

The Knowledge Stream

Call for Proposals Issue



Director's Message

Two important Call for Proposals are occurring this spring: our annual call to Reclamation researchers for proposals under our Science and Technology Program and our call to outside researchers, industry, water utilities, and other organizations for proposals under our Desalination and Water Purification Program.

The Science and Technology Program involves researchers from all over Reclamation: regions, area offices, and the Technical Service Center in Denver, Colorado. Reclamation staff identify issues, find partners, and submit research proposals. Outside experts then review these proposals for technical considerations, and Reclamation managers determine which ones best meet Reclamation's priorities. Details regarding this call are found on pages 4 and 5.

Our Desalination and Water Purification Research Program currently has a Call for Proposals on advanced water treatment technologies, with particular emphasis on combining renewable power sources and the development of technology suitable for small communities. Details regarding this call are found on page 6.

This issue of the Knowledge Stream also covers a wide range of updates on current or previous Science and Technology Program research, ranging from the development of floating antennas to detect fish movements to using unmanned aerial vehicles to gather data more easily.

We look forward to your submissions to the Science and Technology Program Call for Proposals and the Desalination and Water Purification Research Program Funding Opportunity Announcement. With everyone's ideas and ingenuity, we will be able to address some of Reclamation's most pressing challenges.

Also, with this issue we inaugurate "Featured Faces" and "Innovation Around Reclamation." These new segments will highlight individual Reclamation researchers and Research and Development Office staff, along with some great ideas that others in Reclamation are pursuing.

The Research and Development Office Launches New Website

Be sure to check out our new website for more information on our research projects, people, and results, which can be found at:

www.usbr.gov/research

We have updated the "Research and Development" website to make it easier to find the research information and results you need.

You can:

- Keep track of events
- Find out about our research needs and priorities
- Search through the Science and Technology Program projects, researchers, and results
- Read our bulletins on research results
- Learn about patents and intellectual property issues
- Find out how to use our laboratories and facilities
- Discover more about our staff and programs



Kristin Swoboda handling, and preparing to gather data with, the "Raven" unmanned aerial vehicle (see research update on page 24 and additional images on page 31).



Print Options and Instructions

This document is designed to be read either electronically via PDF or printed in color or black and white. Please forward it to your colleagues and friends.

You have three options for printing parts or all of this document:

1. Print individual research updates on one sheet of paper, print double-sided for the two-page updates.
2. Print the whole document double-sided, corner stapled on 8.5 x 11-inch paper.
3. For magazine-style, instruct your print professional to print the document double-sided, head-to-head, saddle-stitched on 11 x 17-inch paper.

Your suggestions for improvements are always welcome. Please email them to jakervik@usbr.gov.

Thanks,

Jake Akervik
Communication and Information Systems Coordinator,
Research and Development Office



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Calls for Proposals

Where Can a List of Previously Successful Proposals Be Found?

A listing of successful proposals in fiscal year 2013 is available at: www.usbr.gov/research/projects/years.cfm.

Review Schedule

April to June:

Proposal preparation. Full proposals are due in late June.

July to August:

Relevance and technical reviews.

September:

Multidiscipline Reclamation-wide team reviews and recommends projects for funding.

October:

Awards are announced.

Science and Technology Program Call for Proposals

During the spring to early summer the Research and Development Office accepts proposals from Reclamation employees to research solutions to the many challenges associated with managing water and generating power in the West. While proposals are only accepted from Reclamation employees, groups and individuals can team up with a Reclamation employee to submit a joint proposal. These proposals are being solicited for funding in the Federal fiscal year 2014, starting October 1, 2013.

What Is the Science and Technology Program?

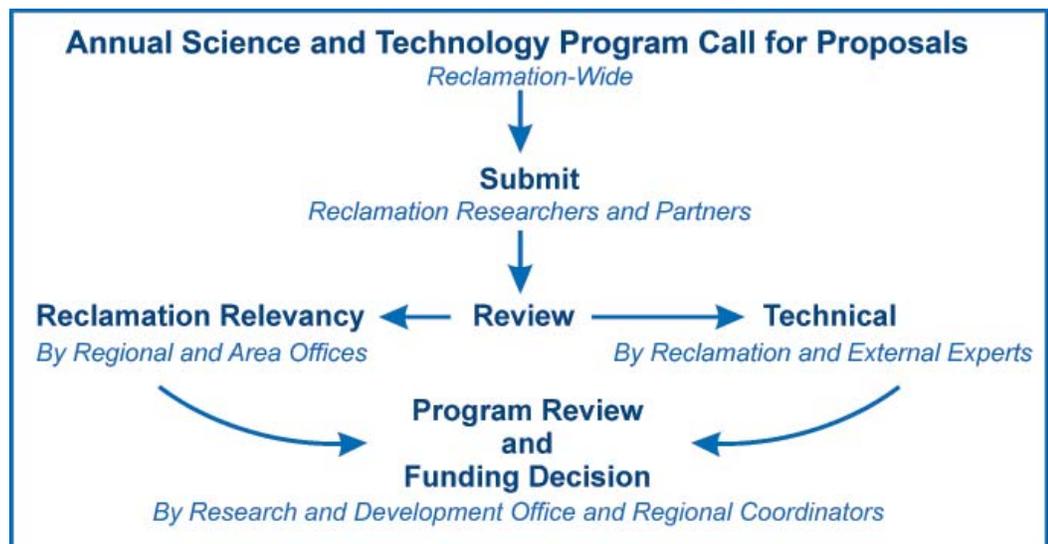
The Science and Technology Program is the primary research and development arm of Reclamation. It is a Reclamation-wide, competitive research and development program focused on innovative solutions to benefit Reclamation water and power facility managers as well as our stakeholders. Only efforts proposed and led by Reclamation staff are eligible for funding. The Science and Technology Program seeks solutions that can be widely applied across the agency.

How Are Science and Technology Program Proposals Reviewed?

Proposals are reviewed for technical merit by a team of outside experts to determine the technical soundness, contribution to the field of investigation, and the reasonableness of the budget. Reclamation offices review the proposals for their relevance to our overall mission and current priorities. A small multidiscipline Reclamation-wide team then reviews, incorporating the previous two reviews and any additional criteria to prepare a final list of research projects.

Research projects:

- Provide Reclamation-wide benefits
- Involve partners
- Are cost shared
- Address highly relevant issues for Reclamation



Science and Technology Program Call for Proposals review process.

— continued



Calls for Proposals

— continued

What Research Is Needed?

The Science and Technology Program is structured to support water and power deliveries in the Western United States through applied research and development and falls into the following areas:



Invasive Zebra and Quagga Mussels



Climate Change and Variability



Advanced Water Treatment



Renewable Energy Including Hydropower



Environmental Stewardship



Water Operations and Decision Support



Water Infrastructure Reliability



Expanding Water Supplies

“There is no doubt that creativity is the most important human resource of all. Without creativity, there would be no progress, and we would be forever repeating the same patterns.”

—Edward de Bono

Contact Miguel Rocha at 303-445-2841, mrocha@usbr.gov.



U.S. Department of the Interior
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Calls for Proposals

Desalination and Water Purification Research Program Goals

The Desalination and Water Purification Research Program has three major goals:

1. Augment the supply of usable water in the United States.
2. Understand the environmental impacts of desalination and develop approaches to minimize these impacts relative to other water supply alternatives.
3. Develop approaches to lower the financial costs of desalination so that it is an attractive option relative to other alternatives in locations where traditional sources of water are inadequate.

Due Date

Proposals are due by April 18, 2013.

Desalination and Water Purification Research Program Funding Opportunity Announcement

The Desalination and Water Purification Research Program invites private industry, universities, water utilities, and others to partner with Reclamation to address a broad range of desalting and water purification needs. This Funding Opportunity Announcement invites non-Reclamation researchers to cost share with Reclamation on vital desalination research. These proposals would be funded in fiscal year 2013.

Researchers can be individuals, institutions of higher education, commercial or industrial organizations, private entities, public entities (including state and local), and Indian Tribal Governments. Federal agencies and foreign entities (other than United States-Mexico binational research foundations and inter-university research programs established by the two countries) are not eligible for funding under the authorizing legislation for this program.

Researchers can submit proposals for:

- Research studies to determine whether a process works well
- Pilot projects to determine the physical and economic suitability of a process

For fiscal year 2013, Reclamation's research priorities focus on combining renewable power sources and developing technology suitable for small communities.

The Desalination and Water Purification Research Program covers a wide range of advanced water treatment technology and methods. Some recent topics have included establishment of an industry standard 16-inch filter element, development and testing of membranes bioreactor systems, minimization of membrane fouling, efforts toward zero discharge desalination, and desalination using natural freeze-thaw processes. Reclamation is particularly interested in research where the benefits are widespread and where Federal investment is needed.



More information

Search for DWPR Funding Opportunity No. R13SF80007 at: <http://www07.grants.gov/search/basic.do>

Curt Brown, Director
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Three-stage reverse osmosis unit used for sulfate removal—experimental test unit for the Paradox Project.



U.S. Department of the Interior
Bureau of Reclamation

Innovation Around Reclamation

We are pleased to present a new segment to the Knowledge Stream—Innovation Around Reclamation. This segment will highlight some of the great ideas that others in Reclamation are pursuing.

