2017 Annual Interim Report

Project Title: Relative Population Densities, Movements, and Spawning Success of Asian Carp in the Tennessee River and Cumberland Rivers, Tributaries of the Ohio River

Geographic Location: Ohio River Basin; Tennessee and Cumberland rivers

Lead Agency: Tennessee Wildlife Resources Agency

Agency Collaboration: Kentucky Department of Fish and Wildlife Resources (KDFWR), Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP), Alabama Department of Conservation and Natural Resources, Murray State University (MSU), Tennessee Technological University (TTU), U.S. Geological Survey (USGS), U.S. Fish and Wildlife Service (USFWS).

Statement of Need: Baseline information on Asian carp populations and invasion movements in the Tennessee and Cumberland rivers.

Project Objectives:

1) Conduct targeted sampling for the purpose of surveillance, early detection, distribution, and relative population characteristics of Asian carp in the Tennessee and Cumberland rivers.
2) Evaluate lock and dam passage of Asian Carp and movements among reservoirs
3) Evaluate reproductive success, established leading edges, and age – 0 abundance of Asian carps in Kentucky and Barkley reservoirs.

Project Highlights:

In 2017, intial Federal funding to support and execute objectives of the Ohio River Basin Asian carp control strategies were implemented in the Tennessee and Cumberland rivers, tributaries to the Ohio River. Primary goals focused on collecting baseline information on population densities and developing a framework to monitor lock and dam passage, using acoustic telemetry technology, to inform upstream invasion. The final goal was to conduct spring and summer sampling for juvenile Asian Carp to help inform the current reproductive capacity and success within Kentucky Lake and Barkley Lake.

Objective 1 Methods TWRA,TTU:

Targeted sampling for adult bighead and silver carp was conducted in Kentucky and Pickwick reservoirs on the Tennessee River and Barkley and Cheatham reservoirs on the Cumberland river. Three reaches were sampled in the downstream reservoirs on both rivers (Figure 1), while two sites were sampled in the upstream reservoirs of each river (Figures 2 and 3). Short gill net sets (approximately 2 hours) and pulsed DC electrofishing were conducted at each site during Summer 2017. Overnight gill net sets were used to sample in Fall 2017 and Spring 2018. Gill net mesh sizes ranged from 3.5” to 5” and nets were constructed of multitwist monofilament. All bigheaded carp captured were measured (TL, mm), weighed (g), and gonad weights (g) were taken for females to help identify spawning seasonality. Lapilli otoliths were removed from the majority of individuals to inform population age structure. Otolith processing and age estimation

followed methods of Ridgway and Bettoli (2017). Calculations of catch-per-unit-effort (CPUE) for each gear type will be used to compare relative densities within and among reservoirs and within reaches. Size structure, length-at-age, condition, sex ratios, and gonadosomatic index (GSI) values will be compared to assess differences in population characteristics among reservoirs.

Objective 2 Methods TWRA, TTU:

TTU procured and emplaced acoustic telemetry receivers across the locks and dams within the Tennessee River except for Kentucky Dam that was already monitored by KDFWR and MSU (see below). Receivers were affixed using either bottom set anchors or custom fabricated receiver holders suspended from lock walls. TTU will download data from receivers every few months to keep an updated data set of Asian Carp movements. TTU CRU will continue to work with the states of Mississippi, Kentucky, and Alabama to increase the number of tagged fish and increase efficiency of downloading receivers. Data from the navigation locks of Pickwick, Wilson, and Wheeler Dams were downloaded February 26th and 27th. Data from Duck River, RM 176.5, and the headwater and tail water of Pickwick will be offloaded at a later date in March because of dangerous boating conditions due to high water flows and dam discharges. All data will be shared with collaborators.

Fish intended for transmitter implantation were collected using electrofishing and gillnetting. Fish were held less than five minutes including the surgery procedure. Surgical procedures were similar to KDFWR methods below, however TTU used electro anesthesia to comply with university IACUC requirements and fish were not held in tanks to evaluate recovery. Cooperators developed and shared a "methods matrix" that identified the entire process for capture, handling, surgeries, and release to facilitate commonality and repeatability.

