

FY21 Asian Carp Project – Tennessee - Cumberland River Basin

Project Title: Tennessee – Cumberland Rivers Data Management Application

Agency and Author: Mississippi Department of Wildlife, Fisheries, and Parks, (MDWFP)
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Cooperating Agencies: Kentucky Department of Fish and Wildlife Resources (KDFWR), Tennessee Wildlife Resources Agency (TWRA), Alabama Wildlife & Freshwater Fisheries Division, Tennessee Cooperative Fishery Research Unit

Statement of Need:

Data management, data analyses, and reporting are key components of a monitoring program. Although large expenditures are commonly made on data collection, the amount of resources allocated to data management, analyses, and reporting is relatively small and inadequate. The TNCR is a collaborative network for monitoring invasive Asian carp and sharing data collected by individual members. Data collection by TNCR is guided by standardized sampling procedures developed to facilitate compatibility of data. To encourage further standardization, we will develop a system for digitizing data processing, analyses, and reporting. Products from this mechanization will focus on producing information useful to fish managers and policy makers in their decision making.

A similar application (FRAS) was developed for MDWFP and is currently in use by the agency to store and analyze statewide fisheries data. This application is currently being expanded to include monitoring planning support. Also, an application to access telemetry data (FishTracks) was developed by the USGS Upper Midwest Environmental Sciences Center. Our application is expected to be similar to FRAS and able to interface with FishTracks.

Objectives:

- 1. Develop web or desktop applications to analyze, summarize, and distribute data collected by Tennessee and Cumberland Rivers (TNCR) collaborators through standardized procedures from stored data
- 2. Provide a platform for storing and sharing non-standard data relevant to TNCR collaborators but contributed by external agencies.
- 3. (New Objective): Identify the potential impacts of invasive carps on native fish and their habitats, and options for addressing these impacts in the Tennessee and Cumberland rivers.

Change in Scope of Work:

Some of the agencies that own the data limit the rights of distribution so a platform for storing and sharing non-standard data would not be used by the state agencies. In August 2022 we notified the USFWS that we were not able to fulfill Objective 2 because of proprietary data restrictions and we submitted a project narrative for a change of scope to pursue objective 3. Therefore, we will use the remaining grant funding to accomplish a new objective - # 3 in CY2023.

Project Highlights:

- A data application and data entry form were developed and disseminated to stakeholders during this reporting period.
- A website and materials were developed to present the data application to cooperators
- A project factsheet was developed for the USFWS
- The current data application link is: <https://tncr-invasivecarps.shinyapps.io/data-app/>
- A manuscript about the statistical power needed to sample invasive carp was written for journal submission.
- Work was started on a gillnet selectivity manuscript for journal submission.

Activities and Methods:

Objective 1 - Develop web or desktop applications to analyze, summarize, and distribute data collected by Tennessee and Cumberland Rivers (TNCR) collaborators through standardized procedures from stored data.

Invasive carp sampling data was obtained from the KDFWR, the TWRA, the Alabama Department of Conservation and Natural Resources and the USGS Tennessee Cooperative Wildlife and Fishery Research Unit. These data were file formatted and uploaded for data integration. Standardized protocols for monitoring bigheaded carps in the Tennessee and Cumberland rivers were developed. The timeline for working on this objective is shown in Table 1. The project area is shown in Figure 1.

Table 1. Timeline of work on Objective 1 in CY2022.

Project Activity	Time Period (Season, Quarter, month/year)	Progress in CY2022
Program data entry modules	Jan-Jul 2022	Completed Jul. 2022
Program data storage modules	Jan-Jul 2022	Coordinating with USFWS/USGS
Program data analyses modules	Jan-Jul 2022	Completed Jul. 2022
Fixing system bugs	Apr-Aug 2022	Completed Aug. 2022
System demonstrations and check in with stakeholder	Aug. 2022	Completed Aug. 2022
System revisions based on stakeholder inputs	Aug-Sept 2022	Completed Sept. 2022
Program automated report module	Aug-Sept 2022	Completed Sept. 2022
Annual report to funding agency	Sept. 2023	Completed Dec. 2022

