Dam Removal:

The Form and Function of Active vs. Passive Sediment Management

CASE STUDIES - HEADWATER STREAMS AND DAYLIGHTING
&
DAM REMOVAL & POND CONVERSION

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First National STREAM RESTORATION Conference

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Levels of management

Care must be taken to understand the history of the impoundment, how it was prepped for the dam, and what happened after, which will dictate the level of management

1. **LESS COMPLEX** - Simply clearing trees and damming, low sedimentation (minimal management)
2. **MORE COMPLEX** - Excavating to enlarge reservoir, removing any evidence of the original stream/river channel and floodplain, or moving the channel from its former location
3. **EVEN MORE COMPLEX** - Infrastructure and historic fill encroachment in the floodplain and to the channel
4. **WAY MORE COMPLEX** – A larger impoundment that has accumulated significantly more sediment than can be managed by downstream sediment transport capacity
5. **WAY, WAY, WAY MORE COMPLEX** – Any combination of 2, 3, and 4

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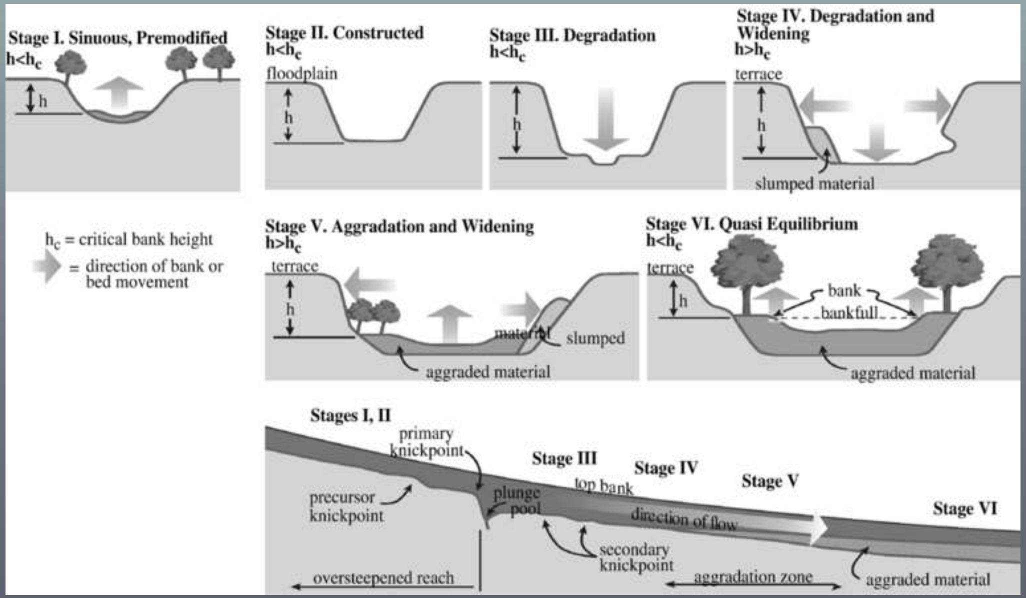
Channel Evolution Model



(Schumm et al. 1981, Simon and Hupp 1986, Simon 1989)

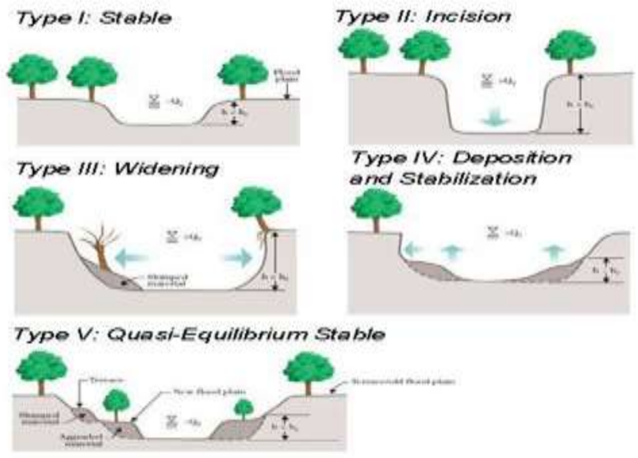


Figure 7: Channel cross sections illustrating the 5 CEM classes (NRCS 2007, Ch3).

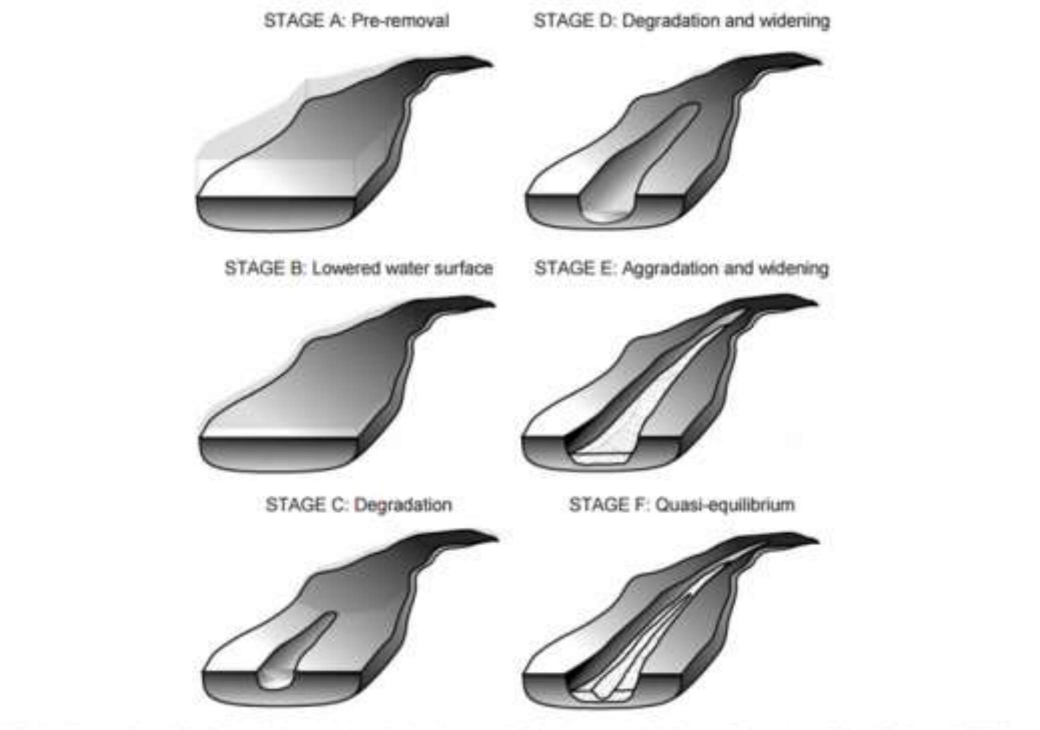
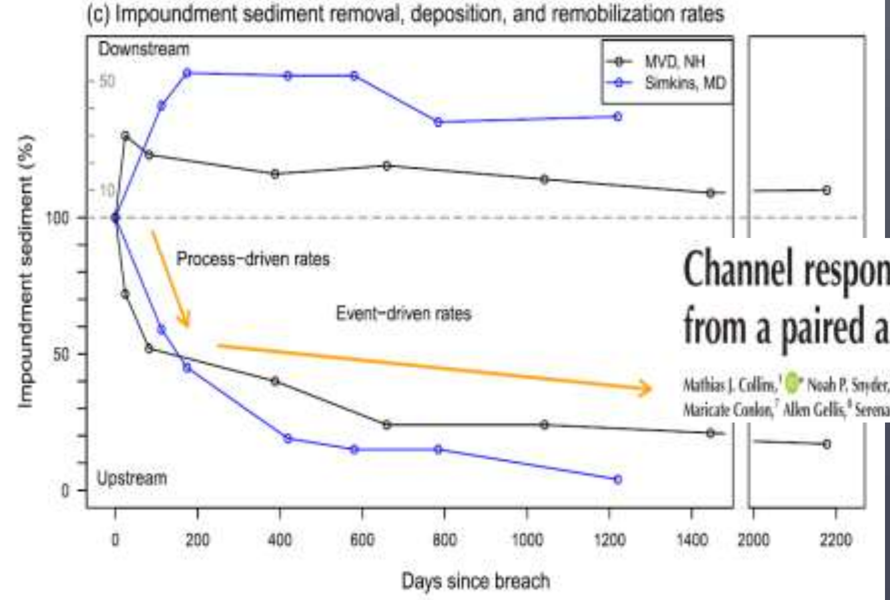


