Dam Removal Sediment Management Examples and Considerations
For the Matilija Fine Sediment Group
1-24-11

Hello all,

At the last couple meetings, and in personal conversations with some of you, I have spoken about a couple of dam removal and sediment management projects that were recently completed, are underway, or are in the planning phases. I told several folks that I would send more information about these projects for consideration in the Matilija Dam removal project and sediment management effort. Some of these projects will be familiar to a lot of you and I am not claiming to be an expert on any of them, but I have visited several of these sites during construction, know individuals involved with their planning or implementation, and have followed and reviewed some of the data and post-removal monitoring results with interest. I have also managed a few small dam removal projects in California and am monitoring sediment transport at one dam removal site locally.

Between the time of initiation of the Matilija Dam removal effort and now, much has been learned about dam removal and sediment management and impacts. Over the past decade, several large dams have been removed and the outcomes studied. Very large dams such as Elwha, Glines Canyon, and Condit in Washington State are scheduled to come out this summer and preparations have already begun. Our understanding of dam removal, sediment transport, and impacts to wildlife has improved greatly over the past few years. Some previous assumptions and predictions with dam removal projects have changed or been disproved. For these reasons, and as I think many folks involved with the Matilija effort agree, I believe we need to thoroughly consider the new information available in relation to Matilija Dam removal and sediment management alternatives. I am optimistic about the new data and examples available and about our ability to move forward collectively with the best possible alternative. Recent examples have shown that dam removal and sediment management can be far less technically complicated and expensive than some complex alternatives, and more desirable for funders and stakeholders.

The below examples focus on natural sediment transport following dam removal or notching as well as newer sediment transport models being employed. It is interesting to note that I have not been able to find past or planned dam removal projects that employed more expensive and technically challenging alternatives such as slurrying sediment to disposal sites or permanent sediment storage (except with the San Clemente Dam removal project where some sediment is being stored). Many of the dams effectively removed, and being planned, allowed transport of all sediment to habitat downstream with multiple salmonid species, including steelhead, with overall biological benefits and the earlier concerns about “biological devastation” not realized. In addition, several of the completed (and planned) dam removals (Rogue River, Elwha, others) implemented significant infrastructure improvements to existing water diversion and treatment facilities and improved flood protection measures such as bridge modifications and levee improvements. Please see the links for images, videos, and associated reports.

Marmot Dam, Sandy River, Washington State

Removed in the summer of 2007, this 47–foot tall dam released close to 1 million cubic yards of sediment downstream; much of that occurred in the 24 hour period following the removal. This project has shown that large-scale releases of sediment can be accomplished without significant negative biological impacts downstream and major biological benefits overall. Continued monitoring has also shown the economic and logistical effectiveness of "natural" sediment transport downstream and compatibility with flood protection requirements.

http://www.stillwatersci.com/case_studies.php?cid=58
http://or.water.usgs.gov/projs_dir/marmot/index.html

Rogue River Dams Removed (4 total)

Elk Creek Dam (Army Corps)-
This Army Corps Dam was effectively "notched" with results that are comparable to a full dam removal with remnants of the dam on both banks. The dam was notched in 2008 and the stream channel was allowed to reclaim its natural stream bed. This is an example of the Army Corp blasting a dam to near streambed grade and allowing the river to "naturally" reestablish its channel.

http://www.oregonwild.org/waters/elk_creek_dam/elk-creek-dam-timeline
http://waterwatch.org/programs/freeing-the-rogue-river/notching-the-elk-creek-dam

Gold Hill Dam-
This dam removal took place in 2009 and also allowed natural sediment transport downstream along with a new water facility for the city.

http://waterwatch.org/programs/freeing-the-rogue-river/rogue-river-dams

Gold Ray Dam-
Removed last summer (2010), this 38–foot tall dam also allowed trapped sediment to flush downstream to where instream diversion intakes were modified to enable continued diversion effectiveness. Chinook salmon were observed spawning in the former reservoir site within days of the removal and while sediment was still flushing out.