Measuring Water On the Go With a New Mobile Application Software (App)

“Measure H2O” is a new water measurement App created by Reclamation’s Provo Area Office for water managers to perform range of water measurement functions on mobile devices efficiently and accurately. Reclamation has provided precise measurement techniques since 1953, with the first edition of the *Water Measurement Manual*. We have been revising this manual ever since, and now we have moved into the digital iPhone age with this device. The free Measure H2O App became available for download in the Apple Store on February 4, 2013. Search for “Measure H2O” (letter ‘O’) or “water measure.” See www.usbr.gov/uc/feature/wtrMsr for more information.



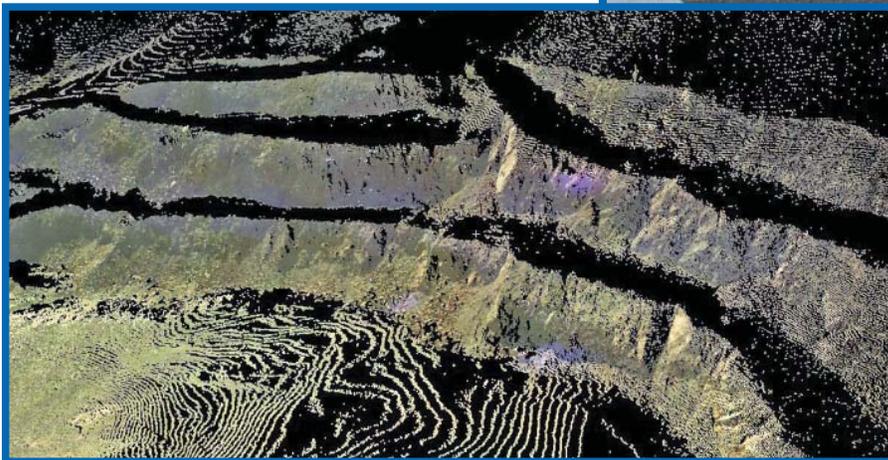
Measure H2O App icon.

Contact Edward Vidmar at 801-379-1182, evidmar@usbr.gov.

Getting Down to Details With Ground-Based Lidar

High Definition Scanning (HDS), or sometimes termed light detection and ranging (LiDAR), is a method of analyzing features. Ground-based LiDAR covers a smaller area, such as a historic artifact or even a crime scene, with a higher degree of accuracy. LiDAR uses laser technology to envelope the area that we want to analyze. This static LiDAR instrument is set on a tripod and can be set over a known point or be freely set at any advantageous point for the maximum line of sight. Alejandro Orosco has applied this technology to civil, archaeological projects, including:

Archaeological Surveys. Hoover Dam’s Monument Plaza has a black terrazzo floor and an island covered with black diorite material, with 30-foot bronze statue of the winged figures of the Republic. This important historic monument is showing its age, and exact information about potential problems is needed to ensure that this monument can delight and inform future generations. Reclamation is using ground-based LiDAR to create a three-dimensional model, which can be used to show Reclamation’s operation and maintenance staff the current conditions in a 360-degree interactive virtual environment.



Quantity Surveys. Using ground-based LiDAR allowed us to scan the borrow area for riprap rock safely. This can help establish a baseline before the blast, and perform a surface comparison analysis done in AutoCAD Civil 3D. This analysis and depiction can be so detailed that field visits may not be needed.

Contact Alejandro Orosco at 702-293-8586, aorosco@usbr.gov.



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Featured Faces

Reclamation Researcher

Brent W. Mefford, M.S., P.E.

Brent Mefford is a Hydraulic Engineer Technical Specialist/Fisheries Engineer with over 35 years experience working for the Technical Service Center's Hydraulic Investigations and Laboratory Services Group. He has extensive experience in hydraulic structure design, modeling, and testing of hydraulic structures related to water storage, diversion, and environmental compliance, with a major area of interest in the design and evaluation of fish passage and fish exclusion structures.

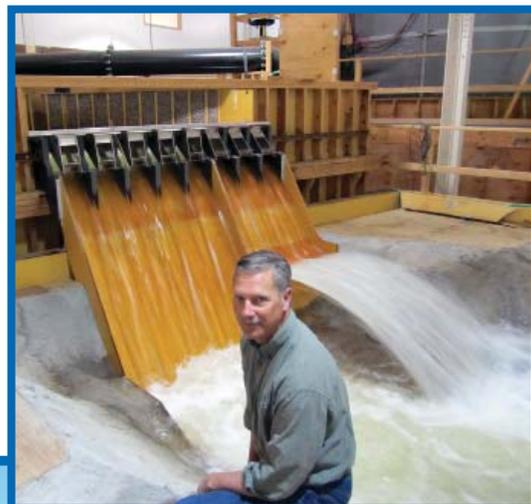
Brent holds a Bachelor in Natural Resources and Master of Science in Civil Engineering from Colorado State University, holds three United States Patents in hydraulic structures engineering, and was selected as Reclamation's Engineer of the Year in 1999.

Among an extensive list of both hydraulic structures and fisheries projects that Brent has been involved in—such as the Hydraulic Design of Hoover Dam Outlets Needle-Valve Replacement (Nevada), Flaming Gorge Dam Tunnel Spillway Air Slot Evaluation (Utah), Yellowtail Tunnel Spillway Cavitation Analysis (Montana), Shasta Dam Fish Passage Concept Development (California), and Price Stubb Fishway (Colorado)—his experience has also extended into areas of research and development. Areas such as the development and design of fish passage and fish protection methods for non-salmonids, overtopping protection for embankment and rock filled dams, and prevention of abrasion damage in high energy hydraulic jump stilling basins, to name just a few.

Brent began doing research for Reclamation's Science and Technology Program since the program's conception. His most recent research project, "Developing Design Guidelines for Low Head Fish Friendly Diversion Dams" was funded by the Science and Technology Program, as well as his current projects, "Design of Articulated Fishways for Small Diversion Dams" and "Design of Predator Fishtaps Using Smell as an Attractor." In addition, Brent has presented numerous short courses on fish passage and screening for a wide variety of audiences; has written over 100 published reports and professional papers in the field of hydraulic structures and fisheries engineering; and is the co-author of Reclamation's *Design Manuals on Fish Protection Structures and Water Measurement*.

Working his entire career in the same laboratory, Brent sums up his work: "The hydraulics laboratory is a fantastic place to work. Where else can you go to work and study in real time your ideas for building a better fishway, put fish in it to test your theories, then test the prototype following construction. Having the opportunity to work at dams like Hoover, Yellowtail, and Flaming Gorge is a hydraulic engineer's dream."

Brent, a fourth generation Colorado native resident, lives in Lakewood with his wife, three Labrador Retrievers, and five horses. When not working, he likes to ranch, ski, hike, and fly fish.



Bryan Heiner (left) and Brent Mefford (right) working on Cui-ui sucker passage.

Featured Faces

Research and Development Office Staff

Erin Foraker

Recently, Erin Foraker joined the Research and Development Office as the Renewable Energy Research Coordinator. In this position, she is directing the R&D Office renewable energy research program, which focuses on improving maintenance practices of hydropower systems, improving reliability and efficiency for hydropower generation, and researching opportunities for other renewable energy generation within Reclamation.

Erin holds a Bachelor of Science in Mechanical Engineering from the University of Memphis and a Master in Business Administration from the University of Denver, with 19 years of power industry experience. Prior to joining Reclamation in June 1999, she worked at the Tennessee Valley Authority in the Hydro Modernization Program and Fossil Power Engineering at the Allen Fossil Plant. Prior to joining the Research and Development Office, Erin worked in both Reclamation's Hydroelectrical Research and Technical Services Group and the Power Resources Office.

She has served as chairperson and representatives on several power industry committees.



Events

Reclamation Research Jam 2013 Is in the Jar

Our 2nd annual research and science idea gathering event saw more votes, increased discussion, and comments

The Research and Development Office hosted the 2nd Annual Reclamation Research Jam online internal crowdsourcing event from February 25 through March 15, 2013.

The ideas gathered will be shared with Reclamation researchers for possible submission as research project proposals during the upcoming fiscal year 2014 funding cycle (see Science and Technology Program Call for Proposals, page 4).

Top 10 Research Jam Ideas:

Net Votes	Title
43	Use of Tablet Computers for Field and Laboratory Work
41	Material Compatibility Issues for Concrete Repair Materials
31	Mitigate Hard Mineral Scaling in Reclamation Facilities
31	Share Research Results—Don't Re-invent the Wheel
30	Develop Methods to Seal Leaking Contraction Joints in Dams
29	Off-Grid Power Sources for Cathodic Protection
28	BIM (Building Information Modeling)
27	Novel Electrodes for Soil Characterization
26	Impacts From Operational Releases to Populations at Risk
26	Mussels to Fuel

2013 Research Jam Participation by the Numbers:

- 1,071 Reclamation employees from all five regions, including Washington, D.C., and Denver, Colorado
- 925 total votes—847 up votes and 78 down votes
- 181 comments
- 57 ideas

Contact Jake Akervik, Research Jam Project Manager, Research and Development Office at 303-445-2136, jakervik@usbr.gov.



Research Jam People's Choice Award winner for Most Votes—Jessica Torrey, Materials Engineer, Materials Engineering and Research Laboratory, Technical Service Center.