Fig. 1. Conceptual model of channel changes through time in reservoir following removal of a small dam (adapted from Doyle et al., 2003a).



Channel response to sediment release: insights from a paired analysis of dam removal

Mathias J. Collins, Noah P. Snyder, Graham Boardman, William S.L. Banks, Mary Andrews, Matthew E. Baker, Maricate Conlon, Allen Gellis, Serena McClain, Andrew Miller and Peter Wilcock

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Sediment Transport from Dam Removal: Downstream Transport

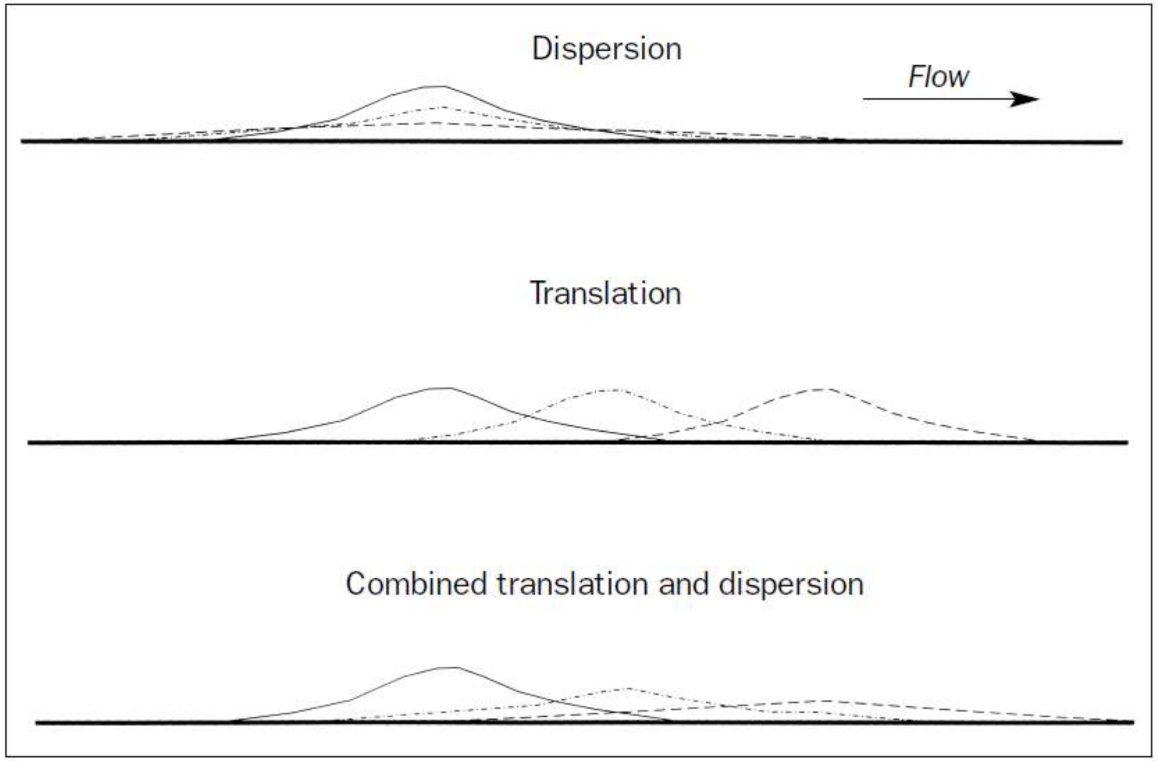
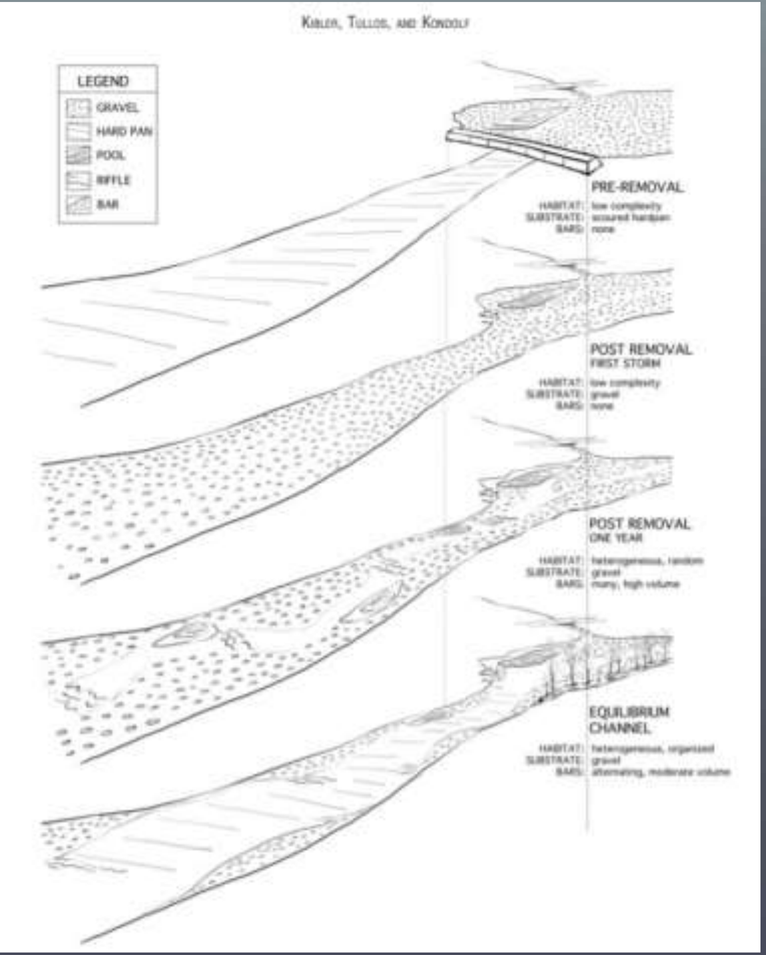


Figure 4. Dispersion, translation, and combined translation and dispersion of bed material waves illustrated in profile. The solid line represents the initial bed topography. The dashed and dotted line represents the second position of the bed, and the dashed line represents the final position of the bed (after Lisle et al. 2001).

