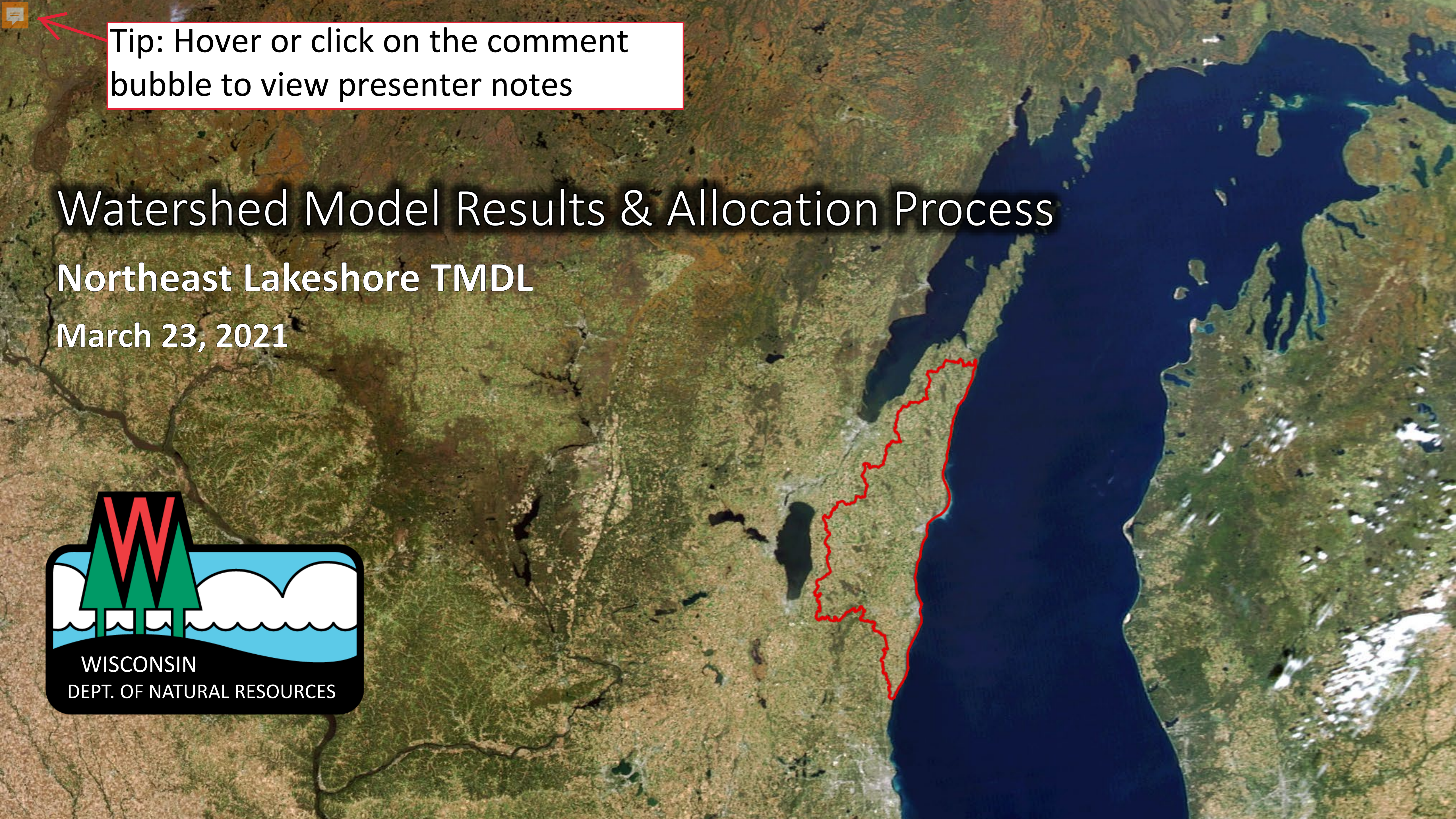
Tip: Hover or click on the comment bubble to view presenter notes

Watershed Model Results & Allocation Process

Northeast Lakeshore TMDL

March 23, 2021



WISCONSIN
DEPT. OF NATURAL RESOURCES

Comment Period

Watershed Model Report

Prepared by The Cadmus Group through an EPA contract

Find report on the NE Lakeshore TMDL webpage

Send Comments to Kim Oldenborg
kimberly.oldenborg@wisconsin.gov

Comment Period	Topic
October 2020 (past)	Watershed Model Report 1. Overview 2. Model Setup
March 24 – April 16	Watershed Model Report 3. Calibration and Validation **Approach** 4. Calibration and Validation **Data** 5. Calibration and Validation **Results** 6. **Discussion** of Calibration and Validation 7. Summary of Model Results 8. References
Anticipated Summer 2021	Draft Allocations

