IOWA STATE UNIVERSITY
Department of Agricultural and Biosystems Engineering

Analysis of BMP Trends and Nutrient Loads in Black Hawk Lake Using SWAT+

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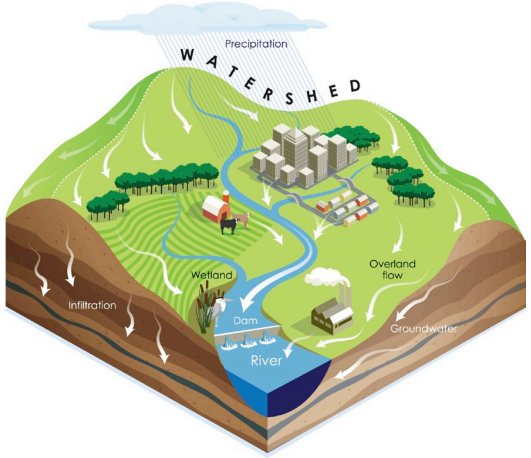
Water Quality Research Lab (https://www.abe.iastate.edu/soupir/)



Hydrological Modeling - A Watershed Inside Your Computer

- **Turns rainfall into runoff, ET, groundwater recharge**
- **Helps us predict floods, droughts, and water quality changes**
- **Essential tool for water management**

Soil & Water Assessment Tool

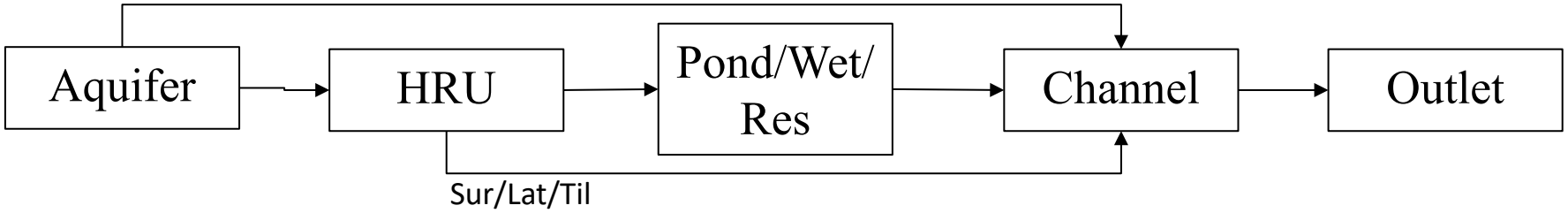
SWAT+

- **History of SWAT model**
- Developed in early 1990s by USDA-ARS (Arnold et al., 1998)
- Successor to EPIC and CREAMS models
- Widely applied in >100 countries

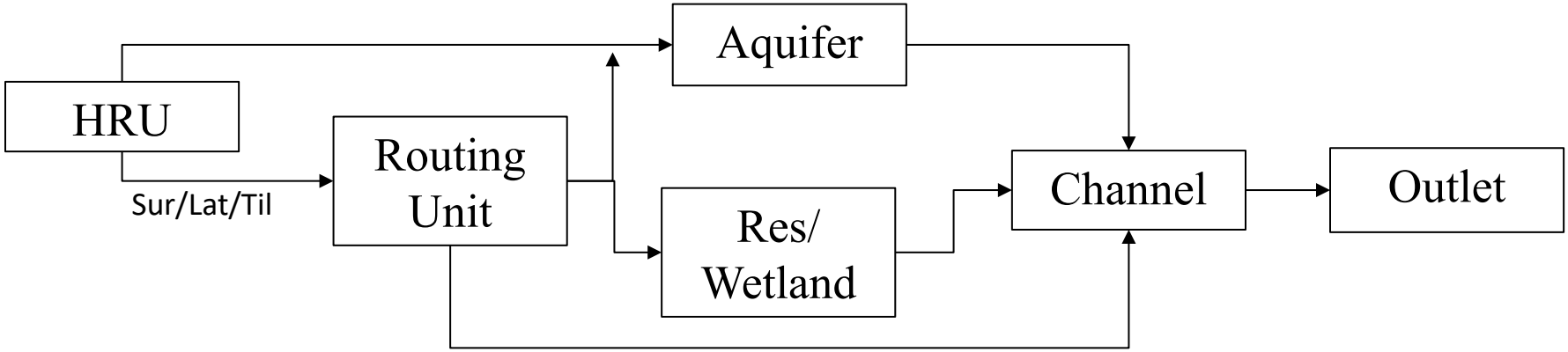
- **SWAT+** (Arnold et al., 2018)
- Released in 2018
- Modular & object-oriented design (Bieger et al., 2017)
- Greater flexibility for management & processes

New Pathway in SWAT+ ?

