Evaluating Future Water Supply Scenarios in Mount Rainier National Park

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I. Abstract

Mount Rainer National Park (MORA)'s water supply primarily depends on streams and lakes fed by snowmelt and perennial snowfields. Declines in annual snowpack and increased air temperatures, as well as increasing park visitation, are expected to stress the park's water supply systems. Here, we scaled region-wide streamflow projections under multiple emissions scenarios to water supply intake drainage basins in order to estimate future trends in the magnitude and temporality of surface flows available for park use. These estimates inform management recommendations for increased storage capacity and exploration of alternative water sources as MORA adapts its infrastructure in response to climate change.

II. Background

MORA's most drought-sensitive water supply systems rely entirely on intakes located above barriers on snowmelt-fed surface streams. Three systems located in the drier East side of the park – White River Entrance, Stevens Canyon, and Ohanapecosh – are particularly susceptible. Throughout the Northwest, climate change is expected to drive declines in snowpack and shift peak runoff earlier, which may limit water availability late in the summer[1]. Park managers saw a preview of what future conditions may look like in water year 2015[2] (Fig. 1).

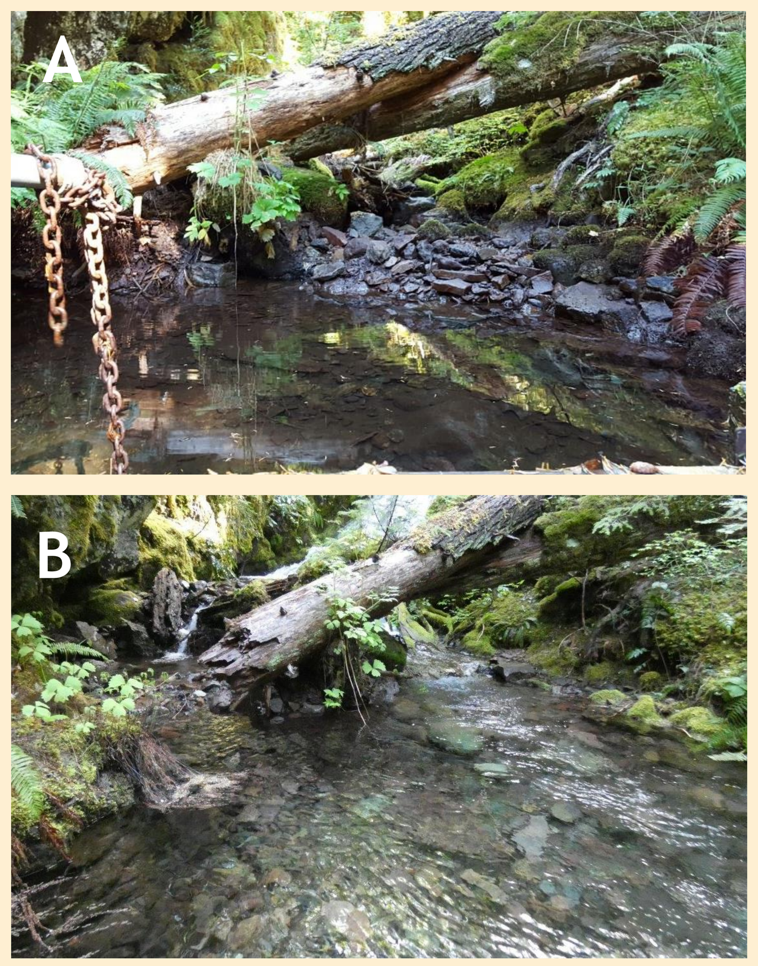

Figure 1. *Ohanapecosh water supply intake in (A) 2015 and (B) 2018.*

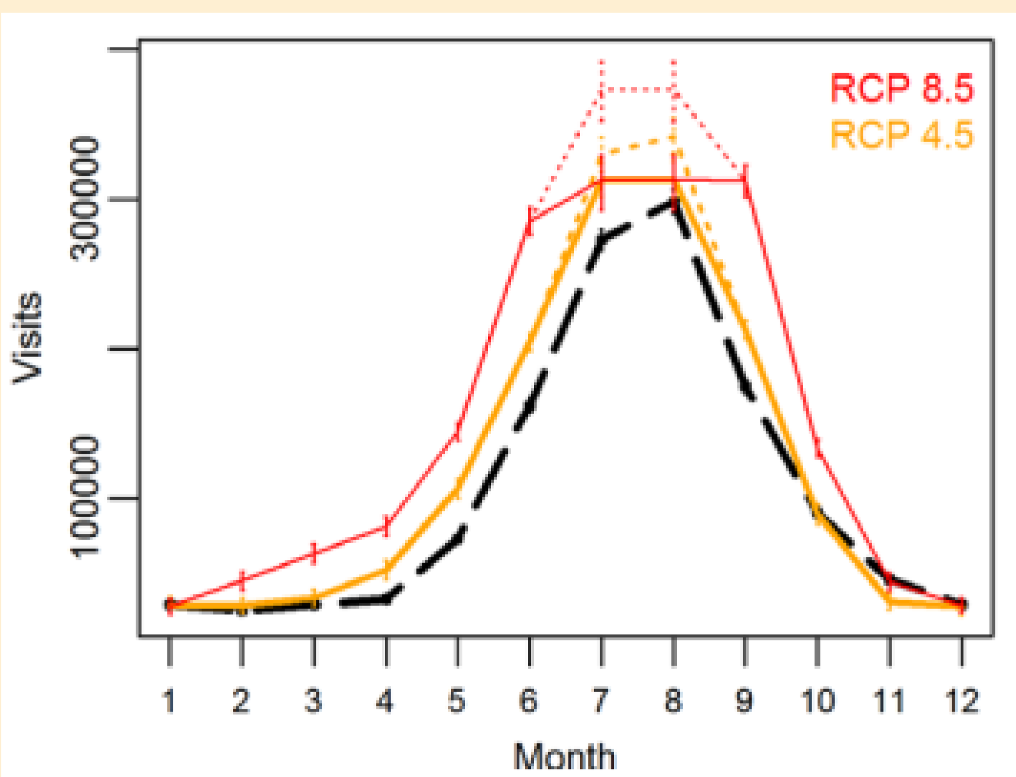

Figure 2. *Historic (black) and projected visitation under high (red) and low (yellow) emissions[3].*

