NCASI Fact Sheet
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Forest Harvest Effects on Low Flow

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Introduction

Seasonal low flow is critical for human water supply during prolonged dry periods, and is important for aquatic biota and riparian vegetation. In some regions, such as the Pacific Northwest, this dry period coincides with the growing season when evapotranspiration rates are elevated. Understanding the influence of forest management on seasonal low flow is increasingly important with a changing climate.

What effect will climate change have on surface waters?

Long-term declines in snowpack have been observed in the western US and Canada (Déry et al. 2009, Mote et al. 2018). Declines in annual, summer, and peak streamflow have also been observed over multiple decades in the Pacific Northwest (US and Canada) (Kormos et al. 2015, Najafi et al. 2017, Forbes et al. 2019). Other anthropogenic stressors contribute to these declining trends (irrigation and drinking water extraction). Climate change is also expected to increase drought severity in many regions globally (Pokhrel et al. 2021).

A forested Pacific Northwest stream at the onset of the seasonal low flow period
Photo credit: Ashley Coble

How does forest succession affect seasonal low streamflow?

Seasonal low streamflow declines can occur decades after harvest

The expected hydrological response to harvest varies with time as forests regrow and can include positive, neutral, or negative responses, as illustrated in Figure 1 (Coble et al. 2020). A review of long-term low flow responses from 25 watersheds across the US and Canada revealed a consistent increase in low flow within the first 5 to 10 years, followed by variable responses, and then declines in seasonal low flow occurred in the majority (16/25) of watersheds several decades after harvest (Coble et al. 2020).

Which factors affect variable low flow responses?

- Forest characteristics (age, species, regeneration)
- Forest practices (riparian buffers, size of harvest units, silvicultural activities/methods)
- Changes in soil conditions
- Low-flow metrics (differs across studies)

How may long-term climate trends interact with forest management?

The opposing directionality of expected streamflow responses due to forest harvest (positive) versus climate change (negative) have been suggested to potentially off-set each other. However, if long-term effects of harvest are negative, then climate-related declines may be exacerbated as stands age.

Do low flow responses persist downstream?

As watershed size increases, less of the watershed is harvested at once and a mosaic of stand age classes occur. Nested stream gages from Mica Creek Experimental Watersheds in Idaho reveal that as watershed size increased, the magnitude of low flow response was reduced (Coble et al. 2020). Of 7 large watersheds reviewed (range in size from 401 to 3500 km^2) by Coble et al. (2020), low flow declines were not observed and increases in stream flow occurred in 3 of the 7 watersheds.

Are aquatic organisms affected by long-term low flow declines?

Few studies have simultaneously documented long-term low flow declines and aquatic biota response. Where these responses have been evaluated, biota do not appear to have been adversely affected by low flow declines (Coble et al. 2020). For example, despite a legacy of declining low flow in the Alsea watershed, fish populations recovered from historical harvesting (Bateman et al. 2018, Segura et al. 2020).

Will overstory thinning alleviate seasonal low flow declines?

Thinning has been proposed as a strategy to enhance water availability for streams that experience long-term low flow declines, but very few studies have examined these effects. Only heavy thinning (50% to 75% of overstory removal) may elicit an increase in water availability for soil moisture, streamflow, or nearby tree growth. These effects, however, are typically short-lived. Less intensive thinning treatments do not appear to increase water availability (Coble et al. 2020).

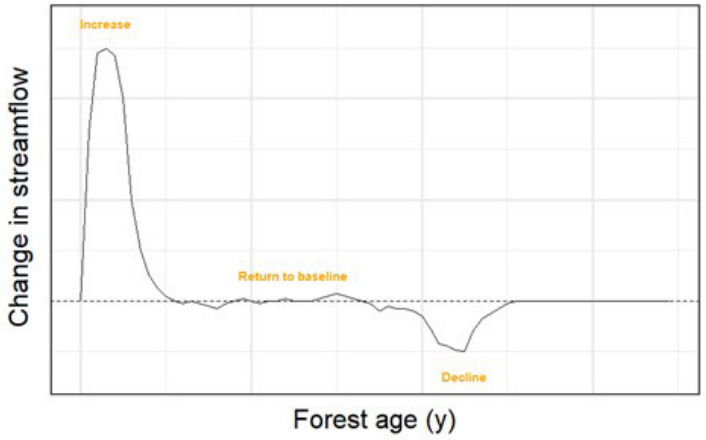
How may riparian buffers affect low flow responses?

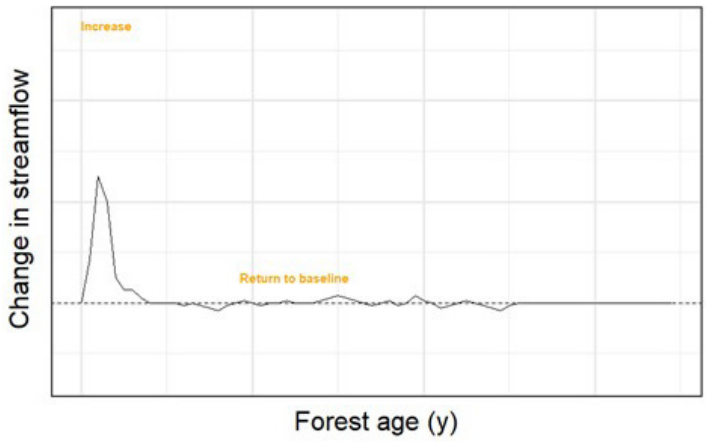
The role of riparian buffers in contributing to low flow declines is unclear. Riparian buffers comprised of young, dense stands of 49- to 61-year regenerating red alder and Douglas-fir trees may contribute to elevated evapotranspiration rates and low flow declines (Segura et al. 2020).

Historical vs. contemporary practices

The majority of studies evaluating long-term effects of forest harvest on streamflow have documented responses following historical harvest practices. More information is needed to understand how current practices, such as retention of riparian buffers or having a smaller proportion of watershed harvested at once, may affect low flow at long timescales.

Figure 1. Seasonal low flow responses to harvest with time can include positive, neutral, or negative responses. Declines occured decades after harvest in 16/25 watersheds, similar to the response observed in the top panel. In some other locations, declines were not observed at similarly long time-scales (bottom panel).





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