

# FUTURE PROSPECTS FOR WHATCOM COUNTY WATER SUPPLY

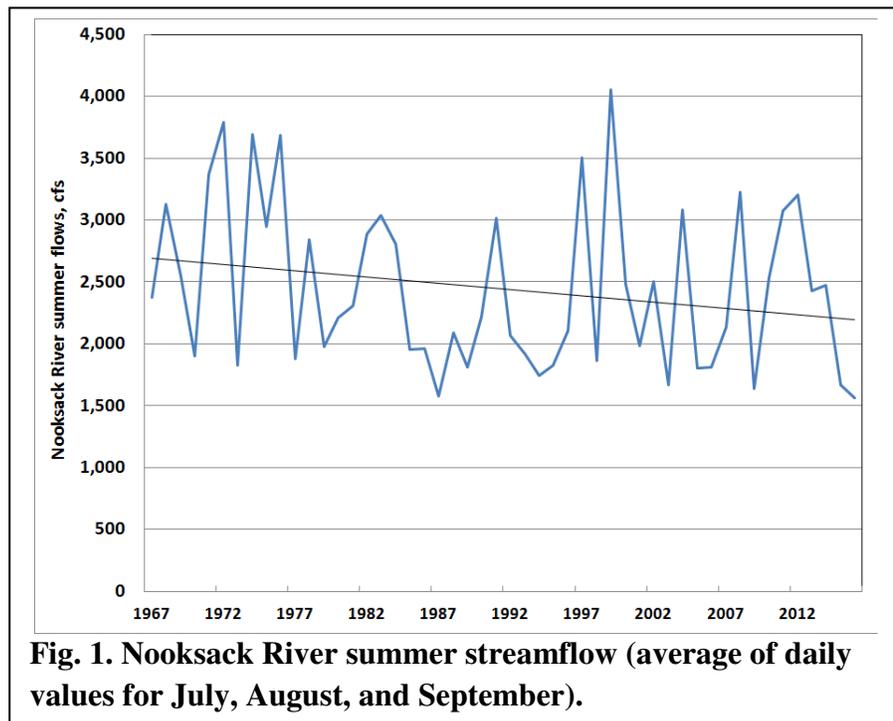
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On an average basis, Whatcom County has more than enough water to meet all human and instream uses. The challenge is timing – usage (especially irrigation) spikes during the summer, while supply (rain and snow) dominates during the winter.

This paper presents historical data to illustrate likely future changes in supply and demand that will exacerbate today’s seasonal imbalance. The focus is on summer (July, August, September) when water demand is highest and supply is lowest. For summer supply, these factors include declines in streamflow, increases in water temperatures, declines in rainfall, and loss of glacier mass. On the demand side, the key factors are population growth plus increases in air temperature and decreases in rainfall (both of which increase demand for irrigation water – golf courses, lawns, gardens, and agriculture). The effect of these changes will be to worsen conditions for salmon, other wildlife, recreation, and scenic values as well as limit supplies for out-of-stream human uses.

## SUPPLY ISSUES

A key indicator of decreasing water supply is the drop in Nooksack River streamflow, as measured at Ferndale (Fig. 1). These data show substantial year-to-year volatility and a long-term decline of 10 cubic feet per second (cfs) per year. Looking at only the past 20 years (1996 – 2016) yields a higher decline of 23 cfs per year, about 1% per year.<sup>1</sup> These data show a small but accelerating decline in Nooksack River summer flows.

