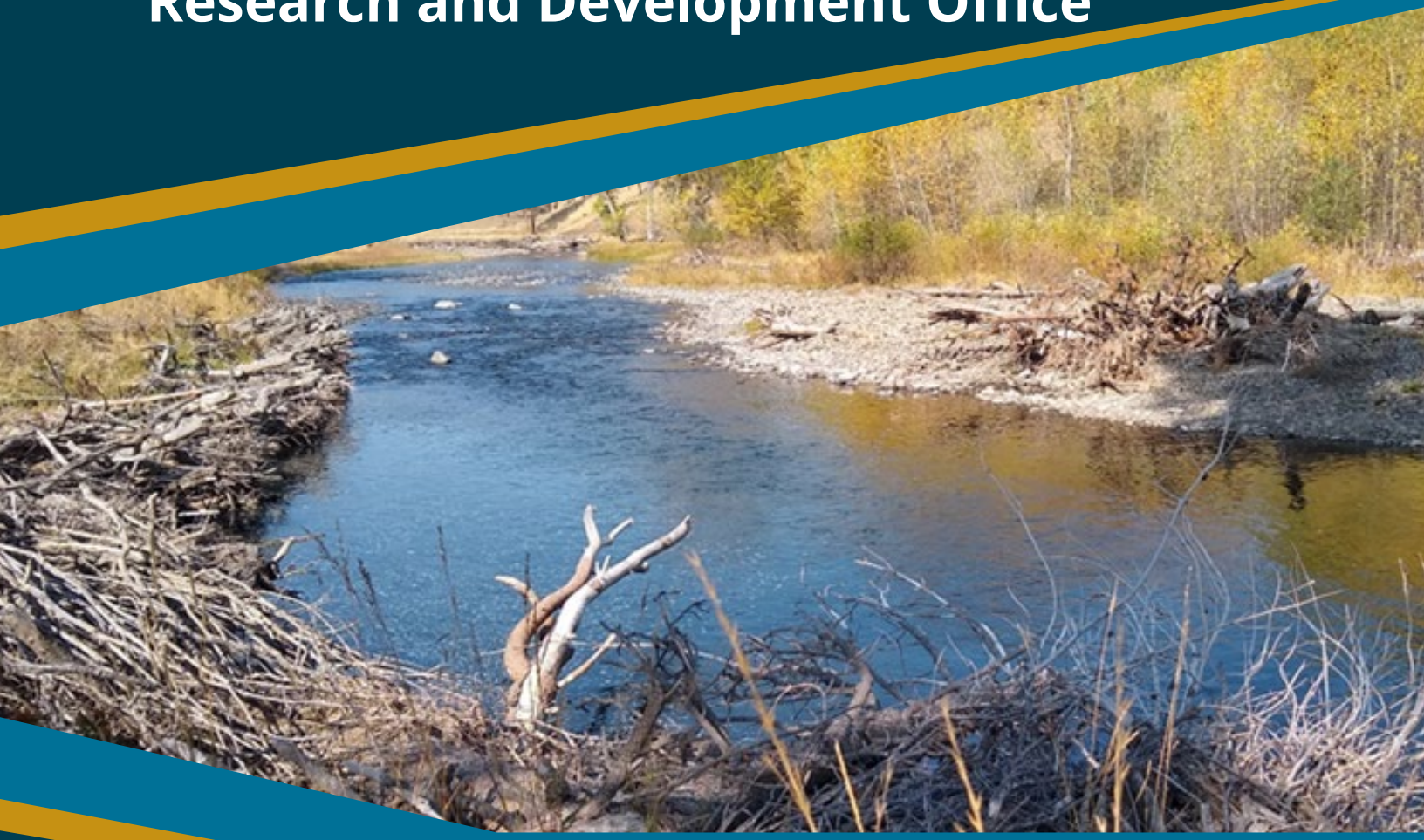
BUREAU OF RECLAMATION

Research Area Summary

Environmental Issues for Water Delivery and Management

Research and Development Office

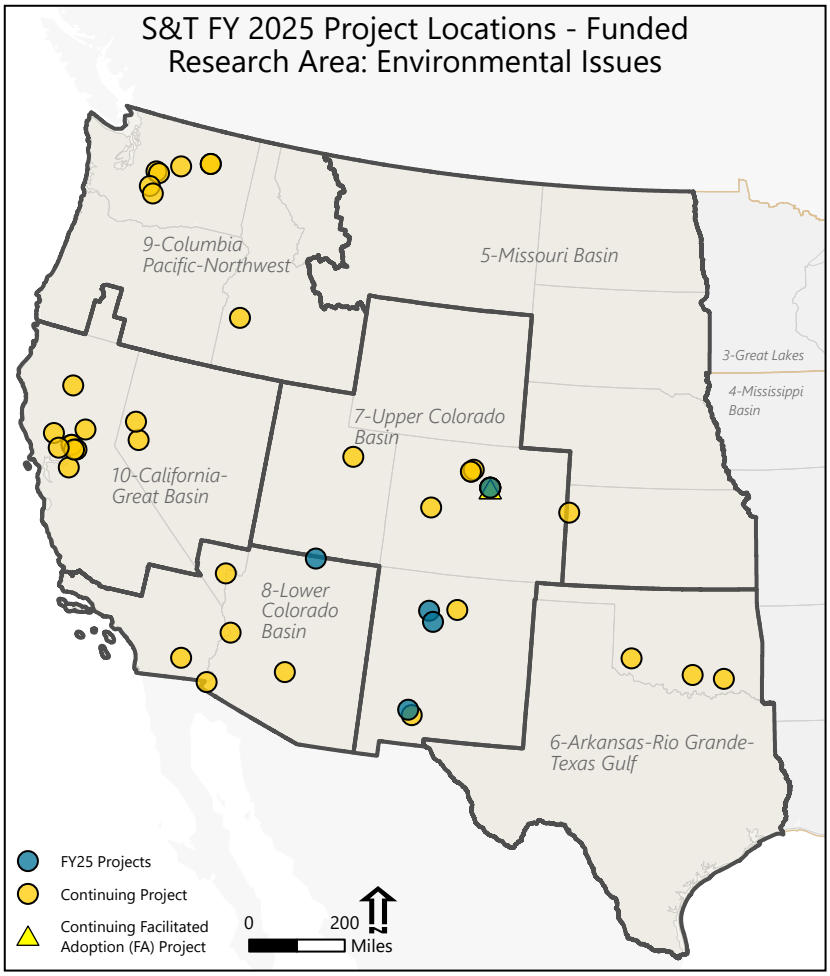


U.S. Department of the Interior

June 2025

Executive Summary

The Environmental Issues for Water Delivery and Management (EN) Research Area of the Science and Technology Program (S&T) examines research in the following categories: Water Delivery Reliability, Invasive Species, Water Quality, Sediment Management, and River Habitat Restoration. In FY25, the S&T Research Program funded 14 EN projects approximately totaling $1.1 M. Two new projects received 0.1 M in FY25, and 12 continuing projects received $1 M in FY25. Additionally, the S&T Facilitated Adoption Program continued to fund one project ($0.2 M). EN research is extremely valuable to Reclamation, both by development of new methods and techniques that are much more efficient than existing processes, as well as by learning about technologies that could be adopted by Reclamation Programs to make environmental compliance more efficient such as remote sensing and deep learning. EN projects have htmlbrought positive value and return on investment to Reclamation through enhanced infrastructure protection, more efficient environmental compliance, and improved water delivery reliability.



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: https://www.usbr.gov/research/st/index.html

S&T Research Areas and Categories

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

Power and Energy (PE)
Hydro Powerplants and Pumping Plants

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

Environmental Issues for 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 Hydrologic Variability

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Environmental Issues for Water Delivery and Management

FY24 Completed Projects

1792: Using Beryllium-10 Derived Erosion Rates as a Proxy for Reservoir Sedimentation – Melissa Foster