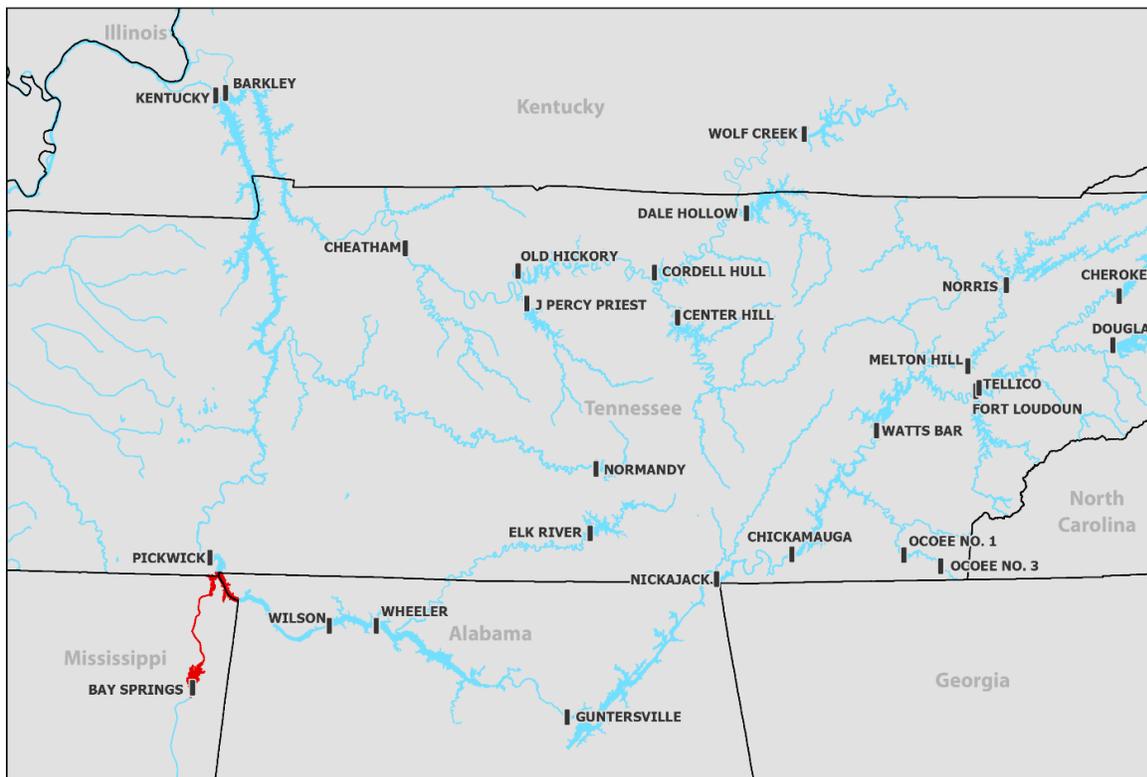


Figure 1. The TNCR project area.

Building the data application consisted of performing many tasks including:

- Updating the relative weight analysis with standard weights from FishBase
- Creating summary tables for some of the continuous data such as total length, weight and relative weight, catch data, catch biomass.
- Accounting for zero catches
- Adding rang4es for variables in the raw data summary table
- Incorporating a power analysis
- Including dynamic figure and table labels which automatically update to show selected species, systems, and years.
- Providing a publication quality sampling map showing which agency collected the data
- Allowing for temporal comparisons for size structure, species composition, catch rates and catch data
- Creating a “standard report” which populates with key analysis using the R program.
- Creating a WRDA map for the app home page
- Creating a table with model fit values for evaluating best-fit model
- Creating a selectivity curve figure showing five models
- Creating a gill net selectivity feature
- Inclusion of a weight-length regression feature
- Inclusion to show invasive carp species composition and the top 5 bycatch species
- Inclusion of Google Analytics
- Support tools for state agency data uploads and data analysis
- Inclusion of a Frequently Asked Questions section to aid data entry and analysis
- Inclusion of Proportional Stock Density (PSD) by system and year
- Inclusion of catch frequency, and relative frequency histograms
- Inclusion of logistic, Richards and Gompertz growth models and AIC selection
- Inclusion of figure and table labels for growth and mortality rates
- Inclusion of sex ratio and GSI data
- Added analyses to R Markdown document for automated report
- Fixing “bug” and revising the data application as requested by state agency biologists

