Changes in Angler Use Associated with Trout Stocking in Two North Carolina Small Impoundments

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Abstract: Brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), and rainbow trout (*Oncorhynchus mykiss*) have been stocked by the North Carolina Wildlife Resources Commission (Commission) into rivers and creeks in the mountain region of the state since the 1940s, but few trout fishing opportunities have existed in other regions. In December 2016, the Commission began to stock trout once a year into publicly accessible small impoundments across western and central parts of North Carolina. However, no formal evaluations of angler use in response to these stockings had been conducted. The goal of this project was to determine changes in angler effort before and after trout were stocked in two of these systems. At one impoundment, data from a trail camera from winters (December to March) 2015–2016 (no trout stockings) and 2019–2020 (first trout stocking) were analyzed to estimate angler effort. Angler effort at this impoundment during the winter of no trout stocking was 179.75 angler hours (angler-h). After trout stocking began, total winter angler effort increased to 833.5 angler-h. At another small impoundment where anglers were required to purchase a supplemental license to fish, license sales were analyzed to determine changes in use. Winter license sales were 250% higher during the three-year period of trout stockings compared to the three previous years when no trout stocking occurred. Results of this study demonstrated that trout stockings significantly increased angler effort and participation at these impoundments during the winter months. We recommend that the program be continued and extended to other similar systems as resources permit.

Key words: camera trap, license sales, total angler effort, community fishing program

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Urban and community fishing programs (UCF) are an integral part of fisheries management programs in many states (Hunt et al. 2008). The programs are typically designed to manage publicly owned waterbodies that provide access to anglers in or near the communities in which they reside. In North Carolina, these waterbodies are often stocked with fish to increase catch rates (Wallace et. al 2011, Ivasauskas et. al 2016) and include amenities such as fishing piers, paved walkways, and fish feeders to enhance the angling experience (Ivasauskas et. al 2016, Dorsey 2019).

Channel catfish (*Ictalurus punctatus*) are a popular species stocked in many warmwater UCF lakes due to their reasonable production cost and availability (Brader 2008, Munger et al. 2015). However, trout also can be stocked in many UCF lakes during cold weather months in many parts of the United States (Ott 1985, Gilliland 1989, Meneau 2008, Snow et al. 2019). Although thermal requirements may limit the fishing season for trout to the winter months in many lakes, these fisheries are popular with anglers. Because channel catfish are normally stocked during warm weather months, winter stocking of trout in UCF lakes generates fishing opportunities and additional participation that would not have occurred otherwise (Ott 1985, Gilliland 1989, Meneau 2008).

In 1989, the North Carolina Wildlife Resources Commission (Commission) initiated a new program intended to manage municipally owned small impoundments (≤50 ha) across the state to enhance fishing opportunities in these systems. The new program was formally titled the Community Fishing Program (CFP) and was focused on the use of periodic stocking of channel catfish throughout the spring and summer months. Since that time, the program has expanded to 58 small impoundments across North Carolina. Until 2016, channel catfish were the only species stocked by the Commission into CFP waterbodies, but beginning in December of that year, brook trout (*Salvelinus fontinalis*), rainbow trout (*Oncorhynchus mykiss*), and brown trout (*Salmo trutta*) were also stocked in many small CFP impoundments. Trout stockings were subsequently conducted once a year during December and were intended to provide additional angling opportunities in the winter when channel catfish were not being stocked.

Although numerous metrics can be used to evaluate UCF programs, angler effort is a coarse-scale metric readily available to assess the impact of management changes in these waterbodies (Ballard 2008). Direct survey methods, such as creel surveys (Malvestuto 1996) and angler opinion surveys (Knuth et al. 2012), can collect these data as well as many additional variables, but require substantial expenditure of personnel time. To minimize these costs, the use of new technology and ancillary data may be effective surrogates for formal surveys. Trail cameras have been

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demonstrated to be effective tools for measuring angler use (Hining and Rash 2015, Dorsey 2019) and fishing permit sales have also been used to track trends in UCF anglers (Gilliland 1989, Meneau 2008). Although neither technique collects data on angler catch, harvest, or motivations, they yield valuable information that can be a precursor to more detailed follow-up surveys. The objective of this study was to measure changes in angler effort using two low-cost techniques at two CFP impoundments before and after the initiation of trout stocking.

