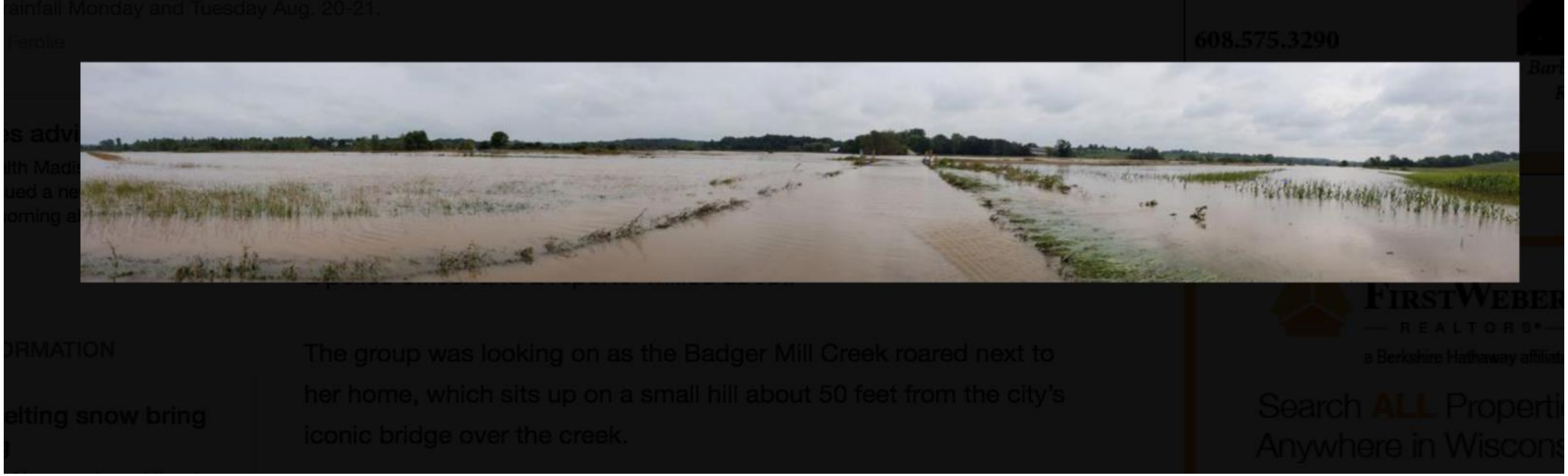


Photo Jim Ferolie

Implications of intense and protracted flooding in the Upper Sugar River Watershed

Dr. Robert E. Bohanan, UW WISCIENCE, North Temperate Lakes Long term Ecological Research and Upper Sugar River Watershed Association

Upper Sugar River Watershed Association

NATIONAL SCIENCE FOUNDATION LTER NETWORK LONG TERM ECOLOGICAL RESEARCH

Learn Teach Share WISCIENCE

USRWA Lesson Package: Flooding

Intended Audience: High School environmental science students; Youth educators (K-12, Nature Centers, Friends groups, Scouts, 4-H, FFA, clubs); Citizen Science Coordinators and Volunteers)

Package Contents:

- PowerPoint (.pptx) presentation: "Implications of intense and protracted flooding in the Upper Sugar River Watershed"
- Activity #1 Handout – Badger Mill Creek Data 2011, 2012, & 2013
- Activity #2 Handout – Scenario Building Framework

Learning Objectives

Through this lesson, students will be able to:

- Recall what constitutes an ecological disturbance
- Recognize the difference between a negative and beneficial ecological disturbance
- Define disturbances within stream ecosystems by examining watershed measurement parameters
- Interpret local USGS watershed data using common measure variables to discuss ecological impact from flooding and drought
- Using the Scenario Building Framework, develop future ecological scenarios

Description of Materials

The materials introduce students to the idea of ecological disturbance within the context of flooding in the Sugar River watershed using data. The PowerPoint slides are designed to engage students during a lesson by providing text and images that emphasize the learning objectives and support the activities.

The Role of Disturbance in Stream Ecology

Vincent H. Resh, Arthur V. Brown, Alan P. Covich, Martin E. Gurtz, Hiram W. Li, G. Wayne Minshall, Seth R. Reice, Andrew L. Sheldon, J. Bruce Wallace, and Robert C. Wissmar

Freshwater Science. Volume 7, Number 4 | Dec., 1988

" We define disturbance in stream ecosystems to be: any relatively discrete event in time that is characterized by a frequency, intensity, and severity outside a predictable range, and that disrupts ecosystem, community, or population structure and changes resources or the physical environment. Of the three major hypotheses relating disturbance to lotic community structure, the dynamic equilibrium hypothesis appears to be generally applicable, although specific studies support the intermediate disturbance hypothesis and the equilibrium model. Differences in disturbance frequency between lentic and lotic systems may explain why biotic interactions are more apparent in lakes than in streams. Responses to both natural and anthropogenic disturbances vary regionally, as illustrated by examples from the mid-continent, Pacific northwest, and southeastern United States. Based on a generalized framework of climatic-biogeochemical characteristics, two features are considered to be most significant in choosing streams for comparative studies of disturbance: hydrologic regimes and comparable geomorphology. A method is described for quantifying predictability of the hydrologic regime based on long-term records of monthly maximum and minimum stream flows. Different channel forms (boulder and cobble, alluvial gravel bed, alluvial sand bed) have different responses to hydrologic disturbance from spates. A number of structural and functional components for comparing disturbance effects within regions and across biomes are presented. Experimental approaches to studying disturbance involve spatial-scale considerations, logistic difficulties, and ethical questions. General questions related to disturbance that could be addressed by stream ecologists are proposed."

