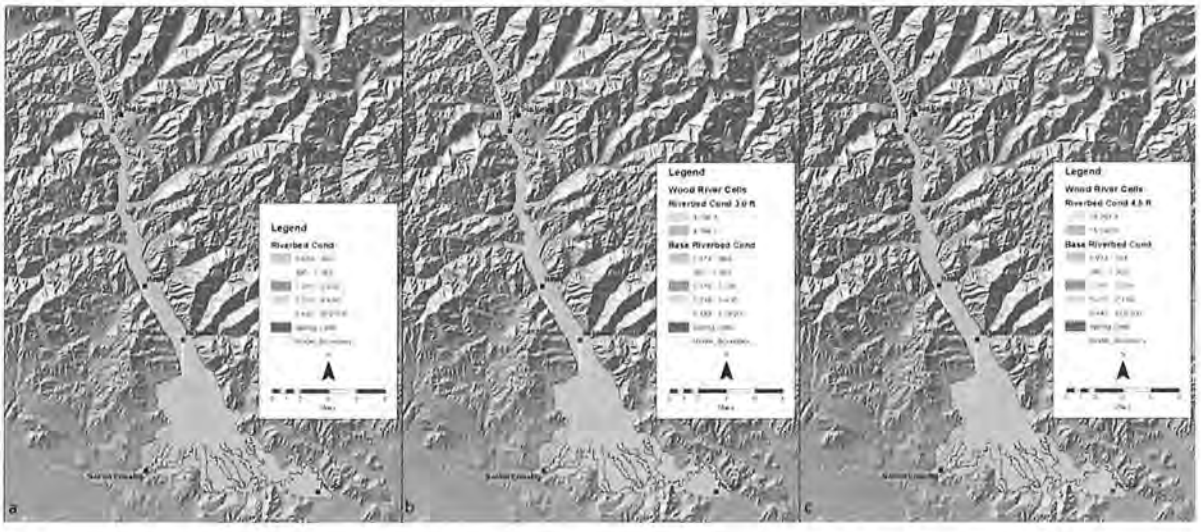

Figure 10. Calibrated riverbed conductance for the Big Wood River.

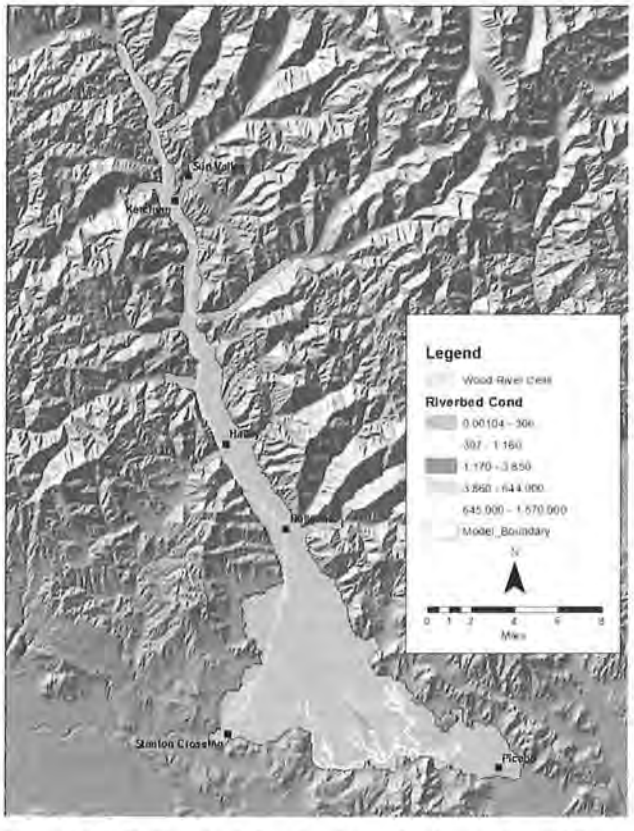

Figure 11. Calibrated riverbed conductance for Willow Creek and Silver Creek.

Head-dependent outlet boundaries

Groundwater leaves the WRV aquifer system as subsurface outflow at the Stanton Crossing and Silver Creek outlet boundaries (Figure 13). This was represented using drain cells in the WRV Aquifer Model Version 1.1. MODFLOW drain cells function much like MODFLOW river cells, except water can only flow from the aquifer out through the drain. No water can flow into the aquifer through the drain.

