	6 (11)	3 (10)	2 (7)	2 (4)	4 (14)
	Equipment/Bait	17 (57)	10 (13)	10 (17)	7 (5)	20 (45)
	Tournament Fee	29 (47)	0 (0)	0 (0)	0 (0)	0 (0)
	Launch Fee	2 (2)	1 (2)	1 (1)	1 (2)	0 (1)
	Repair/Other	0 (3)	0 (0)	5 (35)	0 (0)	0 (0)
	Total	122 (80)	48 (29)	44 (48)	38 (11)	43 (51)
Overnight		(N=125)	(N=53)	(N=26)	(N=10)	(N=13)
	Fuel	47 (7)	26 (5)	23 (6)	24 (6)	24 (9)
	Lodging	20 (27)	9 (14)	15 (29)	10 (10)	21 (30)
	Groceries	23 (18)	28 (29)	26 (20)	28 (22)	27 (26)
	Restaurant	10 (22)	5 (10)	4 (8)	4 (7)	11 (16)
	Equipment/Bait	8 (18)	9 (28)	4 (4)	6 (8)	4 (6)
	Tournament Fee	7 (13)	1 (4)	0 (0)	0 (0)	0 (0)
	Launch Fee	1 (1)	0 (1)	0 (1)	0 (0)	1 (2)
	Repair/Other	11 (119)	0 (2)	7 (19)	0 (1)	2 (7)
	Total	127 (140)	78 (66)	79 (44)	72 (24)	90 (42)

Table 15. Continued.

Trip Type	Category	Bass	Crappie	Catfish	Sunfish	Anything
All Anglers		(N=279)	(N=101)	(N=76)	(N=16)	(N=34)
	Fuel	50 (9)	25 (7)	18 (10)	22 (9)	16 (13)
	Lodging	9 (20)	5 (11)	5 (18)	6 (9)	8 (21)
	Groceries	19 (18)	19 (24)	16 (18)	21 (20)	15 (20)
	Restaurant	8 (17)	4 (10)	3 (8)	3 (6)	7 (15)
	Equipment/Bait	13 (44)	10 (22)	8 (14)	6 (7)	14 (36)
	Tournament Fee	19 (38)	0 (3)	0 (0)	0 (0)	0 (0)
	Launch Fee	2 (2)	1 (1)	0 (1)	1 (1)	0 (1)
	Repair/Other	5 (80)	0 (1)	6 (31)	0 (1)	1 (4)
	Total	125 (111)	64 (54)	56 (50)	59 (26)	61 (53)

Table 16. Summary of angling party expenditures ($) by fishing method (boat/shore) and species per trip day, SD in parenthesis, obtained during the follow-up telephone survey, Millers Ferry Reservoir, Alabama, January – December 2015.

Method	Category	Bass	Crappie	Catfish	Sunfish	Anything
Boat		(N=278)	(N=101)	(N=56)	(N=13)	(N=19)
	Fuel	50 (9)	25 (7)	23 (6)	25 (4)	25 (8)
	Lodging	9 (20)	5 (11)	7 (21)	6 (8)	12 (26)
	Groceries	19 (18)	19 (24)	19 (20)	17 (13)	22 (23)
	Restaurant	8 (17)	4 (10)	4 (9)	3 (6)	8 (16)
	Equipment/Bait	13 (44)	10 (22)	8 (16)	6 (7)	8 (11)
	Tournament Fee	19 (38)	0 (3)	0 (0)	0 (0)	0 (0)
	Launch Fee	2 (2)	1 (1)	1 (1)	1 (1)	1 (2)
	Repair/Other	5 (80)	0 (1)	7 (36)	0 (1)	2 (6)
	Total	125 (111)	64 (53)	69 (52)	58 (14)	78 (42)
Shore		(N=1)	(N=0)	(N=20)	(N=3)	(N=15)
	Fuel	11 (-)	-	4 (4)	6 (5)	3 (3)
	Lodging	0 (-)	-	0 (0)	8 (13)	3 (10)
	Groceries	0 (-)	-	7 (7)	36 (38)	5 (5)
	Restaurant	10 (-)	-	1 (4)	4 (8)	5 (14)
	Equipment/Bait	0 (-)	-	8 (10)	9 (4)	22 (53)
	Tournament Fee	0 (-)	-	0 (0)	0 (0)	0 (0)
	Launch Fee	0 (-)	-	0 (0)	0 (0)	0 (0)
	Repair/Other	0 (-)	-	0 (0)	0 (0)	0 (0)
	Total	21 (-)	-	20 (15)	63 (61)	38 (56)

Table 17. Percent of expenditures by expenditure category, location, and targeted species obtained during the follow-up telephone survey, Millers Ferry Reservoir, Alabama, January – December 2015.

Location[1]	Target Species	Expenditure Category					
		Gas	Lodging	Groceries	Restaurant	Bait	Other
Camden, AL[2]	Bass	25	72	25	83	23	4
	Crappie	26	29	30	48	26	29
	Catfish	29	93	32	89	39	18
	Sunfish	27	17	46	51	42	100
	Anything	16	74	52	88	29	0
Pine Hill, AL[2]	Bass	0	0	0	2	0	0
	Crappie	0	0	0	0	0	0
	Catfish	0	0	0	0	0	0
	Sunfish	0	0	0	0	0	0
	Anything	1	0	0	0	2	0
Yellow Bluff, AL[2]	Bass	0	0	0	0	4	0
	Crappie	0	0	0	0	0	0
	Catfish	0	0	0	0	0	0
	Sunfish	0	0	0	0	0	0
	Anything	0	0	0	0	1	0
Wilcox County, AL	Bass	40	97	52	89	49	4
	Crappie	44	97	43	60	37	29
	Catfish	36	100	34	92	45	18
	Sunfish	42	100	46	51	42	100
	Anything	39	100	61	88	64	0