Flooding in Dane Co., WI August 21, 2018 is best characterized as a ‘Large Infrequent Disturbance’

These tend to:

1) Affect relatively large geographic areas and sociological and ecological effects often persists well after the precipitating event.
2) Sociological impacts (property damage or loss, illness and deaths) tend to be immediate and highly visible, while habitat attributes (physical and biological) are often less visible and may not be as immediate
3) Sociological, ecological, and water quality changes may last for long periods of times

Parsons, 2018.
http://isrs2017.com/images/Parsons_Melissa.pdf

Photos Jim Ferolie

USGS 05435943 BADGER MILL CREEK AT VERONA, WI

https://waterdata.usgs.gov/wi/nwis/uv/?site_no=05435943&PARAmeter_cd=00065,00060

USGS 05435943 BADGER MILL CREEK AT VERONA, WI

PROVISIONAL DATA SUBJECT TO REVISION

Available data for this site | Time-series: Current/Historical Observations | GO

Click to hide station-specific text

LOCATION.--Lat 42°58'37", long 89°32'22", in NW 1/4 SW 1/4 sec.22, T.6 N., R.8 E., Dane County, Hydrologic Unit 07090004, on left bank 60 ft downstream of Bruce Street, 0.8 mi southwest of intersection of State Highway 69 and County Trunk Highway M, at Verona.

DRAINAGE AREA.--20.3 square miles.

PERIOD OF RECORD.--October 1996 to present.

GAGE.--Water-stage recorder, crest-stage gage and water-quality monitor. Elevation of gage is 930 ft NAVD of 1988, from topographic map.

REMARKS.--Gage-height and water-quality telemeter at station.

OPERATED IN COOPERATION WITH:

Madison Metropolitan Sewerage District

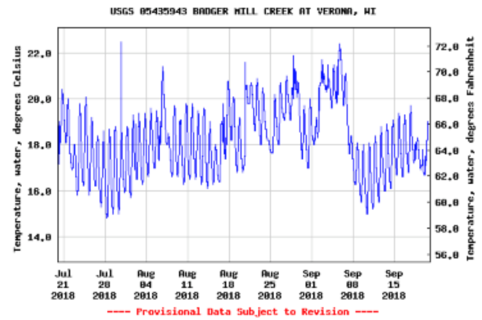
This station managed by the USGS Wisconsin Water Science Center - Middleton WI.

Available Parameters	Available Period
All 6 Available Parameters for this site	
00010 Temperature, water	2007-10-01 2018-09-20
00060 Discharge	1996-10-11 2018-09-20
00065 Gage height	2018-05-23 2018-09-20
00095 Specific cond at 25C	2007-10-01 2018-09-20
00300 Dissolved oxygen	2007-10-01 2018-09-20
00301 Diss oxygen,%saturtn	2018-05-23 2018-09-20

Output format
- Graph
- Graph w/ stats
- Graph w/o stats
- Graph w/ (up to 3) parms
- Table
- Tab-separated

Days (62)
-- or --
Begin date 2018-07-2
End date 2018-09-2
GO

Temperature, water, degrees Celsius
Most recent instantaneous value: 19.0 09-20-2018 15:00 CDT



Add up to 2 more sites and replot for "Temperature, water, degrees Celsius"

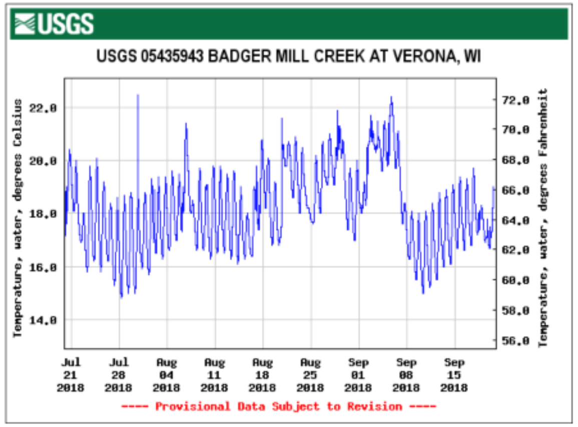
Add site numbers Note

Enter up to 2 site numbers separated by a comma. A site number consists of 8 to 15 digits

GO

Create presentation-quality / stand-alone graph. Subscribe to WaterAlert

Share this graph |

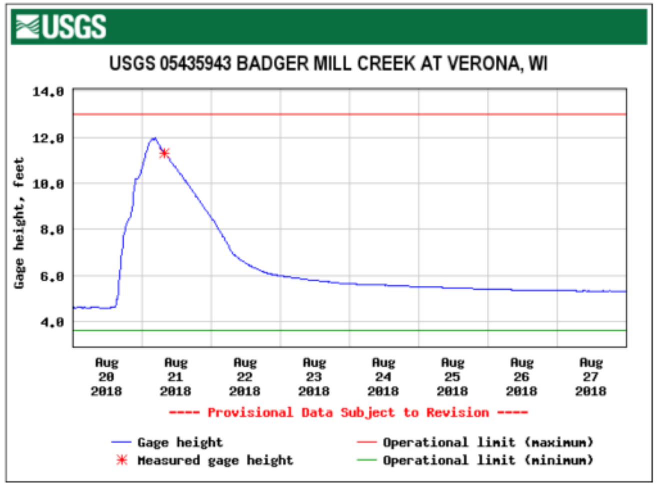


Effects may vary within the same watershed depending on stream size, number of tributaries and geology