Effects of Dam Removal on River Form and Process

JIM PIZZUTO

August 2002 / Vol. 52 No. 8 • BioScience 683



Kibler K, Tullos D, Kondolf M. 2011. Evolving expectations of dam removal outcomes: Downstream geomorphic effects following removal of a small, gravel-filled dam. Journal of the American Water Resources Association 47: 408–423.

Run-of-River Dams

- Low-head
  - No spillway controls; little storage.
  - No specific height; typically, less than 25 feet (7.5 meters) high.
  - Relate Dam Height to Channel Height?

Nationwide Permit 53 - Removal of Low-Head Dams. Structures and work in navigable waters of the United States and discharges of dredged or fill material into waters of the United States associated with the removal of low-head dams.

For the purposes of this NWP, the term "low-head dam" is defined as a dam built across a stream to pass flows from upstream over all, or nearly all, of the width of the dam crest on a continual and uncontrolled basis. (During a drought, there might not be water flowing over the dam crest.) In general, a low-head dam does not have a separate spillway or spillway gates but it may have an uncontrolled spillway. The dam crest is the top of the dam from left abutment to right abutment, and if present, an uncontrolled spillway. A low-head dam provides little storage function.

Impounded Sediment Accumulation

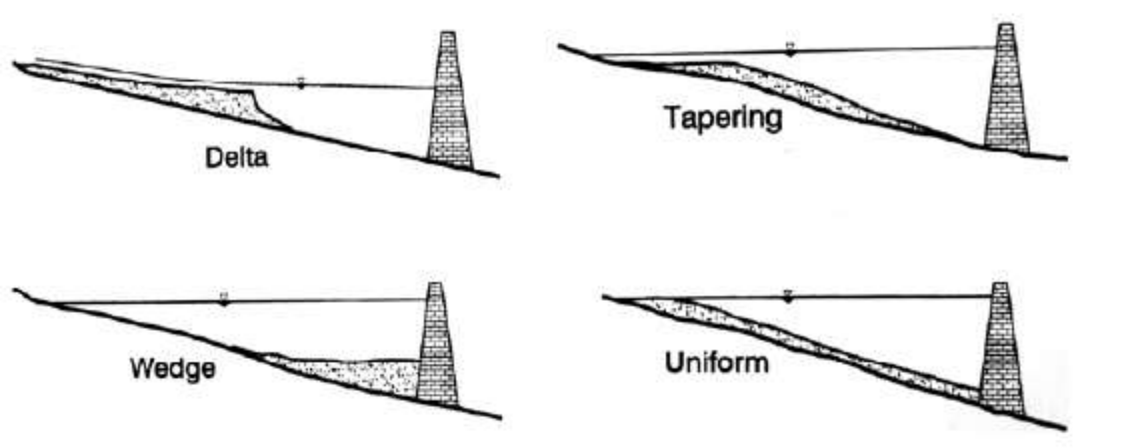
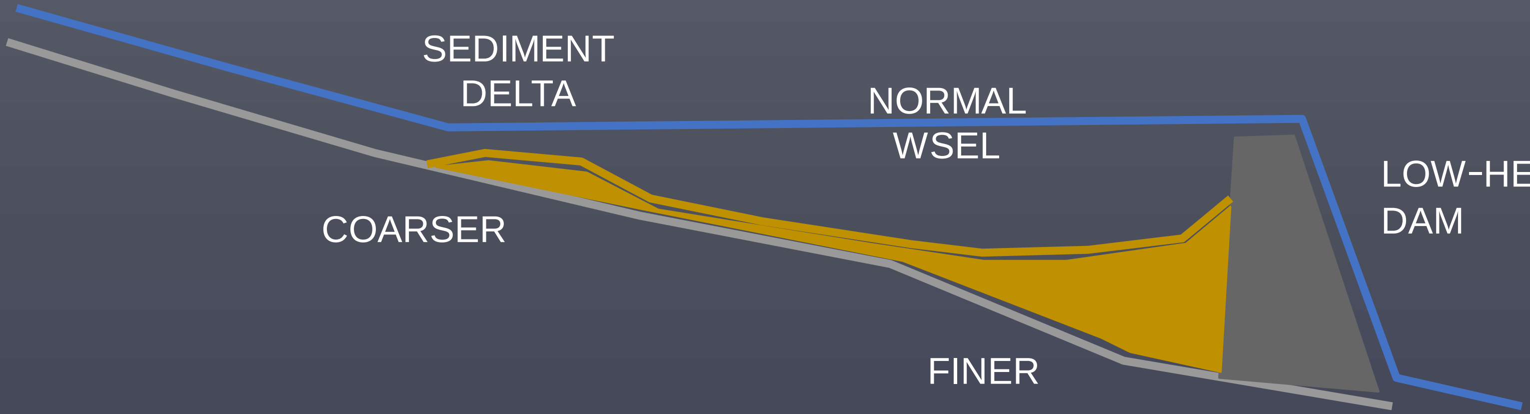


FIGURE 10.2 Longitudinal patterns of sediment deposition in reservoirs. Multiple patterns can exist simultaneously in different areas of the same reservoir.

Morris, Gregory L. and Fan, Jiahua. 1998. *Reservoir Sedimentation Handbook*, McGraw-Hill Book Co., New York.



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Sediment Management

- One of the largest factors in the cost of dam removal.

