**Assessment of natural movements and dispersal of tournament displaced *Micropterus* spp.**

**in Neely Henry Reservoir, Alabama.**

by

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**INTRODUCTION**

Black bass (*Micropterus* spp.)are the most targeted fish by anglers in the United States, with 9.6 million anglers fishing a total of 117 million days targeting black bass in 2016 (Fish and Service 2009; Fish and Service 2018). Black bass anglers tend to be avid anglers and drivers of the sportfishing industry as a whole and spend higher amounts of money on items such as fishing equipment, boats, and boat fuel which directly fund the Sport Fish Restoration Act (Shupp, 2002, Long and Melstrom 2016). Fishing tournaments are very common amongst black bass anglers and provide immense value to local economies (Martin et al. 1982; Driscoll and Myers 2014; Snellings 2015; Boozer et al. 2019). Black bass tournaments on Alabama’s Neely Henry Reservoir, the location of this study, provided an estimated $10.3 million to the local economy in 2017 (Boozer et al. 2019). Furthermore, black bass anglers participating in these tournaments tend to have higher expenditures than their non-tournament counterparts. Coash (2024) reported that individual expenditures per trip for tournament anglers on Neely Henry Reservoir was $204 for tournament anglers compared to $78 for non-tournament black bass anglers, further illustrating the financial boost tournaments give to local economies.

While the number of anglers targeting black bass has remained similar between 2006 to 2016 (Fish and Service 2009; Fish and Service 2018), the number of black bass tournaments is increasing, especially in the southeastern United States (Schramm and Hunt 2007; Driscoll et al. 2012). The number of competitive fishing tournaments in the southeastern United States increased by 124% when comparing tournament estimates from 2002-2004 to 2009-2011 (Driscoll et al. 2012). In Alabama alone, an average of nearly 9000 fishing tournaments per year occurred between 2009-2011 with more than 98% of those tournaments targeting black bass (Driscoll et al. 2012). However, despite the vast economic benefits, the explosion in the number of black bass tournaments has raised concern among both anglers and managers (Kerr and Kamke 2003; Schramm and Hunt 2007).

One of the main concerns associated with an increasing number of black bass tournaments is the potential for overcrowding, or stockpiling, of fish around popular tournament weigh-in sites due to the large numbers of tournament-caught fish released into these areas (Schramm et al. 1991). Overcrowding of fish at release sites has the potential to increase vulnerability to angling and create unnatural accumulations of fish, resulting in decreased body condition and reduced growth (Gilliland 1999; Bunt et al. 2002; Hunter and Maceina 2008a; Maynard et al. 2017). Additionally, the displacement of fish by tournaments during the spring spawning period can disrupt their spawning cycles and reproduction of these populations may be negatively affected (Wilde and Paulson 2003; Hanson et al. 2007; Siepker et al. 2009). Some tournament organizations, most notably Major League Fishing, have recently adopted a tournament format where fish are caught, weighed, and released at their capture location and no translocation of individuals occurs (Cooke et al. 2020). This tournament format eliminates the issues associated with overcrowding at weigh in sites and mortality from long periods of time in a live well, however, this format is not yet widely practiced by fishing clubs or organizations (Cooke et al. 2020).

Previous research of black bass dispersal following tournament capture has been primarily focused on Largemouth Bass *Micropterus salmoides* and Smallmouth Bass *Micropterus dolomieu*. Dispersal patterns of Largemouth and Smallmouth Bass have been variable across studies. Several studies have shown rapid dispersal of translocated Largemouth and Smallmouth Bass and no evidence of long-term stockpiling (Huchzermeyer et al. 2013; Brown et al. 2015; Rupnik, 2018). Conversely, several studies have shown minimal dispersal of released fish from the weigh-in site for 1 or more months (Bunt et al. 2002; Wilde and Paulson, 2003). Wilde (2003) summarized 12 tournament dispersal studies for Smallmouth and Largemouth Bass and found that 51% of Largemouth and 26% of Smallmouth remained within 1.6 km of release sites, suggesting Largemouth may be more susceptible to stockpiling. The large amount of variation in black bass dispersal across studies highlights the need to evaluate potential stockpiling on a system-specific basis. Furthermore, many studies utilize simulated angling or displacement events (Hunter and Maceina 2008a; Brown et al. 2015) or submitted fish to additional stress by preforming transmitter implantation surgeries after fish had already gone through the capture and/or tournament-weigh in process (Gilliland, 1999; Wilde and Paulson 2003; Huchzermeyer et al. 2013; Maynard et al. 2017; Rupnik 2018), which could bias results.

