Grass Carp Advisory Committee (GCAC)

Annual Report 2023

GCAC Overview

The Grass Carp Advisory Committee (GCAC) is a technical committee reporting to the Council of Lake Committees. It coordinates regional efforts to seek eradication of Grass Carp in Lake Erie, if possible, while also maintaining surveillance where appropriate in other lakes to: 1) Coordinate actions that address specific Lake Erie Committee (LEC) Grass Carp Adaptive Response Strategy priorities, 2) Develop coordinated approaches to address uncertainties identified by the LEC, 3) Provide recommendations about additional uncertainties that should be addressed, and 4) Coordinate surveillance throughout the Great Lakes.

GCAC updates

The GCAC held two meetings this past year, located in Ann Arbor. Both meetings included updates from each task group as well as project-specific updates and discussions. The August meeting also included updates on work occurring outside of western Lake Erie and any information about Grass Carp status and distribution. The GCAC also discussed recommendations for future work in these areas, based on the current understanding and perceived level of risk relative to western Lake Erie. Overall, the GCAC recommended continuing to allocate surveillance efforts across the basin to improve understanding of Grass Carp distribution. Lake Michigan and Lake St. Clair were identified as two areas that may warrant additional efforts based on recent capture history and high habitat suitability. In contrast, the GCAC believes Lake Superior remains a lower priority due to the lack of historical captures and lower habitat suitability. Additional recommendations for future work included continued use of otolith microchemistry to identify sources of fish and additional research focused on habitat associations and suitability. This work, combined with the priorities identified in the Lake Erie Committee Response Plan (2024-2028), provide a comprehensive basin-wide approach to address the threat and uncertainties related to Grass Carp in the Great Lakes. The summary of past work and additional details on future recommendations can be found in the "Outside Western Erie GC Summary" document. Over the past year the GCAC also continued to evaluate metrics for tracking progress towards the response plan objectives. This work is ongoing and will be completed during the upcoming year.

Field Work

During the 2023 field season, removal crews captured a total of 191 Grass Carp in the Great Lakes. Lake Erie crews captured 179 Grass Carp and Lake Michigan crews captured 12 Grass Carp. Of the 179 captured in Lake Erie, 26 fish were implanted with telemetry tags; 15 in the Maumee River and 11 in the Sandusky River. Most fish were tagged with acoustic telemetry tags, but two were outfitted with satellite tags that collect more data and upload whenever they can make connection with the satellites. The Lake Erie capture was dominated again by the Maumee and Sandusky rivers where 55 and 87 fish were removed, respectively. In total, Great Lakes Grass Carp crews conducted almost 1000 hours of electrofishing time during the 2023 field season. Catch numbers are similar to previous years but the spatial distribution was different during 2023.

The majority of Grass Carp captures came from unexploited areas where crews did not conduct removal efforts prior to 2022. Of the 63 fish captured in the Maumee River, the Farnsworth area was the most productive with 48 captures (both removed and tagged fish). The area upstream of the Mary Jane Thurston/Providence dams in Grand Rapids, Ohio that was productive during 2022 (45 captures) was not as productive during 2023 (17 captures). Slower replacement of triploid fish could have played a role in the reduction of Grass Carp captured upstream. A majority of the Grass Carp captured upstream of the Mary Jane Thurston/Providence dams were triploid. Of the 101 Grass Carp captured in the Sandusky River, 60 (tagged and removed) were above the known spawning grounds where crews had never sampled before. This area is less than 1 rKM long and bounded upstream and downstream by rapids. The continued discovery of Grass Carp in previously unexplored areas is pushing crews to adapt and find ways to target shallower waters and traverse riffles and rapids in upstream river reaches.

In 2023 the Early Life History (ELH) group documented spawning in the Sandusky River on August 25th, much later than any other documented spawning event. This discovery prompted a look back at hydrographs and the realization that there are relatively common high flow events late in the summer that could produce spawning conditions. The late summer season has been a time when Grass Carp become difficult to find and sampling effort can sometimes be reduced due to limited high streamflow events. However, with this new understanding of the seasonal behavior of Grass Carp, field crews, including ELH crews, are prepared for late season spawning events in the future.

Early Life History

In 2023, results became available for genetic analyses from 2022 ichthyoplankton collections. One notable return was identification of Grass Carp eggs from the Huron River near Milan, Ohio. USGS and University of Toledo scientists developed a description of the collection and the manuscript was recently published in *Journal of Great Lakes Research*(https://doi.org/10.1016/j.jglr.2024.102350). The manuscript is supported by two USGS data releases which are publicly available (https://doi.org/10.5066/P98F9NSZ and https://doi.org/10.5066/P14HMDBT).

