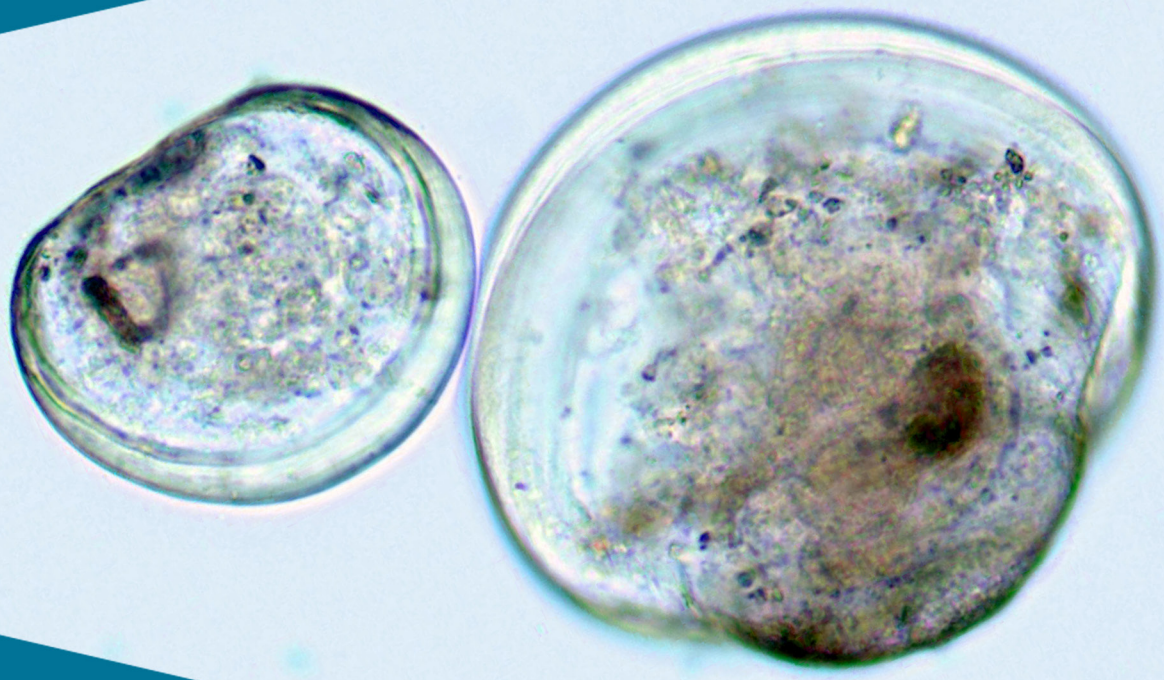
BUREAU OF RECLAMATION

R&D Office Research Updates

Invasive Mussels



U.S. Department of the Interior

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Reclamation's Research and Development Office (R&D) manages the Science and Technology Program (S&T) and is focused on providing innovative solutions for Reclamation water and power facility managers and its western customers and stakeholders, primarily through competitive funding opportunities to Reclamation employees.

The S&T Program has five research areas (listed below) directly related to Reclamation's mission. For more information, visit: www.usbr.gov/research/st/needs_priorities/index.html.

S&T Research Areas and Categories

Water Infrastructure (WI)
Dams, Canals, Pipelines, and Miscellaneous Water Infrastructure

Power and Energy (PE)
Hydro Powerplants, Energy Efficiency, Pumping Plants, and Non-Hydropower Renewable

Developing Water Supplies (WS)
Advanced Water Treatment, Groundwater Supplies, Agricultural and Municipal Water Supplies, and System Water Losses

Environmental Issues in Water Delivery and Management (EN)
Water Delivery Reliability, Invasive Species, Water Quality, Sediment Management, and River Habitat Restoration

Water Operations (WP)
Water Supply and Streamflow Forecasting, Water Operations Models and Decision Support Systems, Open Data, and Climate Change and Variability