Assess:

- Quality: Contamination
- Quantity: Volume
  - Mobile vs. Total
- Risk
  - (Probability x Consequence)

Dam Removal Analysis Guidelines for Sediment

Advisory Committee on Water Information
Subcommittee on Sedimentation

USDOI, Bureau of Reclamation, 2017

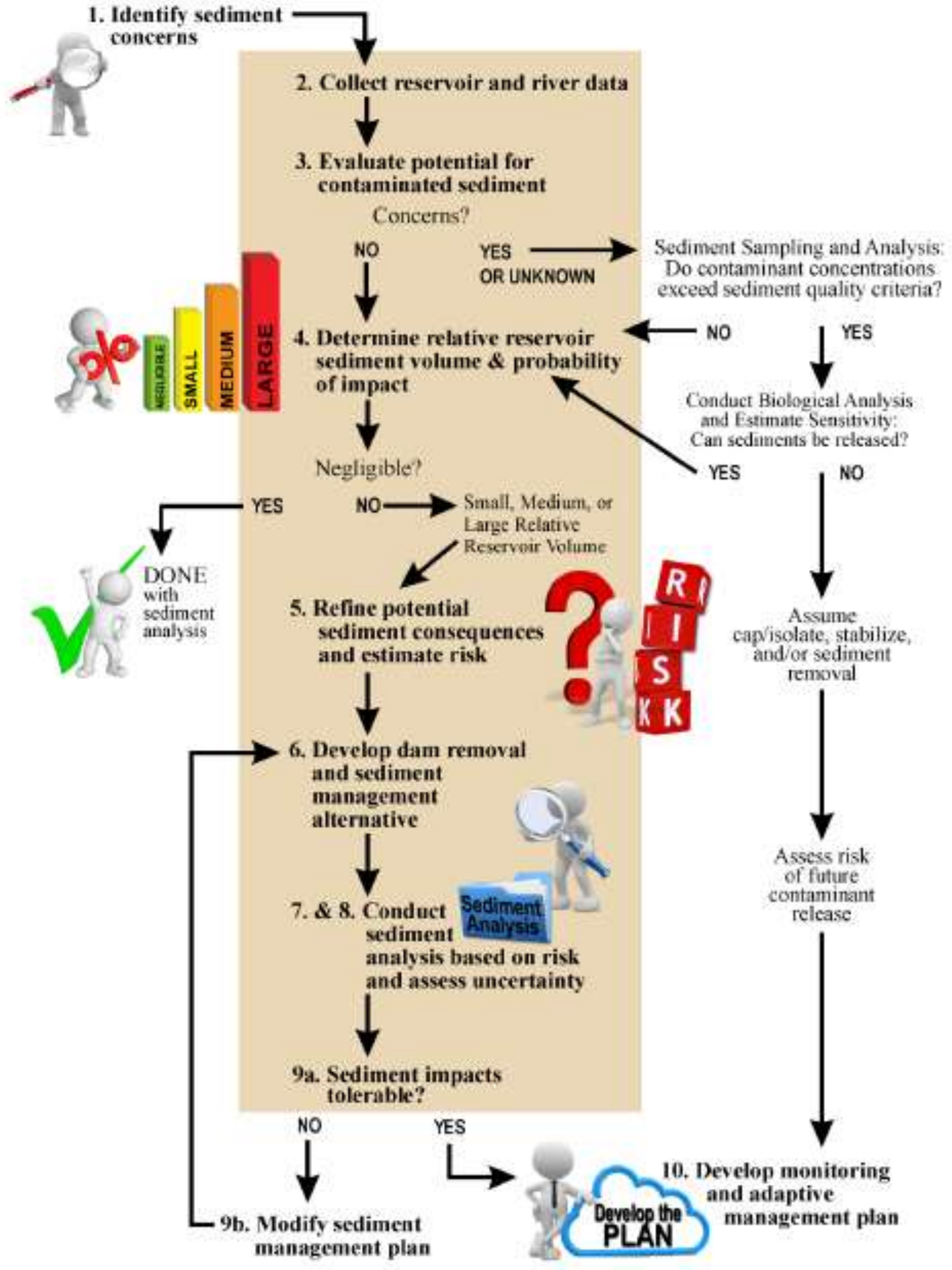
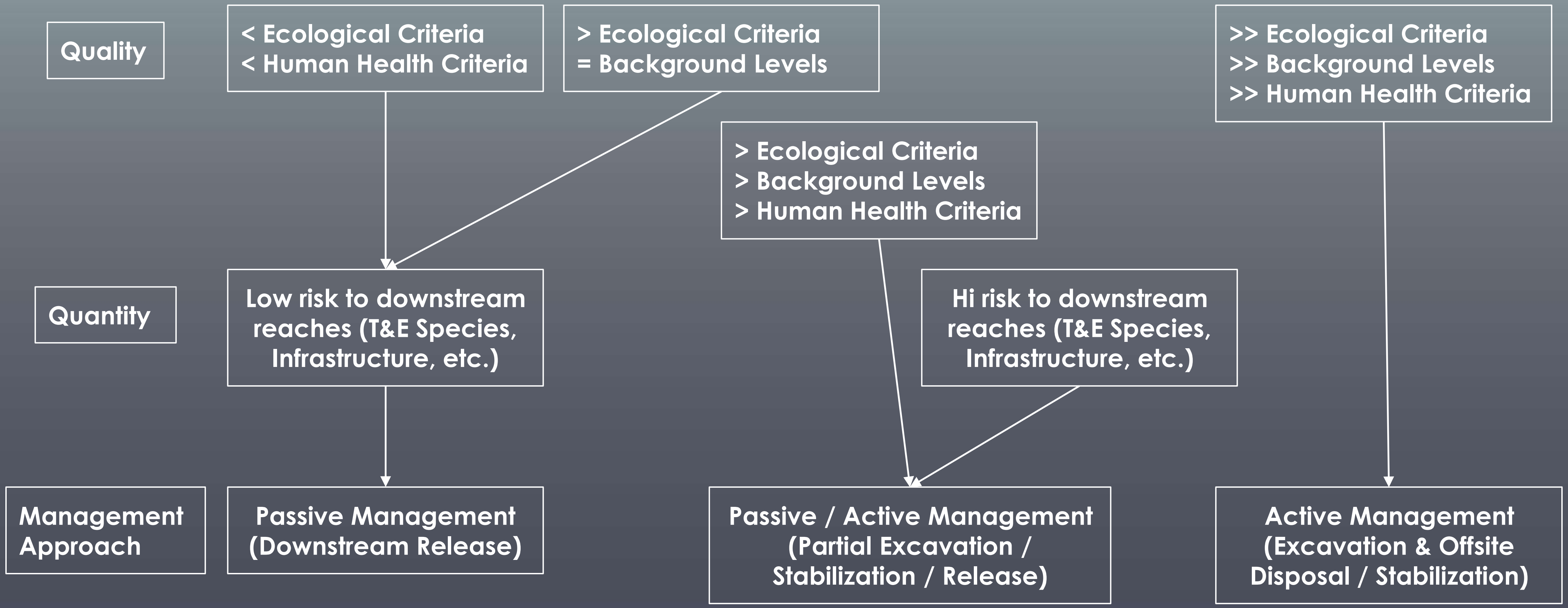


Figure 7.—Sediment analysis steps for dam removal.

