Welcome to *The Current*, the North Central Region Water Network's Speed Networking Webinar Series

Big Data and Water Resource Management: 2PM CT

1. Submit your questions for presenters via the chat box. The chat box is accessible via the purple collaborate panel in the lower right corner of the webinar screen.
2. There will be a dedicated Q & A session following the last presentation.
3. A phone-in option can be accessed by opening the Session menu in the upper left area of the webinar screen and selecting "Use your phone for audio".

This session will be recorded and available at northcentralwater.org and learn.extension.org.

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Today's Presenters:

- **Natalie Nelson**, Assistant Professor, Department of Biological and Agricultural Engineering, NC State University
- **Reid Christianson**, Research Assistant Professor, Department of Crop Sciences, University of Illinois at Urbana-Champaign
- **Jillian Deines**, Postdoctoral scholar, Center on Food Security and the Environment, Department of Earth System Science, Stanford University

Follow @northcentralh2o and #TheCurrent on Twitter for live tweets!

Natalie Nelson

Natalie Nelson is an Assistant Professor of Data Analytics and Integrated Modeling in the Biological & Agricultural Engineering Department at North Carolina State University. She leads the Biosystems Analytics Lab, studies from which take a data-intensive, management-focused, and interdisciplinary approach to the study of complex biological system dynamics. Natalie is particularly interested in questions related to estuarine and coastal water quality, land-sea connectivity, and the influence of global and local change on agroecosystem productivity in the Atlantic-Gulf Coastal Plains.

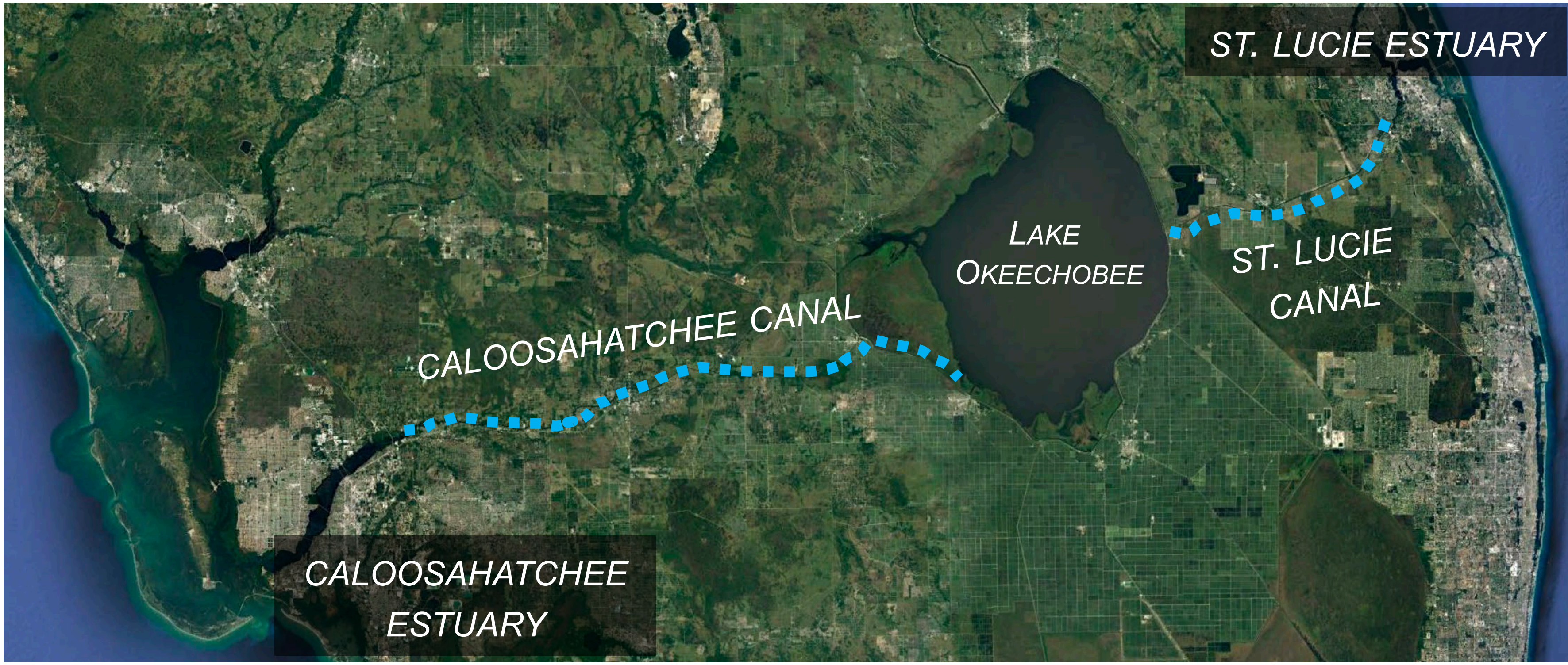
Coupling diverse datasets to investigate connections between water management practices and harmful algal blooms

Natalie Nelson, PhD
Assistant Professor, Biological and Agricultural Engineering
NC State University

Ed Phlips, PhD
Professor, Fisheries and Aquatic Sciences
University of Florida

Eric Milbrandt, PhD
Director, Marine Lab
Sanibel Captiva Conservation Foundation

NSF | NC STATE UNIVERSITY | SCCF Sanibel-Captiva Conservation Foundation | UF IFAS UNIVERSITY of FLORIDA



Caloosahatchee Estuary

Source: Calusa Waterkeeper, 2018

St. Lucie Estuary

Source: USGS, 2016

Source: Planet Labs

Objective: analyze multi-scale data to investigate connections between freshwater management, freshwater cyanobacteria blooms, and coastal red tides

Multi-scale data:

1. Harmful algal bloom observations:

   discrete sampling, remote sensing

   – CyAN, *in situ* field sampling, and FL Fish and Wildlife Commission

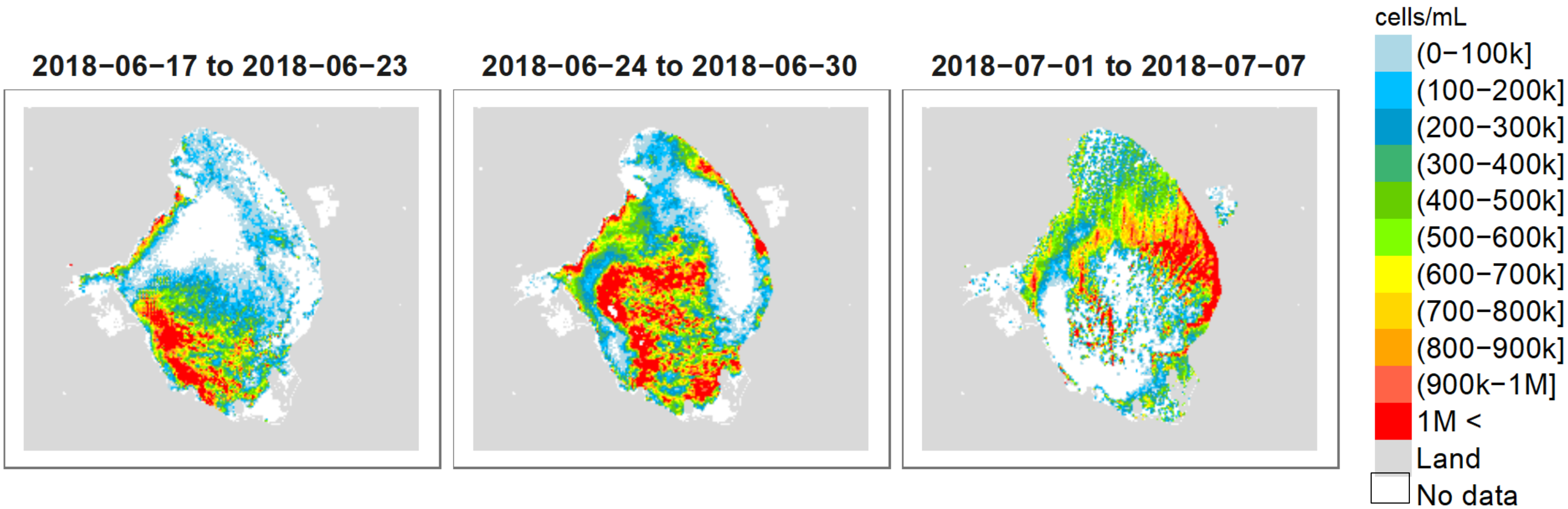
2. High- and low-frequency hydrologic observations:

   flow and water chemistry

   – USGS, Sanibel-Captiva Conservation Foundation, *in situ* field sampling

CyAN

Cyanobacteria Assessment Network (CyAN)



Schaeffer, B., Loftin, K., Stumpf, R., & Werdell, P. (2015). Agencies collaborate, develop a cyanobacteria assessment network. *Eos - Earth and Space Science News*, 96, https://doi.org/10.1029/2015EO038809

NC STATE UNIVERSITY

USGS science for a changing world

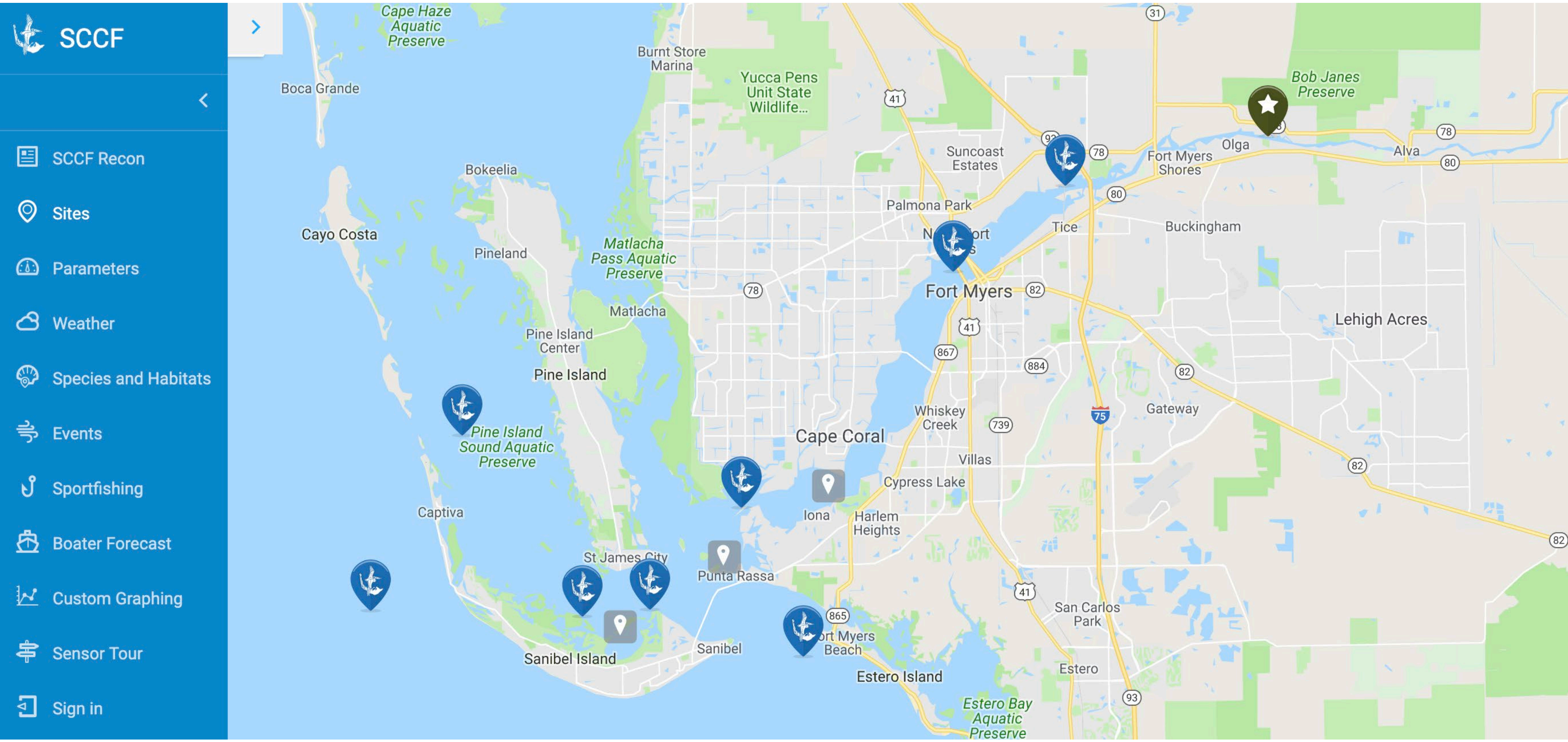
Flow and water quality, logged every 15 minutes

