Ecological Considerations for Dam Decommissioning

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Impacts of Dams

- Barrier Effects
- Hydrologic Alteration
- Water Quality
- Sediments
- Morphology
- Direct/Indirect Biological Impacts
- Social Perspectives

Dam Impacts

Upstream → *Impoundment* → *Downstream*

Upstream

- Reduced marine derived nutrients from migratory fish
- Aggradation
- Groundwater
- Riparian Structure

Impoundment

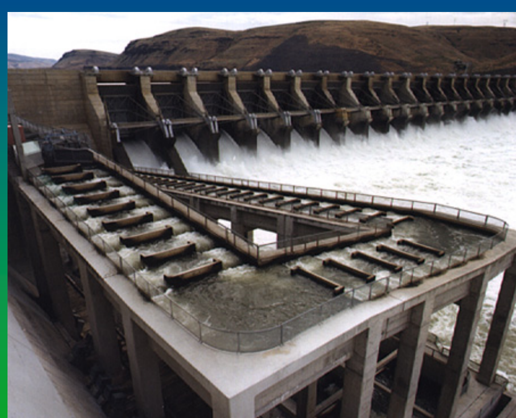
- Inundate riparian zone
- Store water, sediments, seeds, and other seston
- Altered thermal regime
- Altered gas conditions
- Nutrient conversion and storage
- Flood attenuation

Downstream

- Altered hydrology
- Reduce sediment, CPOM and seed supply
- Channel instability
- Decreased heterogeneity
- Anthropogenic disturbance

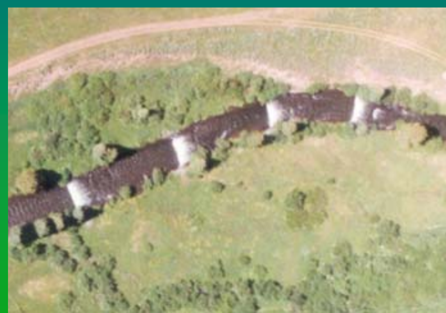
Barrier Effects

- Fish movement
- CPOM storage
- Sediments
- Invertebrates



Rio Blanco Ranch, CO

- Remove Obstructions, Improve Irrigation Ditches, Riparian
- Analytical/Reference
- Immediate Response
- ~ $30,000 / Mile

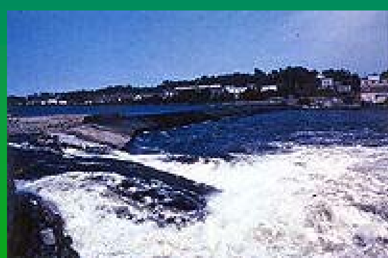


Hydrologic Impacts

- Reduced average annual runoff
- Reduced seasonal variability
- Altered timing of extremes
- Reduced flood magnitude

Water Quality

- Temperature
- Dissolved oxygen
- Nutrients
- Plankton



Nutrient flows and cycling

- The Columbia River system once received about 200,000 tons of nutrients annually from salmon runs.
- ~60% of the carbon structuring the bodies of juvenile salmon and other species is marine in origin in anadromous rivers.
- As much as 18% of nutrients supporting riparian vegetation in salmon rivers is ocean-derived.
- Salmonid fry double their growth rate post-spawning in rivers with active runs, as opposed to control rivers.

Particulate Transport

- Sediment storage in reservoir
- Reduced sediment yield downstream
- Increased plankton downstream
- Altered ice regime
- Woody debris

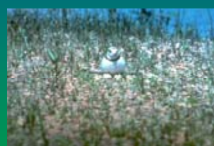
Rhine River

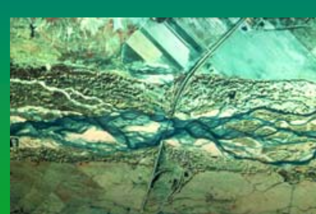
Iffezheim Barrage

Morphologic Impacts

- Upstream aggradation
- Downstream aggradation or degradation
- *f* (Q, ds, Qs, Teff)

Platte River NE





Effects of Dams on Vegetation

DOWNSTREAM

- Altered hydrodynamics
- Groundwater impacts

↓ disturbance
↓ propagule transport
↓ floodplain wetting
↑ vegetation stability
↓ patch diversity
↓ species diversity

IMPOUNDMENT

- Riverine to littoral
- Inundates vegetation
- New shoreline veg.
- Aquatic vegetation may thrive due to reduced turbidity, thermal & flood reg.