Sediment Assessment Framework



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Sediment Transport from Dam Removal: Downstream Transport Modeling

Step 7: conduct sediment analysis based on risk

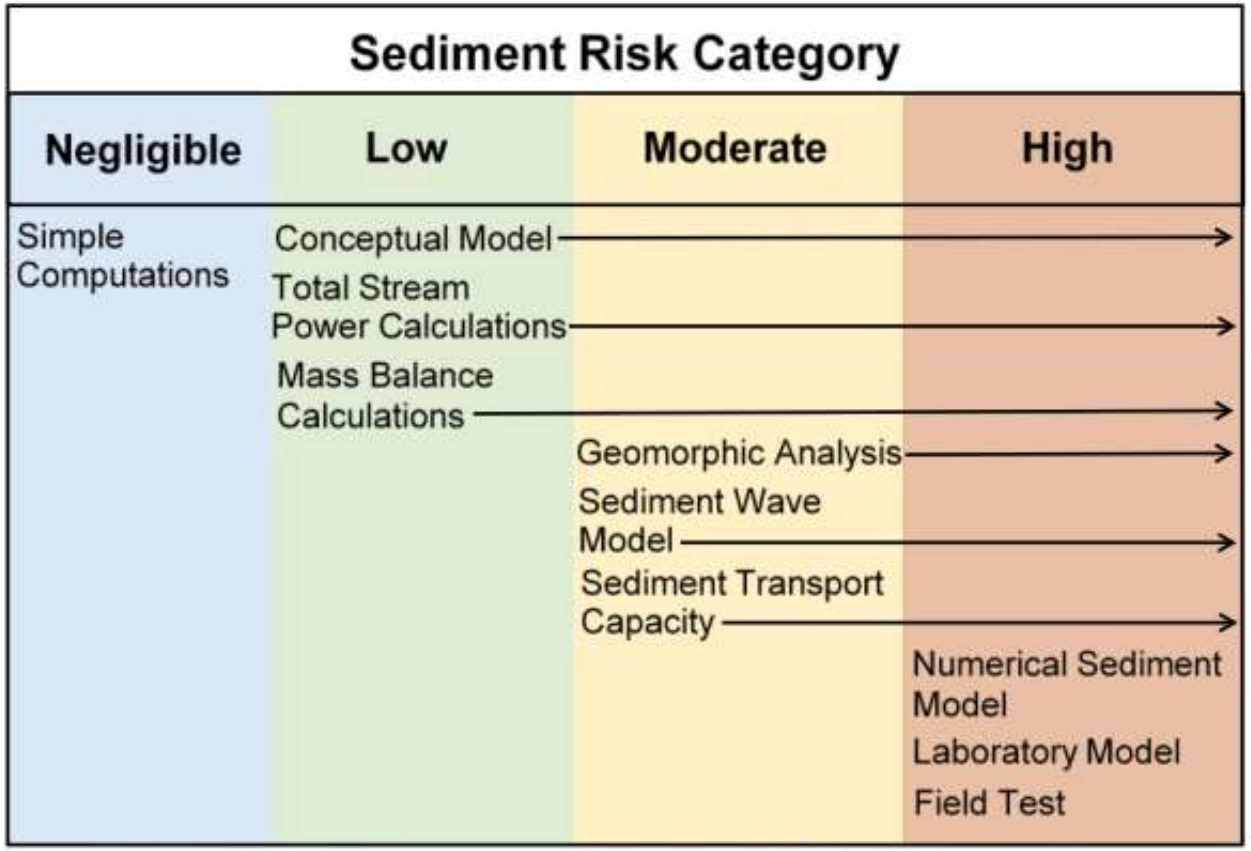

Figure 24.—Sediment analysis and modeling options for each sediment risk category.

Dam Removal Analysis Guidelines for Sediment

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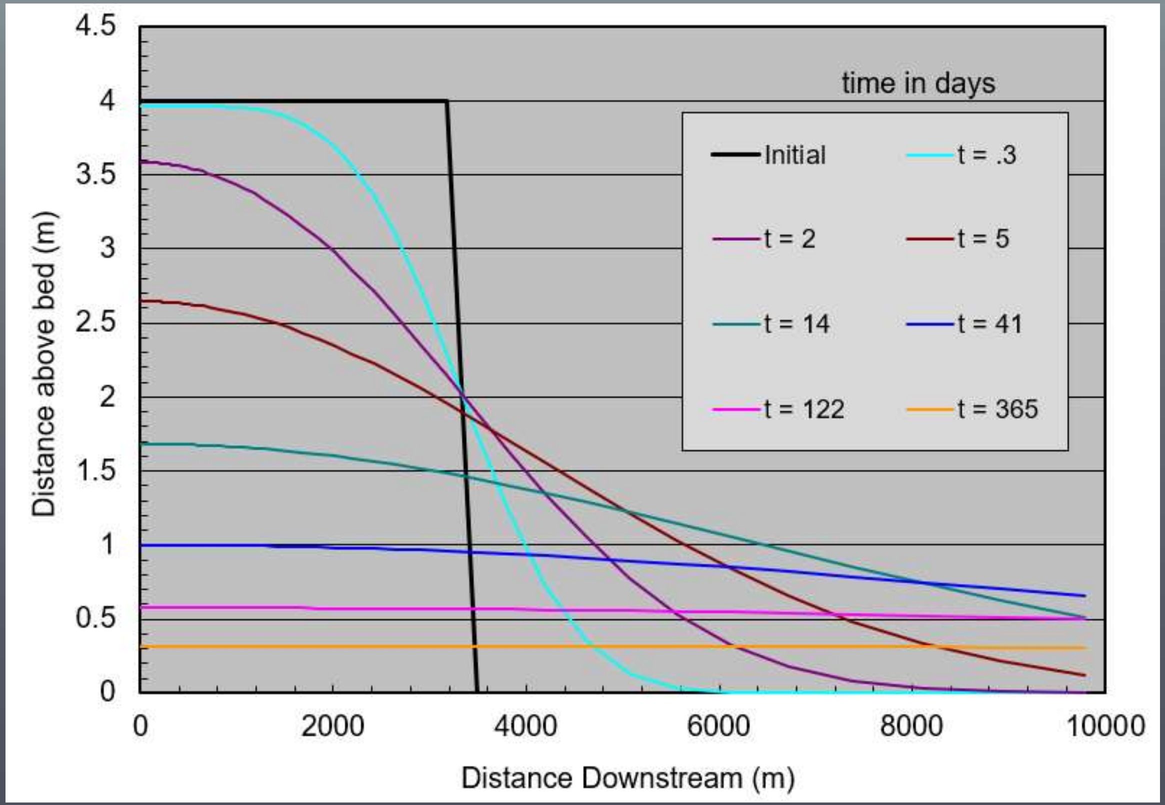
USDOI, Bureau of Reclamation, 2017