Coordination with the cooperating agencies was accomplished through six conference calls held from February – September 2022 where project progress was reviewed and discussed. The post doc also presented the project at the Ohio River Basin Invasive Carp Partnership webinar in May 2022. A website and teaching materials were developed and used at the TNCR Invasive Carp Partnership meeting in August 2022. A half-day workshop was held to allow state and federal biologists to use the data application. Feedback from this workshop resulted in several revisions to the application.

Objective 2 – We intended and planned to provide a platform for storing and sharing non-standard data relevant to TNCR collaborators but contributed by external agencies. We identified all relevant data bases available in the TNCR region. These included contracted fishing, agency netting and electrofishing, water quality, and other collection operations. The TNCR app was to provide centralized access to these ancillary datasets in a scalable, query-able, downloadable database format. However, because of proprietary data restrictions, we were not able to fulfill this objective. Instead, our focus was approved to shift to objective 3 listed below.

New Objective 3- Identify the potential impacts of invasive carps on native fish and their habitats, and options for addressing these impacts in the Tennessee and Cumberland rivers.

Despite ongoing efforts by conservation agencies, it is likely that bigheaded carps will expand into most connected waters in the TNCR basin. Control approaches currently being applied or in development may work in some situations, but generally these efforts are not likely to completely eradicate bigheaded carps considering their current far-reaching spread and rapid dispersal ability. Therefore, there is a need to start looking at ways to manage the impacts of the carp rather than the carp themselves.

We are currently developing a framework for managing the impacts of carp, rather than an emphasis on managing the carp themselves. We expect it is possible, and necessary, to manage the unwanted effects of carp without needing to fully eradicate them. The framework is expected to be a useful planning tool to help managers decide what should be monitored, what is not worth measuring, what actions may best apply to the situation at a given site and time, and which factors we need to focus on for future research.

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Results and Discussion:

Objective 1:

A data application and data entry form were developed and disseminated to stakeholders during this reporting period. The TNCR data app provides TNCR agencies with automated reports and resource managers with summary and visualization tools to analyze the spatial and temporal distribution of bigheaded carps in the TNCR region.

Data Entry Form:

A data entry form was developed to address data standardization issues. The data entry form allows multiple agencies to improve data entry efficiency while minimizing human-induced entry error by automating quality control and data checking. The data entry form is flexible enough to allow agencies add unique variables after the standard set of mandatory variables. A beta version of this form was tested by stakeholders and improvement made based on feedback.

Data Application:

A web-based data application was developed to summarize, analyze, and visualize the spatial and temporal distribution of bigheaded carps in the TNCR region. The data application is stored on a publicly accessible server and available for immediate use.

The current data application link is: <https://tncr-invasivecarps.shinyapps.io/data-app/>

The data application allows users to:

