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Managing Water in the West

HOW TO DEAL WITH SEDIMENT IN DAM REMOVAL

*Fish Passage
Workgroup:*

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U.S. Department of the Interior
Bureau of Reclamation

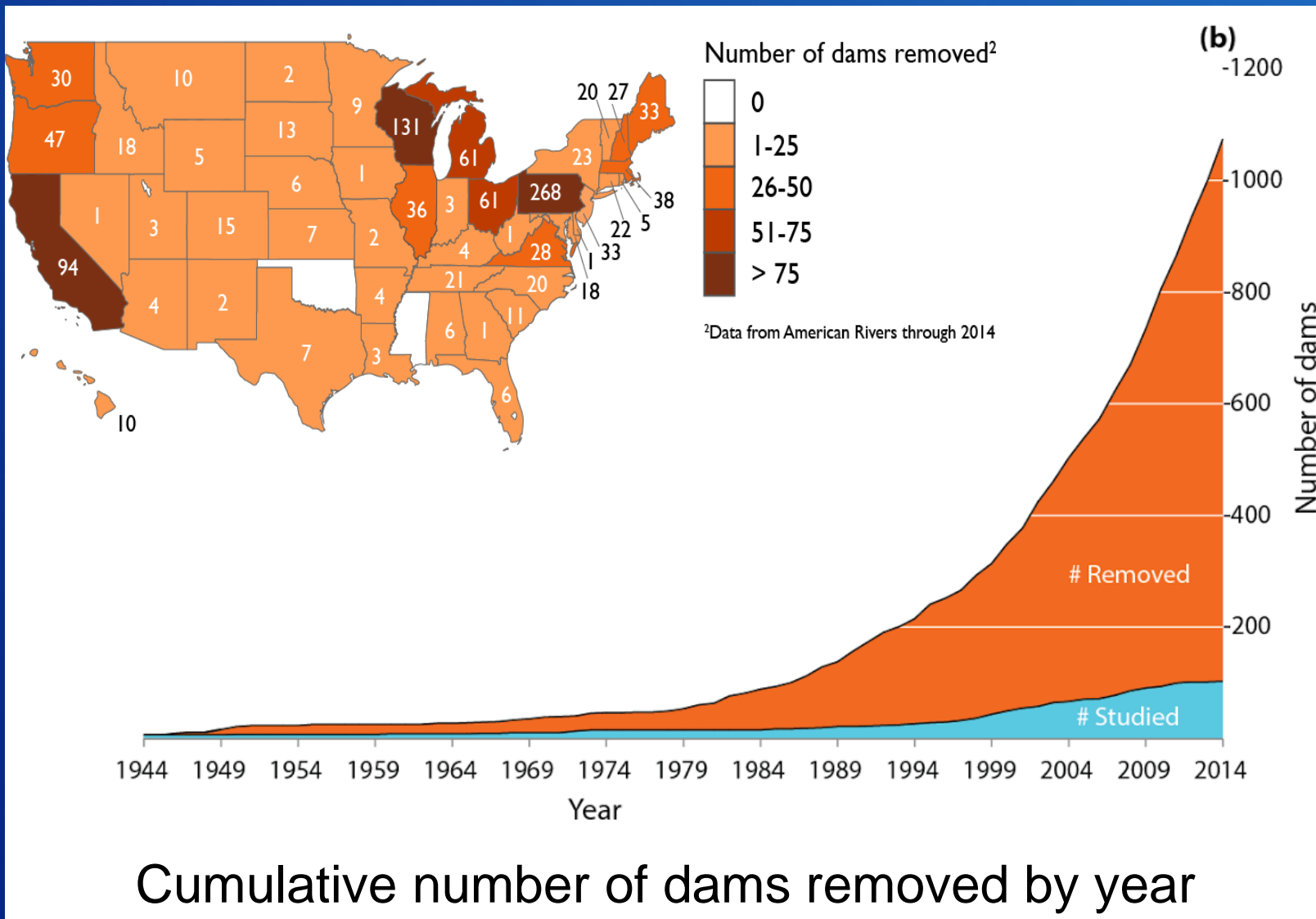
Acknowledgments

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- Laura Wildman, Princeton Hydro
- Tom Augspurger, USFWS
- Subcommittee on Sedimentation
 - Sponsoring Organization