Following a historically low snowpack and warm temperatures, by August flow had ceased into some intake reservoirs. These observations, coupled with projected increases in park visitation due to rising air temperatures (Fig. 2), have motivated an assessment of the park's future water supplies.

III. Objectives

I. Estimate future mean monthly discharge at water supply intake locations.
II. Provide recommendations to park management for immediate and long-term infrastructure adaptations.

IV. Methods

We estimated monthly discharge in the 2040s and 2080s under very rapid economic growth (A1B) and rapid introduction of resource-efficient technologies (B1) emissions scenarios using existing basin-wide streamflow projections for the Cowlitz and White River watersheds[4]. Basin streamflow projections were scaled to the White River, Stevens Canyon, and Ohanapecosh water supply intake sub-basins by relative drainage area proportion. In addition, we also scaled streamflow projections for the previously abandoned Laughingwater Creek intake, which used to supplement Ohanapecosh's water supply.

V. Results

By the 2080s, all four current and former intake basins are projected to shift from a historical annual flow regime of snowmelt-dominant runoff to a rainfall driven regime in which peak runoff coincides with winter storms in December in January (Fig. 3-6). The disparity between historical and future flows is most evident in June and July under the A1B emissions scenario in the 2080s, where mean monthly discharge is projected at 50% or less compared to historic measures across all intake locations (Fig. 3-6 C). Notably, the formerly