1. Import agency-specific data or standardized data entered with the data entry form

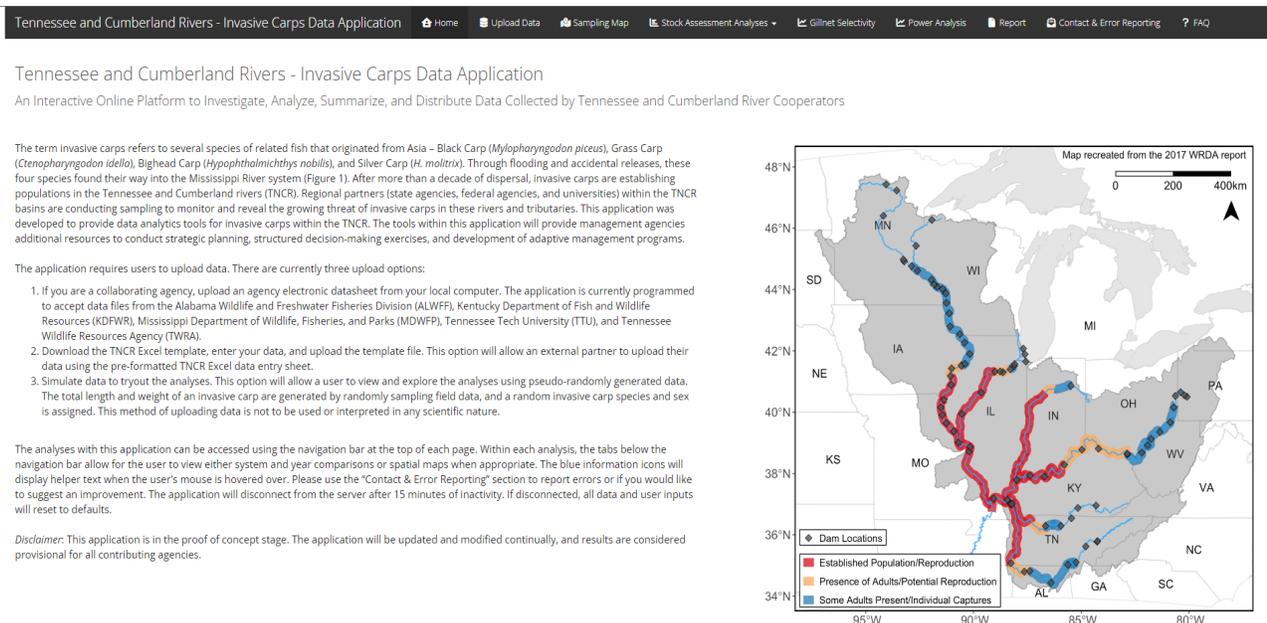
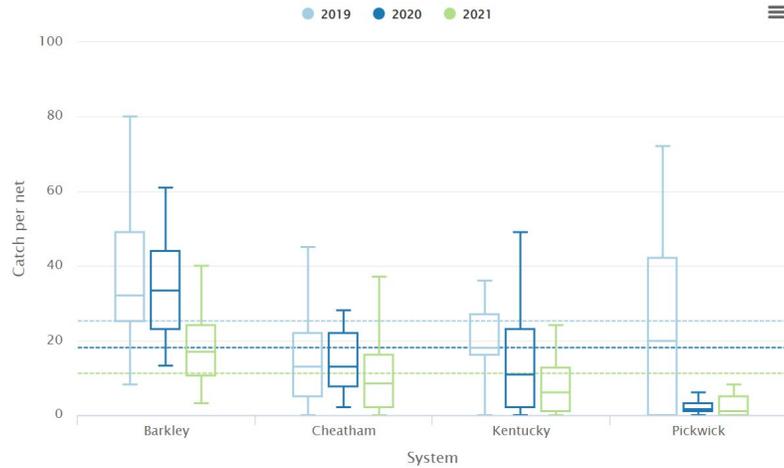


Figure 1. Characterization of relative abundance of Bighead Carp and Silver Carp in the Upper Mississippi, Ohio, and Illinois basins and the Chicago Area Waterway System. Link to reports with original map data.

2. Visualize regional sampling map
3. Perform standard fisheries stock assessment calculations, including:
 - a. Abundance
 - i. Catch Rates (*i.e.*, CPUE)