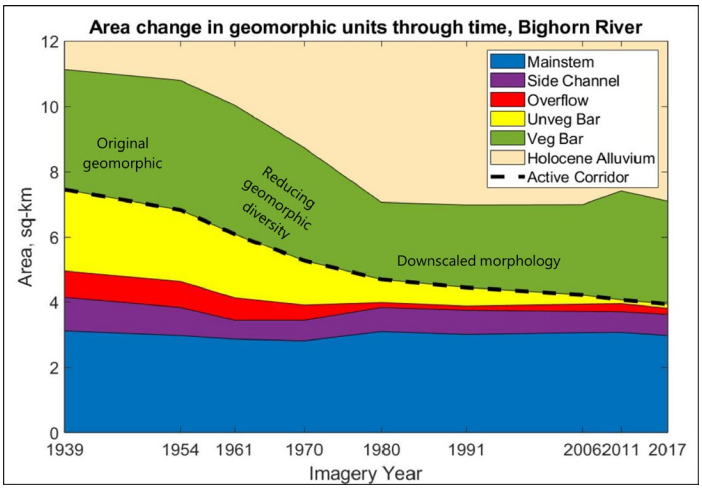
Over time, reservoirs lose water storage capacity due to sedimentation. Reclamation only has repeat reservoir survey data to quantify sedimentation rates at approximately 60% of our reservoirs. A technique to calculate basin-averaged erosion rates from beryllium-10 (10Be) concentrations in quartz river sands was pioneered in the mid-1990s, which can be used to quantify millennial-scale basin-averaged erosion rates. This project investigated how 10Be-derived basin erosion rates compare with sediment yield rates derived from reservoir survey data. The team collected new 10Be samples upstream from reservoirs in addition to using previously published 10Be data across the United States. They found modern sediment yield rates greatly outpace millennial-scale erosion rates in most regions, suggesting an anthropogenic influence on high modern sediment yield rates. However, glaciated landscapes and the Western High Plains/Rocky Mountain Regions exhibited lower modern sediment yield rates, suggesting that sediment delivery is likely stochastic and associated with extreme events. In these regions, large sediment influxes may enter reservoirs during short periods of time. Reclamation owns many reservoirs in these regions where lower, modern reservoir sedimentation rates may not represent the long-term sediment influx potential.

Sampling fresh sands on a river sand bar for Beryllium-10 testing to constrain millennial-scale basin erosion rates. Inset photo: Pure quartz obtained from river sands. Beryllium is isolated by further processing pure quartz.

19306: Side Channel Evolution, Geomorphic Diversity, and Sediment Transport on the Bighorn River Following Larger Dam Releases Between 2008 and 2018 – Melissa Foster

The hydrology, geomorphology, and ecology of the Bighorn River has been substantially altered by the emplacement of large dams in the upper watershed. This project investigated side channels along a 22-river mile reach below the Yellowtail afterbay to better understand sediment transport, geomorphic diversity, and stream morphology. Historically, Yellowtail Dam created a thriving trout fishery, but side channel networks and habitat have recently diminished. The team conducted field research to record observations of channel change or stasis in the last decade, updated longitudinal profiles at previously surveyed side channel entrances, and surveyed side channels to recover the current locations of RFID-tagged gravels. They also completed geomorphic mapping on 2011 and 2017 satellite-imagery datasets and ground-checked the results of the mapping in the field.

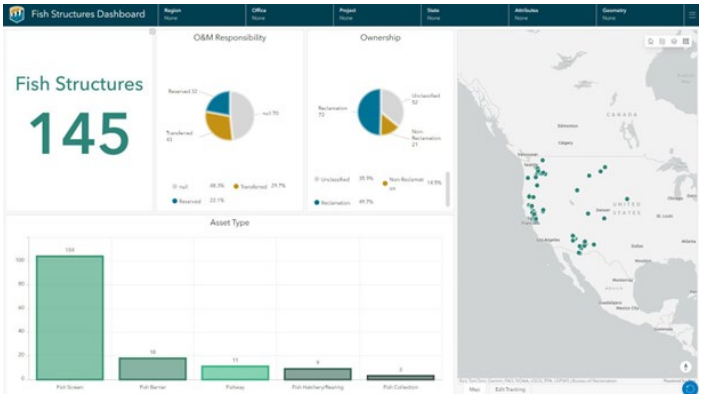
For more information, please check out the journal article available here: https://www.tandfonline.com/doi/full/10.1080/15715124.2024.2344119.



Stacked area plot of geomorphic units that comprise the active geomorphic corridor. Total area of the active geomorphic corridor was greatest in 1939 and reduced dramatically between 1939 and 1980.