Water Level

Flow

A



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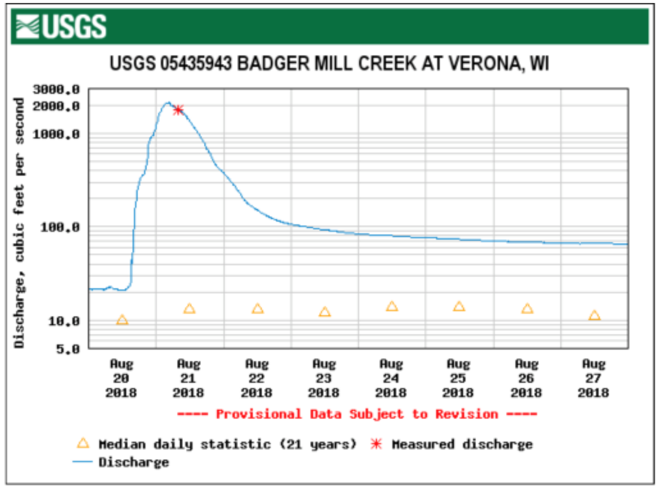

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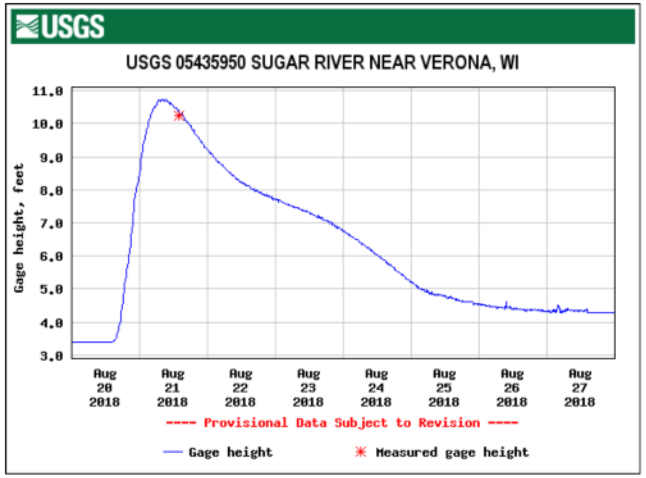

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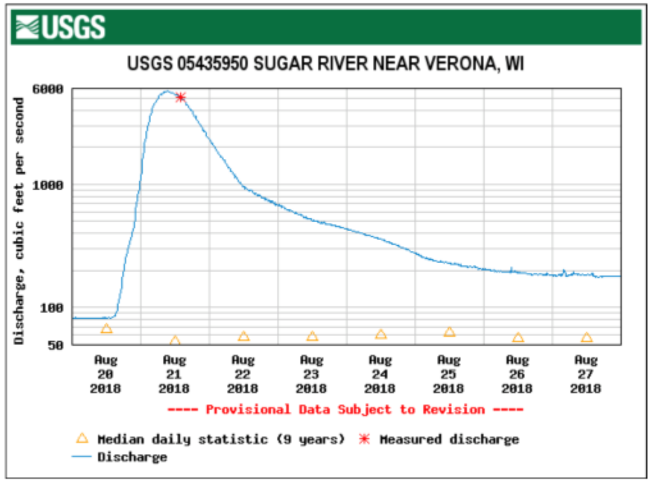
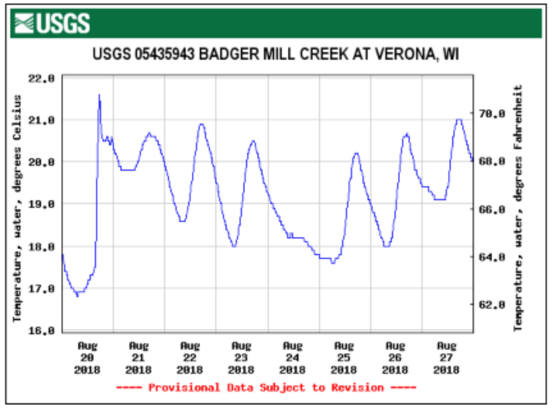


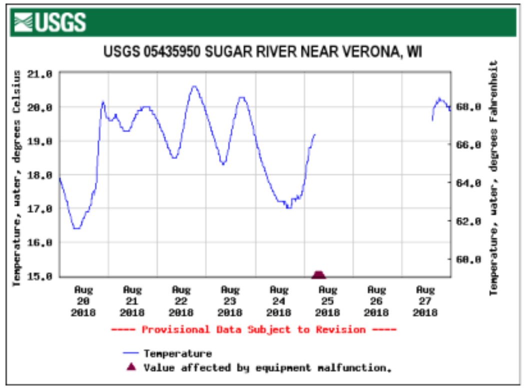
Short term effects Aug 20 – 27

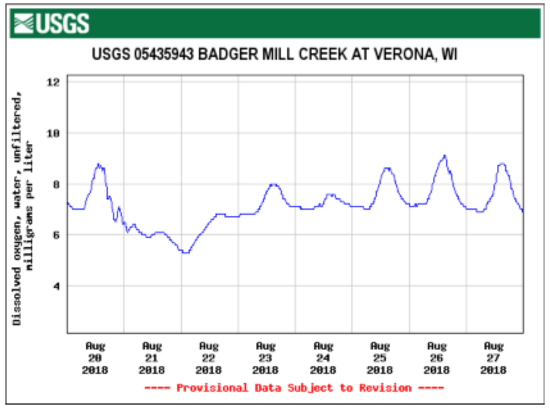
What happens to temperature, conductivity and dissolved oxygen?