Dam effects are highly variable

More exotics below small dams

- Minimal alteration of the flood regime
- Exotic species potentially washed downstream from the disturbed area near dam site

- Reduced propagule transport
- Altered flood regime

Fewer exotics below large dams

Macroinvertebrates

- Barrier Effects
- Reduced Diversity
- Increased Biomass
- Community Shifts
- *ƒ* (Q, ds, D, V, Stab)

Fish

- Barrier Impacts
- Lotic to Lentic Shift
- Tailwaters
- Gas Supersaturation

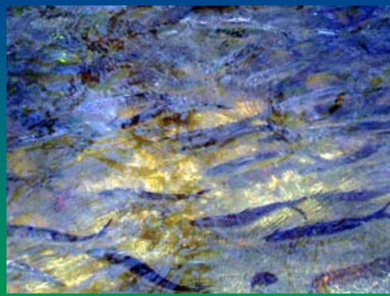
Dams and Ecosystem Impacts

- Altered sediment, hydrologic, woody debris, and ice regimes
- Habitat fragmentation
- Nutrient cycling and flow impacts
- Water quality and thermal regimes
- Major impacts on T&E, anadromous, catadromous, and adfluvial populations
- Mix of lentic and lotic habitats alters predation regimes and other life history processes
- Dams encourage floodplain development and discourage spatial and temporal dynamism

Is Removal Beneficial?

Cited reasons for removals

- Environmental--43%
- Safety--30%
- Economics--18%
- Failure--6%
- Unauthorized structure--4%
- Recreation—2%

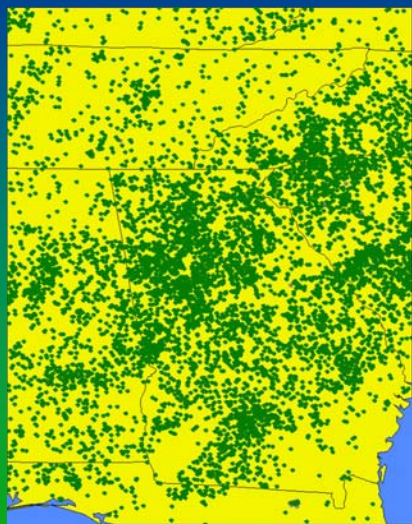


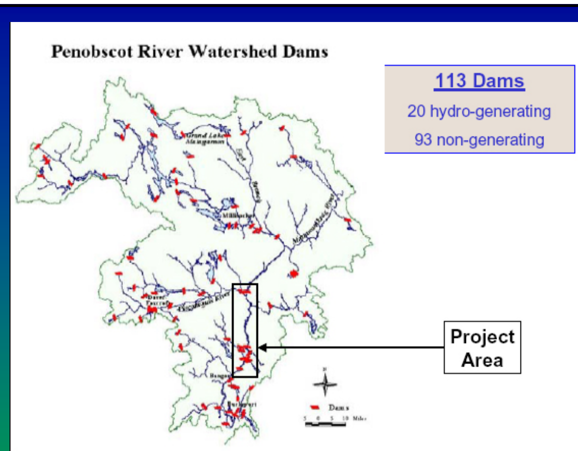
(American Rivers et al., 1999)

Public safety and desire to save costs of repair usually drive removal, not restoration goals (Born et al., 1998)

Statistics

- 68,000 large dams in U.S.
- Est. 2,500,000 total dams
- Impounded water 5X free-flowing water
- 85% of dams will reach their design life by 2020

