

Use of Trail Cameras to Assess Angler Use of Two Remote Trout Streams in North Carolina

Kevin J. Hining, North Carolina Wildlife Resources Commission, 1556 Big Flatts Church Rd., Fleetwood, NC 28626

Jacob M. Rash, North Carolina Wildlife Resources Commission, 645 Fish Hatchery Rd., Marion, NC 28752

Abstract: North Carolina Wildlife Resources Commission (NCWRC) manages approximately 6400 km of self-sustaining, wild trout streams, and recent trout angler opinion data indicated that most trout anglers fish these waters. Given the popularity of wild trout angling, increasing understanding of angler use of these resources would benefit NCWRC. However, gathering this information can be labor intensive and costly, and as a result, very little is known about angler usage of wild trout resources in North Carolina. Recent advances in digital camera and motion detection technology provide a potential low-cost alternative to typical manned-creeel surveys. In an effort to obtain angler use information for wild trout resources in North Carolina, trail cameras were stationed along two wild trout streams with only one or two access points. From 1 June 2013 through 31 May 2014, 225 and 129 angler trips occurred on the two streams, resulting in fishing effort estimates of 593.4 (SE = 15.3) and 491.5 (SE = 21.3) h. Mean angler group size was 1.4 (SE = 0.04) and 1.3 (SE = 0.05), and mean trip lengths were 2.6 h (SE = 0.2) and 3.8 h (SE = 0.2) for the two streams. Angler usage was highest during the summer months with most daily activity occurring on weekends and holidays. Most anglers (>90%) on both streams appeared to be adult, Caucasian, males that used fly-fishing gear; in contrast, 36.4% of youth anglers used spin-fishing gear. Trail cameras provided a low-cost method of obtaining angler use and demographic information from these wild trout resources. Data obtained will aid NCWRC staff in making future management decisions regarding wild trout resources.

Key words: creeel survey, remote cameras, angler trips, fishing effort

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Trout are one of the most popular sport fish in the United States, with trout anglers accounting for 27% of all freshwater anglers and contributing an estimated US\$13.6 billion to the nation's economy (U.S. Fish and Wildlife Service 2010). Trout also represent a significant portion of angling opportunities in North Carolina, with an estimated 131,055 resident trout anglers (Responsive Management 2007) accounting for a total economic output of \$174 million to the state's economy in 2008 (Responsive Management 2009). While many streams in western North Carolina are capable of providing seasonal coldwater angling opportunities, approximately 6400 km are managed by the North Carolina Wildlife Resources Commission (NCWRC) as self-sustaining, wild trout waters. In North Carolina, these coldwater resources are seen as important ecological, recreational, and economic assets, and as a result, a major management emphasis is placed on ensuring their continued persistence and accessibility to anglers (NCWRC 2013).

Wild trout populations in North Carolina are located at the southern range of coldwater fishery habitat in the eastern United States, which restricts trout populations to higher elevations (> 500 m above sea level). An additional limitation to wild trout angling opportunities in North Carolina is the availability of public access for fishing. As a result, wild trout fishing opportunities are more prominent in the southwestern mountains of North Carolina largely due to the 600,000 ha of public land contained in the Great Smoky Mountains National Park, Nantahala and Pisgah nation-

al forests, North Carolina state parks, and NCWRC game lands (Hodges and Borawa 2002). Conversely, most publicly owned lands in the northwestern mountains of North Carolina are limited to four State Parks, NCWRC Game Lands, and portions of National Park Service land surrounding the Blue Ridge Parkway. Furthermore, many of the streams within these public lands are often steep, intermittent, and devoid of trout.

Due to the lack of public land in northwestern North Carolina, wild trout fisheries are restricted primarily to private lands, where public access to these resources requires landowner permission. The NCWRC communicates routinely with private landowners to obtain or maintain public access for fishing. Often, landowners are uninterested in allowing public access for fishing initially, but in many cases they become amenable to the idea and often request additional information. Landowners are often specifically concerned about the approximate number of anglers they can expect to enter their property, which are data NCWRC staff have lacked historically.

