Grass Carp Advisory Committee (GCAC)

Annual Report 2022

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 Grass Carp Advisory Committee met twice in the past year. The first meeting was August 16-17, 2022, at the University of Toledo Lake Erie Center in Oregon, Ohio. This meeting included Task Group updates, research updates, and discussion of accomplishments under the LEC Adaptive Response Strategy. The second meeting was held February 9-10, 2023, in Ann Arbor, Michigan, and included updates for 2022, discussion of recommendations to the LEC, and beginning the development of metrics for measuring accomplishments. Both meetings were a hybrid format, and well attended both in-person and virtually. A report of accomplishments under the LEC Grass Carp Adaptive Response Strategy and recommendations for LEC consideration for the upcoming Strategy review is being developed.

Participation in the GCAC continues to grow. Currently there are 69 GCAC members and resource personnel from 25 agencies/universities/organizations. In 2023 an additional Task Group, the Early Life History Task Group, will be formed to ensure focus on grass carp egg and larvae surveys/research will continue. A Task Group coordinator and membership will be identified and charges developed in the upcoming months.

Field Work

During the 2022 field season a total of 13 crews across the Great Lakes conducted grass carp removal efforts. In 2022, 147 grass carp were removed from Lake Erie and Lake Erie tributaries, similar numbers to recent years (Figure 1.). Fourteen additional captures came from Lake Michigan tributaries in 2022. Effort was spread across five response protocols; sustained, targeted, spawning, exploratory, and bait/attractant (Figure 2.). The real-time response was deemed to be ineffective and was not meeting its goal and therefore removed before the start of the 2022 field season. Overall, targeted was the most common response protocol conducted accounting for 47.7% of effort across all basins by hours sampled (1116 of 2339 total hours). Targeted also accounted for the majority of grass carp captures during 2022 (80). Spawning response accounted for 26.2% (36 fish) of all captures from 7% of the total hours of effort (164 hours). Removal crews spent 14.7% of their time (345 hours) conducting sustained response but only caught five fish during 2022 (3.6% of 2022 captures).

2022 is the first year that both random and non-random site selection was systematically recorded during targeted removal efforts. Removal efforts were split into random and non-random site selection strategies across different protocols. Sustained and exploratory protocols call for random site selection explicitly while targeted protocol efforts are divided between random and non-random. Spawning removal efforts are non-random with crews targeting known spawning locations. Random site selection accounted for 34.2% of effort hours (803 of 2339 hours) but less than 12% of total catch (16 fish captured). Overall, 121 grass carp (88.3% of total catch) were captured using non-random site selection (spawning and targeted) across 1537 hours of removal effort (65.7% of total effort hours). Non-random targeted response efforts accounted for 70 grass carp captures during 2022 or 51% of the total catch, and this was by far the most effective removal method.

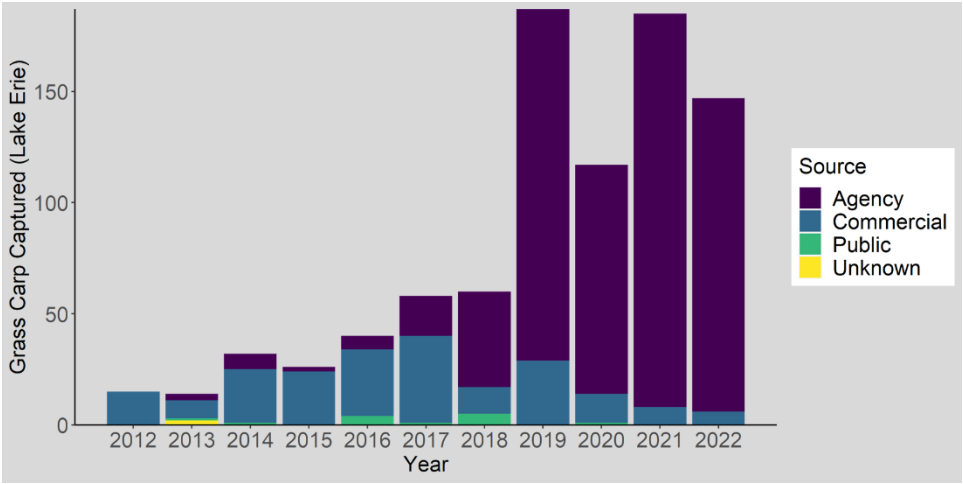

Figure 1. Grass Carp captures, by capture source, from Lake Erie and tributaries, 2012-2022.

