Implementation of Runoff Risk Forecast Tools in the Great Lakes

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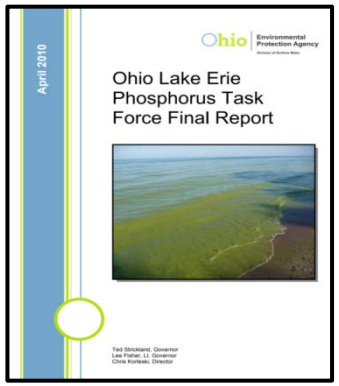
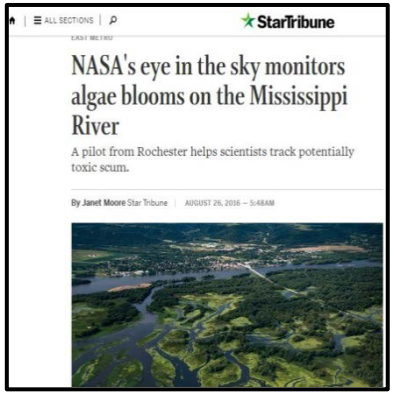
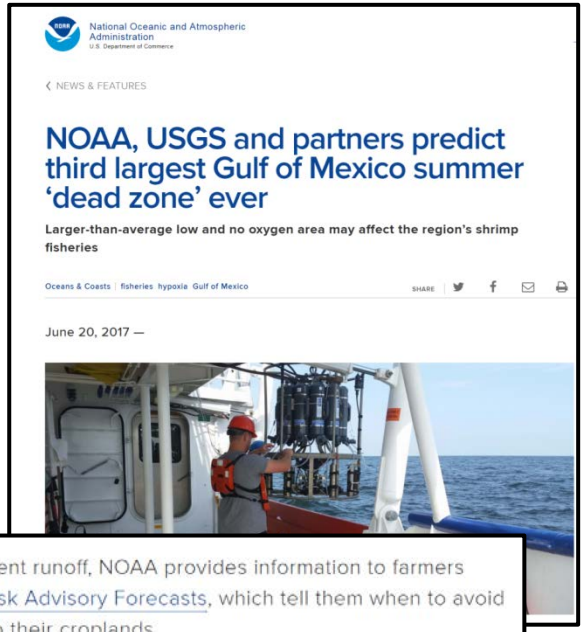
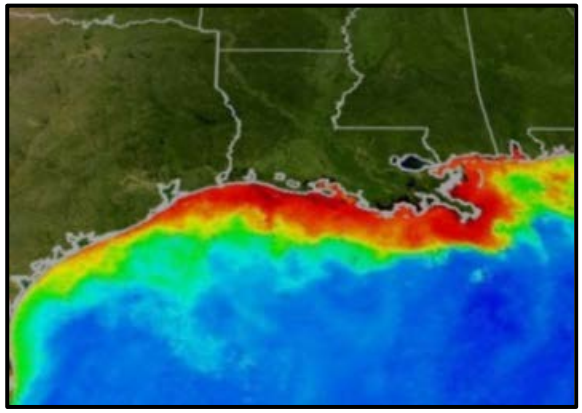
Excess Nutrient Impacts







To help reduce nutrient runoff, NOAA provides information to farmers through its Runoff Risk Advisory Forecasts, which tell them when to avoid applying fertilizers to their croplands.



Governments of Canada and the United States Announce Phosphorus Reduction Targets of 40 percent to Improve Lake Erie Water Quality and Reduce Public Health Risk

What are Runoff Risk Tools?

- Decision Support tools for farmers and producers based on real-time NWS weather/hydrologic forecast models to support short-term field management decisions for nutrient applications

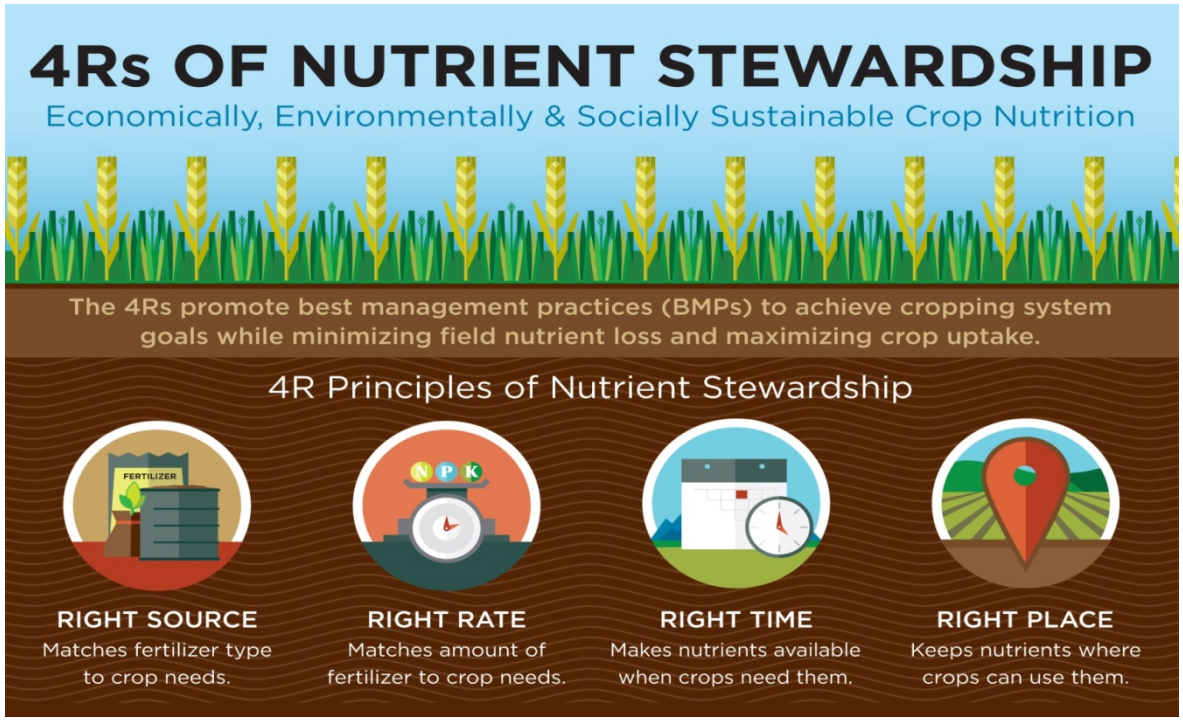
- Goal is to reduce acute loss events → Don't make the problem worse
  - Identify future conditions correlated with field runoff
  - Delay applications → Reduce nutrient loads leaving fields