http://www.rvcog.org/mn.asp?pg=NR_Gold_Ray_Dam

Savage Rapids Dam-
Removed in 2009, this project included the construction of a new water diversion and pumps that effectively divert water from the river without the need for the dam. It is noteworthy that several of the above-mentioned dams were removed from the Rogue River before and after Savage Rapids Dam was removed and the irrigation district was able to maintain their diversions with the improved facility while natural sediment transport occurred past the intake. At least $28 million dollars in funding was obtained for this dam removal and water diversion upgrade project that the Bureau of Reclamation oversaw.

http://waterwatch.org/programs/freeing-the-rogue-river/savage-rapids-dam-removal

Elwha River Dams (Elwha and Glines Canyon)

Preparation for removing these two dams has begun and will commence is full force this summer (2011). This will be the largest dam removal project in the U.S. to date and includes natural sediment transport of over 18 million cubic yards (3 times Matilija) downstream, levee improvements, and new city water facilities before, during, and after removal. The project uses an innovative strategy and new facilities to ensure that naturally transported sediment does not negatively impact water supply. As noted below;
"Both treatment plants will protect water users from the turbidities that will occur upon **removal of the Glines Canyon and Elwha Dams**." "The Elwha Water Facilities also provide for **local area flood protection**."
"The facility is designed to remove sediment from the water supply"
"During high turbidity, it would allow the city to turn off the Ranney collector pumps to prevent plugging of the subsurface gravels. When times of high turbidity pass, the city could again send water from the Ranney collector to the PAWTP."
http://www.nps.gov/olym/naturescience/elwha-ecosystem-restoration.htm
http://www.nps.gov/olym/naturescience/water-treatment-overview.htm
http://www.nps.gov/olym/naturescience/elwha-water-facilities.htm
http://www.nps.gov/olym/naturescience/dam-removal-overview.htm

Klamath Dams (4 total)

Scheduled for removal in 2020, this is looking to be the largest river restoration project in the world and involves the removal of 4 huge dams and natural sediment transport downstream. Studies have found that 11.5 to 15.3 million cubic yards of mostly fine sediment occur behind the dams (approximately double, or more, than Matilija Dam, but mostly fines). Stillwater Sciences has done amazing work to assess sediment transport scenarios, impacts to wildlife, and determining optimal reservoir drawdown alternatives and sediment transport modeling using their DREAM-1 model below. Such analysis and modeling has been used (Marmot Dam removal) and it being used on the Klamath Dam removals to determine and implement ideal sediment transport strategies to effectively move sediment downstream without the need for expensive and challenging slurry-type options or permanent sediment storage.

From the Stillwater Sciences website:
"Although removing four dams on the Klamath River will have dramatic effects on the river ecosystem and may fundamentally alter riverine nutrient cycling downstream of the dams, our studies show that impacts of releasing the millions of tons of fine sediment stored behind the dams will be relatively short-lived and will not likely eradicate any species."

"Sediment transport simulations- In order to arrive at an optimum reservoir drawdown scenario, Stillwater Sciences used the DREAM-1 dynamic sediment transport model (Cui et al. 2006) to analyze multiple concurrent drawdown alternatives, including a variety of different drawdown start dates and drawdown rates. For more information, download the full Sediment Transport Technical Report. If you have questions about sediment transport modeling, contact Dr. Yantao Cui."

http://www.stillwatersci.com/case_studies.php?cid=55

Sediment Transport Models- From (Sillwater Sciences)
http://www.stillwatersci.com/tools.php?tid=51

Suite of Models Our sediment transport models are developed in-house, in conjunction with leading academics specializing in sediment transport dynamics. The models can be customized for a particular river system or condition, or to address specific questions. Model development, validation, and testing are described in several publications in some of the leading academic journals for sediment transport. Sediment transport models developed by Stillwater Sciences include: **TUGS** (The Unified Gravel-Sand) model simulates the transport of both gravel and sand in predominantly gravel-bedded rivers. TUGS model incorporates the latest research in sediment transport, including accurately predicting interactions between gravel and sand particles. TUGS can be useful in predicting changes to the river bed based on changes in sediment and water supply to a river. For more information about this model, download a documentation publication and a publication with TUGS applied to the Sandy

River, OR.

