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Using Stratigraphic and Hydrologic Data from the Yuba River System to Develop Reliable Sediment Transport Predictions

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Abstract

In 1998, a CALFED task force recommended studying the feasibility of removing or lowering the Englebright Dam to return steelhead trout and spring-run salmon to the Upper Yuba River.

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CALFED SCIENCE FELLOWS PROGRAM

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Background

In 1998, a CALFED task force recommended studying the feasibility of removing or lowering the Englebright Dam to return steelhead trout and spring-run salmon to the Upper Yuba River.

The rationale for this recommendation, made by the Ecosystem Restoration Program, is the river's relatively pristine condition. Downstream of the dam, the river supports one of the last self-sustaining runs of wild salmon in the Central Valley. Upstream of it are areas where historically the fish have lived.

Another plus, the dam was built (construction ended in 1940) to contain waste sediments produced by hydraulic gold mining in the western Sierras. Thus, compared with dams built to supply fresh water or hydroelectric power, changes to the Englebright Dam might have fewer economic consequences and therefore, the panel reasoned, might be politically palatable.

The panel ultimately recommended that the Upper Yuba River be a candidate for restoration to boost wild salmon and improve riparian ecosystems. The recommendation, however, came with the caveat that there were still many important geological, ecological and public health questions about what would happen if the dam were removed.

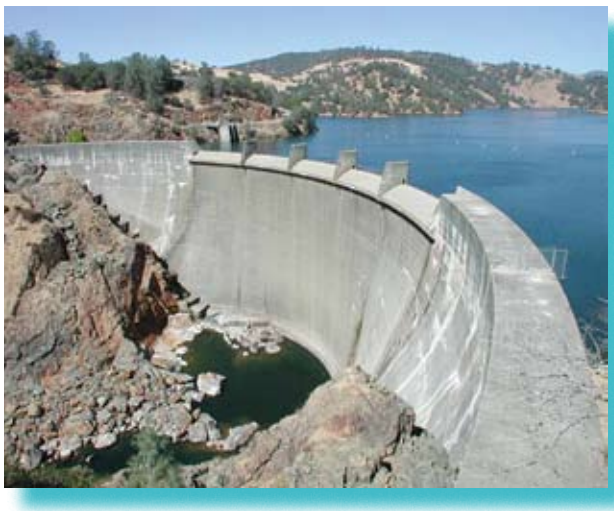
A primary concern was whether removing the dam would re-activate sediments trapped behind the dam, causing an influx of mud into the river. Mud reduces water quality and degrades salmon habitat. A lot of sediment can also change riverbed morphology, increasing the chances of flooding during heavy rains or rapid snowmelt.

Project

In 2002, Noah Snyder, then a postdoctoral researcher at the U.S. Geological Survey (USGS) Pacific Science Center in Santa Cruz, received a CALFED Science Fellowship to address some of these questions.

His project, which ended in late 2004, was conducted in collaboration with David Rubin, a geologist at the USGS Pacific Science Center; Charles Alpers, a mercury geochemist at the USGS Water Resources Division; and Lorraine Flint, a hydrologist also at the USGS Water Resources Division. The project had additional support through CALFED's Upper Yuba River Science Studies Program.

During his fellowship, Snyder analyzed sediment cores taken from the bottom of Lake Englebright, the reservoir created by the dam. From these, he calculated sediment accumulation rates, characterized the sediments' physical properties—things such as grain size—and made inferences about past rainfall patterns in the watershed from the cores' depositional records.



Englebright Dam. Photo: Jonathan Childs, USGS—Menlo Park

Findings

Based on his analyses, the amount of sediment in the reservoir in 2001 represented about 25 percent of the reservoir's original holding capacity. In simple terms, the sediment filled about a quarter of the bowl. The figure is valuable because it allows scientists to estimate the amount of sediment that would have entered the Upper Yuba River between 1940 and 2001 if there had not been a dam.

Using two independent methods, Snyder estimated that the maximum basin-wide annual sediment flux over this 61-year period was about 340 tons per square kilometer. Approximately 64 to 69 percent of this material was sand and gravel, not mud—an important distinction since salmon spawn in gravel-bottomed areas. If removing the dam were to release a lot of mud, the project would sabotage itself by destroying the same habitats it seeks to enhance.

Another interesting finding, the depositional record in one area of the reservoir suggests that sedimentation rates declined about 30 percent since 1970, likely because of fewer large floods, changes in watershed management and winnowing of stored hydraulic-mining sediments.