While tournament dispersal of Largemouth and Smallmouth Bass is well studied across many systems, movement and dispersal patterns of Alabama Bass, *Micropterus henshalli,* is not well understood. Alabama Bass are native to the Mobile River Basin which encompasses parts of Alabama, Georgia, and Mississippi (Rider and Maceina 2015). Alabama Bass are a popular sportfish within their native ranges and can make up are large amount of the annual catch by anglers in some systems (Rider and Maceina 2015). Ricks and Maecina (2009) found that Alabama Bass made up approximately 70% of the total tournament capture on Lake Martin, Alabama. They also make up a large amount of the tournament captures throughout reservoirs on the Tallapoosa, Coosa, and upper Warrior rivers (Rider and Maceina 2015). Although Alabama Bass are actively caught by anglers throughout their range, minimal information is available regarding their tournament dispersal. Ricks and Maecina (2008a) found that Alabama Bass had high dispersal rates and dispersed at a higher rate than Largemouth Bass and long-term stockpiling was not observed. However, due to the high variation in dispersal for other black bass species (Largemouth and Smallmouth) it is unlikely that Alabama Bass would disperse the same across its entire range.

Seasonal movement data of fishes is also a critical part of fishery management. Movement data can inform managers of high use areas, home ranges, critical spawning grounds, overwintering locations, and areas of resource competition between species (Winter 1977; Mesing and Wicker 1986; Karchesky and Bennett 2004; Hunter and Maceina 2008b; Goclowski et al. 2013). Movement patterns of Largemouth Bass are well studied (Warden Jr and Lorio 1975; Winter 1977; Savitz et al. 1983; Mesing and Wicker 1986; Hunter and Maceina 2008b); however, movement patterns of Alabama Bass in reservoirs are largely unknown. Its close relative, the Spotted Bass *Micropterus punculatus* has been studied in rivers and streams, but it also remains understudied in reservoirs (Horton and Guy 2002; Horton et al. 2004; Goclowski et al. 2013; Edge et al. 2020). To our knowledge, only one study (Hunter and Maceina 2008b) has utilized telemetry to evaluate Alabama Bass movement within a reservoir, and the need for movement analyses of Spotted Bass has been established (Churchill and Bettoli 2015).

The objectives of this study are to (1) examine post-release dispersal patterns of Largemouth and Alabama Bass weighed in at tournaments, (2) evaluate differences in seasonal movements and large-scale space use between Largemouth and Alabama Bass, and (3) evaluate the potential for long-term stockpiling of black bass near a popular tournament weigh-in site. By achieving these objectives, my study will better inform managers of the potential long-term effects of tournament translocation on the spatial distribution of black bass stocks and provide insight into the movement and ecology of Alabama Bass.

**METHODS**

**Study Area**

Neely Henry is a 4547-hectare reservoir located in Northeast Alabama constructed in 1966 and operated for hydroelectric power by the Alabama Power Company (Figure 1). It is the second reservoir located on the Coosa River, located just below Weiss Lake and above Logan Martin Reservoir. It is shallow (mean depth = 3.3 m) and eutrophic with several of its creeks being designated as impaired in 2022 by the state of Alabama’s 303(d) impaired waterbody list. While other species are present, anglers typically target the two black bass species on the lake (Alabama Bass and Largemouth Bass). It is a high effort reservoir with an estimated 143 black bass tournaments conducted on the reservoir during the year 2017 bringing in an estimated $10.3 million and 8490 anglers to Etowah county (Boozer et al. 2019). Neely Henry reservoir is not only the site of numerous local tournaments, but it has also hosted larger events from national tournament organizations including the Bassmaster Elite Series (BASS), Phoenix Bass Fishing League (MLF), and the American Bass Anglers (ABA).

