# Minimum Streamflow Trend Attribution in the Spokane River Basin

Heather Baxter[a], Tung Nguyen[a], Jennifer Adam[a], Cailin Huyck Orr[b],
[a] Department of Civil and Environmental Engineering
[b] School of Earth and Environmental Sciences

## Introduction and Background

The Spokane River basin (SRB) is divided between northern Idaho and eastern Washington and passes over the Spokane Valley Rathdrum Prairie (SVRP) aquifer before merging with the Columbia River (see Figure 1).

Previous studies have demonstrated high interconnectivity between the aquifer and the river. A MODFLOW model has been made of the aquifer to replicate some of the groundwater/surface water interactions. This model has had reasonable estimations of aquifer flow and somewhat less excellent results with well water levels. Policy scenarios have been modeled on this to compensate for low flow trends with expensive but effective results.

Low flows in the Spokane River show trends towards decreasing (see Figure 2)—a trend complicated by the high interconnectivity between the river and aquifer. Low flows have been exacerbated by reservoir operations, changes in water use patterns, municipal pumping, and climate change (Barber et al. 2009). The SVRP aquifer was the sole source of water for about 500,000 in 2007. Population factors likely have played a significant role in exhibited trends.

Water rights between Idaho and Washington were independently decided for the Spokane river until 2001. After 2001, the Washington State Department of Ecology and the Idaho Department of Water Resources acknowledged the need for collaborative, mutually beneficial long term solutions to the growing water resource problem.

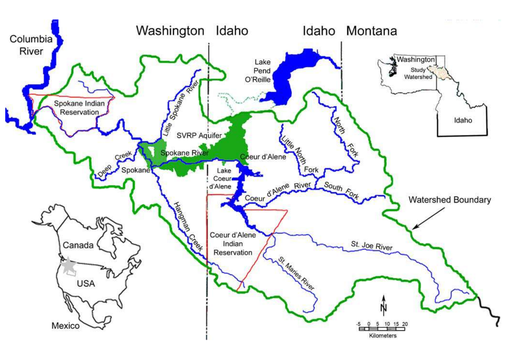


**Figure 1:**

Map of Spokane River watershed and the SVRP aquifer. Figure from Barber et al. 2007.

## Results and Discussion

In an attempt to separate climate influence on flow, a composite analysis was conducted on low flows. Results are shown in Table 1. They showed no statistically significant differences between El Niño and La Niña years. However, climate effects cannot be totally negated; rather, the flow rate trend cannot be completely explained by climate factors.

Municipal water pumping could be affecting low flows in the Spokane River. Spokane city population has been increasing rapidly since it first began in 1881. Population has a significant impact on pumping rate. It does not, however, totally explain pumping rates in a city (see Figure 3). Irrigation also draws from wells.

Documented flow conditions and well development in the Spokane area are shown in Figure 4. Some undocumented but potentially significant factors include changes in reservoir operation, changes in water usage, change in municipal pumping magnitude.

**Table 1:** El Niño and La Niña flow rates in the Spokane river and compositing analyses F-test and T-test.

| Warm | | Cold | |
|---|---|---|---|
| Year | Flow | Year | Flow |
| 1953 | 6,682 | 1950 | 10,656 |
| 1957 | 7,257 | 1955 | 7,068 |
| 1958 | 7,071 | 1956 | 9,108 |
| 1963 | 5,280 | 1971 | 8,412 |
| 1965 | 8,221 | 1973 | 4,113 |
| 1969 | 7,467 | 1974 | 11,678 |
| 1972 | 9,635 | 1975 | 7,384 |
| 1977 | 3,340 | 1984 | 7,087 |
| 1982 | 8,384 | 1985 | 5,878 |
| 1987 | 3,906 | 1988 | 3,768 |
| 1991 | 7,058 | 1989 | 6,291 |
| 1992 | 3,610 | 1999 | 7,695 |
| 1994 | 3,184 | 2000 | 6,625 |
| 1997 | 10,456 | 2007 | 5,499 |
| 2002 | 7,713 | 2008 | 7,290 |
| | | 2011 | 9,801 |
| Average | 6,618 | Average | 7,397 |
| Standard Dev | 2,283 | Standard Dev | 2,171 |
| | T-Value | 0.34 | |
| | F-Test | 0.85 | |

