Exploring Synchrony Between Black Bass Angler Activity and Management Actions in Tennessee Reservoirs

M.S. Thesis Proposal

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Introduction

Recreational fishing is an important social, cultural, and economic activity worldwide. In the US, approximately 13% of the population participates in recreational angling, and in 2016 the sector was estimated to provide $83 billion in US economic activity, supporting 500,000 jobs (ASA 2018; USFWS 2018). In North America, sales of fishing licenses and taxes on fishing and boating equipment are a primary source of funding for conservation efforts (16 U.S.C. 777-777k, 64 Stat. 430; Ditton 2008). State natural resource agencies are tasked with supporting, conserving and regulating these important fisheries, and to do so undertake a wide variety of management actions such as fish stocking, habitat management, access programs, and much more. However, all too often the result of these management actions remain unquantified, and natural resource agencies are left guessing about what effect if any their actions have had. This can lead to extensive time, effort, and funding spent on actions that have little or no effect. Improved analysis of management action efficacy is crucial for natural resource agencies to make informed decisions about what actions should be continued, halted, or implemented (Beacham et al. 2019). Knowing what the return on investment has been historically and what patterns exist (and their drivers) allows agencies to provide the best possible product for their constituents and agency decisions.

Stocking of black bass species is a widely applied management tool that is appreciated by anglers, yet costly to management agencies. When used in an informed manner and an appropriate location stocking can be a highly effective tool to bolster a recreational fishery. However, it is not effective in every situation, and can be extremely expensive (Boxrucker 1986, Hoffman and Bettoli 2005). As such, it is vital to understand where black bass stocking is successful and where it is not meeting desired expectations. Continued stocking of a fishery that

is not significantly benefiting from agency investments may constitute an enormous sink of money and effort more effectively spent elsewhere. Management agencies often fall under heavy political and public pressure to stock black bass for perceived benefits to the fishery that may or may not be substantiated by data (Wingate, 1991). Post stocking analysis of success or failure to improve the fishery can save managers significant time and money, and provide information needed to justify the decision to stock or not stock. Other factors can affect resource use such as proximity to populated areas, boat ramp access or other social aspects.

Perhaps the most effective metric to assess how well a given management action improves recreational angling opportunity and success is angler effort, or the amount of time the combined angler pool invests in angling on a body of water. If an increase in angler effort is detected in response to a particular management action, that action has likely provided a better fishery, increased economic value, and potentially recruited new anglers. Managers obtain estimates of angler effort through angler interview programs known as creel surveys. Deployment of creel clerks in temporal and spatial patterns that are designed to intercept a representative random sample of anglers using a waterbody for interview produces an accurate estimate of effort on that waterbody. These interviews collect data on time spent fishing, as well as catch and harvest rates, demographic data, and other assorted metrics. Historically, creel surveys were often conducted in a piecemeal basis to answer temporally and spatially discrete questions (Bartley et. al. 2015). Increasingly however, management agencies have begun to realize the utility of a standardized statewide system of creel surveys to provide insight into landscape scale spatiotemporal trends.

The Tennessee Wildlife Resource Agency has been proactive in conducting statewide standardized creels, conducting regular surveys on large, high angler use reservoirs across the

state. This provides a high quality data set to analyze for landscape patterns on spatial and temporal scales, which can then be modeled against management action covariates to assess the efficacy of those actions.

Objectives

The objectives of this study are to 1) identify landscape level trends in black bass angler effort across Tennessee reservoirs, 2) to identify reservoirs that deviate from the landscape scale patterns in black bass angling effort, and 3) to relate the probability of a reservoir deviating from the common trend to management and environmental covariates.

Methods

Creel Reports

This project will utilize creel reports from the Tennessee Wildlife Resources Authority from 2000 to 2018 to obtain estimates of angler efforts on large reservoirs across Tennessee. All reservoirs except Normandy were sampled with roving survey methods using non-uniform probability, stratified random sampling. Sections on each reservoir were delineated that could be sampled in a 1-1.5 hr creel circuit, and assigned a sampling probability based on expected angler use in a specified month where the sum of the probability across all sections equaled 1. Daylight hours were split into 2 sampling periods which were similarly assigned sampling probabilities by month, and split into weekends and weekdays to account for higher expected effort on weekends. These probabilities were used to create stratified random work schedules for creel sampling where each sample day consisted of a ½ day period within a single predefined section of lake. Normandy reservoir used an access point survey rather than a roving survey, however the study design was essentially the same with the exception of access points substituted for the predefined sections in the roving framework.

In a given sampling day, creel clerks interviewed as many anglers as possible during the study period. If there were more anglers than could be interviewed in the sampling period, fishing parties were systematically skipped in order to obtain a representative spatial sample of the entire section. If anglers agreed to an interview, the creel clerk would proceed to collect information on length of the trip, target species, catch data, distance traveled to fish, dollars expended on the trip, and whether they were fishing a tournament. The clerk also counted all the fish harvested, and obtained bulk weight of harvested fish per species.

