Dams and Gravel Mining: Alteration of Watershed Function in the Pacific Northwest

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Abstract

Did you know that there are nearly 75,000 dams in the continental US and they are wreaking havoc on river hydrology and ecological services across the country? These dams were built with good intentions such as providing jobs, flood control, and energy production. However, dams have significantly impacted river hydrology and riparian habitats.

Here in the Pacific Northwest, there are 2,048 dams and many are no longer in use. There is currently a trend by some river managers to remove dams and restore rivers to their unaltered state.

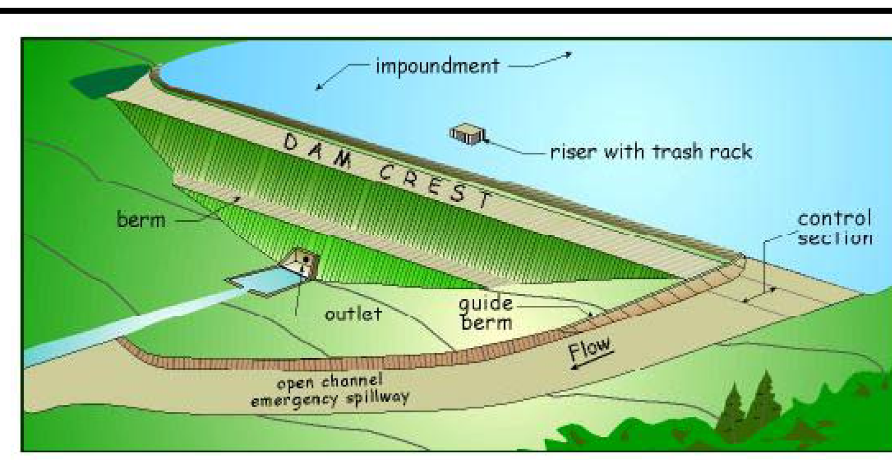
Several of the related problems identified in the Northwest include the amount of sediment accumulated behind the dams, downstream erosion, and the practice of in-stream gravel mining. Gravel mining involves the removal of sediment from the channel for use in construction materials. Gravel mining adds to the effect of downstream erosion with significant alteration to the channel bed, armoring of gravel, and loss of spawning habitat for salmonids.

Introduction

Out of the nearly 75,000 dams in the lower 48, the Pacific Northwest contains about 2,048 and many are adding to river degradation, as affected by years of dam's operation (Graf, 1999). If a dam closes, there is the issue of what to do with it. Is it most feasible to drain it and remove it or is it better to just leave it there because removal would cause only more problems? For instance, dam removal commonly releases sediment back into an eroded fluvial system, thus increasing bed load and causing aggradation downstream.

How Dams Work

- By definition, it is a structure that blocks the flow of a river, stream, or other waterway (Figure 1).
- This dramatically changed the discharge of river which diminishes the amount of sediment the river carry.
- Up stream of the dam, all bedload sediment and a significant proportion of the suspended load accumulates behind the dam.
- Down stream, there is excess energy available to move sediment, and channel scour is common.
- The net result is downstream erosion and upstream aggradation (Kondolf, 1997).



