Preface: A Look Back at Driftless Area Science to Plan for Resiliency in an Uncertain Future

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This Special Publication of the 11th Annual Driftless Area Symposium is a review of the science conducted in the Driftless Area that is relevant to stream restoration (including habitat improvement), with each section written by scientists or restoration practitioners who have worked in the region. The review is driven by an interest in understanding the current state of the science in the Driftless Area to allow better planning into the future, which is essential given the increased frequency of floods over the past decade and the fact that climate projections predict an increased frequency of high-intensity rainfalls into the future. The intense rains and subsequent flooding in late-August and early-September of 2018 highlight the issue, thus begging the question: What can we glean from past science to plan for flood resiliency in an uncertain future?

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This Special Publication of the 11th Annual Driftless Area Symposium is intended to be a review of past and current science related to the physical and biological attributes of streams and watersheds in the Driftless Area, a geographic region including southeastern Minnesota, southwestern Wisconsin, northwestern Illinois, and northeastern Iowa. The Driftless Area was bypassed during the last glacial period and, therefore, lacks glacial drift - sediments carried and deposited by glaciers. As such, the Driftless Area is a region with steep hills and limestone bluffs, and it contains over 600 cold, spring-fed creeks that support a vibrant trout fishery with a substantial socioeconomic impact to the regional economy. Legacy impacts to streams and rivers from historical agricultural practices have led to an active stream habitat enhancement and restoration community. One purpose of this publication is to review this history of restoration in the Driftless Area with special regard to climate change. The Fourth National Climate Assessment Volume I was released in November of 2017 and it unequivocally states that the climate is changing (1), and Volume II released in November of 2018 suggests that changes in climate are highly likely to have substantial impacts on global economies, including in the midwestern United States (2). Because the Driftless Area has a substantial trout fishery resource with an active stream restoration community, this publication will also review stream restoration standards of practice with a focus on resiliency given the projected increases in the temperatures, droughts, and especially the frequency and magnitude of high intensity precipitation events from the present through the latter half of this century (1, 3).

Why a Science Review Now?

A Decade of Flooding. Climate projections portend an increase in frequency and magnitude of high intensity precipitation events, but these events have already been observed with high frequency over the last decade in the Driftless Area. In 2007, 15 inches of rain fell in 24 hours in the Whitewater River drainage in southeastern Minnesota, which resulted in catastrophic flooding that re-arranged stream channels, flooded towns, caused millions of dollars of damage to state parks, and killed seven people (see Pioneer Press, 19 April 2015). In 2013, over three feet of rain fell over three days in the Root River drainage (southeastern Minnesota), again resulting in large floods. Similar high-intensity rainfalls have caused flooding in northeastern Iowa and southwestern Wisconsin in 2004, 2007, 2008, 2013, 2014, 2016, and even in 2017 (see summary here). In fact, the frequency of high-intensity rainfall events has increased over the last half century (4), and those events are predicted to become even more frequent given future climate projections (4, 5). Record floods were again observed in 2018 (reviewed by National Weather Service).

Fig. 1. Flooding in near Viola, Wisconsin in August, 2018. Over 20 inches of rain fell in some areas. Credit: E. Daily, La Crosse Tribune.

Observations from the 2018 Floods. In September 2018 two high intensity precipitation events on August 27-29 and September 2-4 again caused major flooding in parts of the

Statement of Interest

The Driftless Area is an iconic landscape in the Upper Midwest. It contains over 600 coldwater streams that have been subject to an increased number of record floods over the past decade, including - yet again - in 2018.