Project Background

Background

Study area

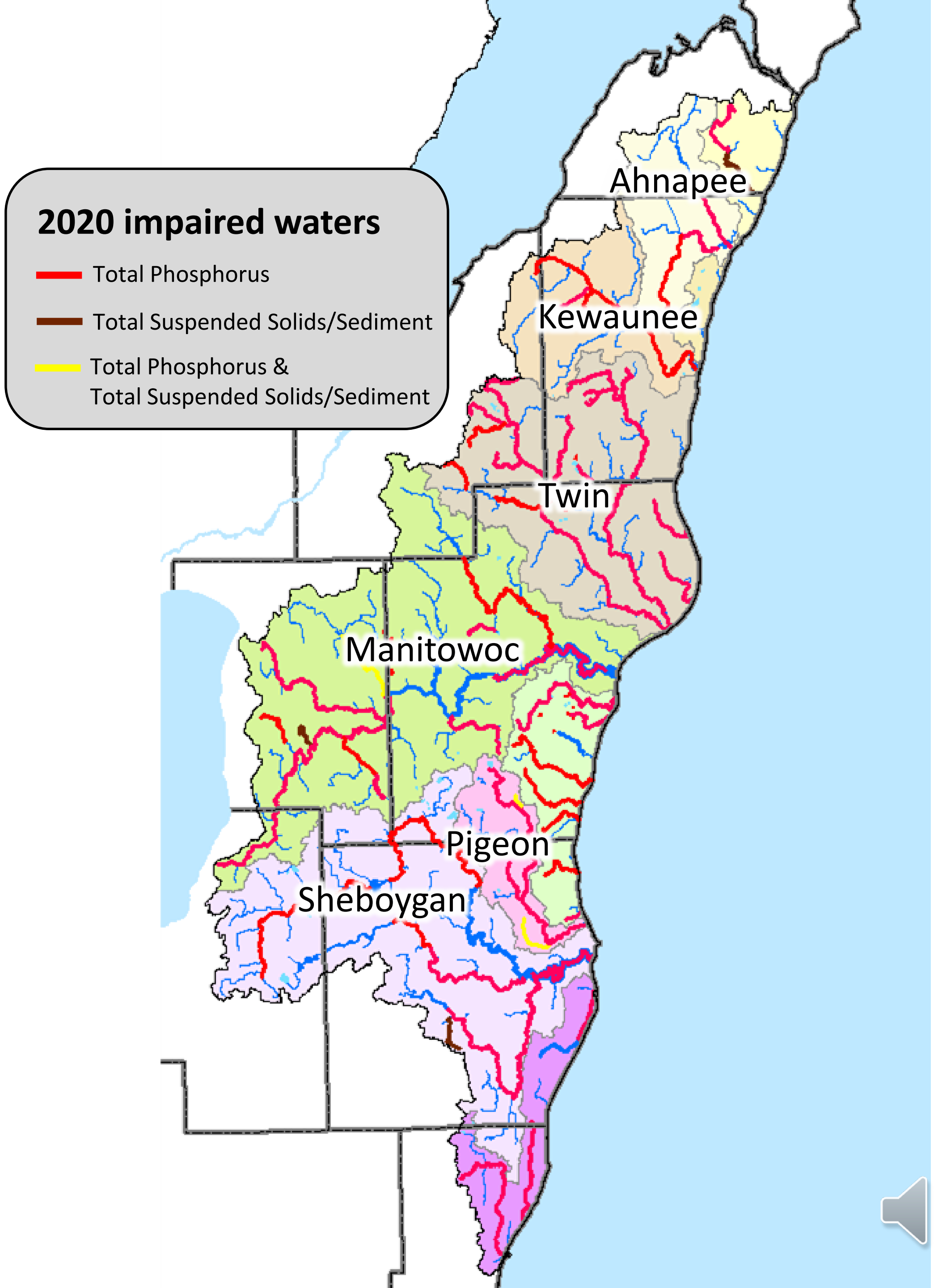
Covers nearly 2,000 square miles
Includes many major river basins

