Title: Assessing the Ecological Status and Vulnerability of Springs in Wisconsin

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Background/ Need: The need for a clear understanding of the range of physical and ecological characteristics of springs in Wisconsin provides the overall motivation for this project. The topic is relevant in Wisconsin because the Wisconsin Department of Natural Resources must evaluate whether groundwater pumping by new high-capacity wells will result in significant environmental impacts to springs that result "in a current of flowing water with flows of a minimum of one cubic foot per second at least 80% of the time (2003 WI Act 310, p.2)". However, Wisconsin's springs, irrespective of the flow criterion, are poorly studied, resulting in a lack of information for use in determining significance of impacts.

Objectives: Our primary goal is to collect, classify, and evaluate baseline data on physicochemical characteristics and biological communities of Wisconsin's spring resources. Using historical spring surveys and a comprehensive springs classification system developed by Springer et al. (in prep.), the physical, biological, and sociocultural characteristics of typical spring systems in two regions of the state were documented. The two regions differ in their topography, geology, land use, and development pressures. The approach allows the assessment of the physical and ecological status of spring systems and the formulation of hydrogeological conceptual models of springs in these settings.

Methods: The methodology involves mapping springs in Iowa and Waukesha Counties, conducting surveys of representative springs in each county, building a database for the spring-related information, and interpreting these data in association with regional information on geology and topography to assess vulnerability to groundwater withdrawals. The study represents the first assessment of spring resources in these regions in approximately 50 years.

Results and Discussion: Iowa County is rich in spring resources; any loss of spring resources over the last 50 years is minimal. Field data support conceptual models for springs in Iowa County that are based on a typical contact spring. Springs are associated with every major stratigraphic unit, but are most commonly found in association with the Sinnipee Group, near the upper contact of the St. Peter Fm., or near the upper contact of the Cambrian sandstones. Therefore, heterogeneities like vertical and horizontal fractures, both of which are prevalent in the Sinnipee Group rocks, or partings along major stratigraphic contacts may be particularly important in promoting discrete flow in the region. Spring waters discharging from different geologic units can be distinguished on the basis of major ion geochemistry, and springs discharging from stratigraphically higher units have more variable flow.

In Waukesha County, much of the land that historically contained springs has been developed for residential or commercial purposes. The spatial distribution of springs was historically influenced by the glacial topography and the position of the Maquoketa shale subcrop. Geochemical groups of spring waters suggest that although flow paths originate in the unlithified aquifer, groundwater may flow through shallow bedrock before discharging as depression springs in low-lying wetlands or near streams.

Agricultural and historical uses of spring water have impacted the ecological status of springs in both regions. Plant diversity is somewhat higher at the Waukesha County springs, but the percent cover of native plants is lower and the percent cover of invasive plants is higher. Benthic fauna communities are dominated by non-insect taxa (Amphipoda, Isopoda, Gastropoda), although low numbers of aquatic insects (Tricoptera and Diptera) were found in most springs.

Conclusions/ Implications/ Recommendations:

Overall confidence in historical spring locations is high, which allows their use in association with patterns of regional geology and topography. This regional information is complemented by the depth of the site-specific information collected using the Springer et al. (in prep.) system. At least 20 springs were surveyed in each county. This number of springs provided sufficient data to develop conceptual models and preliminarily assess vulnerability to pumping, which suggests the overall approach may also be successful elsewhere in Wisconsin.

Springs discharging from stratigraphically higher units in Iowa County are likely to be vulnerable to pumping from wells along ridge tops that are installed in these aquifers or that span multiple aquifers. Because recharge areas for these springs are probably small and shallow, pumping could result in substantially reduced spring flow or complete loss of flow to small springs. Springs discharging from stratigraphically lower units are probably less vulnerable, due in part to broader contributing areas, but also because most high-capacity wells that pump water from the Cambrian sandstones are located in the floodplain of the Wisconsin River, where few springs exist. Because regional pumping in southeastern Wisconsin affects shallow flow patterns and downward flow from the shallow to the deep parts of the system occurs, springs in Waukesha County are vulnerable to additional groundwater withdrawals from both the shallow and deep parts of the system.

Related Publications:

Bartkowiak, B.M. and Swanson, S.K., March 2007. Geochemical and flow characteristics of two contact springs in Iowa County, Wisconsin, American Water Resources Association - Wisconsin Section Annual Meeting, Wisconsin Dells, WI.

Swanson, S.K., March 2007. Assessing the ecological significance and vulnerability of springs in southern Wisconsin, American Water Resources Association - Wisconsin Section Annual Meeting, Wisconsin Dells, WI.

Key Words: Springs, Iowa County, Waukesha County

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Final Report: A final report containing more detailed information on this project is available for loan at the Water Resources Institute Library, University of Wisconsin - Madison, 1975 Willow Drive, Madison, Wisconsin 53706 (608) 262-3069.