Science in the Driftless Area Symposium
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Aquatic Invertebrate Diversity on Gilbert Creek (Dunn County, WI)

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Abstract: Gilbert Creek, Dunn County WI, drains from the sandstone bluffs of the Knapp Hills of the northern most Driftless Area. It is approximately 13.5 miles long, and over 20,000 feet of bank in the headwaters have been restored to enhance spawning habitat of Brook Trout (Salvelinus fontinalis). General monitoring (temp, pH, N, P, E. coli, etc) has been compiled for 10 weeks, during the past 4 summers in the restored area. Invertebrates surveys were completed monthly at 8 locations along the entire stream. The diversity and density are directly correlated to the impacts of restoration. The greatest density and diversity of invertebrates was found at the 2003 site, 5 years post-restoration, while the least diverse sites were those with no restoration and little habitat.

Ecological Considerations for the Design of Stream Crossings

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Connectivity is vital to the physical, chemical, and biological functioning of streams and rivers. While it's recognized that Wisconsin's 3,800 dams fragment rivers, the extent of the impacts of improperly designed, installed, or maintained road-stream crossings are less understood. There are well over 60,000 stream crossings in the state, and extrapolation of crossings data gathered in several Wisconsin counties suggests that more than 15,000 of Wisconsin's road-stream crossings may block adult gamefish passage. The impacts to small fish, other aquatic, amphibious, or terrestrial species that rely on stream corridors for movement are relatively unknown. The Wisconsin Department of Natural Resources is working with the USDA Forest Service to gather data to better define the spatial extent of the problem, and partnering with the Wisconsin Department of Transportation and the Nature Conservancy to train agency staff responsible for the design and installation of road-stream crossings, to reduce stream fragmentation in the state.

Determination of appropriate metrics for sediment-related total maximum daily loads

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The most common cause of impaired rivers and streams in the United States is sediment pollution. Sediment impacts on stream systems result from both its effect on water clarity and its physical characteristics. High levels of fine suspended sediment reduce aquatic health in numerous ways, including a reduction in light transmission, interference with aquatic organisms, and reduction in benthic habitat quality following deposition on the bed. There are many ways of measuring suspended sediment levels, including both direct measurements of concentration and indirect measures such as turbidity. Measurements of total suspended solids concentrations are obtained from water samples, which are then filtered and processed in a laboratory. Turbidity, on the other hand, is an expression of the optical property of a sample of water, in which the amount of light scattered by a given water sample is compared with that scattered by a standard sample. In many systems, particle size characteristics change rapidly both temporally and spatially, so turbidity does not always correlate well with suspended sediment concentrations. Therefore, since Minnesota has a water quality criterion based on turbidity alone, it is possible that stream habitat quality is being reduced by sediment pollution effects that are not captured by an analysis of water clarity alone.

Here, we asked the question of what is the most important aspect of sediment pollution. We tested the null hypothesis that turbidity is the most important factor by experimentally manipulating turbidity levels within an outdoor stream ecosystem and observing impacts of turbidity on this system. We introduced water with different compositions of suspended load (e.g., different proportions of fine sand, silt, mud, and different levels of organic matter and nutrients) but the same turbidity level into the Outdoor Stream Lab facility at St. Anthony Falls Laboratory (SAFL), and compared the ecosystem response. Trials were performed under high flow conditions, which often accompany high turbidity levels and typically exert substantial stress on aquatic ecosystems. The results were analyzed to determine whether turbidity (i.e., NTU) most closely correlates with benthic habitat quality, or whether another metric or combination of metrics (e.g., suspended sediment concentration, transparency, net sedimentation, or embeddedness) provides a better understanding of the effect on benthic habitat. These results are needed by federal and State agencies to modify their TMDL program and better protect the water quality of Americas rivers and streams.

Forests to the Faucet: A Direct Connection

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A four-step GIS overlay process was designed to identify and rank watersheds where forest conservation and stewardship is and will be especially important to protect drinking water supplies. The first step used a set of biophysical attributes (e.g., %forest, %agricultural land, road density, etc.) to develop an index of each large watershed's ability to produce clean water (APCW). The second step added the number of water consumers per unit area for each watershed to the APCW layer. The top scores represent watersheds with a high inherent ability to produce clean water upon which a large number of water consumers depend. The third step accounts for the proportion of private forest land (versus public or other forest land that is permanently protected from conversion to other uses) – combined with the preceding steps – to highlight the public water supply systems that depend upon the private forest land and landowners for source protection. The fourth and final step ("development pressure") uses US Census Bureau population projections for 2030 and David Theobold's algorithm that forecasts the spatial pattern of forest conversion to residential and associated commercial and industrial land use ...added to the output of the three preceding steps (APCW + Number of water consumers + proportion of private forest land + development pressure) to highlight the parts of the Northeastern Area (20 midwest and northeast states) where watershed forest conservation and management efforts are particularly important. Put another way, the top scoring watersheds are those that have a (1) very high ability to produce clean water, (2) large number of water consumers, (3) large proportion of private forest land (that is subject to conversion to other land uses), and (4) high forecasted (for 2030) population increases and subsequent loss of private forest land. This analysis could be scaled down to a state or larger watershed level.