Methods

Study Area

Indian Camp Lake is a 1.7-ha CFP impoundment located in the Commission's Sandhills Game Land near Hoffman, North Carolina. Fishing is open to the public with a standard North Carolina fishing license. The impoundment is in an area that is classified as "micropolitan high commuting" by the U.S. Department of Agriculture (USDA 2010) and could generally be described as a rural area; population density is 38.0 people km^{-2} (U.S. Census Bureau 2010). Indian Camp Lake amenities include a gravel parking lot, two fishing piers, bank fishing areas, and access to launch small, non-motorized boats. Historically, this impoundment has been stocked annually with channel catfish and contains various other sportfishes such as largemouth bass (*Micropterus salmoides*) and bluegill (*Lepomis macrochirus*). Trout were first stocked into Indian Camp Lake in December 2019.

Also in the CFP program, 3.3-ha Frank Liske Park Pond is in Concord, North Carolina, in Cabarrus County, which is classified as "metropolitan" by the USDA (2010) and has a population density of 190.0 people km^{-2} (U.S. Census Bureau 2010). Frank Liske Park is managed by the Cabarrus County Active Living and Parks Department. During the time of this study (2015–2020), anglers over the age of 12 were required to pay a fee (US$1 daily; $20 annually) to fish in the Park impoundment. Park employees collected fee monies and recorded the number of anglers (both paid and free) each day. Anglers who chose to purchase an annual license were considered 'paid' anglers for the day the license was purchased and were counted as 'free' on any subsequent days they visited the park. Anglers 12 years old and younger received a free license. Unfortunately, youth anglers and returning annual license holders were not counted independently, thus analyses of exclusively youth anglers, or exclusively annual license anglers, were not possible. Anglers over the age of 16 were additionally required to have a North Carolina fishing license. Frank Liske Park Pond has been regularly stocked with channel catfish; trout stocking began in December 2017.

Study Design

Trout were stocked at Frank Liske Park in December 2017, 2018, and 2019 and in December 2019 at Indian Camp Lake (Table 1). Each impoundment was stocked once annually with a mixture of brook trout, brown trout, and rainbow trout at the discretion of hatchery staff. Most fish (98%) averaged a total length (TL) of 262 mm and an additional 2% of fish averaged 554 mm TL (Adam Moticak, Commission, personal communication). Trout were stocked at Indian Camp Lake at 471 fish ha^{-1} (Table 1). Fish were stocked at Frank Liske at a stocking rate of 377 fish ha^{-1} in 2017 and 546 fish ha^{-1} in 2018 and 2019. The increase in stocking rate between 2017 and 2018/2019 occurred because of improved hatchery production and fish availability.

Indian Camp Lake.—One Moultrie N990I field camera (Moultrie Feeders, Birmingham, Alabama) was installed at Indian Camp Lake on 1 October 2015 and was removed 30 September 2016 for a study examining angler use at Sandhills lakes (Dorsey 2019). The camera was reinstalled in the same location on 2 December 2019 prior to trout stocking and was removed 27 March 2020. The camera was approximately 75 m from the pond and fishing pier areas and field of view included the parking area, bank fishing areas, and both fishing piers. Image resolution was set to four megapixels to balance image resolution and memory card storage. The camera captured still images at 15-min intervals from 0700 to 1800 hours daily, consistent with the prior study (Dorsey 2019). Images were recorded during a 97-day period, between 10 December and 15 March.

Camera data were downloaded approximately every 30 days to a field laptop and flash drive. Images were analyzed using TimeLapse2 image enumeration software (Greenberg and Godin 2015, Dorsey 2019). Images were censored from the data if the field of view was not clear due to factors such as fog and low light. Anglers were counted from the first to the last photo in which they were found. Anglers were also categorized by age when possible, although these determinations were subjective to the authors. For the purposes of this study and based on the delineation of adults and youths by the Commission, adults were anglers who appeared to be 16 years or older (thus, required a North Carolina fishing license); anglers under 16 were categorized as youths. Anglers were

Table 1. Number and species of trout stocked into two North Carolina study impoundments, 2017–2019. Stocking rate is number of fish stocked per hectare.

Stocking location	Year	Brown trout	Brook trout	Rainbow trout	Total stocked	Stocking rate
Frank Liske Park	2017	80	524	640	1244	377
	2018	875	627	298	1800	546
	2019	346	900	554	1800	546
Indian Camp	2019	160	394	246	800	471

classified as bank/pier anglers or boat anglers. Images were also classified as weekday (Monday to Friday) or weekend (Saturday, Sunday, and all federal holidays). Angler counts were determined using the same methods implemented by Dorsey (2019). To generate an estimate of daily anger effort (angler-h) for each date, we summed all instantaneous counts for that day, divided the sum by the number of images analyzed for the same date, then multiplied this resulting mean anger estimate by the hours the camera collected images. We evaluated differences in daily angler effort prior to and after winter trout stocking with paired *t*-tests in R (R Core Team 2013).

