Historical Flows for Bridge Creek above East Canal, Oregon

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Bridge Creek originates along the northwestern slopes of Steens Mountain. It drains an area a fraction of the size of the Blitzen River watershed (approximately 30 mi^2). Flow in Bridge Creek moves westerly toward the refuge where it enters roughly 3 miles northeast of Page Springs Dam. After entering the refuge, Bridge Creek joins East Canal for a short distance before separating again and flowing further west and into the Blitzen River. The purpose of this report is to provide information and analysis on the historical flows in Bridge Creek as it enters the refuge and compare those flows with flows in the Blitzen River.

Historical Flows

A continuous record of streamflow in Bridge Creek above East Canal is available from the USGS and extends from 1938 to the end of water year 1970 (USGS site no. 10397000). The USFWS and the refuge resumed streamflow monitoring and measurements in June of 1994 at the same site (USFWS gage no. 357004). Measurements are quite irregular during water years 1994 to 1999, although a continuous record extends from 2000 to 2003. The period of record used in this analysis incorporates measurements from both the USGS and USFWS records excluding years 1994 to 1999.

Bridge Creek has experienced little fluctuation in mean annual streamflow during its 37-year period of record. Annual runoff has averaged 9,680 acre-ft/yr for the period of record. It has ranged from a maximum of 13,900 acre-ft in 1942 to a minimum of 5,530 acre-ft in 1961. Maximum daily discharge occurred on 15-March, 1939 when mean daily flow reached 120 cfs. On two other occasions mean daily flows reached 118 cfs however, flows of this magnitude are relatively infrequent. Historically, mean daily discharge has been 25 cfs or less 95 percent of the time and 42 cfs or less 99 percent of the time.

Like the Blitzen River, streamflow in Bridge Creek is driven by snowmelt in the spring. However, peak flows are generally of shorter duration and relatively smaller proportion than peak flows in the Blitzen. Peak flows usually don't continue past June. By July, flows in Bridge Creek are already near the minimum for the year, much earlier than Blitzen flows recede to baseflow conditions. Minimum flow, or baseflow, generally extends from July through February and averages 11.8 cfs (Figure 1), although large discharge events have occasionally exceeded 100 cfs during this period. Monthly total

runoff during baseflow conditions average 716 acre-ft with a minimum and maximum of 693 acre-ft (November) and 740 ft (July), respectively. Streamflows during the spring months of April, May and June average 19.1 cfs, 21.5 cfs and 14.6 cfs, respectively with monthly totals amounting to 1,140 acre-ft, 1,320 acre-ft and 870 acre-ft. Average seasonal flows and totals are summarized in Table 1. Total monthly runoff and mean daily streamflow at Bridge Creek are shown in Figure 1.

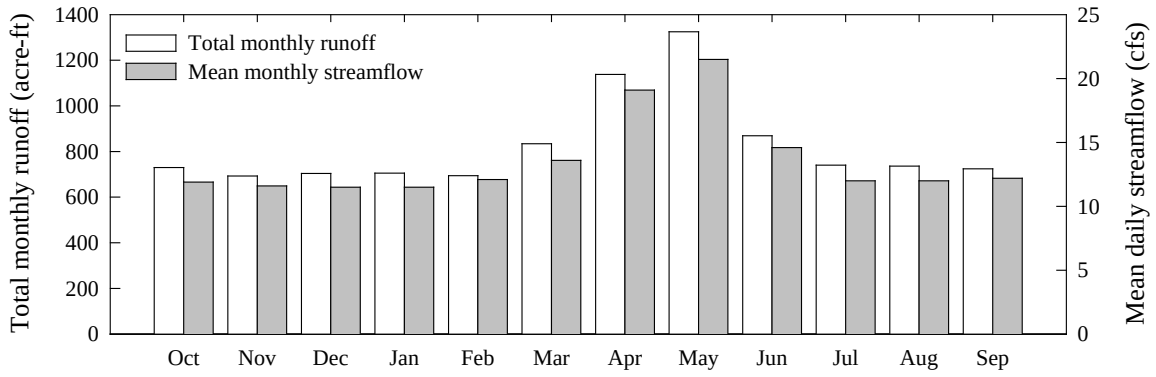

Figure 1: Mean monthly runoff and streamflow at Bridge Creek above East Canal, USGS site no 10397000 (1938 to 1970) and USFWS site no. 357004 (2000 to 2003).

Table 1: Seasonal streamflows and total runoff at Bridge Creek above East Canal

	Fall (Oct – Dec)	Winter (Jan – Mar)	Spring (Apr – Jun)	Summer (Jul – Sep)
Mean daily streamflow (cfs)	11.7	12.4	18.5	12.1
Total monthly runoff (acre-ft)	2,128	2,233	3,368	2,200
Percent of annual total (%)	21	22	34	22
Mean daily streamflow during dry years (cfs)	12.5	11.2	11.8	10.4

Bridge Creek Flows and Blitzen River Flows

Bridge Creek flows are considerably less than Blitzen flows. Mean annual flow in Bridge Creek is 13.7 cfs and in the Blitzen River is 126.6 cfs. The timing and distribution of flows differ as well. Figure 2 illustrates the monthly percentage of total annual flow over the period of record for both Bridge Creek and the Blitzen River. Generally, Bridge Creek has a higher proportion of baseflow and a lower proportion of peak flows when compared with the Blitzen. Flow in Bridge Creek during peak conditions (Apr – Jun) is 34% of the annual total, compared to 60% in the Blitzen (Table 1). Approximately 60%, or 5,950 acre-ft, of the total annual flow at Bridge Creek occurs during the irrigation season (15-March to 1-October). In comparison, irrigation season flows in the Blitzen account for 76% of the total annual flow. September monthly flows account for 7.4% of the total annual flow on Bridge Creek but only 2.7% of the total annual flow in the Blitzen.