dataRetrieval USGS R

SCCF Sanibel-Captiva Conservation Foundation Marine Laboratory

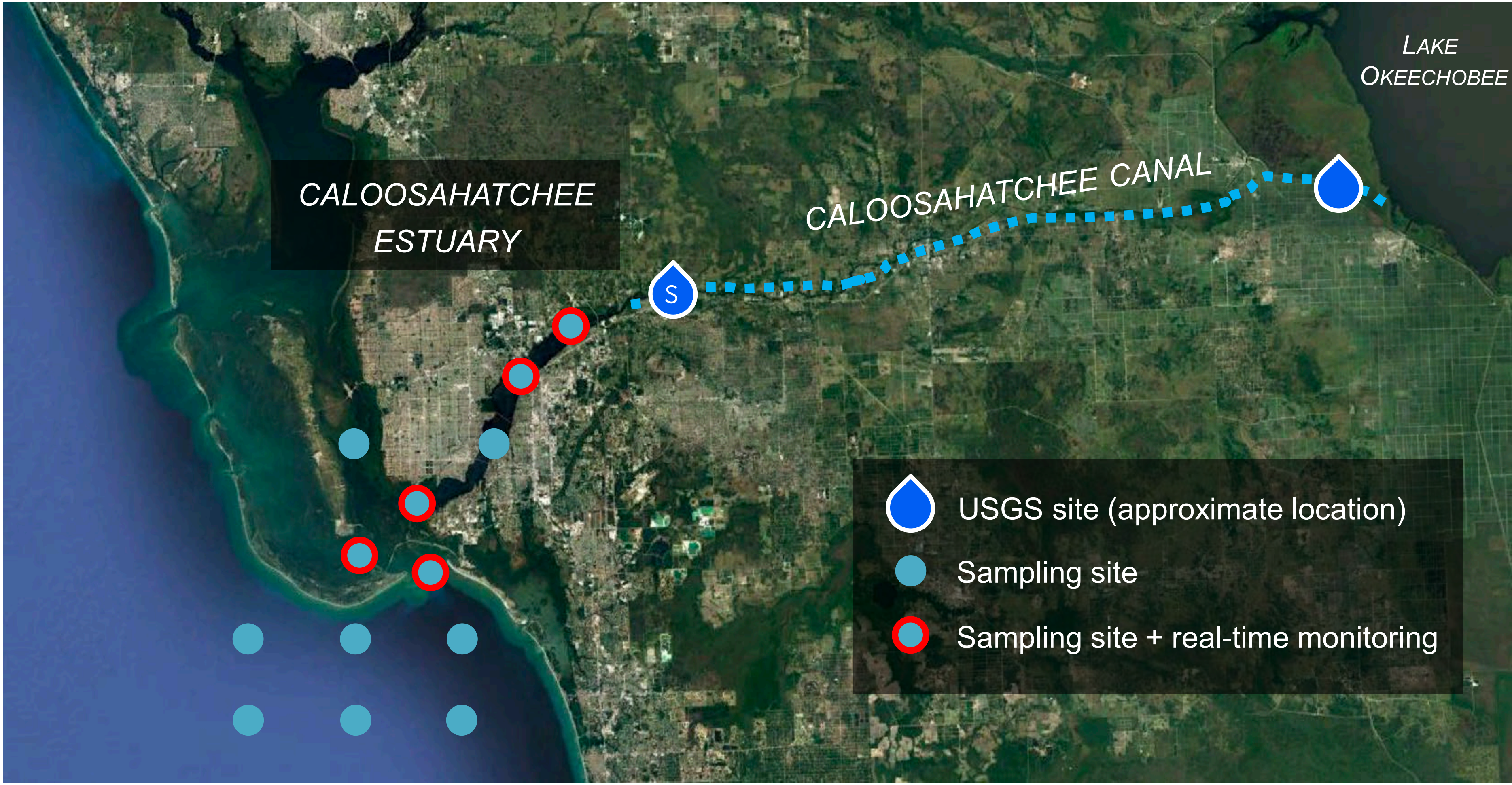
RECON: River, Estuary and Coastal Observing Network

Real-time data starting in 2007, logged hourly



http://recon.sccf.org/

In situ observations to fill in the gaps: phytoplankton community



High-frequency data:

RECON ← **USGS** ← **CyAN**

RECON

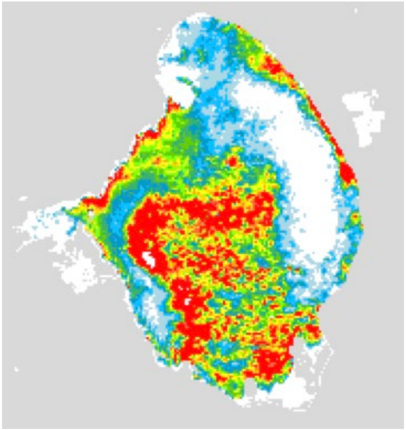
Track algal biomass trends in the Caloosahatchee River + Estuary using chlorophyll-a

USGS

Transport of cyanobacteria biomass + NO_3/NO_2 from Lake O to the Caloosahatchee River

CyAN

Supply of cyanobacteria biomass to the Caloosahatchee Canal



Low-frequency data:

In situ sampling

Supplement high-frequency data with discrete / detailed data on phytoplankton community composition and water chemistry

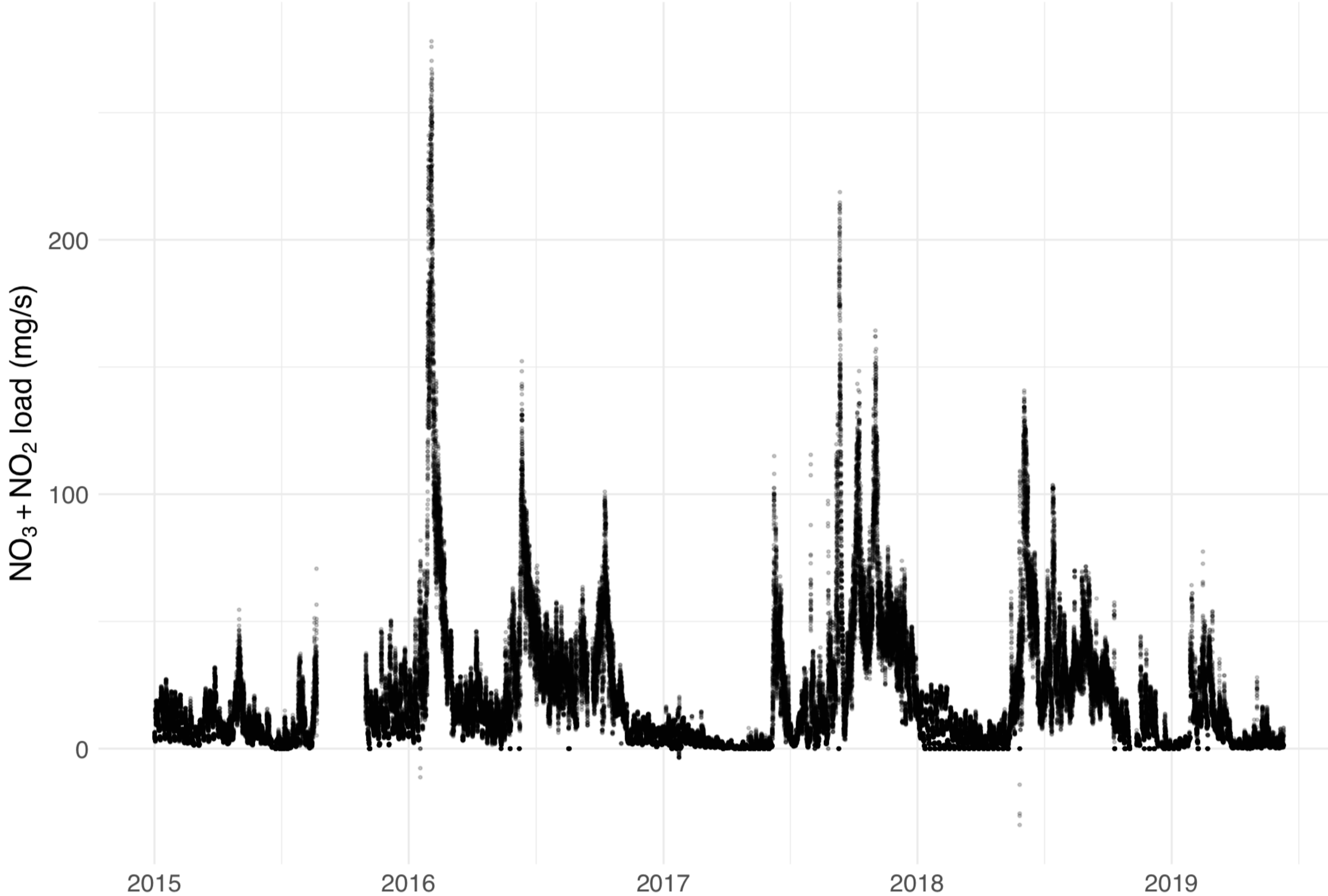
Time series analysis

Management-relevant insight on the effects of water management on harmful algal blooms

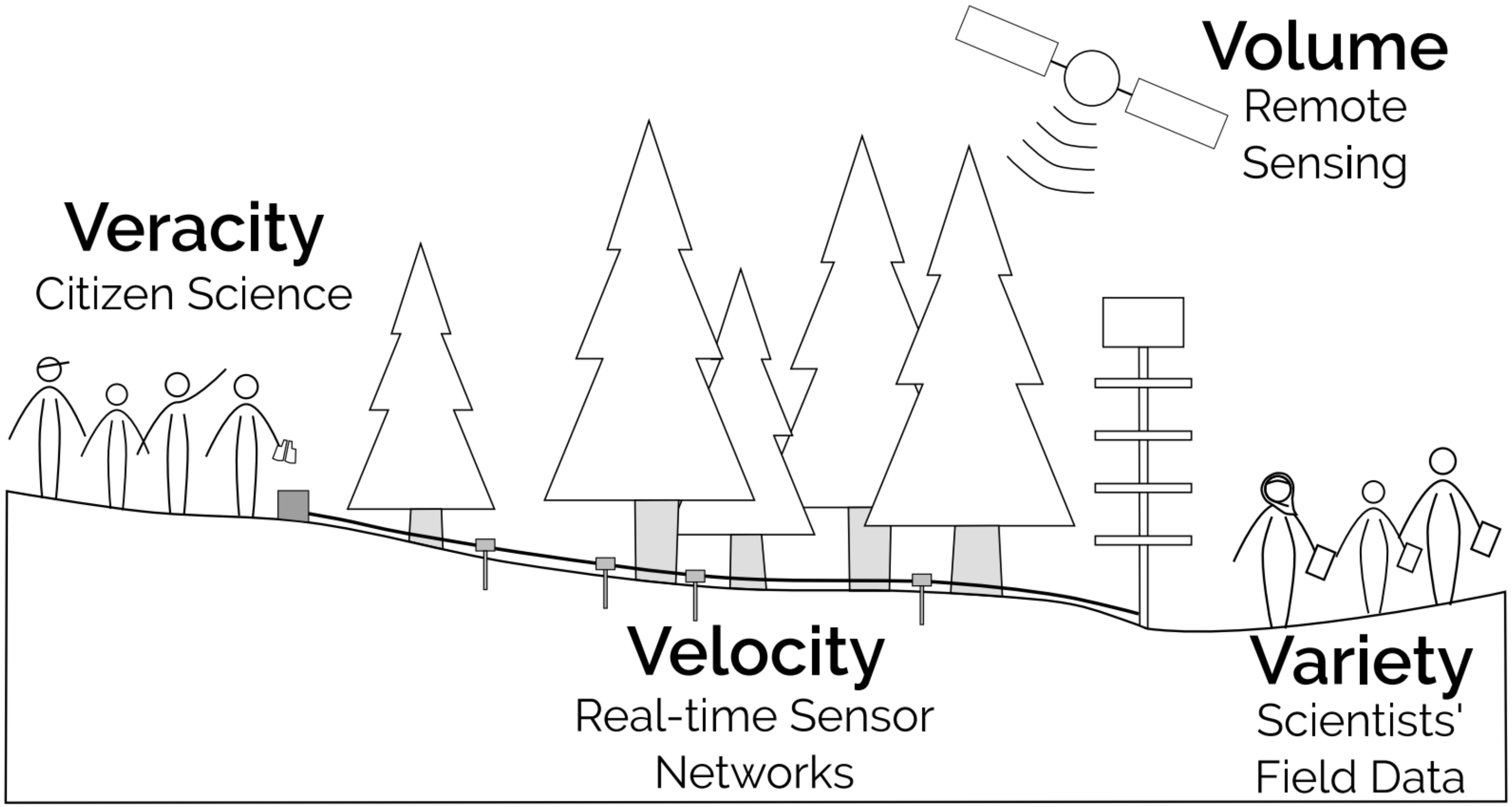
Thank you!