Drains were emplaced in each active model layer at both boundaries (one layer at the Stanton Crossing outlet boundary, three layers at the Silver Creek boundary). The table in Figure 13 shows the calibrated drain-conductance values. The average modeled discharge out the Stanton Crossing boundary is 275 AF (0.38 cfs); the average discharge out the Silver Creek boundary is 22,942 AF (31.7 cfs). Previous estimates of discharge beneath Stanton Crossing by other researches range from 0-300 AF and previous estimates of discharge beneath Silver Creek range from 4,000-53,000 AF (Fisher and others, 2013).

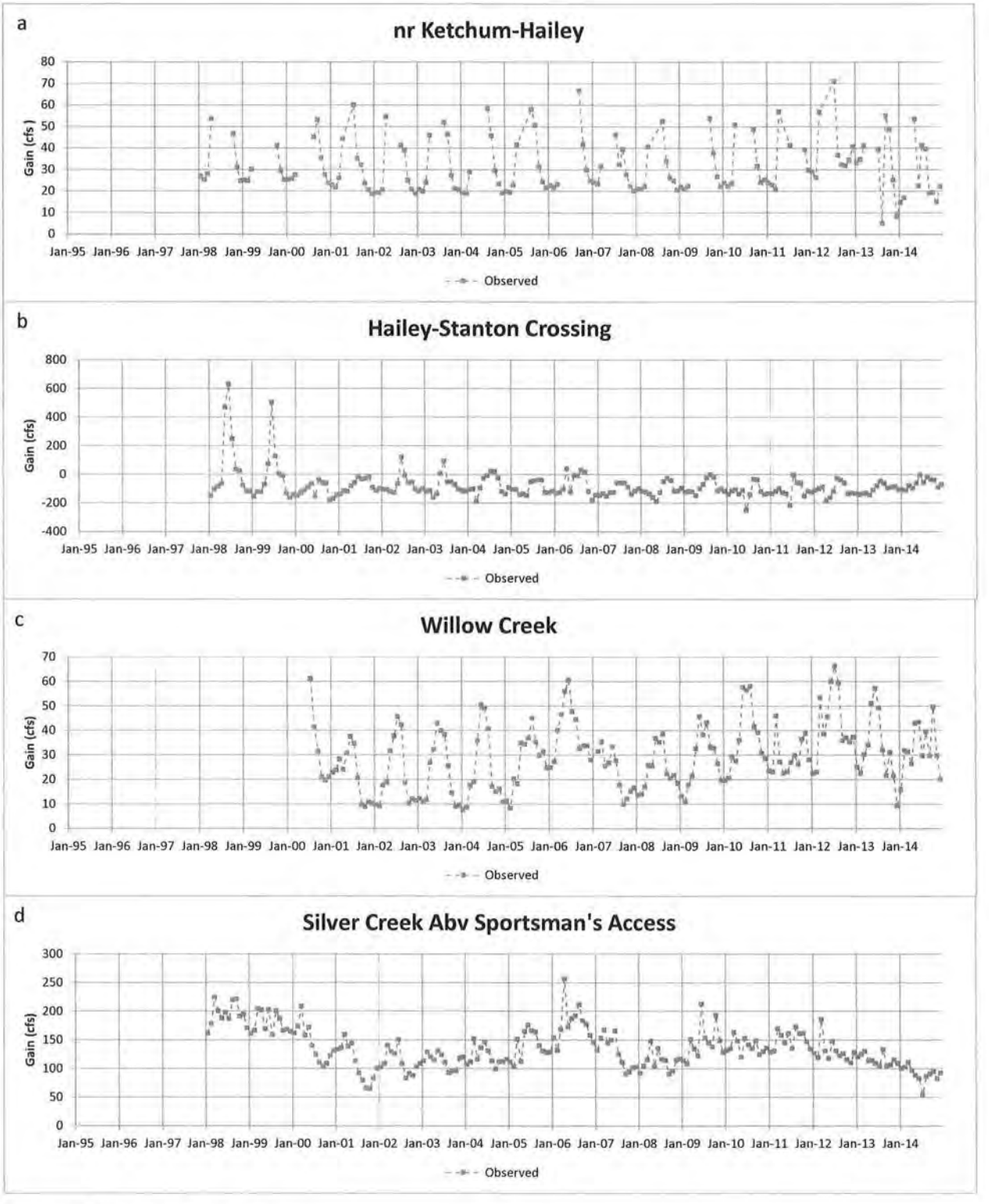

Figure 12. Observed river gains.