Sediment Transport from Dam Removal: Downstream Transport Modeling

Diffusive Sediment Wave Model
Blair Greimann
bgreimann@usbr.gov
303-445-2563
Greimann, B., Randle, T. and Huang, J. (2006). "Movement of Finite Amplitude Sediment Accumulations," J. Hydraulic Engineering, ASCE, Vol. 132, No. 7, 731-736.
http://dx.doi.org/10.1061/(ASCE)0733-9429(2006)132:7(731)

Step	**Description**
1	Measure height of sediment deposit in reservoir
2	Compute fraction reservoir sediment that will transport as bed load
3	Multiply height by fraction transported as bed load
4	Input height profile (z0) as function of downstream distance (x)
5	Compute downstream river slope, S0
6	Compute bed load transport rate of upstream bed material per unit channel width, G0. Use the bed material gradation of the river bed upstream of the reservoir's influence and the hydraulics in that same reach.
7	Compute bed load transport rate of reservoir sediment per unit channel width, Gd. Use the reservoir gradation and the hyraulics of the downstream channel reach.
8	Input times at which output is desired, t
9	Plot results
	Function to compute aggradation wave is written in VBA and included in this spreadsheet



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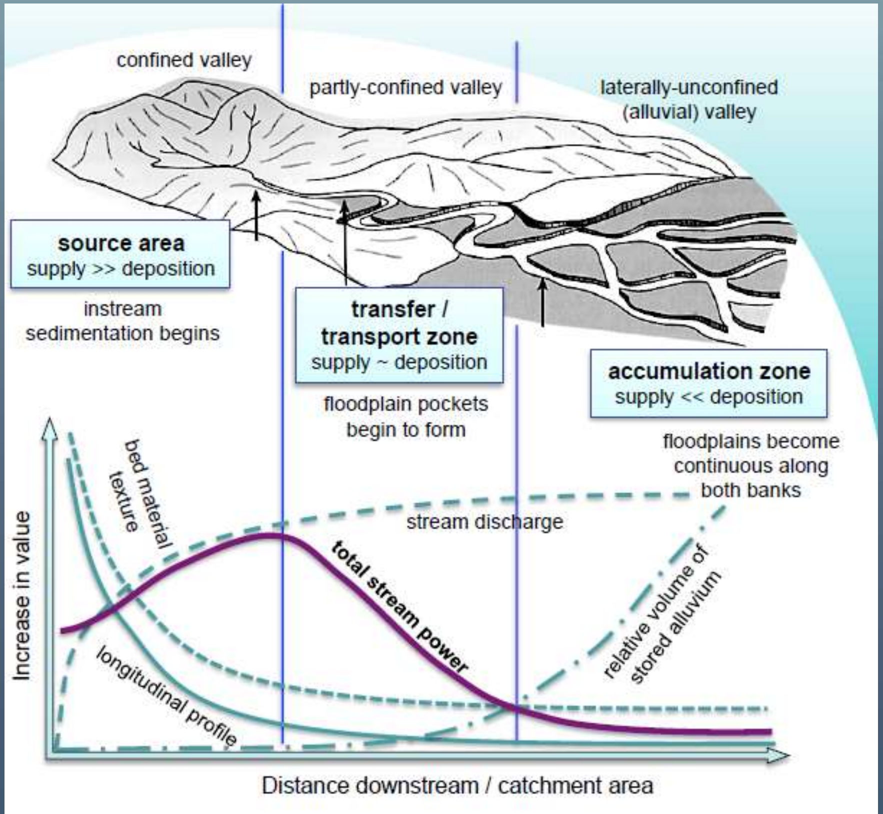
Sediment Transport from Dam Removal: Stream Power and Risk



Schematic representation of the relationship between downsteam changes along a typical stream profile, and associated transitions in sediment process zones and valley setting (*Fryirs and Brierley, 2005 & 2013; Church 1992*)

Risk of Erosion

Specific Stream Power (W/m²)	0-60	60-300	>300
Valley Confinement	>10	6-10	<6
Increase (%) in Confinement by Infrastructure	<10	10-25	>25
LEVEL OF RISK	**LOW**	**MODERATE**	**HIGH**

Risk of Aggradation (Deposition)

Specific Stream Power (W/m²)	>300	60-300	0-60
Number of slope decreases > 5%	0	1	≥2
Number of > 3rd order confluences	0	1	>1
Number of road crossings	0	1-2	>2
LEVEL OF RISK	**LOW**	**MODERATE**	**HIGH**

$$\Omega = \gamma Q s$$

$$\omega = \frac{\Omega}{w}$$

(Total) Stream Power (Ω) is the rate of potential energy expenditure against the bed and banks of the channel per unit length, and is a function of:

- specific weight of water (γ) [in N/m^3]
  γ = density (ρ) x gravity (g)
- Stream discharge (Q) [m^3/s],
- bed slope (s) [-]

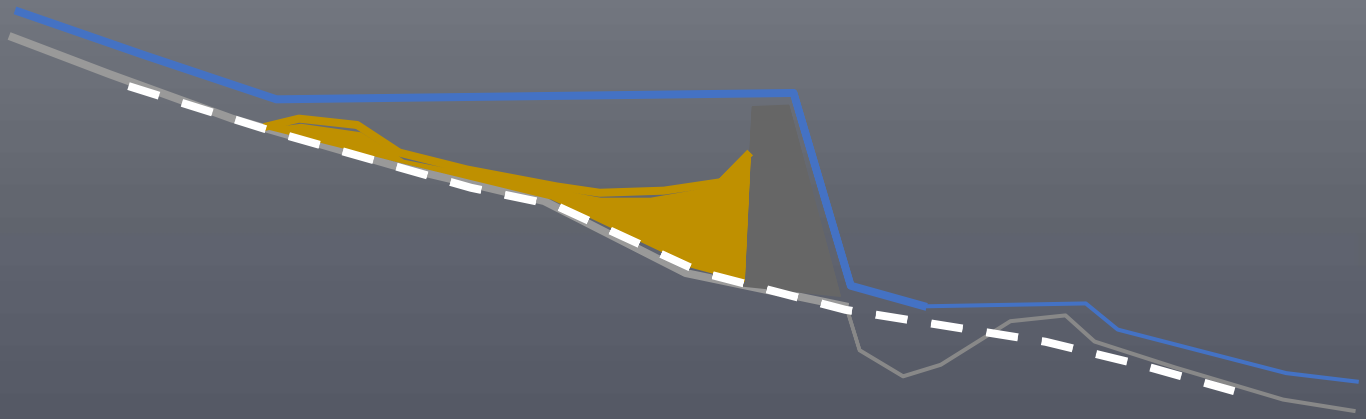
Specific Stream Power, SSP (ω) is total stream power per unit width (w), (usually bankfull width).

supporting ecologically restorative flood prevention and remediation in New England
riversmart communities

Riversmart communities et. al. (date unknown)), *Stream Power (and River Sensitivity Coarse Screening*. U Mass Amherst, https://extension.umass.edu/riversmart/sites/extension.umass.edu.riversmart/files/fact-sheets/pdf/Task_Force_StreamPower.pdf

Estimating River Profile / Equilibrium Slope Post-Dam Removal

1. Investigate the site to identify:
    - Extent of the impoundment,
    - Character and depth of uncompacted impounded sediment,
    - Geologic / geomorphic features that influence river profile.
2. Plot the survey of the longitudinal profile of the river thalweg (to scale).
3. Identify the first control point *downstream* of the dam.
4. Identify the first control point *upstream* of the impoundment.
5. Draw a line connecting the two control points.
6. Adjust this line based on probes.
7. Measure the representative slope(s).
8. Compare/contrast with the upstream and downstream reaches, and calculated values.