Natalie Nelson
Biological and Agricultural Engineering
North Carolina State University

nnelson4@ncsu.edu
@natnels
http://nelson.rbind.io/

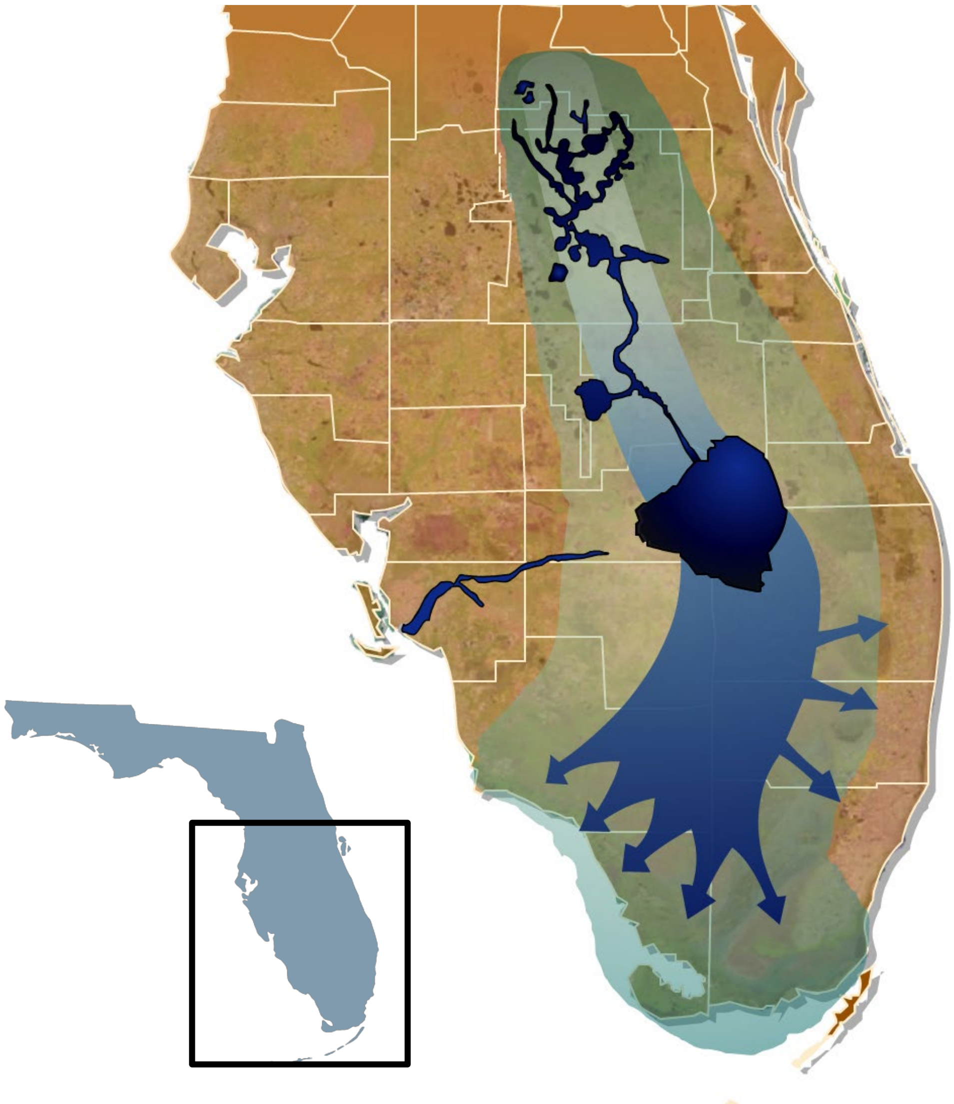


Data: Caloosahatchee River at S-79, USGS site 02292900; temporal resolution = 15 min

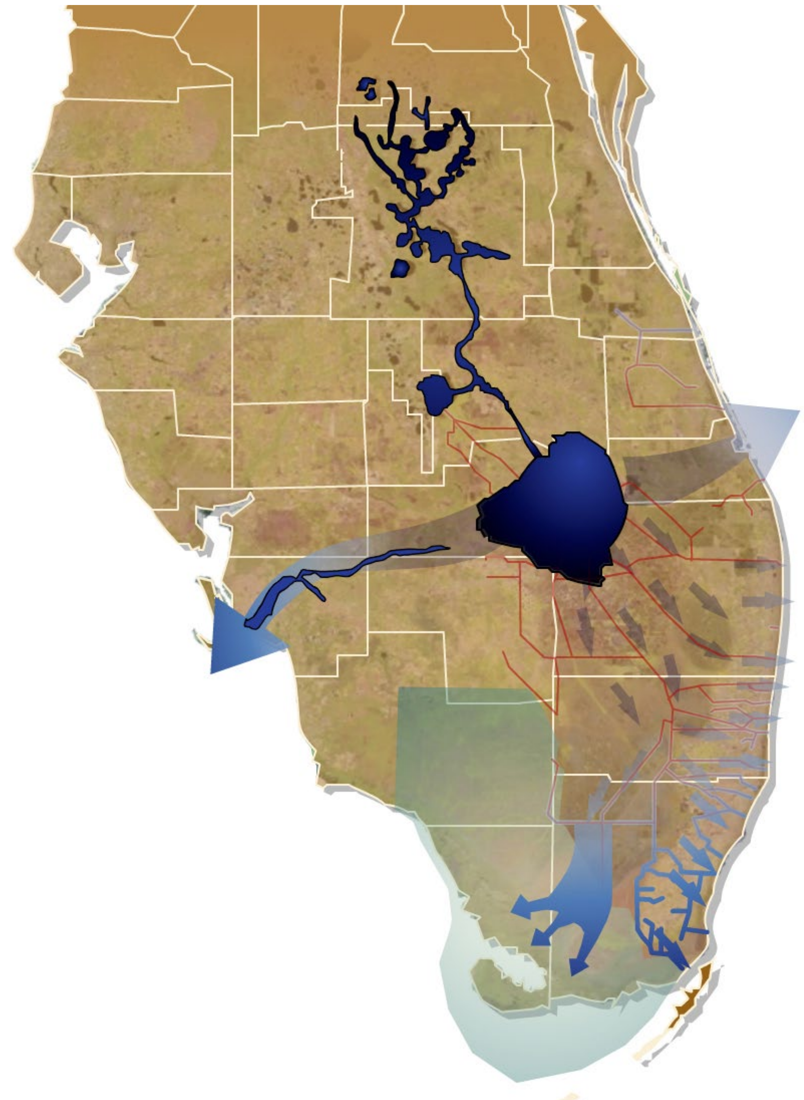


S.S. Farley et al. (2018). Situating Ecology as a Big-Data Science: Current Advances, Challenges, and Solutions. *BioScience*, 68(8), 563–576. https://doi.org/10.1093/biosci/biy068

Historical hydrology



Modern hydrology



Source: South Florida Water Management District

Reid Christianson

Reid Christianson, is a Research Assistant Professor in the Department of Crop Sciences at the University of Illinois at Urbana-Champaign. He has been doing work on surface water quality and water movement in the environment since 2003. Reid has degrees in Biological and Agricultural Engineering from Kansas State University (B.S. and M.S.) and Biosystems Engineering from Oklahoma State University (Ph.D.). He is registered professional civil engineer in Illinois, Iowa, and Maryland and has previously worked for the Center for Watershed Protection, Iowa State University, Massey University (New Zealand), Kansas State University, and Oklahoma State University.

COMPARING DATA SOURCES FOR WATER QUALITY PRACTICE IMPLEMENTATION

Reid Christianson
University of Illinois

The Current Webinar Series

June 12, 2019

Thank you to Walton Family Foundation, SERA-46, and the Indiana State Department of Agriculture

ILLINOIS

ACES College of Agricultural, Consumer and Environmental Sciences

CONSISTENT STORY

- A measure of what we're doing on the ground
  - We already have tools for Water Quality and ways to measure the size of the hypoxic zone
- Incorporate practice life to track persistence in the environment

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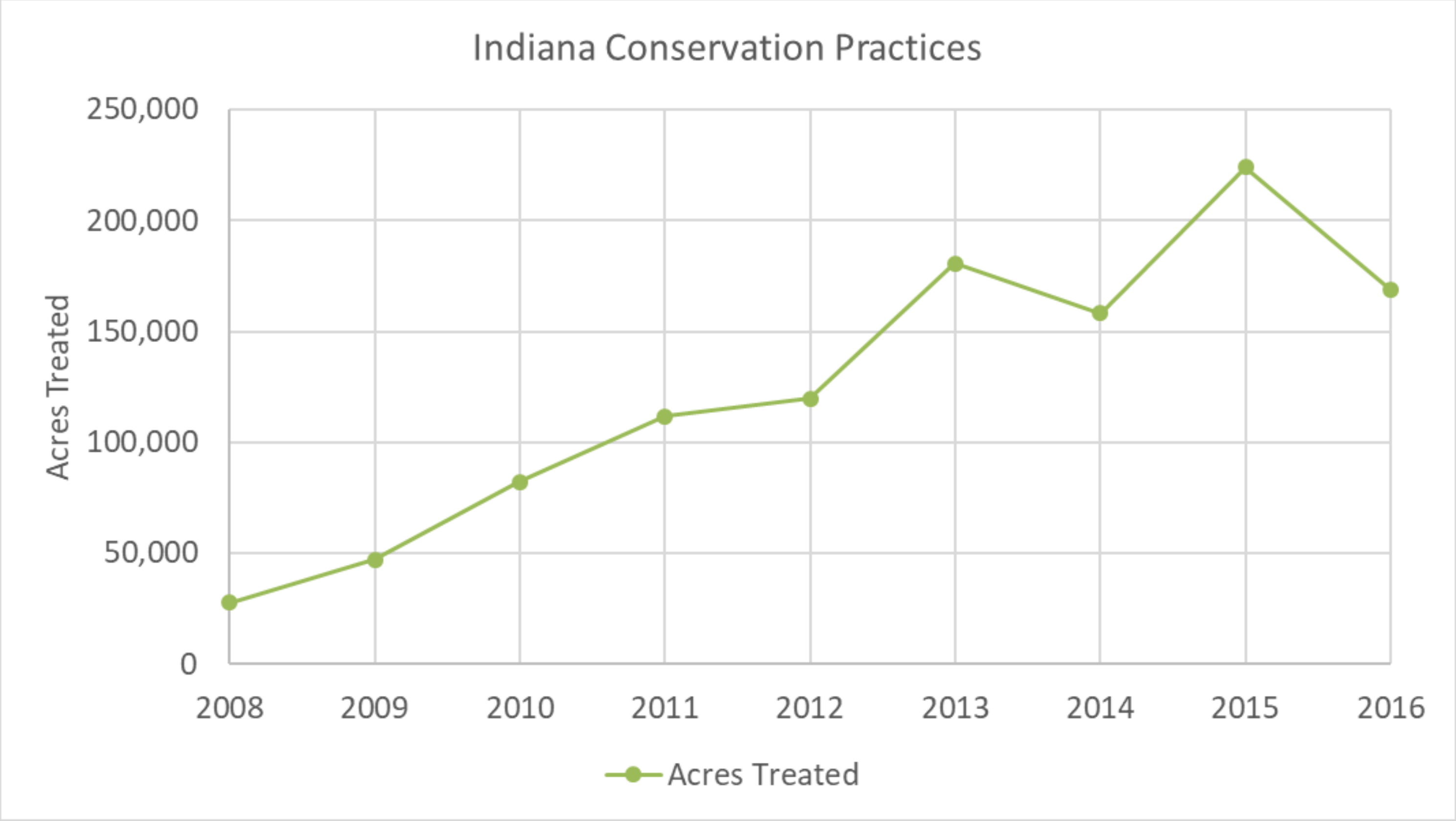
https://www.epa.gov/sites/production/files/2018-05/documents/nps_measures_progress_report_1-_may_2018.pdf

COVER CROPS (EQIP, CSP & EPA 319)

- Cover Crops in Indiana (~2008-2017)
  - 6,300 data points through EQIP
  - 275 data points through CSP
  - 925 data points through EPA 319



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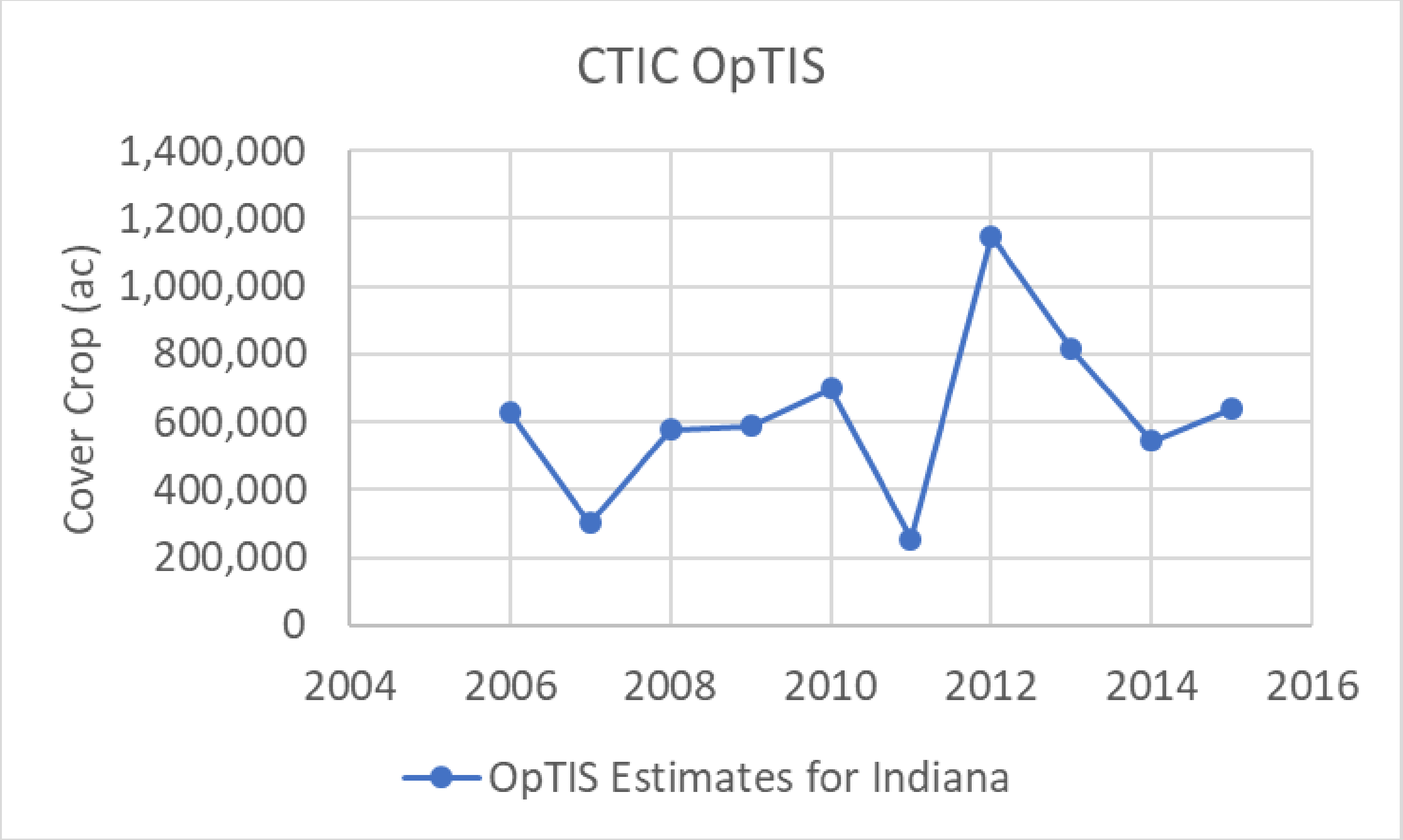
COVER CROPS (OPTIS)