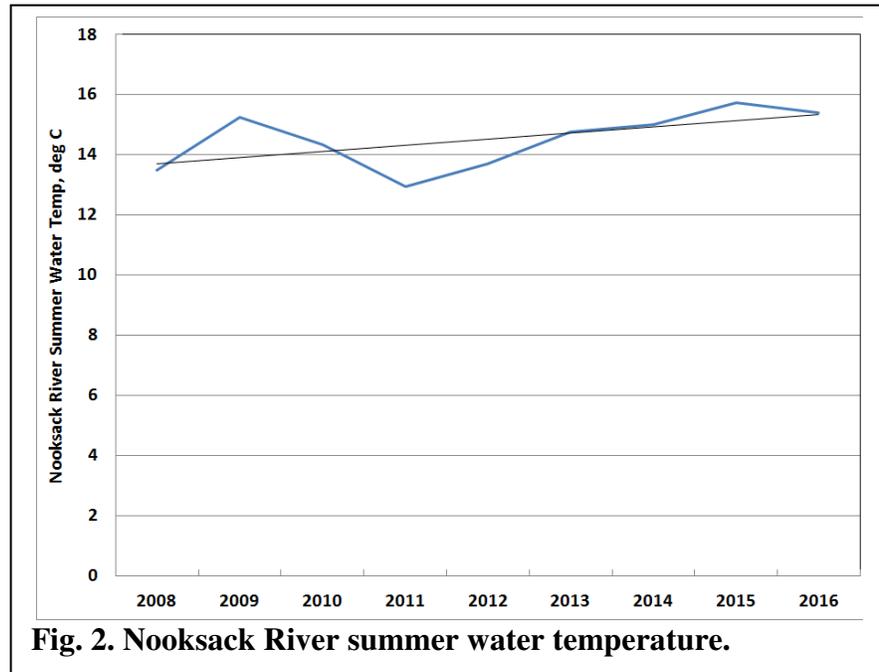


**Fig. 1. Nooksack River summer streamflow (average of daily values for July, August, and September).**

<sup>1</sup> Because of the substantial variation from year to year in summer rainfall, the measured decline in annual flow depends on the starting date. Nooksack River flows were quite low in the mid-1980s, so starting the analysis then suggests an *increase* in summer flows.

As a check on these results, I conducted a similar analysis using streamflow data for the Wickersham and Saxon Bridge stations on the South Fork of the Nooksack River.<sup>2</sup> The results are quite similar to those from the Ferndale station on the mainstem: large year-to-year variations, with a long-term decline of about 2/3% per year (1% per year over past 20 years).<sup>3</sup>

In addition to lower streamflows, water temperatures are increasing (Fig. 2) by an average of 0.21 °C (0.37 °F) per year per year.<sup>4</sup> Water temperatures in many parts of the Nooksack River system are already too high for healthy salmon.<sup>5</sup> The combination of lower flows and higher water temperatures will make it even more difficult for salmon and other wildlife to thrive.<sup>6</sup>



**Fig. 2. Nooksack River summer water temperature.**

Summer rainfall has been decreasing slowly and erratically over the past several decades (Fig. 3). The historical decline averages 0.028 inches of rain per year at Clearbrook, about 0.5% per year. Results are similar for Bellingham International Airport (-0.026) and Blaine (-0.022).

Finally, glaciers throughout the North Cascades are shrinking. Between 1985 and 2016, glacier mass declined by more than 25% (Fig. 4).<sup>7</sup> Because glaciers act as giant reservoirs, their loss means less snowmelt and streamflow during the summer.

<sup>2</sup> Data for Wickersham are available through September 2008, and data for Saxon Bridge are available from October 2008 (RH2 Engineering, *Whatcom County Streamflow Analysis*, prepared for Public Utility District #1 of Whatcom County, Dec. 2016).

<sup>3</sup> I would have liked to examine results for some of the tributaries, but long-term data for these stations are not available (see Table 4 of RH2 Engineering report cited in prior footnote).