Table 17. Continued

Location	Target Species	Expenditure Category					
		Gas	Lodging	Groceries	Restaurant	Bait	Other
Selma, AL[3]	Bass	4	0	3	3	1	2
	Crappie	5	0	3	6	2	71
	Catfish	7	0	2	4	14	45
	Sunfish	4	0	1	5	7	0
	Anything	2	0	4	3	6	100
Dallas County, AL	Bass	5	0	4	3	4	2
	Crappie	11	3	4	6	22	71
	Catfish	8	0	7	6	21	73
	Sunfish	4	0	1	5	7	0
	Anything	8	0	19	3	7	100
Alabama	Bass	91	100	93	100	96	100
	Crappie	97	100	93	100	99	100
	Catfish	97	100	100	100	97	100
	Sunfish	95	100	74	100	99	100
	Anything	100	100	100	100	100	100

[1] Includes only the cities located within the counties containing the study site that apply taxes; percentages are nested within higher levels i.e. percentages in Camden will be present in Wilcox County and the State of Alabama percentages
[2] City located in Wilcox County, AL
[3] City located in Dallas County, AL

Table 18. Total angler trips (trip days) and total extrapolated expenditures by targeted species obtained during the instantaneous count and follow-up telephone survey, Millers Ferry Reservoir, Alabama, January – December 2015.

Target	Trips	Fuel	Lodging	Groceries	Restaurant	Equipment/ Bait	Tournament Fees	Boat Ramps	Other	Total
Bass	13,718	$686,400	$122,613	$260,944	$107,479	$173,786	$263,813	$19,891	$71,340	$1,706,265
Crappie	5,140	$128,857	$23,495	$97,968	$21,905	$49,636	$1,527	$3,141	$824	$327,352
Catfish	4,865	$88,710	$25,291	$76,204	$15,379	$37,910	$0	$2,006	$26,837	$272,336
Sunfish	973	$21,092	$5,978	$20,440	$3,207	$6,044	$0	$517	$253	$57,531
Anything	2,720	$42,069	$21,587	$40,239	$18,614	$37,787	$0	$1,560	$2,800	$164,657
Total	27,416	$967,129	$198,962	$495,796	$166,584	$305,163	$265,339	$27,114	$102,055	$2,528,141

Table 19. Tax revenue by location generated by all angler expenditures obtained during the follow-up telephone survey, Millers Ferry Reservoir, Alabama, January – December 2015.The fuel tax revenue was based on the average price per gallon for regular unleaded ($2.429) in the State of Alabama in 2015.

Location	General Sales Tax	General Sales Expenditures[1]	General Sales Tax Revenue	Fuel Tax	Fuel Expenditures	Fuel Tax Revenue	Lodging Tax	Lodging Expenditures	Lodging Tax Revenue	Total Tax Revenue
Camden, AL	2.5%	$371,407	$9,285	-	$245,737	$0	3%	$135,390	$4,062	$13,347
Pine Hill, AL	2.5%	$2,955	$74	1¢/gal	$496	$2	-	$0	$0	$76
Yellow Bluff, AL	1.5%	$7,943	$119	-	$0	$0	-	$0	$0	$119
Wilcox County, AL	3.5%	$533,330	$18,667	2¢/gal	$389,966	$3,211	$4/night	$194,946	$13,419	$35,296
Selma, AL	4.5%	$46,613	$2,098	4¢/gal	$43,678	$719	6.0% + $2/night	$0	$0	$2,817
Dallas County, AL	1.5%	$85,332	$1,280	2¢/gal	$60,752	$500	-	$753	$0	$1,780
State of Alabama	4.0%	$1,030,473	$41,219	16¢/gal	$900,837	$59,339	4%	$198,962	$7,958	$108,516
Total	-	-	$72,741	-	-	$63,771	-	-	$25,439	$161,951

[1] Includes expenditures incurred from groceries, restaurant meals, equipment/bait, and repair/other

Table 20. Tax revenue by location generated by bass angler expenditures obtained during the follow-up telephone survey, Millers Ferry Reservoir, Alabama, January – December 2015.The fuel tax revenue was based on the average price per gallon for regular unleaded ($2.429) in the State of Alabama in 2015.

Location	General Sales Tax	General Sales Expenditures[1]	General Sales Tax Revenue	Fuel Tax	Fuel Expenditures	Fuel Tax Revenue	Lodging Tax	Lodging Expenditures	Lodging Tax Revenue	Total Tax Revenue
Camden, AL	2.5%	$197,643	$4,941	-	$174,668	$0	3%	$87,935	$2,638	$7,579
Pine Hill, AL	2.5%	$2,112	$53	1¢/gal	$0	$0	-	$0	$0	$53
Yellow Bluff, AL	1.5%	$7,490	$112	-	$0	$0	-	$0	$0	$112
Wilcox County, AL	3.5%	$318,458	$11,146	2¢/gal	$275,552	$2,269	$4/night	$119,349	$8,134	$21,549
Selma, AL	4.5%	$13,214	$595	4¢/gal	$29,254	$482	6.0% + $2/night	$0	$0	$1,076
Dallas County, AL	1.5%	$20,162	$302	2¢/gal	$36,187	$298	-	$0	$0	$600
State of Alabama	4.0%	$588,751	$23,550	16¢/gal	$627,688	$41,346	4%	$122,613	$4,905	$69,801
Total	-	-	$40,699	-	-	$44,395	-	-	$15,677	$100,771

[1] Includes expenditures incurred from groceries, restaurant meals, equipment/bait, and repair/other

Table 21. Tax revenue by location generated by crappie angler expenditures obtained during the follow-up telephone survey, Millers Ferry Reservoir, Alabama, January – December 2015.The fuel tax revenue was based on the average price per gallon for regular unleaded ($2.429) in the State of Alabama in 2015.