- Collaborative partnerships where states build and own their tool in the regional network
  - State working groups of federal/state agencies, academia, industry

- Long-term Impact? Initiate voluntary behavioral change to support state nutrient reduction goals while providing multiple benefits
  - Producer economics and environment

Importance of Nutrient Application Timing

- Many BMPs are focused on *Right Place*, *Right Amount*, *Right Source,* or landscape modifications
  - NMPs and buffers/no-till/etc. aimed at chronic long-term losses



Importance of Nutrient Application Timing

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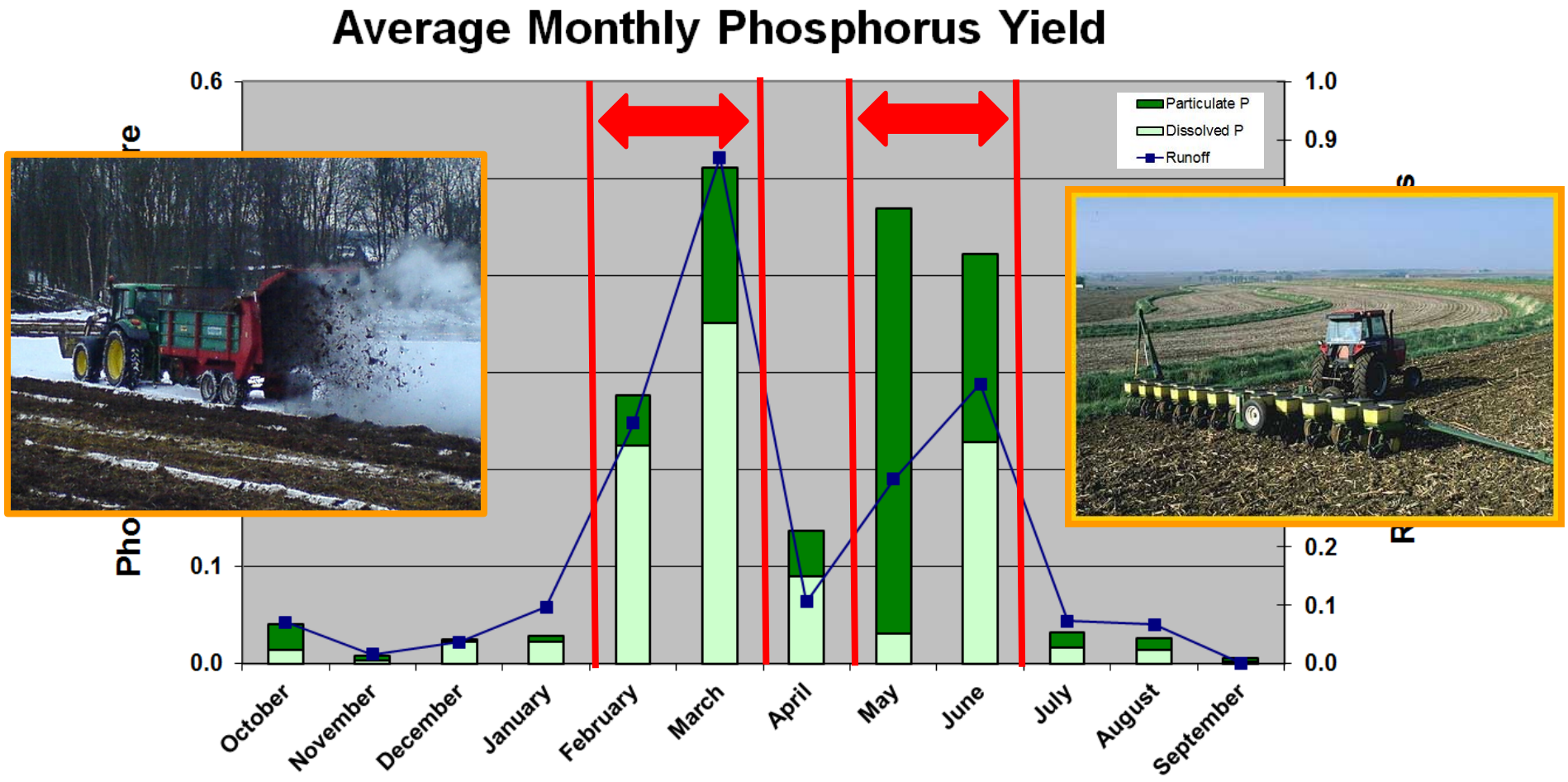
- Typical ***Right Time*** guidance is often (1) crop demand centric or (2) generic/static weather guidelines, but what about challenging day-to-day decisions/situations?
  - Actionable real-time guidance related to runoff threat doesn't exist

- Would more emphasis on daily field management decisions lead to additional nutrient loss reductions? What does EOF data indicate?
  - (1) Some parts of the year are more important (***critical loss periods***)
  - (2) Field activity in relation to runoff occurrence is a water quality factor
  - (3) Largest runoff events contribute significantly to nutrient losses