- Cover Crops in Indiana – soon to be available for the corn belt (https://www.ctic.org/OpTIS)
- Available from 2005/6 to 2015



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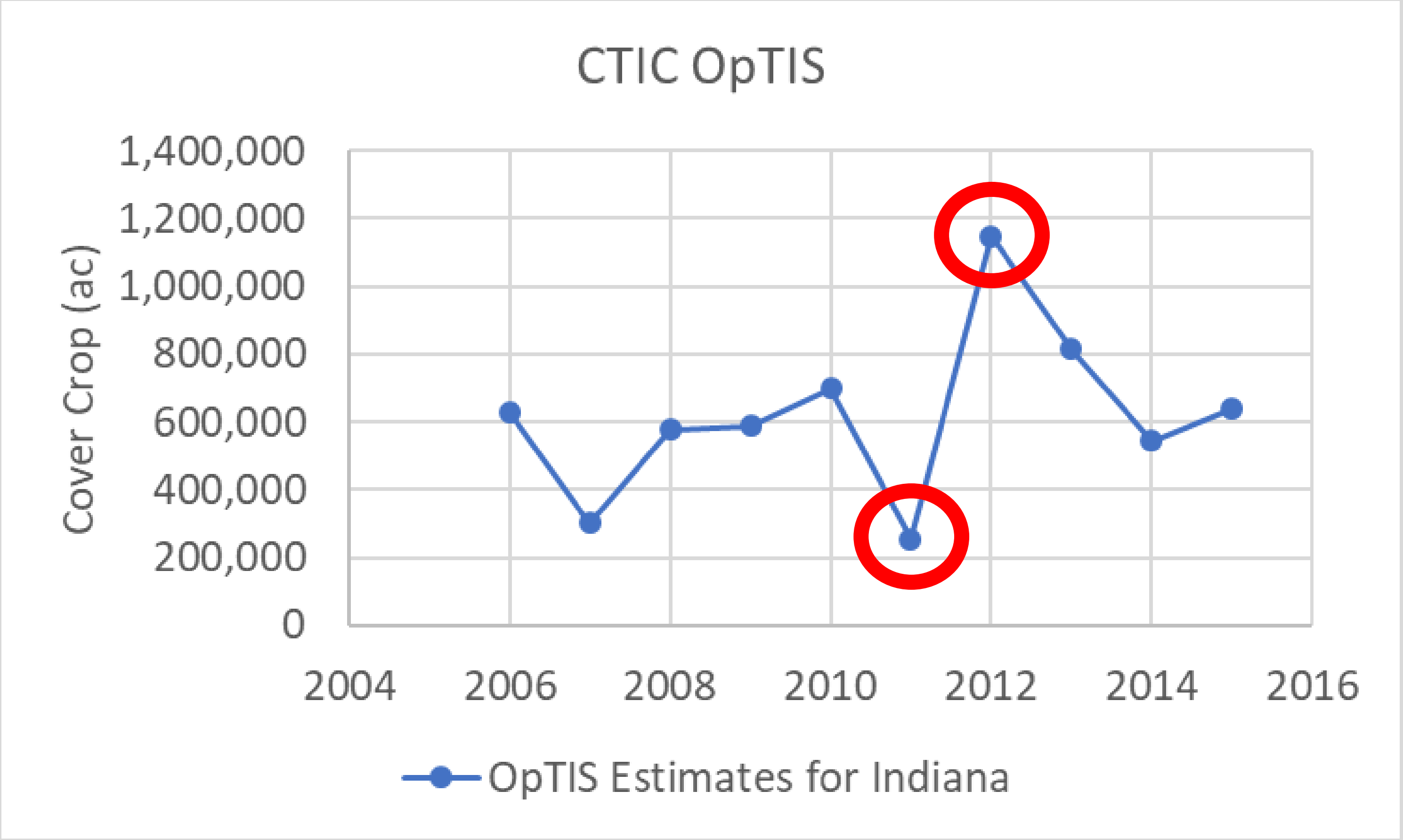
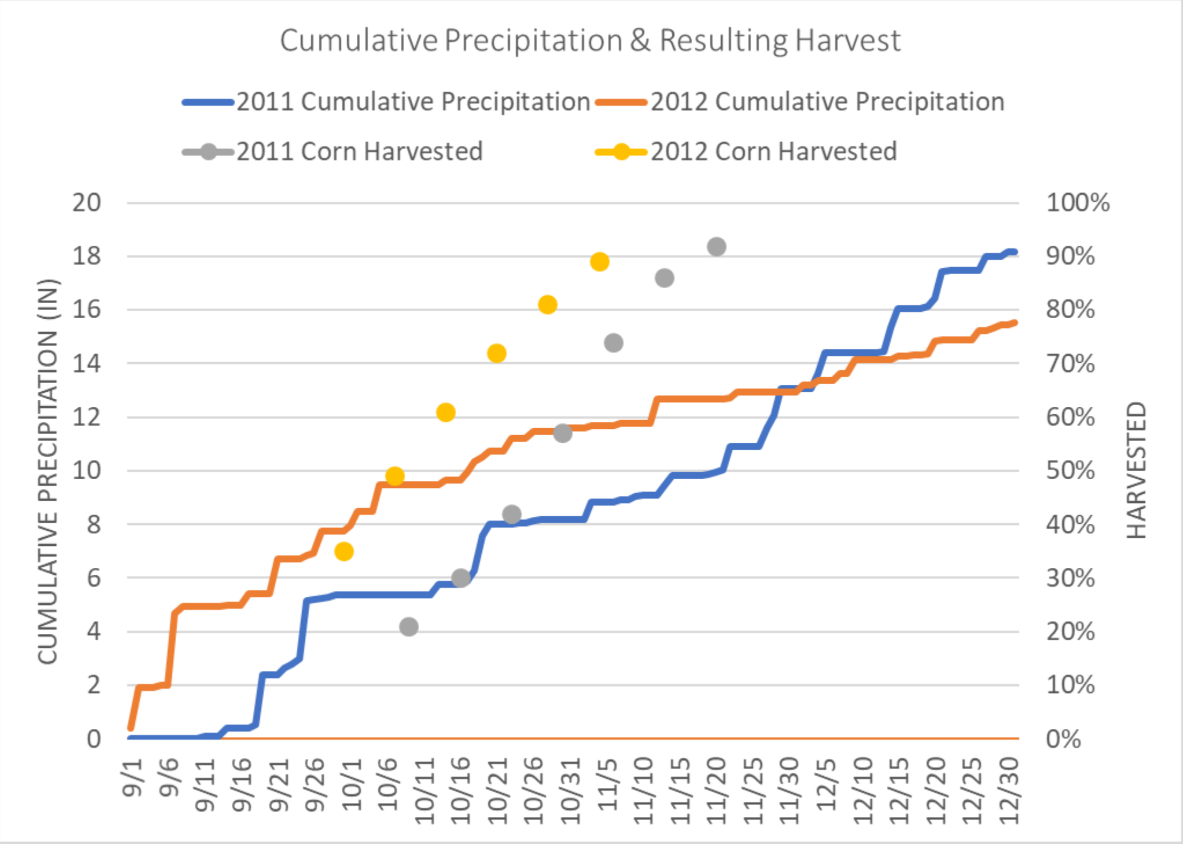


WHAT HAPPENED IN 2011/2012?

- Substantial Harvest delays in 2011
- OpTIS measuring emerged cover crops – not planted
- Common data measures planted
- NASS Census of Agriculture data measures planted
    - 2012 & 2017

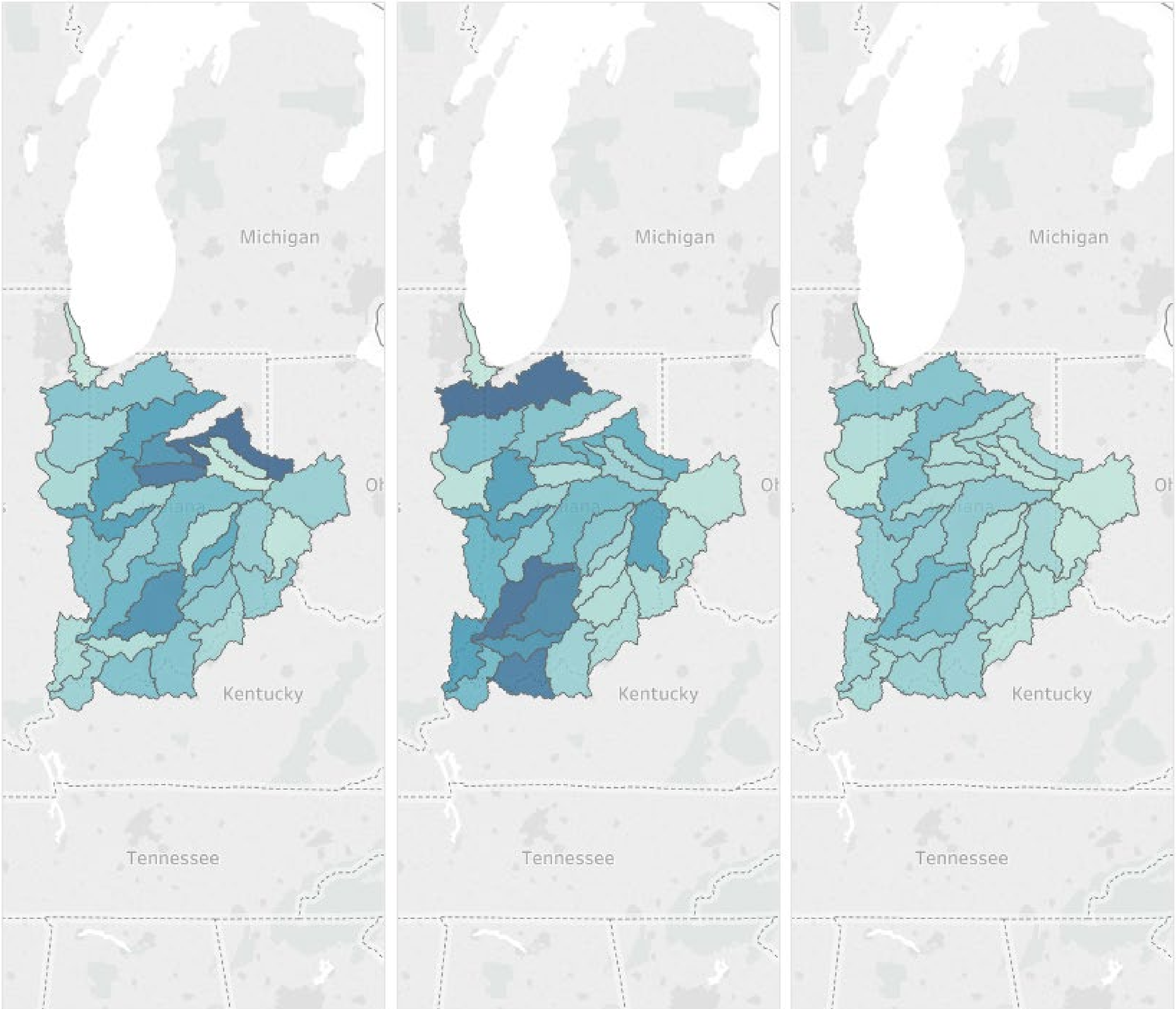


*Precipitation data from Weather Underground (Indianapolis Airport)
*Harvest data from National Agricultural Statistics Service Crop Progress Reports

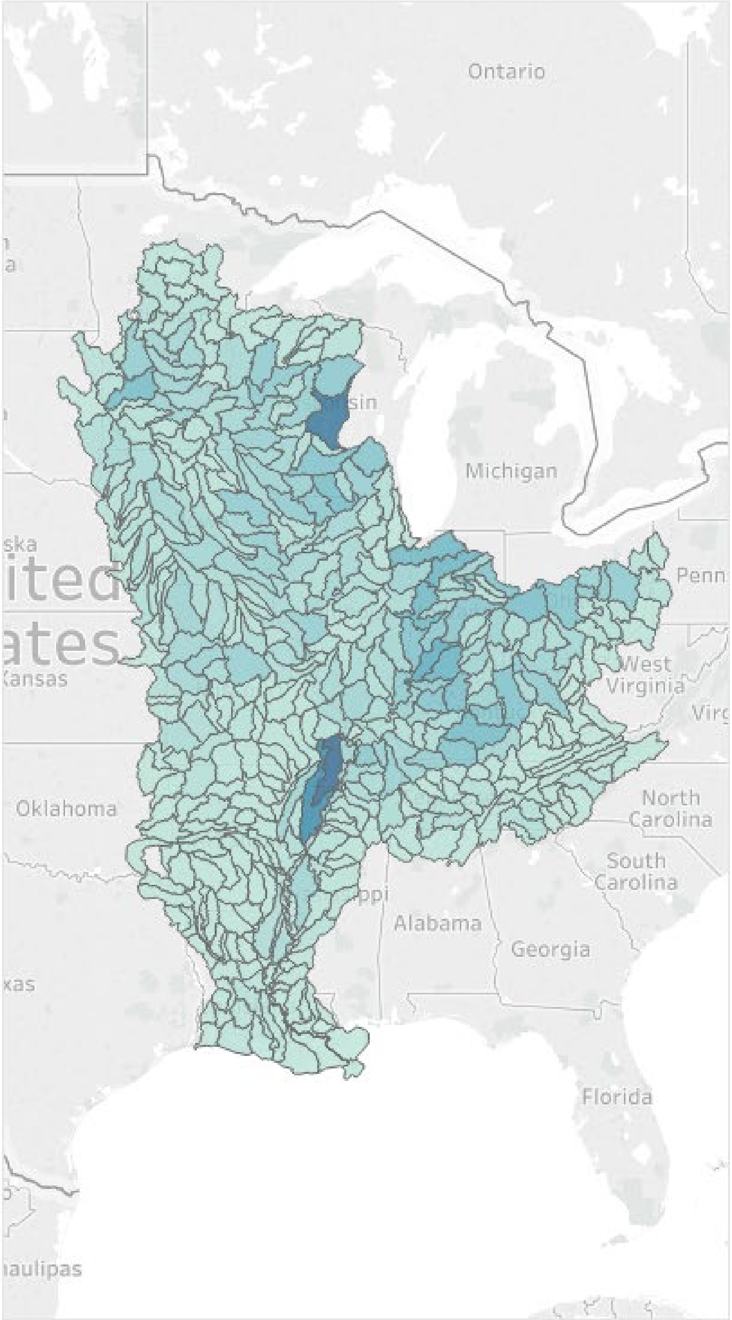
EQIP, CSP, and EPA 319 2012 Cover Crop Estimates