Objective 2 Methods KDFWR:

In Kentucky Lake, Silver Carp to be surgically implanted with acoustic transmitters were captured using a Paupier net. The Paupier net was operated by USFWS staff from Columbia, MO. Paupier net settings varied depending on water conditions and reaction of fishes. Paupier net sampling was conducted in the Sledd Creek and Big Bear embayments of Kentucky Lake for one night in each location in April, July, and October. Silver Carp were not implanted with transmitters in July due to high water temperatures. The fish were captured with the Paupier net and then transferred to a holding tank on a tender boat where surgeries were conducted. Murray State University provided the tender boat used for performing surgeries and assisted with surgeries on each occasion. In December Silver Carp in Lake Barkley Dam tailwaters were captured via targeted electrofishing runs and transferred to surgery stations on the bank. Electrofishing settings varied depending on water conditions and conductivity.

Prior to surgery all tools, tags and sutures were soaked in alcohol. Fish were placed upside down or on their side in cradles, a bilge pump was inserted into their mouths to keep fresh water on the fish's gills and a wet rag was placed over their head. Using a scalpel, scales were scraped from approximately 1 ½ in x ½ inch area of fish lower abdomen just posterior of the pelvic fin. The area was then cleaned with betadine solution and the incision was made with as few cuts as possible until access to the abdominal cavity was obtained. Forceps were then used to open the incision and insert the tag into abdominal cavity. The incisions were closed with three stitches,

tying each stitch with three knots. After the incision was closed, superglue was applied over the stitches. Once the surgery was complete the fish was tagged with an exterior marker of a jaw tag or self-locking loop tag. Jaw tags were applied to the lower jaw and crimped into place with pliers. Loop tags required a needle to be used to pierce the flesh and insert the tag directly posterior of the dorsal fin where the tag extended through the either side of the fish and the ends locked together. After surgery and exterior tagging was complete, fish were released directly back into the water body from which they were captured. If the fish did not swim vigorously from release location, it was held by the tail until equilibrium was achieved and strong muscle contractions became obvious. Fish that did not recover were euthanized and the tags removed. KDFWR conducted manual tracking efforts on Kentucky Lake to locate tagged Silver Carp.

Manual tracking was accomplished by using a VR100 and omnidirectional hydrophone deployed from a boat. The hydrophone was lowered into the water at 1km intervals and monitored for at least two minutes before moving to the next location. It was determined through range testing that the omnidirectional hydrophone could detect transmitters from a distance of 500km. Therefore, stopping at 1km intervals provided sufficient coverage of the lake. Twenty-four-hour manual tracking efforts of individual Silver Carp were also conducted in Kentucky Lake. Four of these studies were attempted in 2017. Tagged Silver Carp were located from a boat using the VR100 and omnidirectional hydrophone. Once located, the directional hydrophone was utilized to hone in on the fish's location. When locations are determined, time, waypoints, water depth, temperature are recorded. The fish is then relocated every hour and the same information recorded.

In 2017 two VR2W stationary receivers were deployed in Lake Barkley on bottom stands. Two receivers were deployed in ladder wells of the Lake Barkley lock chamber with one receiver inside the lock chamber and one receiver outside of the lock chamber on the upstream approach wall. One receiver was deployed in the Lake Barkley Dam tailwaters on a channel marker buoy. Another receiver was deployed on a buoy in the canal between Kentucky Lake and Lake Barkley. Two receivers were deployed in the Kentucky Dam tailwaters on buoys. There are now 23 stationary receivers deployed throughout the northern portion of Kentucky Lake, Lake Barkley, and their tailwaters. Files are downloaded from all stationary receivers at least every other month throughout the year.