**Field Methods**

*Sampling Design*

We captured and tagged both Alabama and Largemouth Bass from Neely Henry reservoir (4547 hectares) in January-February 2022, December 2022-January 2023, and May of 2023 using standardized daytime boat electrofishing with a Midwest Lake infinity shock box producing 12-15 peak amps. Sampling sites were standardized by distance instead of time. Neely Henry reservoir was divided into 1.6 km long shoreline sites, 100 of which were randomly selected to be sampled for both the January-February 2022 and December 2022-January 2023 field seasons. Originally selected sites as well as sites that were not originally selected were utilized if sampling goals were not met after completing the initial 100 sites. For the May 2023 sampling event, only 80 shoreline sites were randomly selected to be used, and no revisiting or use of alternate sites was needed. The upper, more riverine portion of the lake (above Hokes Bluff) was not sampled for this study due to its lack of access and low catch rates.

*Reward Tagging*

When collecting fish from selected sites, Alabama and Largemouth Bass greater than 300 mm from each site were collected and put into the live-well on our electrofishing vessel. We tried to avoid tagging more than 10 of each species per site to ensure proper spread of tags across the entirety of the reservoir, however, this was violated on some occasions. Additionally, for both species, we attempted to tag 66 fish in six 50 mm length groups ranging from 300-600 mm. Once a desired length bin was completed, future collected fish within that length bin were released, and thus not tagged. However, due to some size bins not being able to be filled, some 50 mm length groups have more than the initially 66 fish goal in order to reach the targeted tag amount of 400 tags per species per year. Fish selected for tagging were affixed with an external dart tag manufactured by Hallprint Inc. (model: PDAT; length: 120 mm; color: yellow). Every third fish for the January-February 2022 and December 2022-January 2023 field seasons were “double tagged” with an additional dart tag of the same reward value, however, anglers were still only paid on a per fish basis, i.e., a double tagged fish did not carry double the reward. Fish tagged during the May 2023 were only single tagged to try and minimize the tagging stress of being tagged during the higher water temperatures that occur in May. The spatial distribution of dart tagged fish across all three sampling periods is seen in Figures 2-7.

When applying tags, both dart tags and the tag application tool were first sterilized in a 2% chlorhexidine solution before inserting the reward tag between the dorsal pterygiophores at a lateral and diagonal angle. Once inserted into the fish, the tag was rotated 90 degrees to ensure the tag was locked into place between the dorsal pterygiophores. Each external reward tag had a unique tag number, the reward amount ($100, $200, or $300), and a phone number for the angler to call and report their capture of the fish printed on the tag. Additionally, the tag instructed anglers to clip/cut the tag off the fish so it can be sent to us in the mail as proof that they caught the given fish. Upon calling the tag in, a short survey was administered by Auburn fisheries staff. Information obtained from the survey included basic information such as but not limited to: capture date, capture location, whether the fish was kept or released, and whether the fish was weighed in at a tournament. If weighed in at a tournament, the boat ramp where the fish was released after weigh-in was obtained from the angler.

*Telemetry Tagging*

A subset of the external dart tagged fish in both the January-February 2022 and December 2022-January 2023 periods were also surgically implanted with radio-telemetry transmitters. Only fish with a total length (TL) greater than 350 mm were eligible for implantation of a radio telemetry transmitter. For January-February 2022, 50 Alabama (mean TL = 431 mm, range = 358-527 mm) and 50 Largemouth Bass (mean TL = 438 mm, range = 355-532 mm) were implanted with a F-185 transmitter manufactured by Advanced Telemetry Systems (Isanti, Minnesota) with a 24-hour mortality switch. In the December 2022-January 2023 field season, 75 Alabama (mean TL = 420 mm, range = 350-514 mm) and 75 Largemouth Bass (mean TL = 440 mm, range = 344-532 mm) were implanted with F-185 radio transmitters manufactured by Advanced Telemetry Systems (Isanti, Minnesota) with an 8-hour mortality switch. The mortality switch allows the tag to send a mortality signal if no motion of the tag is detected. If motion is detected within the time interval of the mortality switch the tag will begin coding “alive” again. The change to a shorter mortality switch interval for the December 2022-January 2023 field season occurred due to several fish from the first tagging event appearing dead (based on tracking surveys) but continuously coded alive.