Location	General Sales Tax	General Sales Expenditures[1]	General Sales Tax Revenue	Fuel Tax	Fuel Expenditures	Fuel Tax Revenue	Lodging Tax	Lodging Expenditures	Lodging Tax Revenue	Total Tax Revenue
Camden, AL	2.5%	$53,248	$1,331	-	$32,959	$0	3%	$6,850	$206	$1,537
Pine Hill, AL	2.5%	$163	$4	1¢/gal	$0	$0	-	$0	$0	$4
Yellow Bluff, AL	1.5%	$0	$0	-	$0	$0	-	$0	$0	$0
Wilcox County, AL	3.5%	$73,695	$2,579	2¢/gal	$56,937	$469	$4/night	$22,742	$1,709	$4,757
Selma, AL	4.5%	$5,473	$246	4¢/gal	$6,666	$110	6.0% + $2/night	$0	$0	$356
Dallas County, AL	1.5%	$16,900	$253	2¢/gal	$13,785	$114	-	$753	$0	$367
State of Alabama	4.0%	$162,353	$6,494	16¢/gal	$124,569	$8,205	4%	$23,495	$940	$15,639
Total	-	-	$10,909	-	-	$8,898	-	-	$2,855	$22,661

[1] Includes expenditures incurred from groceries, restaurant meals, equipment/bait, and repair/other

Table 22. Tax revenue by location generated by catfish angler expenditures obtained during the follow-up telephone survey, Millers Ferry Reservoir, Alabama, January – December 2015.The fuel tax revenue was based on the average price per gallon for regular unleaded ($2.429) in the State of Alabama in 2015.

Location	General Sales Tax	General Sales Expenditures[1]	General Sales Tax Revenue	Fuel Tax	Fuel Expenditures	Fuel Tax Revenue	Lodging Tax	Lodging Expenditures	Lodging Tax Revenue	Total Tax Revenue
Camden, AL	2.5%	$58,075	$1,452	-	$25,583	$0	3%	$23,594	$708	$2,160
Pine Hill, AL	2.5%	$0	$0	1¢/gal	$0	$0	-	$0	$0	$0
Yellow Bluff, AL	1.5%	$0	$0	-	$0	$0	-	$0	$0	$0
Wilcox County, AL	3.5%	$62,372	$2,183	2¢/gal	$32,023	$264	$4/night	$25,291	$1,644	$4,091
Selma, AL	4.5%	$19,936	$897	4¢/gal	$6,044	$100	6.0% + $2/night	$0	$0	$997
Dallas County, AL	1.5%	$33,767	$507	2¢/gal	$6,686	$55	-	$0	$0	$562
State of Alabama	4.0%	$155,284	$6,211	16¢/gal	$86,463	$5,695	4%	$25,291	$1,012	$12,918
Total	-	-	$11,250	-	-	$6,114	-	-	$3,363	$20,727

[1] Includes expenditures incurred from groceries, restaurant meals, equipment/bait, and repair/other

Table 23. Tax revenue by location generated by sunfish angler expenditures obtained during the follow-up telephone survey, Millers Ferry Reservoir, Alabama, January – December 2015.The fuel tax revenue was based on the average price per gallon for regular unleaded ($2.429) in the State of Alabama in 2015.

Location	General Sales Tax	General Sales Expenditures[1]	General Sales Tax Revenue	Fuel Tax	Fuel Expenditures	Fuel Tax Revenue	Lodging Tax	Lodging Expenditures	Lodging Tax Revenue	Total Tax Revenue
Camden, AL	2.5%	$13,946	$349	-	$5,634	$0	3%	$1,042	$31	$380
Pine Hill, AL	2.5%	$0	$0	1¢/gal	$0	$0	-	$0	$0	$0
Yellow Bluff, AL	1.5%	$0	$0	-	$0	$0	-	$0	$0	$0
Wilcox County, AL	3.5%	$13,946	$488	2¢/gal	$8,902	$73	$4/night	$5,978	$461	$1,023
Selma, AL	4.5%	$745	$34	4¢/gal	$752	$12	6.0% + $2/night	$0	$0	$46
Dallas County, AL	1.5%	$745	$11	2¢/gal	$752	$6	-	$0	$0	$17
State of Alabama	4.0%	$24,643	$986	16¢/gal	$20,046	$1,320	4%	$5,978	$239	$2,545
Total	-	-	$1,867	-	-	$1,412	-	-	$732	$4,011

[1] Includes expenditures incurred from groceries, restaurant meals, equipment/bait, and repair/other

Table 24. Tax revenue by location generated by anything angler expenditures obtained during the follow-up telephone survey, Millers Ferry Reservoir, Alabama, January – December 2015.The fuel tax revenue was based on the average price per gallon for regular unleaded ($2.429) in the State of Alabama in 2015.

Location	General Sales Tax	General Sales Expenditures[1]	General Sales Tax Revenue	Fuel Tax	Fuel Expenditures	Fuel Tax Revenue	Lodging Tax	Lodging Expenditures	Lodging Tax Revenue	Total Tax Revenue
Camden, AL	2.5%	$48,494	$1,212	-	$6,893	$0	3%	$15,968	$479	$1,691
Pine Hill, AL	2.5%	$679	$17	1¢/gal	$496	$2	-	$0	$0	$19
Yellow Bluff, AL	1.5%	$453	$7	-	$0	$0	-	$0	$0	$7
Wilcox County, AL	3.5%	$64,858	$2,270	2¢/gal	$16,552	$136	$4/night	$21,587	$1,470	$3,876
Selma, AL	4.5%	$7,245	$326	4¢/gal	$962	$16	6.0% + $2/night	$0	$0	$342
Dallas County, AL	1.5%	$13,758	$206	2¢/gal	$3,342	$28	-	$0	$0	$234
State of Alabama	4.0%	$99,441	$3,978	16¢/gal	$42,069	$2,771	4%	$21,587	$863	$7,612
Total	-	-	$8,016	-	-	$2,953	-	-	$2,813	$13,782