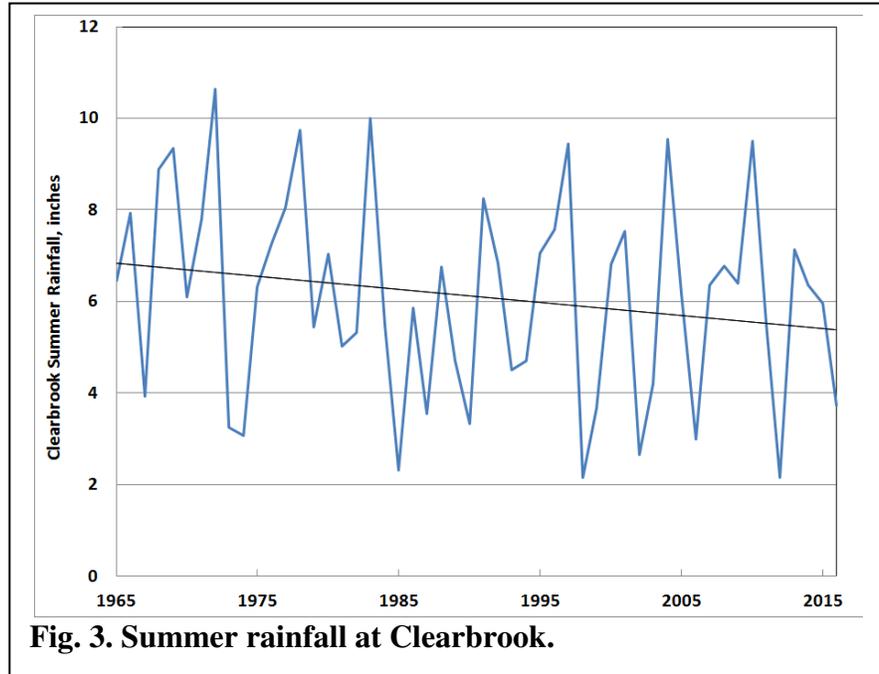
<sup>4</sup> These data are for only nine years; therefore the results are suggestive, not definitive.

<sup>5</sup> O. Grah and J. Beaulieu, “The effect of climate change on glacier ablation and baseflow support in the Nooksack River basin and implications on Pacific salmonid species protection and recovery,” *Climatic Change*, 2013.

<sup>6</sup> Of course, many other factors related to water quality and habitat affect salmon and other wildlife.

<sup>7</sup> American Geophysical Union Blogosphere: M. Pelto, “Disastrous Year for North Cascade Glacier Mass Balance (Snow/Ice Economy),” Aug. 20, 2105. <http://blogs.agu.org/fromaglaciersperspective/2015/08/20/disastrous-year-for-north-cascade-glacier-mass-balance-snowice-economy/>; also M. Pelto, personal communication, Jan. 2017.

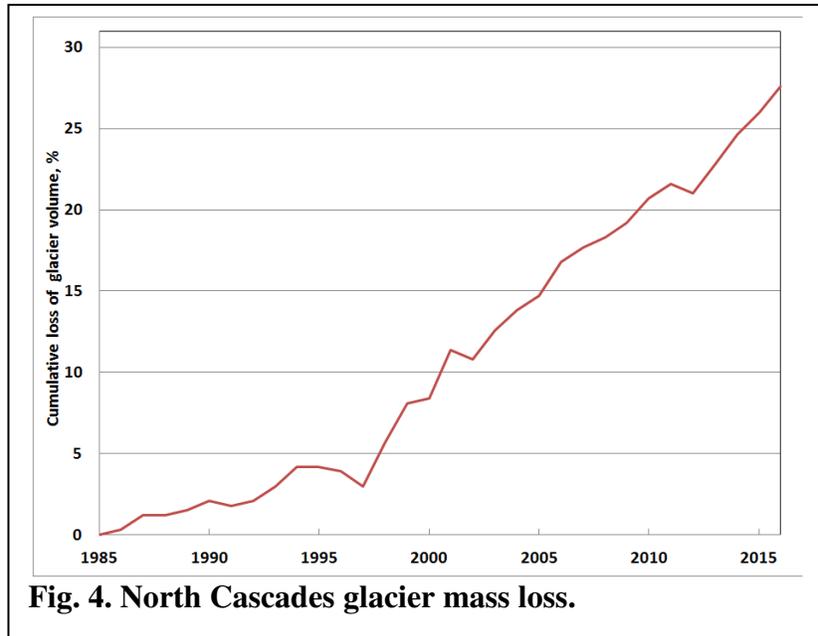
The long-term trends in all four of these factors (summer streamflow, summer water temperature, summer rainfall, and glacier mass) will almost surely limit water supplies in the future. Although the year-to-year changes are small, the trends are clear. For example, data from the last 20 years suggest that Nooksack River streamflows are dropping by 1% a year, yielding less water for human use and the environment.