Objective 3 Methods TWRA:

Kentucky Lake and Barkley Lake were sampled in 2016 and 2017 to detect larval fish and inform potential in-lake spawning events. Light traps were deployed across the longitudinal gradient of the reservoirs and boat neuston net tows were conducted in the same locations. Samples collected with light traps and net tows were washed down and samples were split evenly into separate jars containing either ethanol or formalin. The justification for using two different preservatives was to ensure 1) that formalin preserved samples would facilitate identification, and 2) that ethanol preserved samples would allow genetic testing if identifications indicated presence of larval Asian Carp. Larval fish identification is being conducted by Dr. Quenton Fontenot at Nicholls State University.

2017 Annual Interim Report

Results and Discussion:

Objective 1 Results, TTU:

Electrofishing, short gill net sets and overnight gill net sets were completed for Summer and Fall 2017 across study lakes (Table 1, Figures 1-3). Approximately 950 person hours were expended during standardized sampling, and 671 bigheaded carp (60 bighead carp, 611 silver carp) were captured across gears. The majority of carp were captured in Lake Barkley (332 individuals), and overnight gill net sets had the greatest success, capturing 498 individuals across the four reservoirs. In addition to individuals captured during standardized sampling, bigheaded carp obtained via boat motor agitation and paupier boat sampling with USFWS were included in the total catch summary, increasing our sample size to 741.

Table 1. Completed and ongoing sampling to delineate relative densities of Asian carp in Kentucky Lake, Barkley Lake, Pickwick Lake, and Cheatham Lake.

Project Activity	**Sampling Location**	**Season**	**Year**
Electrofishing	Kentucky, Barkley, Pickwick, and Cheatham reservoirs	Summer	2017
Short Gill Net Sets	Kentucky, Barkley, Pickwick, and Cheatham reservoirs	Summer	2017
Overnight Gill Net Sets	Kentucky, Barkley, Pickwick, and Cheatham reservoirs	Fall, Spring	2017, 2018 (respectively)

Table 2. Catch summary for bigheaded carp sampling conducted in 2017.

Reservoir	Sample Site	Total # of carp captured
Lake Barkley	Barkley Dam	63
	Little River	207
	Saline Creek	96
Kentucky Lake	Kentucky Dam	80
	Big Sandy	24
	Duck River	84
	Johnson Creek	7
Cheatham Lake	Cheatham Dam	76
	Sycamore Creek	31
Pickwick Lake	Pickwick Dam	4
	Bear Creek	76
Total		**741**