[1] Includes expenditures incurred from groceries, restaurant meals, equipment/bait, and repair/other

VIII. FIGURES

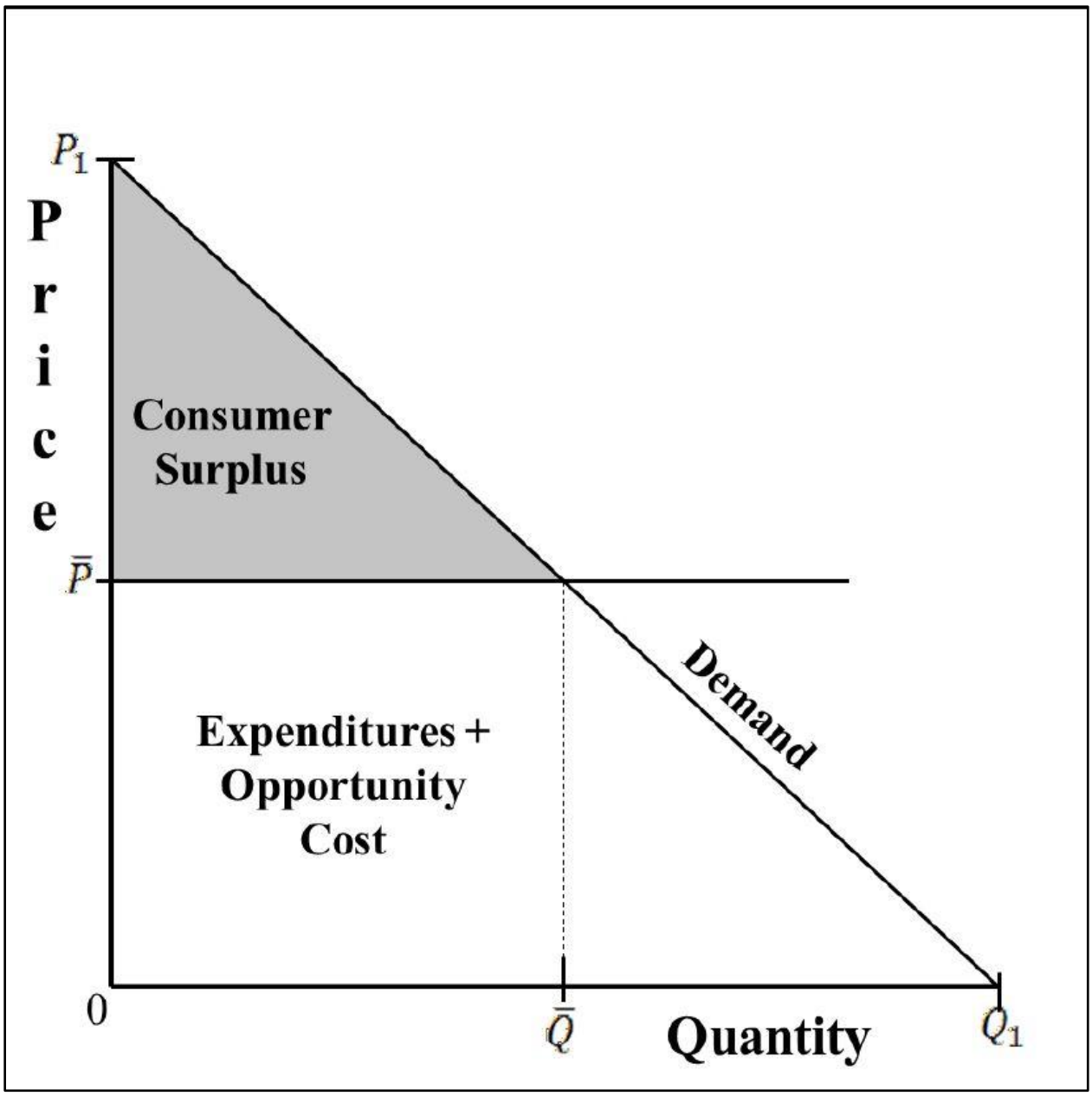

Figure 1. Graphical representation of a demand curve (quantity demanded) and consumer surplus. P_1 is the maximum visit price that one is willing to pay and Q_1 is the maximum number of visits a consumer will demand as a price of \$0. $\bar{P}$ Is the equilibrium (mean) price paid and $\bar{Q}$ is the equilibrium (mean) number of visits demanded by a typical (average) consumer. Consumer surplus is the willingness-to-pay for a recreational visit above and beyond a person's actual visit expenditures and is the area below the recreational visit demand curve and above the equilibrium visit cost ($\bar{P}$). Expenditures are actual purchases incurred by the person on the visit plus the opportunity cost of time based on the respondent's wage rate and the calculated roundtrip travel time to the site. Taken from Parsons 2003.