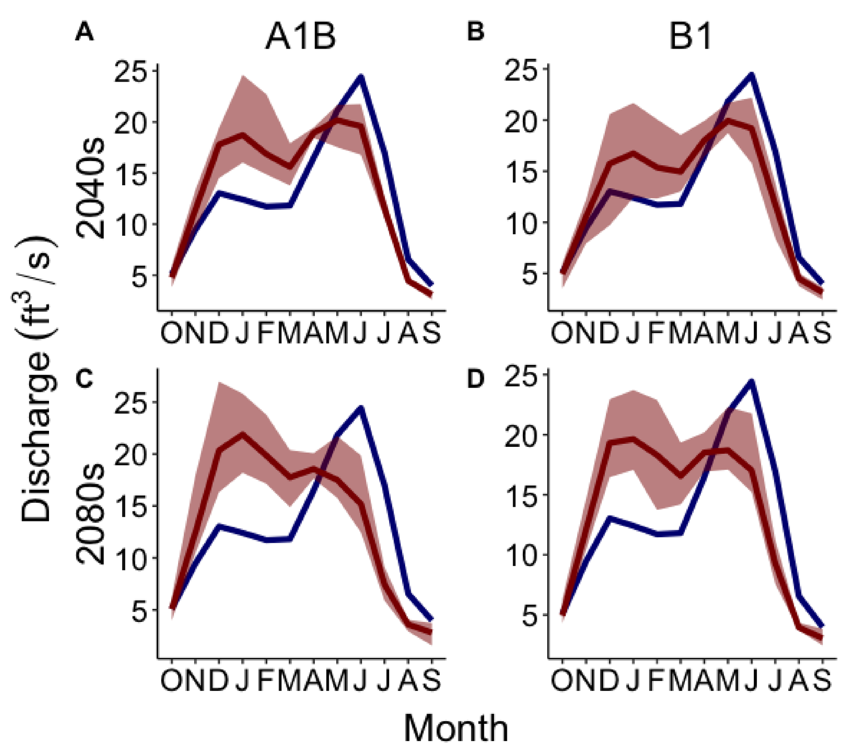

Figure 3. *White River Entrance*

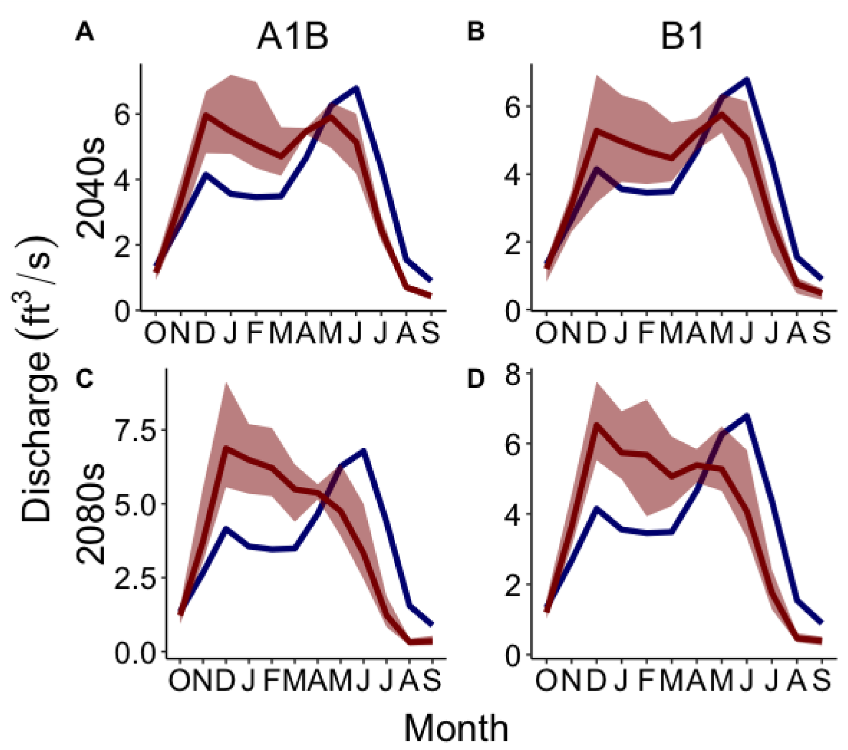

Figure 4. *Stevens Canyon*

Figures 3-6. *Monthly mean (blue) historic and (red) projected discharge at indicated intake in 2040 and 2080 under (A,C) A1B and (B,D) B1 climate scenarios. Error ribbons on projection curves indicate maximum and minimum predicted flows from among the five best-fit basin-scale models.*

Results (cont.)

abandoned Laughingwater Creek intake receives significantly more discharge than the current intake for Ohanapecosh, suggesting that this location may be more reliable long-term (Fig. 5-6).