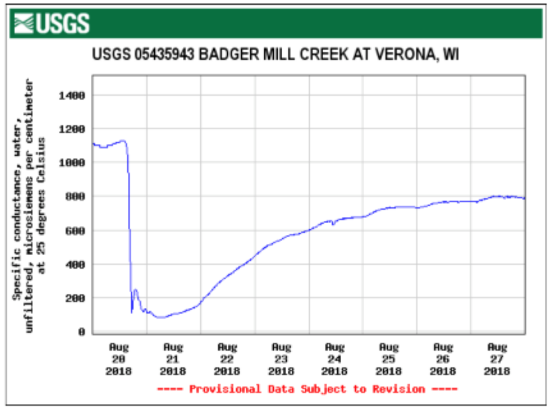
Badger Mill Crk
Bruce St, Verona, WI

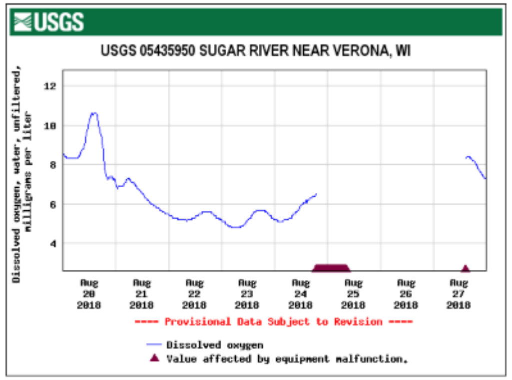


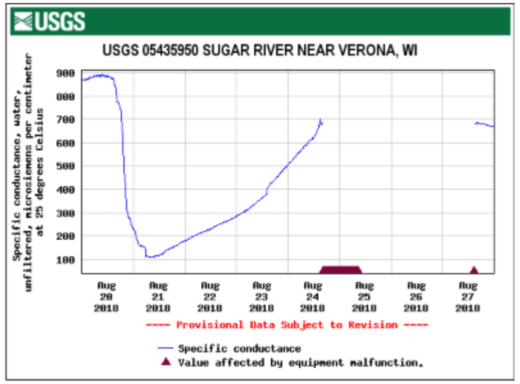
Sugar River
Near HWY 69
Sensors off line
In red







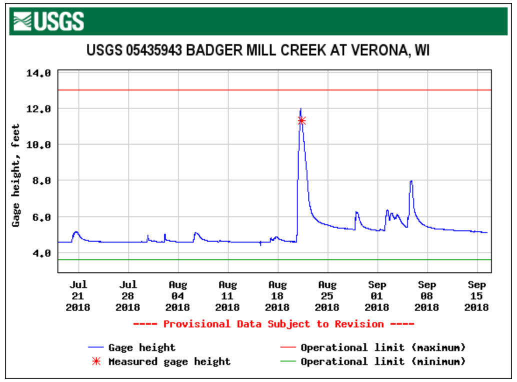


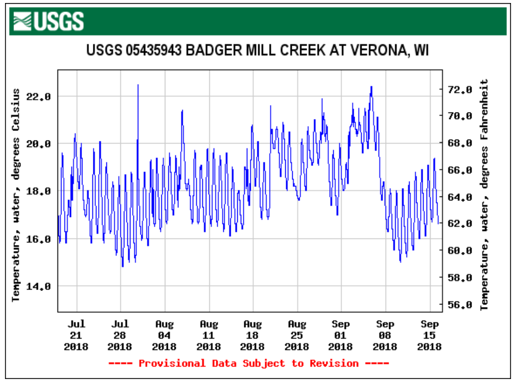


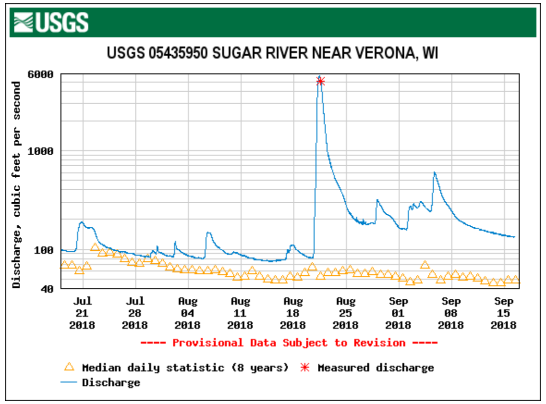
Conductivity is a measure of minerals or salts such as calcium, sodium, chlorides
Dissolved oxygen is diatomic oxygen or O2 in the water

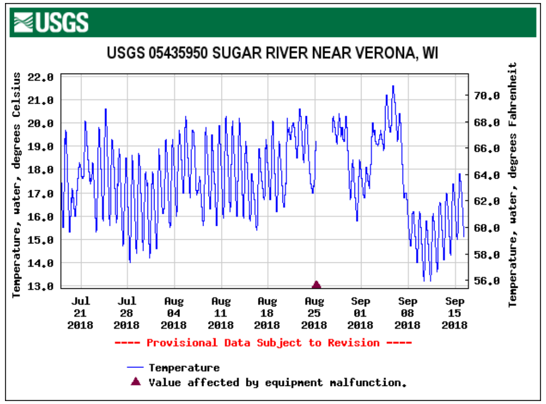
Longer term responses / recovery July 20 – Sept 20, 2018 one month before flooding and one month after flooding

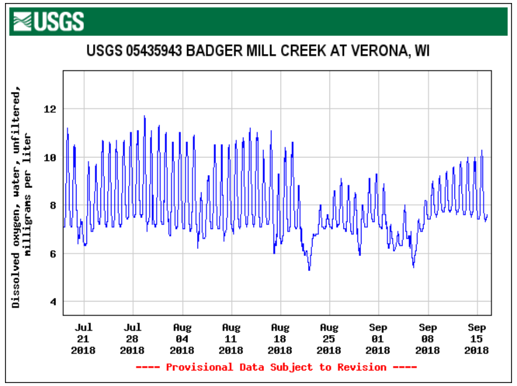
What can two months tell us that one week cannot?