20060: River Restoration Interactive Geospatial Database to Inform Future River Rehabilitation Design – Melissa Shinbein

This research project aimed to create a river restoration database to collect information about projects that have already been implemented to eventually inform future rehabilitation designs for fish and aquatic species recovery under the Endangered Species Act. This project began with talking to experts both internal and external to Reclamation on river restoration, asset management, and geospatial database development. Metrics were developed to inform the data schema. Afterwards, the regional data stewards provided some of their previously developed databases to compare and incorporate into the schema. Past river restoration projects in a variety of programs across all of Reclamation's regions were evaluated to compare and contrast successes and lessons learned. At the end of this project, this data was presented to the Enterprise Asset Registry team to be incorporated to the Fish Structures Asset Class layer. As the Fish Structures Asset Class continues to develop, river restoration data will be added and continue to remain up to date as part of the Enterprise Asset Registry Project, resulting in the living dataset for all of Reclamation to use as a resource. Therefore, project- and program-wide knowledge will be obtained to help inform agency-wide knowledge on river restoration projects.

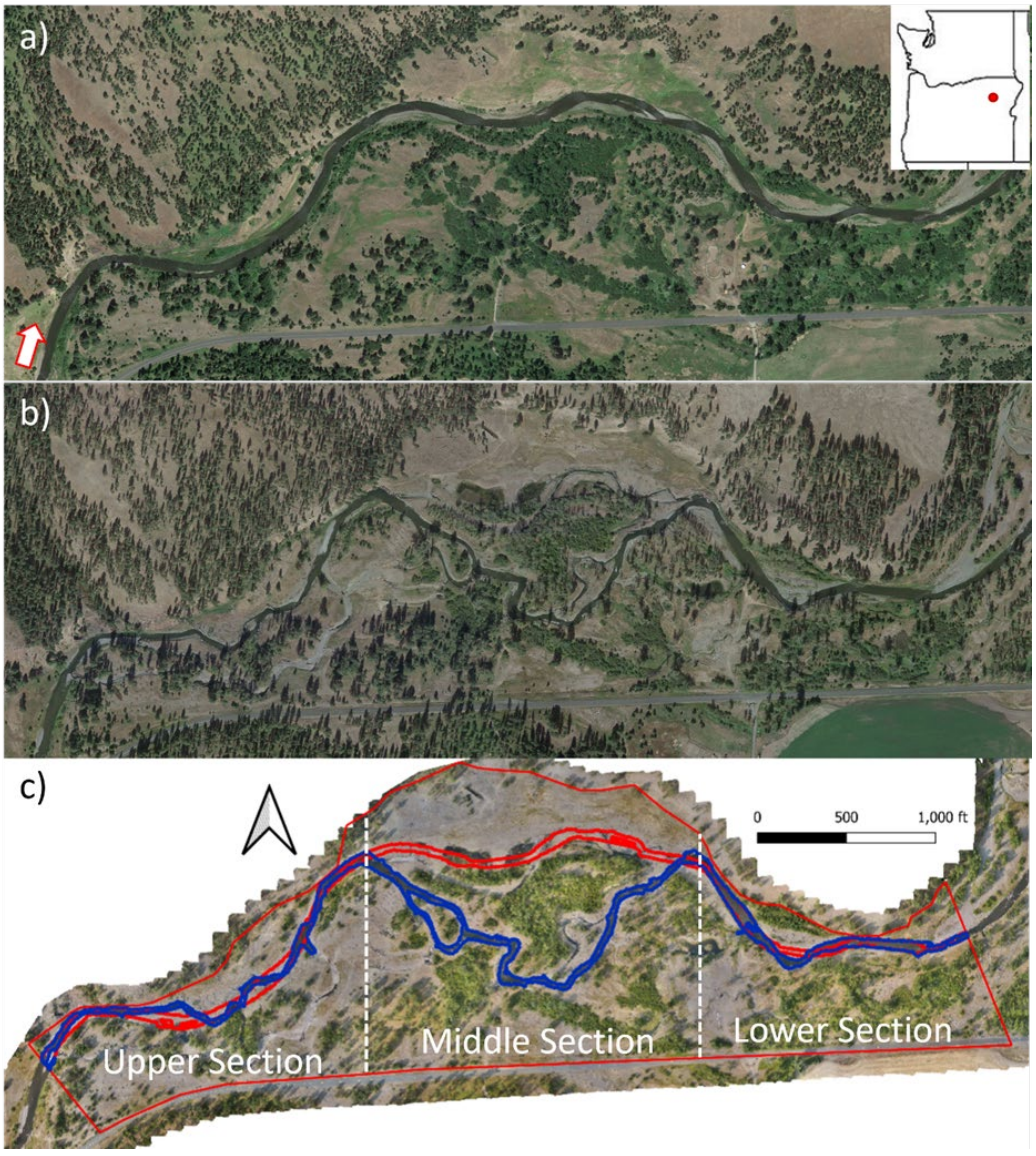


Screenshot of Fish Structures Dashboard on the Asset Management Registry Dashboard page.

