RECLAMATION Managing Water in the West

April 2013
Research and
Development Office
Bulletin 2013-10

The Knowledge Stream
Research Update

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

Nick Williams
Environmental Engineer
801-524-3888
nwilliams@usbr.gov

Collaborators

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

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

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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