Events

Reclamation Booth Highlights Public-Private-Academic Partnerships

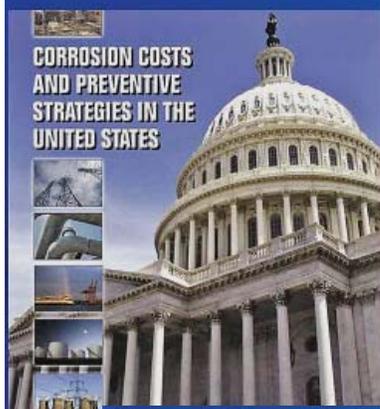
Reclamation has a cooperative agreement with the New Mexico State University (NMSU) Water Resources Research Institute to develop affordable, efficient, desalination processes. We highlighted these techniques at a booth at the Membrane Technology Conference organized by the American Water Works Association and American Membrane Technology Association, March 4-6, 2013. Randy Shaw, Manager of Reclamation's Brackish Groundwater National Desalination Research Facility (BGNDRF) greeted visitors to the booth with pamphlets on opportunities for research at the facility, folders with information on Reclamation Desalination oriented projects, and a video tour of BGNDRF.

Michelle Chapman, Physical Scientist from Reclamation's Technical Service Center, also presented a paper, "Is There a Role for Membrane Technology in Planning for Drought in Texas?" The presentation described the development and evaluation of the "Tool for Planning Temporary Water Supply Response in Drought Emergencies" for Texas. The Drought Tool is an interactive PowerPoint-based program that brings information together in an easy to navigate form. The Drought Tool provides guidance to small community water managers in preparing for water shortages; evaluating alternative sources; identifying necessary treatment processes, distribution options, short-term treatment equipment solutions; and navigating the regulatory process in Texas. For a CD, contact Michelle Chapman at 303-445-2264, mchapman@usbr.gov.



Booth at Membrane Technology Conference, March 5, 2013.
Left to right; Racheal Jones, Fataneh Naderi, Randy Shaw, Jalal Rastegary, Michelle Chapman, Jim Loya, Laili Abkar, Collins Balcombe, and Leila Karimi.

Economic Costs: \$276 billion annually



- "Corrosion Costs and Preventive Strategies in the United States," Publication No. FHWA-RD-01-156, NACE International and U.S. Federal Highway Administration, 2002.
- Estimates economic impact of corrosion for specific industries and extrapolated to a national total
- Total Annual Estimated Direct Cost of Corrosion:
 - \$276 billion
 - ~ 3.1% of the country's GDP

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Corrosion Webinar

Jessica Torrey and Daryl Little, Materials Engineers from Reclamation's Technical Service Center, gave an "Introduction to Corrosion," webinar class on February 26, 2013. The presentation covered common forms of corrosion found on Reclamation structures, and showed examples to help students recognize when and where corrosion may occur. Thirty-eight people viewed the 1-hour-long presentation, from many Reclamation area offices.

Other students were from the U.S. Army Corps of Engineers, National Park Service, Langell Valley Irrigation District, Imperial Irrigation District, Friant Water Authority, and the Volta River Authority (Ghana).

The presentation went very well. There were a lot of good questions after the program and the organizers have already received requests for future webinar topics.

Contact Jessica Torrey at 303-445-2376, jtorrey@usbr.gov.

Screenshots from the Corrosion Webinar.

Now Available: New Antenna System to Detect Tagged Fish

New antenna system detects tagged fish in waterways while floating over them

Bottom Line

Passive Integrated Transponder (PIT) tags, along with a floating antenna system to read the information from the tagged fish, can track fish moving through rivers and streams.

Better, Faster, Cheaper

PIT tags allow researchers to track fish over time without harming them, and for lower costs. Remote antennas gather information 24/7 with little maintenance or upkeep.

Principal Investigator

Mark McKinstry
Biologist
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Collaborators

- Utah State University
- San Juan River Recovery Implementation Program

Future Plans

We plan to continue the development of floating PIT tag systems and are planning for several river-long trips to test the effectiveness over long distances. A manuscript is in preparation explaining the technique and its various applications.

Problem

Accurate fish counts are an important aspect of Reclamation's programs concerned with the recovery of endangered fish species. However, accurately detecting fish moving through rivers and streams is difficult and costly. Typically, fish are captured by electrofishing or trapping, which involves large amounts of personnel and equipment. Also, capturing can lead to mortality or changes in behavior and movements. The fish are captured and tagged with Passive Integrated Transponder (PIT) tags to allow researchers to track their movements and survival. PIT tags resemble a grain of rice and function similarly to barcodes used to scan goods in stores. Existing systems that detect PIT-tagged fish are only effective for species with predictable movement patterns that can be funneled past stationary antennae. System improvements are needed to detect other species without involving their capture to reduce costs and cause less disruption to the fish.

Solution

Reclamation and Utah State University researchers developed a system to detect fish as an antenna network floats over them. The researchers developed an innovative floating antenna system allowing remote detection of fish that have been PIT tagged but do not have predictable movement patterns, like salmon, that can be funneled through elaborate antenna systems and detected during their migration.

Unlike other PIT tag systems that require fish to travel through a detection device, this system floats on the river and does not disturb the fish. The system's antenna modules are 3 feet wide by 10 feet long, made of polyvinyl chloride (PVC) and foam with internal antennae, and float on the surface of the water.



Instream application of new floating antenna system on the Boise River, Idaho.

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The entire system consists of the floating antenna modules, a multiplexer to operate the antennas, battery power supply, an integrated Global Positioning Software (GPS), and data recorder to record tag number, date, time, and location of tag in the river. This floating antennae system can be mounted to a raft and floated down a river or mounted to stationary wires hung across a river.

Application

Reclamation programs, as well as other programs for detecting fish, can benefit from this technology. Better data on fish populations would assist numerous Reclamation programs in managing fish species and give Reclamation more information to manage its facilities in an efficient manner. For example, if the successful use of this system allowed better estimates of fish populations, progress toward recovery would be improved through better-informed stocking goals, flow recommendations, and management activities. PIT-tagged fish would not have to be individually captured and handled, thus reducing mortality and expense.

An early prototype of the system was constructed and tested in 2008 - 2012. The system's efficiency at detecting endangered fish that were free swimming in the San Juan River, New Mexico, was proven and documented. Antennas floated over a 19-mile reach of the river detected 76 tags, including 22 that were in a side channel inaccessible by electrofishing boats. An electrofishing effort that was running concurrently with the test detected approximately the same number of fish at a much higher cost. This test effectively demonstrated that fish can be detected with the floating antennae system, that it is less harmful to the fish, and much cheaper to operate.



Using PIT tags on floating antenna on the San Juan River, New Mexico.

Floating PIT tag antennas can also be deployed in a stationary configuration similar to antennas that are installed in the streambed. The floating antennas are deployed by hanging them from an overhead cable and allow debris to pass underneath them. Importantly, floating systems can be used in rivers and streams that have unstable substrates that are not suitable for antennas anchored to the streambed. In 2012 a stationary floating system installed on the Boise River, Idaho, also successfully detected tagged fish as they passed underneath.

BioMark, Inc., is now producing the floating PIT tag antennas and can custom-build a system for specific applications.

“This product exists because of the early stage funding provided by your projects as well as the hard work and creativity of the people involved. We have figured out how to manufacture the antenna efficiently and with robust quality. Now we need to thoroughly test the product in the river.”

Dean Park
President, Biomark, Inc.

“This provides another example of how we are able to achieve the transfer of Federally funded technologies into usable products without patents, licenses, or royalties.”

Chuck Hennig
Deputy Director, Research and Development Office, Reclamation

More Information

Science and Technology Program
Research Project:
www.usbr.gov/research/projects/detail.cfm?id=257

Contact Biomark, Inc., for specific applications and purchases:

Biomark, Inc.
705 South 8th Street
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Telephone: 208-278-0011
www.Biomark.com, email:
customerservice@biomark.com



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Elwha Science Symposium Event—Online and In Person

Getting scientists and the public together on the science of dam removal as part of river and reservoir restoration

Bottom Line

This symposium brought river restoration experts to share research results and inform the scientific community and the interested public to improve the understanding of the Elwha River Restoration Project, Washington.

Better, Faster, Cheaper

While active participants need face-to-face interactions to share analysis and results and plan further research collaboration, online public events can help inform other interested parties from all over the world.

Principal Investigator

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Collaborators

Peninsula College, Washington

Future Plans

Reclamation conferences can use this technology and these lessons learned for future conferences. Reclamation will continue to participate in Elwha adaptive management monitoring and research collaboration activities in the future.

Elwha Science Symposium Event—Online and In Person

The Elwha Dam removal project in Washington is the biggest dam removal project in the world. When the Elwha and Glines Canyon Dams are removed, five species of Pacific salmon will be able to return to over 70 miles of pristine habitat. Salmon populations are projected to grow from 3,000 to nearly 400,000.

The project involves adaptively managing 34 million cubic yards of sediment stored behind the dams, requiring a myriad of scientific monitoring studies of biological, hydrological, sedimentation, and other aspects. Scientists and planners are using many unique field monitoring programs, analyses, and predictive tools. Since there has not been a project of this scale before, the opportunity to learn what happened to fish and sediment as a result of the project is unprecedented and is not likely to occur again in the near future.

Scientific collaboration and public understanding are crucial to learn how the reservoir and river are responding to the dam removal, along with how the real-time nature of the adaptive management program is working (and lessons learned). Mutual information sharing with these diverse audiences can be both in person and online.