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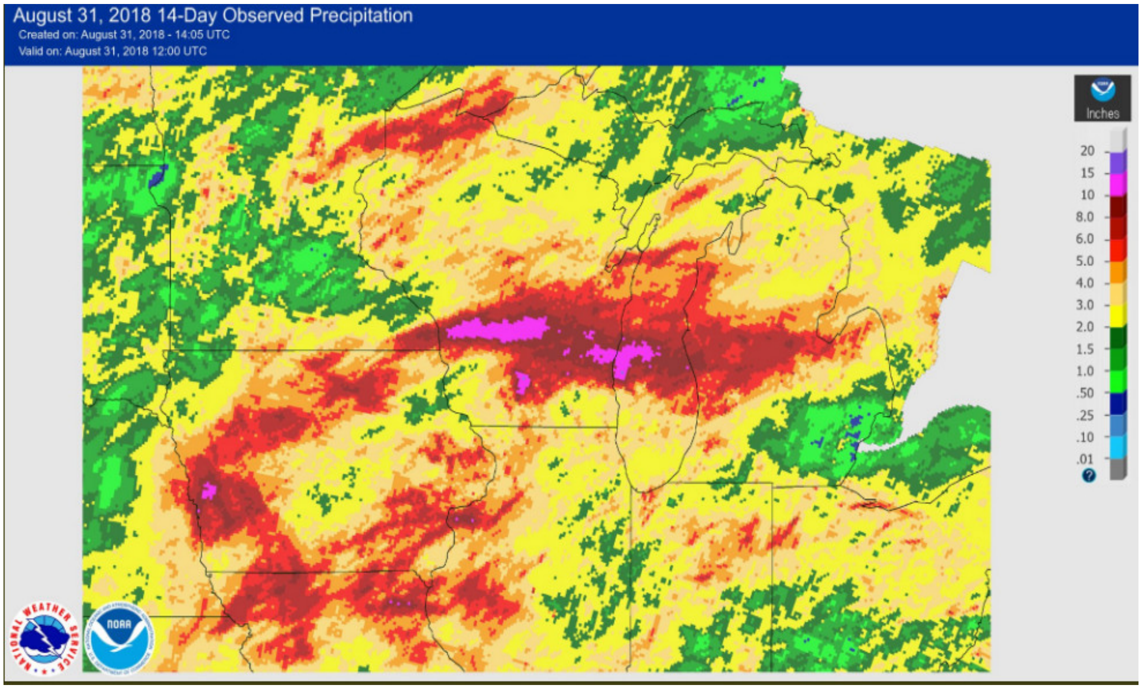

Fig. 2. Observed 14-d precipitation totals (inches) prior to August 31, 2018. Data from National Weather Service.

Driftless Area (Figs. 1,2). The heaviest impacts of the two rainstorms generally followed Highway 33 from north of Coon Valley to Cashton, Hillsboro and Reedsburg in Wisconsin. But they were not a narrow band. While Ontario received 15.6 inches of rain between August 26 and September 3, Westby got over 18 inches, Elroy over 23 inches and Readstown 11.6 inches, according to the National Weather Service. Just before these events occurred, another event dumped 15.3 inches of rain on Cross Plains and Black Earth Creek in 24 hours, a state record.

That rain resulted in substantial flooding and flood damage (Fig. 3). Six flood-control dams failed, and others suffered damage. When dams failed, as in the case of one in the Upper Rullands Coulee drainage in Monroe County, large amounts of water were released downstream and caused substantial damage (Fig. 4).

Rullands Coulee was a mess (Fig. 5), with barn and shed parts scattered across the landscape, and tipped-over gravestones at the Skogsdalen Lutheran Church. For many years, the late Palmer Olson had a small fly shop along Rullands, with a pond from an impounded spring where he would cast nearly every day. That pond's berms are gone, and his house sat cantilevered over an undercutting bank immediately after the flood. A tree slide on the ridge to the north of Rullands at County Highway P and Oakdale Avenue brought trees and mud 350 feet down a swath of hillside. Where box elders edged the stream, many were torn out and washed down into Timber Coulee where the stream became wide and shallow for some distance below the Highway P bridge. Some older restoration work in Timber Coulee (from the 1970s and 1980s) failed below the confluence, as did some older project work on Bohemian Valley.