This pattern is consistent with other climate studies showing that

the late 1950s and early 1960s were unusually wet in California.

Applications

Computer modelers can use Snyder's results as a basis for calibrating computer simulations of river dynamics. Such truth checks are crucial for improving the predictive capacity of computer simulations.

Yet another application is in quantifying the amount of mercury that might be sent into the Upper Yuba River if the dam were removed. Mercury is a waste product of hydraulic gold mining. Removing the dam could mobilize sediments contaminated with merucy, increasing public exposure to the toxin vis-à-vis fish.

In 2004, Snyder accepted a position as an assistant professor in the Department of Geology and Geophysics at Boston College. He continues to study salmon-habitat restoration in relation to dam removal, now in the context of New England rivers and watershed management practices.

Mentors

Research: David Rubin, U.S. Geological Survey, Pacific Science Center, Santa Cruz, California

Community: Charles Alpers and Lorraine Flint, U.S. Geological Survey, Water Resources Division, Sacramento, California

Awards

U.S. Geological Survey STAR Award for Englebright Lake coring project given in 2002.

Publications

Snyder, N.P., D.M. Rubin, C.N. Alpers, J.R. Childs, J.A. Curtis, L.E. Flint, and S.A. Wright. 2004. Estimating accumulation rates and physical properties of sediment behind a dam: Englebright Lake, Yuba River, northern California. *Water Resources Research,* v. 40, W11301, doi:10.1029/2004WR003279.

Snyder, N.P., J.R. Allen, C. Dare, M.A. Hampton, G. Schneider, R.J. Wooley, C.N. Alpers, and M.C. Marvin-DiPasquale. 2004. Sediment grain-size and loss-on-ignition analyses from 2002 Englebright Lake coring and sampling campaigns. U.S. Geological Survey Open-File Report 2004-1080, http://pubs.usgs.gov/of/2004/1080/, 46 pp.

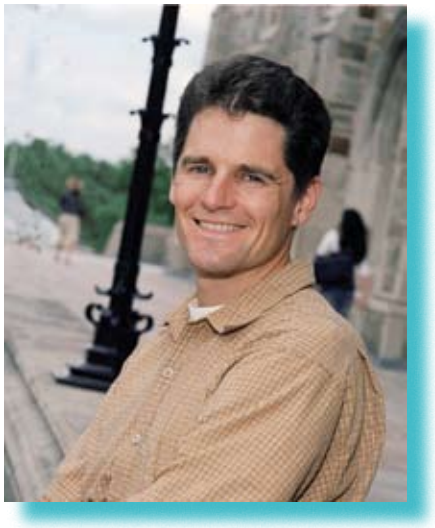
Snyder, N.P., C.N. Alpers, L.E. Flint, J.A. Curtis, M.A. Hampton, B.J. Haskell, and D.L. Nielson. 2004. Report on the May–June 2002 Englebright Lake deep coring campaign. U.S. Geological Survey Open-File Report 2004-1061, http://pubs.usgs.gov/of/2004/1061/, 32 p., 10 plates.

Snyder, N.P. and M.A. Hampton. 2003. Preliminary cross section of Englebright Lake sediments. U.S. Geological Survey Open-File Report 03-397, http://geopubs.wr.usgs.gov/open-file/of03-397/, 1 plate.

Childs, J.R., N.P. Snyder, and M.A. Hampton. 2003. Bathymetric and geophysical surveys of Englebright Lake, Yuba-Nevada Counties, California. U.S. Geological Survey Open-File Report 03-383, http://geopubs.wr.usgs.gov/open-file/of03-383/, 20 pp.

Presentations

2004: American Geophysical Union, San Francisco (December); Boston College Department Seminar Series (November); CALFED Science Conference Sacramento (October); U.S. Geological Survey, Menlo Park and Santa Cruz (April).



Dr. Noah P. Snyder. Photo: Lee Pellegrini, Boston College

2003: Geological Society of America, Seattle (November); Upper Yuba River Studies Program Technical Review Panel Meeting, Nevada City (September/October); University of Montana (March); San Francisco State University, Oregon State University and Boston College Department Seminar Series (February); CALFED Science Conference, Sacramento, and UC Santa Cruz (January).

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CALFED BAY-DELTA PROGRAM

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The CALFED Bay-Delta Program is a collaborative effort of more than 20 state and federal agencies with management or regulatory responsibilities for the San Francisco Bay-Delta system. The CALFED Science Fellows Program has been established to bring world-class science to all program elements to help achieve overall CALFED goals. California Sea Grant administers CALFED research projects towards those ends.

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