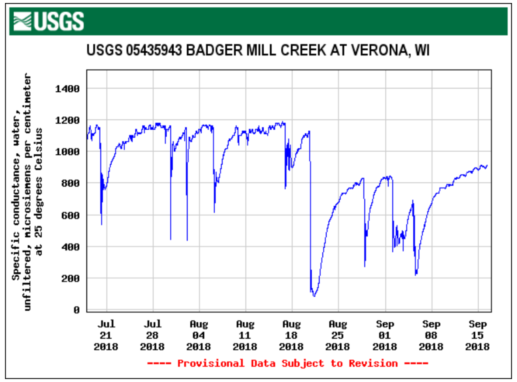


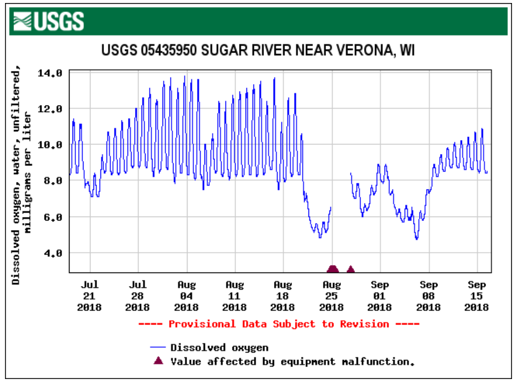


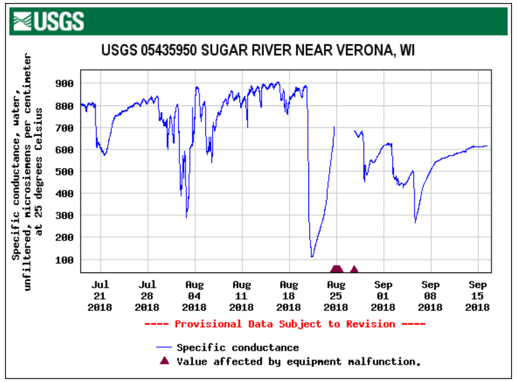






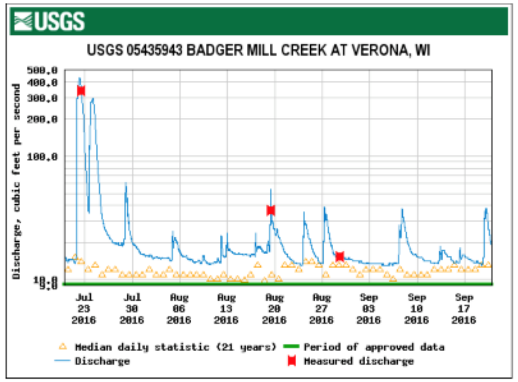


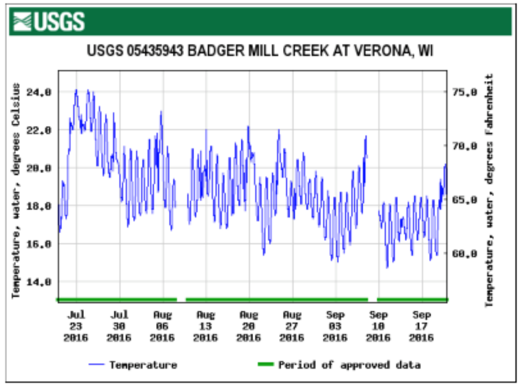


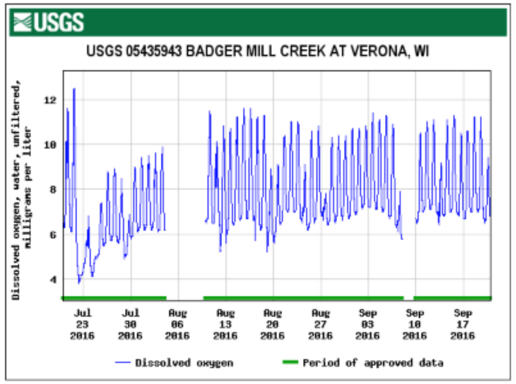


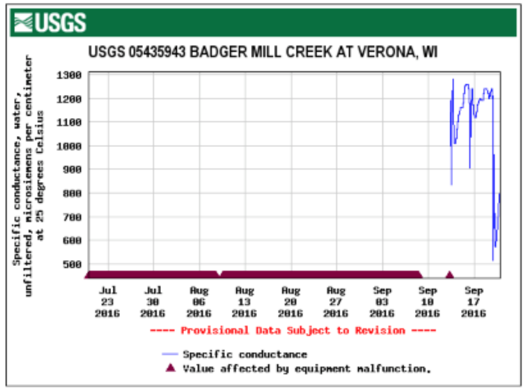
How unique or unprecedented are July – September 2018 events compared to 2016 and 2017?