Another study examined the relationship between egg collections and the presence of electrofishing on the spawning grounds. The probability of collecting Grass Carp eggs was lower during electrofishing periods and may indicate that removal efforts could disrupt spawning activity. Several studies were also on-going using the Fluvial Egg Drift Simulator (FluEgg) to understand various aspects of Grass Carp's early life history and reproductive biology. A study simulated the transport of eggs collected in the Sandusky River to compare simulated egg age variability to observed egg age from the field (https://doi.org/10.1016/j.jglr.2024.102376). FluEgg performed well in reproducing observed egg age variability, supporting its validity as a tool to estimate Grass Carp spawning locations and interpret age variability in egg samples. Two recently published analyses examined the Maumee River to estimate spawning areas (https://doi.org/10.1016/j.jglr.2024.102347) and to define optimal spawning conditions in the river (Jackson et al. 2024

[https://www.sciencedirect.com/science/article/pii/S0380133024000868]; LeRoy et al. 2024 [https://www.sciencedirect.com/science/article/pii/S0380133024000844]). The studies estimated at least 12 spawning locations in the Maumee River and that low and high discharge periods would be less suitable than intermediate flow periods for maintaining suspension to support in-river hatching. Finally, an analysis in progress looked at changes in the Sandusky River spawning areas and ichthyoplankton drift following removal of the Ballville Dam and estimated that spawning locations in the Sandusky may exist ~15 km upstream of the former Ballville Dam site.

Ichthyoplankton surveys took place on both sides of the international border in 2023 with eight high risk tributaries sampled by Fisheries and Oceans Canada and six tributaries sampled in U.S. waters by U.S. Geological Survey and University of Toledo. During the thermally suitable spawning period, few high flow events were observed in 2023. However, spawning was observed beyond the previously known spawning period in the Great Lakes basin, as confirmed Grass Carp eggs were collected during a late season hydrologic event in the Sandusky River (August 25, 2023). This finding expands the known spawning period in the Great Lakes watershed by more than one month. These results will provide important information to understand the status of Grass Carp reproduction and improve the efficiency of control efforts by identifying when and where spawning takes place.

Data Management

Prior to the 2022 field season, we reconfigured Survey123 for the submission of Grass Carp removal data to create a relational database that automatically connects all data collected as part of each removal attempt by a unique identifier. The five tables associated with this database are: 1) *event_operations*, considered the "parent" table that all other tables relate to, 2) *effort*, 3) *environment*, 4) *bycatch*, and 5) *grass_carp_harvest*. Before the start of the 2023 season, minor updates were made to the primary data collection form based on user input. Additionally, a quality control (QC) process was developed and agreed upon by all task group members and field crew leaders. In the new process, all data collection entries must be submitted within 48 hours of the removal event and the identified field crew lead for each agency will quality control check their respective agency's entries within 10 business days of submission. Data collection and QC training were given before the field season started and the University of Toledo sent out weekly reports during the field season summarizing submission statuses for each agency. Additionally, a SharePoint site was created to log data edit requests that came up during the QC process and to log suggested improvements to the data collection form. During the 2023 field season, a glitch occurred in some, but not all, users' surveys where the page button would skip, and the survey would crash if the data collection tablet went into sleep mode. The U.S. Fish and Wildlife Service (USFWS) opened a help ticket with ESRI, the product developer of Survey123, in June 2023. After many consultations, the issue was finally identified and resolved in August 2023. In addition to the primary field data collection form used during each removal attempt, there are now Survey123 data collection forms for 1) lab dissection, 2) ploidy, 3) incidental capture, and 4) aging, which all feed into the same relational database described above. All collection forms were fully operational, and used, in 2023.

The change to a relational database in 2022 required the integration of 2020 and 2021 data into our current format. To do so, the University of Toledo had to manually link combination (electrofishing and net set) events and their associated data together. After linking events together with unique identifiers, the University of Toledo and USFWS worked together to organize the older data and match field types and names to our current relational database. We then combined the two datasets (2020/2021 & 2022/2023), maintaining table relationships, and published them to ArcGIS Online as a feature layer. All Suvey123 data collection forms were updated so new collections feed directly into the integrated database. Metadata documentation was started in 2023 and will be finished in 2024. Additionally, a README document with standardized summaries from the integrated database was started in 2023 and will be finished in 2024.