Frank Liske Park Pond.—Angler use was estimated using license data provided by Frank Liske Park personnel for the 1 December to 15 March timeframe of each winter. This timeframe was selected to account for the variable dates of trout stocking and the period that park staff reported trout angler harvest. Total numbers of licenses issued were calculated for each winter from 2014–2015 through 2019–2020. To evaluate differences in angler use prior to and after winter trout stockings, the number of licenses issued over the three years without trout stocking and the three years with trout stocking were compared using paired *t*-tests (R Core Team 2013). Statistical significance was set *a priori* at $P \leq 0.05$ for all analyses.

Results

Indian Camp Lake

A total of 4352 pictures were collected and analyzed in winter 2015–2016; 4205 were collected and analyzed over the same time period in winter 2019–2020. Overall angler effort was 4.5 times higher in winter 2019–2020 than in winter 2015–2016 (Table 2). Total angler effort during weekends was more than three-fold higher in winter 2019–2020 than in winter 2015–2016, and weekday effort was almost seven times higher between the same time periods. Adult angler effort was almost five times higher in winter 2019–2020 than in winter 2015–2016 (Table 2). When separated by weekdays and weekends, adult angler effort was more than three times higher during both weekdays and weekends between the same time periods. Total youth angling effort was also significantly higher in winter 2019–2020 (Table 2). Weekend youth angling effort was almost five-fold higher in winter 2019–2020 than in 2015–2016. Conversely, youth angler weekday effort was not significantly higher in winter 2019–2020 than in winter 2015–2016.

When comparing daily trends of angling effort at Indian Camp Lake between the two time periods, effort was higher on 77% of the days in 2019–2020, compared to the 2015–2016 period. Throughout most of the 97-day period angler-h remained higher after trout stocking (Figure 1). Most anglers at Indian Camp Lake fished from the bank or the fishing piers, rather than from a boat, and this trend did not change between time periods. In 2019–2020, total angler-h from the bank or piers was 831.5 (SE = 1.1), compared to 2.0 (SE < 0.1) angler-h for boat anglers. In 2015–2016, bank and/or pier anglers accounted for 179.0 (SE = 0.4) angler-h, whereas boat anglers only accounted for 0.8 (SE < 0.1) angler-h.

Table 2. Mean (SE) total angler effort (angler-h) and effort separated by angler age group and time period at Indian Camp Lake, North Carolina, during winters of 2015–2016 and 2019–2020. Results from *t*-tests are included.

Group	Period	2015–2016	2019–2020	*t*	df	*P*-value
All anglers	Overall	179.75 (4.3)	833.5 (14)	6.08	96	< 0.001
	Weekday	67.8 (0.3)	462.5 (1.2)	5.38	64	< 0.001
	Weekend	112 (1.0)	371 (2.3)	3.65	31	< 0.001
Adult anglers	Overall	149.5 (0.3)	736.5 (0.9)	6.40	96	< 0.001
	Weekday	60.75 (0.2)	435.75 (1.1)	5.34	64	< 0.001
	Weekend	88.75 (0.7)	300.75 (1.8)	3.87	31	< 0.001
Youth anglers	Overall	18.75 (0.1)	75.5 (0.2)	2.51	96	0.014
	Weekday	7 (0.1)	22 (0.2)	1.72	64	0.090
	Weekend	11.75 (0.2)	53.5 (0.6)	2.05	31	0.049

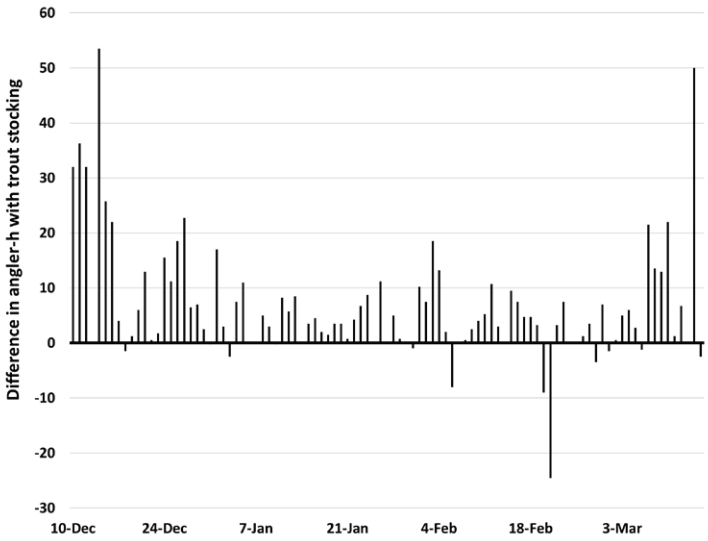

Figure 1. Comparison of angler-h at Indian Camp Lake, North Carolina, with and without trout stocking, throughout the 97-day study period (10 December–15 March). Bars above the zero line represent days where angler-h was higher with trout stocking and bars below the zero line represent days where angler-h was lower with trout stocking.