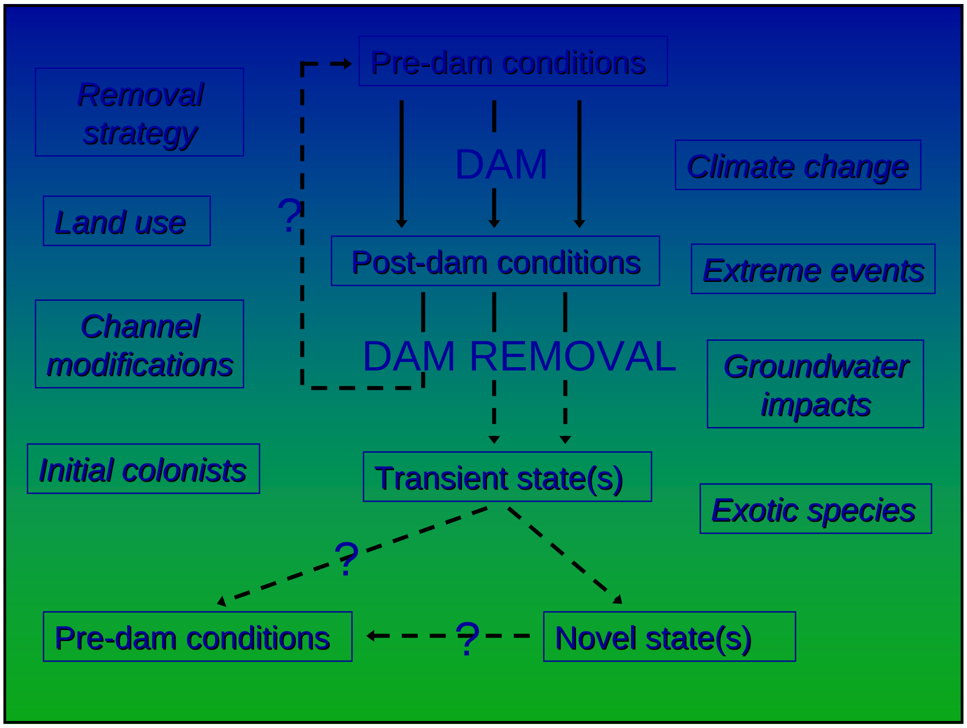




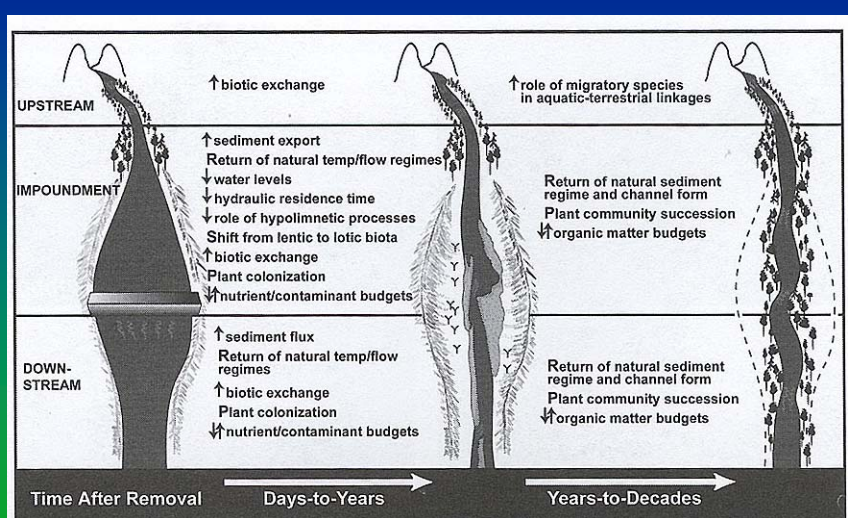
Species	Current	Potential
Alewives	Below 1,000	4-6 million
Atlantic salmon	Below 1,000	10,000-12,000
American shad	Near 0	1.5 million

Potential Adverse Impacts

- High Turbidity
- Downstream Aggradation
- Upstream Headcutting and Erosion
- Release of Contaminants or Nutrients
- Exotic Species Exploitation
- Vegetation Impacts
- T&E Species Stress
- Altered Ice Regime



Realistic Expectations for Response



From Hart, D.D, T.E Johnson, K.L. Bushaw-Newton, R.J. Horwitz, A.T. Bednarek, D.F. Charles, D.A. Kreeger, and D.J. Velinsky (2002) "Dam removal: Challenges and opportunities for ecological research and river restoration." BioScience, Vol. 52, No. 8, p. 669-681.

Dam decision metrics

- Physical
  - Hydrology and hydraulics
  - Sediment budget, storage, and properties
  - Channel and valley morphology
  - Headpond capacity
- Chemical
  - WQ and temperature
  - Sediment contamination
- Biological
  - Aquatic and riparian ecosystems' processes and functions
  - Recovery of T&E populations
  - Keystone population needs
- Economic values
  - Site, reach, and system values w/dam and w/o dam(s)
  - Regional economies
  - Flood risk
  - Relevant infrastructure
- Social and legal
  - Ownership
  - Tribal rights
  - Safety and liability
  - Aesthetics and cultural

Considerations

- Acceptable Risk and Uncertainty
- Degree of Potential Impact
- Recovery Potential
- Physical Constraints
- Public Perception
- Available Data
- Costs