Action items for 2024 include finishing standardized summaries for 2018-2019 data, a data website that will house dashboards and allow for easier access to Grass Carp capture numbers, updates to the survey based on user input, changes to tandem entry submissions, a QC app that streamlines the verification process for field leads, and additional data collection and QC training.

Modeling

One general area of development over the past year has been increased communication between the Field task group, Telemetry task group, and Modeling task group. The communication between these groups is meant to identify questions and needs of those directly working in the field collecting Grass Carp and make use of the data that has been acquired across GCAC members. During the past year, the Modeling task group was provided a list of questions by Bob Mapes, on behalf of all field crew leads, and we have shared what information we can to address those questions and identified possible analysis steps to approach other questions. The Modeling task group also worked with the Field task group over the past year for discussions regarding the *sustained sampling protocol* currently being used by field teams during the summer months and proposed changes to the protocol that were presented to the full GCAC at the February 2024 meeting.

Project updates related to modeling:

Great Lakes Basin-wide Distribution Modeling

A habitat suitability model has been developed to predict probability of occurrence throughout the Great Lakes tributaries. The model has also been extended to encompass the upper Mississippi River. Preliminary results were disseminated to the GCAC in February 2024. The model uses the joint Grass Carp capture database, non-indigenous aquatic species (NAS) database, and the National Hydrography Dataset High Resolution (NHDplus HR) dataset. The results of this model are meant to guide the exploratory sampling, identify large scale patterns of distribution which could be exploited, and identify areas that are considered high risk of invasion. The project is being led by Rob Hunter with support from Chris Mayer and Matthew Acre.

Individual-Based Bioenergetics Model

Individual-based model (IBM) is continuing to be developed by Brian Benton, Ed Rutherford, and Doran Mason for Grass Carp and key native species. The model is expected to predict the magnitude and timing of Grass Carp population growth, potential impacts on native species, and evaluate factors affecting Grass Carp recruitment success. It is also expected that this model could be used to evaluate spawning barriers and target removals. Data have been gathered from several sources, including the Telemetry and Modeling task groups but the PIs have identified further data needs that will enhance the IBM approach, e.g., mortality rates across life stages and additional macrophyte data. The PIs on this project are currently preparing a manuscript based on the initial model results but are also looking to add new data sources. This project is led by Brian Brenton with support from Ed Rutherford and Doran Mason.

Grass Carp Catchability

This research focuses on evaluating current capture methods, estimating catchability for population models, and ways to improve removal efficiency. The co-authors used telemetry and jointly managed capture data from the GCAC group. Results from analysis suggested that using telemetered fish positions in real-time could improve capture, that generally Grass Carp had low catchability (< 0.026), and that capture could be improved through shifting removal crew activity to more night-based sampling as well as earlier and later in the year (e.g., March-April and October-November). A manuscript has been submitted to the Journal of Great Lakes Research and should be published in 2024. This research is being led by Matthew Acre with support from many members of the GCAC.

Reproductive Biology and Stock Assessment

The goal of this research is twofold 1) to inform the reproductive strategy of Grass Carp in Lake Erie using gonad histology and 2) assess the current stock status and determine the effects of management efforts on Grass Carp biomass. The project uses the joint capture database and additional gonad samples collected in 2022 and 2023 to inform models. The results of the gonad work identified age-3 fish are fully capable of reproducing, that Grass Carp in Lake Erie of indeterminate asynchronous batch spawners capable of spawning from April to November. Results from the stock assessment model suggest that current removal efforts are insufficient to meaningfully reduce biomass, but that densities may be low. This research is being led by Tammy Wilson supported by Matthew Acre and Michael Byrne.

Sandusky River VPS Projects

The acoustic telemetry position array in the Lower Sandusky River has been in operation seasonally since 2020. There are now two projects working with this data to describe the movements and habitat selection of Grass Carp in the lower Sandusky River. The VPS grids give increased spatial resolution to fish movements not possible from the standard acoustic receivers deployed in other areas of Lake Erie. The projects making use of these data include a habitat selection analysis within the array using a resource selection function approach. This project aims to identify if there are habitat characteristics (e.g., depth or substrate type) that are selected by Grass Carp and is led by Michigan State University researchers with the Quantitative

Fisheries Center (Alex Maguffee, Scott Colborne, Travis Brenden). A second effort is using the VPS data to examine movements outside of the VPS array by focusing on when and where fish are leaving the Sandusky River array. This project is being led by USGS CERC (Sophia Bonjour, Matthew Acre). We anticipate that these analyses will continue during 2024 and result in manuscripts submitted for publication.