Frank Liske Park Pond

During the three years prior to trout stocking 348 licenses were issued from 1 December to 15 March ($\bar{x} = 116$ per winter; Figure 2). Conversely, in the three years when trout were stocked, 873 licenses were issued ($\bar{x} = 291$ per winter), which constituted a significant increase in angler license sales with trout stocking ($t = 5.78$, df = 2, $P = 0.03$). Most of this increase was due to paid (adult) license sales, which were also significantly higher ($t = 6.99$, df = 2, $P = 0.02$). Av-

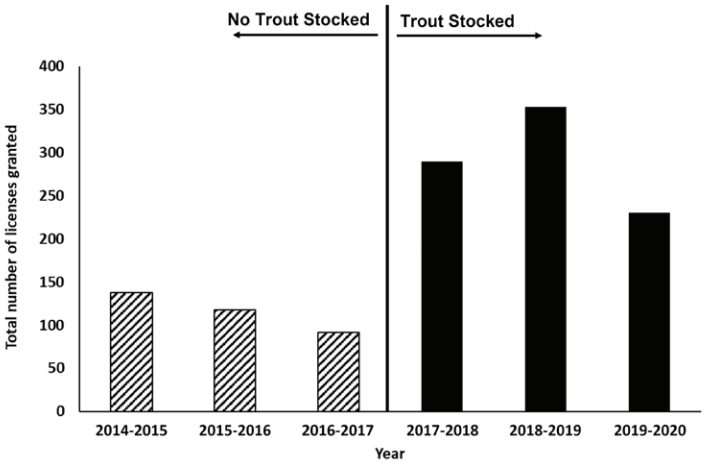

Figure 2. Total number of licenses issued at Frank Liske Park, North Carolina, from 1 December to 15 March of each winter.

erage revenue produced through the sale of fishing licenses before trout stocking was $99 annually. With trout stocking this revenue increased to $340 on average. Before trout stocking no annual licenses were sold. After trout stocking an average of four annual license were sold each year. Based on the overall number of licenses issued, and those that were paid for, only a small portion of total licenses issued were to youth or returning annual license holders and this portion only slightly increased with trout stocking (7% for the three years prior to trout stocking; 11% for the three years with trout stocking).

Discussion

Angler participation during winter months increased substantially after implementation of a winter trout fishery at these two CFP impoundments. The six years of license sales data at Frank Liske Park confirmed that increases in angler participation occurred for multiple years after the initiation of trout stocking at this location. While data collection at Indian Camp Lake was limited to a prior year without trout stocking and the first year after trout had been stocked, the angler participation was more than four and half times higher than was measured by Dorsey (2019) for the winter months. Similar increases may be being realized in other CFP impoundments across North Carolina where winter trout stocking programs have been established in recent years (Corey Oakley, Commission, personal communication). Previous studies of winter trout stockings in small impoundments have demonstrated success in terms of high angler interest and cost-effectiveness (Ott 1985, Gilliland 1989, Meneau 2008), but those studies did not measure changes in angler effort before vs. after the introduction of trout.

The Indian Camp Lake study utilized a camera trap which assessed bank, pier, and boat angling. At larger reservoirs, camera traps have been used to assess the number of boat trailers and subsequent angler effort at access points (Rash et al. 2020) and similar methods could be employed at larger sites with trout stocking in the future. Powers and Anson (2016) demonstrated that video cameras operated to record continuously at boat ramps can be useful in determining angling effort and this method may be useful for future studies where video surveillance equipment can be installed.