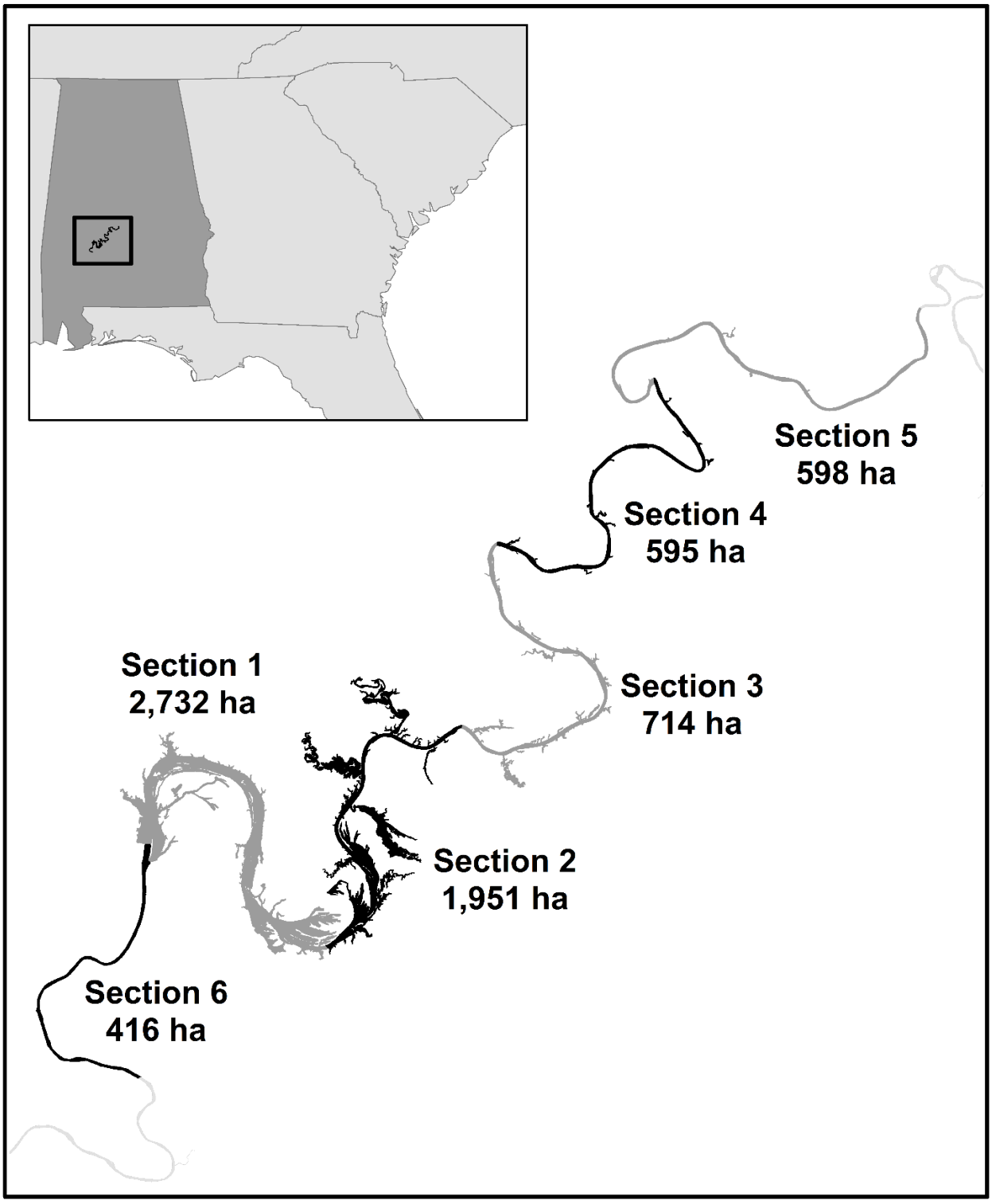

Figure 2. Major reservoir sections at Millers Ferry Reservoir, Alabama sampled January – December, 2015. Sections 1 through 5 are above the lock and dam and section 6 is the tailrace.