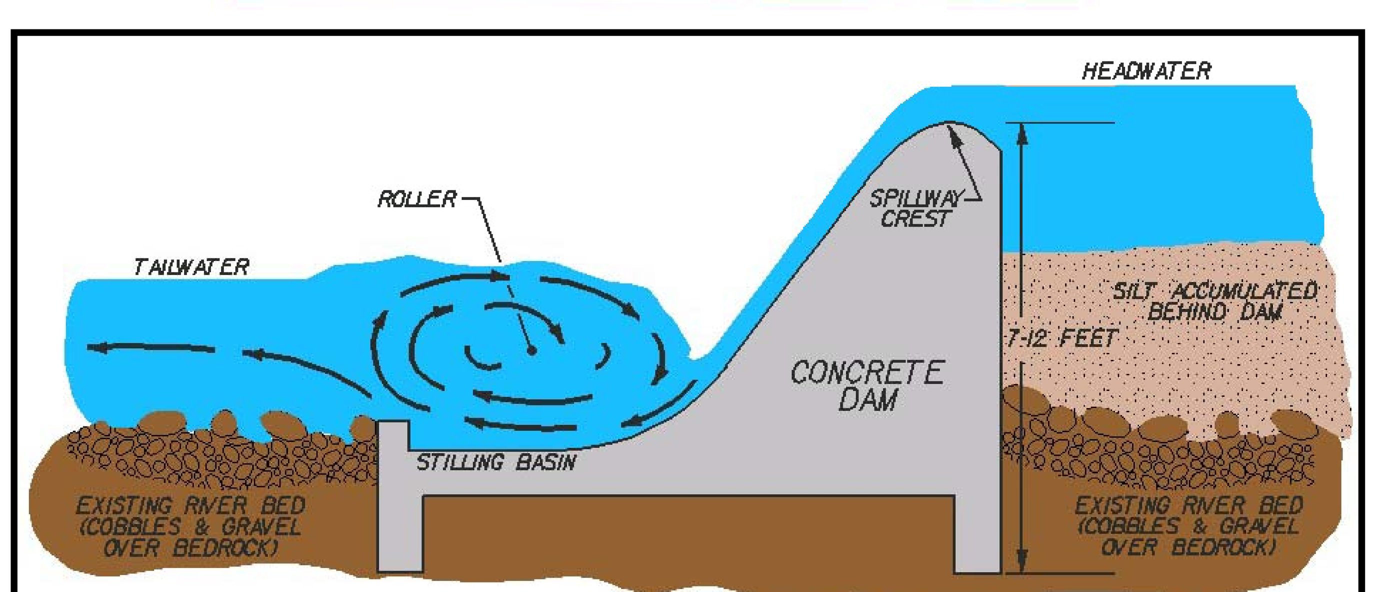


Figure 1. Cross section and diagrammatic sketch of a dam (ODNR, 2008; Curry, 2008).

Gravel Mining

Gravel mining involves the removal of sediment from the channel for use in construction materials, particularly sand and gravel. These sediments are commonly removed from the river's floodplain, terraces, and channel. Resulting mine pits in the channel alter the gradient of the stream and commonly encourage channel incision. In-stream mining also leads to lateral channel incision and bed coarsening, all of which promotes channel instability. Secondary effects include elevated water temperatures and loss of woody debris that provides cover for aquatic life.

Floodplain pit mining can transform riparian woodlands and affect the water table. These pits can be breached by bank erosion and overflowing flood waters (Figure 2; Kondolf, 1997).

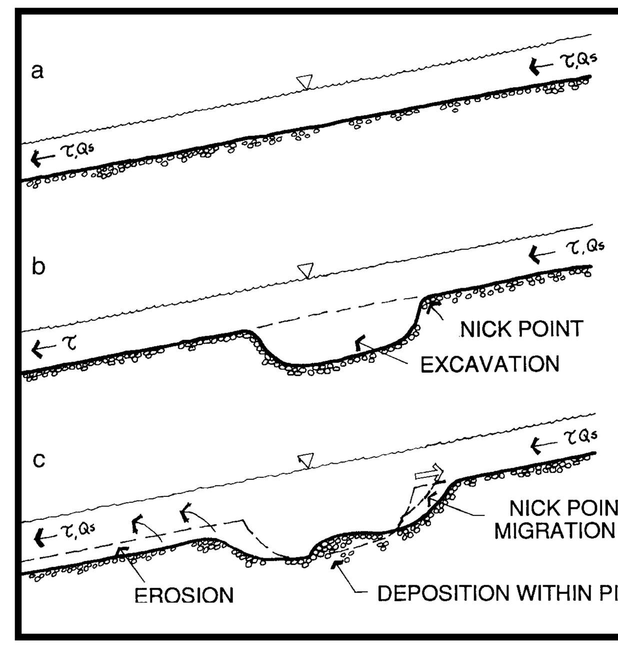


Figure 2. Incision produced by instream gravel mining. **A.** The initial, preextraction condition, in which the river's sediment load (*Qs*) and the shear stress (τ) available to transport sediment are continuous through the reach. **B.** The excavation creates a nickpoint on its upstream end and traps sediment, interrupting the transport of sediment through the reach. Downstream, the river still has the capacity to transport sediment (τ) but no sediment load. **C.** The nickpoint migrates upstream, and hungry water erodes the bed downstream, causing incision upstream and downstream. (Reprinted from Kondolf 1994, with kind permission of Elsevier Science-NL.)