Given the popularity of wild trout resources, increasing understanding of angler usage levels and patterns of wild trout waters would benefit managers. Whereas studies designed to assess angler usage have been implemented by NCWRC on both stocked and wild trout streams (Borawa et al. 1995, Borawa and Clemmons 1998, Borawa et al. 2002, Besler et al. 2005), efforts to obtain angler use data from wild trout resources have focused on selected situa-

tions such as waters receiving supplemental feeding (Borawa et al. 1995), a natural bait allowance (Borawa and Clemmons 1998), or streams that require lengthy, strenuous hikes to access (Hining and Rash 2015). As a result, very little is known about typical angler usage on wild trout streams in North Carolina. Additionally, communication with fisheries personnel from various state agencies indicated that only a few studies (e.g., Geddings and Rankin 1997, Durniak et al. 1997, Habera et al. 2003, Reeser and Mohn 2004, Greene et al. 2005, Kristine 2012, Palmer 2013) and data summaries (National Park Service, unpublished data) have been conducted on angler use of wild trout streams in Appalachian streams. Furthermore, many of these surveys were conducted on larger (>6 m wide) streams (Geddings and Rankin 1997, National Park Service, unpublished data) or on nationally recognized, heavily fished waters (Durniak et al. 1997, Reeser and Mohn 2004, Palmer 2013).

Obtaining angler usage information from smaller, more remote streams can be labor intensive and costly. This is especially true for streams that provide anglers multiple access points. In contrast, obtaining information from streams with limited access may be easier. Recent advances in digital camera and motion detection technology provide a potential, low-manpower alternative to typical, more intensive creel surveys (Greenberg and Godin 2015).

Remote cameras are often used to collect wildlife information (Kays and Slauson 2008, O'Connell et al. 2011). In recent years, use of remote cameras has extended to fisheries related projects (Smallwood et al. 2012, Greenberg and Godin 2015) including monitoring angler use on trout streams (Kristine 2012). By analyzing the digital images obtained, along with the time and date information provided with each image, researchers can determine the number of anglers, estimate fishing effort, describe temporal usage patterns, and even obtain angler demographic information (Greenberg and Godin 2015). Therefore, we assessed the utility of this method on two wild trout streams with limited access points in North Carolina. Our objective was to estimate angler use and demographics in these streams over a 1-yr period.

Study Area

Garden Creek and Basin Creek, two streams containing self-sustaining trout populations, were selected for this study because both flow through watersheds on public land and contain a limited number of access points. These streams were representative of many of the wild trout resources within North Carolina, and we expected them to provide an experience similar to what trout anglers would encounter elsewhere within the state.

Garden Creek is located within Stone Mountain State Park near Roaring Gap, North Carolina, while Basin Creek is in the next drainage to the west and begins near the Blue Ridge Parkway. Both

areas are managed for fishing and other recreational activities and are protected from large-scale anthropogenic effects such as development and logging. Each creek begins at an approximate elevation of 1000 m above sea level on the Blue Ridge Escarpment in Alleghany County and flows southeasterly into the Roaring River, a tributary of the Yadkin-Pee Dee River. These streams are similar in length (6 km of fishable water) and wetted width (5 m) and exhibit the characteristic high-gradient channel morphology and boulder-cobble substrate of many southern Appalachian streams. The drainage area of both streams are forested, with dominant vegetation including an understory of rhododendron (*Rhododendron* spp.) and doghobble (*Leucothoe axillaris*) surrounded by mixed deciduous forest and remnant stands of eastern hemlock (*Tsuga canadensis*).

Garden and Basin creeks contain similar fisheries with respect to densities and sizes of trout (NCWRC unpublished data). Garden Creek contains brook trout (*Salvelinus fontinalis*) and brown trout (*Salma trutta*) and is managed by NCWRC as a Wild Trout Water, requiring the use of single-hook, artificial lures. Basin Creek is managed by the National Park Service and contains rainbow trout (*Oncorhynchus mykiss*). Angling in Basin Creek is restricted specifically to the use of single-hook, artificial flies. On both streams, anglers may harvest up to four trout, with a 178-mm TL minimum-size limit.

Both waters are paralleled by a trail that terminates in the headwaters of each stream. Sole access to the trail along Garden Creek is via a parking area at the lower end. In contrast, there are two points of entry to the trail along Basin Creek. The primary entry is from a parking area beside the creek at the lower end of the trail, similar to the one at Garden Creek. A second, more remote entry is located 2.4 km upstream and involves a steep, lengthy (8 km) descent from the Blue Ridge Parkway.