20031: The Potential for Restoring Thermal Refuges in Rivers for Cold-Water Salmonids – Aaron Hurst

River restoration targeted at promoting thermal refuge for cold-water salmonids is often critical for encouraging fish recruitment and success in channels that are too warm for fish survival. One method of promoting thermal refuge is to increase the exchange of surface-subsurface flow (hyporheic flow) through creating geomorphic diversity. Previous studies have not explored the impacts of these types of features on reach-scale thermal buffering. This study combines field work, two-dimensional hydraulic modeling, and three-dimensional groundwater modeling to address the question of if river restoration can increase hyporheic exchange at the Bird Track Springs restoration site of the Grande Ronde River, Oregon. The model results showed that restoration did increase the overall hyporheic exchange in the channel. However, the magnitudes of upwelling and downwelling were relatively small due to the low hydraulic conductivity of the alluvial material. Despite this, the reach showed an overall reduction in the maximum summer water surface temperatures and thermal buffering that reduced the temperature variations from 12 °C to 4.5 °C between pre- and post-restoration. Pool stratification can account for the observed reduction in temperatures and thermal buffering. These effects are flow-dependent and only come into play at very low flows. Field observations showed that thermal refuge was localized to morphologic features that could retain the low magnitude hyporheic discharges.

For more information, please check out the journal article available here: [Fluvial pools as reach-scale thermal regulators - ScienceDirect.]



Overview of the Bird Track Springs restoration site. a) Pre-restoration Grande Ronde River channel and floodplain in July 2017, b) post-restoration channel and floodplain in August 2022, and c) comparison of pre- and post-restoration channel alignments. The river planform before restoration is outlined in red and the river planform after restoration is outlined in blue. The thin red outline identifies the boundary of the restoration reach. Vertical dashed lines indicate the boundaries of the different river sections discussed in the text. The white arrow in (a) indicates the flow direction.

20042: Threat Assessment and Evaluation of Burrowing Crayfish in Reclamation Canals – Laura Hertz

Crayfish species are invasive in many areas within the United States. Some species have expanded their native ranges while others have been brought to new areas through human activity. The burrowing behavior of these species may be detrimental to infrastructure within the Bureau of Reclamation. There is a potential for extensive burrowing to cause embankment stability concerns, seepage, or even collapse. Reclamation began with a literature review for pertinent information on the topic of invasive crayfish. Areas of information gathered included diet and behavior, water quality and substrate preferences, burrowing behaviors, and integrated pest management options. Preliminary trapping techniques were attempted in Washington state and Colorado. Samples of species were taken to work towards an eDNA assay for crayfish.

There are limits to the current literature available for management of invasive crayfish. The burrowing habits of crayfish have been summarized by species but there is not much information on behaviors when more than one species has become invasive to a waterbody. There is a need to summarize behaviors of the most common invasive crayfish species so that an overarching best management practice can be authored for use within the United States. There is a need to take actual imaging to assess the burrowing habits of crayfish using LiDAR and ground penetrating radar. The current best management practice for crayfish would include a trapping program with a release of males after sterilization is performed, removal and culling of females, and a catch and release program for predatory fish. The National Park Service at Lake Roosevelt National Recreation Area and Colorado Parks and Wildlife at Lake Granby are willing to partner on a multi-year project to implement the previously mentioned management practices.

Research supports that crayfish behavior puts Reclamation infrastructure at risk. From the literature review, best management practices support a strong trapping regime, release of sterilized male crayfish, and increase in predatory fish populations. There is a need for more research and imaging to describe the burrowing habits or crayfish especially when there are more than one crayfish species present.

Crayfish traps on Lake Roosevelt, Washington.

Snake River Physa Snail.

Paonia Reservoir outlet works intake structure during emergency actions to maintain diversion.