SWAT



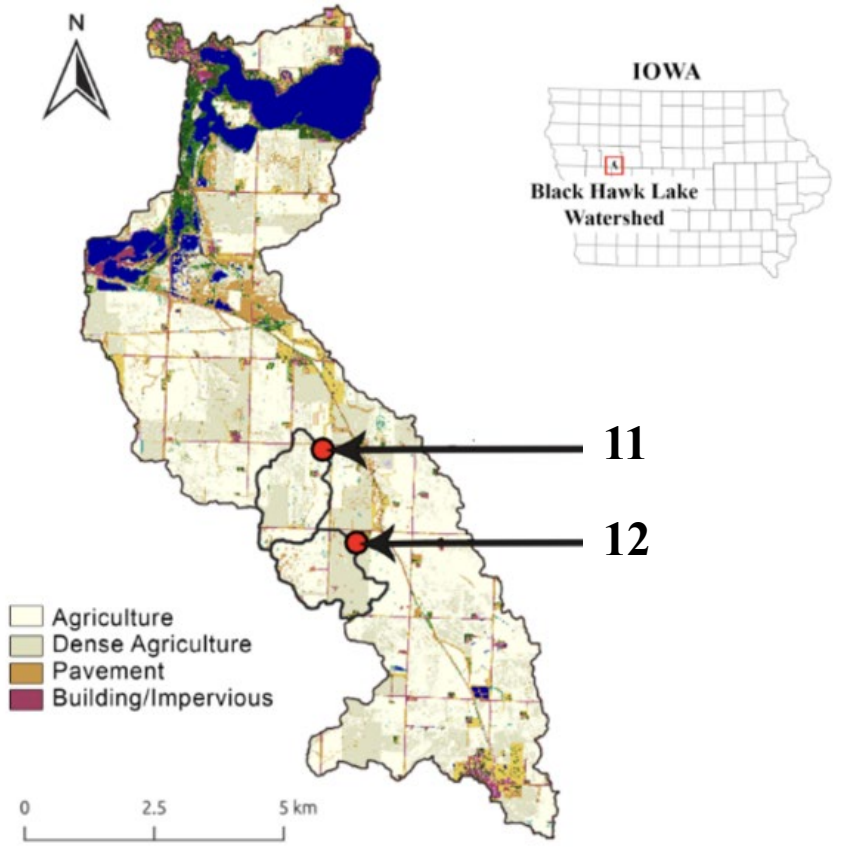
SWAT+



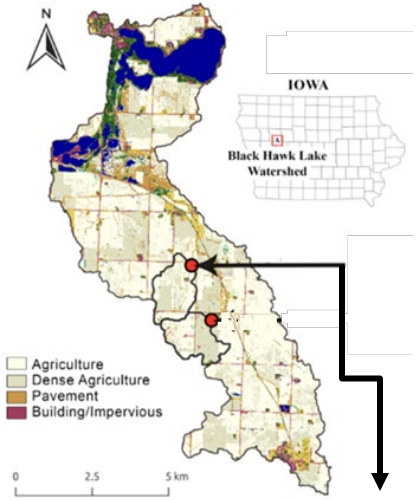
Study Area

- Sub watershed 11 &12 of The Black Hawk Lake (BHL) watershed
  (HUC12, 5342 ha or 53.42 km^2)
  94% of the land area is agricultural

- Drainage area:
  - S11 - 229.4 ha (2.29 km^2)
  - W12 – 221.2ha (2.21 km^2)