CTIC OpTIS 2012 Cover Crop Estimates

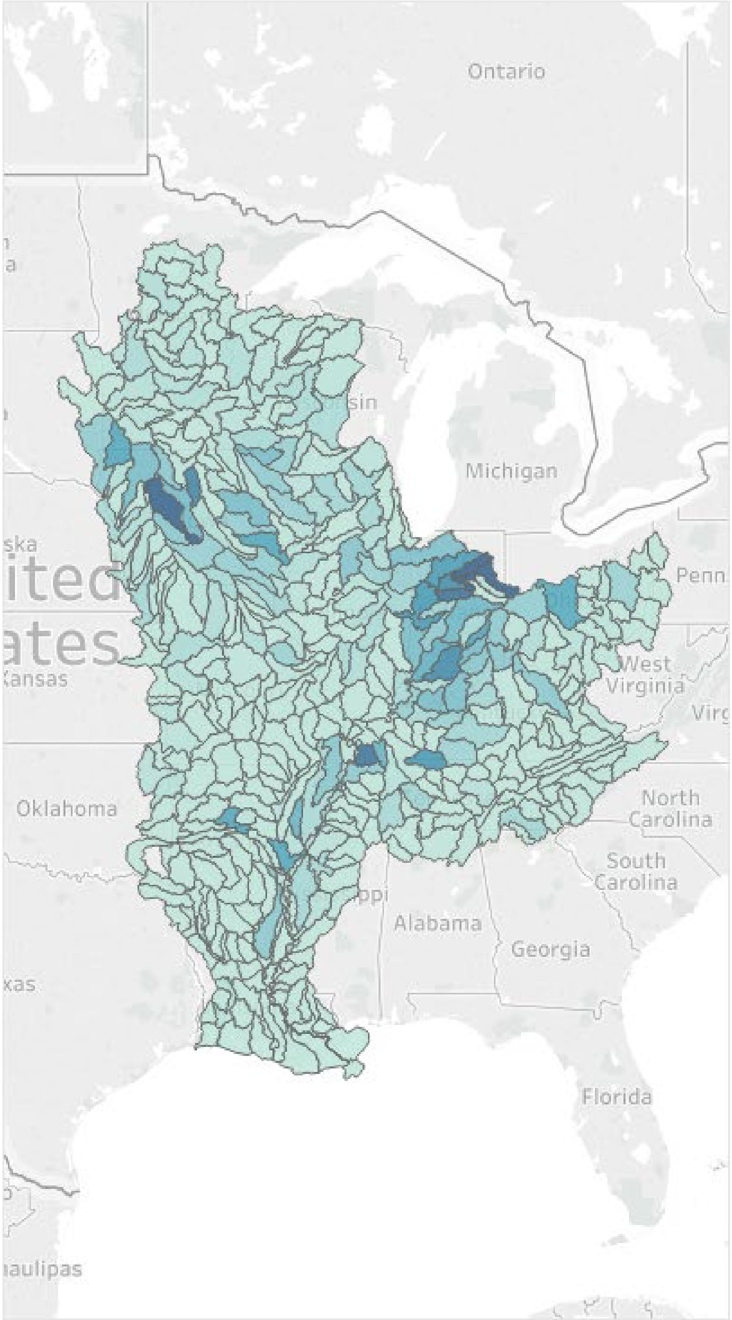
Census of Agriculture 2012 Cover Crop Estimates