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History of Dam Removal



Courtesy of Ryan Bellmore (USFS) and Jeff Duda, USGS

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Guidelines needed for a wide range of dam removals

Gold Hill Dam, Rogue River, OR



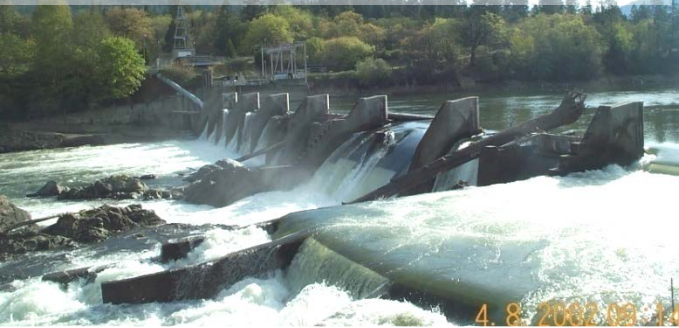
Matilija Dam, Matilija Creek, CA



Elwha Dam, Elwha River, WA



Savage Rapids Dam, Rogue River, OR



Chiloquin Dam, Sprague River, OR



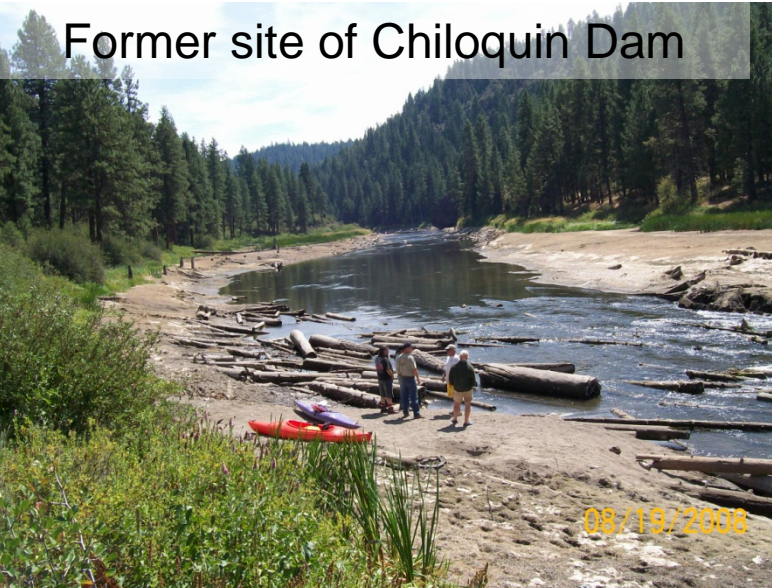
Glines Canyon Dam, Elwha River, WA



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and a wide range of sediment issues

Former site of Chiloquin Dam



Reservoir sediment behind Matilija Dam



Reservoir sediment in Lake Mills
behind Glines Canyon Dam



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U.S. Subcommittee on Sedimentation: Dam Removal Analysis Guidelines for Sediment

Objective:

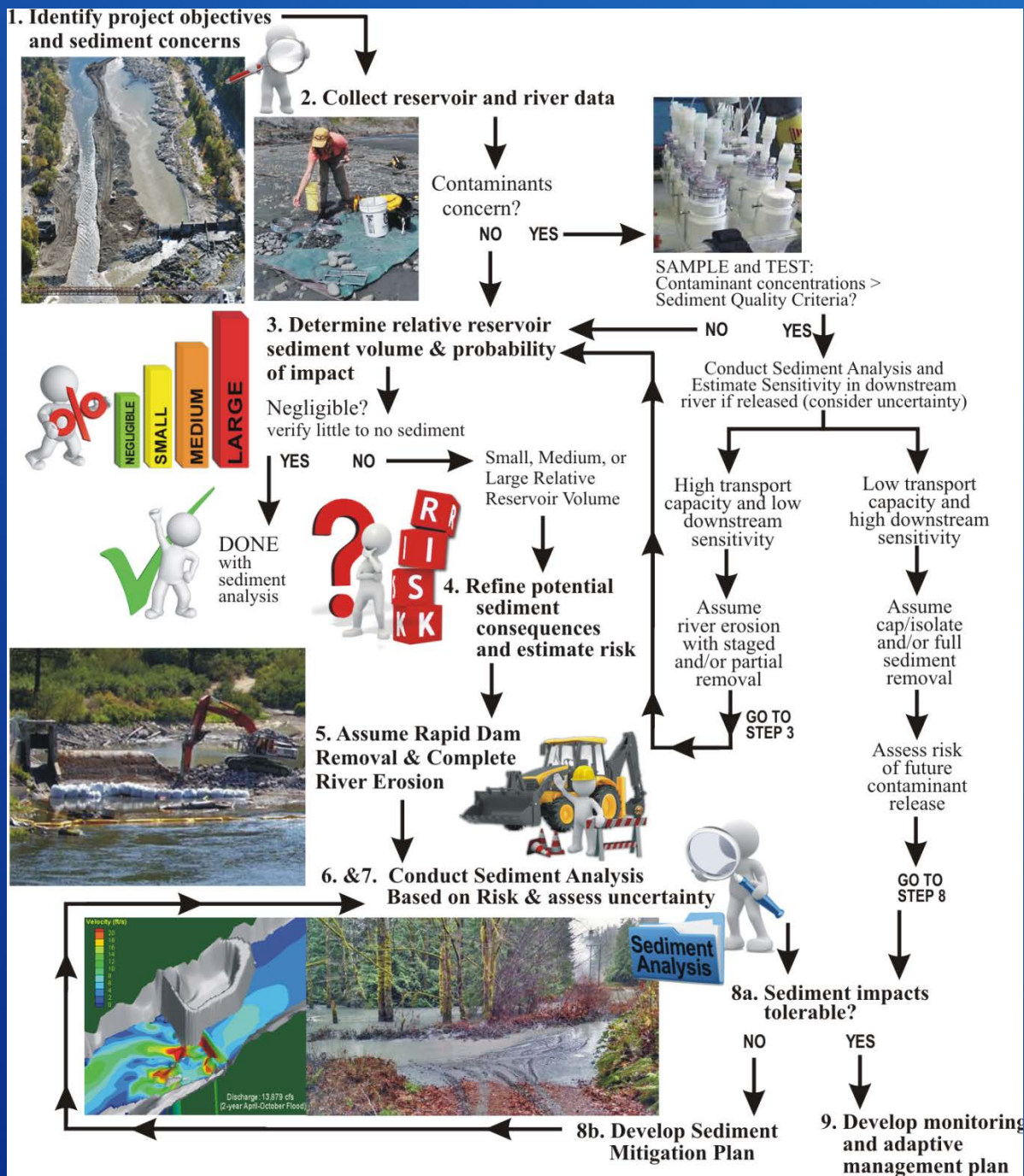
Provide a national guideline to link the risk of sediment impacts to the level of data collection, analysis, modeling, and sediment management alternatives.



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GUIDELINE PROCEDURES

1. Identify Objectives
2. Collect Data
3. Determine Sediment Volume
4. Estimate Risk
5. Develop Dam Removal and Sediment Management Plans
6. Conduct Sediment Analysis
7. Assess Uncertainty
8. Sediment Impacts Tolerable?
9. Monitoring and Adaptive Management