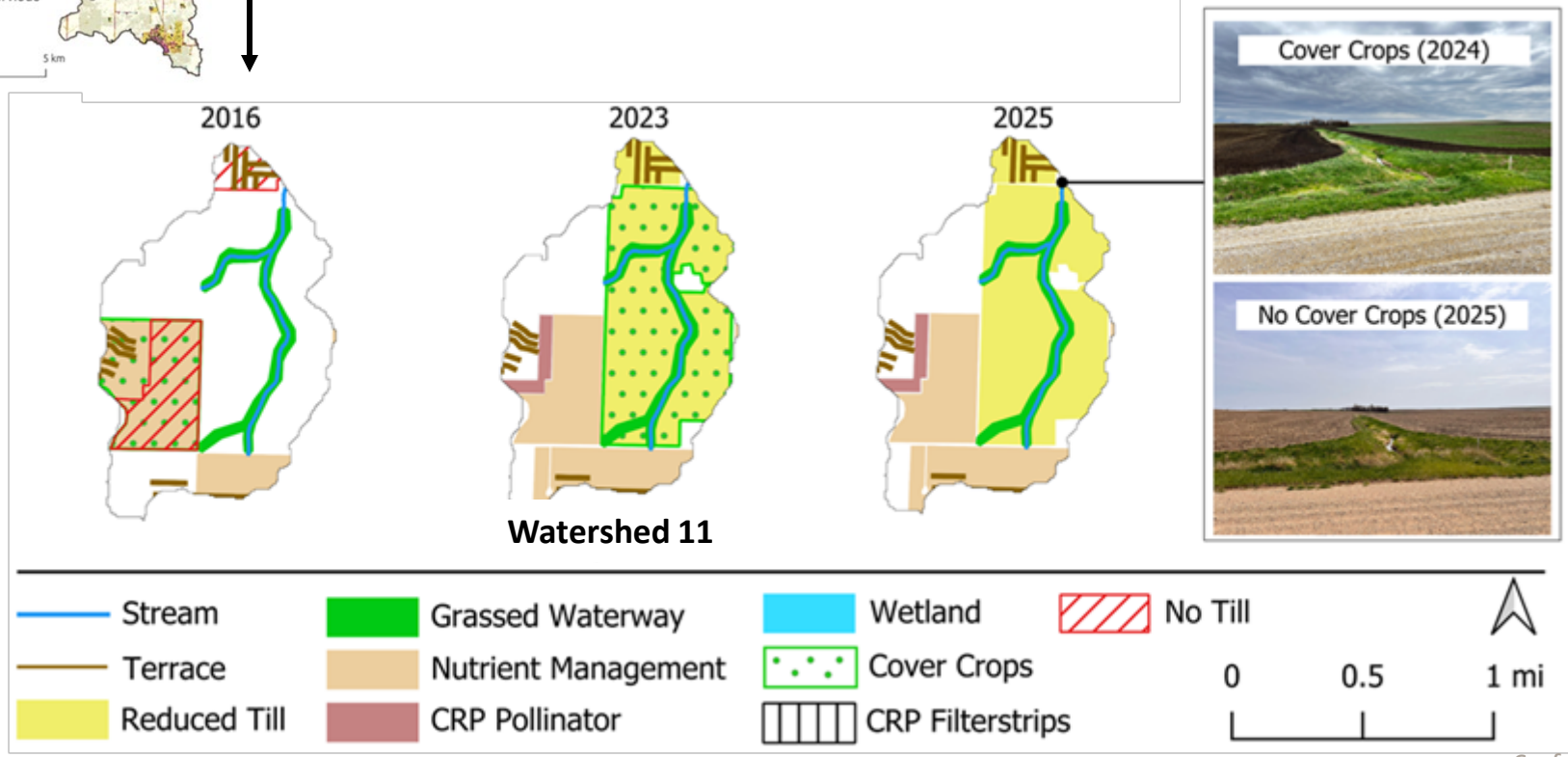


Management Practices' Trends



Many Iowa Farmers Stop Using No-Till, Cover Crops, Study Finds

October 20, 2025 | Posted in Economics, Soil Health



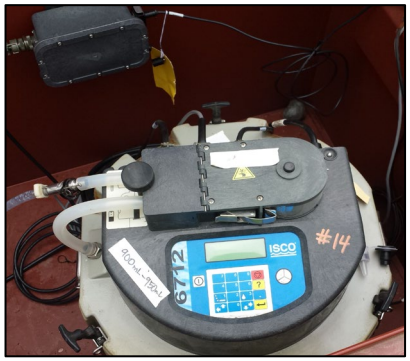
Objective

To calibrate Black Hawk Lake Watershed on SWAT+ for Streamflow and Nitrate.