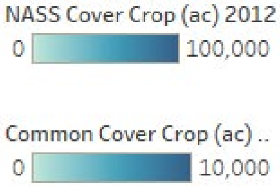


NASS Cover Crops for 2012

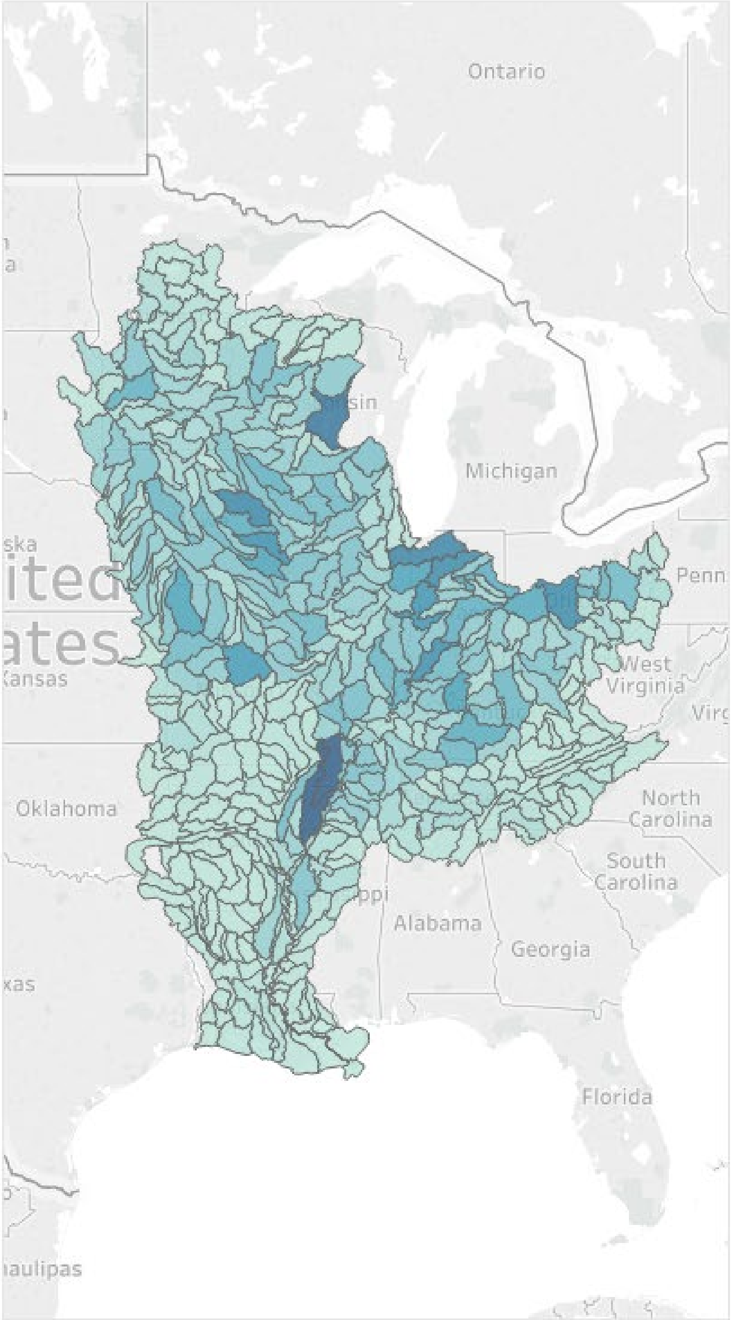


EQIP, CSP, and 319 Cover Crops for 2012

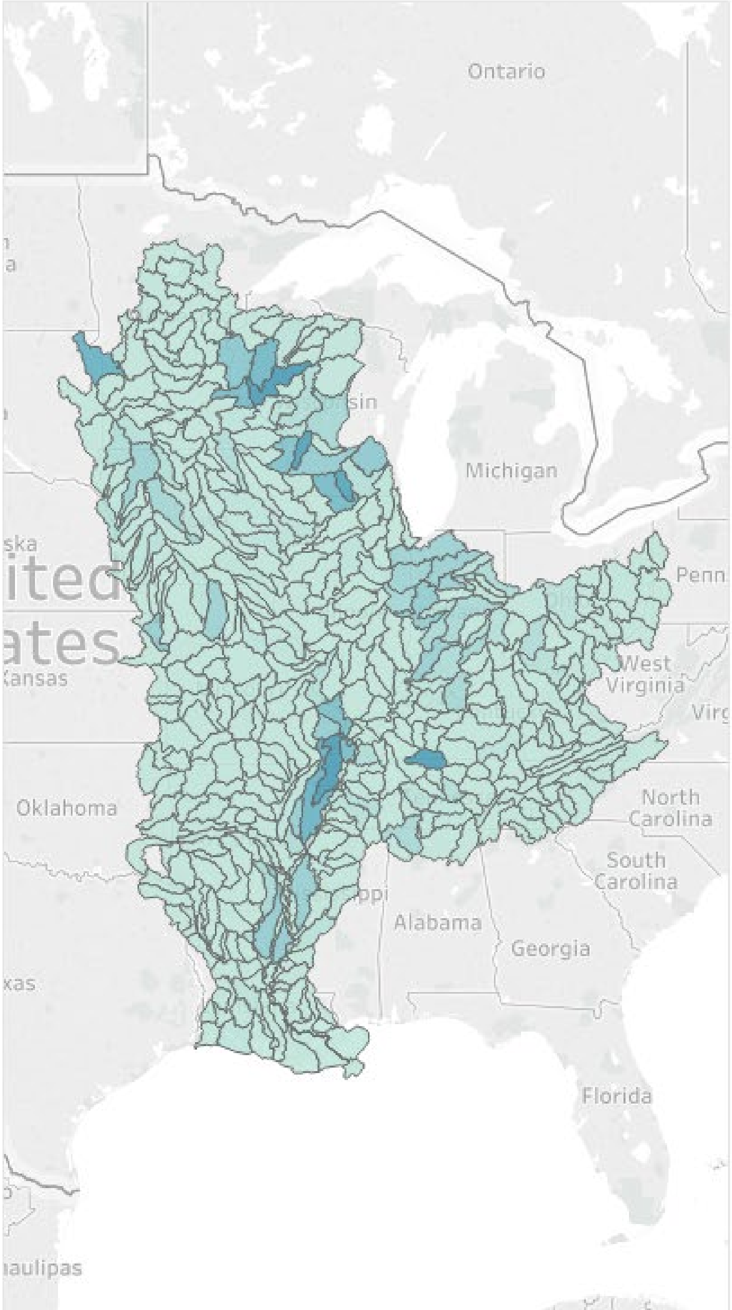




NASS Cover Crops for 2017



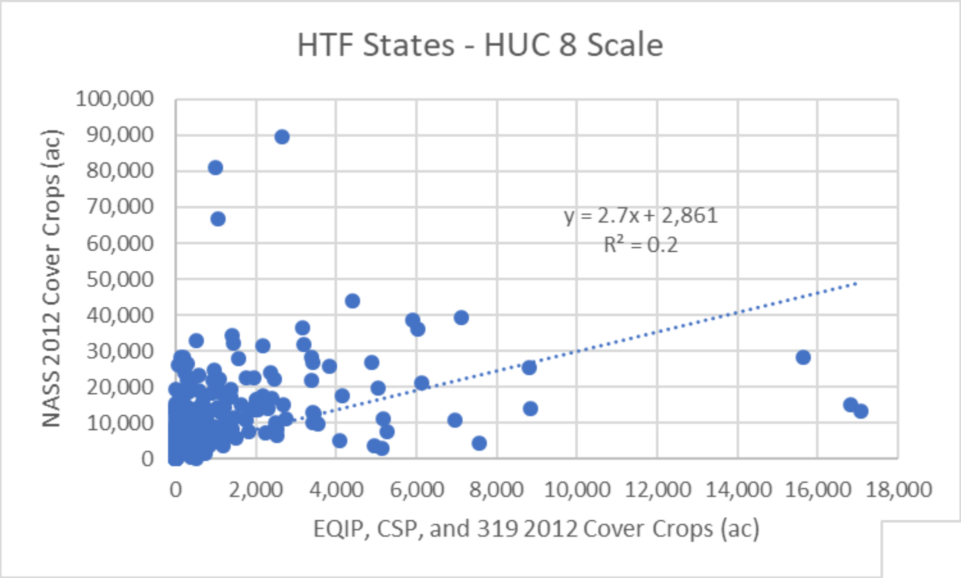
EQIP, CSP, and 319 Cover Crops for 2017

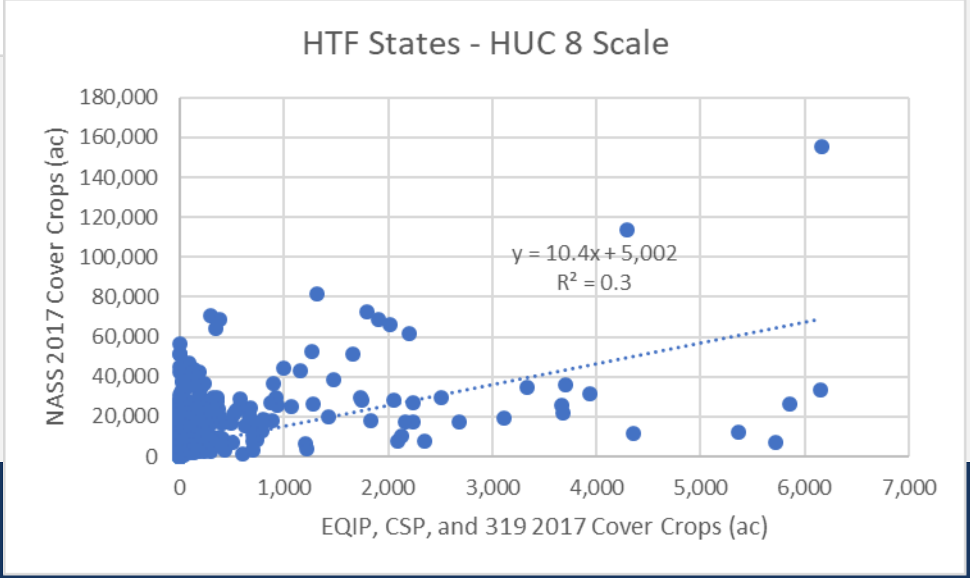


NASS Cover Crop (ac) 2017
0 – 100,000

Common Cover Crop (ac) ..
0 – 10,000

COVER CROP RELATIONS





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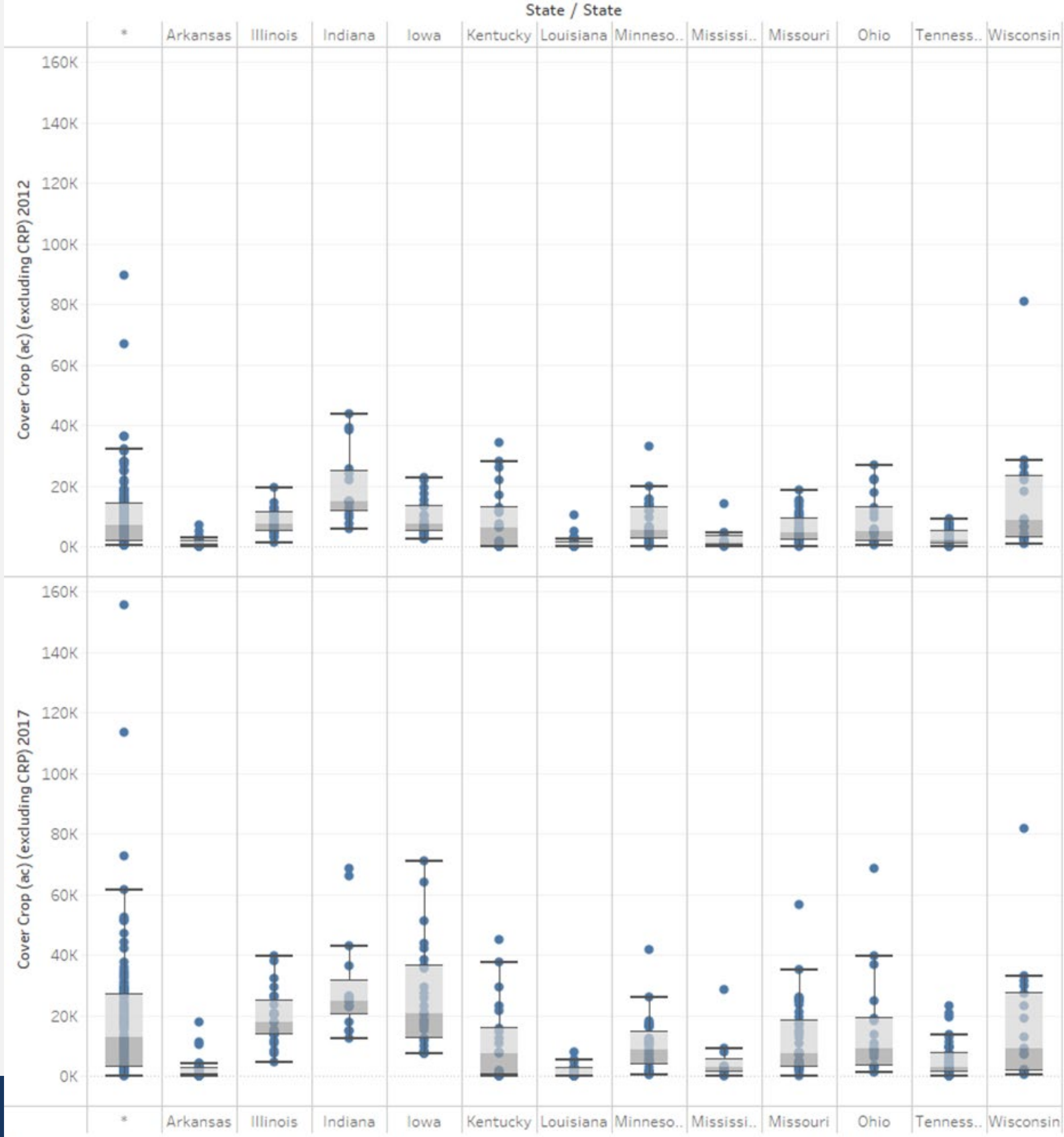
CRITICAL QUESTIONS

- Is there a good and persistent proxy for total implementation every year?
- How do we reconcile differences between datasets intending to tell the same story?
- Can we look at these data with nutrient transport lag-times in mind?
- When has adoption of a given conservation practice been achieved?
  - How will we know?

Thank you!

Census of Agriculture Cover Crop Estimates for 2012 and 2017



Sum of Cover Crop (ac) (excluding CRP) 2012 (Sheet1 (Watershed_Tableau)) and sum of Cover Crop (ac) (excluding CRP) 2017 (Sheet1 (Watershed_Tableau)) for each State (Sheet1 (Watershed_Tableau)) broken down by State (Sheet1 (Watershed_Tableau)). Details are shown for Huc8. The data is filtered on Huc 8 (Sheet1 (Watershed_Tableau)), which keeps 425 of 425 members. The view is filtered on State (Sheet1 (Watershed_Tableau)), which keeps 12 of 12 members.

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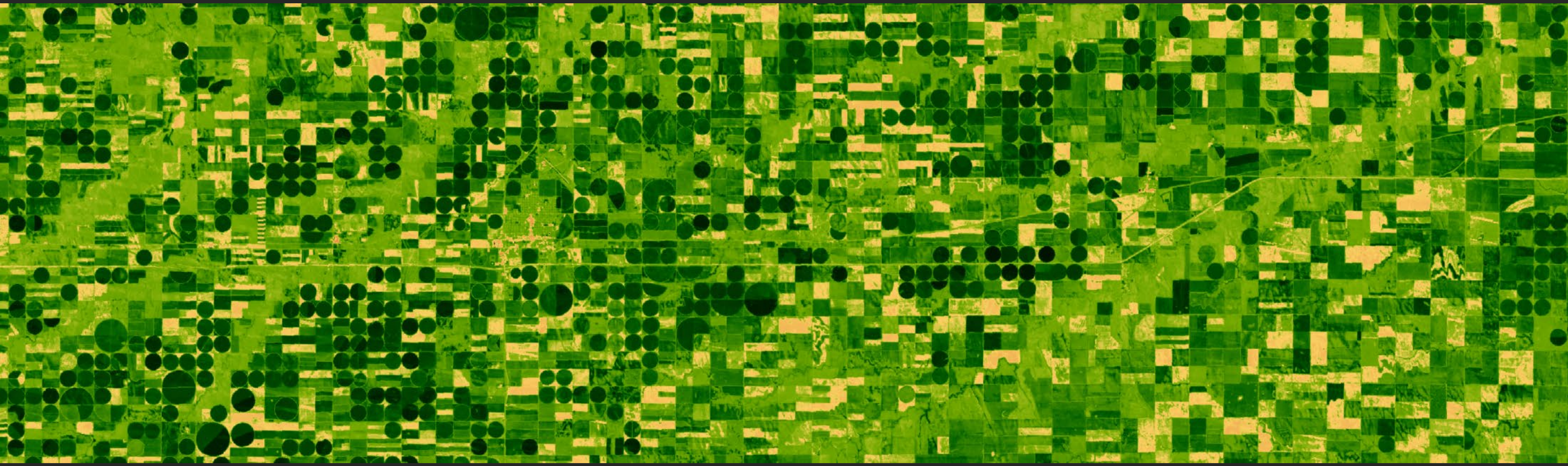
ACES

Jillian Deines

Jillian Deines is a postdoctoral scholar with the Center on Food Security and the Environment at Stanford University. Jill's research links agriculture, hydrology, and advanced spatial tools to promote food security, water management, and sustainable land use systems. She specializes in applying statistical and modeling techniques to take satellite data from bits to dynamic maps to process-based understanding, with a goal to inform effective management. Her work is part of the NASA Harvest multidisciplinary consortium to support food security efforts and agricultural decision-making in the US and around the globe. Jill holds a Ph.D. in Environmental Geosciences from Michigan State University, a M.S. in Biology from the University of Notre Dame, and a B.S. in Ecology and Evolutionary Biology from Saint Louis University.

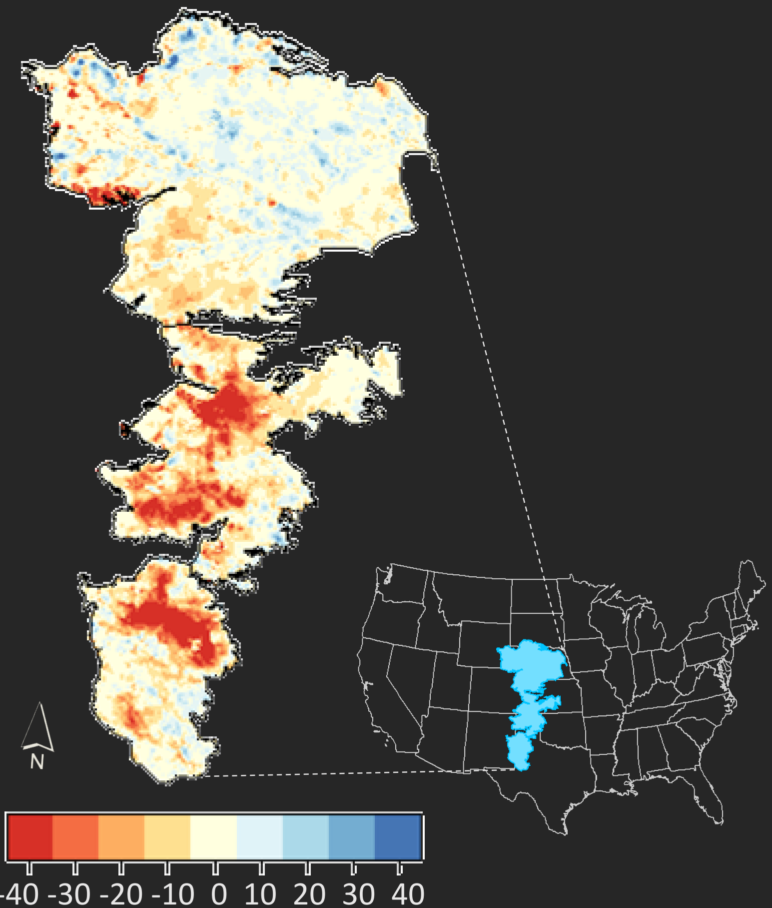
Informing Groundwater Management with Satellite Data:
Mapping Three Decades of Irrigation Over the High Plains Aquifer



Jillian M. Deines, PhD
Postdoctoral Scholar
Center on Food Security and Environment
Stanford University
11 June 2019

MSU Hydrogeology
hydrogeology.msu.edu @MSUHydro

Depletion in the High Plains Aquifer



Δ Water Levels since 1950 (m)
Haacker et al. 2016

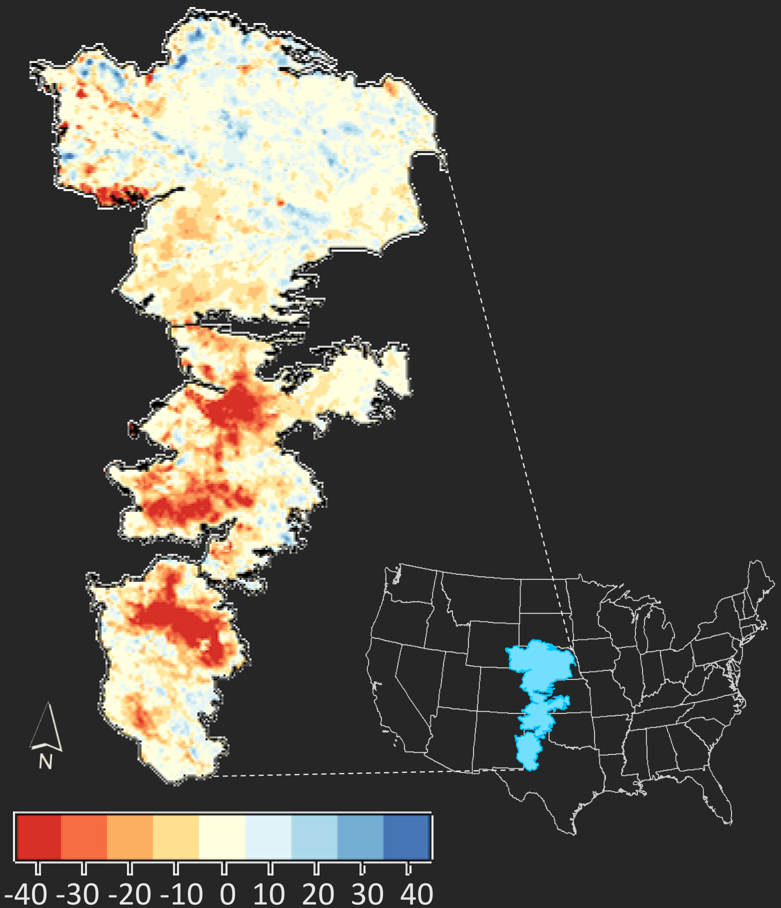
27% of US agricultural land

$7.5 billion agricultural net income (including 40% of US beef)

Irrigation ~doubles yields

Water lost since 1950: ~ 80% Lake Erie

Depletion in the High Plains Aquifer



Δ Water Levels since 1950 (m)
Haacker et al. 2016

How has irrigation changed in space and time?