2020 Impaired Stream Segments
TP: 73
TSS: 3
TP & TSS: 3
Impaired Lakes
TP: 13

Addresses phosphorus and sediment impaired waters

Focused on waters draining to Lake Michigan, but not Lake Michigan

Funding from WI legislature in 2017



Watershed Complexity

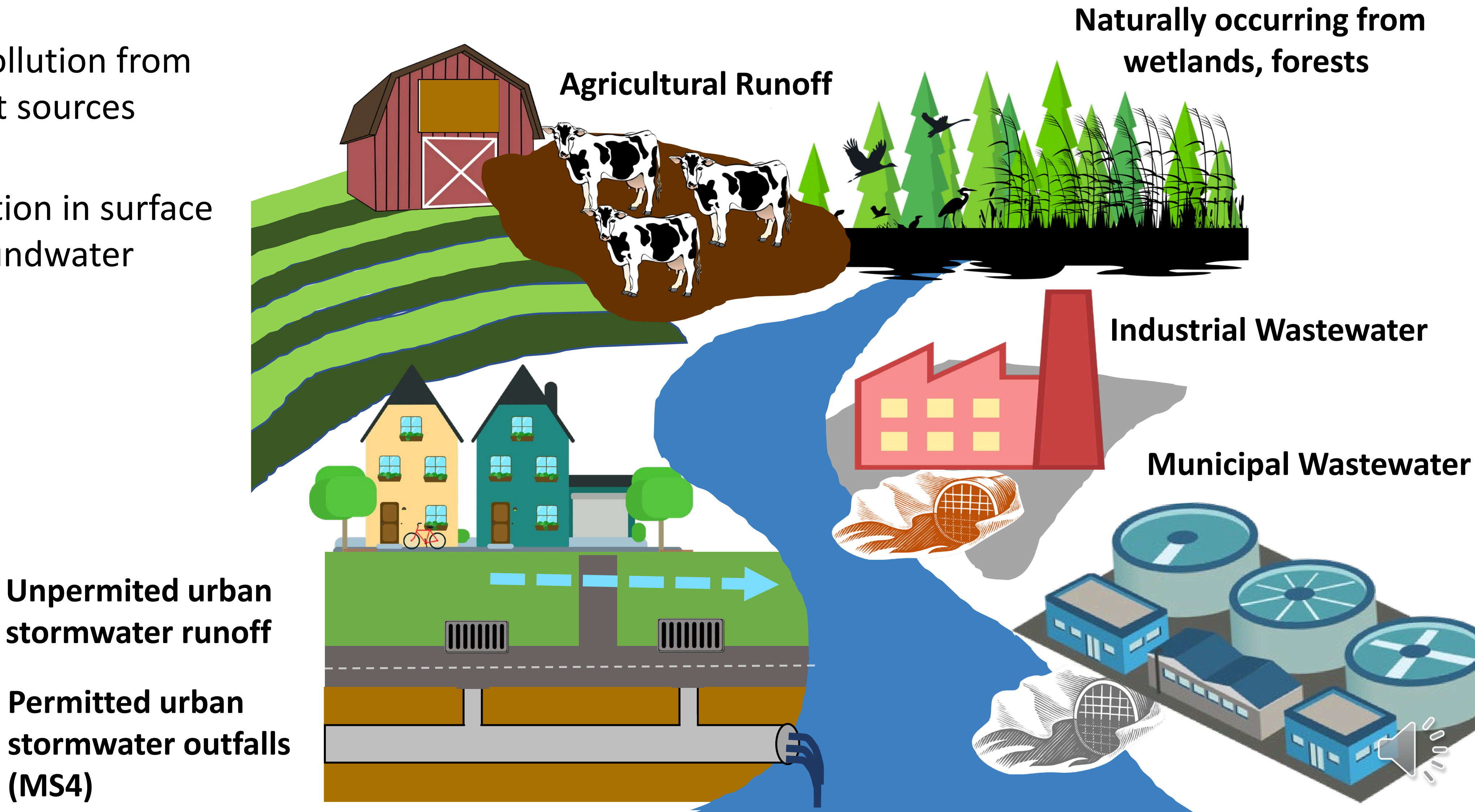
Pollutants come from many sources

University of Wisconsin-Extension and the Wisconsin Department of Natural Resources

Total Maximum Daily Load (TMDL)
A framework for watershed restoration

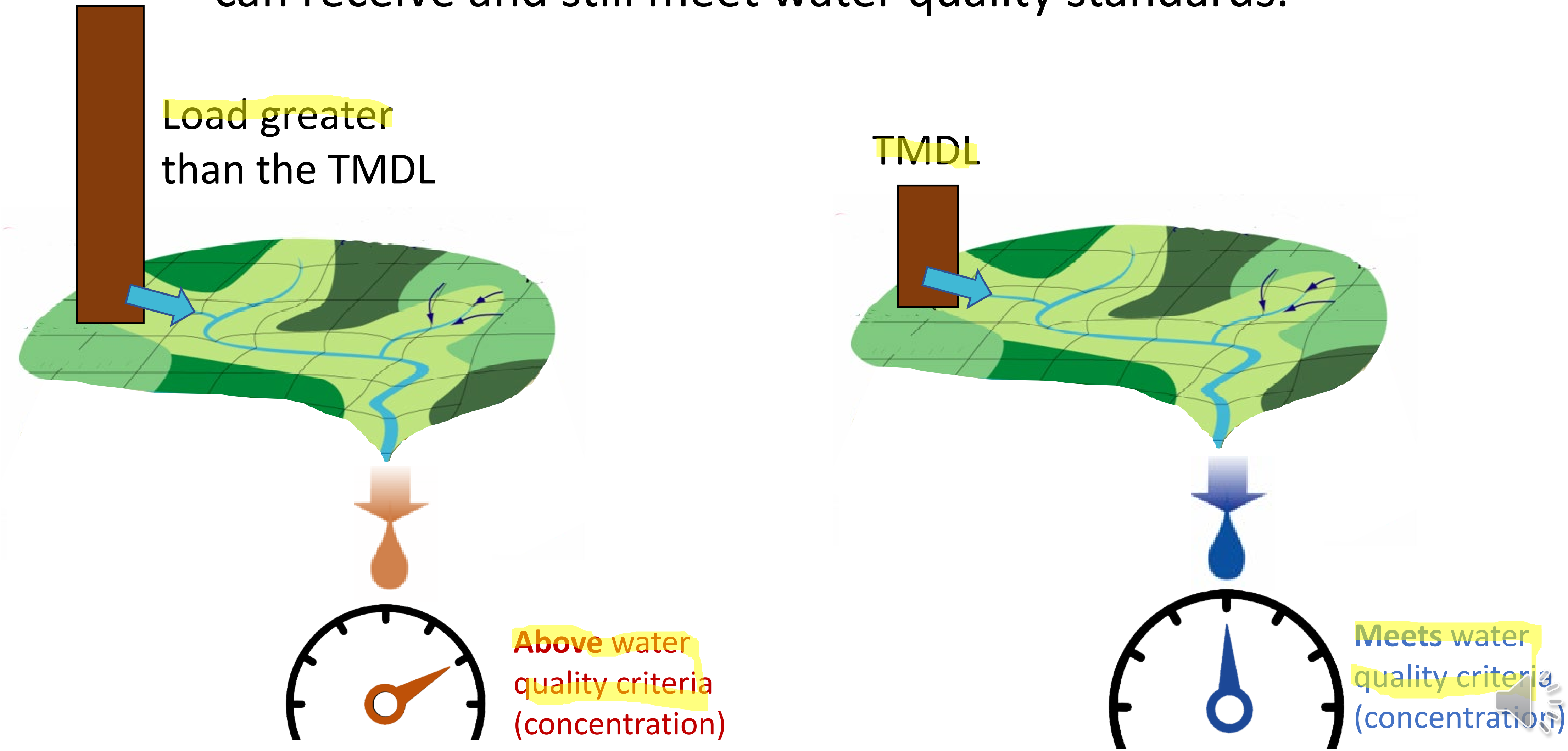
TMDLs address pollution from many different sources