**Fig. 3. Summer rainfall at Clearbrook.**

**DEMAND ISSUES**

Over the past several decades, Whatcom County population has grown at about 2.2% per year (Fig. 5), which suggests an increase in water use for the residential, commercial, and industrial sectors. However, historical declines in per capita water use may have, at least roughly, offset the effects of population growth (Fig. 6).



**Fig. 4. North Cascades glacier mass loss.**

Declines in summer rainfall (discussed above) and increases in summer air temperatures (Fig. 7) are likely increasing water use to irrigate lawns, yards, golf courses, and crops. Each inch of rainfall during the summer month reduces agricultural irrigation requirements by about 0.74 inches.<sup>8 9</sup>

<sup>8</sup> E. Hirst, *Whatcom Irrigation Water Use*, May 2016 (based on material in Natural Resources Conservation Service, *National Engineering Handbook*, Sept. 1993, chapter 2).

<sup>9</sup> I was unable to find estimates of the effects of summer air temperatures on irrigation requirements.

## FUTURE SCENARIO

Although the historical data shown above are interesting in their own right, the key question is what they suggest for Whatcom County's future water supply/demand balance.

To explore that issue, I created a scenario 20 years out. I assumed that indoor water use for the residential, commercial, and industrial sectors remains unchanged in spite of population growth (Fig. 5). This assumption is based on the historical record of continued improvements in water-use efficiency with only modest efforts from local water suppliers (Fig. 6).

Outdoor water use will almost surely be greater because of higher temperatures and lower rainfall. I calculated the effects of lower summer rainfall (Fig. 3) on irrigation, which led to a 3% increase in water use in 20 years. I arbitrarily increased that

effect by 50% to account for the effects of higher air temperature on irrigation water use. I then calculated the reduction in streamflows and compared today with the future for July, August, and September streamflows and human uses (Table 1).

Under current conditions, out-of-stream summer water uses are equivalent to 14% of Nooksack River flows. The percentage is highest in August (20%) and lower in July and September (11%).

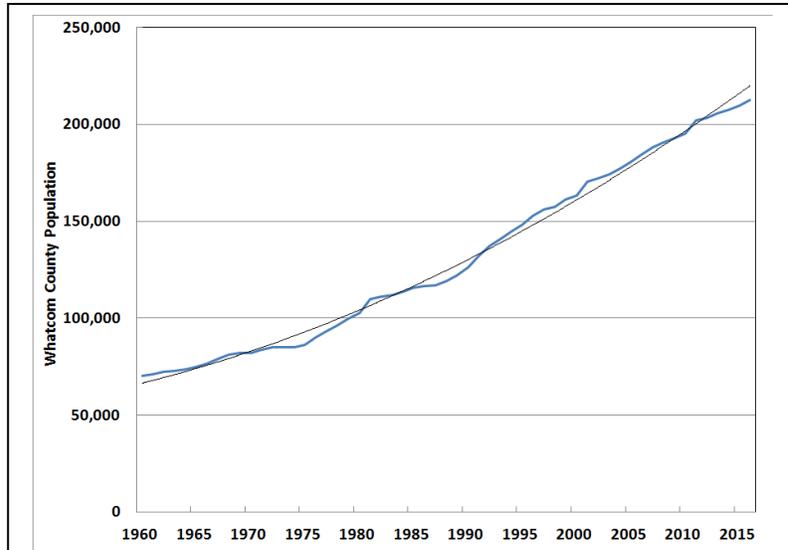


Fig. 5. Whatcom County population.