Methods

Trail Cameras

Bushnell Trophy Cam trail cameras (Model 119576, Bushnell Outdoor Products, Overland Park, Kansas) were used to collect angler data from both streams from 1 June 2013 through 31 May 2014. These cameras used a passive infrared motion sensor for triggering photos and a black infrared LED flash. Cameras were placed in security boxes (Trailcampro, Springfield, Missouri) that were affixed to each tree with screws and secured to the tree with a cable lock. A camera was placed at both entry points to the Basin Creek trail, as well as the entry point to the Garden Creek trail. All three camera locations were 3–4 m from the center of each trail, and positioned at a 90-degree angle to the trail and stream. Cameras were mounted at a height of 2 m above ground on trees located

on hillsides above the trail, allowing the cameras to be elevated 3–4 m above the trail. This allowed staff to access each camera without having to use a ladder. Furthermore, setting the cameras back and above the trail enlarged the field of view for each camera.

Upon installation, cameras were set at the highest motion detection setting and staff walked along the trail past the camera multiple times at a variety of paces. Photos were reviewed to ensure staff were included in photos regardless of the speed they moved up the trail. After several trials staff determined that a 10-sec delay between photos would prevent multiple photos of the same subject, while still optimizing the chances of triggering photos of anglers regardless of walking speed. Medium photo resolution (5 megapixels) was used, allowing >6000 photos on each 8-megabyte camera card.

Cameras and security boxes were brown in color and blended in with the surroundings, but were at a height and location approachable by the public. Text informing the public of the research effort and NCWRC contact information was placed on the side of each security box to allow the public a method for obtaining information regarding the purpose of the cameras. This also provided a method of ensuring cameras were working properly as individuals that approached the camera should have had their photo taken. Those individuals who called NCWRC staff were asked about the number of people in their group and the approximate date and time they visited the camera. These individuals were also asked if they were fishing, and if so, the gear they were using. Photos captured from that date and time were reviewed to find a photo matching the caller's description to verify that the camera was functioning properly. This also allowed us to determine the effectiveness of cameras at capturing all individuals in each group, detecting anglers from non-anglers, and fly-anglers from spin-anglers.

Camera maintenance was performed every two months to evaluate battery life and camera settings and to exchange the memory card. During maintenance visits NCWRC staff walked past each camera prior to servicing it and then walked past the camera immediately after completing the maintenance. Dates and times that any maintenance was performed were noted. As a result, photos of NCWRC staff were the first and last photo on each memory card, and the date and time stamp on these photos were matched with known dates and times of maintenance on each camera to conduct an additional evaluation of camera functionality.

Images from the memory cards were downloaded onto a computer and sorted by the month the photo was taken. An initial visual review of photos was performed and photos without subjects were discarded. Remaining photos were segregated between those containing anglers (individuals with waders, fishing vest, or fishing rod) and those of non-anglers. Non-angler information for

each stream was arranged by activity type (hiking or horseback riding). Summaries of these photos were provided to the National Park Service and North Carolina State Parks to aid both organizations with evaluations of trail usage.

Angler Counts

Photos containing anglers were analyzed to determine number of angler groups and number of anglers in each group for each stream. A two sample *t*-test ($P < 0.05$) was used to compare the mean group size between the two streams. Because there were two possible entry points to the trail along Basin Creek, a comparison of angler groups captured on the two Basin Creek cameras was conducted to help ensure the accuracy of angler counts. Angler groups only captured by the upper camera were assumed to have accessed the stream via the entry point from the Blue Ridge Parkway, while angler groups captured on both the upper and lower cameras must have accessed the stream from the lower entry point. This two-camera set-up also provided a method of evaluating the cameras for determining the angler group size, since photos of each angler group captured by the upper and lower camera could be compared.

Fishing Effort

For each day that photos of anglers were captured, efforts were made to match an entry and exit photo for each angler group. When an entry and exit photo was obtained for a specific angler group, the fishing effort for that angler group (e) was calculated as:

$$e = (m)(t),$$

where m is the number of anglers in the angler group and t is the trip length (h) for that angler group determined by the time elapsed between the entry and exit photo. Total fishing effort (Σe) could then be determined by summing the trip length obtained for each angler group (e). The mean trip length (Xt) for both streams was obtained by:

$$Xt = \frac{\Sigma e}{\Sigma m},$$

where Σm is the number of anglers with trip length information. A two sample *t*-test ($P < 0.05$) was used to compare the mean trip length between the two streams.