July 20 – September 20, 2016

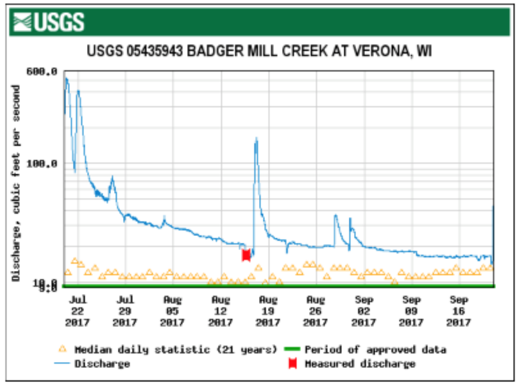


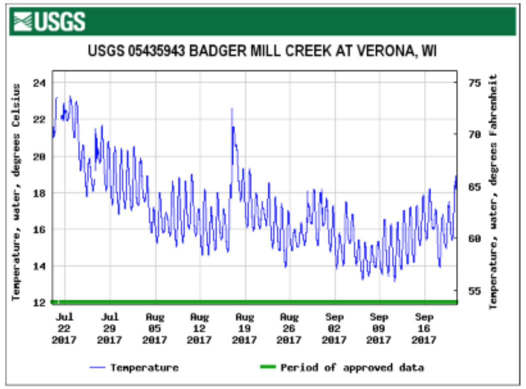


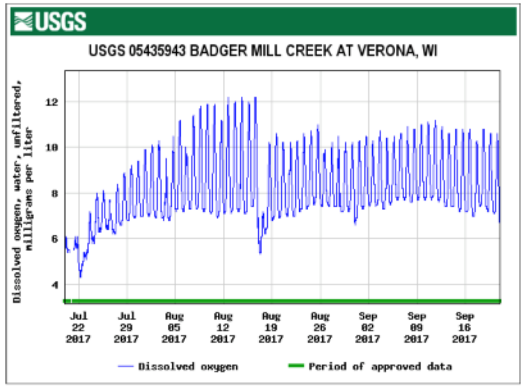


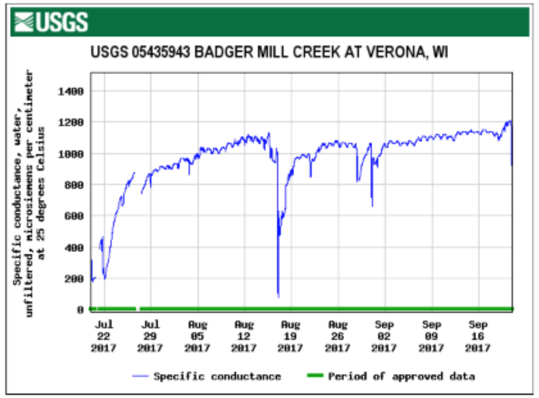


July 20 – September 20, 2017



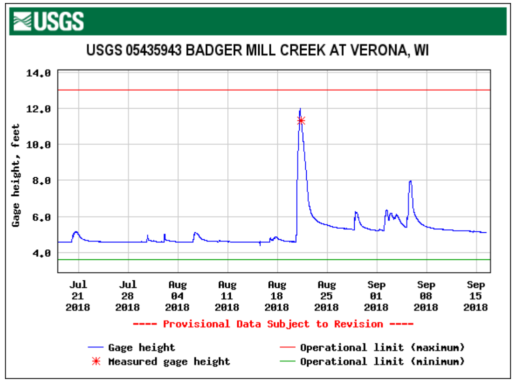


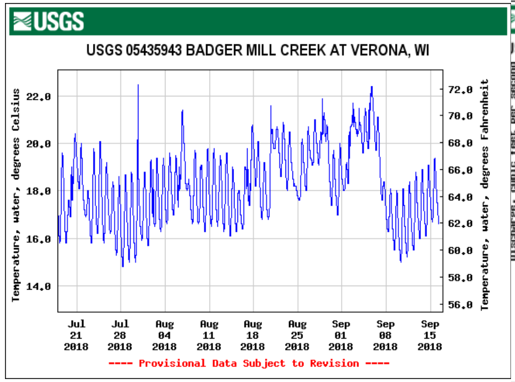


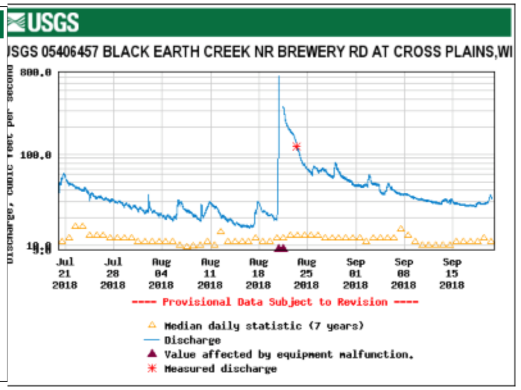


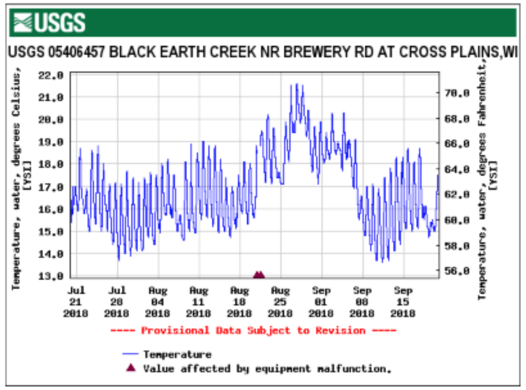
In 2016 and 2017 conductivity and dissolved oxygen return to pre-discharge event levels within days

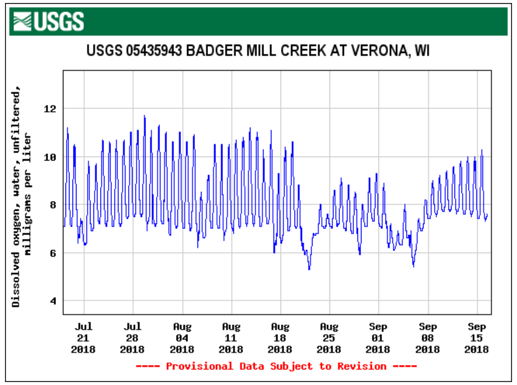
What about streams in nearby watersheds in the 2018 flooding alert area? Black Earth Crk, Brewery Rd., Cross Plains, WI compared to Badger Mill Creek, Verona, WI

