Comparison of Historical Streamflows to 2014 Streamflows in the Williamson, Sprague, and Wood Rivers, Upper Klamath Lake Basin, Oregon: Method Documentation

By Adam Stonewall

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Definitions

- Spring Recession period—The period of decreasing streamflows after the peak of the spring snowmelt, defined as May1–June 1 for this analysis.
- Regulation Transition period—The period during which regulations of surface water diversions are being implemented.
- Equilibrated Regulation period—The period of basinwide regulation.
- Post-Regulation period—A period after the Equilibrated Regulation period without significant precipitation events, when diversions are expected to be minimal.
- Composite Index Year (CIY) Hydrograph—A hydrograph of the average daily streamflow or baseflow for a set of years most similar to WY 2014 streamflows during the Spring Recession period.
- CIY-Adjusted Hydrograph—The CIY hydrograph corrected for the average difference between the measured hydrograph and the CIY hydrograph during the Spring Recession period (May1–June 1). The CIY-adjusted hydrograph approximates the no-regulation 2014 hydrograph (see below) for purposes of calculating the amount of streamflow gained by regulation of diversions.
- Measured Hydrograph—The amount of streamflow measured or baseflow calculated at a streamflow gaging station over time.
- No-Regulation Hydrograph—The hydrograph that would have occurred if diversions had not been regulated.

Background

The Upper Klamath Basin will be under drought conditions in spring and summer of 2014 because of below average precipitation during the winter of 2013–2014, In February 2014, Oregon Governor John Kitzhaber declared a drought emergency for Klamath County. In late May, the Bureau of Reclamation called in their water rights in accordance with the Klamath Basin Restoration Agreement (KBRA). Regulation of irrigation diversions in the Upper Klamath Lake Basin, principally in the Sprague and Wood River Basins, began in June. This narrative documents the analysis of the effects of diversion regulation on inflows to Upper Klamath Lake for summer 2014.

Approach

Different approaches are used to determine the effects of the 2014 regulation of surface water diversions in the Sprague and Wood River Basins because of differences in streamflow record availability between the two basins. Also, the method used for the Wood River Basin will be different for 2014 than for 2013 (*Hess and Stonewall, 2014*).

Sprague River Basin

Methods used for estimating the effects of the 2014 regulation of surface water diversions in the Sprague River Basin, the Baseflow and Streamflow Methods, are detailed in *Hess and Stonewall (2014)*. The methods include the development of a Composite Index Year (CIY) based on individual years of historical streamflow records with similarly-shaped hydrographs during the spring. The CIY is then adjusted to account for differences in the measured streamflow data from the years of interest and extended into the summer regulation period. The difference between the adjusted CIY hydrograph and the measured data from the year of interest is considered to be attributable to diversion regulation.

Ten years of record were used to develop the 2014 CIY. More information on the development of the 2014 CIY can be found In the “Development of the 2014 Composite Index Year” section, below. An overview of the error analysis of the method is provided in the section “Analysis of Error Rates for the Baseflow and Streamflow Methods.”

Wood River Basin

Wood River streamflow gain estimations are not yet available. The analysis will use alternative techniques to those used for the Sprague River because the historical streamflow record for the Wood River is insufficient to produce reliable estimates.

Development of the 2014 Composite Index Year

The Composite Index Year (CIY) hydrograph used for evaluating the effects of regulation of surface water diversions on inflows to the Upper Klamath Lake was developed using the methods detailed in *Hess and Stonewall (2014)*.

For 2014, 10 candidate years (table 1) were chosen for inclusion in the CIY rather than the 6 chosen for the 2013 analysis because more years of record fit the criteria for similarity to the year of

interest, 2014. The 10 best-fit candidate years identified using both baseflow and streamflow were the same, although not with the same ranks.

Table 1. Best-fit evaluation of candidate years for the Sprague River near Chiloquin gage (station 11501000) 2014 Composite Index Year

[Years are ranked from lowest to highest mean error.]

	Method	
Rank	Baseflow	Streamflow
Best fit	1990	1994
2nd best fit	2001	1990
3rd best fit	1994	2001
4th best fit	1977	1977
5th best fit	1988	1988
6th best fit	1991	1992
7th best fit	1992	1987
8th best fit	2004	2004
9th best fit	1987	1981
10th best fit	1981	1991

Analysis of Error Rates for the Baseflow and Streamflow Methods

The 10 hydrographs used to develop the 2014 Composite Index Year (CIY) and 2014 CIY-adjusted hydrographs (see "Definitions") were evaluated using the Baseflow and Streamflow Methods (*Hess and Stonewall, 2014*). For each of the 10 years, an error rate was calculated by comparing measured data against the CIY-adjusted hydrograph during the Equilibrated Regulation period, the period when regulation was in effect basinwide.

For example, using the Baseflow Method with baseflow data from the Spring Recession period, a CIY-adjusted hydrograph was developed for the year 2001, one of the CIY component years. Eight best-fit years were used to develop the 2001 CIY-adjusted hydrograph. The resulting error rate was 26%. This analysis was repeated for each of the years listed in table 1. The analysis was conducted on June 20 using a short, experimental Equilibrated (basinwide) Regulation period, June 1–June 19. Error rates will change as the Equilibrated Regulation period lengthens.

A small sample population of error statistics was constructed. In this example, error rates for the 10 CIY hydrographs ranged from -35% to +26%, with a median of -4%. Using percentiles of 33.33% and 66.67% (one third and two-thirds), error rates range from -17% to + 11%. Use of a larger confidence interval is not appropriate in this analysis due to the small sample size (n=10).

2014 Streamflow Gains from Regulation

Excel table updated periodically: *http://or.water.usgs.gov/Klamath drought/streamflow_gain.xlsx*.

References Cited

Hess, G.W., and Stonewall, Adam, 2014, Comparison of historical streamflows to 2013 streamflows in the Williamson, Sprague, and Wood Rivers, Oregon: U.S. Geological Survey Open-File Report 2014-1128, *http://pubs.usgs.gov/of/2014/1128/*.