Other On-going Projects

-E-fishing vs. combined fishing efficiency (Rob Hunter and Christine Mayer)

-DNA metabarcoding of Grass Carp stomachs (Matthew Acre)

-Fine-scale Grass Carp distribution mapping (Rob Hunter and Christine Mayer)

Telemetry

Using detections from 2023, there were confirmed to be 36 tagged Grass carp alive at large whose transmitters have remaining battery life. During 2023, seven at-large fish from 2022 had their battery life expire and 1 was harvested. These active tags include 25 new Grass Carp tagged during 2023, 10 in the Sandusky River, and 15 in the Maumee River. Two of these newly tagged fish from the Maumee River were also given external satellite tags that provide real-time locations via satellite communication when these fish swim close to the water surface allowing the tethered tags to break the surface. There were also 57 native fish tagged in the Sandusky River close to Brady's Island to continue providing spatial ecology information as it relates to the proposed seasonal barrier/deterrent planning process. The nearshore array which included 72 receivers in Lake Erie habitat less 5m depth and less than 1km offshore was maintained in 2023 including the 6 near-real-time receiver stations outside of important river mouth habitats. There were also 5 new real-time receivers placed on seasonal buoys in nearshore habitats of the south shore from the Maumee River to Cuyahoga River. The fine-scale positioning arrays in the Sandusky River were also maintained in the Sandusky River which include 30 receivers surrounding Brady's Island and 100 receivers in the lower river. New receivers were deployed in the Huron River (OH; n=2) and the Upper Maumee River (n=19) near Napoleon, OH.

Detections from these receiver arrays and tagged Grass Carp in 2023 have added to a database of millions of detections and provided novel insights of Grass Carp movement and behavior. During 2023 Grass Carp were detected in two new tributaries the Huron River (OH) and the Thames River. One unique fish was detected in each tributary and the fish moving through Lake St. Clair to enter the Thames River was only the second tagged Grass Carp detected upstream of the Detroit River. Detailed analysis of Grass Carp habitat use with the fine-scale positioning array around Brady's Island during spawning events (confirmed via egg captures) suggests augmented numbers of Grass Carp in this area 2-4 days pre and post egg collections. Telemetry data have been linked with removal data to empirically estimate catchability of the species. Results from this work suggest the fish is elusive, timing of removal efforts may be mismatched, and that catchability is extremely low (< 0.026). A manuscript with these catchability results has been submitted to the Journal of Great Lakes Research and is currently *in revision.*

The Telemetry task group has also continued tracking manuscripts related to Grass Carp telemetry data which has improved coordination among the researchers and managers. The task group will continue to provide data and analyses to help improve the capture and removal of Grass Carp by furthering our understanding of Grass Carp habitat-use, movements, and abiotic drivers in these patterns within Lake Erie and the surrounding waters.

Barriers

Sandusky River Grass Carp Behavioral Barrier Feasibility Study (Ashley Binion – Zuccaro USACE)

- Feasibility Study Cost Share Agreement was signed by the Great Lakes Fishery Commission and the USACE in March of 2023.
- Focused Array of Alternatives were developed in September of 2023
- Cost Effectiveness/Incremental Cost Analysis was completed by eliciting an expert panel and developing rough order magnitude costs for the barrier alternatives.

Invasive Carp Behavioral Deterrents (Andrea Fritts - USGS):

The evaluation of the BioAcoustic Fish Fence (BAFF) at Barkley Lock and Dam continued in 2023. This is a multi-modal deterrent comprised of bubble curtains, sound, and lights and is constructed by Fish Guidance Systems from the United Kingdom. Grass carp (N = 177) have been surgically implanted with acoustic transmitters to evaluate their response to the BAFF. Statistical analyses are underway to evaluate grass carp behavioral response and crossing rates of the BAFF, plus full upstream passage through the lock chamber. The BAFF switched from experimental operation (i.e., cycling weekly between on and off operation) in Nov 2023 and is now operating continuously.