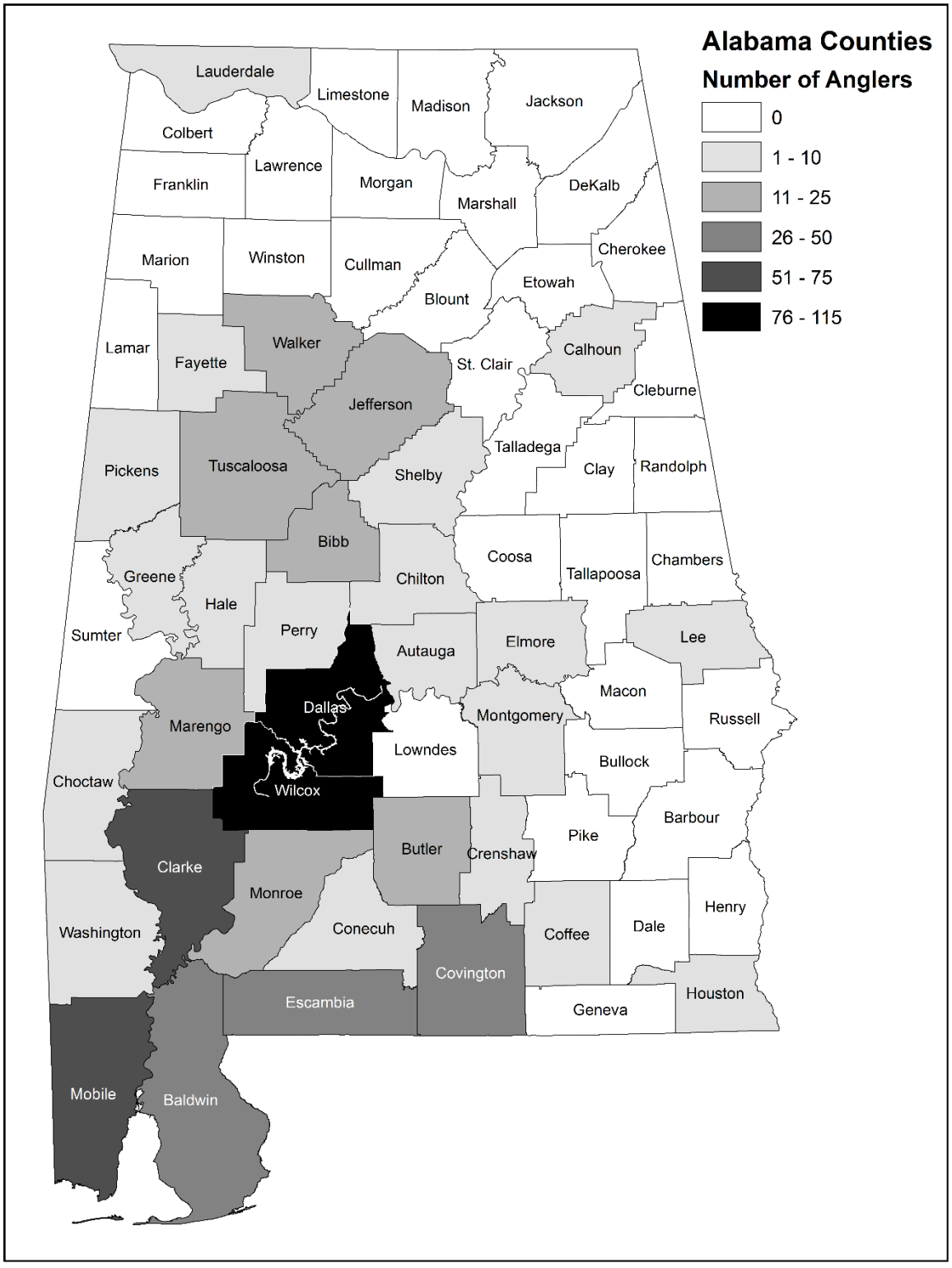

Figure 3. Alabama county of residence for anglers interviewed during the on-site roving creel survey at Millers Ferry Reservoir, Alabama sampled January –December, 2015.

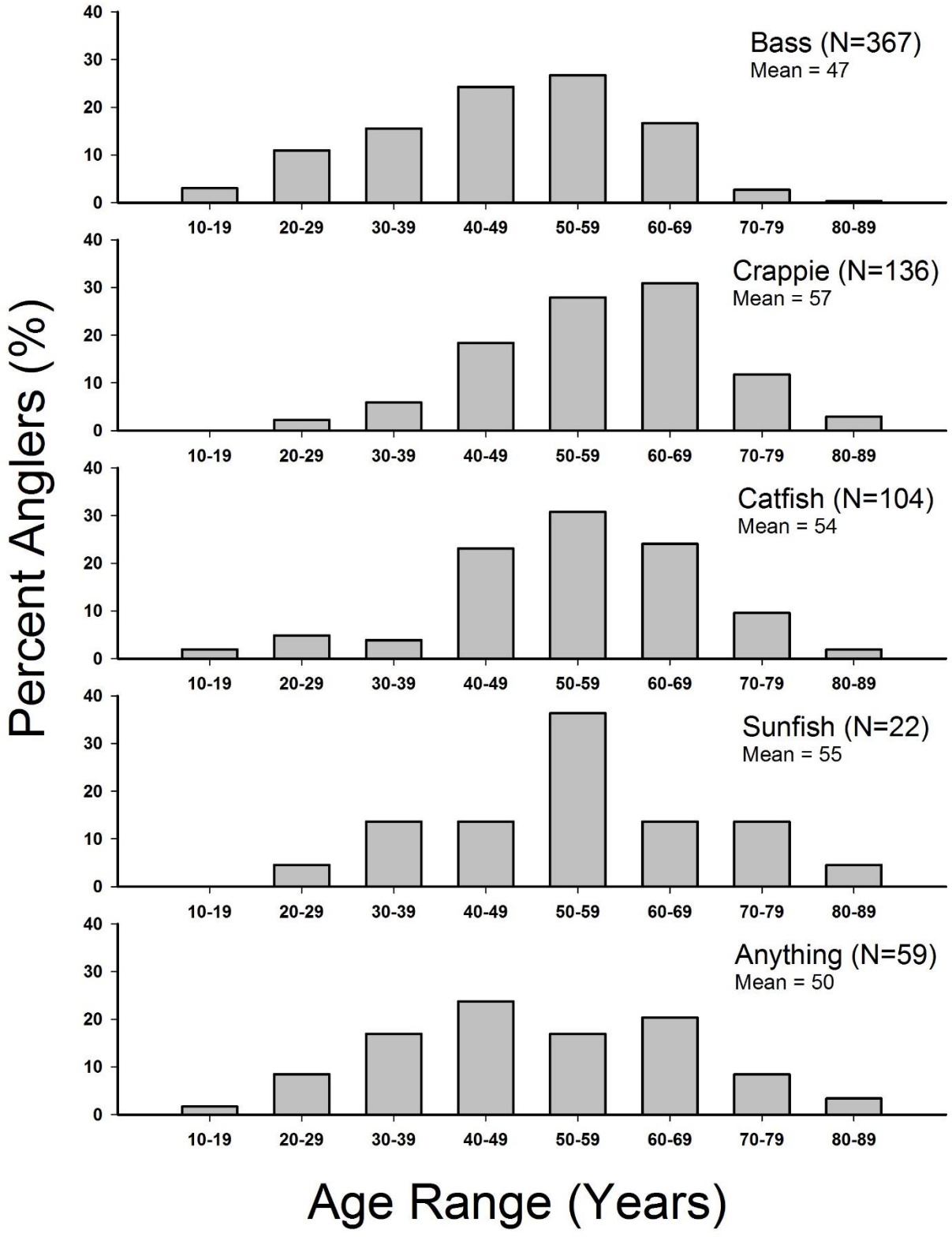

Figure 4. Age range (years) distribution of recreational anglers targeting specific species contacted during the on-site roving creel survey, Millers Ferry Reservoir, Alabama, January – December, 2015. The mean age was 50.4 years old (N=688).