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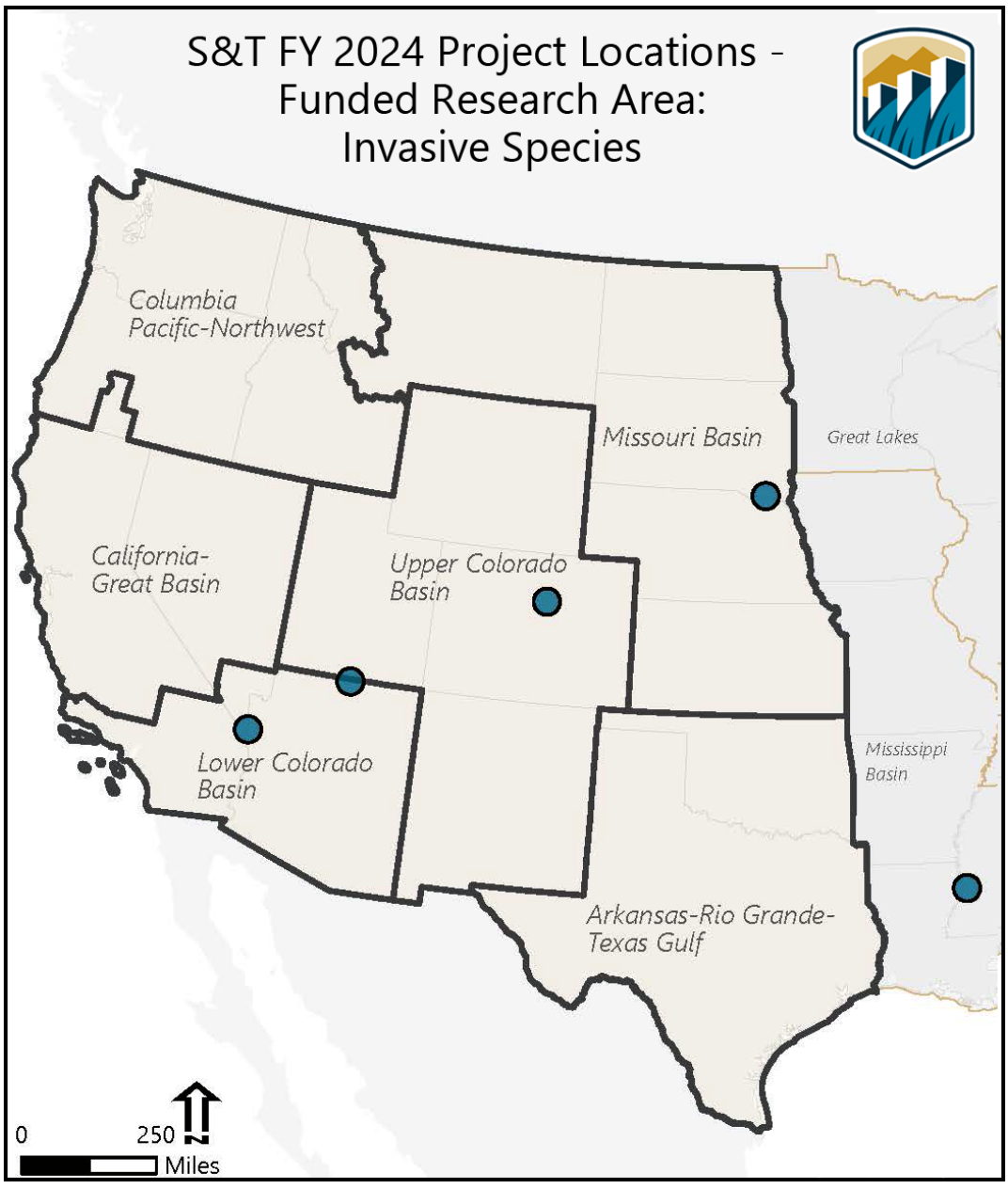
Invasive Mussels

Executive Summary

The Invasive Mussel (ZQ) Research Category of the Science and Technology Program (S&T) examines research in the following topic areas:

- Prevention
- Early Detection and Monitoring
- Management and Control
- Impact Assessments
- Increasing Fundamental Knowledge of Mussels



In FY24, S&T funded 16 ZQ projects approximately totaling $1.9M: 5 were new totaling $0.6M and 11 were continuing totaling $1.3M. ZQ research is extremely valuable to Reclamation and has led to the development and implementation of new methods to control mussel fouling and reduce maintenance costs in hydropower plants. Research optimizing early detection and monitoring methods are utilized by Reclamation and partners to limit the spread of mussels in the Western United States.

FY23 Completed Projects

20026: Investigation of environmental RNA (eRNA) as a detection method for dreissenid mussels and other invasive species – Jacque Keele

Collection and preservation of quagga mussel eRNA samples at Canyon Reservoir in Arizona.