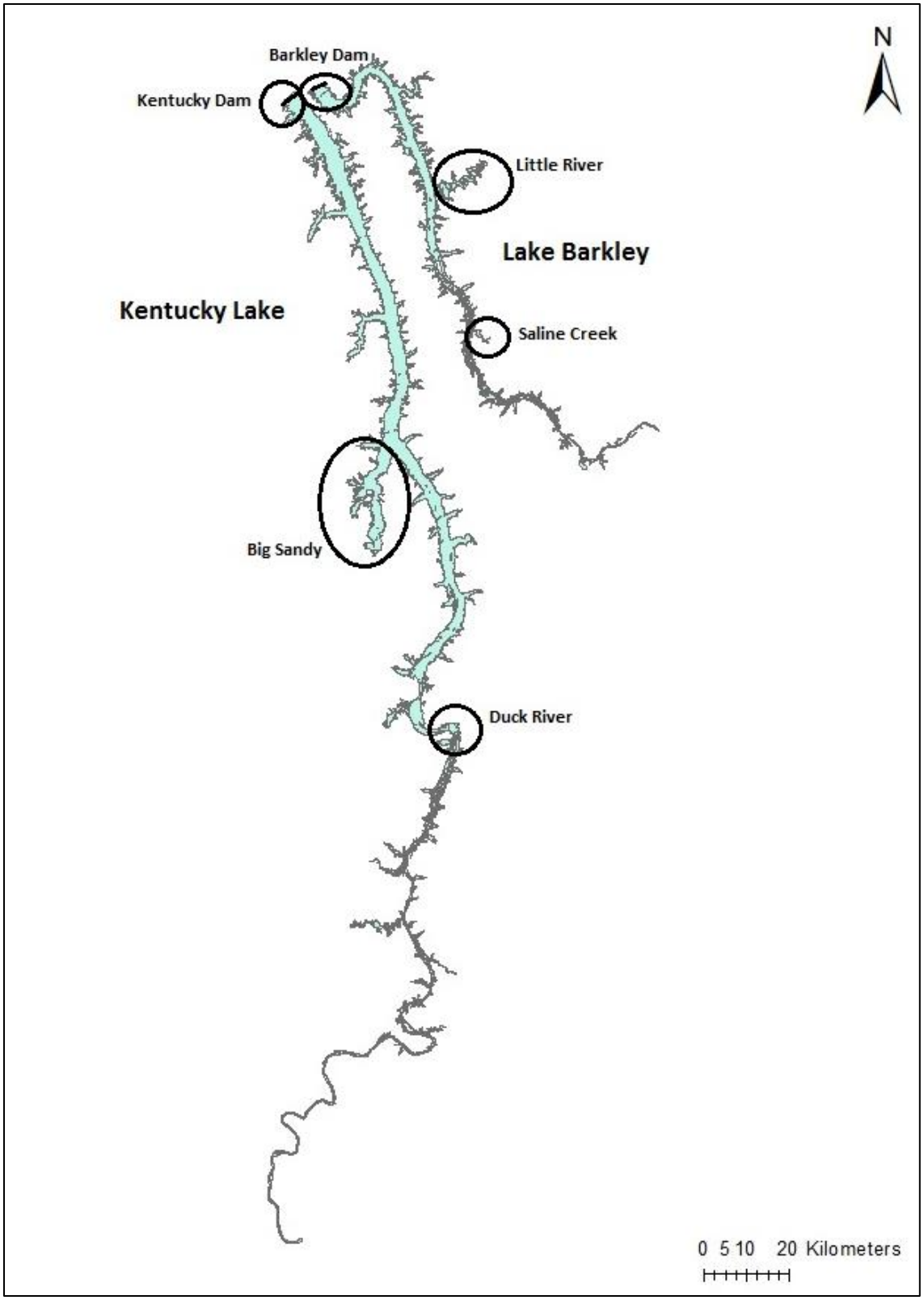

Figure 1. Sampling areas on Kentucky Lake and Lake Barkley.