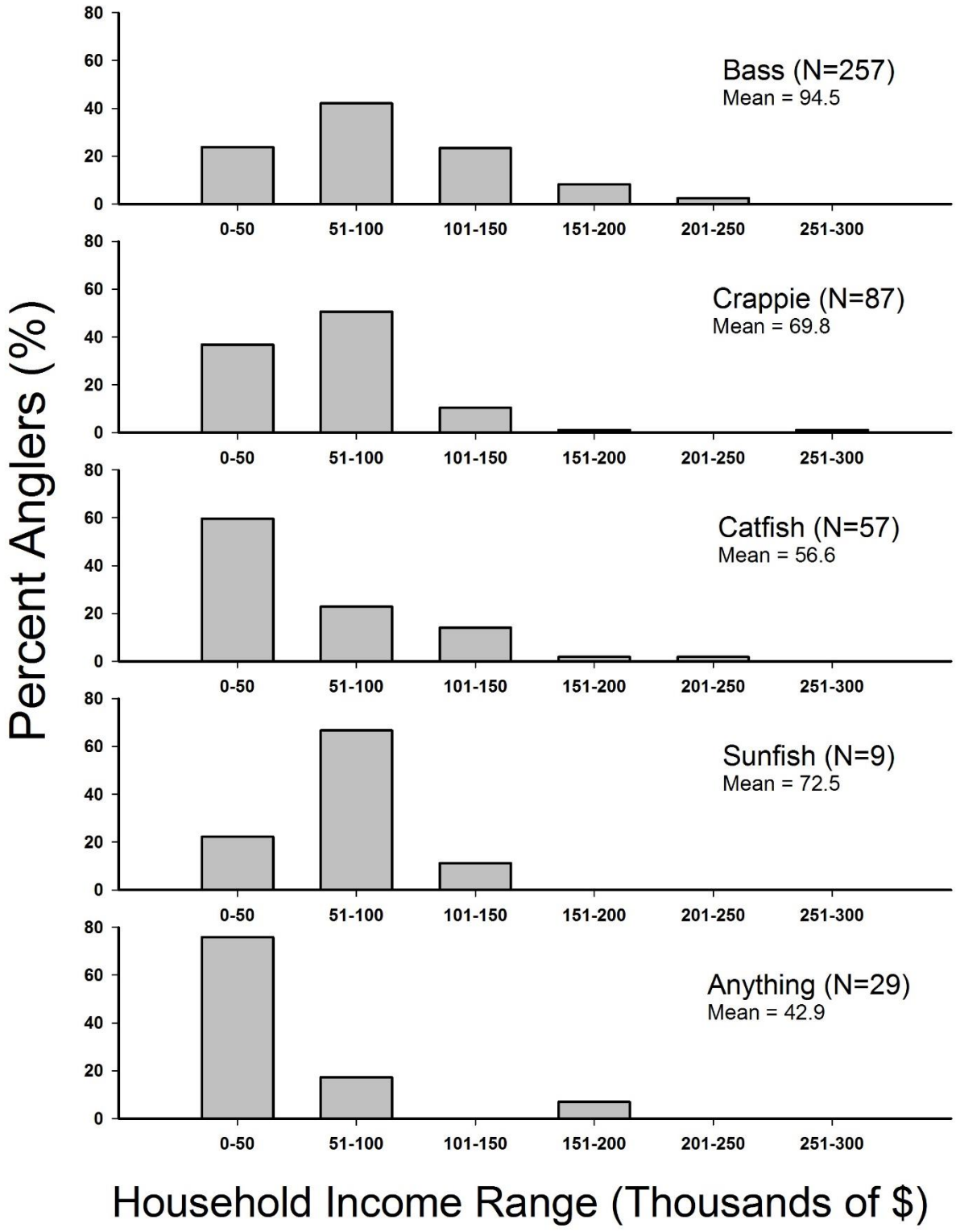

Figure 5. Household income range (thousands of dollars) distribution of recreational anglers targeting specific species contacted during the on-site roving creel survey, Millers Ferry Reservoir, Alabama, January – December, 2015. The mean household income was $80.8 thousand dollars (N=439).

IX. APPENDICES

IX.1. Instantaneous Count Survey Form

Millers Ferry Initial Count

Sample Dates: _____ **Crew:** _____

Date	Sub Sec.	Shift	Start Time	End Time	Wind Speed (mph)	Air Temp. *(°C)*	Water Temp. *(°F)*	Precip. (Y/N)	Fishing Boats* (# ppl/boat if multiple*)	Shore Anglers	Other Boats Fishing (ie. Pontoon)*	Boats Not Fishing*	Interviews

*Write the number of how many people are in a boat

Example 1: If you see 2 boats, each with only 1 person…write as 11

Example 2: If you see three boats, one with one person, one with 5, and the other with 3…write as 153

IX.2. On-site Roving Creel Survey Form

Millers Ferry Interview Form 2015

Date: _______ **Major River Section:** 1 2 3 4 5 6 **Creel Clerks:** ____________ **Interview #** ______
Interview Time (military)**:** ___________ **WPT:** _______ **Latitude:** ___________ **Longitude:** __________
Circle One: *Fishing Boat* *Pontoon Boat* *Shore* *Other* ______________
Hello, we are working with Auburn University Fisheries Department… May we interview you? *Y* *N*
- -(if yes, continue) -

1. What are you primarily fishing for? *Bass/ Crappie /Catfish/ Sunfish/ Anything/ Other*_________

2. How many of each species have you caught today?

Bass	Crappie	Catfish	Sunfish	Other:____________
Keep: _______	Keep: _______	Keep: _______	Keep: _________	Keep:_________
Release: _______	Release: _______	Release: _______	Release: _________	Release:_________
Livewell: _______	Livewell:_______	Livewell: _______	Livewell:_________	Livewell:________