Ecological Implications

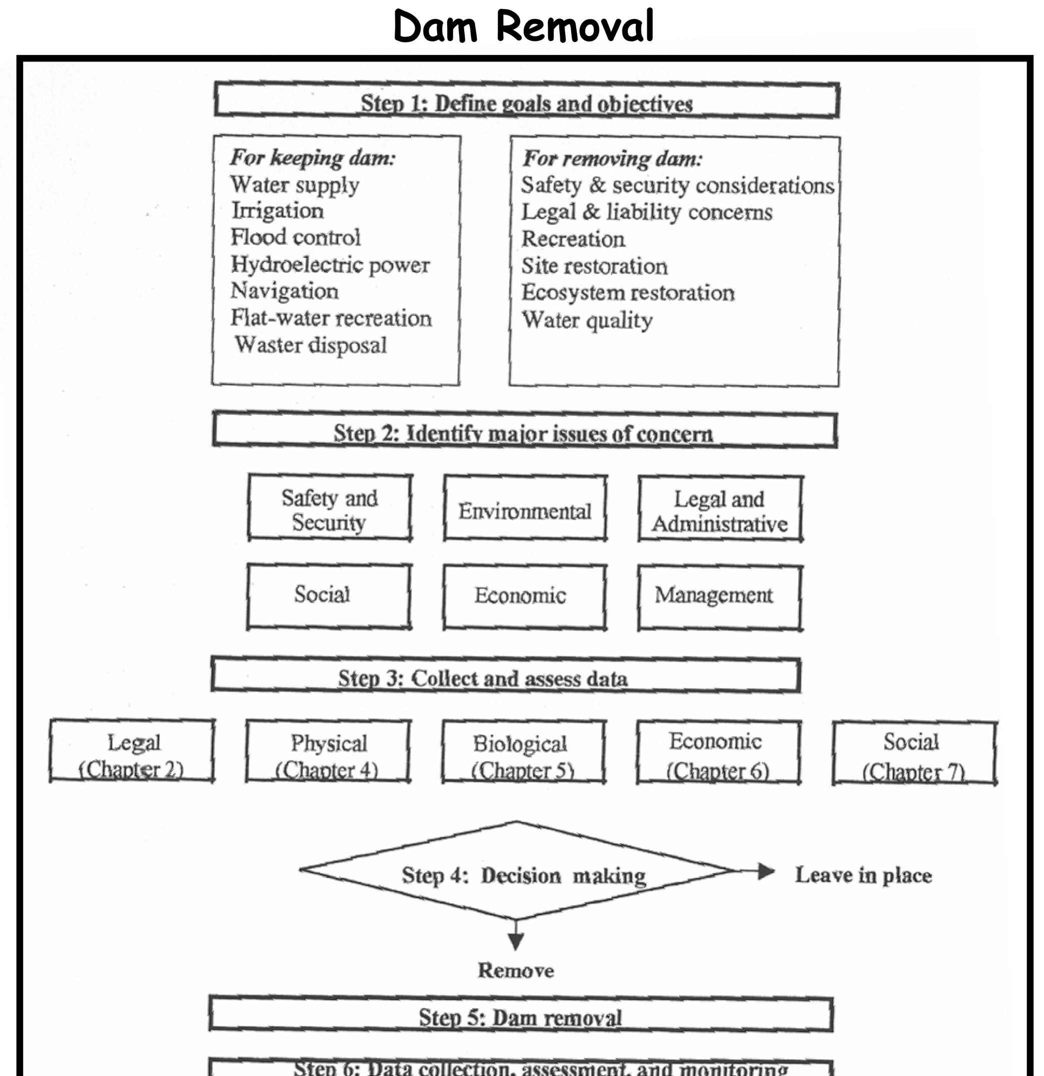
1 – Dams inhibit native salmonids ability to reach spawning grounds.

2 –Woody debris contaminants trapped behind the dam can lead to poorly oxygenated water.

3 –Dams can lead to decline in wetland area.

4 –Exotics species invasion of the riparian zone may also be a consideration.

Dam Removal



(Heinz Center, 2002)

Figure 3 . A general method for dam removal decisions

Dams in the Willamette River Basin

- There are 25 major dams in the Willamette basin, including 11 hydropower dams operated by public and private utilities, one multipurpose dam on the Tualatin River, and 13 multipurpose reservoirs (flood control, hydropower, recreation) operated by the U.S. Army Corps of Engineers (Figure 4, Northwest Power & Conservation Council, 2008).
- Most of the hydroelectric dams in the High Cascades don't store much water and do little to affect the natural hydrology (Grant et al. 2003).

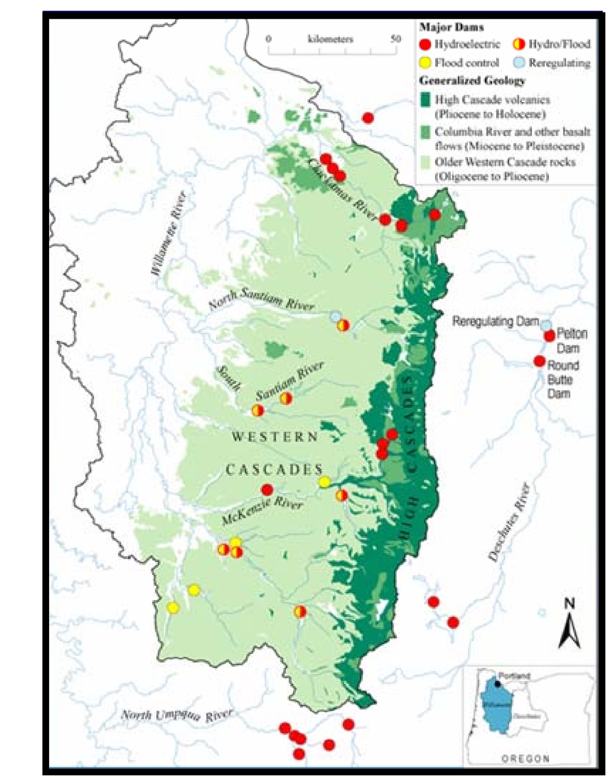


Figure 4. Map of dams in the Willamette Basin (Grant et al. 2003) with examples from Big Cliff Dam, North Santiam River; and Marmot Dam breach, Sandy River.

Conclusion

(1) Dams in spite of their useful purpose, can lead to serious environmental problems, if not thoroughly planned.

(2) Gravels should be returned to the river to help restore natural hydrology and to prevent erosion.

(3) By returning gravels, the river can efficiently work relative to the amount of discharge and maintain a sustainable spawning habitat.

(4) Dam removal must be will thought out to avoid inadvertent harm to the environment.

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