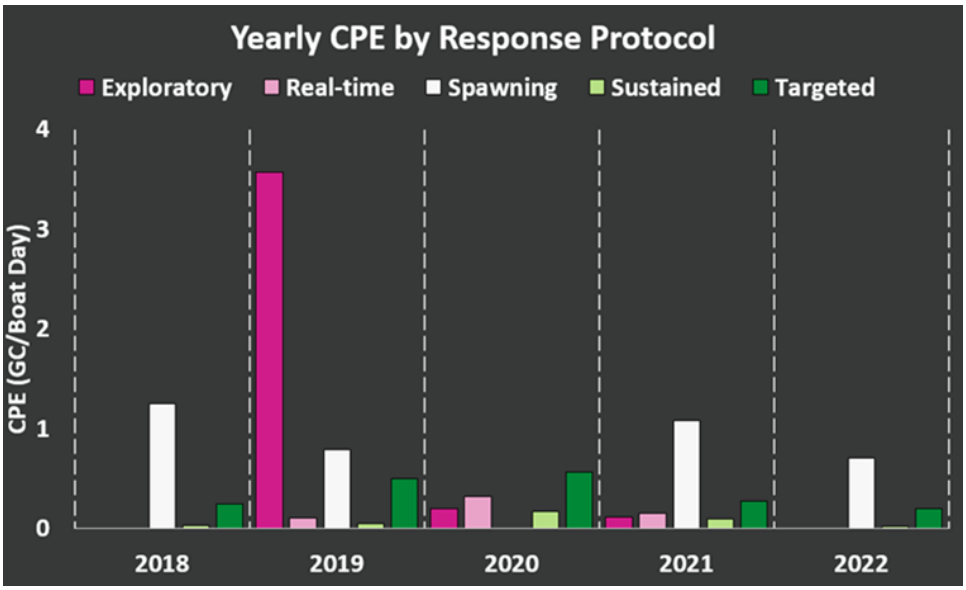

Figure 2. Grass carp catch per effort (capture/boat day) by Response type, 2018-2022.

Geographically, grass carp control efforts expanded into the eastern basin of Lake Erie and Lake Michigan efforts increased scope into full time efforts from exploratory work during 2021. USFWS - Lower Great Lakes (USFWS-LGL) and the University of Buffalo (UB) conducted eastern basin Lake Erie removal efforts. USFWS-LGL sampled for ~10 hours resulting in two grass carp captures, one in Dunkirk Harbor and one in Cleveland Harbor. UB conducted over 262 hours and captured six grass carp from Bell Slip (Outer Harbor), Tonawanda Creek, and the Erie Canal. USFWS-Green Bay (USFWS-GB) conducted a total of 218 hours in Lake Michigan tributaries. The majority of effort was applied in the St. Joseph River, 174 hours or 79.8% of total effort. The St. Joseph River also accounted for the majority of USFWS-GB captures as well with 9 of 12 total captures coming from that tributary.

In 2022, University of Toledo and U.S. Geological Survey both had one crew dedicated to sampling grass carp early life history. The two crews combined for 290 larval tows on the Cuyahoga, Huron, Grand, and Sandusky rivers in Ohio and the St. Joseph and Tittabawassee rivers in Michigan. To date, grass carp eggs were only confirmed from the Sandusky River. Several eggs were sent for genetic analysis from the Huron, Maumee, and Tittabawassee rivers. Eggs from the Maumee and Tittabawassee were negative for grass carp whereas the samples from the Huron River are still undergoing testing. Staff from University of Toledo, U.S. Fish and Wildlife Service, and U.S. Geological Survey are processing larval fish samples from 2021 and 2022.