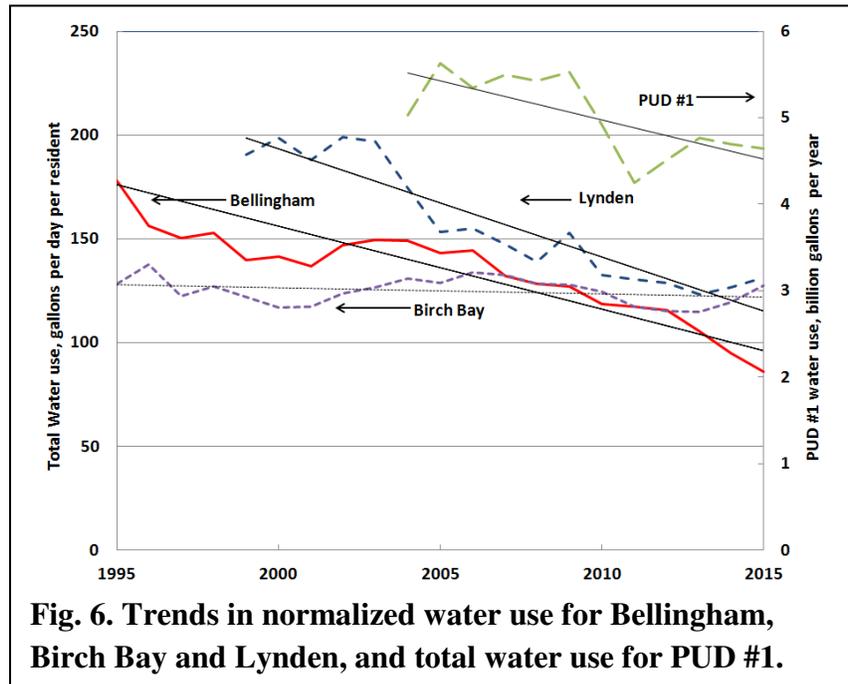


Fig. 6. Trends in normalized water use for Bellingham, Birch Bay and Lynden, and total water use for PUD #1.

Under the future scenario, streamflows are lower by 15% and water use is higher by 3%. The combined effect of these two factors is a 17% increase in the effects of water use on stream flows.

**LIMITATIONS**

One limitation in this examination of historical data is the reliance on only

two streamflow gauges (one on the mainstem of the Nooksack River and the other on the South Fork) and three locations for rainfall (Clearbrook, Bellingham International Airport, and Blaine). A recent study examined data on streamflows at many locations throughout Whatcom County; that study found very few stations with long-term records (e.g., greater than 20 years).<sup>10</sup>

Another important limitation is the focus on surface water. Because about half the water used in Whatcom County comes from wells (groundwater), this omission could materially affect the results presented here. However, the effects of this omission are dampened by the fact that much groundwater is in hydraulic connectivity with surface waters, which means that pumping water from wells affects streamflows, although later in time and downstream of the diversion point.<sup>11</sup>

Finally, the future scenario implicitly assumes that all water consumption and flow occur at one location, the Nooksack River at Ferndale. A more comprehensive analysis would spatially disaggregate both water sources and water consumption.

**CONCLUSIONS**

This study yields several important points:

- Various environmental factors that affect Whatcom County summer water supply (streamflow, water temperature, rainfall, and glacier loss) are all trending in negative directions. That is, the historical record shows slow, small, erratic declines in supply.
- Environmental factors (rainfall and air temperatures) combined with population growth suggest increases in human (out-of-stream) water uses during the summer, especially for irrigation.

**Table 1. Nooksack River flow and human consumption of water, current and 20 years out**

	Jul	Aug	Sep	Summer
	Current Conditions			
Nooksack River flow, cfs	3,400	2,000	1,800	2,400
Consumption, cfs	390	410	200	330
Consumption/Flow	11%	20%	11%	14%
	20-year Future			
Nooksack River flow, cfs	3,100	1,700	1,400	2,100
Consumption, cfs	400	420	220	350
Consumption/Flow	13%	25%	15%	17%

<sup>10</sup> RH2 Engineering, *Whatcom County Streamflow Analysis*, prepared for PUD #1 of Whatcom County, Dec. 2016.

<sup>11</sup> An ongoing project will better identify and quantify the relationships between ground and surface waters in much of Whatcom County; see Associated Earth Sciences, Inc., *Final Draft Technical Report, Phase 2 – Data Collection and Conceptual Model Development*, Sept. 30, 2016.

- Human water use has a material effect on streamflows and, by implication, on the health of salmon, wildlife, and other instream resources.
- Simple projections of the historical record over the next 20 years shows that—absent concerted effort to improve water-use efficiency and implement new supply options—these trends will get worse for both people and the environment.
- I suggest that either the state Dept. of Ecology or Whatcom County (better yet, both agencies working together) develop and apply methods to estimate future water supplies and consumption over the next few decades. Crude as the current study is, it is the only one of its kind that I know of for Whatcom County.