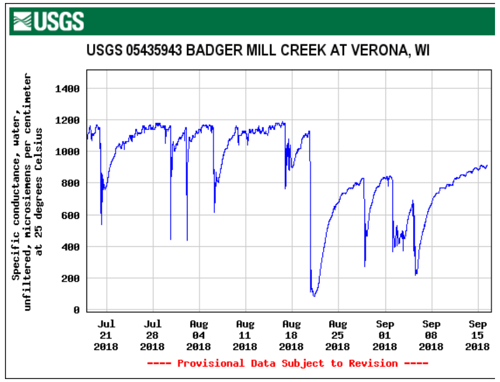


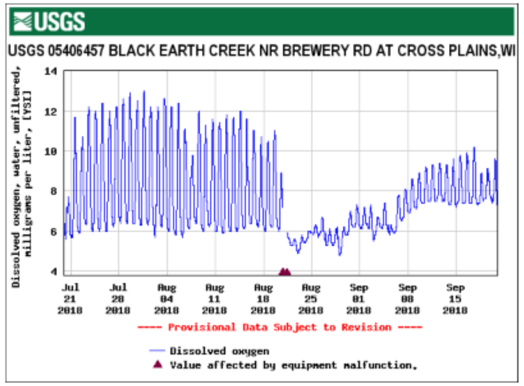


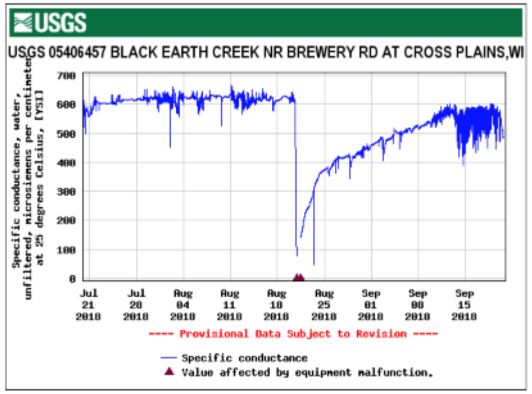












Badger Mill Crk

Black Earth Crk

Habitat Assessments Pre-flooding on Badger Mill Creek July – September 2016

- Substrate was primarily cobble (golf ball to football sized rock) and gravel
- Siltation or sandiness varied from 10-50%
- Sparse woody habitat in stream with no large fallen trees obstructing flow
- Turbidity or cloudiness of water low with bottom of stream clearly visible
- Undercut stream banks were few
- Approximately 25% of shoreline with signs of erosion

Cobble-Gravel
Low silt

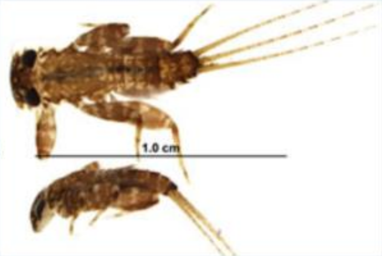
Cobble-Gravel
Medium silt

Coarse woody habitat
Minimal erosion
High water clarity

Undercut banks
Highly eroded
Low water clarity

Biological diversity included species associated with low to moderate water quality based on dissolved oxygen and water temperature

Family Heptageniidae



Flathead Mayflies

This family of mayflies is one of the most common in the Upper Midwest. As this family's common name implies, the head and body of these mayflies is flattened. Gills are located on each abdominal segment. The larvae have three caudal tails like most mayfly larvae, but unlike other larvae Heptageniid larvae have only short setae, or hairs, present on these tails. Most mayfly larvae have feathered caudal filaments. The mandibles, or mouth parts, are smaller than that of most mayfly families, and are hidden from the dorsal view. Heptageniid larvae are well adapted to flowing water in lotic water systems. Their head, bodies, and legs are flattened to reduce drag by redirecting water over the insect. Most of these larvae are scapers that feed on algae and other microorganisms that are attached to rocks. There is one genus of the Heptageniidae family that has only two caudal filaments. This insect can be distinguished from stoneflies, organisms that usually have only two tails, by the presence of a single tarsal claw at the end of each leg (stonefly larvae have 2 claws at the end of each leg).

Family Elmidae

Riffle Beetles

Elmids are often found in areas of fast moving current in streams. Specifically they are often collected under logs or rocks in these areas. Both the larval and the adult Elmids are aquatic, and riffle beetles are one of the few Coleopteran families where the entire life cycle is underwater. The larval body has three pairs of legs that terminate in a tarsal claw, and 9 abdominal segments. The average body length of the larvae is between 3 to 8 mm. The adult body is hard and square. Antennae are thin and protrude from the head below the eyes. The average adult body length is between 1 and 8 mm. Although the adults are aquatic, in some species the adult may fly for a short period of time before returning to the water. After returning to the water, the wings become non-functioning and the adult stays in the water for the rest of its life.

Family Hydropsychidae

Common Net-spinner caddisflies

Hydropsychid larvae have a unique way to collect food. The larva spins a silk net in which it resides. The larva is able to collect detritus and other food sources which collect on the net. Hydropsychid caddisflies will defend their nets, or retreats if threatened. These caddisflies are the most commonly collected from areas where there is a cobblestone substrate. They are also found in areas where there is a solid woody substrate that they can attach their nets to. The larval body length is 9 to 30 mm. Most of the abdominal segments have tufts of gills, and there are many setae, or hairs on the final abdominal segment.