TMDLs address pollution in surface waters, not groundwater

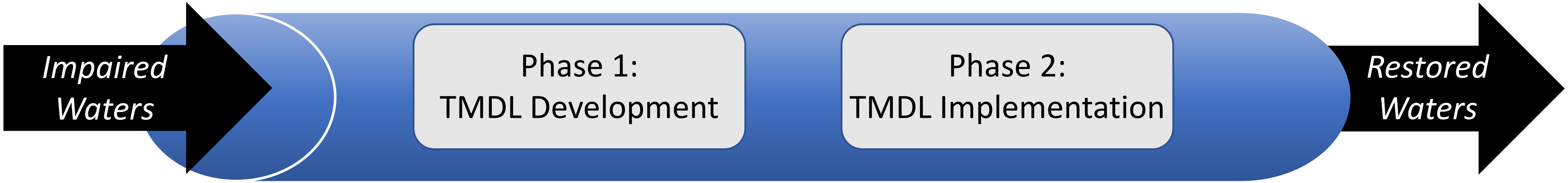


Total Maximum Daily Load (TMDL):

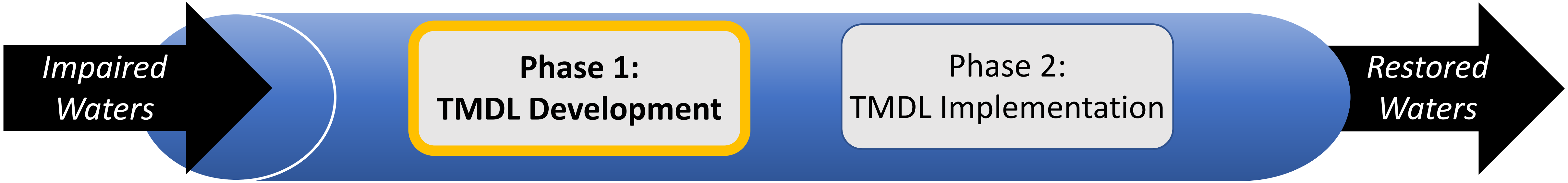
Estimates the ***amount*** of pollutant a waterbody can receive and still meet water quality standards.



Total Maximum Daily Load Process



Total Maximum Daily Load Process



TMDL Development Steps

Public outreach/communication

1. Calculate Baseline Loads

What are the current pollutant loads and how much is coming from each source?

2. Determine Loading Capacity (TMDL)

What amount of pollutant can a waterbody receive?

3. Allocate load among sources

What amount of pollutant reduction is needed from each source?

TMDL Development Steps

Public outreach/communication

1 Calculate Baseline Loads

What are the current pollutant loads and how much is coming from each source?

Watershed model needed for nonpoint sources
(ag, urban, natural)

2 Determine Loading Capacity (TMDL)

What amount of pollutant can a waterbody receive?