IT IS LESS ABOUT DESIGN AND MORE ABOUT PREDICTION.

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Dam Removal Analysis Guidelines for Sediment

Advisory Committee on Water Information
Subcommittee on Sedimentation

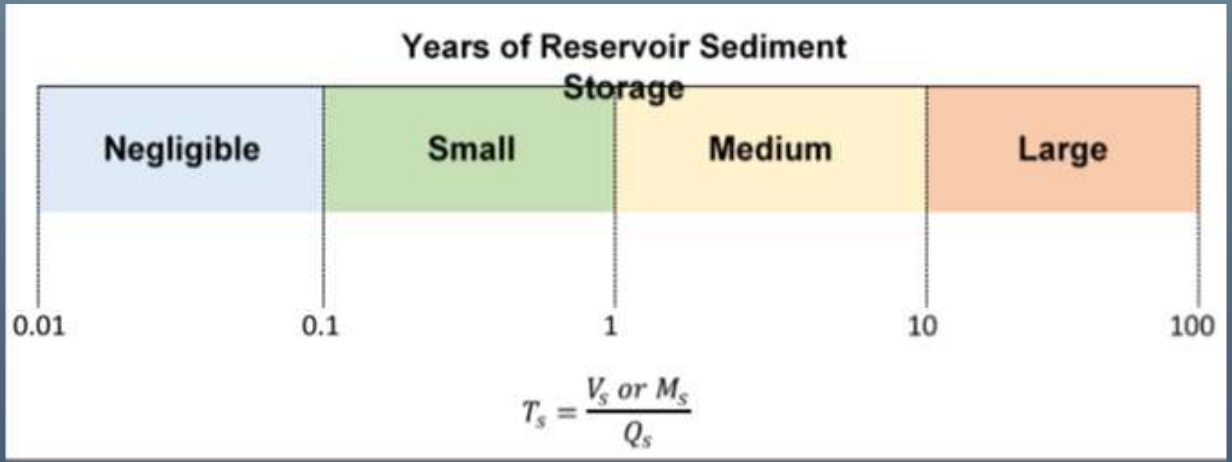
U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
Denver, Colorado

December 2017

Determine Relative Sediment Volume

Estimate average annual sediment load

To release or not to release?



***T_s* = years of trapped sediment load**
V_s or M_s = reservoir sediment volume or mass
Q_s = mean annual sediment load
:: Probability of Sediment Impact

Focus on the portion that is prone to transport, not what will remain on the floodplain.

Varying Sediment Volumes

Relating **dam height** to **channel depth** helps to indicate the magnitude of geomorphic impact.

- 1x < 5x D_{bf}
  - Small; Trap mainly Bedload Sediment
- >5x D_{bf}
  - Larger; Trap Bedload and Suspended Sediment