— continued



Elwha Science Symposium in 2012. Photo by Barb Maynes from Olympic National Park, Washington.

Conference Solution: Talking Face-to-Face and Online Application

To share research results and plan future research, this Science and Technology Program research project partnered with other key Federal agencies to plan and sponsor a symposium consisting of three components: online presentations (one for the general public and one for researchers), a fieldtrip, and 2 days of science workgroups featuring a mix of speakers and discussions.

About 200 people attended various events in person, with 100 attending the 2-day science conference. Online, 25 people participated in general broadcast and 34 in the scientific discussions. These online presentations allowed people to submit questions in real time for a broader range of participation.

The online portions used a remote broadcasting tool, Blackboard Collaboration. We found that the technology is readily available, but a person knowledgeable about the tool is needed to troubleshoot in real time. Microphones to capture speakers and local audience questions are needed, as well as an online monitor/moderator to integrate the online portion into the local discussion.

River Restoration Solutions

Presentations and posters over the 2 days covered a wide variety of subjects to answer questions such as:

Sediment Management

How will suspended sediments and sediment deposits change?
How will intertidal coasts respond to sediment supply processes?
How much sediment will remain in the reservoir and how much will travel downstream? How can we model and adapt to sediment transport?

Woody Debris

What are the interactions between woody debris, fluid flow, and sediment transport?
What are the baseline parameters of the large woody debris and how will this change?

Riparian Vegetation

How will native and non-native species change above and below the dam sites?
What role do birds play in spreading seeds?

Salmon and Other Fish

How will fish move and spawn in the newly accessible mainstem and tributaries?
How do, and will, fish use the nearshore of the Elwha River?

Wildlife

How will the wider range of salmon affect other wildlife?

Tributaries and Reservoirs

How will tributaries and the reservoirs change (e.g., incision, fish habitat, and suspended fines)?

Economics

How do people value the use (birdwatching, sightseeing) and non-use (restoration regardless of visits) of the habitat restoration?
How do we ascribe monetary values to the environmental, economic, and social import?

“This conference allowed scientists and the public to share information that will help shape the future of Elwha River research. The online forum was efficient and easy to use, and was a huge time saver.”

David S. Parks, M.S.
Geologist/Wetland Scientist
Forest Practices Division
Washington Department of
Natural Resources

More Information

Conference:
www.elwharesearchconsortium.wildapricot.org

Elwha Project:
www.nps.gov/olym/naturescience/elwha-ecosystem-restoration.htm

Science and Technology Program
Research Project:
www.usbr.gov/research/projects/detail.cfm?id=6959



*Remains of Elwha Dam, February 14, 2012.
Photograph courtesy of Ben Cody.*

Assessing the Ecological Costs of Streamflow Regulation

Measuring the biological health of ecosystems in streams with altered flows

Bottom Line

This study assessed macroinvertebrates (stream animals without backbones, such as crayfish) to determine the effects of streamflow alterations on stream ecosystems. Examinations of 25 mountain streams showed that winter flow depletions strongly and negatively affected biological conditions.

Better, Faster, Cheaper

Understanding how alterations of natural streamflows affect ecosystems is critical to managing water resources.

Principal Investigator

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Collaborators

- U.S. Geological Survey
National Water Quality
Assessment Program
- Central Utah Water
Conservancy District
- Utah Division of Water Quality

Problem

Changing natural streamflows (that is, changing the frequency, duration, amount, and timing of various streamflows) can alter the ecosystems and biological communities associated with these streams and rivers. Increasingly, riverflows are being managed to balance the needs of ecosystems and society. A key question is: How much can natural hydrology be altered before there are measurable declines in biological integrity (as measured by how the community composition and native species richness in a particular stream segment differ from regional reference conditions)?

Unfortunately, the range of flows that protect biological communities are largely unknown beyond a few case studies. Understanding the relationships between biological integrity and hydrological alteration at regional scales is necessary to establish water management goals that balance ecosystem and society's needs.

Study and Results

This Science and Technology Program research project, in conjunction with the U.S. Geological Survey's (USGS) National Water Quality Assessment Program, evaluated the relationship between the severity of hydrological changes and biological integrity. We conducted biological assessments of macroinvertebrate communities (such as aquatic insects) in 25 rivers with varying degrees of hydrological alteration with the Wasatch-Uinta Mountain Ecoregion in northeastern Utah and southwestern Wyoming.

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S. Mark Nelson, Reclamation; Ken Eng, USGS; and Ben Holcomb, Utah Division of Water Quality—taking samples at Carrant Creek, Utah.

Streamflow Alterations. We quantified the severity of alteration of monthly mean streamflows by comparing observed flows to flows expected in the absence of human activities (natural streamflows). Monthly flows represent the seasonal dynamics of runoff, summer recession, and base flow, which are important for many species to signal the next phase in their lives, such as metamorphosis.

Streamflow changes varied widely among sites and, as expected from known water management operations, seasonal streamflow alterations differed between reservoirs and diversions. Diversions appeared to deplete flows throughout the year, while reservoirs tended to inflate flows in summer and substantially deplete flows in spring, fall, and winter. Streams appeared to experience unique patterns of monthly streamflow alteration during spring runoff (May and June) and fall (October).

Biological Integrity. We used the quantity and diversity of aquatic invertebrates and analyzed how the observed levels differed from what would be expected in a natural stream as indicators for biological integrity. To compare the biological integrity of the 25 study sites to reference streams, we used recently developed models from the Utah Division of Water Quality.

These results yielded quantitative relations between the severity of streamflow alteration and the degree of biological impairment. Results suggest that water management that reduces streamflows during winter months is likely to have negative effects on biological communities at the bottom of Utah mountain streams, as well as reservoirs downstream.

Future Plans

Although the exact mechanisms remain unclear, these relationships are still a useful guide to decisions about the tradeoff between flow depletion and stream health. The ability to generalize this relationship to other Rocky Mountain streams also remains unclear and needs corroboration by similar studies in other subregions.

As the streamflow and biological factors that were measured provided little information on community makeup, further research is needed to determine the possible ways altered streamflows could influence macroinvertebrate communities. Analyzing how macroinvertebrate interact with the environment and other species could provide this evidence.

We are currently analyzing an additional dataset collected from streams in California to determine the role that altered temperatures, in conjunction with hydrological alteration, may play in controlling macroinvertebrate communities.



Caddisfly larvae—one of the many macroinvertebrates that live in the bottom of Utah mountain streams.

“Our study yielded quantitative relations between the severity of streamflow alteration and the degree of biological impairment and suggests that water management that reduces streamflows during winter months is likely to have negative effects on downstream benthic communities in Utah mountain streams.”

D.M. Carlisle, et al. 2012.

More Information

Carlisle, D.M., S.M. Nelson, K. Eng. *“Macroinvertebrate Community Condition Associated With the Severity of Streamflow Alteration.”* River Resesarch and Applications, 2012.

Science and Technology Program Research Project:

www.usbr.gov/research/projects/detail.cfm?id=6188



Assessing Gravel Bars' Habitat Complexity and Ecological Functions

Determining how restored gravel bars affect the aquatic ecosystem in the Trinity River, California

Bottom Line

This scoping study determined that gravel bars do provide habitat, and that future evaluations could greatly improve the conditions in the Trinity River.

Better, Faster, Cheaper

Channel rehabilitation projects can use this information to determine the best location and methods for building gravel bars. Dynamic construction (creating bars with flowing water rather than heavy equipment) may save costs and create better habitat.

Principal Investigator

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Collaborators

- Trinity River Restoration Program (TRRP)
- University of California, Berkeley

Future Plans

These and other pilot results will be expanded upon in fiscal year 2013, as we continue our investigations into the ecological function of gravel bars with support from the Science and Technology Program and collaboration with TRRP.

Problem

Sediment may be held back by dams resulting in losses of habitat for fish and other aquatic wildlife, such as riffle-pool sequences and gravel bars. Restoring gravel bars downstream from dams is an important way to improve physiological, ecological, and thermal diversity in these river reaches. Having these diverse rivers is important for fish, such as salmon, which require different types of habitat during various life stages. Gravel bars are also believed to function as 'natural filters' for particulate organic matter, nutrients, and plankton. Retaining this organic matter helps purify the river and provide primary energy resources to the river ecosystem.

The Trinity River Restoration Program (TRRP) has been at the forefront of efforts to restore coarse sediment supply and transport in regulated rivers, with the goal of re-creating the instream geomorphological features lost due to sediment starvation by upstream dams. Part of this restoration effort is to create new gravel bars, either by augmenting sediment for natural deposition downstream or rehabilitating channels to construct bars.

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Gravel bar in the Trinity River, California.

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TRRP is documenting and evaluating the physical processes involved in these changes (creating gravel bars, augmenting coarse sediment, and rehabilitating fossilized channels) and the resulting channel changes. Direct measurements of salmon-spawning habitat have been taken; however, the ecological roles of these newly formed gravel bars still need to be assessed from the critical perspectives of habitat diversity and material exchange interactions.

We need to improve our current understanding of the ecological role of gravel bars to determine the most effective ways to design gravel bars, rehabilitate the river, and restore the fishery.

Solution

This Science and Technology Program research pilot project evaluated the ecological function of restored gravel bars downstream from dams in the Trinity River, downstream from Lewiston Dam, California.