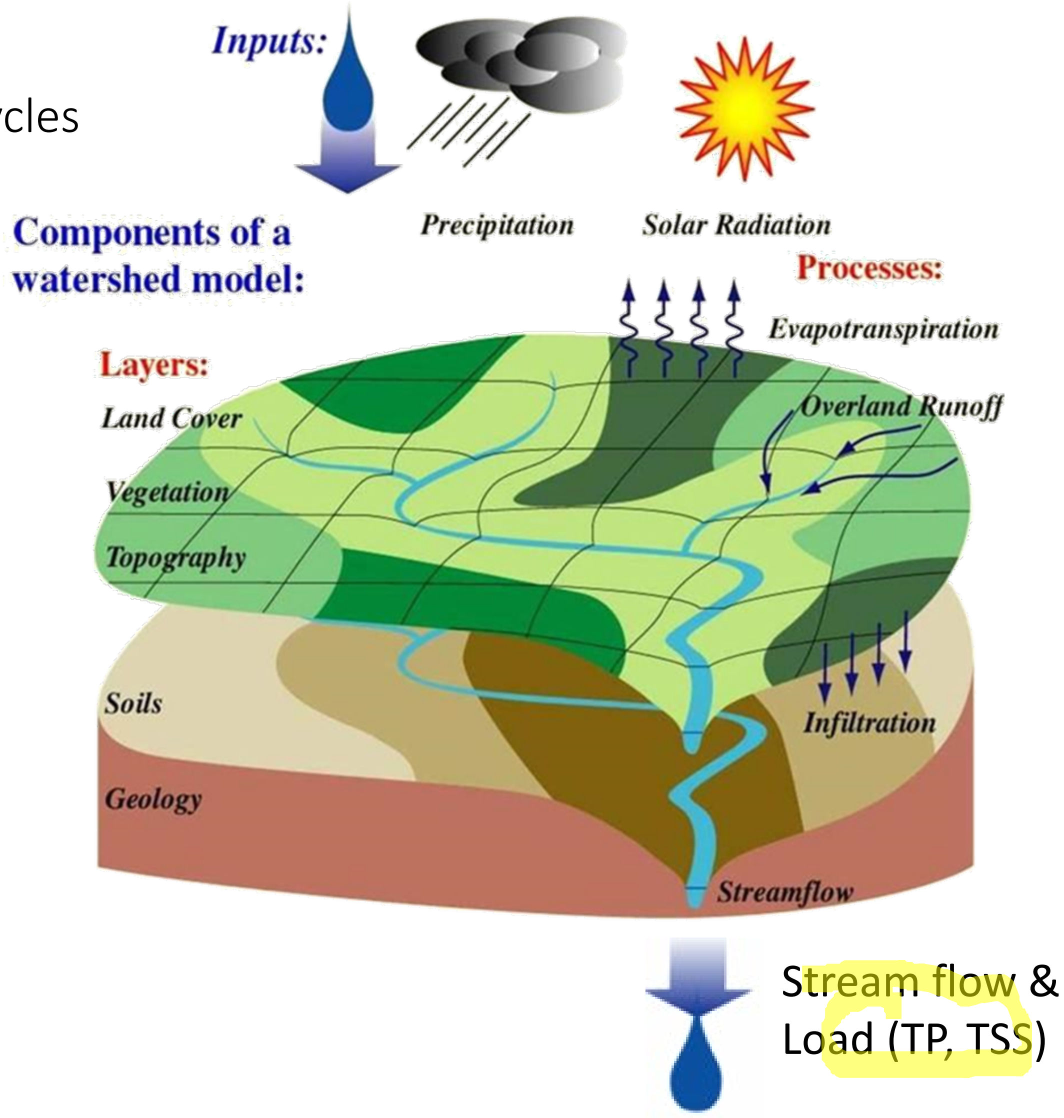
3 Allocate load among sources

What amount of pollutant reduction is needed from each source?