Data Management

During the 2021-2022 offseason, a new Survey123 collection form was created to streamline the data collection process. The primary change was creating four relational databases (effort, grass carp harvest, environmental, and bycatch) that can tie back to a single sampling event. This form was published in early April and minor updates were made throughout the 2022 field season. A lab survey was also created so Jen Bailey (Onalaska USFWS) can submit ploidy results for individual fish and fish processors can add all laboratory measurements to the grass carp harvest database. Data from surveys are housed in an ArcGIS Online (AGOL) Feature Layer, which all partners have access to. In early July, it was discovered that data from April to June were accidentally deleted from the database. The Detroit USFWS team, with the help of ESRI, was able to recover most of the missing data. Three days were missing from the first part of July but were recovered from paper datasheets and re-entered into Survey123. Each partner reviewed the recovered data, and it was then appended to the current database in August. Additional restrictions were applied to the Feature Layer to ensure data security. In November, new groups were also created, Data Managers, Field Crews, and Lab Managers, in AGOL to restrict access to only the relevant data required for each partner. Only the Data Manager group has access to edit data, which includes one representative from USFWS and UT. In addition, the USFWS GIS team is using FME (Feature Manipulation Engine) to back up data weekly and UT is using R to back up the data daily. Backup data from UT is being stored in the GLFC Box location.

University of Toledo (UT) has begun the QA/QC process for all historical and current data (2018-2022). An RMarkdown file was created for each agency and each year to flag errors in the database. UT will be meeting with representatives from each partner in early 2023 to go through the flagged errors and correct them if possible. Once each partner's data, for each year, are validated they will be merged and formatted to fit the current database. Two meetings regarding the updating of the Survey123 collection form have taken place during the 2022-2023 offseason. Minor updates will be made before the next field season. In addition, USFWS and UT are looking into auto-populating river kilometers based on the user's selected location in the survey. If successful, this will reduce errors related to the manual selection of river kilometers out in the field. Integration of the Lab Survey with fish processing will begin in the 2023 field season.

Action items for 2023 include continuing the QA/QC process, which will eventually lead to the integration of 2018-2021 data into the current format, creating a ploidy results report in Survey123, auto-populating river kilometers in the survey form, and creating a SharePoint location where partners can request data, Survey123 changes, and any other data related requests that may arise. A QA/QC protocol will be established along with an updated Survey123 data entry protocol manual. To help integrate new crews and team leads into the program, a data entry training will be held in the spring before field season begins.

Modeling

Brian Brenton, Ed Rutherford, and Doran Mason, have constructed individual-based-simulation models for the western basin for grass carp, silver, and bighead carp to predict abundance through time. The model currently incorporates adult and juvenile mortality estimates, current estimates of carrying capacity based on macrophyte growth and distribution, grass carp diet, and current grass carp abundance estimates. Much of this data has been obtained through empirical estimates and literature values, but the team plans to work in collaboration with members from the Modeling and Telemetry task groups to obtain more empirical data inputs to feed into the model. The team plans to draft a paper in the third quarter of 2023 that includes USGS FluEgg simulations of egg drift for multiple spawning locations.

Justin Bopp, Kelly Robinson, and Lucas Nathan have employed hierarchical occupancy models with eDNA data collected in the nearshore Michigan waters of Lake Erie (River Raisin, Hot Ponds, and Detroit River) from 2018-2019 by Michigan State University to understand the influence of season, primers, and sites on grass carp detection probabilities. Additionally, opportunistic use of acoustic telemetry detections has been used to validate the presence of grass carp with positive eDNA detections. Preliminary results indicate that detection probabilities among DNA markers were different, but did not differ among sites or season. Mean detection probabilities ranged 40%-60%. A note is currently being drafted for publication, and we hope to submit it for peer review by the second quarter of 2023.

Another iteration of the MSU population model was conducted with updated survival and spawning probability estimates from the University of Toledo, and movement probabilities

obtained from 2022 acoustic telemetry data with preliminary values of catchability and F that were derived from mark-recapture estimates and abundance. The updated number of removed fish required to achieve target densities outlined in the structured decision-making framework in the Western Basin of Lake Erie is 373 fish/year. Parameters that have not been updated since Dufour et al. 2021 include survival and abundance at age <5 years, stock-recruitment relationship, spawn-per-recruit, and age at maturity. Updates from the population model have enabled the revision of the adaptive management/decision-analytic framework and the ability to evaluate new alternative management scenarios and understand how uncertainty may influence the preferred alternative option. A manuscript is currently being drafted and plan to submit it to a peer-reviewed journal in the first half of 2023.