Use of trail cameras and license-fee data provided a low-cost method to evaluate the impact of these winter trout stockings. Creel surveys have often been used in studies similar to this but their cost is considerably more. For example, as of 2021, the Commission typically budgets US$120 per person day for creel surveys plus mileage costs that vary depending on study location, duration, and survey design. A previous creel survey on several CFP ponds required eight person days per month over a two-month period to obtain interviews and angler counts (Russell Wong, Commission, personal communication). Conversely, the camera downloads at Indian Camp Lake only required 2.5 person days over a three-month period. In addition, mileage costs were certainly less due to the smaller number of trips needed to the study site to collect data from cameras. Reductions in costs using trail cameras in lieu of, or to bolster, traditional creel surveys have been documented in other studies (Stahr and Knudsen 2018, Dorsey 2019, Rash et al. 2019) and although no comparisons of the costs using existing license-fee data versus traditional creel surveys were available for Frank Liske Park Pond, it is likely that using existing data is much less costly than an onsite creel survey.

While our study found increases in overall angler effort in these systems, it was less apparent for youth anglers. Youth weekday angling effort at Indian Camp Lake was slightly higher with trout stocking, but it was not statistically significant. This result is not unexpected considering the impact of school on the time available for youth to visit the fishery. There was, however, a significant increase in youth angling on weekends with trout stocking, indicating trout are an incentive to get youth to fish in these systems. The percentage of free licenses issued did slightly increase with trout stocking (3.7%), but this change was unlikely to signify any major increases in youth angling.

Each year, the Commission posts the winter trout stocking program schedule on various social media platforms. Frank Liske Park has utilized road-side banners and news outlets to notify nearby residents of the stockings. While these marketing strategies appear to have influenced angler participation, it may be beneficial to strategically market these fishing opportunities towards younger individuals to increase youth participation. During the time of this

study, very little, if any, marketing was done to directly target youth anglers. This youth-oriented marketing could be done through additional social media platforms or by distributing printed advertisements at locations such as libraries and schools. Programs and events specifically designed for children, young adults, and families have been shown to increase youth participation in states such as New York and Iowa (Schramm 2008) and similar programs could be implemented in the winter trout stocking program lakes.

In small impoundments located in Texas (Ott 1985) and Oklahoma (Gilliland 1989), winter trout stocking programs were found to generate significant economic benefits that added to the year-round economic impacts of these fisheries. Additional research is needed to determine if similar economic benefits are provided to North Carolina winter trout fisheries. Since Frank Liske Park requires anglers to pay a small fee to assist with park maintenance costs, increased angling effort yielded additional funds for park maintenance. While the increase in revenue was only an average of $241 annually, this is still money that can be used towards park improvements, and revenues could increase as the program continues in succeeding years. Our study at Indian Camp Lake did not measure overall economic value but the observed increase in angler effort at this impoundment has the potential to increase angler expenditures for surrounding businesses (Palm and Malvestuto 1983, Loomis 2006).

The costs to raise the trout that were stocked into these impoundments were approximately $0.70 per 262 mm TL fish and $8.00 per 554 mm TL fish (Adam Moticak, Commission, personal communication). It is estimated that the fish stocked into Indian Camp Lake in December 2019 cost $676.80. The total cost for the three years of trout stocking at Frank Liske Park was an estimated $4,878.88. While these costs are incurred by the Commission, the trout used were considered surplus production by the state, and costs were not prohibitive. Overall, the benefits anglers received from the winter trout stocking program appear to outweigh the costs of trout production for these stockings.

Future studies, including creel surveys and those where park staff record user data, should consider recording detailed data (age, gender, expenditures, etc.) so that more precise and varied analyses can be conducted (Loomis 2006). A better understanding of the individuals using these fisheries would allow for managers to tailor programs to suit the wants and needs of the constituents. In urban areas, it is common for a high concentration of individuals to have lapsed fishing licenses, or to have never purchased a license (Balsman and Shoup 2008). By marketing and designing stocking programs to attract these individuals we could recruit and retain new and returning anglers. Future studies could also try to examine angler license sales around the time of stocking, near stocking locations, to determine if an uptick in license sales occurs. An uptick could indicate recruitment of new anglers to the system and may be additional evidence of successful stocking programs. Frank Liske Park, located as it is within a metropolitan area, could be especially useful to evaluate increases in license sales near stocking times (USDA 2010). Both locations saw significant increases in angler effort, indicating success of winter trout stocking programs in both urban and rural impoundments.

Significant increases in angler effort with trout stocking indicate that the winter trout stocking program was successful in attracting anglers to these fisheries. Our methods, while not as comprehensive as traditional creel surveys, provided coarse user data on two CFP systems in an efficient manner and provide the basis for more detailed future surveys. While adult angler effort was significantly higher at both locations, we found that youth angling did not increase to the same degree, indicating promotion of the fishery and increased angling effort in this group is still possible. This project demonstrates the positive benefits of stocking trout in North Carolina small impoundments and indicates that future trout stockings will be utilized by anglers.

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