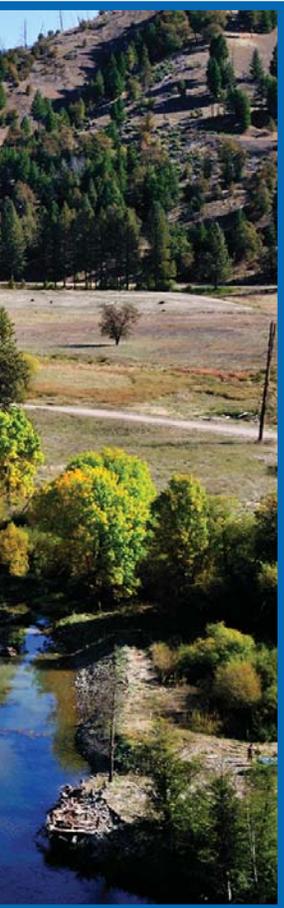
Four gravel bars or islands, each constructed differently (i.e., a side channel dug to form a bar on the shore, construction in the river, gravel injection to deposit a gravel bar, and a naturally deposited bar), were selected. We assessed the ecological function of the features of each of these gravel bars using a number of ecologically significant parameters at more than 20 locations, including the concentration of suspended particulate organic matter, water temperature, dissolved oxygen, conductivity, pH, flow velocity, hydraulic head, and macroinvertebrate samples. All field work was performed during the summer of 2012 under summer base flow conditions.

Findings

Gravel bars are needed to provide slow, shallow water habitats to rear juvenile salmonids, which require cooler temperatures. All of the gravel bars, both constructed and naturally occurring, did provide the temperatures and habitat diversity needed for salmonid rearing, presumably due to water flows in the hyporheic zone (beneath and alongside a streambed, where shallow ground water and surface water mix). Further research to determine the nature and timing of these flows would provide insights into gravel bar construction and fishery management.

The shape and height of the bar is important for determining how well the bar retains organic matter and provides diverse habitat. A more complex shape with alcoves and more shoreline could provide additional habitat value, but further research is needed to determine the most effective configurations. All four bar types retained the organic matter. The naturally occurring bar was the most efficient in retaining this matter, possibly because these bars have more sand and smaller particles. The reasons for this finding could be a topic for further analysis.

Naturally formed gravel bars may be more effective; however, all of the gravel bars did increase habitat diversity and provided better habitat. Further research to fully understand the ecological role of gravel bars could yield insights to improve gravel bar design, environmental management, and fisheries within complex river systems such as the Trinity River.



“The Trinity River Restoration Program (TRRP) has been at the forefront of efforts to restore coarse sediment supply and transport in regulated rivers, with the goal of re-creating the instream geomorphological features lost due to sediment starvation by upstream dams.”

Reclamation, 2000.
TRRP Record of Decision.

More Information

Ock, Giyoung and G. Mathias Kondolf. *“Assessment of Ecological Roles of Gravel Bar Features Restored by Gravel Augmentation and Channel Rehabilitation Activities Below Lewiston Dam.”* Cooperative Ecosystem Studies Unit (CESU) Scoping Report, November 2012.

Science and Technology Program
Research Project:

www.usbr.gov/research/projects/detail.cfm?id=5907



U.S. Department of the Interior
Bureau of Reclamation

Modeling Changes in Water Quality From Sediment Delta Interactions

Determining the implications of reservoir drawdowns for sediment delta interactions

Bottom Line

Understanding sediment delta interactions provides foresight into potential water quality issues in reservoirs.

Better, Faster, Cheaper

Sediment measuring chambers eliminate the need for scuba divers.

Other methods for collecting sediment-water quality data are not really established. This project provides consistent guidance for collecting data. These consistent methods will provide a better understanding of sediment water quality parameters and analyses.

Principal Investigator

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Collaborators

- Brigham Young University, Provo, Utah
- Provo River Watershed Council

Chamber for measuring sediment on reservoir bottoms. The rubber seals create a better seal on uneven bottom surfaces.

Problem

The major inflows to most reservoirs carry large sediment loads that settle out, forming sediment deltas. The sediment deltas are exposed to cycles of drawdown and refilling, so they are exposed and re-worked by inflows. The sediment deltas thus store and release both organic and inorganic materials. As these materials are released, nutrients, metals, and other constituents become available and result in changing aquatic habitats, escalating or interrupting plankton growth, and altering the overall water quality. As Reclamation's reservoirs age and sediment deltas increase in size, this problem will be exacerbated.

Reclamation, states, local agencies, and other stakeholders currently monitor the physical, chemical, and biological characteristics of water at Reclamation's reservoirs through testing and sampling. These characteristics are not well understood in sediment deltas, and sampling is time-consuming, expensive, and generally not performed. Sample collection methods have not been well established, in part, because sampling equipment presents significant limitations. Methods for data processing and interpreting these type of data are still being researched. Improving upon these

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capabilities will address problems concerning how sediment delta interactions affect municipal taste and odor issues with water delivery, fisheries in reservoirs and tail waters, harmful algal blooms, and other water quality issues.

Solution

This Science and Technology Program research project is improving the current sample collection methods and equipment, and processing and analysis of results by:

1. Characterizing the spatial distribution of nutrients in the sediment delta by taking sediment samples from the delta, analyzing the nutrients, and developing a representation of the spatial distribution using geostatistical measures.
2. Designing, manufacturing, and testing sediment oxygen demand (SOD) chambers for collecting samples and observing in situ SOD rates for deeper water applications.
3. Characterizing and quantifying the sediment loading processes from the reservoir inflows by determining volume changes in the sediment delta area using sonar and Global Positioning Software (GPS) measurements.

Application

We took 91 sediment samples from the sediment delta of Deer Creek Reservoir, Utah, and analyzed them for phosphorus content. Contours of phosphorus concentration were developed using Geographic Information System (GIS) software and interpolation. Water soluble phosphorus showed a decreasing trend along the reservoir (Casbeer, 2009; Williams, et al., 2010).

We manufactured chambers for measuring SOD and fitted them with ports for collecting samples and measuring water quality parameters. Chambers were deployed as a pair, one chamber with the bottom open to the sediment and the other chamber with the bottom closed for a control comparison. Laboratory testing showed distinct trends in dissolved oxygen measurements over time for the two chambers. Field testing has provided challenges deploying the chambers and collecting samples and data. These challenges will be addressed in future plans (Lounsbury, 2011).

Using sonar and GPS measurements over an area of the sediment delta, we investigated sediment deposition and re-suspension in the reservoir. Estimates of the potential sediment to be re-suspended during reservoir drawdown were related to previous field measurements of sediment phosphorus concentrations. This provided an estimate of the effect sediment re-suspension could have on reservoir phosphorus concentrations (Ricks, 2011).

Future Plans

Additional field testing of the SOD chambers will be performed in Deer Creek Reservoir to establish sample collection methods and equipment deployment, and collect data for water quality modeling. These improvements to sample collection methods and equipment will help characterize the effects of sediment deltas on water quality. The data and results of the research characterizing sediment delta water quality interactions will be used to simulate sediment delta effects on water quality using a CE-QUAL-W2 model of Deer Creek Reservoir. The model will be calibrated by using over 10 years of historic reservoir operations. Representing the sediment delta effects on water quality is expected to produce a more robust water quality model.

The methods will be available to be transferred to other reservoir sampling and modeling programs.

“Sediment nutrient cycling and processes are complex. This research is providing tools and methods to help us understand these important processes.”

Dr. Gustavious Williams
Associate Professor, Civil and Environmental Engineering,
Brigham Young University,
Provo, Utah.

More Information

Casbeer, Warren C. (2009).
“Phosphorus Fractionation and Distribution Across Delta of Deer Creek Reservoir.”
Master’s Thesis. Brigham Young University, Provo, Utah.

Williams, G. P., et al. (2010).
“Phosphorus Distribution in Reservoir Sediments: Implications for Ground Water Transport.”

Lounsbury, D., et al. (2011).
“Sediment Oxygen Demand and Pore Water Phosphate Flux.”

Ricks, Collin R. (2011).
“Quantifying Mass Sediment Movement in Deer Creek Reservoir.” Master’s Thesis. Brigham Young University, Provo, Utah.

Science and Technology Program
Research Project:
www.usbr.gov/research/projects/detail.cfm?id=589



Using Tree Rings Analysis to Reconstruct Paleoclimate and Streamflows

Using tree rings to determine historic climate conditions in Utah

Bottom Line

Studying rings from various tree species can provide longer records of climate impacts for better future planning.

Better, Faster, Cheaper

Recorded data for streamflows only goes back a century. However, tree ring analysis provides indicators to project historic weather conditions and streamflows back to 800 years.

Principal Investigator

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Collaborators

- Utah State University
- Columbia University, Lamont-Doherty Earth Observatory
- Brigham Young University, Provo, Utah

Problem

City planners and others in the Wasatch Front area of Utah need a way to determine previous climate impacts and forecast supplies in the future.

The Wasatch Front metropolitan region, from Logan through Ogden, Salt Lake City, and past Provo in Utah, depends on mountain snow for its water supply. About 2 million people consume treated, potable water impounded from snow runoff or pumped from percolated ground water for indoor personal use and outdoor irrigation of largely turfgrass landscapes. This area, like many in the urbanizing West, faces uncertain water supplies that are being strained and threatened. Utah has one of the highest population growth rates in the country, nearly 30 percent from 1990 - 2000, and a similar trajectory since then. High population growth and very high per-capita water use rates will create future demand that is projected to exceed limited existing supplies. Water wholesalers and the Utah State Division of Water Resources are focused on bringing future water demand and supply into balance.

