Field Methods in Ecohydrology: Studies in an Urban Watershed

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Background

In 2008, the ***U.S. Department of Agriculture's Integrated Research, Education, and Extension Competitive Grants Program: National Integrated Water Quality Program*** awarded funding to the University of Nevada for the proposal *Undergraduate Education: Watershed-focused Field Studies in Ecohydrology for Arid Rangeland Management*. Objectives in this proposal included teaching practical skills in a watershed-oriented field course, and providing students with local government and other perspectives and training opportunities. In Fall, 2009, the University offered the field course as NRES 485. This complemented the newly established (2007) Ecohydrology B.S. program – the first of its kind in the United States (Saito, et al 2009). This poster reports the results of a successful first offering of the field course in 2009, which featured a strong partnership between the University of Nevada, the City of Reno, the U.S. Forest Service, a neighborhood association and the county wastewater treatment facility.

Urbanization of watersheds increases impervious area, thereby changing the hydrologic response to precipitation and snowmelt. This includes increasing the volume of runoff and peak flow discharge rates (Bernhardt and Palmer 2007). Consequently, sediments and nutrient loadings to urban streams increase, and channel morphology and flow patterns are often dramatically altered (Bernhardt and Palmer 2007; Roesner et al. 2001). In the arid west where agriculture (including rangeland for cattle production) was formerly the dominant land use, irrigation diversions may effectively increase the size of a watershed by conveying stormwater from beyond watershed boundaries. In addition, public utilities may provide significant amounts of water annually for residential and commercial use. The Truckee River is a good example of a western river that has historic water appropriations for irrigated agriculture and hydropower and now also serves a growing urban population (Horton 1997).

Methods

Field site:
Alum Creek is a tributary to the Truckee River (**Figure 1**). The creek rises in the Toiyabe National Forest west of Reno, NV and flows through Caughlin Ranch, a 2300-acre community that has multiple land uses, including single family residences, commercial zones with retail stores, food services and professional offices, and recreational facilities and green space. The watershed boundary for the creek encloses 5.2 square miles. The watershed is an example of the conversion of agricultural land to urban land. It is also an example of an intrabasin transfer of water by the Steamboat Ditch that traverses and contributes to subwatersheds for the Truckee River. The chemical and physical quality of the Truckee River at the primary point of diversion for Steamboat Ditch is excellent and meets standards. However, increased flow due to water transfers via the ditch add the potential for non-point source influences, especially from areas that have been urbanized. The Alum Creek watershed is an interface between forest and natural rangeland and urban land use, which makes it an excellent area to investigate the separate and combined influences of these land uses on water quality. Its proximity to the University of Nevada facilitates linkages between research and instructional activities in the watershed, providing opportunities to enhance undergraduate and graduate coursework with field studies.

Based on samples collected at the confluence with the Truckee River, the Nevada Division of Environmental Protection included Alum Creek on a 2006 list of impaired waters in the State of Nevada, as required by Section 303(d) of the Clean Water Act. Alum Creek has been added to the State of Nevada's Impaired Waters List (http://ndep.nv.gov/BWQP/file/303d_list09-att1.pdf, under Section 303(d) of the Federal Clean Water Act) with impairments for E. coli, phosphorus (total and orthophosphorus), total suspended solids, sulfates, water temperature, turbidity and iron. While the priority is low for assessing land management options in the context for setting total daily maximum loads, student presentations of analyses conducted to evaluate different aspects of the listed impairments will be useful for members of the Caughlin Ranch homeowners' association, Caughlin Ranch Board of Directors, City of Reno and Nevada Division of Environmental Protection.

Steamboat Ditch, which began delivering water in 1887, was originally constructed as an agricultural diversion from the Truckee River to irrigate pastures. Investigations of potential sources of contamination are complicated by the external influence of Steamboat Ditch, which traverses the watershed, sustains flow in the creek during the irrigation season (April—October), and also has the potential to contribute storm runoff throughout the year. In some places the Ditch flows adjacent to Alum Creek and may have some hyporheic influence on water quantity and quality. Within the watershed, irrigation may recharge shallow groundwater and enter the creek as internal soil drainage. Runoff from residential uses and stormwater also reaches the creek directly through the gutter and storm sewer network. However, it now traverses urban watersheds across the Truckee Meadows.