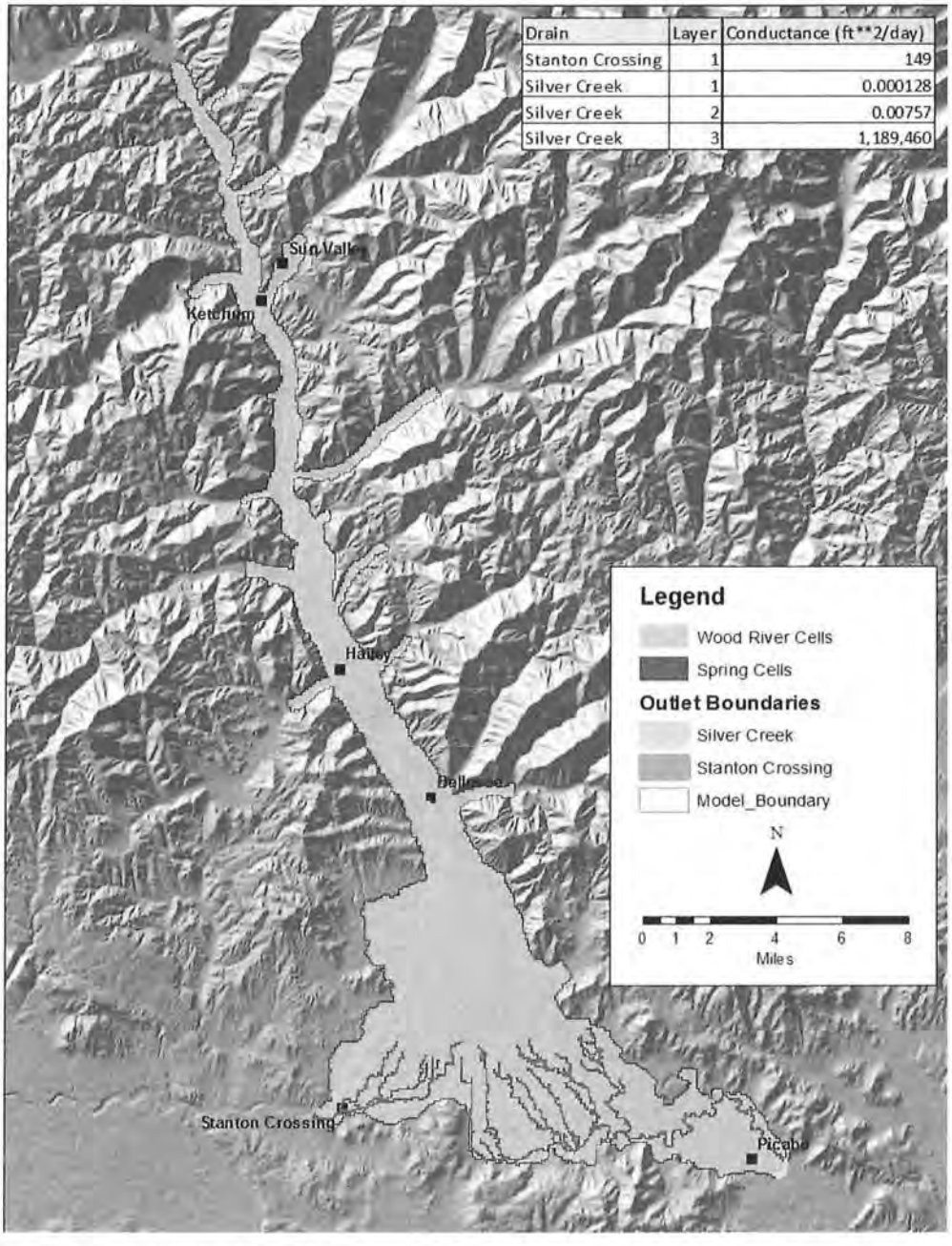

Figure 13. Model drain locations.