In the last ten years, environmental DNA (eDNA) has emerged as a technique for the detection and monitoring of invasive, endangered, and threatened species. The use of environmental RNA (eRNA) is starting to emerge as a method for addressing questions that eDNA cannot answer. eRNA could be a useful tool in determining if an organism is alive or dead. The goal of this project was to investigate eRNA preservation and extraction methods for the detection of the quagga mussel 16S and 18S transcripts. eRNA samples were collected at Canyon Reservoir, AZ, and preserved with Zymo Shield, RNAlater, or ethanol. The effectiveness of three RNA extraction kits (Monarch, Zymo Mini, Zymo Water) were examined. RT-qPCR was performed on the samples for both the 16S and 18S transcripts. It was possible to detect the 18S transcript with all three-preservation methods and the three extraction methods. The project showed that it is possible to extract viable eRNA from plankton tow samples, which is the method Reclamation currently uses to collect veligers and eDNA. Additional research is needed to optimize the collection, extraction, and analysis methods for eRNA, and to determine the best uses of eRNA in the early detection and management of invasive species.

FY24 New Projects

24004: Investigation of remote sensing tools for harmful algal blooms, invasive mussels, and invasive aquatic vegetation – Brianna Benjamin

This project will assess existing open-source tools to remotely sense HABs, while also investigating the capability to create new tools for invasive mussels and vegetation. The research team will be partnering with the U.S. Army Corps of Engineers (USACE) Engineer Research and Development Center (ERDC) to investigate existing HAB remote sensing tools and to develop a plan to create new remote sensing tools for invasive mussels and aquatic vegetation. The team plans to develop standard operating procedures (SOPs) and user-friendly implementation plans so that these open-source remote sensing tools can be easily utilized by anyone at Reclamation.

FY24 New Projects - continued

24008: Pilot Scale Carbon Dioxide Treatment for Dreissinids – Kevin Kelly

A pilot scale carbon dioxide treatment for quagga mussel settlement prevention will be installed and tested at Davis Dam Powerplant. Carbon dioxide will be delivered by a Speece Cone into mussel infested reservoir service water within the generator cooling system to prevent quagga mussel veliger settlement and colonization. Carbon dioxide is an alternative to registered molluscicides as it is inexpensive, widely available, easily applied, environmentally ubiquitous, lacking harmful chemical residues or disinfection byproducts, and low risk to human health. The Technical Service Center (TSC) has been working closely over the past 6 years with scientists from the Upper Midwest Environmental Sciences Center (UMESC) of the U.S. Geological Survey (USGS) in laboratory and field studies using carbon dioxide to successfully cause mortality and a reduction in the rate of veliger byssogenesis (settlement and colonization). Given the knowledge gained and success of field and laboratory trials over the past 6 years, the pilot scale implementation of the Speece Cone on one of the hydropower generation units in Davis Powerplant is expected to successfully prevent quagga mussel settlement.

24015: Development of environmental RNA (eRNA) as a tool for dreissenid mussel detection and assessment of invasive mussel populations -Jacque Keele

The goal of this research project is to continue to investigate eRNA as a tool for invasive mussel monitoring. This project will build on the findings of a previous eRNA project which showed that it is possible obtain eRNA signal from a plankton tow sample. We will investigate any new eRNA sample collection and handling methods that may have emerged over the last few years, and further investigate the limit of detect of eRNA transcripts in bulk water samples. The quagga mussel genome will be scanned for additional transcripts that may provide information on development and stress response. For RNA transcripts of interest, reverse transcription quantitative PCR (RT-qPCR) primers and assays will be validated and tested. This research will provide a greater understanding of eRNA, and eventually eRNA can be added to the toolbox of assays that Reclamation can perform to assess invasive mussel populations.

FY24 New Projects - continued

24022: Determining the Lowest Effective Liquid Copper Concentration to Prevent Invasive Mussel Fouling at Hydropower Plants – Sherri Pucherelli

This project will investigate the lowest effective concentration of EarthTec QZ liquid copper treatment that can be used to prevent invasive mussel fouling in hydropower plant systems that utilize raw water. Data from the study will also be incorporated into a USACE model that will demonstrate copper fate in the downstream river to investigate the potential exposure to sensitive species. The research team and partners includes experts from Reclamation, United States Army Corps of Engineers (USACE) Engineer Research and Development Center (ERDC) and USACE Hydroelectric Design Center (HDC) and United States Geological Survey (USGS). The effectiveness of EarthTec QZ at reducing mussel settlement at continuous and intermittent doses lower than 20 parts per billion (ppb) will be examined. The study will be conducted in a USGS research trailer at the Gavins Point National Fish Hatchery at Lewis and Clark Lake along the Missouri River. This study will help identify the lowest effective concentration and treatment regime which may significantly reduce treatment costs and the amount of copper released into the downstream river. Modeling of the copper in the downstream river will likely provide additional evidence that the treatment is safe even when sensitive species are present.