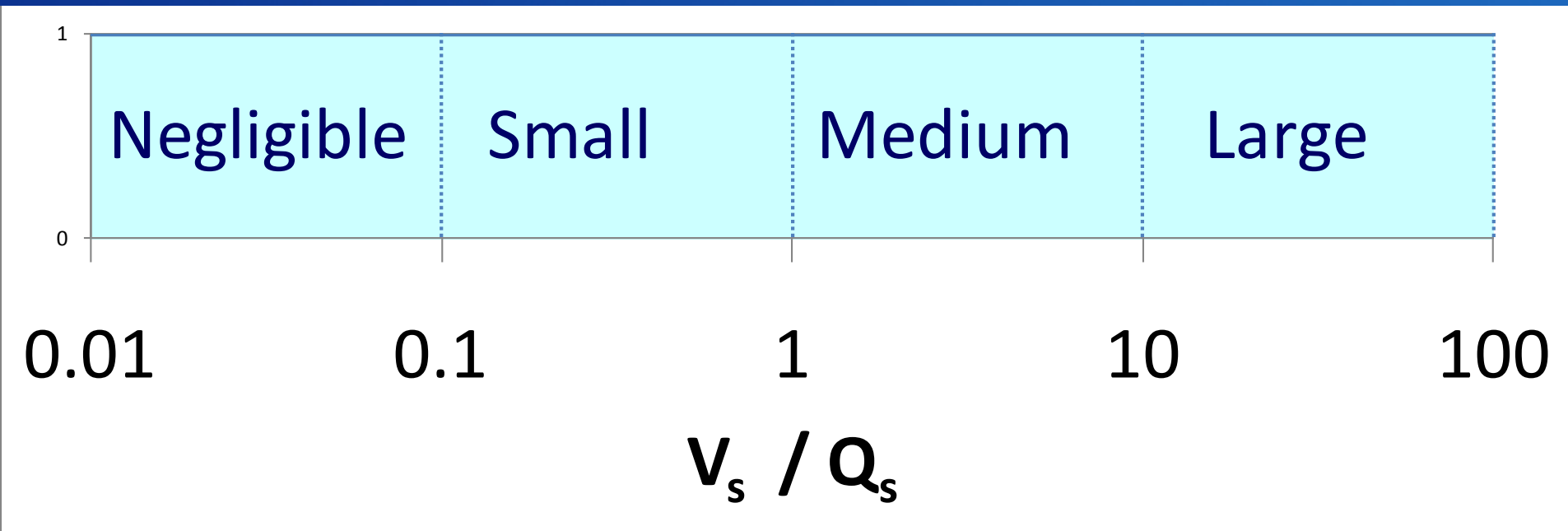
Step 3 - Reservoir Sediment Probability Determination

- Estimate expected reservoir sediment erosion
<50%? *50 to 75%?* *> 75%?*
- River Erosion
 - wide or narrow reservoir relative to river?
 - cohesive or non-cohesive?
- Mechanical Removal
- Reservoir Stabilization



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Step 3: Probability of Sediment Impact: Relative Reservoir Sediment Volume



Ratio of **reservoir sediment volume** (V_s) to **mean annual sediment load** (Q_s)

****For ratio convert volume to mass using bulk density**

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Criteria for Negligible Reservoir Sediment Volume (V_s)

- $V_s < 0.1 Q_s$
- Alternate Reconnaissance Criteria
 - $W_{\text{reservoir}} / W_{\text{channel}} \leq 1.5$
 - Dam height \leq bank-full height in alluvial reach
 - Little or no sediment found by visual observations or probing
 - Longitudinal profile does not reveal a sediment wedge
 - Sediment volume less than a sand or gravel bar