The USGS Columbia Environmental Research Center (POC Matthew Acre, Tyler Hessler and Robin Calfee) is currently working on compiling catch and effort data from the Grass Carp database, telemetry detections, and eDNA detections from 2021-2022 within the Sandusky River to estimate seasonal catchability and detection probabilities. All of the 2022 Sandusky VPS telemetry data has been processed for this work. This work is currently in progress, and some preliminary data analyses have been conducted.

The USGS Central Midwest Water Science Center (POC Ryan Jackson, Jessica LeRoy, Henry Doyle, Gregory Lasher) have worked on three projects pertaining to the identification of grass carp spawning areas, optimal river conditions for recruitment and spawning, and the USGS SpawnCast tool :

1. Update on “Identification of optimal river conditions for spawning and recruitment of invasive carps in tributaries of the Western Basin of Lake Erie”

The purpose of this study is to use FluEgg to simulate the drift of grass carp eggs and larvae in tributaries to the Western Basin of Lake Erie under a variety of combinations of flow conditions, water temperatures, and spawning locations. We use the results of the FluEgg simulations to determine the scenarios that result in the highest rates of in-river hatching rates (i.e., the percentage of eggs that are still suspended and located in the river at hatching) and in-river larval retention rates (i.e., the percentage of larvae that reach the GBI stage within the river). The first stage of this study addresses in-river hatching and larval retention rates in the lower Maumee River. We have completed the modeling work, published the results as a model archive/data release (LeRoy et al., 2022), and are currently preparing a journal article documenting these results. We aim to have a draft journal article on the lower Maumee River work submitted by March 2023. Additionally, outputs from the Maumee River FluEgg simulations were provided to collaborators at NOAA for use in developing an individual-based bioenergetics model (IBM) of the Maumee River. The second stage of this study is a similar analysis for the Sandusky River. We are in the process of converting an existing unsteady (time-varying) hydraulic model of the Sandusky River into a steady (not varying in time) model that can be used to drive the suite of FluEgg simulations. We aim to have the hydraulic and FluEgg simulations completed for the Sandusky River completed by October 2023 and published as a model archive/data release by December 2023.

2. Update on "Identifying grass carp spawning areas in the Maumee and Sandusky Rivers using FluEgg inverse modeling and UT ichthyoplankton data"

The purpose of this study is to use FluEgg's reverse-time particle transport (RTPT) model and University of Toledo grass carp ichthyoplankton data to identify the most probable spawning grass carp spawning areas in the Maumee and Sandusky Rivers. The spawning seasons analyzed included 2017-2019 for the Maumee River and 2019 for the Sandusky River (post Ballville Dam removal). We have completed the hydraulic and FluEgg modeling for both rivers and identified the most probable spawning areas in each. Provisional results were shared with GCAC partners in 2022. The Maumee River results are published as a model archive/data release (LeRoy et al., 2022), and we are currently preparing a journal article documenting these results. We aim to have a draft journal article on the lower Maumee River work submitted by March 2023. We are in the process of preparing the results of the 2019 Sandusky spawning area analysis for publication as a model archive/data release and associated journal article with a goal for submission by July 2023.

3. Update on "USGS SpawnCast–A Grass Carp Spawning Event Prediction Tool"

In FY2022, this project continued the development maintenance of USGS SpawnCast, a web-based decision support tool (DST) that provides 5-10 day forecasts of potential grass carp spawning events in select tributaries to the Western Basin of Lake Erie. USGS SpawnCast is currently used by GCAC resource management agencies to guide the efficient mobilization and deployment of a limited number of strike teams for the collection of adult grass carp and grass carp ichthyoplankton in known spawning tributaries of Lake Erie. In response to requests from agency response coordinators, grass carp spawning forecast dashboards for the Maumee and Cuyahoga Rivers were added to USGS SpawnCast prior to the 2022 spawning season. In addition, a methods document was drafted in 2022 in preparation for review. However, refinements in the methods used and continued development of tool has postponed formal peer review until 2023. In 2022, we also began investigating how we could extend SpawnCast from a point-based model to a reach-based forecast model using NOAA's National Water Model. This branch of development will continue in 2023 along with the addition dashboards for two more Great Lakes tributaries as determined by the GCAC.