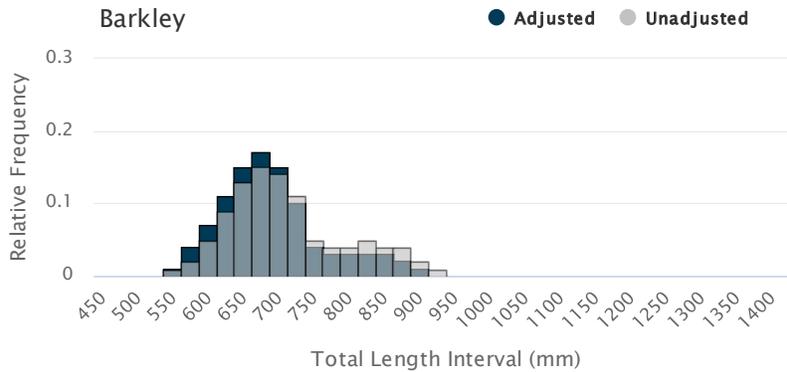


- ii. Catch Frequency
 - iii. Proportion of Zero Catch
 - b. Biomass
 - c. Size Structure
 - i. Length Frequency
 - ii. Empirical Cumulative Length Distribution
 - iii. Proportional Stock Density (PSD)
 - d. Weight-length Relationship
 - e. Relative Weight
 - f. Growth
 - i. vonBertalanffy Growth Function
 - ii. Mean Length-at-Age
 - g. Mortality
 - h. Sex Ratio

Year	Species	Barkley	Cheatham	Kentucky	Pickwick
2019	Silver Carp	1.2:1.0	1.4:1.0	0.9:1.0	0.9:1.0
2020	Silver Carp	1.4:1.0	1.0:1.0	0.9:1.0	1.6:1.0
2021	Silver Carp	0.9:1.0	0.9:1.0	1.0:1.0	0.9:1.0
2019	Bighead Carp	2.0:1.0	1.0:1.0	1.0:1.0	--
2020	Bighead Carp	1.2:1.0	0.0:1.0	0.0:1.0	2.0:1.0
2021	Bighead Carp	0.0:0.0	0.3:1.0	0.3:1.0	0.0:1.0

- i. Gonadosomatic Index
 - j. Species Composition

4. Catch rates, catch biomass, and PSD can be visualized spatially on a map displaying the temporal trend of each variable at each sampling location
5. Two advanced analyses were included:
 - a. Gillnet Selectivity – calculate selectivity curves and relative retention; perform model selection; estimate an adjusted length frequency based on size-bias correction



- b. Power Simulation – simulate future catch changes and calculate sampling effort required to detect simulated change with sufficient statistical power
6. Automated report generation – All maps, tables, and figures from fisheries stock assessment analyses can be inserted into a generated monitoring report. All tables and figures are displayed and dynamically labeled according to the user-defined options for each analysis.
7. Users can define parameters specific to each analysis and subset data by categorical (e.g., year, species, system) and continuous (e.g., total length, weight) variables.
8. Descriptive, helper text was added to all analyses to guide the user through implementation and interpretation.

A beta version of the data application was showcased to TNCR stakeholders in August 2022. Stakeholders were allowed to explore the application and provide feedback. Modifications and improvements were made based on stakeholder feedback.

A contractor is in place to provide IT support for the data application and address any bugs encountered or improvements that need to be made as stakeholders continue to use the application. The contract term dates are January 1 - September 30, 2023.

Data Storage:

Data storage for the TNCR was not pursued as colleagues at the U.S. Geological Survey (USGS) and U.S. Fish and Wildlife Service (USFWS) are developing a database to store structured and unstructured invasive carp monitoring data. Personnel from this project are consulting with the federal database developers on best practices to integrate the data analytics tools available in the TNCR data application with the federal database in development.

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Objective 2:

A data sharing agreement was drafted and shared with TNCR stakeholders in November 2022 in anticipation of migrating invasive carp data collected using federal funds to the federal database. Some of the agencies that own the data limit the rights of distribution so a platform for storing and sharing non-standard data would not be used by the state agencies. Considering this, we could not accomplish this objective.

As no data storage was pursued in direct relation to this project, the data application does not store any data in order to not violate any data sharing policies. The user will be required to upload their data to the data application until USFWS/USGS finalize their database and the database can be integrated as a data source for the data application. The data entry form and data standardization tools provided by this project will be critical to expedite the data migration and database integration process.

Objective 3 : An incoming Mississippi State University student will begin work on this objective early in 2023.

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