20064: Monitoring Detritus Deposition and Scour Downstream of Minidoka Dam with Implications to Snake River Physa Snail Habitat and Irrigation Canals – Daniel Dombroski

In 2019, the Reclamation Snake River Area Office requested the Technical Service Center (TSC) Sedimentation and River Hydraulics group to conduct a collaborative investigation into potential sources of pressures impacting the Snake River physa snail (physa) community downstream of Minidoka Dam. A collaborative research proposal was successfully funded the following year through the Science and Technology Program. The initial aim of the project was to test the hypothesis that operational conditions of the dam periodically disturb critical snail habitat through release and deposition of detritus into bedrock pools immediately downstream. The investigation included a series of coordination meetings, a site visit, literature review, and exploratory data analysis. The TSC has concluded that the initial trajectory of framing the problem in the context of monitoring suspended sediment transport and deposition is likely too narrow in focus. Although reservoir operations are highly likely to be an important factor, consideration of water quality effects and the biology of the physa snail are also relevant. Future work should consider the potential impact of water quality effects and the biology of the physa snail.

21077: Predicting Reservoir Drawdown Flushing to Improve Reservoir Sustainability – Victor Huang

This study employs Sedimentation and River Hydraulics - Two Dimension (SRH-2D) to investigate the impact of reservoir geometry on drawdown flushing efficiency. The model was calibrated using data from a 2014 flushing event, reproducing observed sediment release concentrations and loads. To examine the influence of reservoir shape, simulations were conducted with various modified geometries. Two approaches were employed: 1) altering reservoir width at different depths while maintaining constant capacity and 2) modifying reservoir width at ratios (0.5, 1, 2, 4) relative to the original width, with corresponding capacity adjustments. Reservoir operation rules, including winter pool elevation, drawdown flushing elevation, refilling date, and summer irrigation flow rate, were incorporated into the simulations as the downstream boundary condition. By understanding the relationship between reservoir shape and flushing efficiency, this study provides valuable insights for optimizing reservoir management and extending their operational life.

22015: Dye Tracing for Enhanced Nuisance Aquatic Vegetation Control in Water Delivery Systems – Kevin Kelly

Nuisance aquatic vegetation growth may detrimentally impact water flow and water quality in delivery systems such as canals. A traditional method of control is the use of federally approved aquatic herbicides which are commonly added to the water by slug or surface applications. However, these chemicals may not be as efficacious in flowing water systems due to a lack of real-time measurements of diluting concentrations and exposure time. The problem is further compounded when the flow rate in a water delivery system is fluctuating. Uncertainties in the applications of aquatic herbicides such as travel times, length and duration of slug or surface injections, and water delivery parameters cannot be easily determined since aquatic herbicides cannot be detected in real time. This project was successful in demonstrating the capability of improving precision of aquatic herbicide applications in canals that are impacted by nuisance aquatic vegetation (NAV). A fluorescent dye (Rhodamine WT) was successfully used as a surrogate which can be monitored in real time with the use of in-situ fluorescence detectors. Co-injection of aquatic herbicides and dyes may help alleviate uncertainties of aquatic herbicides applications to improve water delivery.

24025: Recommended Monitoring and Response Guidance for Addressing Surface and Benthic Algal Blooms within Reclamation's California Great Basin Region – Kelly Kaye

This study employs Sedimentation and River Hydraulics - Two Dimension (SRH-2D) to investigate the impact of reservoir geometry on drawdown flushing efficiency. The model was calibrated using data from a 2014 flushing event, reproducing observed sediment release concentrations and loads. To examine the influence of reservoir shape, simulations were conducted with various modified geometries. Two approaches were employed: 1) altering reservoir width at different depths while maintaining constant capacity and 2) modifying reservoir width at ratios (0.5, 1, 2, 4) relative to the original width, with corresponding capacity adjustments. Reservoir operation rules, including winter pool elevation, drawdown flushing elevation, refilling date, and summer irrigation flow rate, were incorporated into the simulations as the downstream boundary condition. By understanding the relationship between reservoir shape and flushing efficiency, this study provides valuable insights for optimizing reservoir management and extending their operational life.

View of nuisance aquatic vegetation present in Caldwell Low Line Canal.

Algal bloom on the shore of Stony Gorge Reservoir in 2014.