Early Detection of Invasives-Monitoring protocols

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In Wisconsin there are many successful invasive species education and volunteer monitoring programs targeting lake user groups. There is a lack of such programs geared specifically for river enthusiasts. The River Alliance of Wisconsin is working to raise awareness about the impacts of invasive species to our rivers and streams and develop monitoring protocols for volunteers. They and the Wisconsin DNR are partnering with local citizen groups to implement a pilot project training canoeist and kayakers to assist in the early detection of four invasive species (Japanese knotweed, common reed grass, Japanese hops, and purple loosestrife) along riverbanks throughout southern Wisconsin. We will share the variety of approaches we have attempted, what we found to be successful or unsuccessful and our plans for the future.

Wisconsin Geological and Natural History Survey: Upcoming watershed research in Grant County, Wisconsin

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The Wisconsin Geological and Natural History Survey (WGNHS) participates annually in the STATEMAP component of the National Cooperative Geologic Mapping Program, a federally-initiative to support geologic mapping through state geological surveys. Beginning in July 2009, the WGNHS expects to begin a three-year project to map and study the surficial deposits of Grant County in the Driftless Area of southwestern Wisconsin. The primary objective of the project will be to produce a 1:100,000-scale map of Grant County showing the distribution of unconsolidated surficial sediments; however, the geologic mapping also provides a venue for studying watershed processes within Grant County. While specific research topics are still be determined, we anticipate that the following topics will be among those investigated during the term of the project: (1) the distribution and thickness of wind-blown silt on upland surfaces and their susceptibility to erosion; (2) sedimentary records of climate change and landscape evolution; (3) analysis of precipitation and runoff records from a small monitored watershed; (4) evaluation of historic trends of land use and resultant sediment erosion; and (5) historic and longer-term records of flood frequencies and magnitudes. It is intended that the mapping and related research will assist county and regional managers, and all other interested parties, with an improved ability to make sound land-use decisions.

A Search for Hybrids Between Slimy Sculpin (*Cottus cognatus*) and Mottled Sculpin (*Cottus bairdi*) in Southeast Minnesota

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Hybridization is common among freshwater fishes and is often associated with changes in environmental conditions. When conditions are altered, e.g. through land-use or climate change, species barriers that were once distinct may break down and lead to changes in fish community structure. Slimy sculpin and mottled sculpin, two species with similar appearance and reproductive habits, occur in southeast Minnesota, sometimes syntopically. A study conducted in Pennsylvania found hybrids between these two species, but in general the phenomenon is poorly documented. Our objectives were to determine if hybrids of the two sculpin species occur in southeast Minnesota and describe habitat characteristics associated with species overlap. Using species-specific microsatellite DNA markers, we genotyped 100 individuals from each of four locations where the species overlap. We collected habitat data from overlap sites, including sections of the stream where the species overlapped and sections where both species occurred alone. Slimy sculpin tended to occupy cold, headwater streams, whereas mottled sculpin inhabited warmer, larger systems. Overlap was constrained to confluences of these smaller and larger streams, and occurred mostly in the larger streams. We found no hybrids. Detailed analyses of habitat in overlap sites are pending; however, initial habitat assessments suggest that land-use and climate change impacts may create conditions that lead to increased species interactions, possibly favoring mottled sculpin. Continued monitoring of species distribution and hybridization will provide insight not only into how coldwater fish communities are impacted by environmental change, but also provide an indicator of that change should hybridization occur.