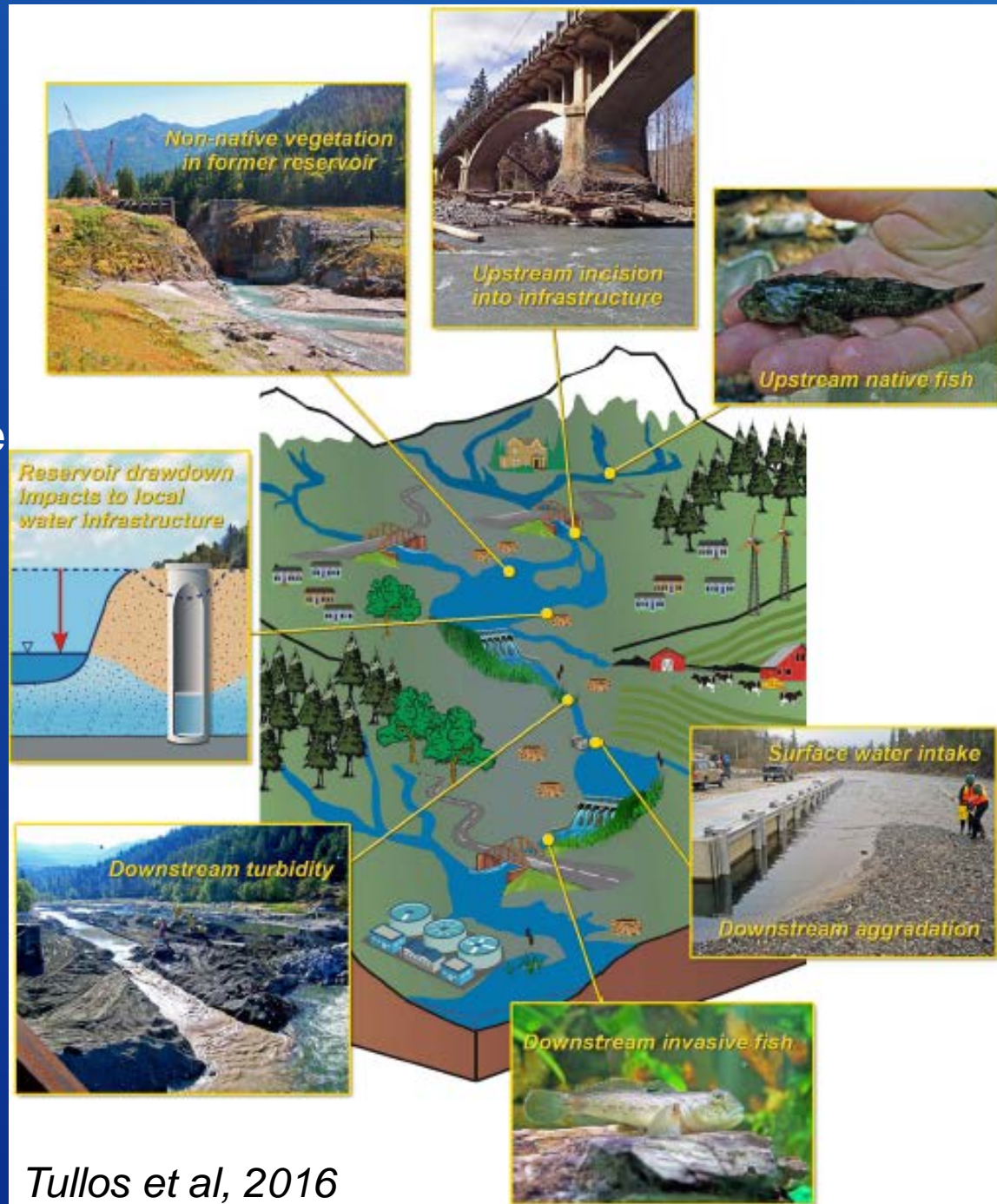
Step 4: Potential Impacts

Reservoir Area

- Headcut into infrastructure
- Non-native vegetation
- Non-native fish
- Well yield reduction

Downstream River

- Burial of habitat
- Elevated sediment loads
- Flood increase
- Erosion of property
- Burial of water intakes



Tullos et al, 2016

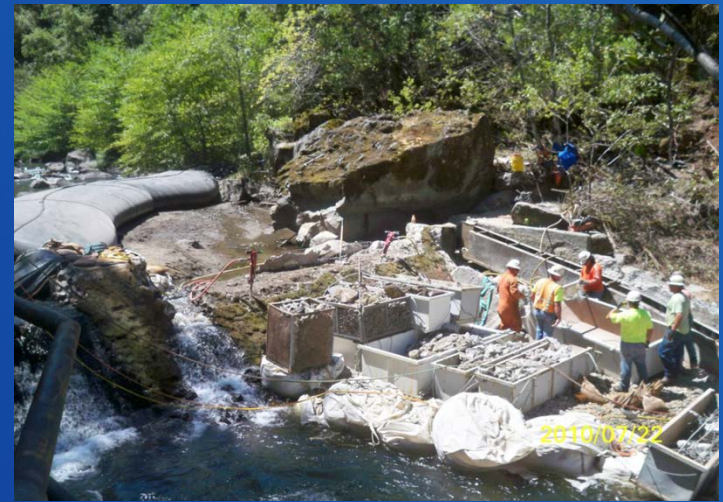
Categorize Sediment Consequences

Low

Medium

High

- Fine vs coarse sediments
- Short-term vs long-term
- Localized or reach-scale
- Consider the benefits of restored sediment