Determining the need for water is complicated by climate change, increasing temperatures, greater evaporative demand, possible earlier snowmelt and late season shortages, and cyclic droughts. Moreover, drought over the past 50 years in northern Utah has been very mild compared to the historical record. While our climate records only extend back approximately 150 years, evidence indicates greater shifts in water availability in this area.

— continued

Coring an old Utah Juniper.



Solution

Most tree species slow their growth when temperatures cause too much water to evaporate from their leaves and stems (transpiration), particularly when transpiration depletes soil water to the point that the tree becomes stressed. We can re-create the records of past precipitation and streamflow data by examining the tree ring widths over time that relate to water and temperature stress. Water wholesalers in Colorado are already using tree ring analysis in developing future water management strategies.

Application

This Science and Technology Program research project is using tree species native to the Wasatch Front range to re-construct paleoclimate and river flows of the major urban watersheds in the greater Salt Lake City metropolitan region. These native trees have very different responses to drought—from the Utah Juniper’s “use it or lose it” strategy of depleting upper zone water and then surviving droughts with a deep root system, to the Douglas fir’s “save it for a rainy day” strategy of using more surface roots. The trees also have a wide geographic range—from the Limber pine in open stands on ridges 5,000 to 9,000 feet in elevation, to the Utah Juniper’s lower elevation habitat. The Salt Lake City region has a climate record dating back to the mid-1800s that can be used to calibrate a tree ring record to climate and streamflows. Once calibrated, comparing the climate responses of the investigated tree species chosen allowed us to re-construct past streamflows and will help water suppliers estimate past precipitation and evaporative demand.

Future Plans

In the next phase, tree ring analyses will be correlated with streamflow data to re-construct flows 800 years back.

The results of these studies will be used to:

1. Expand the dendrochronology record in the eastern Great Basin area of the United States.
2. Determine if other species (such as Rock Mountain Juniper, Rock Mountain Maple, and Mountain Mahogany) can be used to reconstruct streamflow data and/or identify other seasonal information on climate.
3. Identify where wet and dry cycles change and correlate this with other climate research.
4. Prepare stream re-construction from dendrochronology data on the Logan River, Provo River, American Fork River, and Weber River as funding allows.

We will provide Reclamation managers and water districts with important information on cyclic wet and dry periods to help water managers:

- Identify future water storage needs and/or distribution options within a changing climate.
- Better project potential water supplies 2 to 3 years in advance for improved water management.
- Implement water conservation practices to preserve and protect socio-economic resources such as industries, recreation, wildlife, etc.

“This information confirms the climate change that we have been seeing in our annual operations, and we can use this information in future planning.”

Fred Liljegren
Outdoor Recreation Planner,
Reclamation

Sharing Information

We held roundtable meetings with water managers to discuss information from this research and related research, and received input and direction from their perspectives. Water districts participating in these roundtable discussions included: Central Utah Water Conservancy District, Jordan Valley Water Conservancy District, Weber Basin Water Conservancy District, Salt Lake City Public Utilities, Metropolitan Water Conservancy District, Provo River Water Users Association, and Sandy City Water Conservancy District.

More Information

Science and Technology
Program Research Project:

Back to the Future, Part 1:
[www.usbr.gov/research/
projects/detail.cfm?id=7855](http://www.usbr.gov/research/projects/detail.cfm?id=7855)

Back to the Future, Part 2:
[www.usbr.gov/research/
projects/detail.cfm?id=1967](http://www.usbr.gov/research/projects/detail.cfm?id=1967)



Using Unmanned Aerial Vehicles

Determining how Unmanned Aerial Systems (UAS) can help meet Reclamation's remote sensing data needs

Bottom Line

Reclamation and partners are using Unmanned Aerial Systems (UAS) in pilot studies to evaluate the strengths and limitations to find effective niches for using UAS to accomplish various U.S. Department of the Interior agency missions.

Better, Faster, Cheaper

Using UAS is less expensive and provides more detail in more areas than piloted aircrafts or satellites, and covers more area than land and boat surveys.

Principal Investigator

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Collaborators

- NASA
- U.S. Geological Survey
- Utah State University

See page 31 for more images of unmanned aerial systems.

Problem

Reclamation regularly uses remotely sensed data for monitoring habitat, analyzing water quality, generating topography, mapping land use/cover, classifying crops, and measuring evapotranspiration, among other applications. But, each remote sensing system has limitations—satellite imagery is useful primarily for low resolution regional surveys; manned aircrafts can be expensive and subject to weather and other delays; and traditional boat surveys provide detailed data, but cannot cover wide areas with any frequency. Unmanned aerial systems (UAS) can address some of these challenges.

Solution

UAS technology can:

- Readily provide high resolution data more cost-effectively and more frequently than boat surveys and piloted aircrafts
- Provide the ability to fly in areas considered to be too dangerous for piloted aircrafts
- Capture imagery in cloudy areas
- Capture imagery at higher resolution than satellite imagery or piloted aircrafts
- Provide real-time imagery
- Offer highly portable aircrafts that require no landing strip
- Provide aircraft safety for pilots to use

This Science and Technology Program research project is developing a community of interest within Reclamation, and partnering with other agencies to determine the potential uses of UAS to accomplish Reclamation's mission.

Reclamation researchers have developed a UAS community of interest to monitor developments in UAS technology, submit UAS research proposals, organize training workshops, and promote exploration of the potential uses of UAS within Reclamation.



The Raven launch at Aldwell Reservoir on the Elwha River, Washington.

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For example, the U.S. Geological Survey (USGS) Rocky Mountain Science Center and Reclamation have been using the “Raven” unmanned aerial vehicle to monitor shifting topography as sediments are removed from two former reservoirs at dam removal sites on the Elwha River, Washington. The Raven is 3-foot long with a 4.5-foot wingspan, hand-launched, battery-operated, and typically flies from 100 to 400 feet above the ground at a speed of about 30 miles per hour. It has an approximate flight time of 1 hour and carries a 0.5 megapixel camera (11 megapixel cameras have been successfully used as substitutes).

Application

Applications need to be mission-tested to determine whether UAS technology can provide superior results compared with current technology. There are some concerns that need to be addressed, including privacy, security, obtaining certificates of authorizations, maintaining line of site in complex areas, and training. Reclamation is working with partners to address these challenges. Possible UAS applications for Reclamation include:

- Canal monitoring
- Crop identification and yield forecasting
- Dam and levee inspections
- Emergency management response
- Estimating algae density in sewage lagoons
- Evapotranspiration estimation
- Flood hazard analysis
- Flood risk assessment
- Flow-to-habitat relations
- Habitat mapping
- Identification of canal encroachments
- Identification of flood plain encroachments
- Imaging to make ortho-rectified maps
- Integrating remote sensing and point data
- Law enforcement
- Moisture content in snow
- Monitoring dam faces for seepage
- Riparian surveillance
- River corridor change detection
- River restoration monitoring/change detection
- Root zone soil moisture estimation
- Sediment transfer
- Snow depth
- Urban/canal interface mapping
- Volume estimation
- Water spreading
- Water turbidity
- Wetlands classification

Future Plans

As interest in UAS technology continues to grow, the community of interest will start to have regular meetings, its SharePoint site will be upgraded, and more Reclamation staff will receive flight training on both the “Raven” and the “T-Hawk.”

Reclamation’s Pacific Northwest (PN) Region will make presentations to its leadership regarding the merits of UAS technology in fiscal year 2013. PN UAS pilots have identified several missions that are ready to fly once funding and Federal Aviation Administration (FAA) certificates of authorization have been obtained.

“Reclamation’s UAS community of interest now has over 50 people, from every Reclamation region including directors, group managers, information resource personnel, dam safety experts, hydraulic engineers, geographic information systems scientists, geographers, civil engineers, geologists, soil scientists, meteorologists, emergency management staff, remote sensing specialists, and information management specialists. This shows the wide-spread interest in this technology.”

Douglas Clark
Physical Scientist, Reclamation

More Information

A SharePoint site for Reclamation users:
<https://dosp/techResc/TR/TSC/UAS/Pages/default.aspx>

U.S. Geological Survey Rocky Mountain Science Center:
www.rmgsc.cr.usgs.gov/UAS/

Science and Technology Program Research Project:
www.usbr.gov/research/projects/detail.cfm?id=4926



Filtering Light Detection and Ranging (LiDAR) Data for Rivers

A literature review of LiDAR tools, methods, and best practices

Bottom Line

This literature review identified methods and available tools to enhance Filtering Light Detection and Ranging (LiDAR) data to more accurately represent landscape features such as streambanks, levees, and bathymetry.

Better, Faster, Cheaper

This information will help identify practical processes to optimize LiDAR datasets for use in geomorphic studies and hydraulic modeling and engineering analyses. The result will help improve data quality, data quantity, and provide faster results with less expense.