Assessment of Model Calibration

One of the measures of the quality of an aquifer model calibration is how closely the simulated data match with the field observations. This section describes the modeled and observed match for the various observation groups. When working with PEST, the residual, or the difference between the observed value and the modeled value is calculated by subtracting the modeled value from the observed value (Doherty, 2016); thus, a negative residual indicates that the modeled value is too high.

River gain and loss data

Figure 14a through 14d show simulated and observed gains for the Near Ketchum-Hailey, Hailey-Stanton Crossing, Willow Creek, and Silver Creek above Sportsman's Access reaches. Field data indicate that Silver Creek below Sportsman's Access gage has no interaction with the regional aquifer system (Wylie, 2019). Figure 8a shows the location of the reaches.

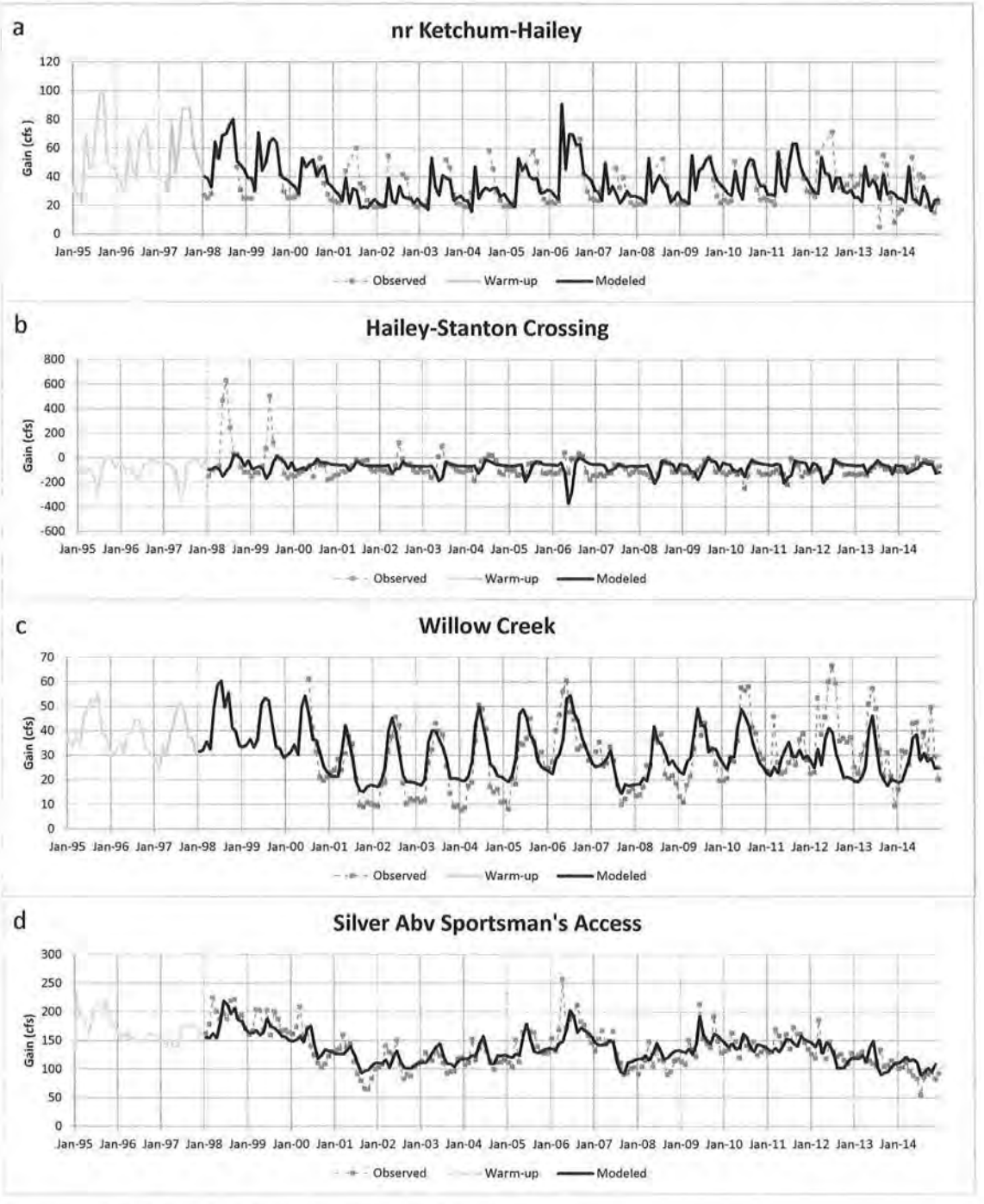

Figure 14. Modeled and observed river gains and losses.

Big Wood River

During the calibration period (1998-2014), the fall through early spring river-aquifer exchange in the near Ketchum-Hailey reach of the Big Wood River (Figure 8a) were calculated; however, because of gage error and ungaged tributary stream contributions, the spring and early summer aquifer and river interactions could not be determined. Figure 14a shows that the observed gains tend to be high in the spring, occasionally more than 60 cfs, and taper down to 20 cfs during the winter months. The WRV Aquifer Model Version 1.1 tends to capture the general character but misses the early season gains in some years. For example the WRV Aquifer Model Version 1.1 does not match the peak gains during the springs of 2001 and 2002.

Ungaged tributary stream contributions to the Hailey-Stanton Crossing reach (Figure 8a) during the late spring and summer are expected to be negligible, allowing calculation of year-round calibration targets. This reach tends to lose water to the aquifer; however, during the summers of 1998, 1999, 2002, 2003, 2004, and 2006 the field data show gains from the aquifer. The calculated gains may be the result of gage error during high flow. The modeled data match the seasonal highs and lows adequately; however, the field measurements tend to gradually decline throughout the summer and winter, while the modeled data drops abruptly. In reality, the Big Wood River gradually dries up between Glendale Road and Wood River Ranch, but in the model, the river either has water, or does not have water. Perhaps the inability to match the gradual decline is due to these abrupt changes in the model river file in the Glendale Road to Wood River Ranch subreach that are intended to simulate the change from high flow conditions during spring runoff to a dry riverbed at the end of summer.