Simulate BMP Adoption and then Disadoption using **Decision Tables in SWAT+.**

Datasets

Data type	Source
Elevation (DEM)	https://www.gis.iastate.edu/gisf/projects/acpf (Iowa HUC12 2m DEM database)
Land use	USDA, National Agricultural Statistics Service, 2020 Iowa Cropland Data Layer
Soils	USDA NRCS WSS (https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm)
Meteorological Data	PRISM 2
Stream Flow	IDNR, ISU (2015-25)
In-Stream Nutrient	IDNR, ISU (2015-25)



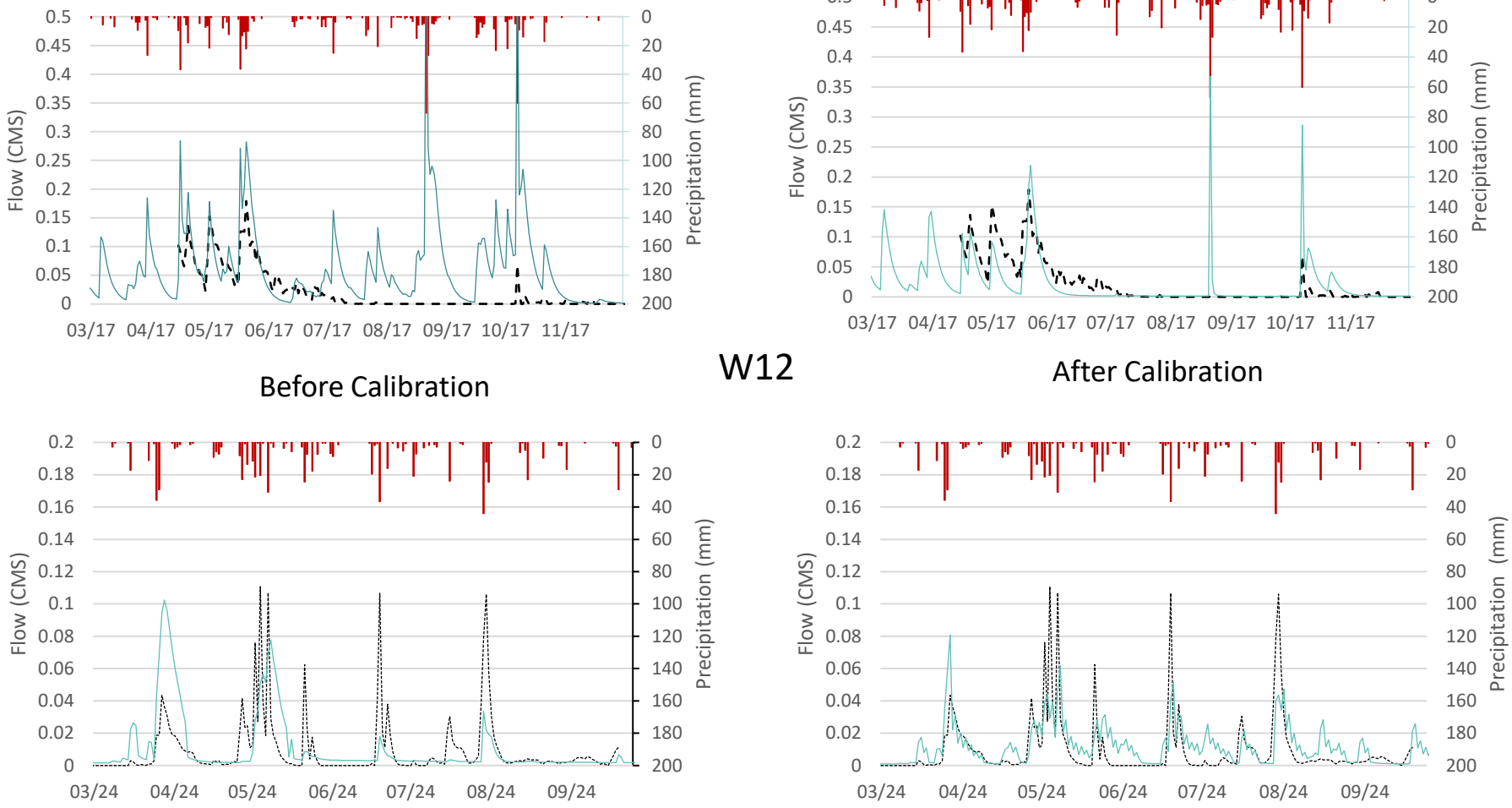


SWAT+ Calibration Parameters

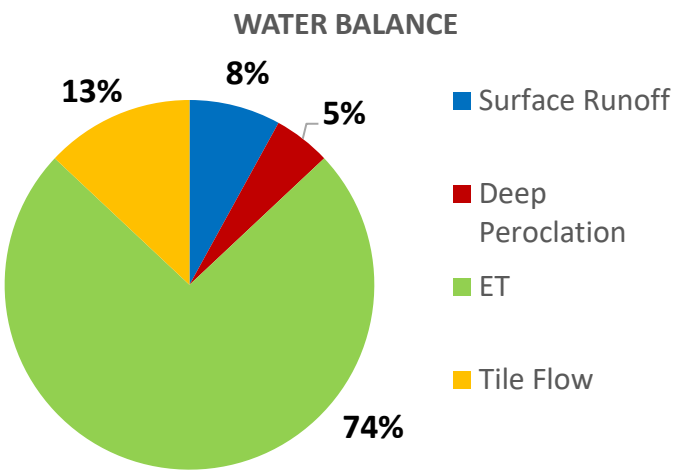
Parameter	Process	Range	Best Value Relative to Default
cn2	SCS Curve No	35-95	10-20%
esco	Soil Evap. Factor	0-1	-10%
Epco	Plant Uptake	0-1	23%
Canmx	Max. Canopy Storage	0-1	0.4
Perco	Percolation Coefficient	0-1	15-23%
Lat_ttime	Lateral Flow Travel Time	0.5-180	4
Cm3_swf	Pothole Evap Coeff.	0-1	20%
Alpha	Baseflow Aplha Fact.	0-1	5-10%
Flo_min	Aquifer Storage until return flow	0-50	-10-5%

Parameter	Process	Range	Best Value Relative to Default
Revap_co	Groundwater revap	0.02-0.2	0.02
Revap_min	Threshold for revap for percolation	0-50	2
Bf_max	Max Baselfow	0.2-1	10%
awc	Available Water Capacity	0.01-1	3%
Surlag	Runoff Lag Coeff.	0-1	0.2
Evlai	LAI for no Evap	0-1	-15%
Nperco	Nitrate Percolation	0-1	24%
Nperco_lchtile	Nperco fraction for tile	0-1	20%