Physical and Biological Metrics for Measuring Stream Restoration Success

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The Kiap-TU-Wish Chapter of Trout Unlimited, West Wisconsin Land Trust (WWLT), and the Wisconsin Department of Natural Resources (WDNR) are conducting a three-year (2007-2009) restoration of Pine Creek, a native brook trout stream in the Driftless Area of Wisconsin. The creek is located in Pierce County, near Maiden Rock, and flows into the Mississippi River at Lake Pepin. Despite excellent water quality, Pine Creek has suffered due to clear-cutting of timber in the late 1800's and poor agricultural practices. The restoration goal of the Pine Creek Project is to stabilize severely eroding banks, provide in-stream cover, and improve aquatic habitat by employing techniques used by WDNR fish managers across the Driftless Area. Because of the cost and visibility of the Pine Creek Project, measurable project objectives have been established, and Kiap-TU-Wish has developed physical and biological metrics to quantify restoration success. Stream improvements are being documented by directly measuring pre- and post-restoration Eastern Brook Trout densities and size distribution, temperature and habitat conditions, and macrophyte and macroinvertebrate community health in Pine Creek. In 2007 and 2008, Kiap-TU-Wish volunteers collected pre-restoration data on stream temperature and habitat, including stream bank condition, stream channel morphometry, stream bed substrate, and macrophyte and macroinvertebrate presence. At the symposium, the physical and biological metrics will be described, and the 2007 pre-restoration data will be presented. The metrics developed by Kiap-TU-Wish can be readily applied by volunteers using relatively inexpensive field equipment, and could prove useful for documenting stream restoration success throughout the Driftless Area.

Gorman Creek Stream and Riparian Wetland Restoration

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Streams throughout southeast Minnesota have been altered in many ways. The headwaters of Gorman Creek, a coldwater trout stream in Wabasha County, MN, were straightened in the early 1900's to increase drainage and expand farmable acreage within its narrow valley. Channelization of the stream and associated riparian area significantly degraded aquatic habitat and water quality. A 2,500 foot channelized portion of the stream was restored to a 4,200 foot meandered channel. An additional 10 acres of riparian habitat was restored along nearly a mile of the stream including the restoration of 3 riparian wetlands. The stream now supports reproducing brook trout and the riparian habitat is home to grassland nesting birds, insects, and amphibians.

Monitoring Temporal Trends in Trout Populations and Stream Flow in Driftless Area Streams

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The management of trout populations in streams is often complicated by high variability in wild trout populations. As managers we would like to know if changes in trout populations are attributable to management actions. Management actions are often confounded with changes in environment, thereby making it difficult to adequately evaluate the management decisions we make. Monitoring fixed sites over time may provide the information necessary to formulate insightful hypotheses about trout population dynamics and trout management in streams. We initiated in summer 2007 a project to monitor temporal trends in trout populations and stream temperature and flow for a selection of trout streams in the Driftless area. Our objectives are to (1) determine the utility of temporal-trend monitoring of coldwater streams as part of the statewide baseline stream monitoring program for fisheries management and (2) quantify relationships between stream base flow and flow variability, precipitation, and trout population dynamics in coldwater streams. We will describe our current monitoring efforts on 18 Driftless area streams, including trout population trends for 5 streams in which trout populations have been monitored since 2004. Within the first year of stream flow monitoring the Driftless area experienced two unusually large rain events. Some monitored streams experienced flash flooding with increases in water level of over 750%. We will show temporal stream flow data for these streams and discuss the implications such flooding events may have for trout population dynamics in coming years.

Lack of Diet Shifts in Slimy Sculpin after Catastrophic Flooding in Two Streams in Southeastern Minnesota

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Slimy sculpin *Cottus cognatus* inhabitat coldwater streams in southeastern Minnesota that were subjected to probable 1000-year flood events in August 2007. Floods scoured streambeds, created new stream channels, and greatly reduced benthic invertebrate communities that serve as the primary food resource for sculpin. Diets of sculpin in Gilmore Creek and Garvin Brook (Winona County) had been examined just prior to flooding, and were re-examined two weeks after flooding to assess possible diet changes. Sculpin diets were more diverse prior to flooding in Gilmore Creek (11 taxa) than in Gilmore Creek (4 taxa), although diets of fish from both streams were dominated by midge (Diptera: Chironomidae) larvae. Post-flood diets were similarly diverse (Gilmore – 10 taxa, Garvin – 5 taxa), with pre- and post-flood diets

having six taxa in common in Gilmore and only one in common in Garvin. These in-common taxa comprised >93% of individual prey items consumed both pre- and post-flood. The average number of prey items per stomach was reduced by half post-flood in Gilmore Creek (8 prey vs. 4 prey), but more than doubled post-flood in Garvin Brook (31 prey vs. 67 prey). However, standardized dry weight of prey (g dry weight of prey/g fish wet weight) declined dramatically post-flood in both Gilmore Creek (6.2 mg/g before vs. 2.2 mg/g after) and Garvin Brook (3.6 mg/g before vs. 1.4 mg/g after). Sculpin diets changed little in composition after flooding, but consumption rates appear to have been reduced by >60%, which may have affected fish condition, over-winter survival, and spring fecundity.