Willow Creek

Willow Creek originates as springs within the model area and is gaged near the southwestern corner of the model (Figure 1). Figure 14c shows the field observations and the modeled match for Willow Creek. The modeled gains match the general shape of the field observations and match the timing of the peak discharge; however, the modeled data does not match the observed seasonal amplitude. The observed data almost certainly contain some runoff from spring snowmelt, which is not represented in the model.

Silver Creek

Silver Creek originates as springs within the model area and is measured at the Sportsman's Access gage shown in Figure 1. Figure 14d shows the field observations and the modeled match. The modeled gains follow the general shape of the field observations but under-predict the seasonal amplitude. Perhaps the mismatch is because peak flows contain some runoff from spring snowmelt.

Several streamflow measurements collected in Silver Creek just north of Picabo suggest that there is minimal aquifer-river interaction between Silver Creek and the WRV aquifer downstream (east) of the Sportsman's Access gage (Wylie, 2019). This finding is consistent with historic seepage studies (Moreland, 1977).

Seepage surveys

Improved resolution of the aquifer-river interaction along the Big Wood River and Silver Creek is possible through incorporating the results of the August 2012, October 2012, and March 2013 seepage surveys (Bartolino, 2014). The modeled match with the three seepage surveys is shown in Figure 15. One of the challenges associated with including the seepage surveys is that the field results are point measurements influenced by daily or even hourly water-management decisions, while the model is responding to average monthly water use. Even so, the cross plot in Figure 15 shows that the model

output matches reasonably well. If the model output were to match the field observations perfectly, the data would fall on the 45° line. The fact that the data do not all fall on the 45° line may be, in part, because the diversions and returns fluctuated from the average during the seepage survey.