Improved Flow Simulation After Calibration

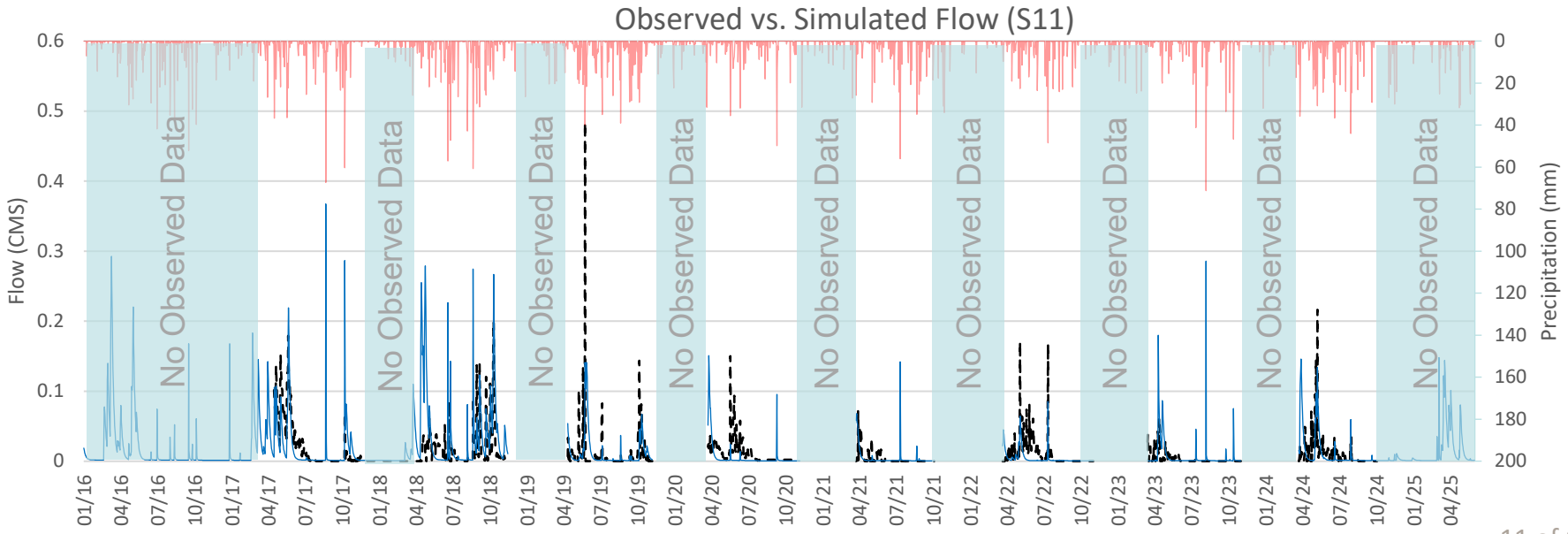


Post-Calibration Water Balance

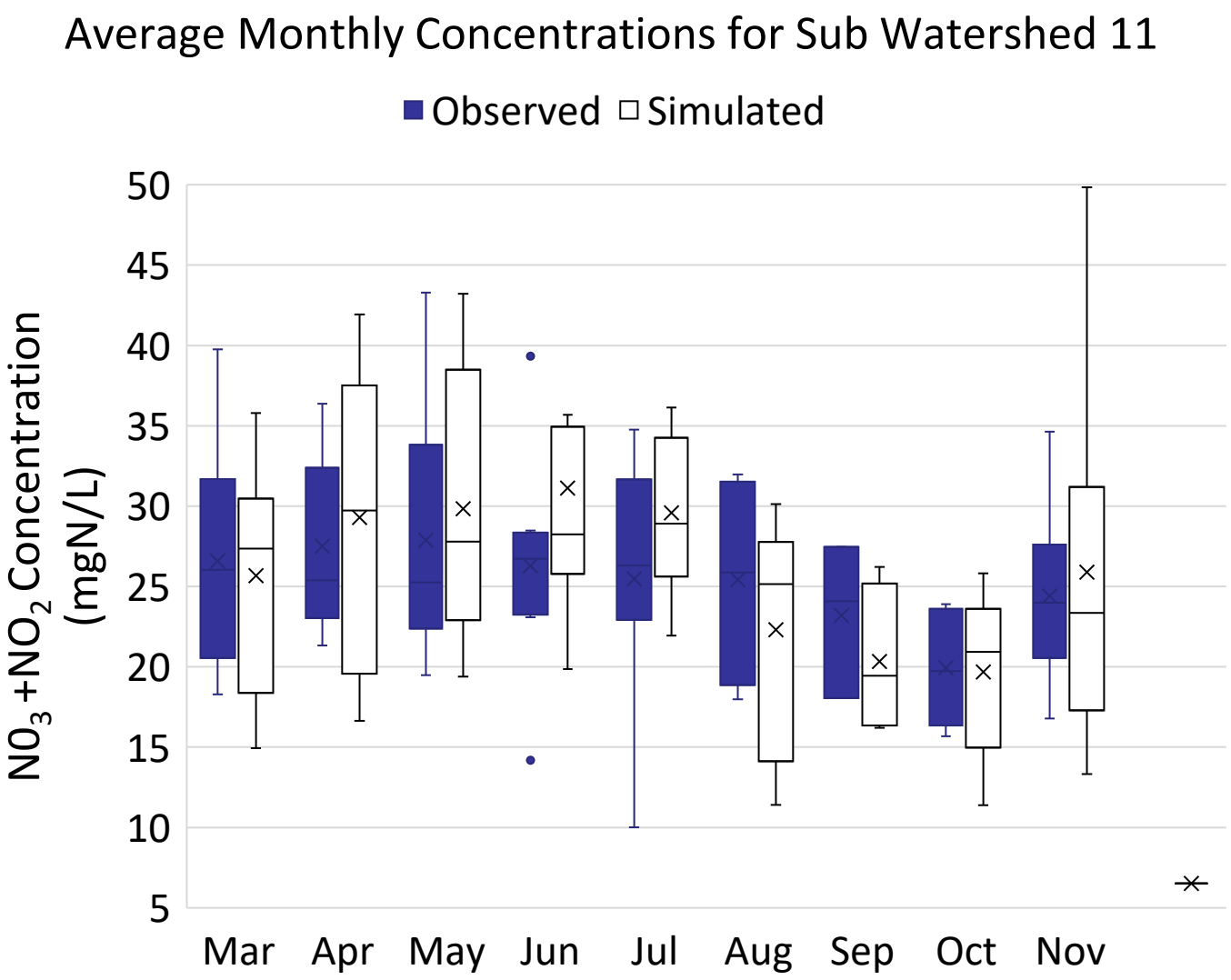


	S11		W12	
	Daily	Monthly	Daily	Monthly
R^2	0.45	0.81	0.13	0.59
NSE	0.31	0.78	0.27	0.67
PBIAS	14	7	27	21

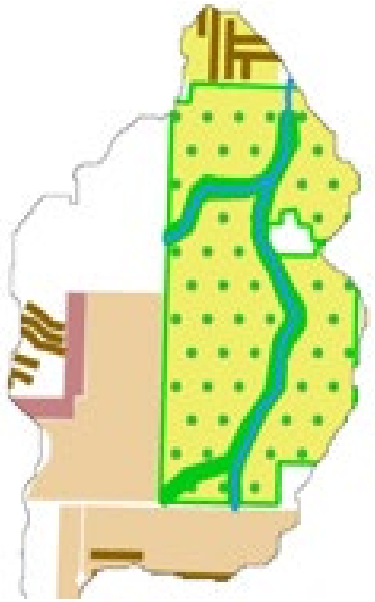
*(Moriasi et al., 2007)