Family Tipulidae

Crane Flies

These larvae are found in many different habitats. They may be under stones, buried in sand, or hiding under detritus in marshes, lakes, or streams. The Tipulids that are found in decaying leaf material are very important to aquatic ecosystems because they break leaves and other organic material into smaller pieces as the first step in decomposition. The larval size is variable ranging from 3 to 60 mm. Mandibles move in a horizontal plane. The body is round and tapered at the ends, and the final abdominal segment has two spiracle used for obtaining atmospheric oxygen.

http://watermonitoring.uwex.edu/wav/monitoring/coordinator/ecology/macro.html

Brown Trout

Brown trout oxygen requirements are somewhat varied depending on the life stage with eggs and embryos being the most sensitive to low oxygen levels, followed by juveniles and adults. Reported optimal levels are above 9 mg/L.

Concerns and implications

Based on your interpretation of the data and any additional background research that you've conducted, how might Badger Mill Creek, the Sugar River and Black Earth Creek change after the flooding of August 20, 2018?

If you were going to plan a follow-up study, what questions would you ask?

What data would you collect to test your hypotheses?

What results would you expect to find compared to pre-flood periods?

What would do to prepare or protect the watershed for the next 0.1% flood when it happens?

Future Scenario: Using past data to predict the future

CLIMATE CHANGE:

Water temperature
Discharge (flow)
Gage height (water level)
Specific conductance (conductivity)
Dissolved oxygen concentration
Percent of dissolved oxygen

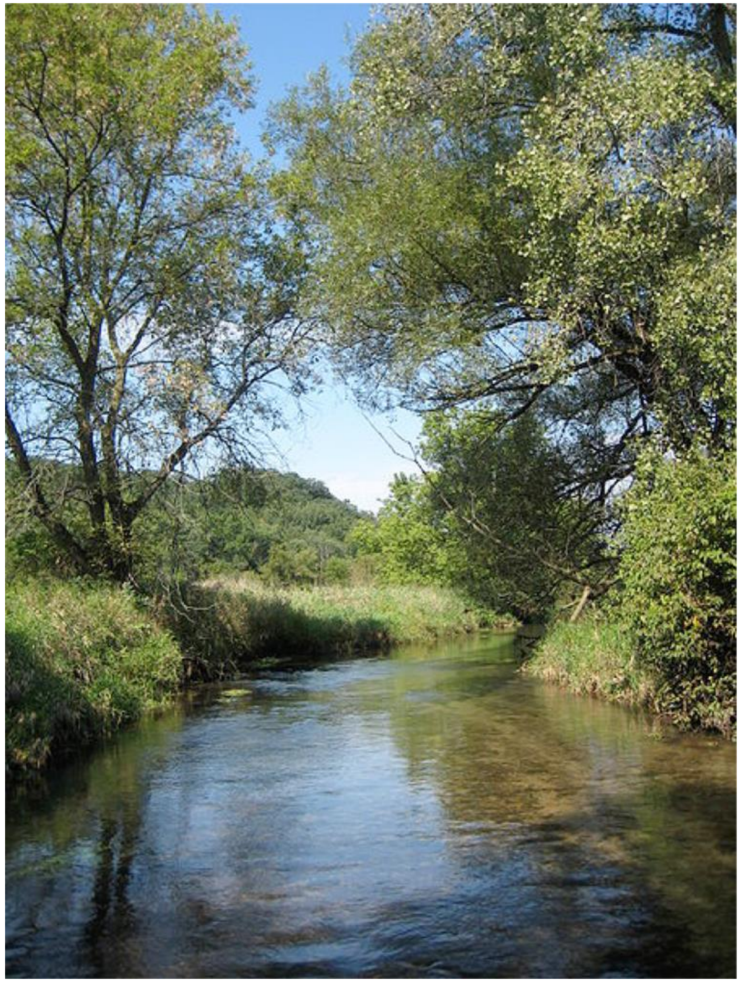


Image Credit: Public Domain

Carpenter, S. R. (2002). Ecological futures: Building an ecology of the long now. *Ecology,* 83(3). Retrieved from: http://esa.org/history/Awards/papers/Carpenter_SR_MA.pdf

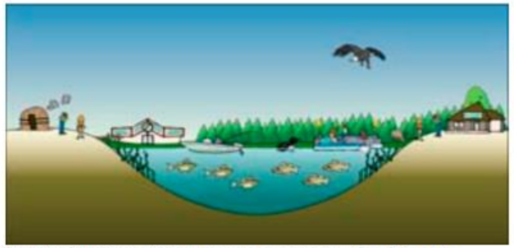
"Ecosystem dynamics unfold into the future but are understood by examining the past. A forward-looking ecology, which assesses a broad range of possible future ecosystem states, is the complement of long- term, historical approaches to ecology."
http://esa.org/history/Awards/papers/Carpenter_SR_MA.pdf

We've looked at past data related to local flooding. Extreme weather events are predicted to increase in the frequency and intensity based on multiple climate models. What is uncertain and unknown, is how climate changes will change the Upper Sugar River Watershed and surrounding areas. Future scenarios are one of the new tools that ecologists have sometimes used to consider future implications of a range of changes.

Future Scenarios for Northern Highland Lake Districts related to development pressure

In this baseline scenario, at present, the remote lakes of Wisconsin's Northern Highlands offer plenty of fish, wildlife, and quiet for enjoying nature.

In this Refugee Revolution scenario, a national crisis leads to intensive management of ecosystems by a much larger population. The Northern Highland becomes an exporter of fresh water, forest products, farm-raised fish and cranberries.



In this Walleye Commons scenario, the Lac du Flambeau economy diversifies to include ethno-tourism, offering tourists more and bigger museums and cultural experiences such as sweat lodges.

In this Anaheim North scenario, larger lakes near major towns are developed for theme parks, water parks and motorized recreation.