In both streams, sometimes only an entry or exit photo was obtained for an angler group. This occurred as a result of anglers fishing up or down the creek rather than walking the trail in closer proximity to the cameras. Camera placement at both streams was not close enough to the water for the motion sensor to detect all anglers in the stream. To correct for this, fishing effort for angler

groups lacking appropriate entry or exit times (H) was estimated as:

$$H = (P)(Xt),$$

where P is the number of anglers without trip length information. Thus the complete total fishing effort was estimated by summing Σe and H . Standard error for total fishing effort was calculated by:

$$SE \text{ of } \Sigma e + H = (H) (SE \text{ of } Xt).$$

Angler Usage Patterns

Number and mean trip length of anglers were stratified by day type. Saturday, Sunday, and major holidays (New Year's Day, Memorial Day, July 4, Labor Day, Thanksgiving, and Christmas) were classified as weekend days and Monday–Friday were classified as weekdays. The mean daily effort and mean trip length of anglers on weekend days and weekdays was compared for each stream using a two sample t -test ($P < 0.05$). To track angler usage through the year, the frequency of angler trips and fishing effort was determined for the summer (June–August), fall (September–November), winter (December–February), and spring (March–May) months. Within each stream, *chi-squared* analysis was used to test for differences in the frequency of angler trips and fishing effort between the seasons ($P < 0.05$).

Angler Demographics

Photos were visually analyzed and anglers were assigned coarse demographic information regarding race (Caucasian vs. other), gender, age (anglers that appeared < age 16 were considered youth and all others were considered adult), and fishing gear (fly-fishing vs. spin-fishing). The percentage of anglers that were Caucasian, female, youth, and used fly-fishing gear were compared between the two streams using *chi-squared* analysis ($P < 0.05$). The percentage of all anglers and youth anglers using spin-fishing gear were also provided.

Results

Three person-days were needed to analyze the 10,298 photos obtained from the Garden Creek and the lower Basin Creek cameras. However, approximately half of the photos did not contain images of people. Many of these photos were triggered by wildlife or were likely a result of wind and snow events. These photos were discarded once it was evident no people were in the picture. All anglers photographed on the upper camera at Basin Creek were also documented by the lower camera; thus, all anglers were assumed to have accessed that creek from the lower parking area. Furthermore, the number of anglers in angler groups captured by both the upper and lower cameras were identical, suggesting the

Table 1. Number of anglers with entry and exit times, and mean and total fishing effort for Garden Creek and Basin Creek, North Carolina, 1 June 2013 through 31 May 2014. Numbers in parentheses are SEs.

Stream	Number of anglers			
	Total	With entry and exit times	Mean fishing effort (h)	Total fishing effort (h)
Garden Creek	225	196	2.6 (0.2)	593.4 (15.3)
Basin Creek	129	101	3.8 (0.2)	491.5 (21.3)

cameras were efficient at determining angler group size. A total of 11 people (five on Garden Creek and six on Basin Creek) contacted NCWRC staff regarding the purpose of the cameras. In all 11 inquiries, information from the individual with regard to date and estimated time the camera was visited, as well as other descriptive information (i.e., group size, fishing gear, pets), matched with photos taken during that same date and time range. Furthermore, NCWRC staff were photographed successfully approaching and leaving each camera during the initial installation and six maintenance visits. Therefore, we assumed that all cameras operated successfully throughout the study.

More anglers were observed on Garden Creek ($n = 225$) than Basin Creek ($n = 129$). Angler group size ranged from 1 to 3 anglers for both streams, and mean group size between Garden Creek (mean = 1.4, SE = 0.04) and Basin Creek (mean = 1.3, SE = 0.05) was similar ($t = 1.59$, $df = 262$, $P = 0.11$). Solitary anglers comprised 46.2% of the anglers fishing Garden Creek and 58.9% of those that fished Basin Creek. Trip lengths were obtained for 196 of the 225 anglers (87.1%) on Garden Creek and for 101 of the 129 anglers (78.3%) on Basin Creek (Table 1). After correcting for missing trip times, total fishing effort was 593.4 h (SE = 15.3) for Garden Creek and 491.5 h (SE = 21.3) for Basin Creek. Mean trip lengths were shorter ($t = -3.81$, $df = 295$, $P < 0.01$) on Garden Creek (mean = 2.6 h, SE = 0.2) than on Basin Creek (mean = 3.8 h, SE = 0.2), with 22.2% of the anglers on Garden Creek fishing < 30 min compared to only 4.7% fishing < 30 min on Basin Creek. Likewise, fewer anglers fished > 1 h on Garden Creek (64.4%) compared to Basin Creek (93.0%).