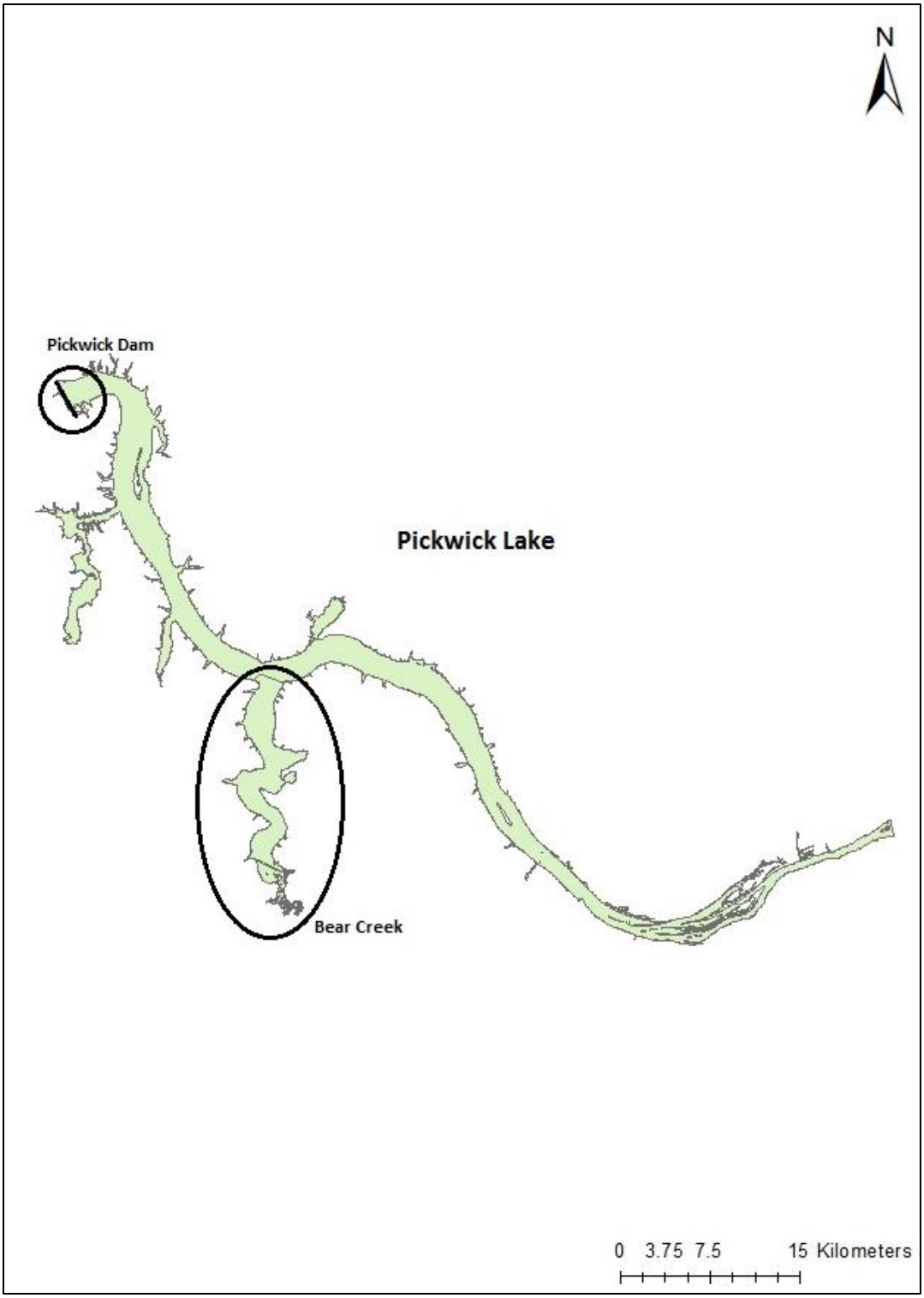

Figure 2. Sampling sites on Pickwick Lake

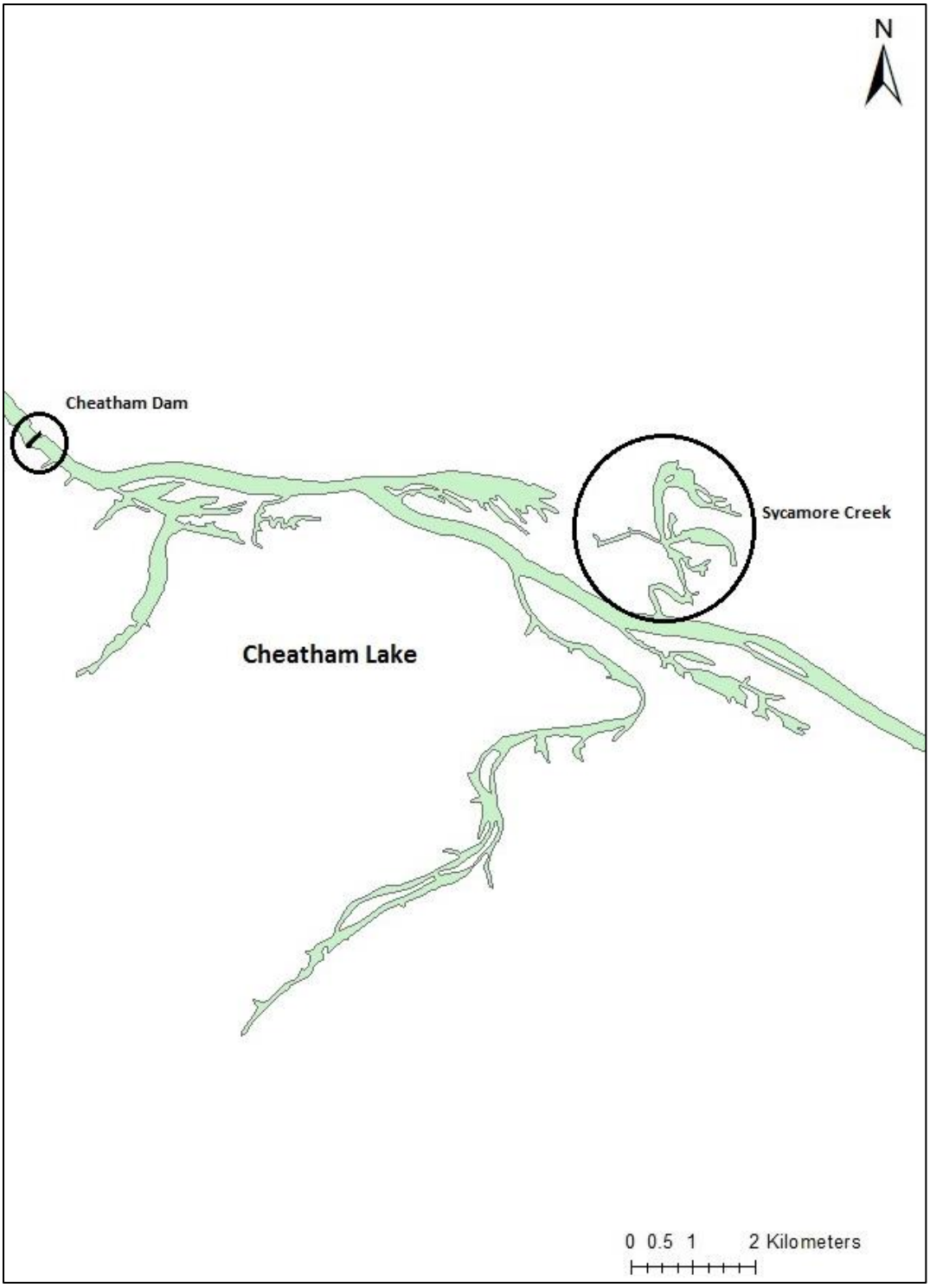

Figure 3. Sampling sites on Cheatham Lake

2017 Annual Interim Report

Objective 2 Results, TTU: TTU placed a total of 11 acoustic telemetry receivers within the Tennessee River system. These locations included one receiver in the lower Duck River, one receiver at RM 176.5, two receivers in the Pickwick Dam tail water, one receiver in the headwater of Pickwick Dam, and two receivers within each of the navigation locks at Pickwick Dam, Wilson Dam, and Wheeler Dam. TTU personnel met with KDFWR personnel in October, 2017 to discuss telemetry database structure, management, and data sharing.

TTU has surgically implanted acoustic telemetry transmitters in 54 Silver Carp in the Tennessee River. Within Kentucky Lake, 44 Silver Carp were implanted with acoustic telemetry tags within Tennessee waters to complement tagging occurring in Kentucky waters (32 individuals at Beech Creek, TN and 12 at Clifton, TN). Within Pickwick Lake, 10 Silver Carp were tagged at Indian Creek, MS. Tagging efforts will continue in Spring 2018 with intentions of continuing tagging in fall pending future funds.

Objective 2 Results, KDWFR and MSU:
In Kentucy Lake, sampling efforts with the Paupier net resulted in 30 Silver Carp tagged in Big Bear and 16 fish tagged in Sledd Creek embayments. This brings the total of tagged Silver Carp in the northern portion of Kentucly Lake to 115. Of the 46 total fish tagged in 2017, 10 are presumed to be deceased due to inactivity for extended periods of time. In the Lake Barkley Dam tailwaters, 20 Silver Carp were surgically implated with transmitters. By increasing the number of tagged Silver Carp in Tennessee and Cumberland river systems we can better quantify movement of these fish between resevoirs through lock and dam structures. These two river systems are connected directly through a canal between Kentucky Lake and Lake Barkley and several tagged Silver Carp have been detected passing through this canal by stationary receivers. Therefore, it is logical to monitor movement of Silver Carp in these two river systems in conjunction.

KDFWR completed 35 manual tracking trips on Kentucky Lake. --- Silver Carp were detected through manual tracking efforts. Three 24-hour tracking studies of individual Silver Carp were also completed.