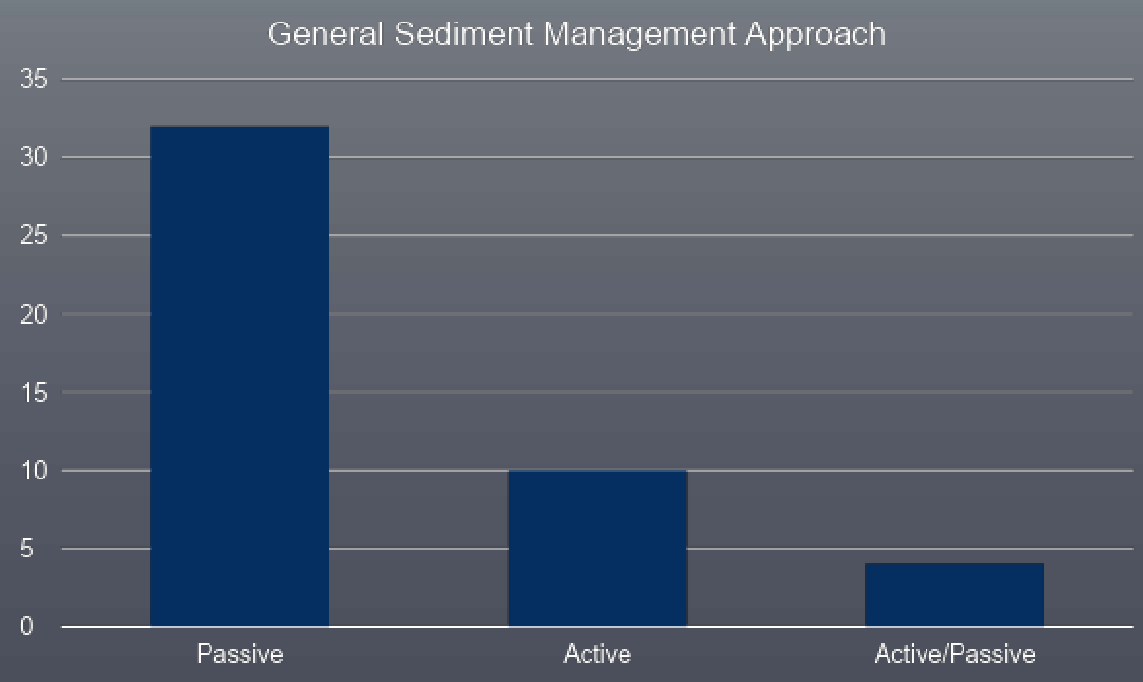
1.2 = 1.2m dam / 1m D_{bf}

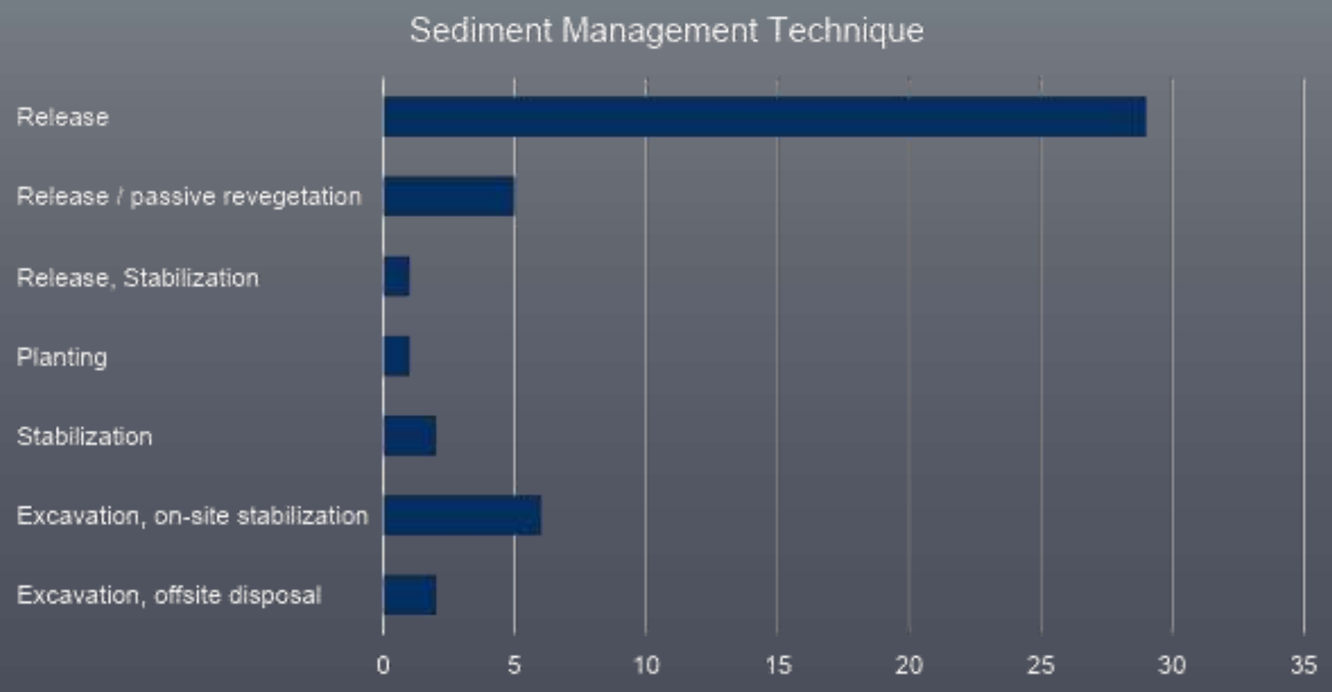
4.7 = 3.57m dam / 0.76m D_{bf}

2.1 = 1.45m dam / 0.7m D_{bf}

7.9 = 5.5m dam / 0.7m D_{bf}

Typical Sediment Management Approaches





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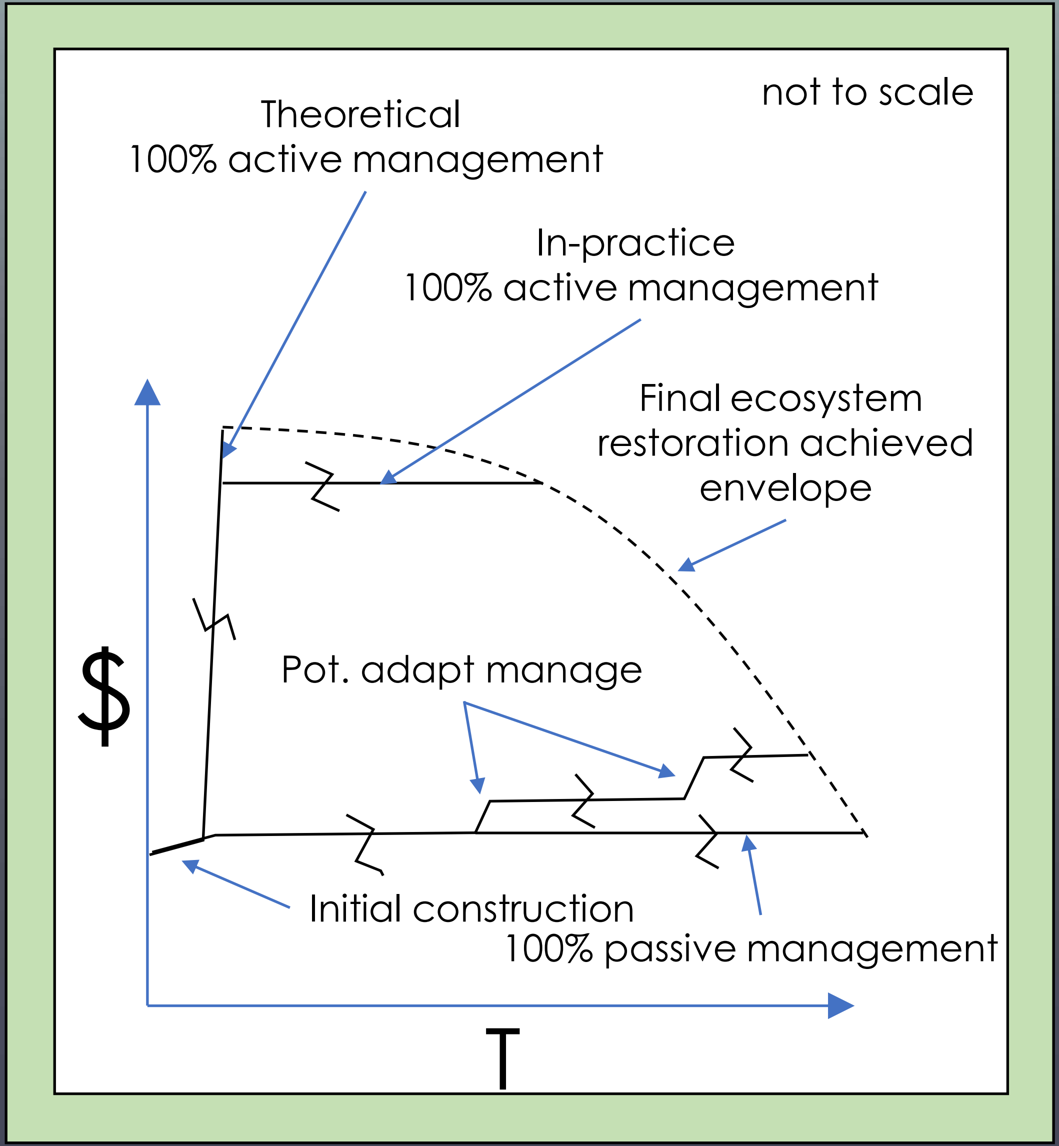
A final note on infrastructure and active management



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THANK YOU!

QUESTIONS?

If you give the river an initial push……


AMERICAN SHAD DISCOVERED JUST MILES UPSTREAM OF FORMER COLUMBIA DAM

Posted on April 22, 2019 by phadmin

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