Critical Loss Periods and Field Activity



23 EOF sites with year-round data collection between 2003-2008 in Wisconsin

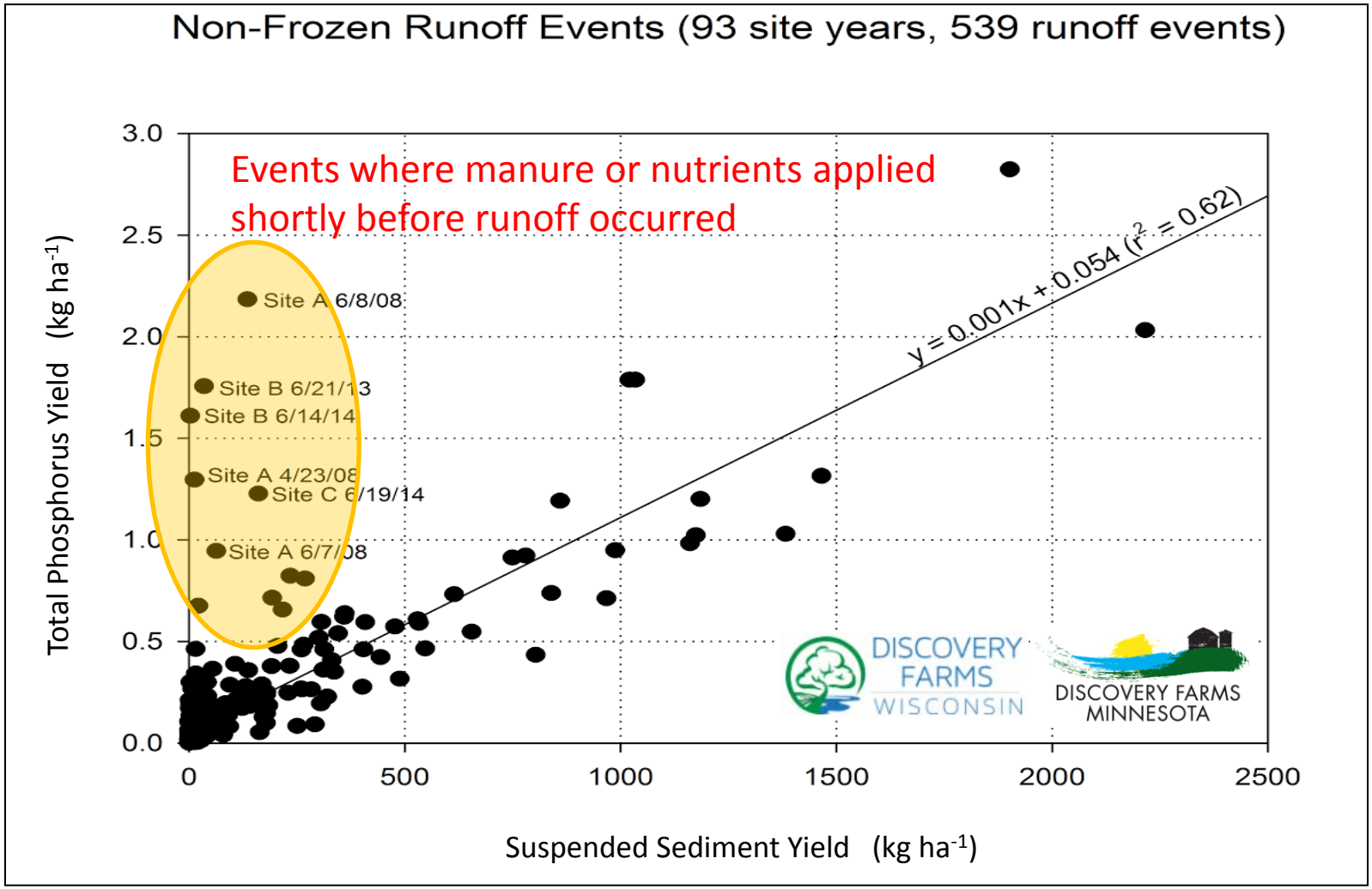
Slide courtesy of Todd Stuntebeck, WI USGS

Timing Decisions Critical on Frozen Ground

- In the north, 50% or more of annual runoff can occur on frozen ground
- Vegetation based conservation practices to limit soil/nutrient loss are not effective → **Timing is the major factor during this period**
  - Timing of field-management practices strongly influenced nutrient yields

Manure applied 5-6 days before rain-on-snow runoff event. Samples from first day of snowmelt.

Impact of Timing Decisions Prior to Runoff



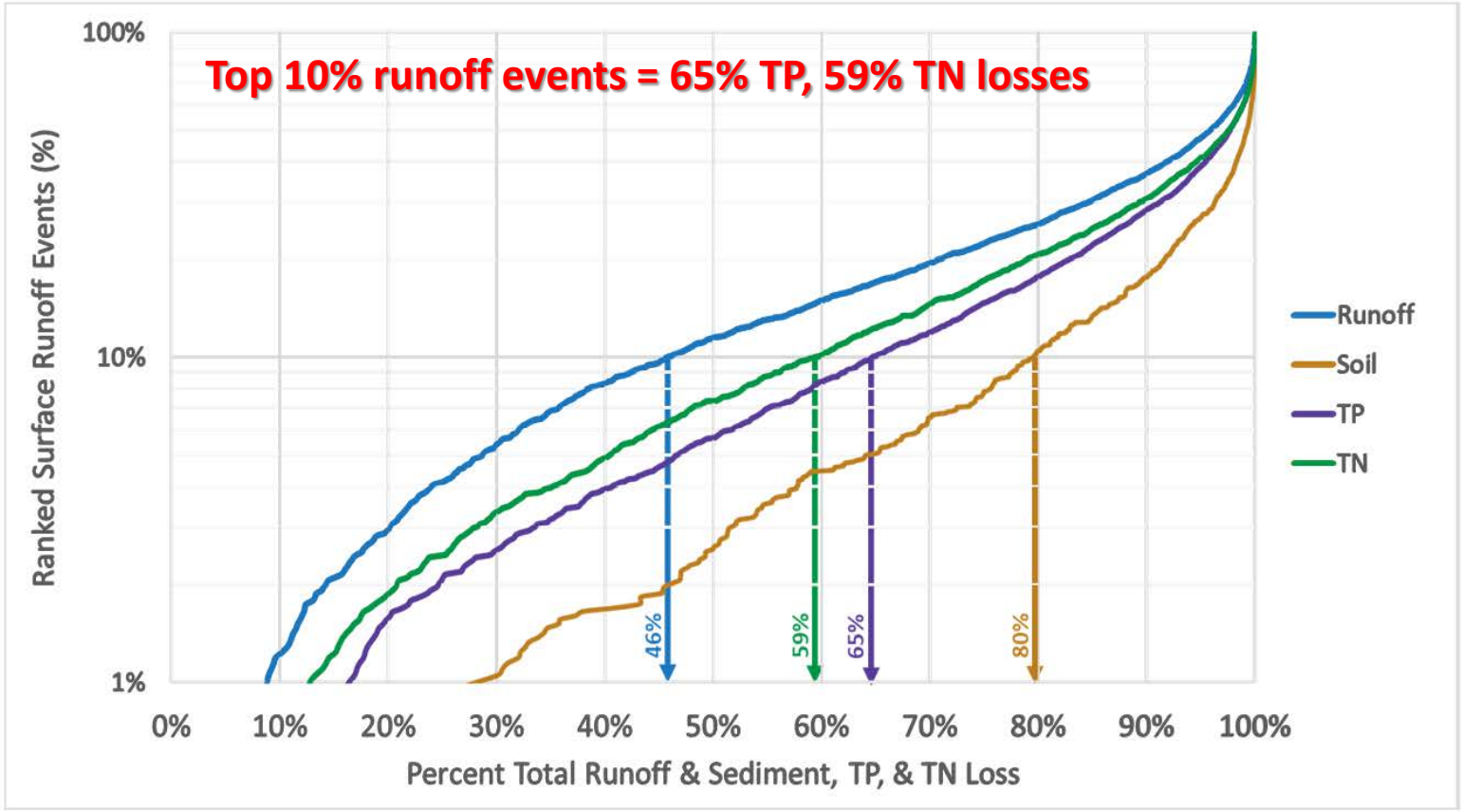
Slide courtesy of Tim Radatz, MN Discovery Farms