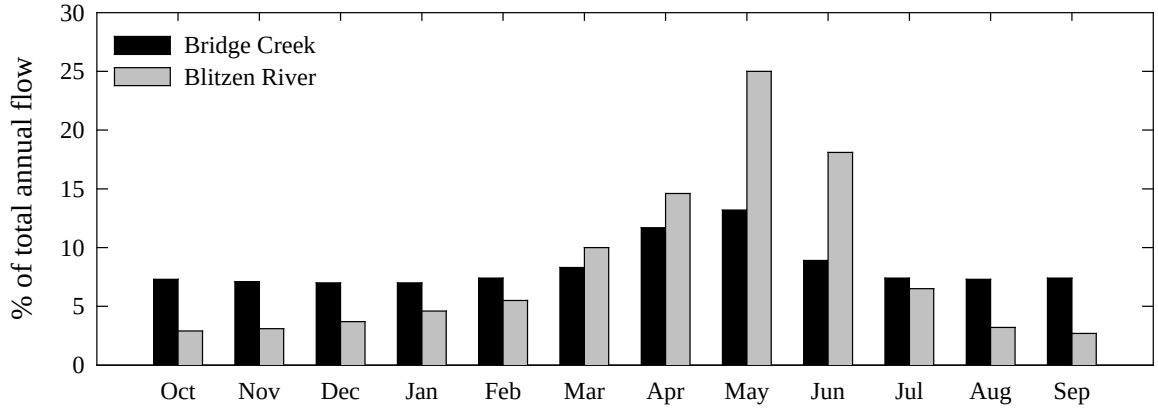

Figure 2: Percentage of total annual flow by month at Bridge Creek above East Canal and Blitzen River near Frenchglen, OR.

During drier than normal years, peak discharge events that are typically observed during spring months are greatly reduced and are only slightly above baseflows. For example, in WY 2002, the maximum daily flow during the runoff period was only 13.5 cfs. What is notable is that baseflows in Bridge Creek during dry years are near normal despite the absence of peak flows in these years (Table 1). Apparently, the spring discharge and subsurface seepage that supports the baseflow in Bridge Creek is much less responsive to climatic trends than the peak flows.

Discharge in Bridge Creek responds very similarly to changing streamflow conditions measured in the Blitzen River near Frenchglen. Figure 2 is a correlogram illustrating how mean daily streamflows at these sites correspond with one another. The measure is given as a crosscorrelation coefficient, which defines the magnitude of how well the variables, in this case streamflows, are related. The strength of association is

described on a scale from -1 to 1, with zero indicating no relation at all, 1 indicating a perfect correlation, and -1 indicating a perfect inverse correlation. The correlogram also provides information on the lag, or offset, of the two variables. The lag describes when or where the two series are most related. Figure 3 illustrates the strength and timing of association between discharge at Bridge Creek and Blitzen River over a two month span (30 days before and 30 days after). The greatest association is at time zero, where the crosscorrelation coefficient is 0.669. This indicates that in most cases, streamflows at Bridge Creek are changing at the same time as streamflows in the Blitzen River are changing. Figure 2 also shows relatively high coefficients for one day before (0.629) and one day after (0.630) zero lag indicating that streamflow response in Bridge Creek may either discharge slightly before (negative lag) or slightly after (positive lag) Blitzen River. The last noticeable pattern in Figure 2 is that the strength of association is greater for negative lag times than for positive lag times. This suggests that peak flows in the Blitzen River are most likely to occur later or over a longer period than peak flows in Bridge Creek.

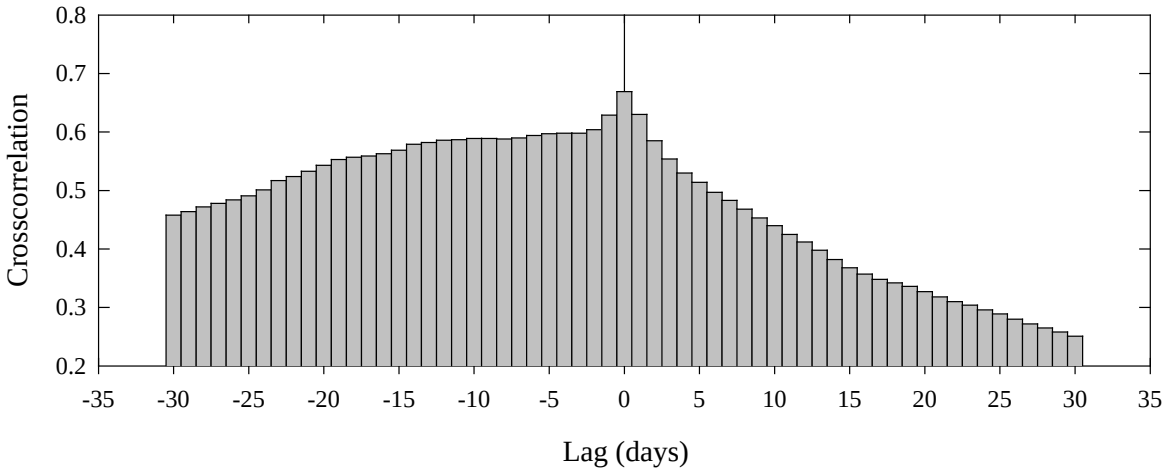

Figure 3: Cross-correlogram of mean daily streamflows at Bridge Creek above East canal and Blitzen River near Frenchglen, OR.