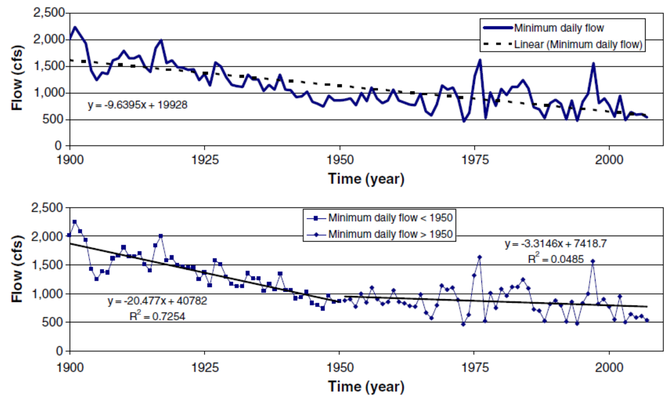


**Figure 2:** Low flow trends in the Spokane River. Figure from Barber et al. 2009.

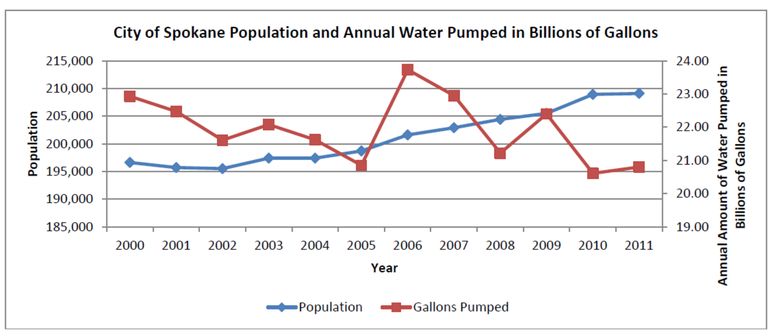


**Figure 3:** Population growth and water usage in Spokane. Figure from Greenlund 2012.

## Conclusions and Future Work

Low flows in the Spokane River are becoming more significantly lower. Climate effects only partially explain low flow trends in the Spokane River. Other factors that could explain flow trends are: municipal pumping, population growth, changing water use, and reservoir operations.

Future work will include investigating reservoir operations and changes in pumping rates in the Spokane area.

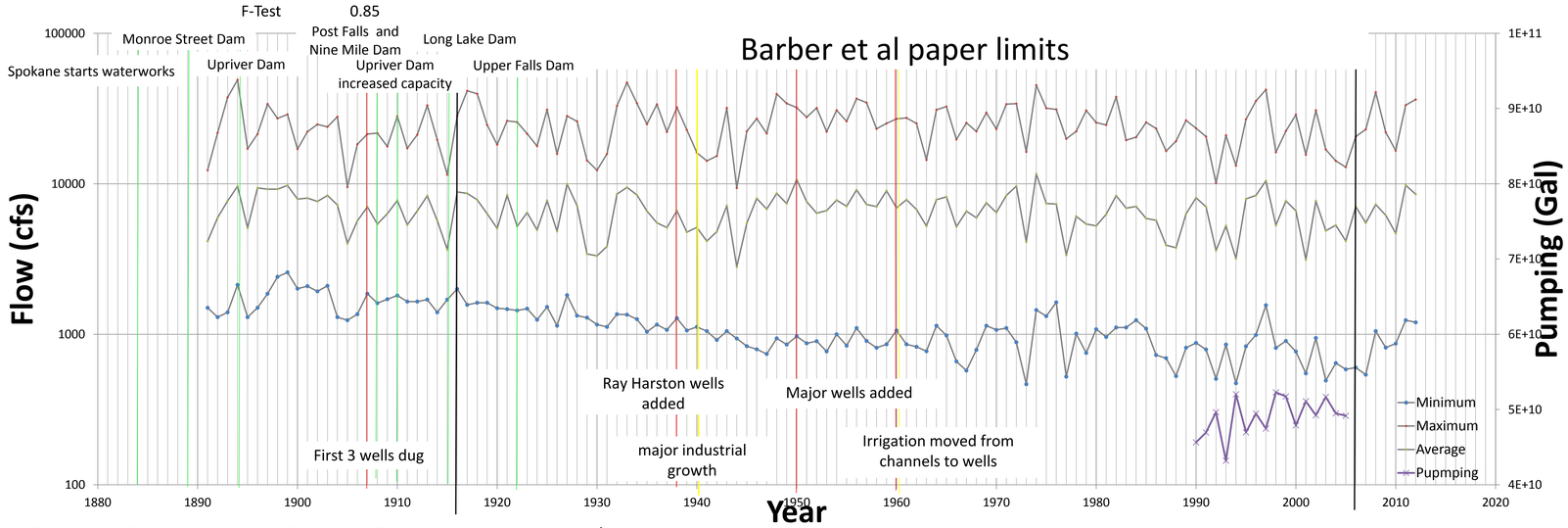


**Figure 4:** Flow rates in the Spokane River plotted with dam/reservoir construction, well construction, and major industrial growth.