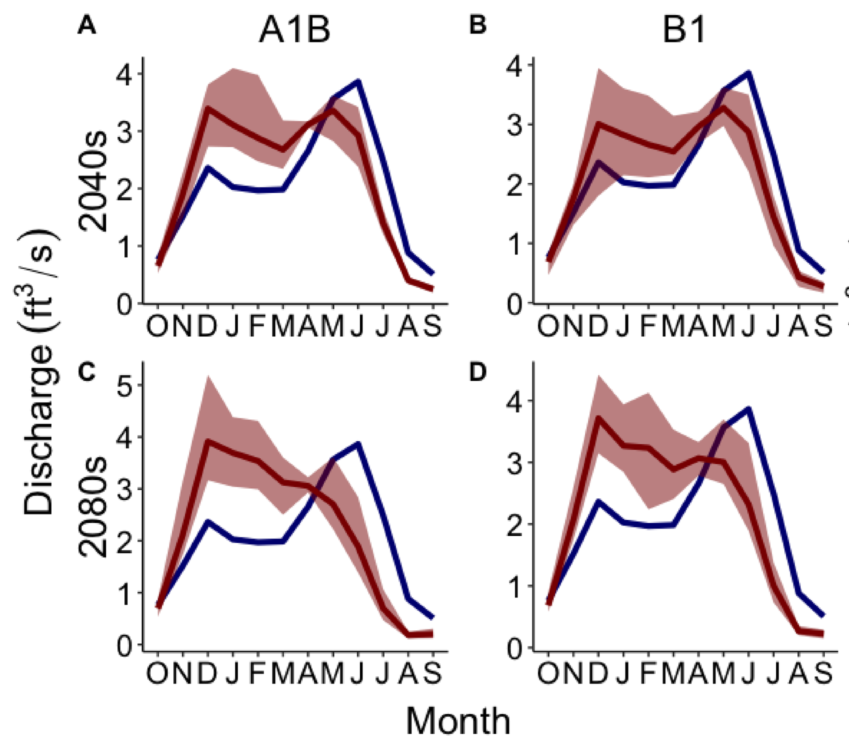

Figure 5. *Ohanapecosh*

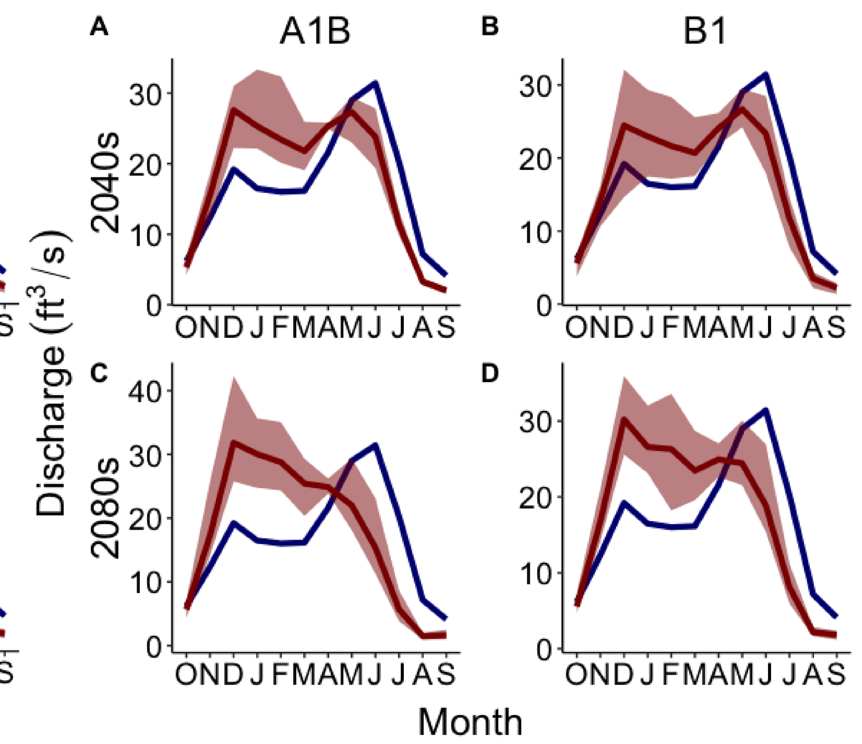

Figure 6. *Laughingwater Creek*

VI. Discussion

Given the projected declines in mid to late summer flow facing MORA's surface streams, a prudent first step in climate adaptation is expanding the storage capacity of these water supply systems. In some cases storage tanks are potentially historical structures, meaning construction of new storage tanks may be warranted (Fig. 7A). Furthermore, the park plans to beta-test reinstalling the Laughingwater Creek intake to supplement Ohanapecosh's water supplies – though the long-term viability of this site is unknown based on the dynamic nature of Laughingwater canyon. Lastly, efforts are underway to explore groundwater options which, if viable, may serve as a redundant rather than replacement water source.

Figure 7. *(A) Water storage tank. (B) Site of former Laugh. Crk. intake.*

References & Acknowledgments

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4. *Data, figures, or summary information were downloaded from the Columbia Basin Climate Change Scenarios Project website at http://warm.atmos.washington.edu/2860/. These materials were produced by the Climate Impacts Group at the University of Washington in collaboration with the WA State Department of Ecology, Bonneville Power Administration, Northwest Power and Conservation Council, Oregon Water Resources Department, and the B.C. Ministry of the Environment.*