Monthly Nitrate Concentration



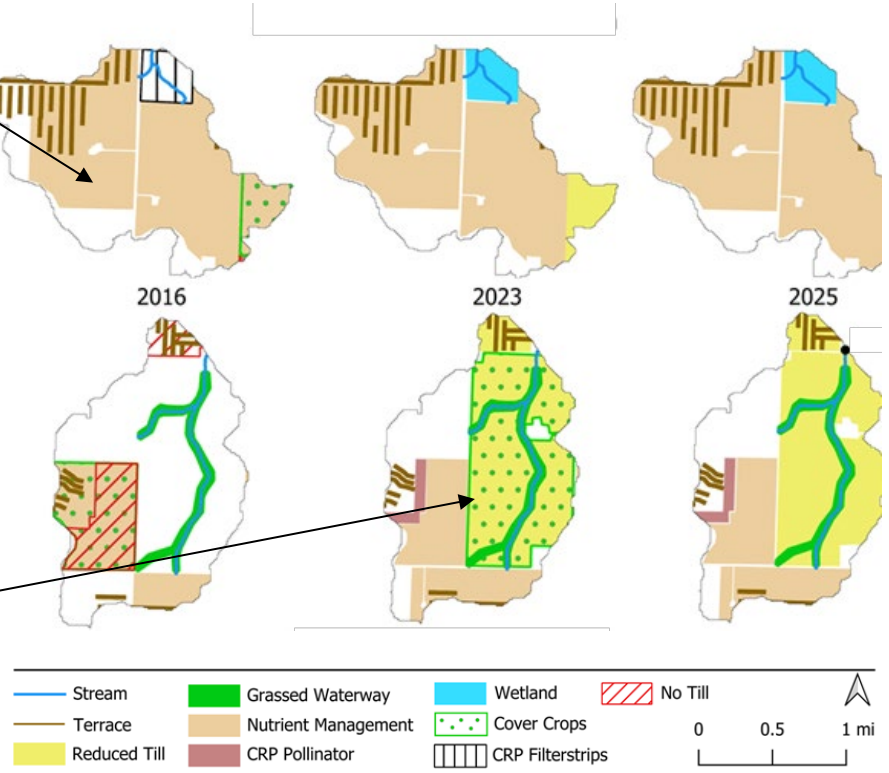
R^2	**0.51**
NSE	0.43
PBIAS	102



Simulating Management Change Scenarios

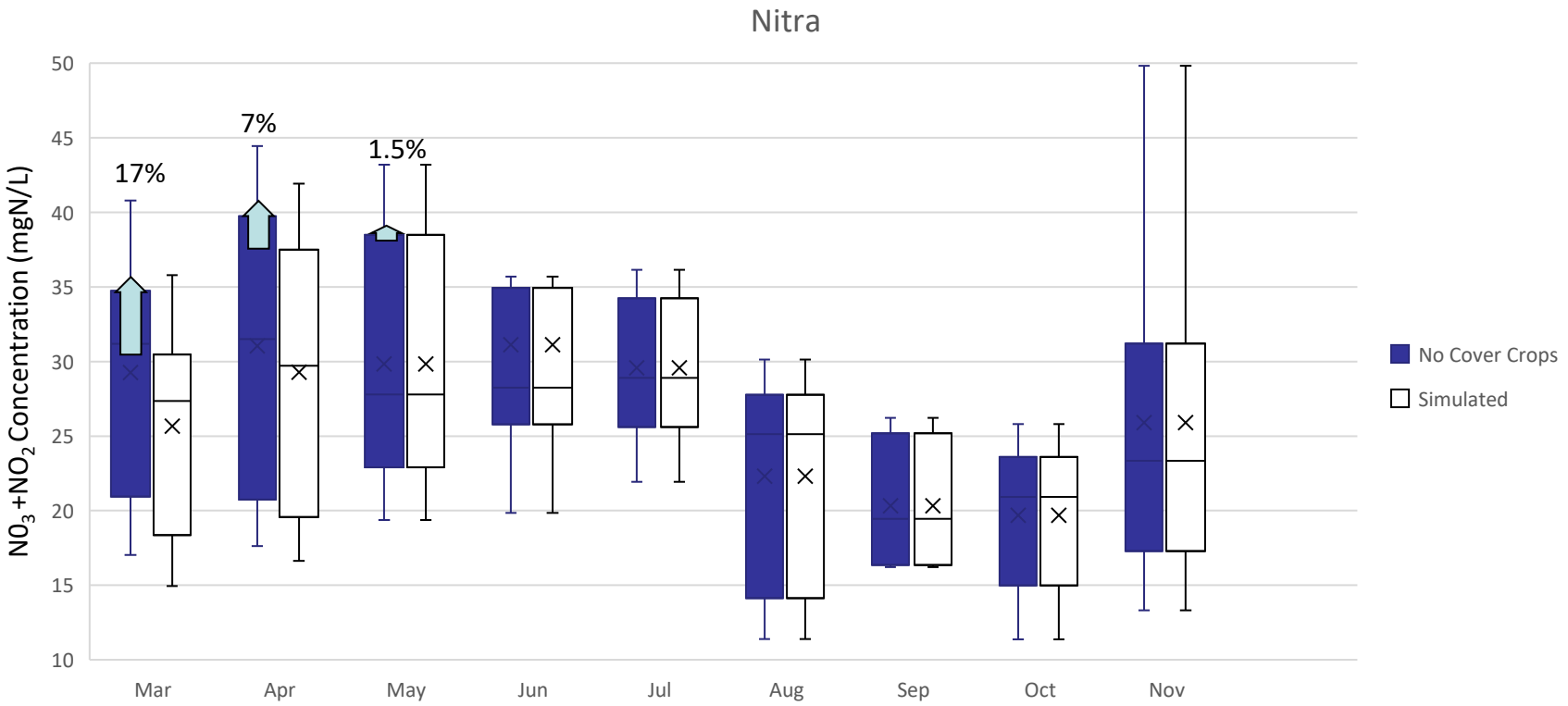
- **Disadoption of Nutrient management** (fertilizer application rate) was simulated with a **25% addition** of the default model fertilizer application rate in sub watershed 12 from **2019-2024.**

- **Cover crop** simulated by **planting a rye winter crop** following corn harvest and kill operation in sub watershed 11 from **2019-2024 – Removed!**



When Management Practices Change!

ID	Practice	Existing Coverage	Percentage Change	Change in Annual Nitrate Export
11	Cover Crops	44%	-44%	+8% (2019-24)



Conclusion & Way Forward

- SWAT+, relatively intuitive than SWAT, successfully simulated BHL.
- **Decision Table** successfully simulated **temporal changes** in management practices and which revealed shows **increased nitrate export.**

- Modeling approaches can help advocate and optimize BMP implementation.
- Integrate long term adoption and disadoption scenarios using DTLs with changing weather patterns

Acknowledgement:

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Thank you!