Wide Range of Dam Removals

- Gold Hill Dam, Rogue River, OR
- Matilija Dam, Matilija Creek, CA
- Elwha Dam, Elwha River, WA
- Savage Rapids Dam, Rogue River, OR
- Chiloquin Dam, Sprague River, OR
- Glines Canyon Dam, Elwha River, WA
Wide Range of Sediment Issues

- Former site of Chiloquin Dam
- Reservoir sediment behind Matilija Dam
- Reservoir sediment in Lake Mills behind Glines Canyon Dam
Subcommittee on Sedimentation
Guideline Objective

• Provide a decision framework to assess dam removal impacts related to sediment.
• Determine the type and level of
  – data collection,
  – analyses,
  – modeling, and
  – monitoring necessary
Subcommittee on Sedimentation

- Agricultural Research Service
- American Society of Civil Engineers
- Bureau of Land Management
- Bureau of Reclamation
- Colorado Water Resources Research Institute
- Federal Highway Administration
- National Center for Earth-surface Dynamics
- National Park Service
Subcommittee on Sedimentation

- National Resources Conservation Service
- Office of Surface Mining
- Universities Council on Water Resources
- U.S. Army Corps of Engineers
- U.S. Environmental Protection Agency
- U.S. Forest Service
- U.S. Geological Survey
Workshop in Portland, Oregon
October 14-16, 2008

Field Trip to Marmot Dam
Workshop Organizers

• U.S. Bureau of Reclamation
  – Tim Randle
  – Blair Greimann
  – Jennifer Bountry

• U.S. Geological Survey
  – Rose Wallic
  – Chauncey Anderson
  – Jon Major
Technical Team Leaders and Sediment Impact Categories

Peter Downs
• Reservoir sediment erosion and redistribution

Will Graf
• Downstream sediment transport and deposition

Chauncey Anderson
• Water quality changes and impacts on biologic resources
Two-Tiered Analysis Decision Tree

1. Assess the scope of the sediment problem.
2. Predict the sediment impacts that will result from the dam removal.
Tier 1. Analysis Decision Framework: Scope the Scale of the Sediment Problem

Scoping Questions:
Needed to help focus an understanding of existing sediment conditions and processes.

Data collection:
Needed to answer scoping questions.

Analyses:
Needed to answer scoping questions and predict consequences.
Tier 1. Analysis Decision Framework: Scope the Scale of the Sediment Problem

Determine Probability of Sediment Impact

Little or No Probability

Low Probability

Medium Probability

High Probability

Risk = Impact Probability × Consequence

Risk determines level of effort for the Tier 2 Analysis
Tier 2. Analysis Decision Framework: Predict Sediment Related Impact

Questions to guide impact predictions:
*Answers lead to the prediction of impacts.*

Data collection and analysis tools needed to answer questions:

- Additional data collection methods
- Detailed analysis methods
- Field experiment methods
- Numerical modeling methods
- Physical modeling methods

Adaptive management monitoring methods
Tier 2. Analysis Decision Framework: Predict Sediment Related Impact

Categorize tools according project risk.

Tier 2 Decision Point:
Recommend appropriate level of data collection and analysis needed to predict sediment impacts and guide dam removal mitigation measures.
Reservoir Sediment Erosion Tier 1 Analysis

Is sediment stored within the reservoir?  
Yes  
- Negligible  
  - Little or no Risk  
  - Contaminant Mitigation  
No  
  - Contaminant screening  
    - Above background levels?  
      - Yes  
      - Contaminant Mitigation  
      - No
Reservoir Sediment Erosion Tier 1 Analysis

Total Reservoir Sediment Mass

- Mass from 10-year flood
  - Low Impact Probability
- Mass from 10 to 50-year flood
  - Medium Impact Probability
- Mass from 50-year flood
  - High Impact Probability
Reservoir Sediment Erosion
Tier 1 Analysis

What portion of sediment would be mobilized? What is the sediment composition?

- Ratio of sediment volume to original reservoir capacity
- Ratio of reservoir to channel width
- Particle size analysis
- Reservoir sediment spatial distribution
Reservoir Sediment Erosion Tier 1 Analysis

Mobile Reservoir Sediment Mass

< Mass from 10-year flood

Low to Medium Impact Probability

Mass from 10 to 50-year flood

Prediction Confidence
Reservoir Sediment Erosion
Tier 1 Analysis

Prediction confidence questions

- Is there a legacy thalweg?
  - Yes: High confidence
  - No: Medium confidence

- Is silt and clay > 30%?
  - Yes: High confidence
  - No: Medium confidence

- Are cohesive sediments > 20%?
  - Yes: Low confidence
  - No: Medium confidence
Downstream sediment transport & deposition

Tier 1 Analysis

Sediment erosion from reservoir.

- No
- Contaminants above background?
  - Yes: High Probability
  - No: Spatial extent of effects
    - Small or non-critical: Low Risk
    - Large or critical
Downstream sediment transport & deposition
Tier 1 Analysis

Matrices to determine risk

Consequences Matrix \times Probability Matrix = Risk Matrix

**Low Risk:**
- Geomorphic analysis
- Sediment budget

**Medium Risk:**
- Quantitative analysis
- Mass balance or 1-D modeling

**High Risk:**
- 2-D or physical modeling
- Field tests
<table>
<thead>
<tr>
<th>Low Risk Impact</th>
<th>High Risk Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less certainty</td>
<td>More certainty</td>
</tr>
<tr>
<td>More qualitative</td>
<td>More quantitative</td>
</tr>
<tr>
<td>More assumptions</td>
<td>Fewer assumptions</td>
</tr>
<tr>
<td>Empirically-based</td>
<td>Physical process</td>
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<tr>
<td>predictions</td>
<td>based predictions</td>
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<tr>
<td>Less data intensive</td>
<td>More data intensive</td>
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<tr>
<td>Matrices to determine risk</td>
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<td>---------------------------</td>
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<tr>
<td><strong>River channel property</strong></td>
<td><strong>Ecosystem</strong></td>
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<tr>
<td>W.S. profile</td>
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<tr>
<td>Thalweg profile</td>
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<tr>
<td>Bank characteristics</td>
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<tr>
<td>Suspended sediment conc.</td>
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</tbody>
</table>
Water Quality Analysis Decision Tree

What is the mass and duration of natural or acceptable turbidity, suspended sediment, and bed load?

Do predicted impacts alter biological communities or human use?

No

Low Risk: Mitigation not needed

Yes

High Risk: Consider mitigation
Conclusions

- Sediment-related impacts of dam removal fundamentally depend on the
  - initial reservoir sediment mass, size, and quality; and
  - the extent and rate of reservoir sediment erosion.
Conclusions

- Sediment-related impacts should be scaled to natural disturbances.
- Probability and consequence should be used to estimate risk.
- Level of risk should determine the level of investigation.
Next Steps

- Integrate results from workshop teams
- Develop draft guideline report
- Review by workshop participants
- Independent review
- Test draft guidelines on actual cases
- Conduct 2nd workshop to make adjustments (Oct 2009)
- Final draft guidelines, review, and publication (2010)
Former Site of Chiloquin Dam

08/19/2008
The End

RECLAMATION