FY25 New S&T Research Projects

25007: Augmenting Dissolved Oxygen at Glen Canyon Dam, AZ to Benefit a Downstream Blue-Ribbon Trout Fishery – Alexander Walker

Releases of water from Glen Canyon Dam (GCD) in AZ control downstream water quality. Recently, low dissolved oxygen (DO) concentrations from GCD releases are a matter of concern due to their impact on the tailwater ecosystem. Many aquatic taxa are sensitive to low DO and effects on rainbow trout populations in Glen Canyon are expected to be particularly pronounced. Low DO affects survivability of trout populations and can cause death. Increasing DO would improve trout population survivability, consequently supporting an important recreational trout fishery and meeting environmental goals. To elevate tailwater DO, we identified aeration or oxygenation as potential methods. These techniques are established, have been applied previously at multiple dam sites, and significantly improve tailwater ecosystems. Still, questions exist at about potential cost-effectiveness and optimal design. We are proposing to develop financially and logistically feasible options for augmenting downstream DO.

25044: Modeling Reservoir Sediment Distribution Through Time – Melissa Foster

Dams trap river sediment in reservoir deltas. Understanding our current and future ability to deliver water and produce hydropower hinges upon understanding both the volume and location of sediment deposited in reservoir deltas. Recent Reclamation applied science projects constrained the total future sediment volume at Reclamation reservoirs. This project seeks to address a key data gap associated with past work: where is sediment deposited in the reservoir delta? Modeling the reservoir area and capacity at a range of elevations will enable better predictions of when key infrastructure, such as low-elevation intakes and dead pool storage, will be impacted by sedimentation. This project will partner with US Army Corps of Engineers (USACE) to apply HEC-HMS, a model developed by USACE to model reservoir sedimentation profiles. Once the model is calibrated with past data, we will move forward to generating elevation profiles for predictions of modern-day reservoir area and capacity.

FY25 Continuing Facilitated Adoption Project

FA25058: Utilizing Satellite Imagery to Document Increasing Sedimentation at Reclamation Reservoirs – Melissa Foster

Dams trap river sediment in reservoir deltas. Understanding our current and future ability to deliver water and produce hydropower hinges upon understanding both the volume and location of sediment deposited in reservoir deltas. Reservoir surveys are the best method to constrain reservoir capacity loss. However, the total cost to survey 215 high-hazard Reclamation reservoirs is $20.4 million dollars. Of these 215 high-hazard reservoirs, 50% have never been surveyed. A previous S&T project demonstrated that measures of reservoir surface area and computed reservoir capacities were within 3% of survey measurement, at a fraction of the survey cost. This project will facilitate the adoption of satellite measurements of reservoir surface area and create a workflow and training opportunities for Reclamation staff to learn these techniques.

New and Continuing Projects*

ID	Final Year	Title	Lead
19105	2025	Fish Passage at River Diversion Juncture: A Science-Based Approach	Yong Lai
20045	2026	A Methodology for Rockwad Velocity and Predator Habitat	Jenna Paul
20057	2025	Modeling effects of wildfire and fire retardant on nutrients downstream in a watershed scale and Lake B Wildfire support	Jun Wang
20091	2025	Determining the capabilities and limitations of Unmanned Aircraft Systems (UAS) equipped with Light Detection Ranging (LiDAR) sensors when applied to hydrologic studies, infrastructure, mapping, and general land data collection	Matthew Klein (formerly Meyer Jay of MBART)
21008	2025	Resolving Spatiotemporal Distribution of Suspended Sediment Concentration over the Columbia and Snake River Using Remote Sensing	Michael Poulos
21015	2025	Physical and Surrogate Data Collection of Sediment Transport in Ephemeral Systems	David Varyu
21016	2025	Laboratory and Field Testing of Enzyme and Microbially Induced Carbonate Precipitation for Mitigation of Fugitive Dust at the Salton Sea	Angel Gutierrez
21054	2025	Abrasivity of Slurry-Transported Sediment: Development of a Laboratory-Based Test System	Evan Lindenbach
21075	2025	Modeling Riverine Pool Temperature Stratification and Reservoir Selective Withdrawal for Fish Spawning and Rearing Habitat	Yong Lai
21078	2025	Chemical Fingerprinting of Delta Smelt for Sensitive Detection in the Environment	Grace Windler
21088	2025	Sediment effects on river restoration habitat features: physical processes and guidelines for effective and sustainable design, planning, and maintenance	Drew Baird
21092	2025	Utilizing Hydrophones to Detect Streambed Mobilization in the Wild and Scenic Reach of the Rio Chama	Rebecca Braz
22019	2025	Potential impacts of phosphorous loading from wildfire-fighting retardants related to the East Troublesome fire on surface water quality in Willow Creek and Willow Creek Reservoir	Lindsay Bearup
22065	2025	Investigating the physical processes that impact reservoir delta fish passage and evaluating potential solutions	Colin Byrne
22066	2025	Recent Advances in Selenium Treatment Technologies, Application to Emerging Wetlands, and Pilot Project Implementation Plan in the Salton Sea, California	Matthew Alinsod
22067	2025	Evaluation of Shallow Acoustic Sub-Bottom Profiling Technologies for Measuring Reservoir Sedimentation Thickness and Stratigraphy – Englebright Lake, California	Daniel Dombroski
22077	2025	Enhancing Reclamation's Watershed Model to Predict Post-Fire Sediment Delivery to Reservoirs and Assess Management Actions.	Benjamin Abban
22088	2025	Evaluation of Mercury Release from Sediment and Dredging to Lahontan Reservoir Waters	Grace Windler