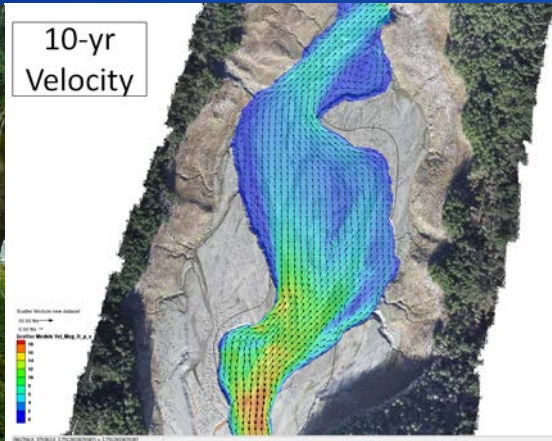
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Risk - Key Guideline Concept

$$\text{Risk} = \text{Probability} \times \text{Consequence}$$

- Probability: reservoir sediment volume relative to mean annual sediment load (~ river's ability to handle it)
- Consequences: potential sediment impacts should they occur (does impact matter?)
- *Guidance draws from: EPA ecological risk framework, Reclamation Dam Safety, ACOE Levee Design*

Greater the risk, the greater the level of investigation



Step 4: Risk Estimates

EPA defines risk: probability of harmful effects to receptors (human health, ecological systems, etc) resulting from exposure to an environmental stressor (sediment in this case).



Probability of fine or coarse sediment impact (Sediment Exposure)	Consequence of Sediment Impact (Receptor Sensitivity)		
	Low	Medium	High
Small	Low	Low	Medium
Medium	Low	Medium	High
Large	Medium	High	High +

Step 6: Sediment Analysis Tools

Sediment Risk Category			
Negligible	Small	Medium	Large
Simple computations	Sediment wave model	Sediment transport capacity	1D or 2D sediment model, laboratory model, field test
	← Develop conceptual model →		
	← Total stream power calculations →		
	← Mass balance calculations →		
	← Geomorphic Analysis →		

Negligible Sediment Risk



- Divers found about 500 yds³ sediment, much less than an average annual sediment load and easily transported by river
- Cofferdam required more sediment than stored in reservoir