Principal Investigator

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Problem

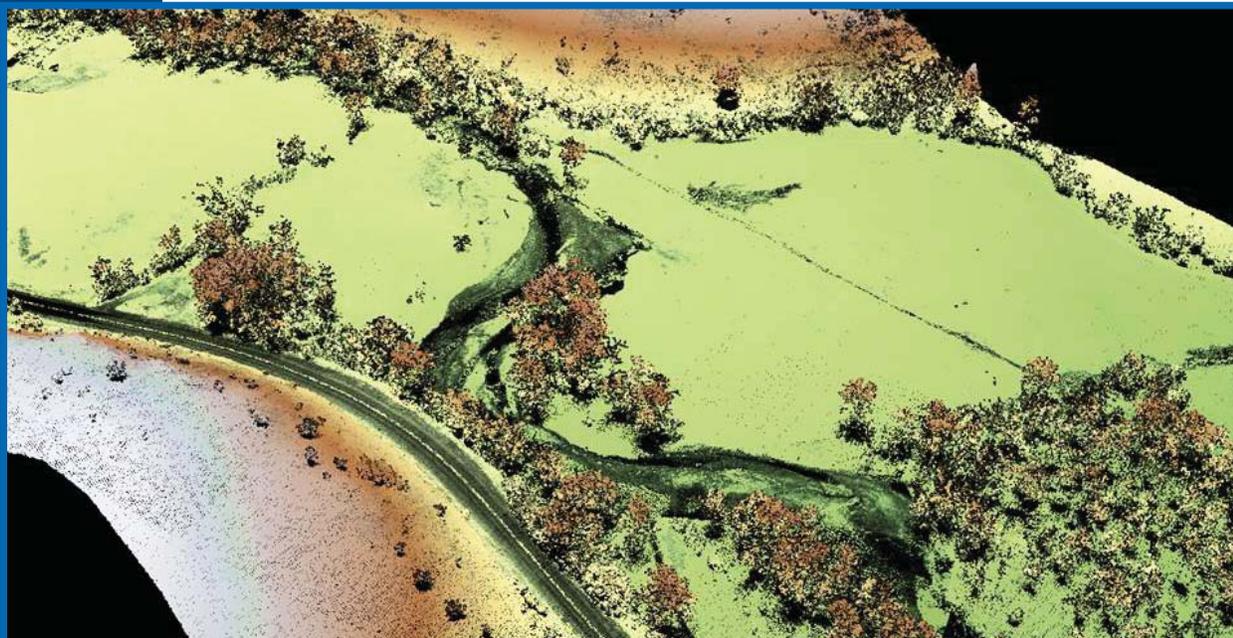
Reclamation uses Filtering Light Detection and Ranging (LiDAR) elevation data to support a variety of programs and applications. Often, LiDAR data are used for understanding river system forms, dynamics, and habitats, and to help design river-related projects. However, using these data in river systems projects has revealed several data quality issues, including inaccurate presentation of landscape features such as streambanks, levees, and water surfaces. Several peer-reviewed articles suggest that these data quality issues may arise from limitation of standard data processing procedures.

The initial LiDAR data capture consists of a dense, three-dimensional collection of sample points (i.e., LiDAR point cloud) for all data returns. This “raw” point cloud includes instrument returns for surfaces that may represent undesired objects, vegetation, manmade objects, and even birds in flight and unobstructed terrain surfaces. To make LiDAR useful as terrain surface data, the LiDAR point cloud must be filtered to separate the terrain and off-terrain data points. The separation and classification of LiDAR data into a terrain dataset is critical in developing accurate surface models. Accordingly, many studies have been conducted on filtering methods to process LiDAR data. The filtering process and final terrain data quality are particularly important during engineering applications.

Solution

This Science and Technology Program research project conducted a literature review to document current knowledge and tools for LiDAR data processing in the context of

— continued



*Terrain surface
from LiDAR data.*

— continued

filtering point clouds to produce terrain datasets, and identifying potential solutions for enhancing the accuracy of the datasets.

The literature review revealed several useful tools that could be used to enhance LiDAR data for use in hydraulic modeling and stream geomorphology studies. It also revealed several data gaps, which could be addressed in potential studies worthy of being undertaken by Reclamation.

Future Plans

Though numerous comparative studies have been conducted evaluating the efficacy of various tools and approaches, the tools that show most promise for use in Reclamation's applications have not been comparatively evaluated to date. A more current and focused comparative study is therefore warranted.

The proposed study would compare the filtering processes of interest. Filtering results would be evaluated against delivered commercial products as the reference dataset. The point of the comparative review would be to assess filter performance using two criteria:

- Minimizing Type I and II errors relative to the reference dataset
- Representing surface shape relative to field surveyed transects

Type I errors represent data points being identified in the filtering process as terrain points that actually are off-terrain points. The erroneous points are included in the resulting terrain dataset. Inversely, Type II errors identify true terrain points as off-terrain points and excludes these points from the final terrain dataset. These errors combine to reduce the accuracy of surface model. Testing for Type I and II errors is only one part of assessing outcomes of the filtering process.

Comparison of the surface model derived from LiDAR against field survey data assesses limitation of the filtering processes and capabilities of the LiDAR itself to accurately represent real surfaces.

LiDAR technology is continually improving and advancing. Currently, Reclamation acquires near-infrared LiDAR, which is collected using laser pulses with wavelengths that are absorbed by water. Newer scanners are becoming commercially available, known as "green LiDAR," that use laser pulses with wavelengths that can penetrate water, bounce off the stream bottom, and return; thereby producing bathymetry data. This technology could provide important stream bathymetry data that is otherwise expensive to acquire using manual surveying techniques and limited in extent. Stream bathymetry is currently acquired through field survey, taking measurements across transects at broad intervals along a river. Future studies with green LiDAR could build off proposed studies involving near-infrared to explore the potential of providing accurate full surface models (terrain surface and stream bathymetry) to Reclamation hydrologists and geomorphologists.

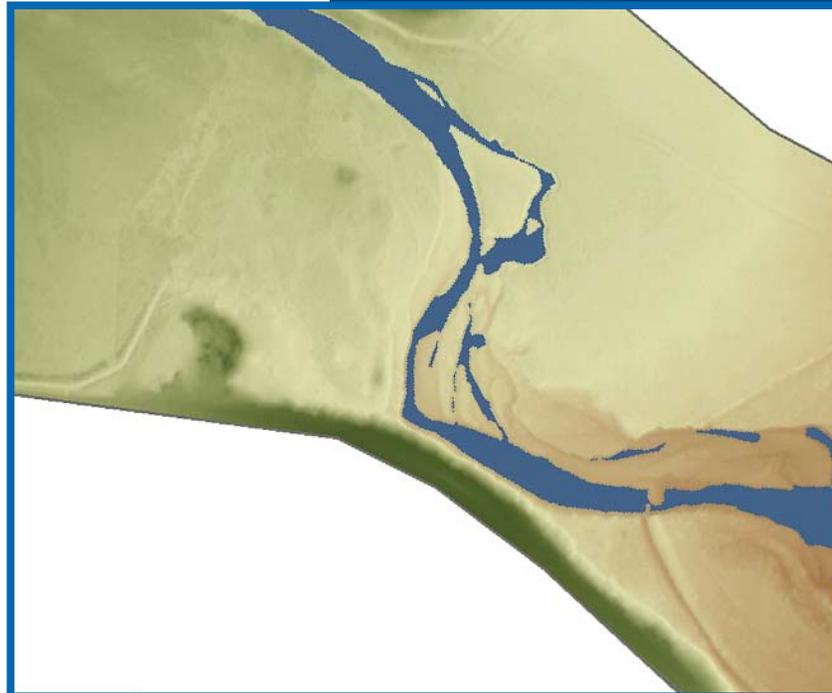
“Overall, this will allow for more accurate analyses of geomorphic forms, processes, and habitat types and provide a basis for more accurate engineering analyses and design.”

Christopher Cuhacyan
Project Manager, Reclamation

More Information

Lindeman, D. 2012. *“Literature Review Focused on Data Processing Techniques for the Selective Filtering of Light Detection and Ranging (LiDAR) Data for Enhanced Surface Representation of River Geomorphology.”* Reclamation, www.usbr.gov/research/projects/detail.cfm?id=657.

Science and Technology Program
Research Project:
www.usbr.gov/research/projects/detail.cfm?id=657



Results from a selective filtering of LiDAR data.



Improving the Range of Hydraulic Performance of Type III Stilling Basins

Determining how stepped chutes affect stilling basin performance

Bottom Line

Current design guidance for Reclamation's Type III stilling basins can be used for stepped spillway applications.

Better, Faster, Cheaper

Successfully applying existing stilling basin design guidance to stepped spillways improves the range of applicability of design standards.

Principal Investigator

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Problem

Water passing over the spillway of a dam typically has a large amount of energy, resulting in high flow velocities at the downstream end of the spillway. Stilling basins at the end of spillways are commonly used to dissipate energy from the flow and slow the water velocity to protect the downstream river channel from erosion and damage.

Traditionally, spillway surfaces were constructed with concrete and made as smooth as possible. Standard stilling basin designs, such as Reclamation's Type III stilling basin, were developed to provide appropriate energy dissipation for these smooth spillways. Over the last 20 years, however, spillway construction techniques have evolved to include using spillways and chutes with a series of abrupt steps built into them, called "stepped spillways."

Flows passing over a stepped spillway exhibit different velocity and energy characteristics than flows passing over a smooth spillway. This has created concerns about the appropriateness and applicability of standard stilling basin designs when used in combination with stepped spillways.

Investigation

This Science and Technology Program research project used a physical hydraulic model to compare the performance of Reclamation's Type III stilling basin for smooth and stepped spillways.

