The Walla Walla watershed, located in rural southeastern Washington and northeastern Oregon (see map), likely has more in common hydrologically with the arid Southwest than with some of the Northwest’s wetter coastal watersheds. Precipitation mainly occurs at higher elevations and flows down to the populated lowlands where it is allocated among various users. While the headwaters receive 40 to 50 inches of annual precipitation, the lowlands get only 5 to 15 inches, making portions of the watershed semi-arid to arid. And typical of most arid watersheds, the Walla Walla Basin’s primary human demands for water are irrigation, consumption, and recreation.

As in the Southwest, protection of endangered fish species drives certain watershed management activities. Until recently, efforts to restore endangered salmon and cold-water fish species were focused on the region’s larger rivers such as the Columbia and Snake, and included improving dam management and passage and developing hatchery programs.

Now more focus has shifted to improving conditions in the numerous tributary watersheds like the Walla Walla. Here the focus is on improving instream habitat, especially the flow volume needed for fish passage, spawning, and rearing. Water managers and farmers have increased streamflow in the Walla Walla Basin through numerous irrigation efficiency and conservation projects, including piping and lining of canals, flood-to-sprinkler irrigation-system conversions, and shifting from high-water- to low-water-use crops. These conservation measures have successfully reduced irrigation water demand, resulting in water “savings” left instream at points throughout the watershed.

No Magic Bullet
This seemingly successful restoration overlooked an important aspect of surface-water management: the role of groundwater. As conservation measures were implemented, the spatial distribution, timing, and volume of recharge to the shallow aquifer system changed. In fact, surface water gains observed in the main tributaries can generally be attributed to a net loss of aquifer recharge. This is because significant amounts of water that used to infiltrate throughout the watershed now flow directly into the river.

Decreases in groundwater recharge altered the equilibrium between recharge and discharge in the shallow alluvial aquifer system. Decreased aquifer discharge is manifested in the drying up of springs and groundwater seeps that feed the same river that is being “restored.” Once-perennial springs that returned cooler groundwater to the Walla Walla River now flow only intermittently—and in some cases are dry nearly year-round—leading to the loss of off-channel rearing habitat and likely a net increase in mainstem river temperatures: hardly the goal of instream flow restoration.

Historic Evidence of Connectivity
Within the watershed, the Walla Walla River Valley consists of an alluvial aquifer system made up of thick (up to 800 feet) clastic sediments overlaying basalt. The alluvial aquifer system is generally unconfined and highly interconnected with surface waters of the watershed through channel and canal-bed gains and losses that have varying infiltration rates.

Evidence of this connectivity can be traced back to the early 1800s, when extensive trapping reduced the beaver population, resulting in the loss of hundreds of beaver ponds. The ponds retained water...
in the watershed, slowing the surface-water velocity and promoting infiltration to the shallow aquifer system; without them, aquifer recharge was diminished.

But later in the 19th century, irrigated agriculture came to the valleys, and stream water was diverted into lateral canals and channels to irrigate fruit orchards and other crops. These new channels and flood-irrigation practices increased the overall recharge to the shallow aquifer system, leading to a corresponding increase in spring and seep discharge from the aquifer. Vaccaro and Olsen (2007) estimated that irrigated agriculture increased annual recharge to the Yakima River Basin aquifer by 38 percent over pre-irrigation conditions, from 3.9 million to 5.1 million acre-feet.

Then groundwater development began in the early 1900s. Initially, some groundwater was returned to the aquifer as irrigation waste, but as practices became more efficient the volume of net discharge from the aquifer increased dramatically. Furthermore, post-World-War-II flood-levee projects straightened many reaches of the watershed’s waterways, speeding the passage of water through the watershed and further reducing opportunities for natural recharge and infiltration.

**Result: Groundwater Declines**

Wells monitored by the state of Oregon since 1933 show a steady decline in the elevation of the shallow aquifer water table. Aquifer-fed springs, referred to by Piper and others (1933) as “…comparable to the spillway of a reservoir, for they are supplied by overflow from the ground-water reservoir in the permeable alluvium…” also showed decreasing discharge despite additional recharge to the aquifer from these historic irrigation practices (see chart, left). Until recently, the hydrologic regime of the system, while in decline, was still significantly dependent on irrigation returns for the aquifer’s year-to-year storage. But the implementation of salmon-recovery water “savings” measures is causing groundwater storage to decline at a faster rate, with springs and wells going dry. As a result, watershed managers have begun to consider conjunctive methods to address these water resource issues.

**Conjunctive Measures**

Since the mid-1990s, more than 23 miles of irrigation canals have been piped or lined, resulting in flow increases of more than 16 cubic feet per second of “saved” water. But this means approximately 11,500 acre-feet per year less water has been recharged to maintain groundwater storage. In 2003, local irrigation districts, state agencies, and watershed groups started exploring the use of artificial aquifer recharge as a way to offset the loss of irrigation-related recharge. The Hudson Bay District Improvement Company (HBDIC) recharge project in Oregon was the first project of its kind to use a new limited-testing license that utilized water during the nonirrigation season (Nov. 1 through May 15) to operate. During a 129-day period from 2006 to 2007, the project recharged 3,330 acre-feet to the shallow aquifer through spreading basins. The additional groundwater subsequently has restored flow to springs directly downgradient of the site. Johnson Creek, an indirect tributary to the Walla Walla River, had not flowed through the town of Umapine, Oregon for nearly 25 years. The creek’s natural channel and lateral canal system had been nearly abandoned, causing minor flow-routing issues as the creek came back to life.

To document the beneficial effects of aquifer recharge on spring discharge and stream flow, a finite-element flow model of Johnson Creek was developed utilizing California’s Integrated Water Flow Model.
The model was calibrated for the period of HBDIC operations (current practices), and two scenarios were run to simulate the flow in Johnson Creek Spring: one where the HBDIC project was not operated and the second where all the irrigation canals were lined. The results (see chart) showed a severe impact to spring-flow volumes if all the canals were lined and indicated that the recharge project was enhancing flow in Johnson Creek’s springs.

These results and additional aquifer recharge testing sites have helped begin to redirect salmon-recovery water management from a surface-waters-efficiency-only mindset to one in which the connectivity of surface water and groundwater resources is employed to better manage the resource.

While water restoration goals are often simple to conceive and outline in policy, a tendency exists to oversimplify the complexity of restorative actions that will truly effect change. In the Walla Walla watershed, through trial and error, water managers are learning that sustainable solutions are possible as long as surface water and groundwater are recognized as linked and interdependent. Kendy and Bredehoeft (2006) perhaps put it best: “Achieving the linked goals of obtaining sustainable groundwater supplies while at the same time maintaining desirable streamflow represents the most basic form of conjunctive groundwater and surface water management.”

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References


Model scenarios compared to current practices (with spreading basins) at Johnson Creek Spring for the period 2003-2006 showed the severe impact to flow that would occur if the canals were lined, and the effect of the recharge project in late 2006 (current practices).