Now might be a good time to consider revisiting affected areas of Timber Coulee and Bohemian Valley that were restored decades ago. And these results should prompt us to question how we do restoration work in narrow upper valleys that have higher gradient streams. We may need to address these areas differently then our efforts on middle reaches. For example, maybe in these areas we will need to focus on using available materials (e.g., no LUNKERS) and diversity, and try and be cost effective and not fix every foot knowing that we may likely need to do maintenance again in the near future.

Fig. 3. The view of West Fork downstream from Highway S bridge at Bloomingdale Road, September, 2018. Credit. D. Welter.

Two dams also failed in the West Fork of the Kickapoo River in Vernon County, Wisconsin (notably the Jersey Valley Dam, where repairs cost $3 million a half-dozen years ago), which along with the rains caused significant flooding. The West Fork Sports Club and past restoration projects upstream were damaged.

More recent restoration projects on lower Timber and lower Spring Coulees, however, appeared to have withstood the floods well. The Bob Jackson and Neperud properties are

Fig. 4. Heavy rains created this mudslide above Skogdalen Lutheran Church, September, 2018. Credit. D. Welter.

in excellent shape. Snowflake Ski Club's property on upper Timber Coulee showed serious damage.

Farther down the Kickapoo, towns from La Farge to Gays Mills flooded twice. Tributary streams, however, seemed to be undamaged other than Brush Creek west of Ontario. The Weister Creek restoration project north of La Farge withstood the floods. Readstown suffered badly, with most of the houses in the flood plain partly submerged. During the floods, one resident paddled his kayak out to check his and his mother's homes. Both were total losses.

Continuing a pattern seen from past storms, dry runs brought significant amounts of sediments down hillsides and into yards and stream corridors. Many homes were historically built in little nooks along the edges of bluffs. Those are funnels for the dry runs, and homes showed significant damage even if they weren't located in or near flood plains.

What About the Projected Future?

With the Midwest projected to see increased temperatures and more frequent high-intensity rainfall events likely to cause flooding (1–3), what do projected increases in precipitation and flooding mean for stream restoration in the Driftless Area? What do we know about the effectiveness of various elements of stream restoration and habitat improvement design, and how can they be used guide projects and better plan for resiliency in the face of extreme climate events (Fig. 6)? Stream and river restoration is still a relatively young discipline that integrates several scientific disciplines (engineering, hydrology, geomorphology, ecology), and it has progressed through a combination adaptive management and increased scientific knowledge (6). While many stream habitat improvement and restoration practices are grounded in science, the links between restoration practices and science are not always made explicit. Luckily, the Driftless Area is one of the best-studied landscapes in the United States, and as a result there is a rich body of scientific literature to draw upon.

Fig. 5. Prior to September 2018 flooding, a barn and shed flanked this silo. Credit. D. Welter.

This Special Publication of the 11th Annual Driftless Area Symposium will highlight region-specific science examining how stream ecosystems function in relation to stream and watershed restoration. Certain sections will also touch on the history of restoration and current restoration standards of practice and how they may be used to increase resiliency of stream systems and trout fisheries in a changing climate (7). One common way to judge whether practices reflect the current state of the science and which practices may help plan for resiliency in an uncertain future is to conduct a review of restoration science as it relates to Driftless Area streams. How do we know that certain conservation practices increase infiltration and improve base flows or that brook trout *Salvelinus fontinalis* are projected to decline substantially in distribution in future climates? Someone studied it, and in some cases those people have studied it for a good portion of their careers and lifetimes. Those are the people contributing to this special publication, and we have much to learn from the studies they have conducted and the knowledge they have accrued as the restoration community continues to restore streams and watersheds of the iconic Driftless landscape into an uncertain future.

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Fig. 6. The confluence of Rullands and Timber coulees, September 2018. Credit. D. Welter.

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