Telemetry

In the fall of 2022, there were confirmed to be 23 tagged Grass Carp at large whose transmitters have remaining battery life. This estimate may change slightly when all the detection data from 2022 is exported, at present the full 2022 record of detections has not been received from the GLATOS network. However, 6-7 of these tags are expected to expire around June 2023. Four new Grass Carp were implanted with acoustic telemetry tags during 2022, all four were captured and released in the Maumee River. There were also 103 native fish tagged in the Sandusky River around Brady's island to provide information on movement and habitat needs of native fishes to the proposed seasonal barrier planning process. The nearshore array which

included 72 receivers in Lake Erie habitat less 5m depth and less than 1km offshore was maintained in 2022 which included visiting each site retrieving the receiver and replacing many of the drag line sets with acoustic release receivers. In addition, 6 near-real time receiver stations were deployed outside of important river mouth habitats which will allow for remote and more frequent data downloads in 2023. The fine-scale positioning arrays in the Sandusky River were also maintained and augmented in the Sandusky River which include 30 receivers surrounding Brady's Island and 100 receivers in the lower river. This lower river array stretched from the mouth at Sandusky Bay upstream to bridge at I-80 or approximately the first 12 km of the river.

All of these arrays and tagging efforts have already produced millions of Grass Carp detections and in 2022 these detections included 1.3 million from native fish related to the proposed Brady's Island seasonal barrier. Of note within the Sandusky River during a spawning event on 5/23/22 where crews from University of Toledo and USGS collected Grass Carp eggs there were eight tagged Grass Carp detected that day within the Sandusky River. Of these eight Grass Carp five were detected at Brady's Island and one was detected at Brady's Island and the lower Sandusky River during May 23rd. Following the increase in quota of tagged Grass Carp from 50 to 65 actively tagged fish the task group has planned a tagging workshop in April 2023 to provide training at the USGS Columbia Environmental Research Center in Columbia, MO. This workshop will provide training for up to 10 individuals and will increase the number of trained surgeons so that Grass Carp can be more effectively tagged when captured by removal crews.

The task group also compiled a list of planned research manuscripts related to Grass Carp telemetry and management. This list includes seven planned manuscripts at various stages of development and revision and three published articles with the first being published in 2021. This research includes topics of general Grass Carp spatial ecology, applications of telemetry data to population estimates, Grass Carp habitat use, Grass Carp spawning ecology, and direct estimates of Grass Carp catchability. Specifically, there are three manuscripts using telemetry to help plan for the operation of the proposed seasonal barrier to prevent Grass Carp spawning in the Sandusky River. This group of research efforts is focused on understanding when Grass Carp arrive to the Brady's Island spawning location and how that relates to native fishes and their use of this habitat for spawning and other life history events.

Barriers

Sandusky River Grass Carp Behavioral Barrier Feasibility Study (Tim Noon – USACE)

Coordinated the below response with Josh Unghire and Rich Ruby for our work on the Sandusky River Grass Carp Barrier. Ashley Binion Zuccaro is out on some medical leave so Tim is transitioning in as project manager in her absence. ODNR and GLFC working with Josh Unghire to establish the Feasibility Cost Share Agreement. USACE Accomplishments in 2022 in support of the Grass Carp Barrier Task Force are as follows:

- USACE initiated work on the Sandusky River Grass Carp Barrier project in March of 2022 and has completed the following milestones:

- Completion of a federal interest determination
- Scoping of a comprehensive feasibility study to develop, evaluate, and select a behavioral barrier alternative.
- Coordination of the draft Feasibility Study Cost Share Agreement with Ohio Department of Natural Resources and the Great Lakes Fishery Commission. Execution of this agreement will enable initiation of the feasibility study this FY.

Invasive Carp Behavioral Barriers (Andrea Fritts - USGS):

Underwater Acoustic Deterrent System (uADS) - Tested at Mississippi Lock No. 19

- Acoustic deterrent comprised of engineered sound signals developed by the US Army Engineer Research Development Center (ERDC).
- 100 grass carp dual tagged with VEMCO depth transmitters and HTI transmitters in 2021.
- 100 grass carp tagged with HTI transmitters in 2022.
- Evaluating behavioral response to the uADS acoustic signals.
- Preliminary results from Year-2 of the evaluation will be presented on Feb 27th.