Influence of riparian condition on impacts from the flood of August 2007

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Heavy rainfall of up to 18 inches fell in a 24 hour period on August 18 and 19, 2007 in an area of SE Minnesota, SW Wisconsin, and NE Iowa. This storm easily eclipsed the previous Minnesota state record for rainfall (10.8 inches). As a result, rivers in this region endured heavy flooding. Flows in most rivers were higher than previous records, and estimates of the magnitude of the event range from a 100 to 1000 year recurrence interval.

Impacts from the flood varied greatly even within a single watershed. In some areas significant streambank erosion occurred, while in other areas stream channel and floodplain deposition was significant. In extreme cases rivers rerouted to entirely different channels, with former the channels filled with deposited material. Differing theories abound regarding the influence of trees in the riparian area, the role of woody debris jams, and the persistence of stream habitat work. This paper looks at the influence of differing riparian vegetation, valley slope and topography, and in-channel obstructions as explanations for varying degrees of flood impact.

Some Biological Effects of Severe Flooding in Southeastern Minnesota Streams

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Severe flooding in southeastern Minnesota, notably in August of 2007, had effects on trout streams that were not always expected: (1) Longterm records indicate that sunfish are typically absent or rare in Gilmore Creek, but after each of two floods they increased dramatically, but temporarily, apparently by moving upstream from Boller Lake. Most of the influx after each flood consisted of green sunfish of multiple size classes, but they were accompanied by pumpkinseeds in 2007. (2) A stand of an exotic invasive plant, Japanese knotweed, has been present at a site on Garvin Brook for several years, probably brought in with fill used to stabilize a bridge. Although this species rarely produces fertile seeds, it is capable of spreading vegetatively. After the 2007 flood, when extensive new rock and gravel bars were created along Garvin Brook, healthy new sprouts were found in 2008 on a rock bar nearly 500 m downstream from the original stand. The original stand survived the highwater event. New rock and gravel bars along Garvin Brook have also been rapidly populated by garlic mustard. (3) A 2008 survey for the nonparasitic American brook lamprey in southeastern Minnesota streams found them in all streams where they occurred during collections in the 1990s, even though concern was expressed about the status of several populations at that time. Catch rates were not obviously correlated with estimates of local rainfall during the August 2007 event.

Status of Brook Trout Populations in Southeast Minnesota: Where are They and Where Did They Come From?

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Brook trout are the only salmonids native to the Driftless Area in Southeast Minnesota; however, relatively little attention has been given to this species compared to the more common brown trout. Brook trout were thought to be extirpated throughout the Driftless Area during the late 1800s and since that time numerous stocking efforts have been aimed at maintaining or increasing their distribution. Stocking records indicate at least 8 different genetic strains of brook trout have been stocked in SE MN in the last 40 years. Many of these re-introductions were never evaluated as to their success. Our objectives were to determine the distribution of brook trout in SE MN and to determine their genetic origin. We sampled 108 streams by electrofishing and collected genetic samples on 46 of those streams. Seventy-nine percent of the streams we sampled contained brook trout. Both the Rush Creek and South Fork Root watersheds had unique genetic strains of brook trout that did not correspond with any known hatchery stock. Future research will examine population characteristics across genetic strains to test for differences in growth, mortality, and size at maturation.

Root River Turbidity TMDL

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The Root River watershed includes eleven separate impaired waters according to the draft 2008 303(d) list. For all eleven listings, the affected use is aquatic life, and the pollutant or stressor is turbidity with the water quality standard of 25 NTU exceeded at each reach. A three-year effort was begun in 2008 to complete TMDL (Total Maximum Daily Load) calculations for each of the turbidity listings in the Root River watershed. The general approach to these impairments will be undertaken at the major watershed scale; however, the final product will include TMDL computations and corresponding load allocations and waste load allocations for each listing. Monitoring stations have been established on each impaired reach for gathering water quality data. Water quality data along with land use and other information will be utilized in a watershed model to help determine load allocations. Smaller scale sites (<6,000 acres) will also be assessed to evaluate effectiveness of Best Management Practices. Management strategies will be developed to address pollutant sources according to the load allocations and waste load allocations. The strategies will be included in an implementation plan to address problems on the major watershed scale, but also provide recommendations specific to each listing.