Largest Runoff Events Drive Most Losses → Avoid Applying Before

Most of the surface runoff losses are associated with only a few of the largest runoff events

Smallest Events

Largest Events



Slide courtesy of Tim Radatz, MN Discovery Farms

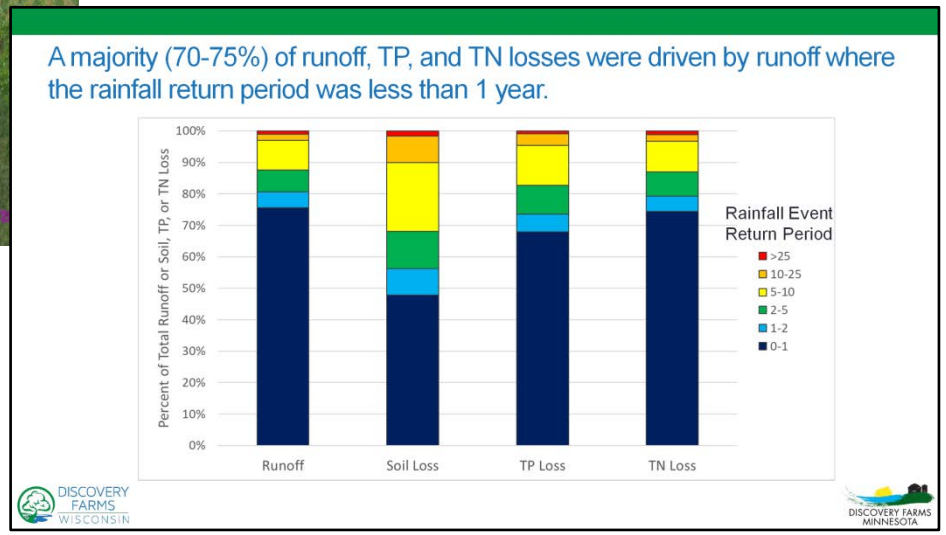
2,184 runoff events over 127 site years across 27 fields from 2004-2016

Rainfall Events, Runoff Events, and Nutrient Losses

Return Period	Site	Start	Precip (in)	Duration (hr)	Avg Intensity (in/hr)	30 Min Max Intensity (in/hr)	Runoff (in)	Soil (lb/ac)	TP (lb/ac)	TN (lb/ac)
1000	ST1	5/31/2014	5.10	4.02	1.27	5.50	1.18	880.59	0.85	8.80
1000	P1	8/18/2005	4.59	3.38	1.36	5.19	0.01	0.50	0.01	0.04

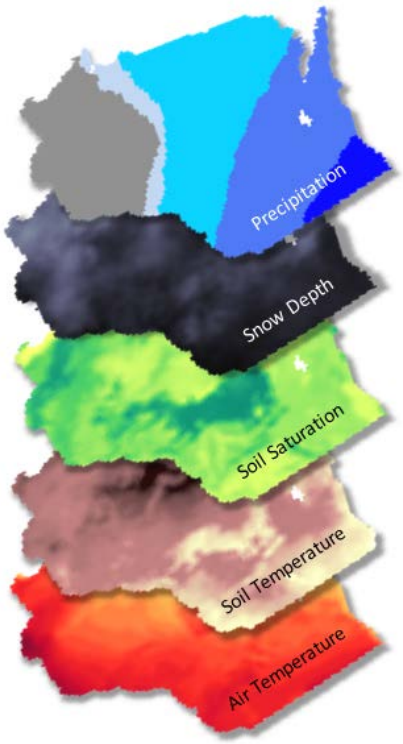
Data courtesy of Tim Radatz, MN Discovery Farms

Runoff threat *not* simply = rainfall magnitude threat



Field management requires consideration of current conditions as well as expected weather conditions (Runoff Risk)

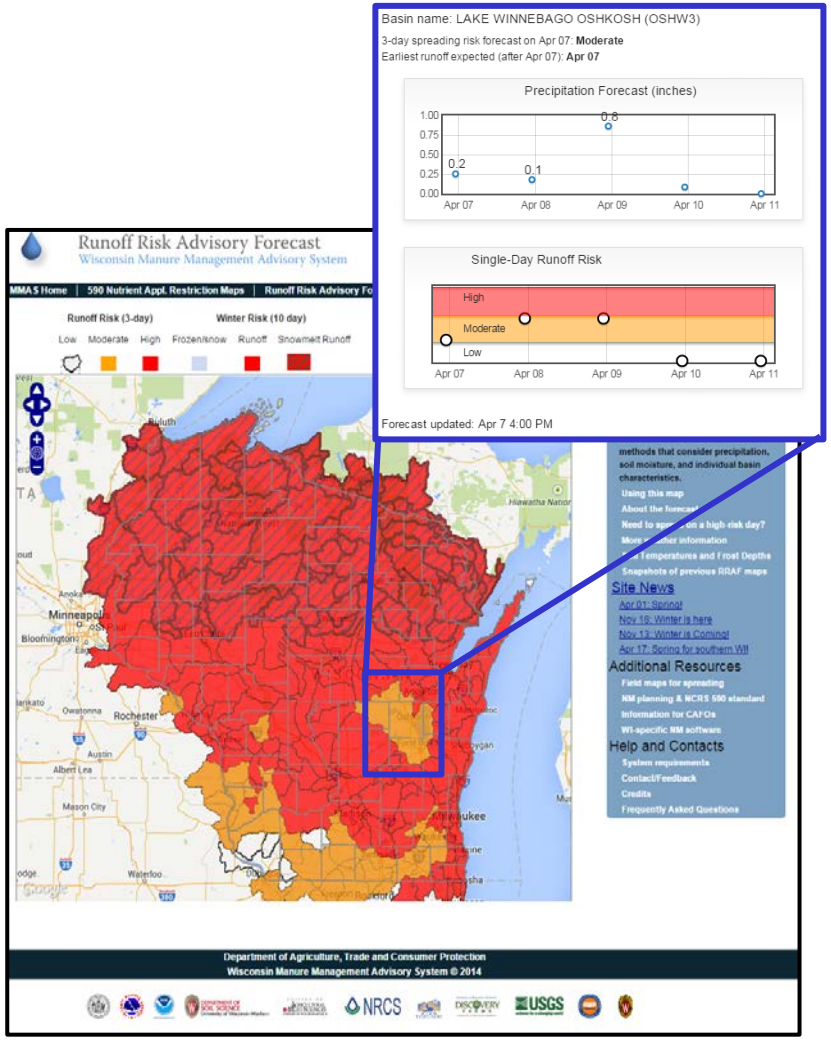
Producers have need for more than “Is it going to rain tomorrow?”