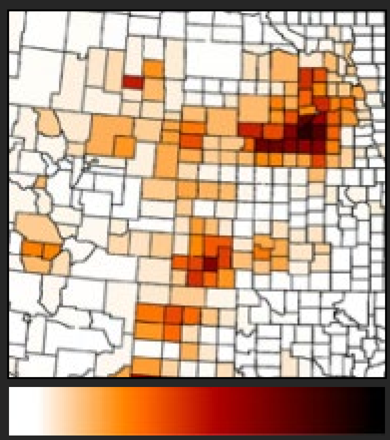
Can we achieve sustainable agricultural water use?
- Where?
- How?

Models Need Better Data

Crop and hydrology models can support management

Existing datasets on irrigation locations inadequate:

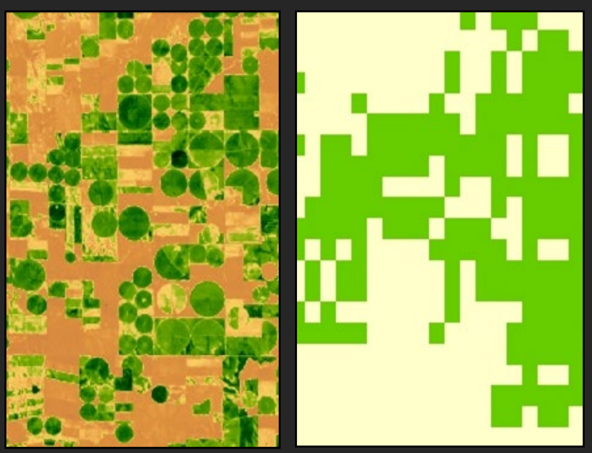
US Ag Census (5 yr)
Lacks Spatial Precision



Modified from Ozdogan & Gutman 2008

0% 100%

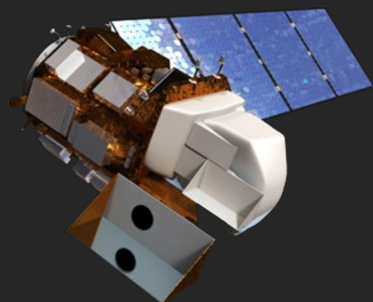
Low Resolution Products
Static Snapshots



Higher-Res Satellite | 1000 m Map

can't manage what you don't know

Annual Irrigation Maps (AIM) from Satellites



Landsat Satellite Series
(30 m)

+

Google Earth Engine

Today:

1) Overview for producing satellite-derived maps 1984-2017

2) Two examples of applications for groundwater management

What Does Irrigation Look Like?

On the Ground

(Visible Wavelengths)


Flood/Furrow


Drip


Center Pivot

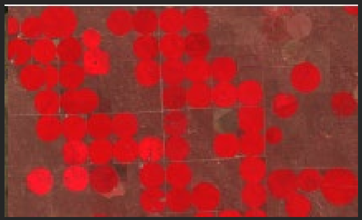

Center Pivot:
Top View

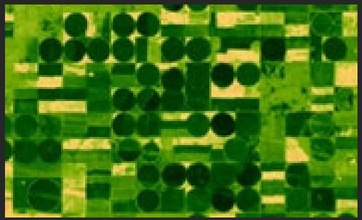
From a Satellite

(Visible + Infrared + Thermal)