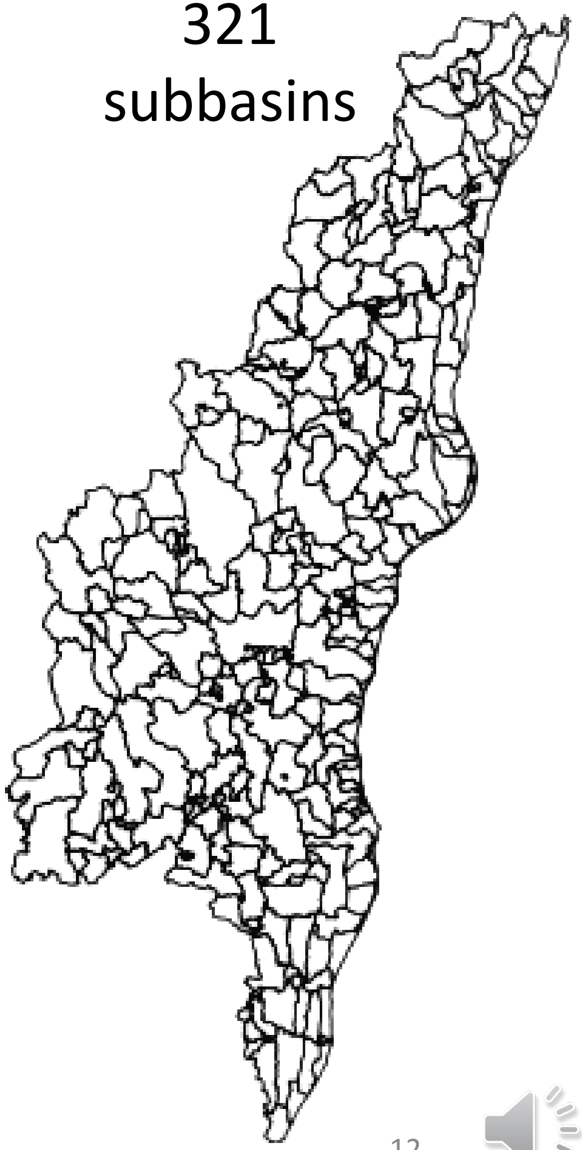
SWAT Watershed Model

Soil and **W**ater **A**ssessment **T**ool

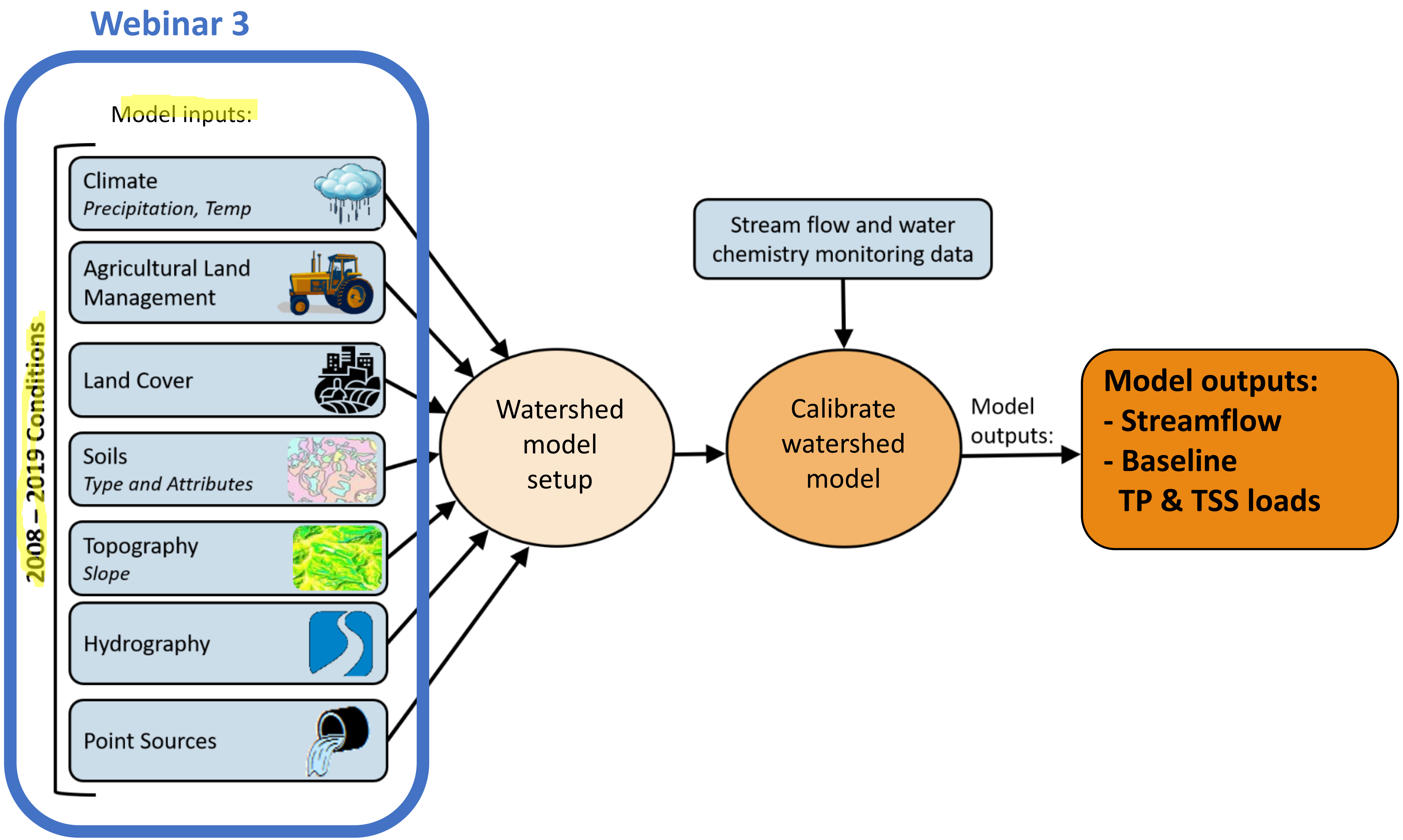
Simulates hydrologic and nutrient cycles each day, in each subbasin, based on the data inputs