- Continuous soil moisture, snow pack, & runoff models
  - 7 days of future precipitation (QPF)
  - 10 days forecast temperatures
- Specific model states evaluated for risk conditions
  - Runoff, soil saturation, meteorological driver
  - Basin specific thresholds based on 60+ year simulation
  - Post-processing ran on output to produce risk events
- Model compared against Edge-of-Field response

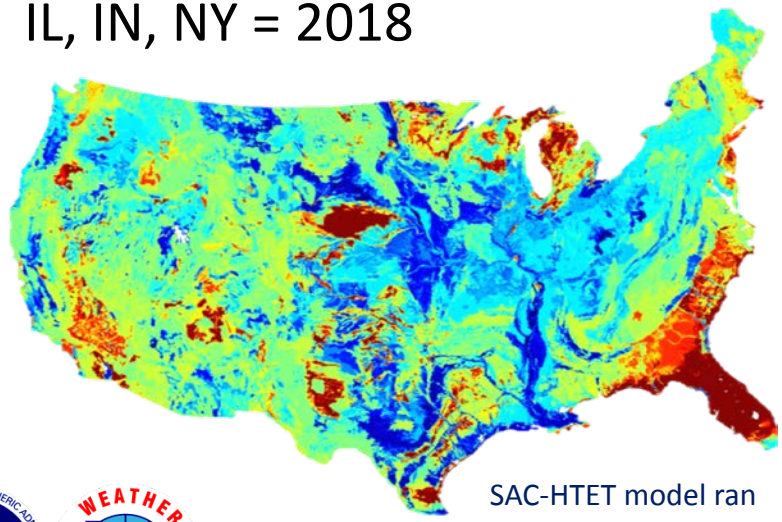
NWS Modeling behind Runoff Risk V1

- 3-times daily (0700, 1100, 2100L)
- University of Wisconsin built/maintains the website
- DATCP leads working group (tool owner) and coordinates outreach and training
- Wisconsin approach to show highest risk in next 72-hours



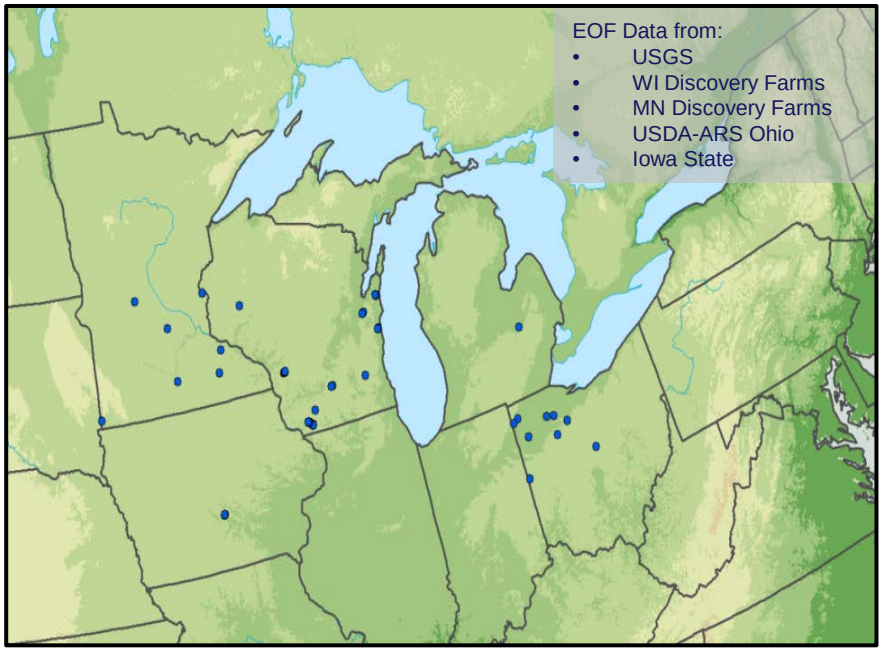
GLRI Partnership Spurs Version 2

- Goal: demonstrate *need and desire* for runoff risk tools across larger region by building runoff risk network based on *consistent modeling framework*
- Required all new model validation and algorithms (4km x 4km grid)
- MN, MI, OH, WI = rollout in 2017
- IL, IN, NY = 2018