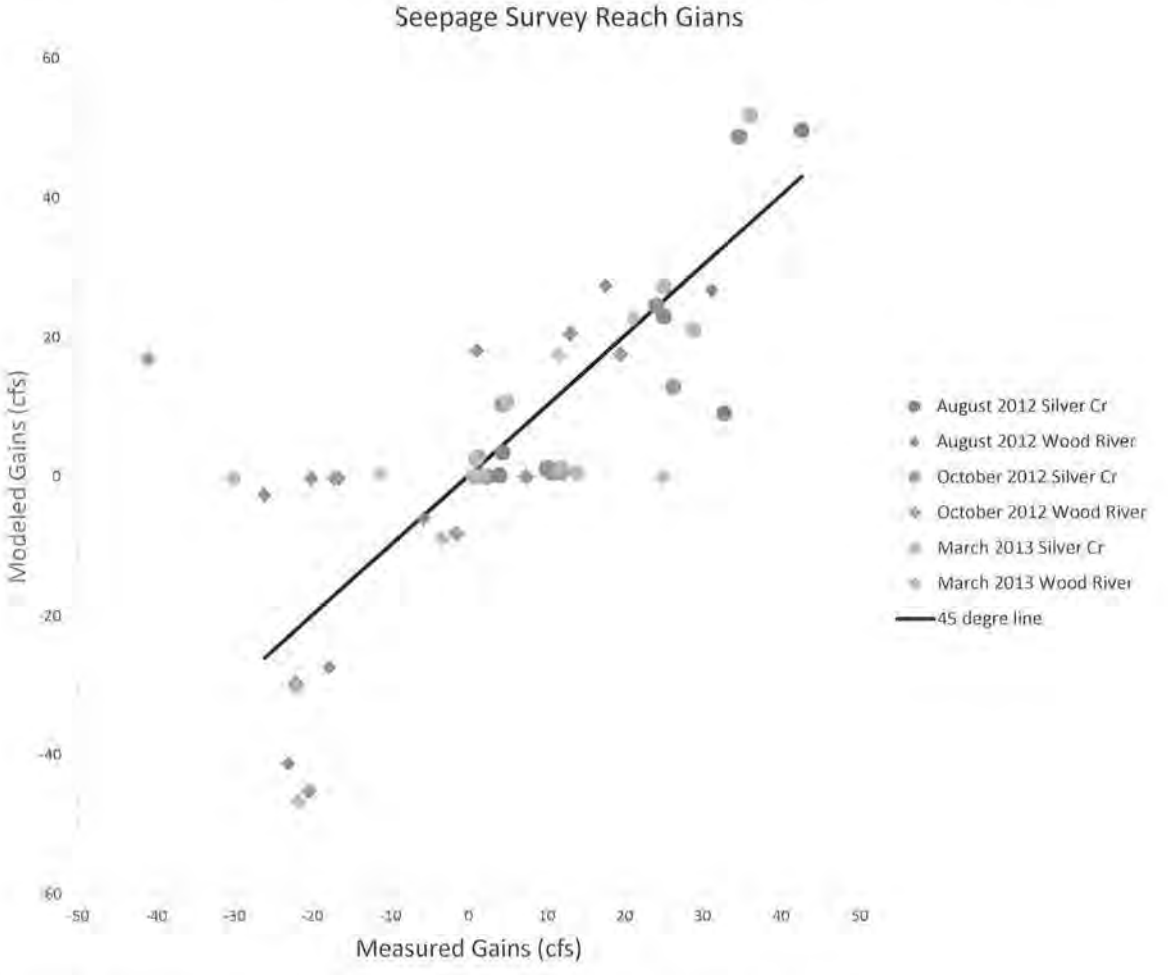

Figure 15. Cross plot of modeled and observed seepage survey reach gains.

Heart Rock Ranch-Stanton Crossing gains

When the flow downstream of the Heart Rock Ranch point of diversion on the Big Wood River is zero, the flow measured at the Stanton Crossing gage represents the gains accrued between the Heart Rock Ranch point of diversion and the Stanton Crossing gage (Figure 16). This situation happened 89 times during the simulation period, and the chart in Figure 16 shows the field observations compared with the modeled values. Some of the mismatch is due to the fact that the seasonal changes to the modeled river are more granular than in the actual river. The Big Wood River between Wood River Ranch and Stanton Crossing is modeled as containing water when Landsat images show water in more than half the reach. The real world situation is much more complex and the wetted length of the river can change daily. This likely explains the deviation between modeled and measured data in the winter of 2007-2008.