Out of a possible 365 days of fishing, anglers fished Garden Creek 117 days of the year (32.1%) and Basin Creek 82 days of the year (22.5%). Seasonal differences were observed in the frequency of trips on Garden Creek ($X^2 = 14.96$, $df = 3$, $P < 0.01$) and Basin Creek ($X^2 = 32.51$, $df = 3$, $P < 0.01$). Seasonal differences in fishing effort on Garden Creek ($X^2 = 34.64$, $df = 3$, $P < 0.01$) and Basin Creek ($X^2 = 42.48$, $df = 3$, $P < 0.01$) were also observed. On both streams, the highest use occurred in the summer and the lowest during the winter (Table 2). For both creeks, average daily number

Table 2. Number of anglers and fishing effort by season for Garden Creek and Basin Creek, North Carolina, 1 June 2013 through 31 May 2014.

Stream	Summer (Jun–Aug)		Fall (Sept–Nov)		Winter (Dec–Feb)		Spring (Mar–May)	
	Number	Effort (h)	Number	Effort (h)	Number	Effort (h)	Number	Effort (h)
Garden Creek	90	288	52	129	30	56	53	120
Basin Creek	62	248	24	92	11	25	32	127

Table 3. Mean daily angler effort and trip length of anglers fishing weekends and weekdays for Garden Creek and Basin Creek, North Carolina, 1 June 2013 through 31 May 2014. Numbers in parentheses are SEs.

Stream	Mean daily effort (anglers/d)		Mean trip length (h)	
	Weekends	Weekdays	Weekends	Weekdays
Garden Creek	1.1 (0.1)	0.4 (0.1)	2.0 (0.2)	3.1 (0.3)
Basin Creek	0.6 (0.1)	0.3 (0.0)	3.6 (0.3)	4.1 (0.4)

Table 4. Angler demographics for Garden Creek and Basin Creek, North Carolina, 1 June 2013 through 31 May 2014.

Stream	Percent (%)					
	White	Female	Youth	Fly-fishing	Spin-fishing	Youth spin-fishing
Garden Creek	100.0	1.3	5.8	98.2	1.8	23.1
Basin Creek	100.0	0.0	7.0	91.5	8.5	55.6

of anglers was higher on weekends ($t = 4.88$, $df = 363$, $P < 0.01$). Average trip length was longer on weekdays than weekends for Garden Creek ($t = -2.55$, $df = 142$, $P = 0.01$), but trip lengths between the two strata were similar ($t = -1.07$, $df = 73$, $P = 0.29$) on Basin Creek (Table 3).

The angler information collected regarding race, gender, age, and gear were similar between the two streams ($X^2 = 3.43$, $df = 3$, $P = 0.67$) (Table 4). Most anglers (92.9%) were identified as adult, Caucasian males; very few female (0.8%) or youth (6.2%) anglers were documented. Although 98.2% of adult anglers used fly-fishing gear, 36.4% of youth were observed with spin-fishing gear.

Discussion

Trail cameras provided useful data with minimal staff time on these remote streams. A total of seven person-days were used to install and perform bimonthly maintenance checks on the three cameras. Counting processing time of the photos, data collection from both streams for an entire year was accomplished with a total of 10 person-days. In two studies designed to estimate recreational angling effort, Smallwood et al. (2012) reported that remote cam-

eras were more cost effective than manned-creel surveys and Kristine (2012) reported that trail cameras required < 10% of the staff time used in a conventional creel survey. Furthermore, the amount of time needed to process photos may become reduced as new innovations in image analysis, like those reported by Greenberg and Godin (2015), are created and further enhanced.