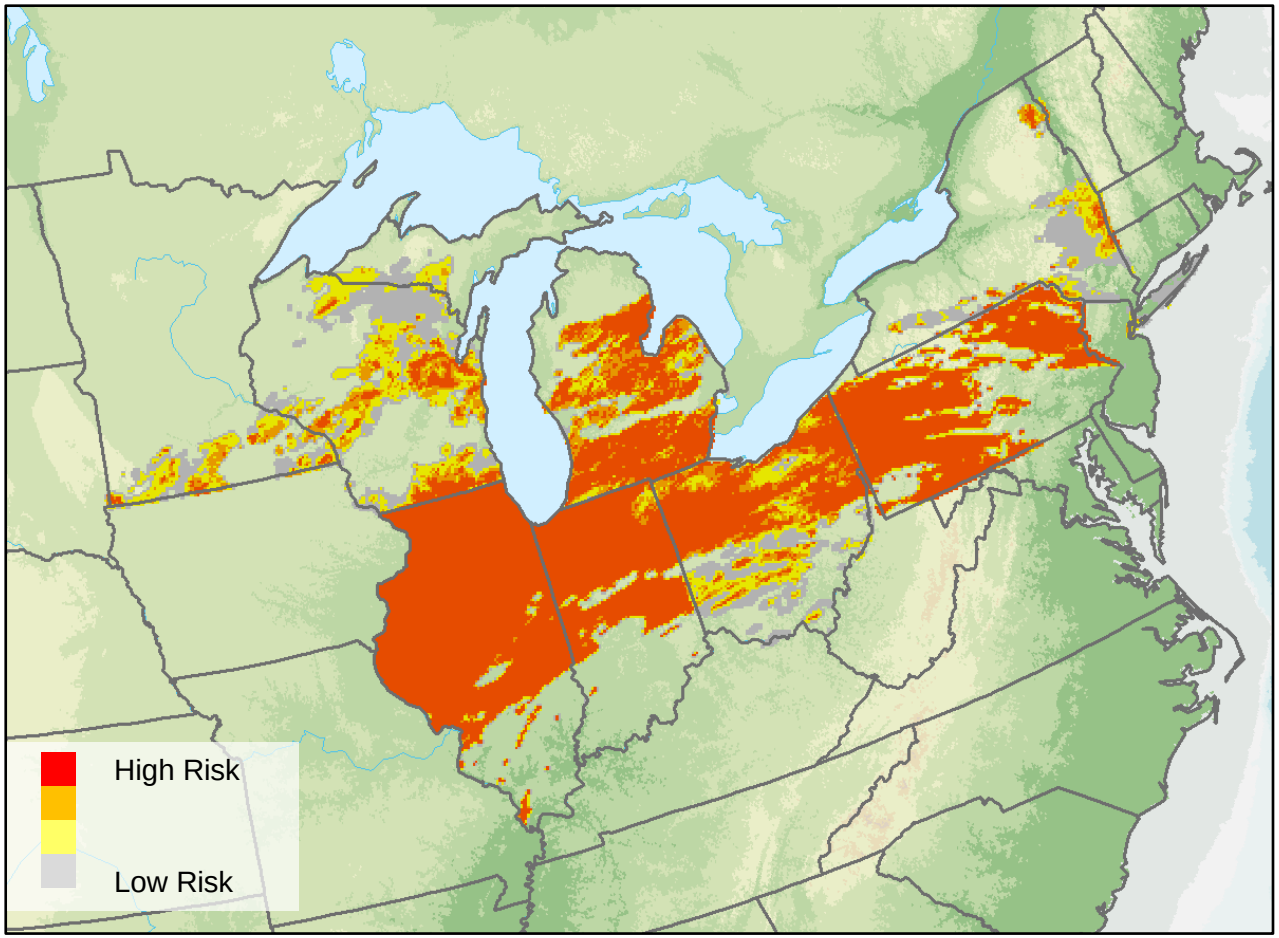


SAC-HTET model ran hourly out 10-days

Performance evaluated between 2002 – 2015 using 54 EOF sites and 31 grid cells (67,302 cells in the 4 states)