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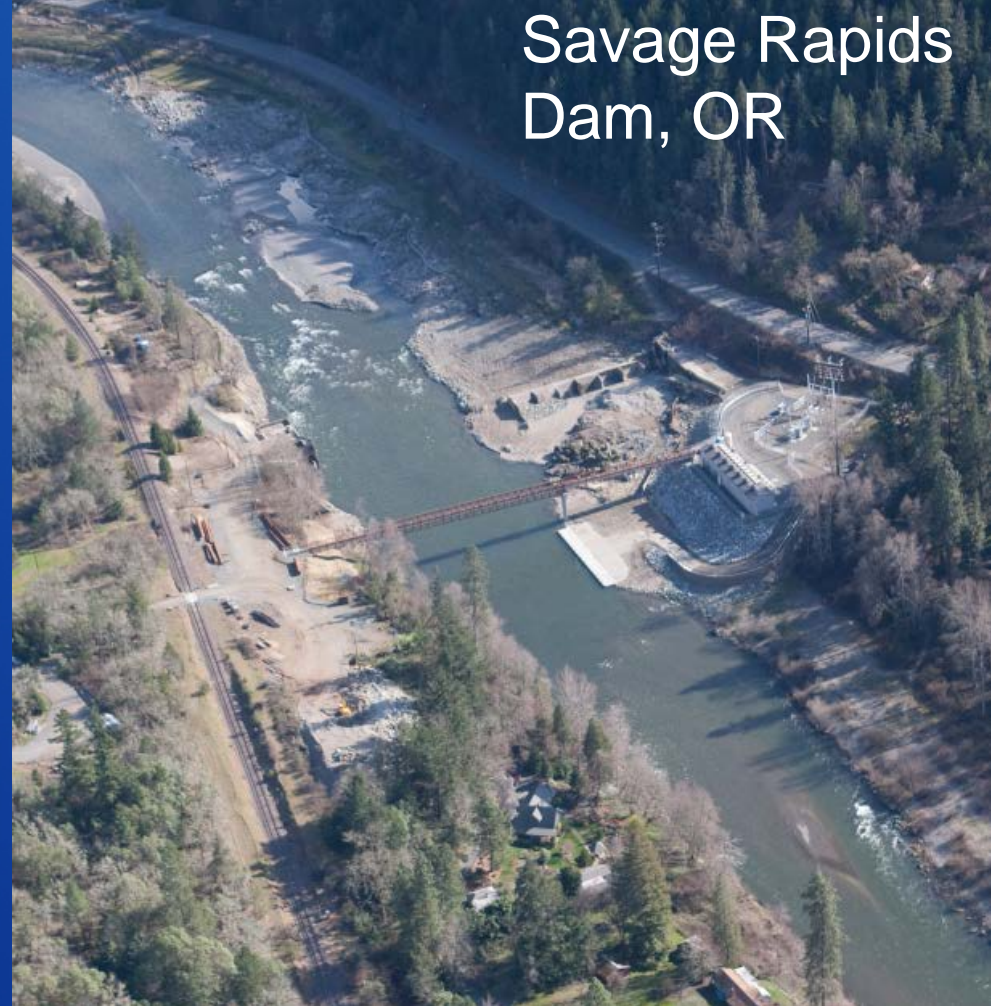
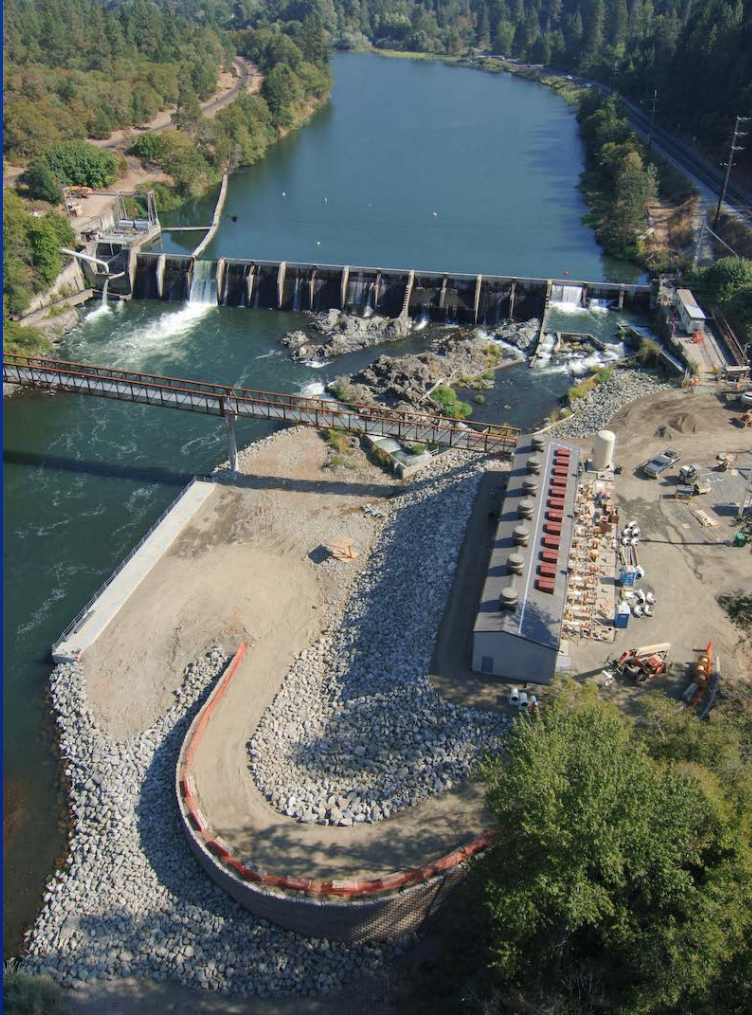
Low Sediment Risk



- Sediment 20% - 30% of river's mean annual transport capacity
- Sawed logs submerged in reservoir discovered after dam removal
- Main concern wood piling at bridge below dam

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Moderate Sediment Risk: 1 to 2 yrs average annual supply sediment



Savage Rapids
Dam, OR

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Savage Rapids Outcome



- Few downstream pools filled with sediment - no flood increase
- Short-term turbidity increase - within range of flood flow
- Burial of water intake just downstream of dam required excavation - flushed by 2-year flood one year post removal



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Guideline Completion

- Add more case examples to increase relevancy
- Share guidelines for interagency review
- Finalize and post online



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