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ID	Final Year	Title	Lead
22097	2025	Evaluating watershed response and increases in sediment loading to Willow Creek and Willow Creek Reservoir due to East Troublesome fire	Kent Collins
23015	2025	Reintroduction of anadromous fish to the blocked areas of the Upper Columbia River. Downstream Movement and Survival of Juvenile Salmon in the Upper Columbia River Basin	Sue Camp
23021	2025	Large Wood Representation in a Two-Dimensional Hydraulic Model for Rapid and Accurate Assessments	Yong Lai
23022	2027	Food for Fish: A 2-Dimensional Fate and Transport Model for Zooplankton with Implications for Juvenile Salmon Growth and Water Management Efficiency	Jenna Paul
23025	2025	Quantification of accuracy improvements related to multibeam data processing.	David Varyu
23026	2025	Tracing salinity through the southern Sacramento-San Joaquin River Delta, California using continuous salinity monitoring, high-speed salinity transects, and ion fingerprinting	Grace Windler
23039	2025	Boulder Cluster Design Guidance for River Restoration	Melissa Shinbein
24009	2026	Evaluation of upstream bank stabilization and sediment removal project on fish passage for threatened and endangered species at Marble Bluff Dam on Lower Truckee River above Pyramid Lake	Jennifer Bountry
24011	2026	Evaluation of Foul-Release Coatings Against Mussel Fouling for Long-Term Use	Carter Gulsvig
24012	2025	Methodology Assessment for Large-Scale Particle Image Velocimetry	Melissa Shinbein
24013	2026	Developing an in-stream Sr isoscape for California's Central Valley to determine migration patterns of anadromous fish	Grace Windler
24014	2026	Fluorotelomer Alcohol Presence Within the California-Great Basin Region: Determine Potential Data Gaps and Identify Risks to Reclamation Waterways	Melanie Lowe
24018	2027	Modeling wildfire effects on surface-water quality at a watershed scale	Jun Wang
24019	2027	Identification of kokanee and burbot spawning habitats in Lake Roosevelt using environmental DNA and RNA.	Yale Passamaneck
24055	2026	Reservoir Sedimentation Management: Evaluation of nature-based solutions for distributed sediment detention and storage in water supply watersheds	Benjamin Abban
24065	2026	Investigating methods to detect turbidity currents; Tuttle Creek	David Varyu
25007	2025	Augmenting Dissolved Oxygen at Glen Canyon Dam, AZ to Benefit a Downstream Blue-Ribbon Trout Fishery	Alexander Walker
25044	2027	Modeling reservoir sediment distribution through time	Melissa Foster
FA24072	2025	Gather and Transfer (Follow-up to "Divide and Conquer" Prize Competition)	Yong Lai
FA25058	2027	Utilizing satellite imagery to document increasing sedimentation at Reclamation reservoirs	Melissa Foster

**Continuing projects include those that received no-cost extensions.*

Front cover photo: The Bird Track Springs restoration site on the Grande Ronde River. Photo is taken looking upstream.

Back cover photo: Box Canyon Creek, a tributary of Kachess Lake, is one of several reservoir tributaries in the Yakima Basin with impaired delta fish passage in dry years (photo credit: Richard Visser).