— continued

Physical
model of
stepped
spillway
and stilling
basin.



The model was constructed to represent two spillway and stilling basin configurations:

1. Smooth spillway with stilling basin featuring chute blocks, baffle blocks, and endsill.
2. Stepped spillway with stilling basin featuring baffle blocks and endsill.

Each configuration was tested using three different spillway slopes: 4 horizontal (H) to 1 vertical (V), 2H:1V, and 0.8H:1V. Two types of baffle blocks were tested in the model to identify the effects of block shape on stilling basin performance. Standard baffle blocks and a new type of baffle block, called a “supercavitating baffle block,” were examined. This supercavitating baffle block was designed to minimize damage to the blocks and the stilling basin floor at high incoming velocities.

Parameters measured in the model for each test configuration included discharge, flow depth entering the stilling basin, flow depth exiting the stilling basin, and the air concentration in the flow at the bottom of the spillway. These parameters and visual observations of the energy dissipation within the stilling basin were used to evaluate the performance of the stilling basin under the various test conditions. The data collected from the model were compared to data from previous studies and design parameters documented in Reclamation’s Engineering Monograph No. 25, *Hydraulic Design of Stilling Basins and Energy Dissipators*.

Conclusions

Results of this study indicate that using Reclamation’s Type III stilling basin design with a stepped spillway is acceptable. The required downstream water depth (tailwater) guidelines outlined in Monograph No. 25 for Type III stilling basins are conservative. For both smooth and stepped chutes, this study showed that acceptable performance can be attained with 20 to 25 percent less tailwater than recommended in design guidelines. For the aerated spillway flows typically encountered on steep slopes and stepped spillways, using clear water parameters allow Reclamation to consistently apply the design principles detailed in Monograph No. 25. For low energy inflows, significantly less tailwater is required to prevent basin sweep-out with a stepped chute. Under certain conditions, only the basin appurtenant structures are needed to maintain basin performance, regardless of tailwater. When supercavitating baffle blocks are used instead of standard baffle blocks, 6 to 12 percent less tailwater is required for acceptable basin performance.

“Understanding how features such as stepped spillways and modified baffle blocks affect stilling basin performance is an important step in extending the operational range of Type III stilling basins.”

Connie Svoboda
Hydraulic Engineer, Reclamation

More Information

“Performance of Type III Stilling Basins - Stepped Spillway Studies.”
Hydraulic Laboratory Report
HL-2012-02:
www.usbr.gov/pmts/hydraulics_lab/pubs/HL/HL-2012-02.pdf

Science and Technology Program Research Project:
www.usbr.gov/research/projects/detail.cfm?id=4925



Stilling basin model with a smooth chute at a slope of 53.1 degrees.

Recent Research Products

To get the information generated by research quickly into the hands of end users and the broader public, our researchers and partners publish their results in peer-reviewed journals, technical memoranda, research reports, and other venues.

Contact the authors for information about these documents or research projects:

Bandrowski, David. *Large Wood Research Roadmap* (ID 3775).
dbandrowski@usbr.gov

Bountry, Jennifer. *Summary of Elwha Science Symposium Event* (ID 6959).
jbountry@usbr.gov

Broderick, Susan. *Using Ultrasound as a Tool for Fish Research and Management* (ID 2817).
sbroderick@usbr.gov

Chugh, Ashok. *Stability Assessment of a Circular Earth Dam* (ID 1540).
achugh@usbr.gov

Dahm, Katharine. *Identifying Well Contamination Through the Use of 3-D Fluorescence Spectroscopy to Classify Coalbed Methane Produced Water* (ID 3259).
kdahm@usbr.gov

Frizell, K. Warren and Connie Svoboda. *Performance of Type III Stilling Basins - Stepped Spillway Studies* (ID 4925).
csvoboda@usbr.gov

Gaeuman, David. *Monitoring the Effectiveness of Gravel Augmentations for Salmonid Habitat Improvement Downstream From Dams* (ID 295).
dgaeuman@usbr.gov



Fluorescence spectroscopy could help determine if organic compounds in produced water are from naturally occurring sources or well production additives. (See Dahm, 2013.)

Representative Spectra Classification

Spectra Characteristics

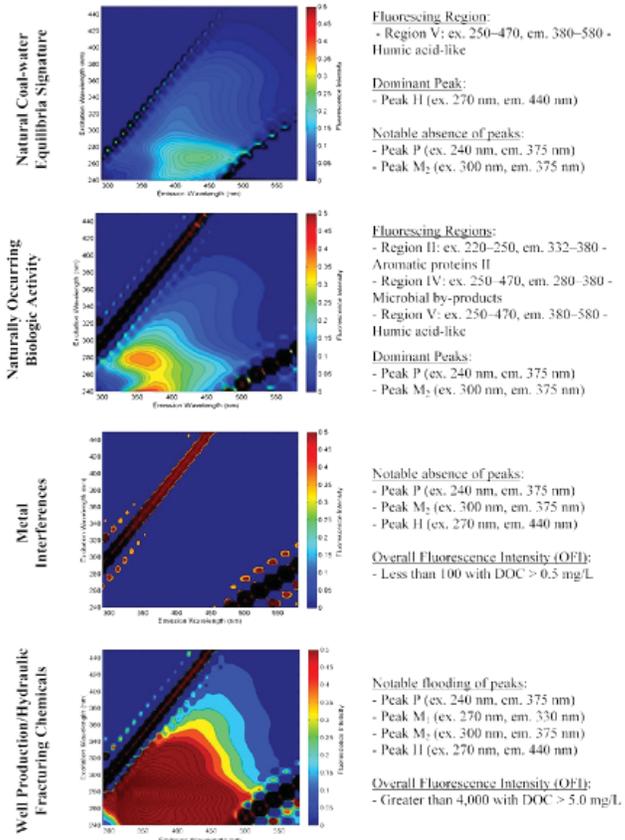




Photo left: Jeff Sloan, U.S. Geological Survey (USGS) (left), and Douglas Clark, Reclamation (right), at the Raven launch at Aldwell Reservoir on the Elwha River, Washington (see research update on page 24).



Photo above: Mark Bauer, USGS, with the Raven.



Photo left: The "Raven" unmanned aerial vehicle.

Photo below: Aerial view from the Raven of ongoing dam removal at Lake Mills in the Elwha River Basin, Washington.

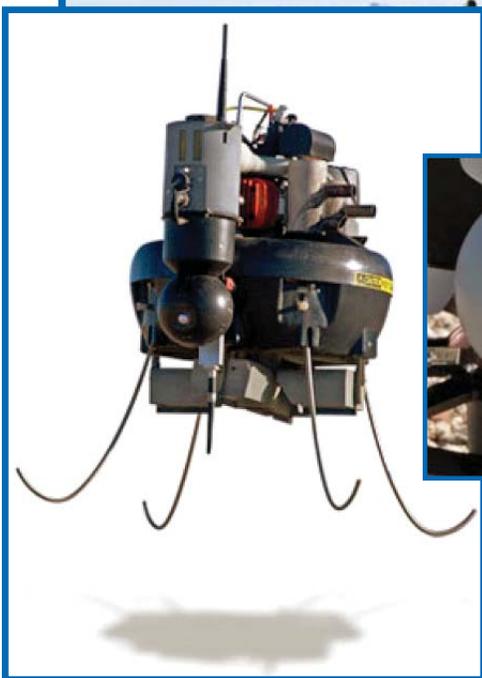
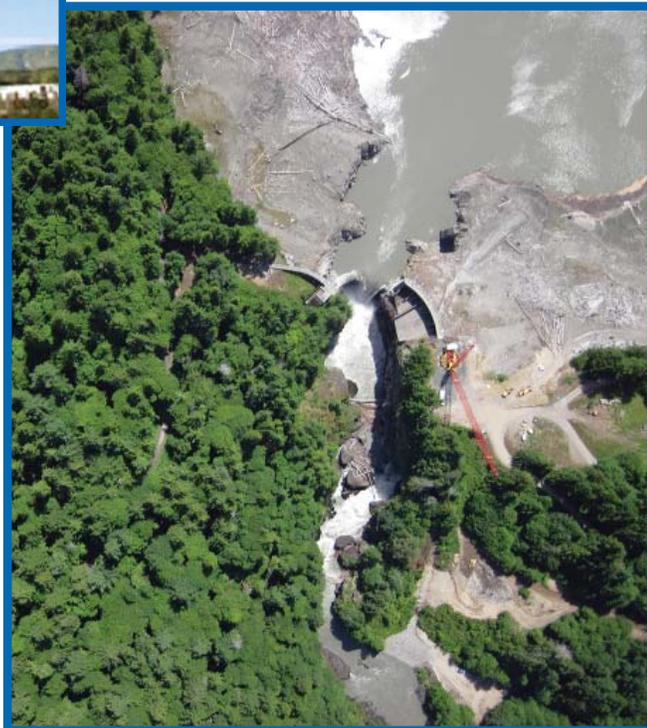


Photo left: The "T-Hawk" unmanned aerial vehicle.

Photo above: A closer view of the gimbal camera with the HD GoPro payload.

For more images and information about the T-Hawk, see USGS website:
http://rmgsc.cr.usgs.gov/UAS/pdf/OSMMineSurveysWV/OSM%20Coal%20Mine%20Poster%20%20THawk_18x24%20.pdf