Bio-acoustic Fish Fence (BAFF) - Tested at Barkley Lock and Dam on the Cumberland River

- Multi-sensory deterrent comprised of bubble curtains, sound, and lights. Constructed by Fish Guidance Systems (FGS) from the United Kingdom.
- 45 grass carp tagged HTI transmitters in 2021.
- 82 grass carp tagged with HTI transmitters in 2022 (subset of 35 also tagged with VEMCO depth transmitters).
- Evaluating behavioral response and crossing rates of the BAFF, plus full upstream passage.
- Preliminary results from Year-2 of the evaluation will be presented on Feb 27th

Efficacy of an Oblique Bubble Screen System as a Two-Way Dispersal Barrier for Invasive Carp (Ryan Jackson USGS):

The purpose of this study is to assess and optimize the efficacy of an oblique bubble screen (OBS) system as two-way, seasonally operated dispersal barrier to disrupt spawning and recruitment of invasive carp in known spawning tributaries to the Great Lakes. This project will result in a novel alternative (or modification) to existing deterrent technologies, to prevent invasive carp from becoming established in the Great Lakes by developing an OBS system capable of redirecting and capturing more than 50% of downstream-drifting invasive carp eggs and larvae, while concurrently deterring the passage of upstream-swimming adult carp with at least 50% efficacy.

In FY2022, three experimental series were completed in a recirculating flume at the Ecohydraulics and Ecomorphodynamics Laboratory at the University of Illinois at Urbana-Champaign. Two experimental series focused on OBS efficacy with surrogate grass carp eggs and one series used live grass carp eggs and larvae from three separate spawning events. To date,

this study has identified critical parameters for the design of a targeted redirection system to collect eggs and larvae of invasive fishes in lotic ecosystems. The hydrodynamic analysis of the OBS revealed the relevance of the ratio between the lateral current generated by the OBS and mean water flow, but also highlighted the importance of secondary flows and turbulence levels driven by the OBS as disruptors for particles traveling below the surface. After conducting initial tests with live eggs and larvae, the disparate redirection patterns observed between buoyant surrogates, neutrally buoyant surrogates, and live grass carp eggs and larvae, yielded promising results that indicate the potential to develop an OBS system capable of targeting particles of a specific size and density for redirection/capture while letting non-targeted particles pass, which is part of our ongoing work on the project. This study has also demonstrated that motile larvae might also be concentrated for potential removal through the use of a bubble barrier, which has not been previously demonstrated.

Grass Carp Barrier Graduate Student (Chris Mayer - UT):

A new MS student project, intended to evaluate potential barrier effects on the native fish community, began in the fall of 2022. Ms. Evelyn Pantelopoulos will collaborate with researchers at the USGS Lake Erie Biological Station, OH DNR, and Michigan State University who have previously begun implanting fish from the Sandusky River with acoustic telemetry tags. They will determine if several species traverse the barrier location to access habitat critical for spawning or foraging during grass carp spawning times, when the barrier is likely to be in force. They will monitor movement of one sport fish (white bass, Morone chrysops) and several other common species (e.g. small mouth buffalo *Ictiobus bubalus*). There are plans to implant tags in more fish. The student met with project partners during the fall semester to scope project ideas and learn about management agency priorities.

Characterization of Hydrology and Sediment Mobility to Inform - Design of a Seasonal Barrier in the Sandusky River (Branden VonIns – USGS):

Below is a list of what was accomplished on the project in calendar year 2022. Please let me know if you have any questions.

- The funds became available for our center's use on July 26, 2022.
- Potential sites to install the gage were visited on July 26, 2022. We selected 2 sites, our preferred option and a backup.
- Talked with City of Fremont officials and ODNR officials and secured permission to install gage at desired location (41.357891°N, -83.103236°E).
- Ordered all sensors and gage equipment.
- Installation began in September 12, 2022 and gage became fully operational on December 9, 2022 (delays caused by spending freeze at end of Federal FY and back-ordered QW sensors).
- Data is being published on web at https://waterdata.usgs.gov/monitoring-location/412122083061400/