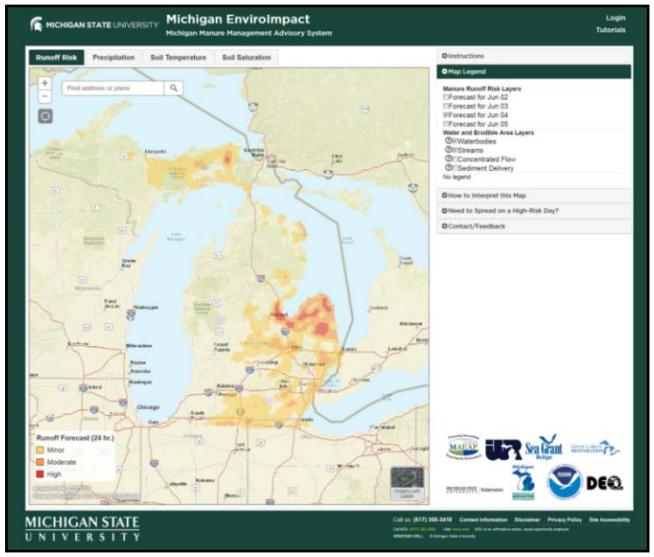


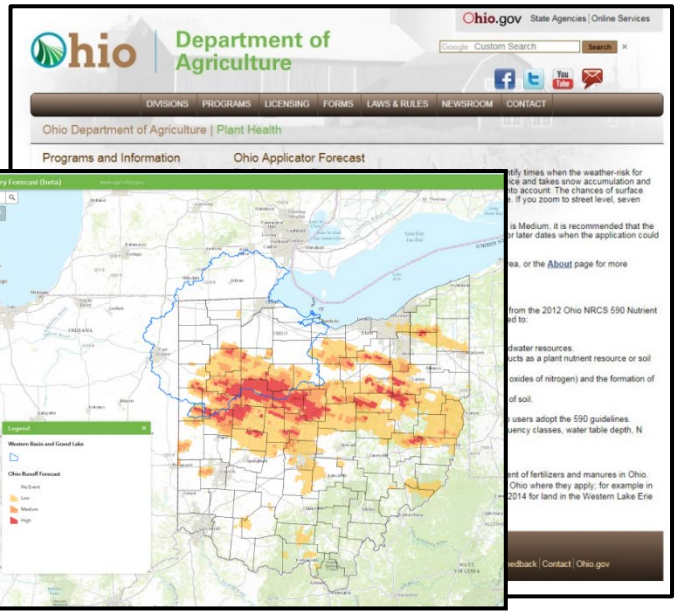
Regional Runoff Risk Version 2

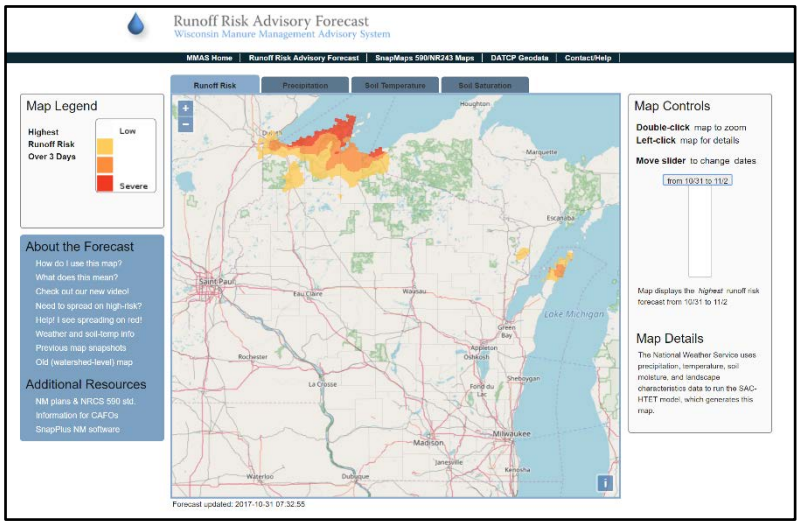


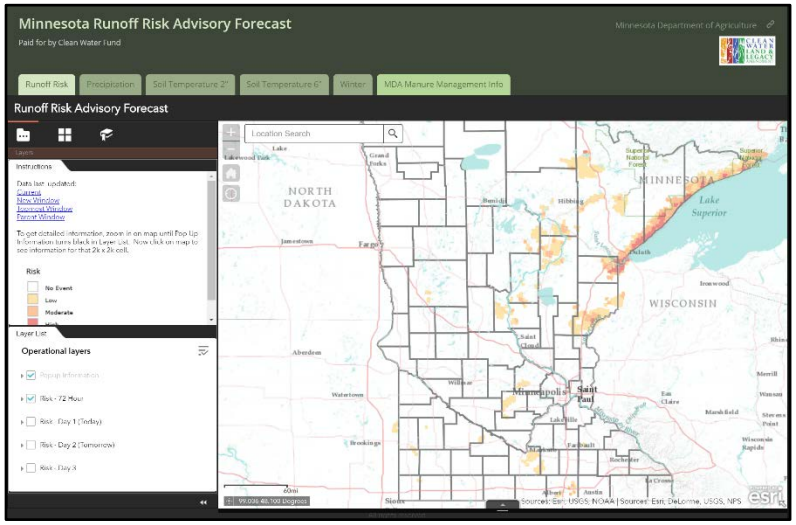
- Runoff Risk downscaled to produce daily 2km x 2km geoTIFF files for states
- Will be updated 4x daily later this winter

States Own the Tools, Build the Websites









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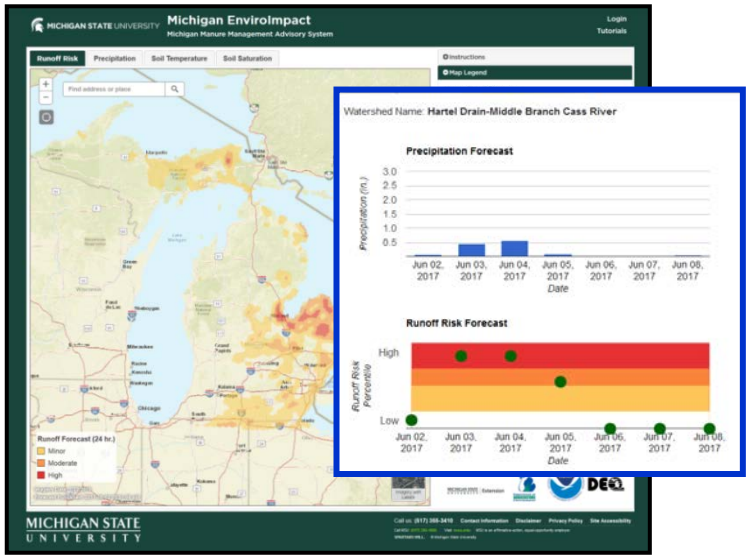