24049: Assessment of Invasive Mussel and Hydroid Biofouling in the Glen Canyon Forebay to Inform a Fish and Thermal Barrier Design -Sherri Pucherelli

The goal of this study will be to investigate how biofouling of invasive quagga mussel and colonial hydroid *(Cordylophora caspia)* will impact a fish and thermal barrier that is being designed to prevent escapement of smallmouth bass *(Micropterus dolomieu)* and other high-risk non-native fishes into critical habitat in the Grand Canyon. Water levels in Lake Powell have declined to historically low levels, which has contributed to water being released at record high temperatures through Glen Canyon Dam. Below the dam, these warmwater releases are creating ideal spawning conditions for smallmouth bass, a predatory invasive fish species. Additionally, low elevations at the Lake Powell forebay are creating prime conditions where nonnative fish are being entrained and passed through the dam down into the Colorado River below. The Grand Canyon is one of the last holdouts for the Endangered Species Act (ESA) listed humpback chub *(Gila cypha)*. This study will provide information about biofouling conditions at Lake Powell that will be used to optimize the design of the fish and thermal barrier. The study design will be informed by experts and partners from the Reclamation Upper Colorado Basin (UCB) Region, Technical Service Center (TSC), National Park Service (NPS), Western Area Power Administration (WAPA), Pacific Northwest National Laboratory (PNNL), and River Connectivity Systems.

FY24 Active Projects

Project ID	Final Year	Title	Lead
1846	2025	Self-Cleaning Strainers and Filtration to Mitigate Mussel Impacts	Bryan Heiner
20061	2024	Ultrasonic Transducer Field Test for Quagga Mussel Settlement Control	Sherri Pucherelli
21024	2024	Analysis of the Quagga Mussel Genome for Development of Biocontrols	Yale Passamaneck
21066	2024	Alternate Control Strategy for Dreissinids Using Carbon Dioxide	Kevin Kelly
21086	2024	Factors Limiting Invasive Mussel Establishment at Salt River Project Reservoirs	Sherri Pucherelli
22005	2024	Survey of 'Cousin' Dreissenid Species in Eurasia for Potential Biocontrol Agents to Control Invasive Quagga and Zebra Mussels in North America	Jacque Keele
22038	2024	Inferring the Provenance of Invasive Dreissenid Mussel Veliger Shells Through Trace Element Analysis	Yale Passamaneck
22057	2024	Development of an Engineered Disseminated Neoplasia to Control Invasive Mussels in Reservoirs	Sherri Pucherelli
22058	2025	Optimization of Sample Analysis Methods for the Early Detection of Invasive Dreissenid Mussels in Reclamation Reservoirs	Rheannan Quattlebaum
22061	2024	Development of a Production and Transport Vector for a Chimeric Biopesticide in the Treatment of Zebra and Quagga Mussels	Kevin Kelly
22063	2024	Collection and Analysis of Invasive Mussel Samples to Prevent the Spread and Impacts at Reclamation Reservoirs and Facilities	Diane Mench
24004	2025	Investigation of Remote Sensing Tools for Harmful Algal Blooms, Invasive Mussels, and Invasive Aquatic Vegetation	Brianna Benjamin
24008	2026	Pilot Scale Carbon Dioxide Treatment for Dreissinids	Kevin Kelly
24015	2026	Development of Environmental RNA (eRNA) as A Tool for Dreissenid Mussel Detection and Assessment of Invasive Mussel Populations	Jacque Keele
24022	2026	Determining the Lowest Effective Liquid Copper Concentration to Prevent Invasive Mussel Fouling at Hydropower Plants	Sherri Pucherelli
24049	2026	Assessment of Invasive Mussel and Hydroid Biofouling in the Glen Canyon Forebay to Inform a Fish and Thermal Barrier Design	Sherri Pucherelli