As the actual data collected in a creel survey only provides data on a small spatiotemporal scale, it was necessary to extrapolate the data to obtain an estimate of the overall metrics. For the purposes of this project, angler effort is the metric of primary importance. Estimates of effort were computed multiplying the angler count by the average length of the fishing trip for a given sampling period (e). This was subsequently expanded to an estimate of angler effort for the whole lake and the whole day (E) by dividing the e by the product of the sampling probabilities assigned to the section and period sampled that day. In order to obtain total monthly effort means of E across weekends and weekdays were calculated separately. These means were weighted by the number of each type of day in the given month and summed to provide a mean daily effort estimate. This estimate was multiplied by the number of total days in the month to give a total monthly effort estimate (T). In order to obtain estimates of effort for individual species, T was multiplied by the proportion of anglers targeting that species during that month.

Study Site Selection

From the many water bodies creeled by TWRA from 2000-2018, only lakes and reservoirs that were sampled at least 9 or more times were selected for inclusion in this study to

ensure temporal coverage. This resulted in the selection of 19 lakes and reservoirs (Figure 1) spatially distributed across Tennessee that include a diverse sample of trophic regimes, angler usage, physical characteristics, and habitat types.

Data Extraction

Using TWRA creel reports from 2000-2018, we extracted data on angler effort, catch, and harvest per year and reservoir for a variety of sportfish species. For this study, the primary metric examined will be Angler effort directed at combined Micropterus spp., hitherto referred to as "black bass" that included largemouth basses, smallmouth bass, and spotted basses. We selected this metric as all study locations had black bass populations that were heavily targeted by recreational anglers. In addition to this, black bass of one or more species/strain were commonly stocked in several of the study reservoirs, allowing us to assess how stocking may influence angler effort. To this end, we combined angler effort per year across all black bass species into a single metric for use in this study.

Model Description

To explore synchrony in angler effort across reservoirs, we will utilize a model framework similar to that found in Li et al. (2012) and Wagner et al. (2016). Namely, in order to determine the probability that patterns of angler effort on a given reservoir deviated from the common trend we will use a Bayesian model choice procedure bolstered by a Bayesian hierarchical modeling framework. To accomplish this, we will fit two alternate models, one hypothesis assumes a common trend in angler effort patterns across all reservoirs, and an alternative hypothesis that estimates trends for each reservoir separately. Subsequently we will introduce a model indicator to select the model that most appropriately describes that reservoir. The posterior frequency of the model indicator selecting the common trend model at each used

Markov chain- Monte Carlo iteration will be used to determine the likelihood that a reservoir differs significantly from the common trend. All models will be fitted using WinBUGS (Lunn et. al., 2000) used from within R (R Core Team, 2014).

We will also attempt to relate likelihood of deviating from the common trend to covariates such as black bass stocking levels, region, environmental factors, and distance to an urban center (e.g., population size and access). To do this we will fit a beta regression model to relate probability of deviance from the common trend to each of these factors.

Implications

This study will provide crucial insight into overall trends in black bass angler effort across Tennessee, and will provide valuable information into the efficacy of stocking management actions undertaken by the Tennessee Wildlife Resource Agency. Understanding where stocking actions are and are not effective, and which species of black bass demonstrate the greatest improvement to the fishery when stocked could help management bodies in Tennessee and elsewhere best direct their resources to areas where they can be most effective.

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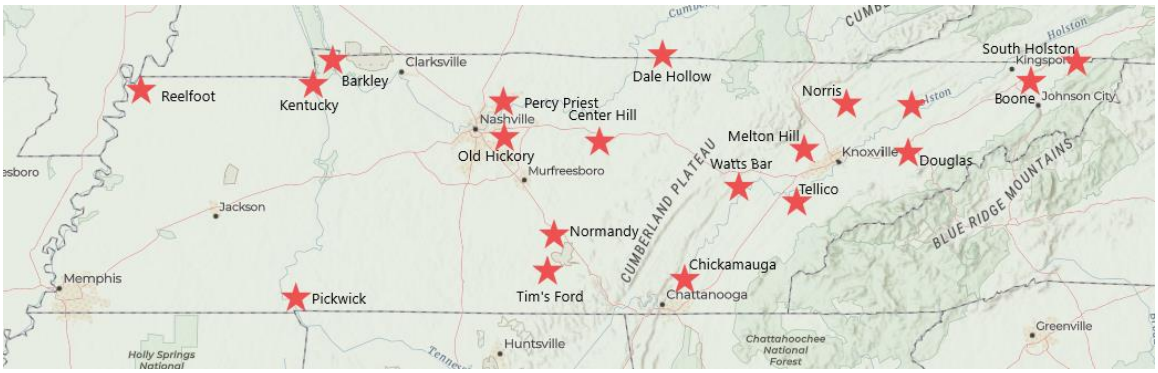

Figure 1. Tennessee reservoirs with at least 9 years of creel survey data from 2000 to 2018.