Before radio transmitters were implanted, fish were anesthetized in 250-ppm carbon dioxide solution created by mixing acetic acid and sodium bicarbonate until loss of equilibrium occurred (Marking and Meyer 1985). Once loss of equilibrium was evident, fish were removed and placed into a padded surgical trough, ventral side up, making sure to flush gills with lake water via a small bilge pump. Transmitters, and all tools used during implantation were all sterilized in 2% chlorhexidine solution prior to each implantation. A small incision of approximately 20-mm was made on the ventral surface of the fish, anterior to the urogenital pore. A transmitter was then placed into the body cavity. A hypodermic needle was utilized to puncture the body cavity of the fish posterior to the incision. The antenna of the transmitter was then threaded into the needle and the needle was subsequently withdrawn, thus threading the transmitter wire through the small puncture created by the needle. The incision was then closed up by 2 sutures of 3-0 ethilon poyamide 6 non-absorbing sutures manufactured by Ethicon LLC fed through the fish by a 30-mm 3/8c reverse cutting needle. Once sutures were in place, VetOne was spread on both the incision site and the puncture site. Fish were then allowed to recover in an oxygenated recovery tank. After full recovery, fish were released at their capture site. I made sure to choose fish for telemetry tagging from sites all across the lake in order to avoid condensed groupings of telemetry tags in small areas (Figures 8-11).

*Tracking Telemetered Fish*

Alabama and Largemouth Bass implanted with transmitters during the December 2022-January 2023 field season were designated to be a part of the upper or lower halves of the lake depending on their initial tagging location. A random subsample of 20 telemetered largemouth and 20 telemetered Alabama Bass from both the upper and lower lake (n=80) was completed in March of 2023 in order to ensure tracked fish were representative of the entire reservoir and spread throughout. Fish that had already coded dead or had been reported to be caught in tournaments or harvested prior to the beginning of April 2023 were not included in this random selection. As fish died or disappeared, they were subsequently replaced by fish that were not originally selected in order to keep a higher sample size to calculate seasonal movement patterns.

Fish were tracked with a 3-element Yagi antenna and R4500C receiver manufactured by Advanced Telemetry Systems Inc. on a biweekly basis. The best location for each fish was marked with a Garmin E-trex 22x handheld GPS, which is accurate to within 3 m. The best location was defined as when the gain on the receiver was minimized, the tag sound was omnidirectional under the boat and the “signal-strength” on the receiver was maximized. Fish were removed from the tracking regimen and location acquisition ceased if they coded dead on more than one occasion and no discernable movement occurred between each dead-code.

Some of the telemetered fish were caught and released in tournaments by anglers. I was notified of such an event by anglers voluntarily calling the phone number on the external dart tag or by Auburn fisheries staff who were present at tournament weigh-ins. The date and location of release of these tournament-caught fish was recorded and they were subsequently added to the tracking regimen. Tournament-released fish were tracked in an identical manner as the original 80 fish on the same biweekly basis, however, they were tracked indefinitely instead of being removed from the rotation after coding dead.

*Movement Distance Calculation*

After fish were tracked, movement distances were calculated between subsequent locations. Fish that had less than 2 fixes were removed from movement value calculations. Movement distance values were defined as the minimized in-lake distance between successive fixes. Fish were removed from movement calculations for every fix after their first dead code. In order to get the minimized in-lake distance I converted Neely Henry reservoir into a cost-grid, meaning that each cell in the lake has a specified cost/resistance to an individual traveling through the cell(s). Land was given a very high-cost value to ensure that fish paths would not be allowed to travel over land between fixes. Water was given a cost value of 0, indicating no possible resistance/cost for moving over these grid cells. Distance between fixes was then calculated as the minimized distance between each fix using this cost grid. The same was done for calculating proximity of released fish from their release ramp, the only difference being that each GPS fix for a released fish was routed back to its release site, not its previously held location.