Each camera's field of view included the stream, but anglers did not always trigger the motion sensor when fishing in the stream. Although this did not appear to be an issue for anglers walking the trail, anglers walking up the stream did not always successfully trigger the cameras. To remedy this issue, a second camera located on the opposite side of the stream from the trail would have greatly improved the chances of capturing an entry and exit photo for every angler. Even though the cameras within this study appeared to work correctly throughout the survey period, complete confidence that cameras captured images of every angler that visited each stream was impossible. However, photos were captured of everyone that approached cameras and subsequently contacted NCWRC staff, and of NCWRC staff before and after all maintenance events. Therefore, we had no reason to believe that the cameras missed more than perhaps a small fraction of anglers visiting either creek.

A disadvantage of using trail cameras as the sole source of data collection was the inability to ascertain catch and harvest data. This and other shortcomings are common when using single survey techniques, and complimentary surveys are often used to provide a more complete understanding of recreational fisheries (Pollock et al. 1994). In future creel studies on fisheries with limited points of entry, a trail camera-access point survey should be considered. By employing a limited number of access point surveys, staff could collect catch and harvest information to compliment the angler effort and usage data collected with trail cameras. Spatial and temporal angler use information provided by the camera could be utilized to determine appropriate times and locations to conduct limited angler access surveys in the most efficient manner. Furthermore, this complimentary approach would provide comparative angler effort data to further test the accuracy and precision of data collected with trail cameras.

Although the number of anglers visiting these streams may appear to be low, they are similar to several other studies focused on small (< 6 m wide) wild trout streams (Greene et al. 2005, Kristine 2012, Hining and Rash 2015). At the current level of usage, anglers are likely to find solitude on both streams as anglers only fished 32.1% of the available calendar days on Garden Creek and 22.5% of available days on Basin Creek. Furthermore, both streams provided several km of fishable wild trout water that allowed anglers to disperse.

Approximately half of the anglers that fished these creeks were solitary anglers, more than twice the percentage (18.0%) reported during the NCWRC 2007 trout angler opinion survey (Responsive Management 2007). These streams represent some of the more remote trout waters found in the state, and as such, may be more desirable to anglers seeking solitude and to fish alone. In contrast, the NCWRC trout angler opinion survey involved a wide variety of trout resources, including large-stocked waters that are fished heavily (Responsive Management 2007), which may not provide an ideal comparison to these small, wild trout streams.

Nearly twice as many anglers fished Garden Creek than Basin Creek. This disparity was likely due to the amenities near Garden Creek within the surrounding state park that include a developed campground equipped with bathhouses and running water, assigned ranger staff, and opportunities to fish the East Prong Roaring River, a popular stocked trout water that may draw anglers closer to Garden Creek. In contrast, Basin Creek lacked developed amenities and was located in a more remote area than Garden Creek which required an additional 20 min of drive time from large, nearby municipalities. Anglers may also prefer to fish Garden Creek because it provides the opportunity to catch brook trout, the only salmonid endemic to the southeast and a species on which North Carolina trout anglers place special emphasis (NCWRC 2013).

While Garden Creek appeared to be more popular with respect to the frequency of angler trips, anglers tended to fish for longer periods on Basin Creek. Although we can only speculate why anglers fished longer on Basin Creek than on Garden Creek, anglers fishing Garden Creek were more prone to encounter other anglers. Thirty-three percent of North Carolina trout anglers reported relaxation and/or being close to nature as the primary motivation for trout fishing (Responsive Management 2007). As a result, wild trout anglers on small streams like Garden and Basin creeks may fish for longer periods of time when experiencing low encounters with other anglers. Furthermore, unlike on Basin Creek, anglers fishing Garden Creek had additional fishing opportunities close by within Stone Mountain State Park, and their proximity to these other resources may have prompted them to abbreviate their trip and fish a different stream if they encountered other anglers or had difficulty catching fish.

In this study, we did not cull trip lengths less than a minimum time. While future studies may decide to omit trips less than what is deemed a minimum trip length (e.g., < 30 min), encountering other anglers or signs that another angler is upstream are all possible reasons why wild trout anglers might abruptly abandon a particular stream. As a result, we opted to include these shorter trips in the summarized data. Furthermore, the mean trip lengths for

Garden Creek and Basin Creek were within the range of mean trip lengths reported for other studies examining wild trout fishing on Appalachian streams (Geddings and Rankins 1997, Greene et al. 2005).