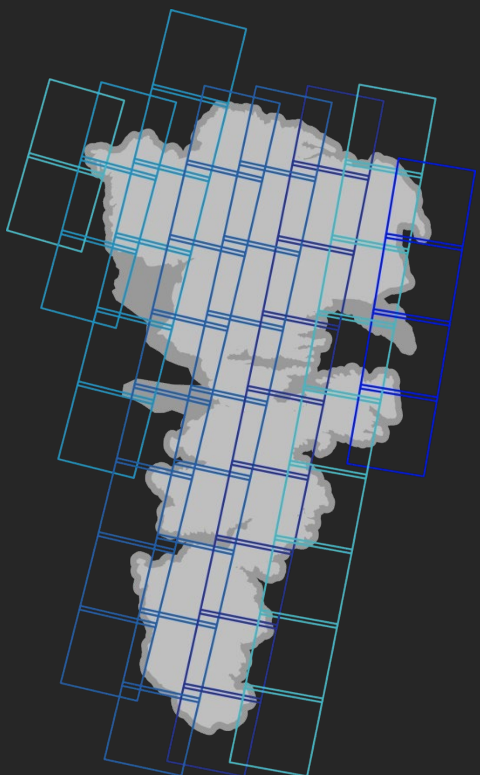

True Color: RGB


False Color: SWIR

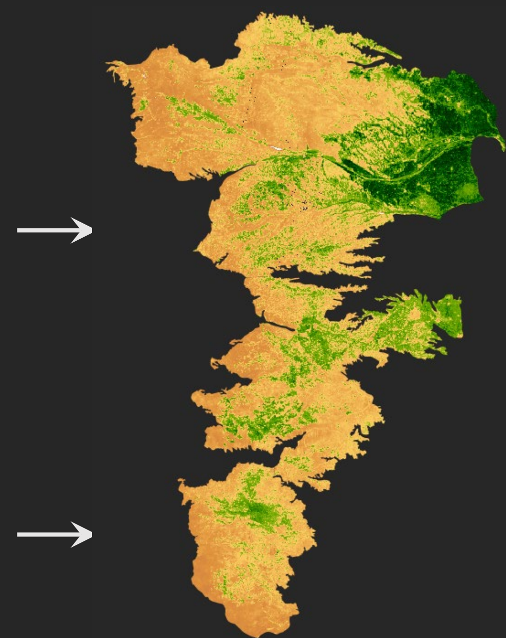

False Color:
Near Infrared


Enhanced
Vegetation Index

Mapping Irrigation in Google Earth Engine

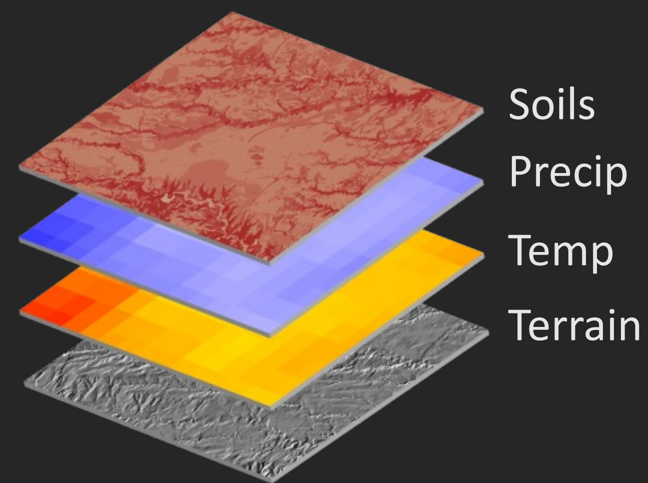


42,635 scenes
1984-2017



18 Annual Landsat Composites

+

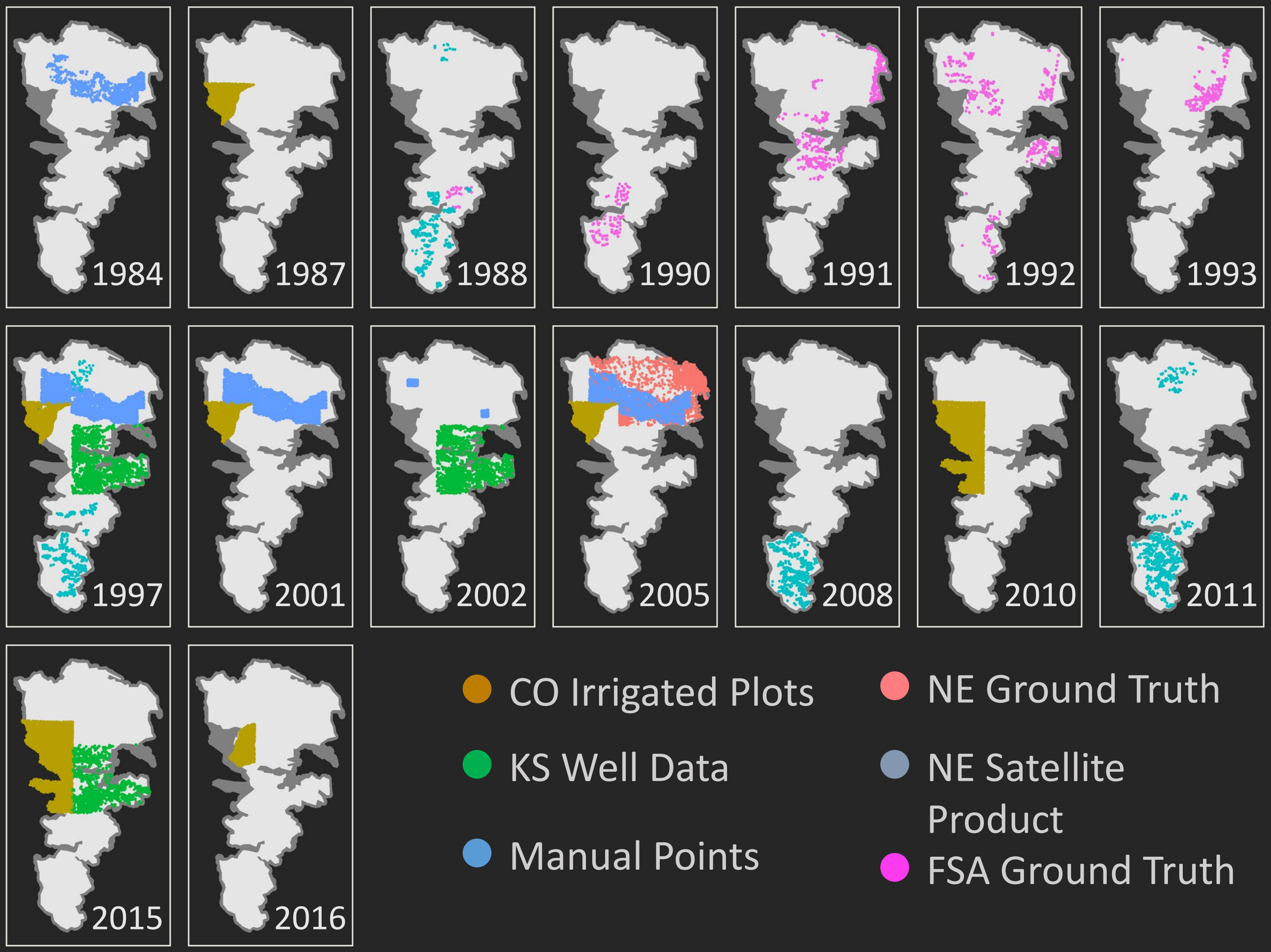


17 Environmental Covariables
(environmental context for crop greenness)

Historical Training Data

Point dataset
14,845 points
16 years

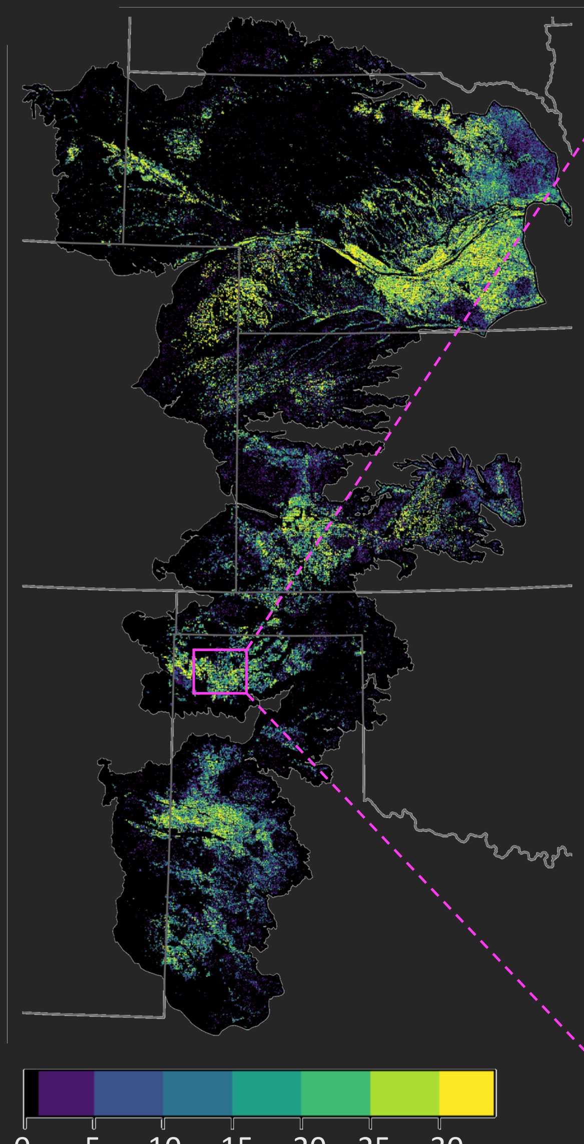
Classifier
Random Forest
91.4% Accuracy

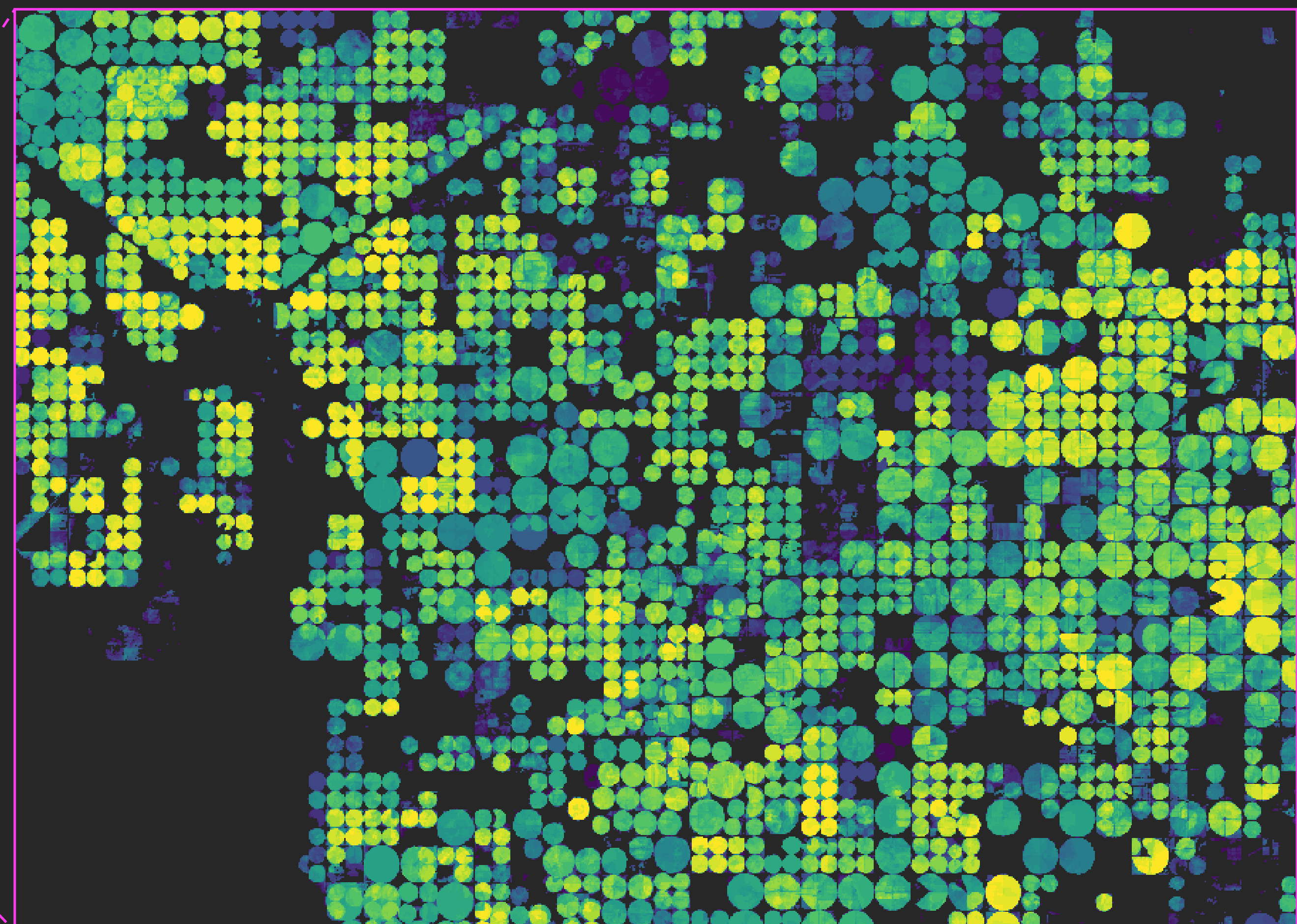


good ground truth (“small” data) is the main limitation in modern remote sensing

Frequency of Irrigation, 1984-2017

Understanding these dynamics helps us understand groundwater use and inform management





Deines et al. 2017, *Geophysical Research Letters*

Deines et al. In Revision, *Remote Sensing and Environment*

Application I: Kansas LEMA Program

2012: Local Enhanced Management Areas

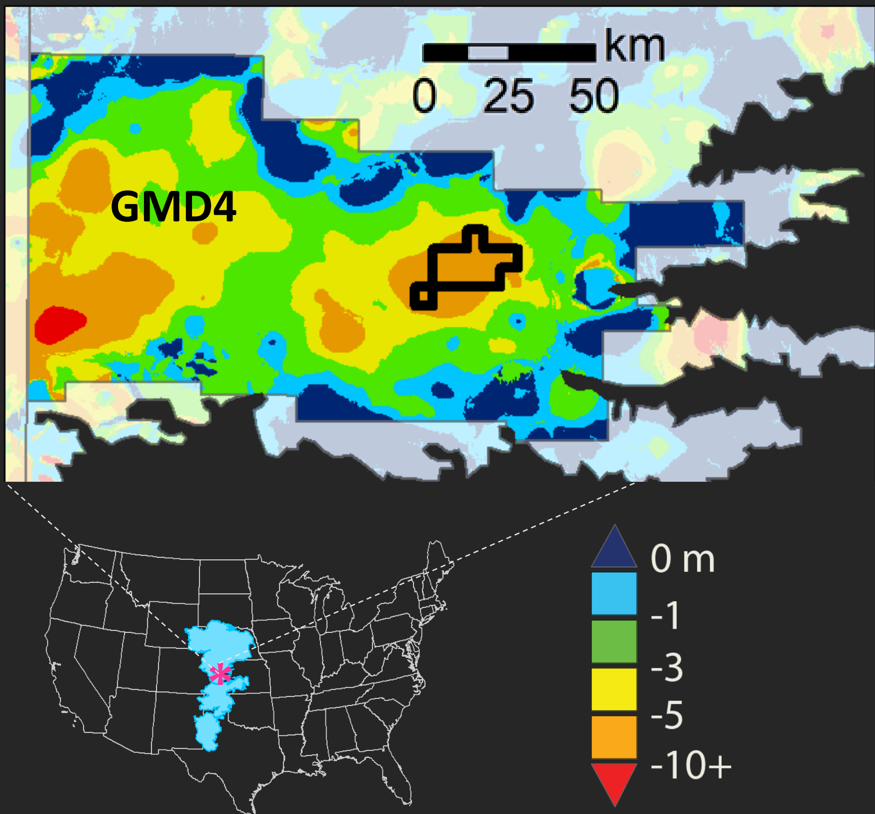
Stakeholder initiated
State monitored and enforced

Sheridan 6 (256 km^2)
2013-2017

Goal: 20% Pumping Reduction from 2002-2012 levels

Renewed 2018-2022
2018: Additional LEMA in GMD4

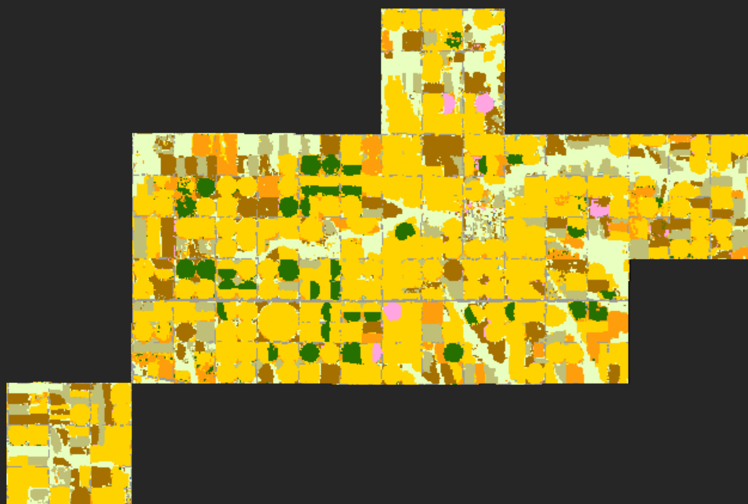
Decline in Water Table Elevation



How did farmers adapt to restrictions?
What were impacts to crop yields and farmer profits?

Combining data + crop models to answer policy-relevant questions

USDA Annual Cropland Data Layers

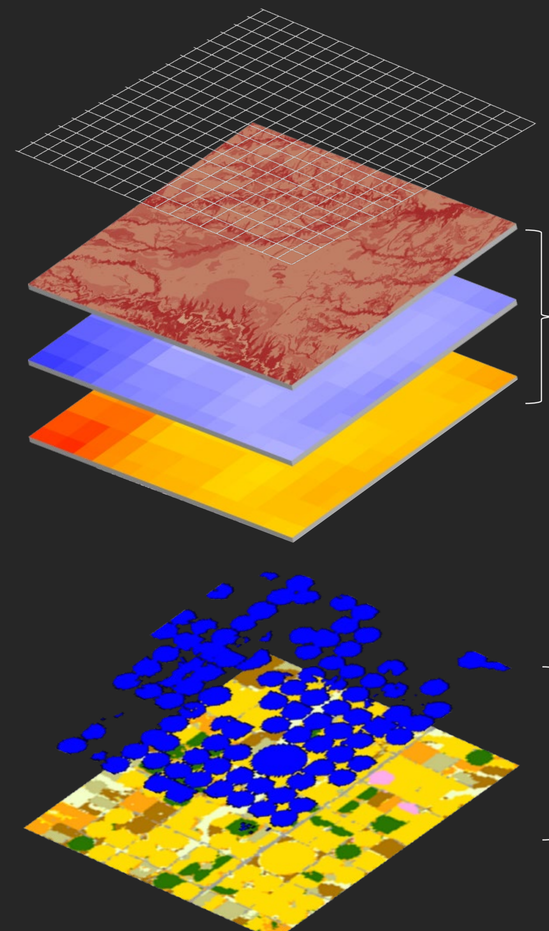


Corn
Sorghum
Wheat
Alfalfa
Soybeans
Grassland

KS Well Data

\+

Grid-based crop model runs



Goal: understand yield changes and water balance impacts

Application I: Is the LEMA Effective?

Farmers exceeded water reduction targets (33% vs 20%)
Farmers were able to maintain irrigated area

Promising for economic sustainability
- Energy savings from reduced pumping were ~3.5x greater than yield penalties
- Shift from maximizing yield to net profits

Hydrologically – an improvement, but…
- 33% reduction in water extracted from the aquifer
- 11% effective reduction in aquifer use

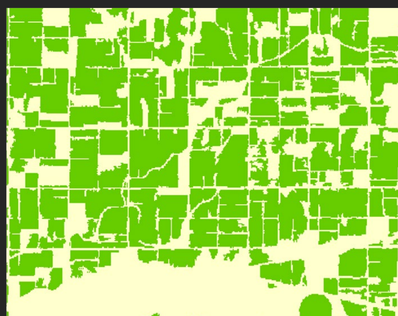
Deines et al. 2019, Environmental Research Letters
Deines et al. In Prep

Application II: Irrigation Technology Change

Haoyang Li, Anthony Kendall, Michigan State

AIM-HPA

1984



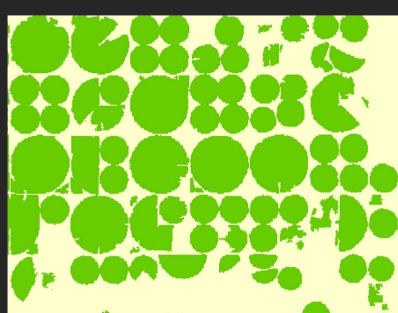
Furrow

2002

High Pressure
Center Pivot

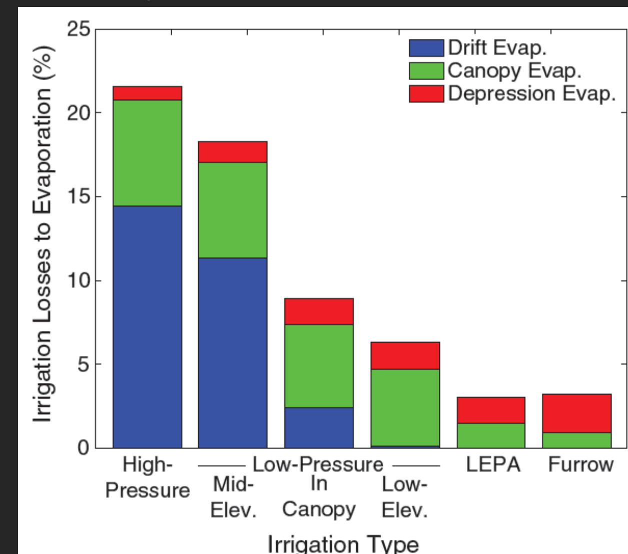
Low Pressure
Center Pivot

2011



LEPA

Shift towards decreased losses to evaporation



Anthony Kendall, MSU

1. How does adoption spread?
2. How does change affect water resources?

Acknowledgements

David Hyndman
Anthony Kendall
Jim Butler, KGS

Erin Haacker
Morgan Crawley
Jeremy Rapp

Bruno Basso
Brian Baer
Lydia Rill

jillian.deines@gmail.com
@JillDeines

Question and Answer Session

We will draw initial questions and comments from those submitted via the chat box during the presentations.

Today's Speakers

Natalie Nelson – nnelson4@ncsu.edu
Reid Christianson – reiddc@illinois.edu
Jillian Deines – jillian.deines@gmail.com

Thank you for participating in today's *The Current*!

Visit our website, northcentralwater.org, to access our webinar archive!

Upcoming Webinar

North Central Climate Collaborative Webinar:
Why Climate Matters to the Health of People in the Northern Great Plains
Monday June 24, 2019 at 1PM CT
Register at https://northcentralclimate.org/webinars/

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