Figure 1: Alum Creek field study site, within Nevada and the City of Reno

Sampling and flow measurement
In Fall, 2009 students from *NRES 485: Field methods in Ecohydrology* carried out several types of studies (**Figure 2**). These included collecting samples from four sites (**Figures 1,3)** that were identified as critical assessment points to detect sources of water quality impairment within the watershed. Samples were analyzed for nitrogen, phosphorus, *E. coli,* and turbidity. In addition, the students recorded water temperature, pH, conductivity, and dissolved oxygen content with a YSI 556MPS (Yellow Springs Instruments, Yellow Springs, OH). *E. coli* samples were analyzed using membrane filtration (Clesceri, et al 1998) and discharge rates were measured with a Marsh McBirney Flo-Mate flow meter (Hach, Inc., Loveland Colorado).

Figure 2: (upper left) students Scott Fennema, Ashley Reid and Andrew Hill carrying out a leveling survey on Alum Creek; (right) the upper watershed for Alum Creek is forested, which is very much an urban/rural interface; (middle) measurements included those made *in-situ*.

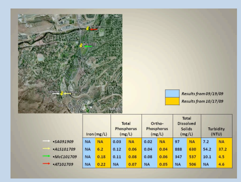

Figure 3. Sampling points included background samples to capture the natural quality of water in the upper portions of the watershed, with samples taken to represent progressively urbanized area. Samples also capture temporal variability.

Results

Water quality and quantity
Discharge measurements (not shown) and observations indicated that the system is composed of several nearly separate components – an upper, forested watershed that rarely has flow sufficient to influence the lower urbanized reaches, an urbanized reach that is seasonally sustained by irrigation water supplied by Steamboat Ditch and a lower section, including the confluence with the Truckee River, that is further influenced by domestic water supplies used for lawn and grounds maintenance. Water quality differs in each of the three sections, with background water quality being very high in total dissolved and suspended solids (**Figure 4**). *E. coli* amounts increased in proportion to flow and the proportion of contributing watershed area in urbanized land use (data not shown). Orthophosphorus amounts exceeded the standards set to protect the Truckee River at the downstream-most sampling point from the Caughlin Ranch development.

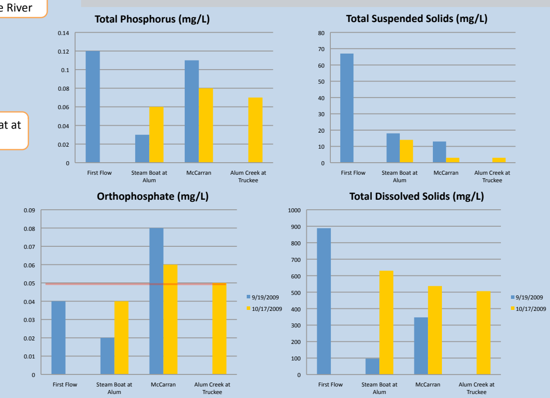

Figure 4. Sampling points included background samples (*First Flow*) and seasonal comparisons (with 9/19 and 10/17 representing water quality with and without irrigation water contributions through Steamboat Ditch) to capture the natural quality of water in the upper portions of the watershed and to represent the influences of progressively urbanized area in the watershed and seasonal influences of irrigation water contributions.

Conclusions

These preliminary results indicate that water quality in the undeveloped portions of the watershed does not meet ambient water quality standards (with respect to total dissolved solids). However, the primary source of contaminants related to human health and eutrophication (*E. coli*, orthophosphorus) is likely to be non-point sources associated with irrigation water contributions to drainage and runoff in Alum Creek. Next steps include seasonal sampling, modeling and increased mapping.

References

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