The evaluation of the Underwater Acoustic Deterrent System (UADS) at Mississippi Lock No. 19 continued in 2023. The UADS is comprised of engineered sound signals developed by the US Army Engineer Research Development Center (ERDC). Grass carp (N = 299) have been surgically implanted with acoustic transmitters to evaluate their response to the UADS. Statistical analyses are underway to evaluate grass carp behavioral response and crossing rates of the UADS, plus full upstream passage through the lock chamber. Underwater Acoustic Deterrent System (uADS) - Tested at Mississippi Lock No. 19

Oblique Bubble Screen (OBS) (Ryan Jackson USGS):

- Preparation of manuscript on the results from the 2022 live grass carp egg/larvae OBS trials
- Developed new custom egg surrogates and collaborated with the University of Guelph on development and testing of alginate beads as invasive carp egg surrogates for lab and field trials (collaborative manuscript planned)

- Developed a new method for preservation of invasive carp eggs at multiple stages of development, storage, and rehydration of eggs for use in experimental studies (manuscript in preparation)
- Refined OBS design to improve surrogate egg capture efficiency. Achieved capture efficiencies of 100% for a mean channel velocity of 0.23 m/s, 72–78% for 0.45 m/s, and 56–64% for 0.75 m/s) (manuscript in preparation)
- Planning and preparation for live grass carp egg/larval OBS trials for May–June 2024 using refined OBS designs and sub-adult upstream passage trials for Fall 2024

Publications and Presentations:

Prasad, V., Suski, C.D., Jackson, P.R., George, A.E., Chapman, D.C., Fischer, J.R., Tinoco, R.O., 2024, Limiting downstream dispersal of invasive carp egg surrogates using a laboratory-scale oblique bubble screen. Journal of Ecohydraulics, 1-20. https://doi.org/10.1080/24705357.2024.2332994.

Doyle, H.F., Prasad, V., Suski, C., Jackson, P.R., George, A., Stahlschmidt, B., Chapman, D., Fischer, J., Tinoco, R.O., May 14, 2024, Assessment of bubble screens as a dispersal barrier to control the movement of drifting invasive carp eggs, 23rd International Conference on Aquatic Invasive Species, Halifax, Nova Scotia, Canada.

Prasad, V., Doyle, H.F., Suski, C., Jackson, P.R., George, A., Stahlschmidt, B., Chapman, D., Fischer, J., Tinoco, R.O., May 5-9, 2024, Assessment of bubble screens as a dispersal barrier to control the movement of drifting invasive carp eggs, 15th International Symposium on Ecohydraulics and Fish Passage, Quebec City, Canada.

Doyle, H.F., Prasad, V., Suski, C.D., Jackson, P.R., George, A.E., Stahlschmidt, B.H., Chapman, D.C., Fischer, J.R., and Tinoco, R.O., September 26, 2023, Developing an oblique bubble screen to redirect drifting eggs in streams: addressing challenges of using live eggs in laboratory tests, 13th Symposium on River, Coastal, and Estuarine Morphodynamics, Urbana, Illinois.

Prasad, V., Suski, C., Jackson, P.R., George, A., Stahlschmidt, B., Chapman, D.C., Fischer, J., Tinoco, R.O., February 22, 2023, Controlling two-way movement of invasive Asian carp using oblique bubble screen as a non-physical barrier, U.S. Army Corps of Engineers R&D Day 2023 at the University of Illinois at Urbana-Champaign, Urbana, Illinois.

Grass Carp Barrier Native Fish Study (Evelyn Pantelopoulos – University of Toledo):

MS student, Evelyn Pantelopoulos, collaborated with researchers at the USGS Lake Erie Biological Station, OH DNR, and Michigan State University to describe fish movement in the Sandusky River where the deterrent is planned, near Brady's Island in Fremont, OH. The primary question is whether native species traverse the deterrent location to access habitat critical for spawning or foraging during grass carp spawning times, when the deterrent is likely to be active.

Acoustic telemetry tags were implanted in five fish species including two that migrate into the river to spawn (white bass, Morone chrysops and shorthead redhorse, Moxostoma

macrolepidotum) and several other common species that reside in the river (smallmouth buffalo Ictiobus bubalus, channel catfish, Ictalurus punctatus, and freshwater drum, Aplodinotus grunniens).

Potamodromous white bass and shorthead redhorse crossed the future deterrent location throughout May, which is when they spawn. Most of the white bass and shorthead redhorse stopped crossing the Brady's Island area by the third week in May, indicating the end of spawning. White bass and shorthead redhorse would have to cross the deterrent to access their spawning habitat because their spawning season (primarily May) would likely overlap with deterrent operation.

Long-term residents (buffalo, drum, and catfish) remained within the river for most of the year. The number of individuals and the average rate of crossing were generally high for May and June but decreased throughout the remaining summer months. These native species would need to cross the deterrent to move among the habitats that they currently use. The decrease in crossings and in the number of individuals in July suggests a decreased need for access between the upper and lower Sandusky River. Deterrent operation after June would result in low rates of interaction with river residents.