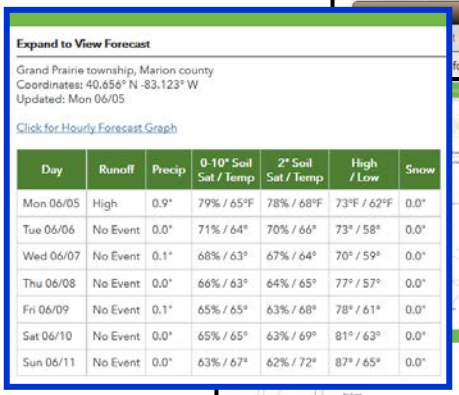

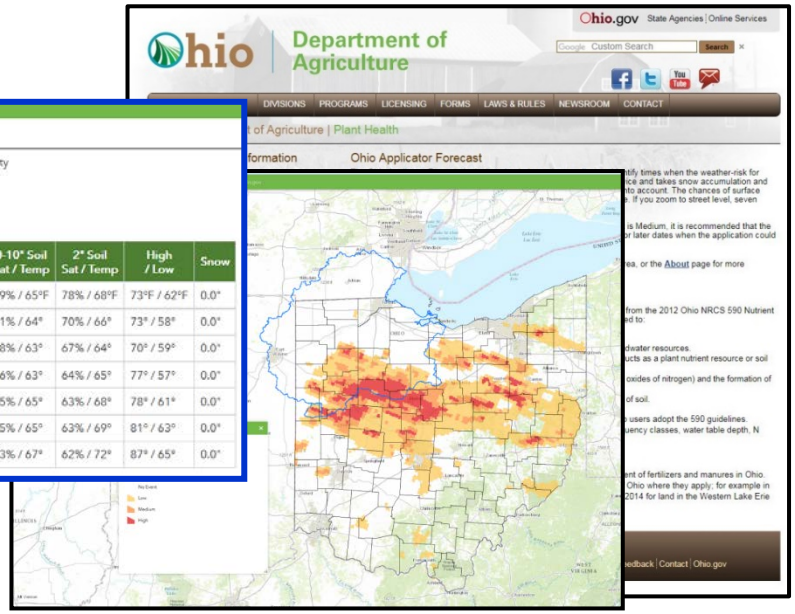

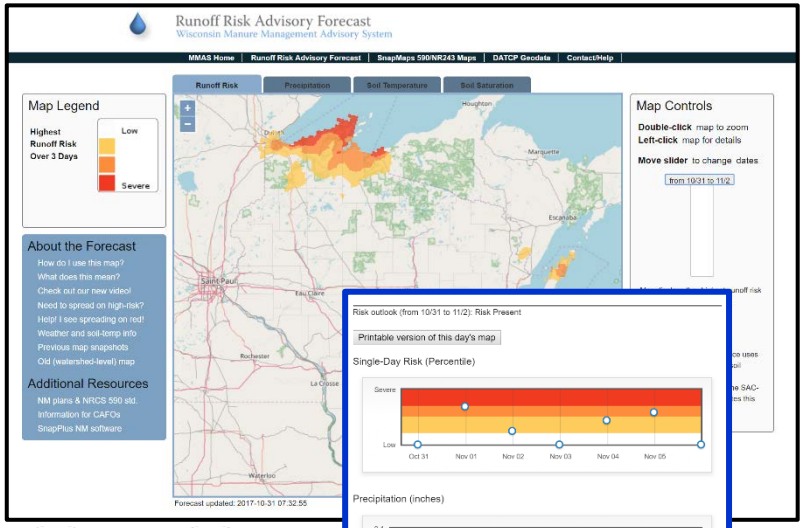

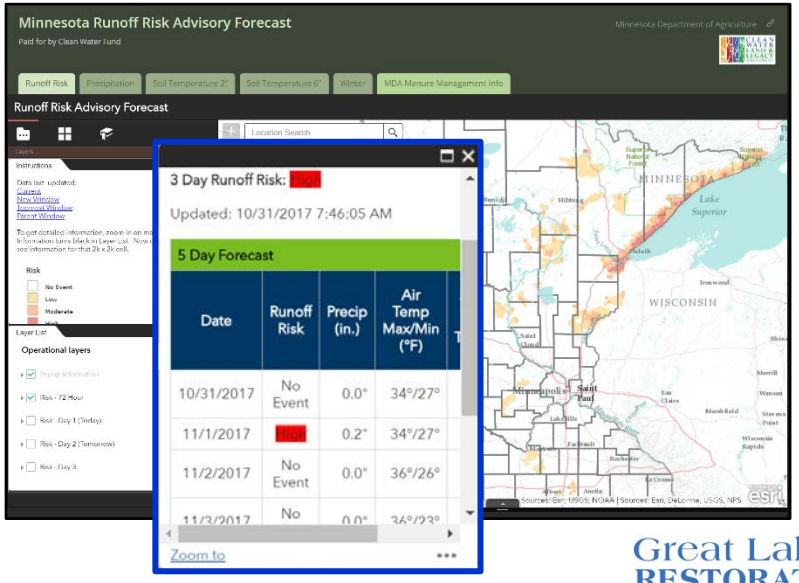

Additional Runoff Risk Considerations

- Runoff Risk is strictly water quantity based, *not modeling water quality*
- Risk is stratified by runoff magnitude: higher runoff → higher risk
  - Focus attention on larger events
  - More confidence in models, more likely to transport nutrients from fields

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- Weather model uncertainty incorporated into Runoff Risk
- Not possible to account for liquid applied to fields (affects soil moisture)
- Spatial scale concerns recognized

- Dynamic tools that incorporate many factors producers must consider in short-term management decisions
  - Backup perspective: "It's red today… why?", "Did I miss something?"
- ***Shouldn't be only information used :: Not intended to be regulatory***

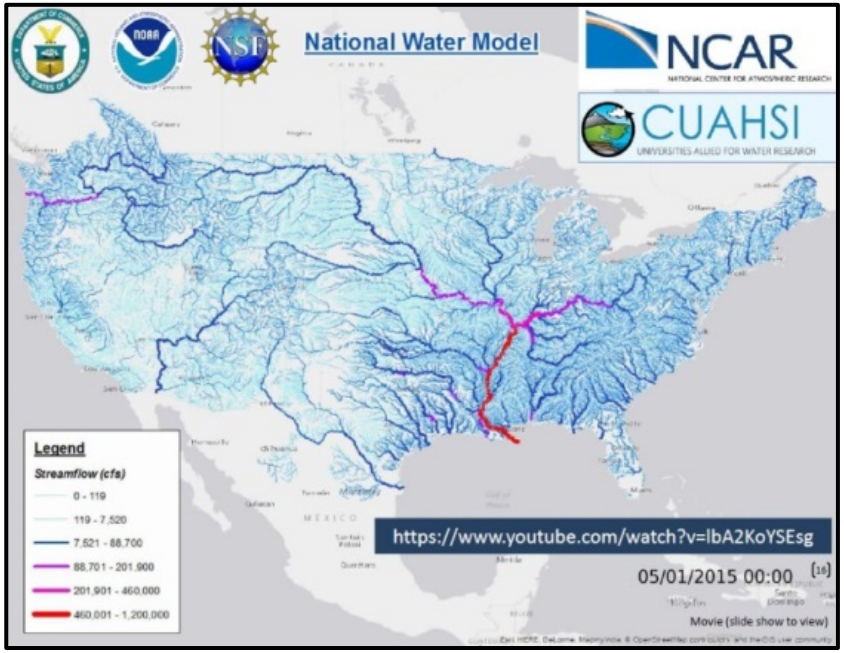
Next Steps: Evaluate Impact, Strive to Improve

- U Wisconsin: Ongoing social science analysis
  - Professional Nutrient Applicator Conference (PNAAW) (n=41)
    - *Before: 59% heard of RR, 37% looked at it, 32% used it in decisions*
    - *After: 85% useful info, 65% likely to use it, 84% tell other producers*
  - Focus Group
    - *"factors consider in spreading?" #1 answer is weather*
    - *What they liked about RR? 1 source of info, liked finer resolution, more updates*
    - *"biggest thing for us…have the most info to do the best job we can"*
- GLRI project with Ohio State in fall 2017
  - Evaluate historical runoff risk forecasts in Maumee River SWAT models to quantify usage impact on nutrient loads into Lake Erie

Next Steps: Evaluate Impact, Strive to Improve

- 2018: Begin transition to Runoff Risk Version 3
  - Move over to NWS National Water Model (WRF-Hydro)
  - Possible 1km or 250m grid on national scale with several daily runs
  - Allows additional States the opportunity for runoff risk tools
  - Requires all new validation planned to start in 2018
  - Expect 3-5 year process?

- Multiple NWM runs daily
  - Every hour → out 18 hours
  - Every 6-hrs → out 10 days
- Finer resolution forcings
- Water quality modeling down the road?



Runoff Risk Take Home Points

- Real-time forecast guidance for producers to avoid losing nutrients (acute events)
- Promotes and expands *Right Time* message
- State owned tools developed out of successful collaboration
- Understand limitations and communicate expectations
- Plan is for continuous improvement

YouTube "runoff risk"
1 min Version:
https://youtu.be/ebCwM6wlJdg

Full Version:
https://youtu.be/FAOLSjtRFZo

Partnerships Are Essential

steve.buan@noaa.gov dustin.goering@noaa.gov

1 – min You Tube Video: https://youtu.be/ebCwM6wlJdg

Provide Feedback to NWS on Runoff Risk Output/Expansion:

-- Product Description Document: https://go.usa.gov/xnR2U

-- NWS Survey: https://go.usa.gov/xnR2B