3. Is this fishing trip in any way related to a tournament? *Y* *N*
   If ***YES***, a. Currently in a tournament b. Prefishing c. Tournament name ___________________

4. Have we contacted you before about this survey? *Y* *N*
   a. If ***YES***, Have we contacted you on this particular fishing trip? *Y* *N*

5. What time did you start fishing today? __________
   a. Are you finished fishing for the day? *Y* *N*
   b. What time do expect to quit fishing today? ________________

6. What city do you live in?
   a. City: __________________ State __________
   b. Trip type: *Day* *Overnight*
   c. Launch site: ___________________________
   d. Waterfront property? *Y* *N* *Cabin*

7. How many miles did you travel one-way from your home to fish? ________

8. How much will your completed trip cost, including gas, lodging, food, drinks, ice, fishing equipment, tournament and license fees, and any other items?____________ **Circle One:** *Individual* *Boat*
   a. Of the $xxx you will spend on this trip, how much will be spent within "20" miles of this river/reservoir section? ___________

9. How many days have you fished for *species* at this stretch of the river or reservoir in the past 12 months? ___________

10. Number of adult anglers in party ____*m* ____*f* ::::::::: Number of children < 16 ____*m* ____*f*

11. Would you be willing to allow us to contact you by phone for a more detailed survey? Y N

Contact information: Name:______________________ Phone number: ______________________

Preferred time of contact Time: ______________ M/F Age _______ Ethnicity __________

Household Income __________ Occupation _____________________

IX.3. Original Off-site Follow-up Telephone Survey Form

Call Date: _____ **Clerk:** _____ *Interview #:* _____ *Name:* _____ *Target Species*_____

Creel Telephone: _____ *Creel Fishing Trip Total Cost (yyy):* _____ *Creel Date:* _____ *Was the Survey Complete* *Y N*

(Fill out the italicized headings before conducting the interview)

Hello, I am with Auburn University Fisheries Department. I contacted you at William Bill Dannelly Reservoir, aka Millers Ferry (or 'along the Alabama River') on *date*. You gave me permission to conduct a follow up survey about your fishing trip that day. The interview should take only 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. May I interview you?

1. Was fishing for *target species* your sole purpose for visiting Miller's Ferry reservoir / Alabama River? Y N
   A. If ***NO*** what was the primary purpose of the trip? _____
2. How many hours did you fish the day I interviewed you on Miller's Ferry reservoir / Alabama River? _____
3. For your fishing trip on *date*, the same trip I interviewed you when you were fishing for *target species*, would you rate the quality of that trip as poor, fair, average, good, or excellent? *Poor Fair Average Good Excellent*
4. Do you plan on returning to Miller's Ferry / Alabama River to fish for *target species* in the future? *Y N*
   a. ***(Yes)*** How many trips do you expect you will go on within the next 12 months? _____
   b. ***(No)*** Why not? _____
5. What ramp do you use the most? _____
6. Was this an overnight trip? *Y N*
7. How many days did you spend at Miller's Ferry / Alabama River? _____
8. What kind of lodging did you use on the fishing trip? *Hotel/Motel Bed and Breakfast RV park (private) USFS site State site County site City site Friends/Families Private property (pp) Other* _____ *None*

   If PRIVATE PROPERTY:
   1. *(PP)* Do you own, rent, or lease this property? *Own Rent Lease*
   2. *(PP)* Is fishing the primary reason you use this property to fish at Miller's Ferry / Alabama River? *Y N*
   3. *(PP)* What city, state is this in? _____
9. Do you ever fish for *target species* at night? *Y N* How many days per year? _____
10. Do you ever target any other species at night? *Y N* How many days per year? _____
11. How many tournaments have you fished on Miller's Ferry reservoir / Alabama River in the past 12 months? _____
    A. Tournament info: Name(s)_____
12. Are you a member of any fishing club? Y N Name: _____

IX.3. Continued

13. How many years of fishing experience do you have? _____

14. Next, we would like to break down your *$yyy* that you spent to fish for *target species* on the trip by what items and by what city you bought it in. If you weren't in a city when you purchased an item, the county will work. How much was spent and where was it bought for:

*Circle one: *Individual expenses* *Entire boat*

Item	TOTAL Cost	Town/County	Cost	Town/County	Cost	Town/County	Cost	Town/County	Cost
Travel/Gas (car/boat/airline)									
Lodging									
Groceries/drinks/ice									
Restaurant meals									
Fishing equipment/bait									
Guide fees/tips									
Boat/fishing rentals									
Tournament fees									
Boat launch/Storage fees									
Repair/Maintenance/ Other									

That is all we need from you at this time. Thank you very much for your time. Do you have any comments about the lake you would like to share?
COMMENTS: _____

_____

IX.4. Supplemental Off-site Follow-up Telephone Survey Form

Name: _____ **Phone:**_____ **Call Date:** _____ **Call Attempts:** _____

Reference ID(s): _____

Hi, this is _____ with Auburn University. Is this/ _____ available? We were conducting the fishing survey on Millers Ferry Reservoir last year and had asked you a few follow-up questions over the phone. Do you have a minute to answer just a couple more questions about your experience at Millers Ferry?

1. If fishing for ____*(target species)*____ was not available at Millers Ferry, where would you go to fish for ____*(target species)*____ instead?

   _____

   a) How many miles is ____*(answer to #1)*____ from your house one-way? _____
   b) Which is better (*circle one*), **Millers Ferry** or ____*Answer to 1a.*____ ?

2. How many other reservoirs have you fished on in Alabama in 2015? _____
   a) What are the names of them? _____
   b) Which one was the best to fish at (*from 2a.*)? _____

If they rented or leased a property:

3. How much do you pay to lease/rent? (*circle one*)

   _____ per *month* *year*

Mr./Ms. _____, that is all the questions that I have for you. I would like to thank you again for your time.

Comments: _____