Stationary receivers (Figure 4) had detections of Silver Carp. Other fish detected included paddlefish that had been tagged by Missouri Department of Conservation (MDOC). To date, only one Silver Carp has been detected passing through Kentucky lock. This fish was tagged in Kentucky Lake, was detected passing through the canal into Lake Barkley and then detected again several weeks later by stationary receivers in Kentucky lock, and on the upstream receiver on the lock approach. These detections took place prior to the receivers being deployed in the Lake Barkley lock. Therefore, it is assumed that this fish swam through the canal into Lake Barkley, downstream through Barkley lock, down the Cumberland River to the Ohio River, and back upstream through the Tennessee River to the Kentucky lock, where it passed back into

Kentucky Lake via the lock chamber. Two paddlefish tagged by MDOC have also been detected using the Kentucky lock chamber to access Kentucky Lake.

Figure 1. *Locations of current VR2W receivers deployed by MSU and KDFWR in Kentucky Lake, Lake Barkley and the lower Tennessee and Cumberland rivers.*

2017 Annual Interim Report

Objective 3 Results, TWRA:
In 2016, 80 light trap samples were collected and 25 contained larval fish. No Asian carp larvae were detected. In 2017, sampling was conducted from May 15 to August 11 and sampling included four days per week. In total, 140 light trap samples were collected at Kentucky Lake with 80 complimentary larval tows, whereas at Barkley Lake there were 130 light trap samples collected with 70 larval fish tows. Currently, over 25% of the samples have been sorted and identified with no detection of Asian Carp larvae. Most common species in samples have included members of the Centrarchidae, Clupeidae, and Atherinopsidae families. Sample sorting and identification will continue through spring 2018.

Discussion and Recommendation:
The distribution and abundances of bigheaded carps in the Tennessee and Cumberland rivers is still uncertain, which creates questions about control intensity, effort requirements, and leading edge to inhibit invasion. These uncertainties are a potential hindrance to implementing efficient controls. For example, TTU had multiple trips to Pickwick Lake with zero catches of Asian Carp, and yet, had one trip where they caught 74 in one night. The schooling nature of Asian Carp, movement rate, and gear avoidance make informing density data challenging after only one full sampling season. We recommend further sampling and gear evaluations for establishing density indices in these large reservoirs.

Passage of tagged Silver Carp through locks with remote receivers should be detected given the minimal passage opportunities through locks and with large dams. However, at Kentucky and Barkley locks, where the most effort has been, very few detections have been made. Therefore, we suggest increasing the number of tagged Silver Carp both below and above these lock structures across the Tennessee River. Increased numbers of fish tagged near Pickwick dam would also help as the detection infrastructure has greatly increased. This will allow us to better evaluate both upstream and downstream movements of Silver Carp through these structures. Additionally, we suggest increasing the number of stationary receivers deployed in Lake Barkley and in the lower Tennessee and Cumberland rivers. Lake Barkeley has received increased focus as a potential test barrier location, and thus, increased telemetry activity in that are would be beneficial. This action will expand coverage in these water bodies which will improve detection probabilities of tagged Silver Carp using these areas. Other studies have examined movement of Silver Carp in river systems extensively. However, there is still some lack of information regarding small scale movements of Silver carp in large resevoirs. At a higher level, there is a knowledge gap regarding usable habitat for these native riverine species in large reservoirs. In order to meet this need we recommend increasing the number of 24-hour manual tracking studies conducted in Kentucky Lake and Lake Barkley. These studies will aid in determining more precise information about Silver Carp movement and habitat usage in large reseviors.

Doubt regarding within-reservoir reproduction can only be improved through continued sampling at life stages that would not be expected to immigrate from the the Ohio River, and thus, light trapping and neuston netting to detect in-lake reproduction are necessary within the the Tennessee and Cumberland rivers with funding availability. Kentucky and Tennessee cooperators are providing samples for otolith michrochemistty to help inform the likelihood of reproduction within the Tennessee and Cumberland rivers systems.