**Analysis – Objective 1: Examine post-release dispersal patterns of Largemouth and Alabama Bass weighed in at tournaments**

For fish that were tracked prior to translocation by tournaments, an ANOVA will be conducted on their pre- and post-tournament release movement rates. Species-specific differences in dispersal movement rates between Largemouth and Alabama bass will be conducted using an ANOVA. Proximity of translocated individuals to their last-known location pre-release will be calculated in order to assess for homing of individuals to their previously held location. Additionally, proximity of tournament released fish to the boat ramp they were released at will be calculated in order to assess dispersal probability over time since release. Fish will be considered dispersed, or not, based on their presence or absence in a designated release zone over time (Figure 1). This area, hereafter referred to as the release zone, will be defined as extending approximately 3-km upstream and downstream of Coosa Landing, which is the host of the majority of black bass tournaments on Neely Henry (Coash 2024). The release zone around the ramp is defined in such a way because of the Neely Henry’s morphology. The release zone area is extremely narrow with minimal backwater pockets, coves, etc. This makes the detection probability of telemetered fish extremely high and our dispersal estimates reliable. However, beyond that 3-km threshold, there are expansive backwaters and creeks, and our detection probability decreases, thus making dispersal analysis more uncertain. Dispersal for each week post-release will be defined as the proportion of alive tournament-released individuals located outside of the designated release zone. The dispersal proportions over time will then be fitted to a logistic regression in order to obtain the probability of an alive fish dispersing over time.

**Analysis – Objective 2: Evaluate differences in seasonal movements and large-scale space use between Largemouth and Alabama Bass**

Monthly species-specific movement rates of Largemouth and Alabama bass will be compared via an ANOVA for each month. To evaluate large-scale space-use trends, fixes for fish will be designated to be part of 1 of 4 categories: main channel, creek-arm, creek, and cove. Main channel will be defined as the mainstem of the reservoir. Creek-arms will be defined as large embayments off of the main channel formed by 1 or more tributary stream(s). Creeks will be defined as the narrow upper reaches of creek-arm tributaries. Coves will be defined as embayments off of the main channel that do not have a primary feeder creek and do not possess flow. Changes in monthly space use within species as well as between species will be evaluated using a multinomial logit model on the proportion of individuals using each category over time.

**Analysis – Objective 3: Evaluate the potential for long-term stockpiling of black bass near a popular tournament weigh-in site**

For this analysis I will focus on stockpiling of tournament-released black bass at Coosa Landing, the most popular site for tournaments on the reservoir. To evaluate the potential for stockpiling near Coosa Landing, I will need to estimate the rate at which fish are moved to tournament release site and the rate at which fish disperse from the area. The rate at which fish disperse from the release site will be taken from objective 1, which estimated dispersal probabilities from a 3-km zone around Coosa Landing. To estimate rates of fish being released from tournaments into this release zone, I will analyze angler tag returns of external dart tags. Finally, I will input the estimates of tournament release rates and dispersal rates into a simulation analysis to assess the potential for stockpiling at the Coosa Landing release zone.

*Dart Tag Estimation Model*

To estimate the monthly rate at which black bass are released from tournament weigh-ins at Coosa Landing from 2022-2023 I will be using a mark-recapture model utilizing tag-return data collected over that same period. Parameters estimated by the model include reporting rate of $100 and $200 tags (λ100 and λ200), yearly mortality (M), monthly probability of black bass being weighed in at tournaments (μt), and monthly probability of angler capture for black bass outside of tournaments (unt).

The baseline model configuration assumes that $300 reward tags were reported with a probability of 1, however, Rubino (2024) was unable to conclude that reporting rate for $300 tags for the same system and study period was 100%. Therefore, I will run a sensitivity analysis of my model under three tag reporting probabilities for $300 tags: 0.70, 0.85, and 1.00. Tag loss will be estimated external to the estimation model from double tagged fish that were reported by anglers with a shed tag (Myers and Barrowman 1996) and the estimation model will be run with a fixed tag loss rate set at this estimate. The model will calculate the multinomial probability of angler tag return data and will be fitted via maximum likelihood in program R using the optim() function.