DREAM-1 (Dam Removal Express Assessment Model 1) was developed to simulate the movement of pulses of **fine sediment** (sand or finer) in rivers with different bed material conditions. The models were developed initially for simulating sediment transport following dam removal but have wide applicability to other questions of sediment transport (e.g., natural landslides or gravel augmentation downstream of dams), especially where the interactions of different sediment sizes have the potential to affect habitat conditions.

DREAM-2 (Dam Removal Express Assessment Model 2) was developed to simulate the movement of pulses of **coarse sediment** (gravel or coarser) in rivers with different bed material conditions. For more information about DREAM, download the Model and Validation publication and the Sample Runs and Sensitivity Tests publication, as well as a publication documenting flume experiments that validate DREAM.

Fine Sediment Needed for Coastal Marshes

I also mentioned a 2010 study and report by the U.S. Geological Survey and four partnering universities, titled *Limits on the Adaptability of Coastal Marshes to Sea Level Rise*, which found that coastal marshes, such as our local lagoons and estuaries, need fine sediment from nearby watersheds to survive rising sea levels. **"Marsh survival strongly depends on sediment availability," it reads. "This raises the possibility that extensive marshes that are degrading today were stable ecosystems during periods of high sediment delivery, but would be unstable today even at relatively low sea level rise rates."** With dams and other practices depriving coastal areas of much-needed suspended (fine) sediment, it says, sea level rise threatens coastal wetlands with ecological collapse.

This and other recent studies related to the benefits of fine sediment, as well as steelhead and other wildlife tolerability of high suspended sediment loads with natural events like fire, changes our understanding of fine sediment. A decade ago it was common to hear people talk about silt and "fines" as a bad thing, the dialog is changing to recognize the importance of all sediment types along with valid concerns about "unnatural" and damaging persistence or absence of some sediment scenarios. Clearly, as observed recently, our watersheds and wildlife are some of the most prone and adapted to periodic, "natural" pulses of massive amounts of sediment transport from fires and erosion (i.e. Sespe Creek, Sisquoc River, Mission Creek). As noted in previous meetings, the mobilization of all, or pulses of, sediment behind Matilija Dam may be comparable to, or less than, that which is mobilized in periodic fire events in Matilija Canyon and the Ventura River watershed.

Summary

There are many completed dam removal projects not included in this short memo, but I hope that this information is useful in moving forward on the Matilija project. As shown with the above projects, and others, natural transport of all sediment downstream of dam removal sites is an effective and preferred alternative in almost all cases I have researched. These projects have included major funding for upgrades or new construction at existing water diversion facilities to facilitate and improve overall diversion function during and following dam removal. Many projects also incorporate funding to improve flood protection and safety at road crossing sites. Significant uncertainty and concerns were widespread only a decade ago about the possible negative biological impacts of relatively quick sediment flushing downstream of dam removal sites, but recently completed projects and monitoring have shown that populations of salmonids, such as steelhead, are very resilient, adapted to massive fire-related sediment transport events, and quickly take advantage of increasing their range upstream of dam removal sites as well as successfully spawn within and below the recently removed dam site (Rogue River and Sandy River removals). Other native wildlife is showing similar adaptability and resilience to high sediment transport following dam removal, in addition to increasing in population size and distribution. As such, some of the concerns about the biological, flooding, and water diversion impacts of dam notching or full removal and natural sediment transport downstream have been considered, addressed, and effectively dealt with and resulted in significant benefits to, and support from, various stakeholders involved. I look forward to discussing these and other issues as we move forward to find a solution that we can all support.

Thanks for your time and consideration,

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