Annual fishing effort on both streams in this study was much lower than on NCWRC-managed, stocked trout waters (Borawa et al. 2002, Besler et al. 2005) but was comparable to fishing effort reported for similar sized wild trout waters (Habera et al. 2003, Greene et al. 2005, Kristine 2012, Hining and Rash 2015). Also, results from our study found that angler use followed similar patterns to most fisheries, with higher use in warmer months and on weekends. Longer trip lengths on weekdays compared to weekends and holidays may be a result of anglers encountering fewer people on weekdays. On both streams within this study, angler visits were more common on weekend and holiday dates than during the week.

Several NCWRC programs to recruit and retain anglers are currently in place, including ones that target female (Becoming an Outdoor Woman) and youth anglers (Fish for Fun program), as well as people living in and near large municipalities (Mountain Heritage Trout Waters program and Community Fishing program). Despite these efforts, these two streams were used almost exclusively by adult, Caucasian, male anglers. Greene et al. (2005) reported similar angler demographics from a wild trout stream in Pennsylvania, with >90% of participants older than age 16 and male. While the demographic information collected in our study was course in nature and slight errors in assignment to specific groups may have occurred, our findings of our study with respect to age, gender, and race were similar to results recently reported for all freshwater fishing within North Carolina (Linehan 2013). This information, coupled with North Carolina's known non-Caucasian population (22.3%; U.S. Census Bureau 2015), illustrates the need for NCWRC to continually attempt to engage non-Caucasian and female anglers across a wide age spectrum with the ultimate goal of boosting fishing participation.

The vast majority of anglers on both creeks used fly-fishing gear. Historical surveys of other NCWRC managed wild trout streams also documented a higher incidence of fly-fishing compared to spin-fishing gear (Borawa et al. 1995, Borawa and Clemmons 1998). Although the nearly exclusive use of fly-fishing gear on Basin Creek could be explained by regulations that limit the use of terminal tackle other than flies, similar results were observed on Garden Creek where use of spin-fishing gear was legal. While the percentage of anglers using spin-fishing gear on Basin Creek may have indicated issues with regulatory compliance and effectiveness, discussions with National Park Service staff suggested that many anglers were likely unaware of the artificial fly only restric-

tion; possibly because the regulation was not well publicized and does not conform to existing NCWRC trout regulations.

Also of interest within this study was the low youth involvement yet relatively high use of spin-fishing gear by youth anglers. Spin-fishing gear was possibly used more frequently by youth because it was perceived to be easier to fish in these small streams. Stream corridors along small, wild trout streams in North Carolina are often lined with trees and shrubs. While these conditions provide excellent cover for trout, they can present challenging areas for casting. This is especially true for fly-fishing, as fly rods are usually longer than spinning rods; additionally, casting of fly rods requires anglers to avoid vegetation and debris in front and behind them. The high incidence of youth observed using spin-fishing gear should be considered within angler recruitment efforts and consideration of regulation proposals that restrict gear types (e.g., fly fishing only).

Trail cameras provided an efficient method for obtaining useful information on remote systems that would have otherwise required greater effort and cost. As a result, use of trail cameras to monitor angler usage of trout waters with restricted entry points should continue, and their use to remotely capture data for other angler use initiatives (i.e., piers, small impoundments, boat launches) should be evaluated. Future studies should consider an access-point survey to compliment the camera data, as this approach would allow for the collection of detailed catch information, as well as opinion data to help explain patterns of use found with the cameras. This complimentary approach would also provide an additional method of ensuring trail cameras were functioning properly. Finally, this study and others (Smallwood et al. 2012, Greenberg and Godin 2015) illustrated the importance of proper camera placement, and future studies should evaluate camera placement carefully to obtain the most complete dataset possible.

In conclusion, Garden Creek and Basin Creek have numerous characteristics that resemble other wild trout resources of western North Carolina and the surrounding southern Appalachian region. As such, this study provided useful information to NCWRC pertaining to wild trout fisheries; including the frequency and duration of trips, weekly and seasonal usage trends, and important demographic information regarding wild trout anglers. This information will not only aid NCWRC in future management decisions, but the documented low angler use of these resources should help address landowner concerns related to overcrowding and assist NCWRC staff in future attempts to obtain public access to wild trout waters on private lands.

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