*Simulation Analysis*

The simulation analysis will use estimates from the estimation model as well as tracking data from radio-telemetered fish to simulate the effects of tournament translocation to weigh-in sites on the spatial distribution of black bass in Neely Henry reservoir. Specifically, the simulation model will examine the potential for long term loading of fish into the area directly around Coosa Landing boat launch, which is the ramp at which a majority of fishing tournaments on Neely Henry occur (Coash 2024). The simulation will model an unstructured black bass stock (no age, size, or species composition) distributed into two spatial strata: either “in” or “out” of the release zone Coosa Landing boat launch described by objective 1.

The model will simulate the monthly probabilistic translocation of black bass from other areas of the lake into the release zone via tournament release. The probabilities will be based on the estimates from the estimation model. The model will also simulate the dispersal of black bass out of the release zone subsequent to tournament release. The initial apportionment of black bass to the release zone and the rest of the reservoir will be proportional to the surface area of the two spatial strata. Fish in each spatial stratum will be subjected to tournament weigh-in, non-tournament release mortality, harvest, and natural mortality. The simulated population will be assumed to be at equilibrium with recruitment replacing natural and fishing deaths annually in April to coincide with the approximate time of spawning for black bass. Recruitment of new individuals into the population will be defined as the number of >350-mm fish recruiting to the population each April, because this is when fish on Neely Henry have been found to be 100% vulnerable to angling, and thus can be weighed in (Pullen 2024). Simulated post-release mortality rates will be based on the estimates from my telemetered fish and from literature values (Plumb et al. 1988; Muoneke and Childress 1994; Wilde 1998; Kerns et al. 2016). The simulation will be run for enough years to ensure that the population has reached a stable spatial distribution. This spatial distribution will be assessed relative to starting conditions to evaluate the potential for tournament translocation to substantially alter the spatial distribution of the black bass stock in Neely Henry reservoir. Because the estimation model will be completed three times under three different reporting rates for $300 tags, the simulation model will also be run three times using the three different outputs from the estimation model and the results will be compared to see how robust our simulation results are to the reporting rate of $300 tags parameter (λ300).

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**FIGURES**



**Figure 1.** Map of Neely Henry Reservoir and its relative location within the state of Alabama.Yellow indicates the 3-km release zone of interest used for the simulation analysis and the red triangle indicates the location of Coosa Landing boat launch.

A map of a river

Description automatically generated

**Figure 2.** Map of the spatial distribution of Alabama Bass tagged with reward tags from January 2022 to February 2022 in Neely Henry Reservoir weighted by number of fish per site.

A map of a river

Description automatically generated

**Figure 3.** Map of the spatial distribution of Largemouth Bass tagged with reward tags from January 2022 to February 2022 in Neely Henry Reservoir weighted by number of fish per site.

A map of a river

Description automatically generated

**Figure 4.** Map of the spatial distribution of Alabama Bass tagged with reward tags from December 2022 to January 2023 in Neely Henry Reservoir weighted by number of fish per site.

A map of a river

Description automatically generated

**Figure 5.** Map of the spatial distribution of Largemouth Bass tagged with reward tags from December 2022 to January 2023 in Neely Henry Reservoir weighted by number of fish per site.

A map of a river

Description automatically generated

**Figure 6.** Map of the spatial distribution of Alabama Bass tagged with reward tags from in May 2023 in Neely Henry Reservoir weighted by number of fish per site.

A map of a river

Description automatically generated

**Figure 7.** Map of the spatial distribution of Largemouth Bass tagged with reward tags from in May 2023 in Neely Henry Reservoir weighted by number of fish per site.

A map of a river

Description automatically generated

**Figure 8.** Map of the spatial distribution of telemetered Alabama Bass from January 2022 to February 2022 in Neely Henry Reservoir weighted by number of fish per site.

A map of a river

Description automatically generated

**Figure 9.** Map of the spatial distribution of telemetered Largemouth Bass from January 2022 to February 2022 in Neely Henry Reservoir weighted by number of fish per site.

A map of a river

Description automatically generated

**Figure 10.** Map of the spatial distribution of telemetered Alabama Bass from December 2022 to January 2023 in Neely Henry Reservoir weighted by number of fish per site.

A map of a river

Description automatically generated

**Figure 11.** Map of the spatial distribution of telemetered Largemouth Bass from December 2022 to January 2023 in Neely Henry Reservoir weighted by number of fish per site.