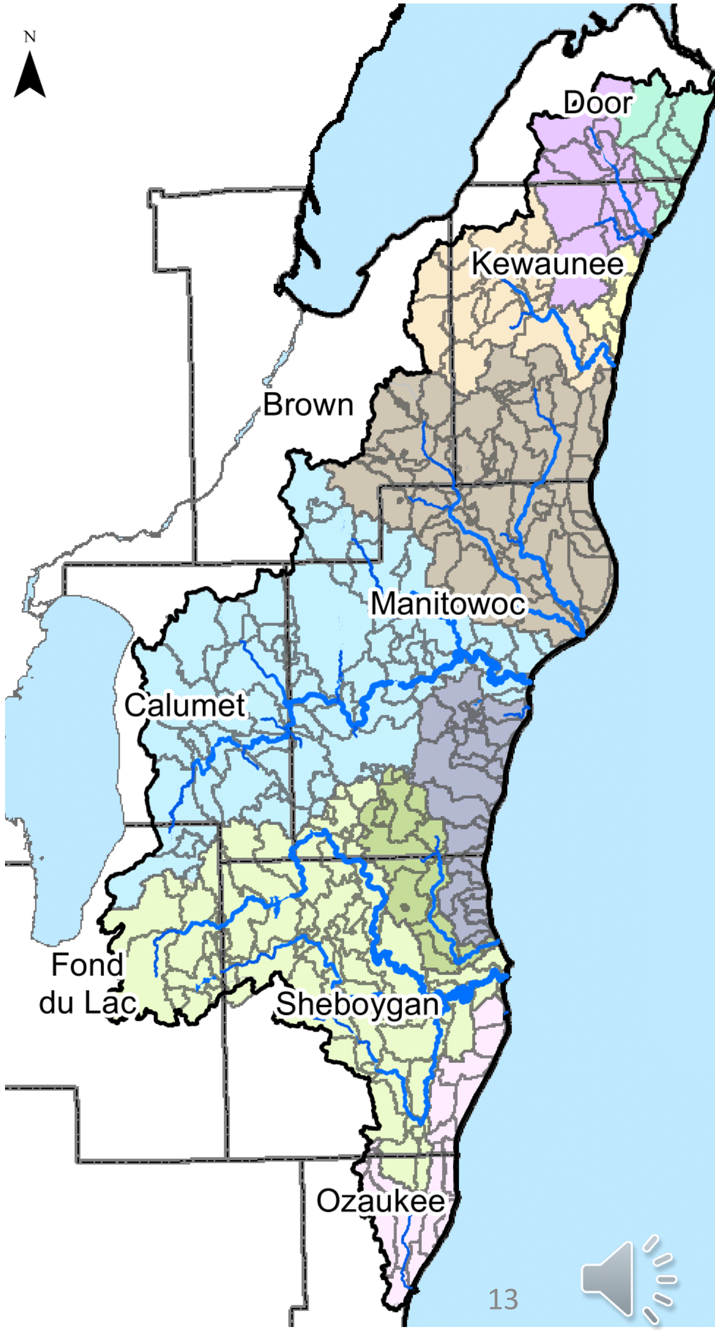


321 subbasins

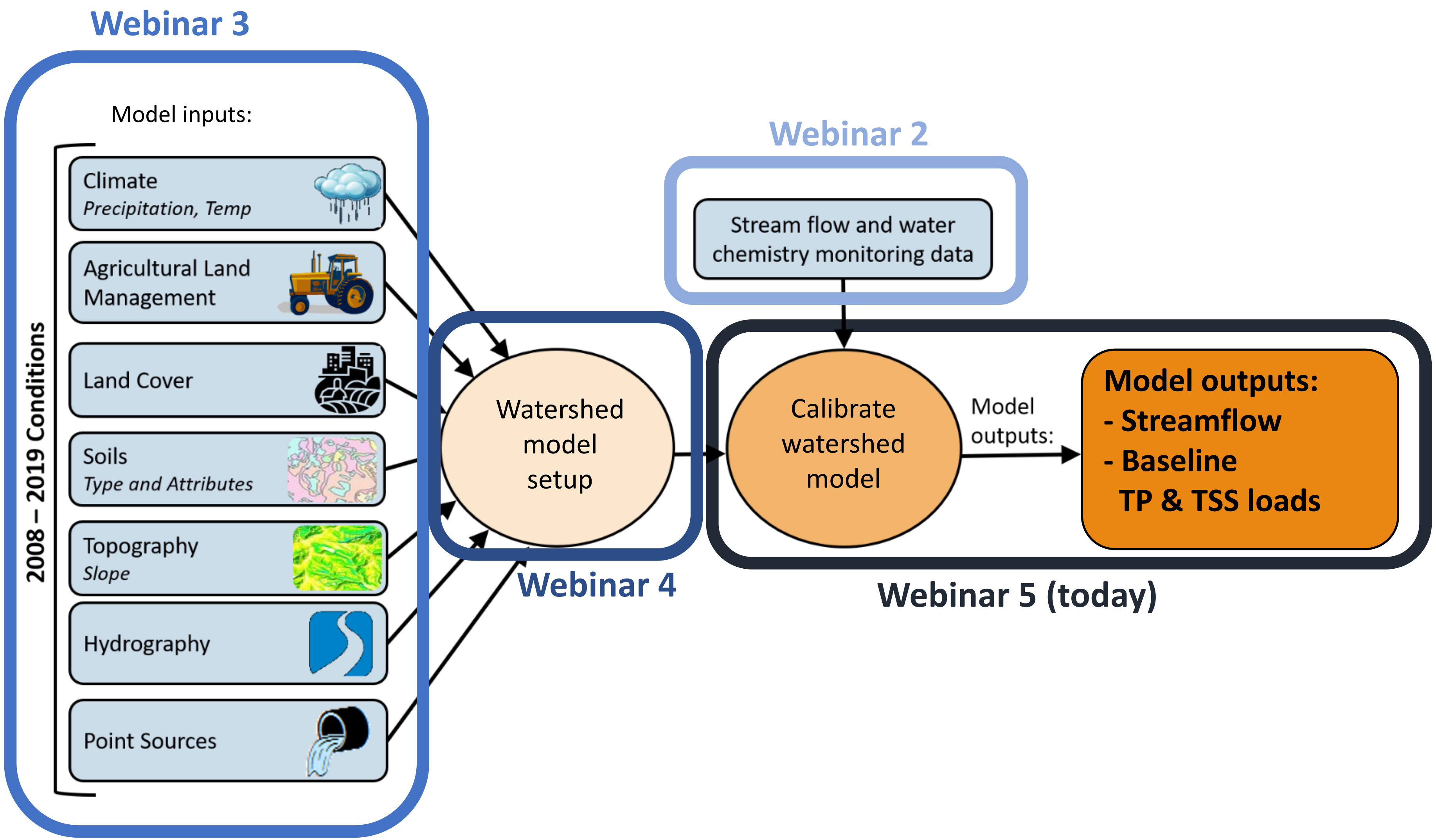


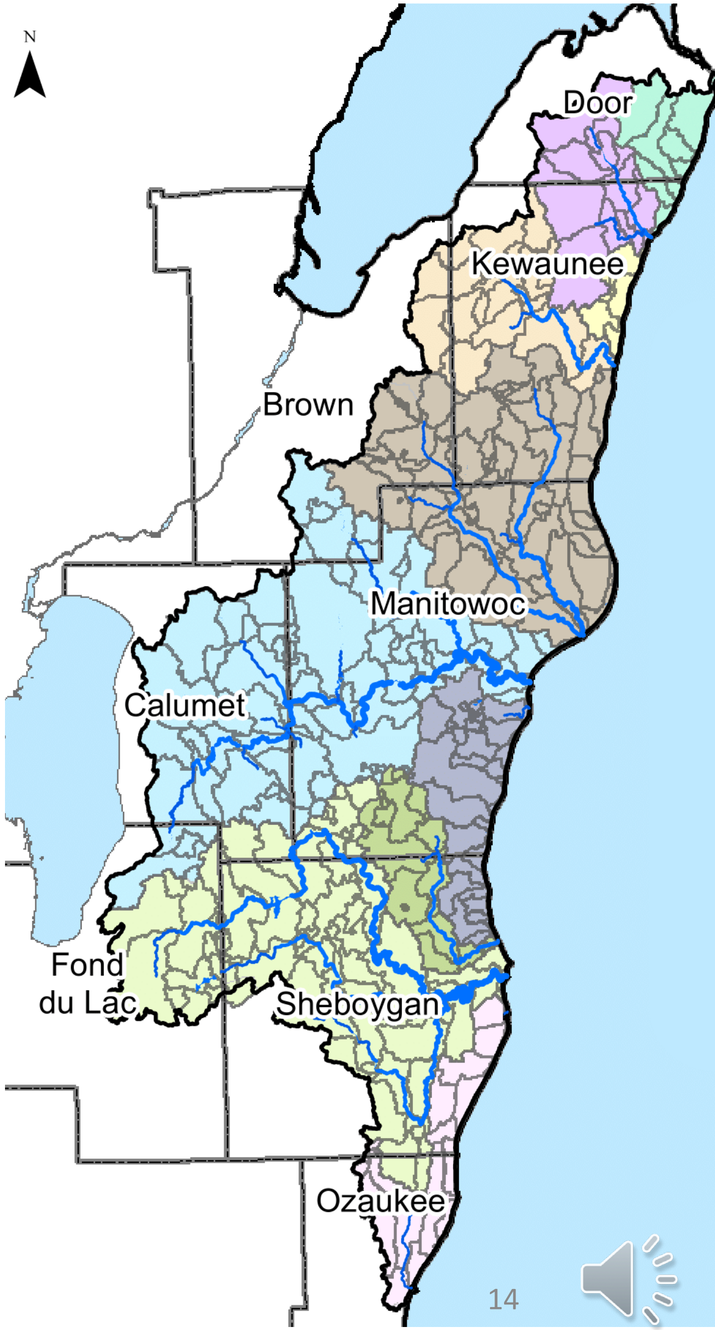
Watershed model development





Watershed model development





Baseline Load Results Summary

TP Rate (lb/ac)

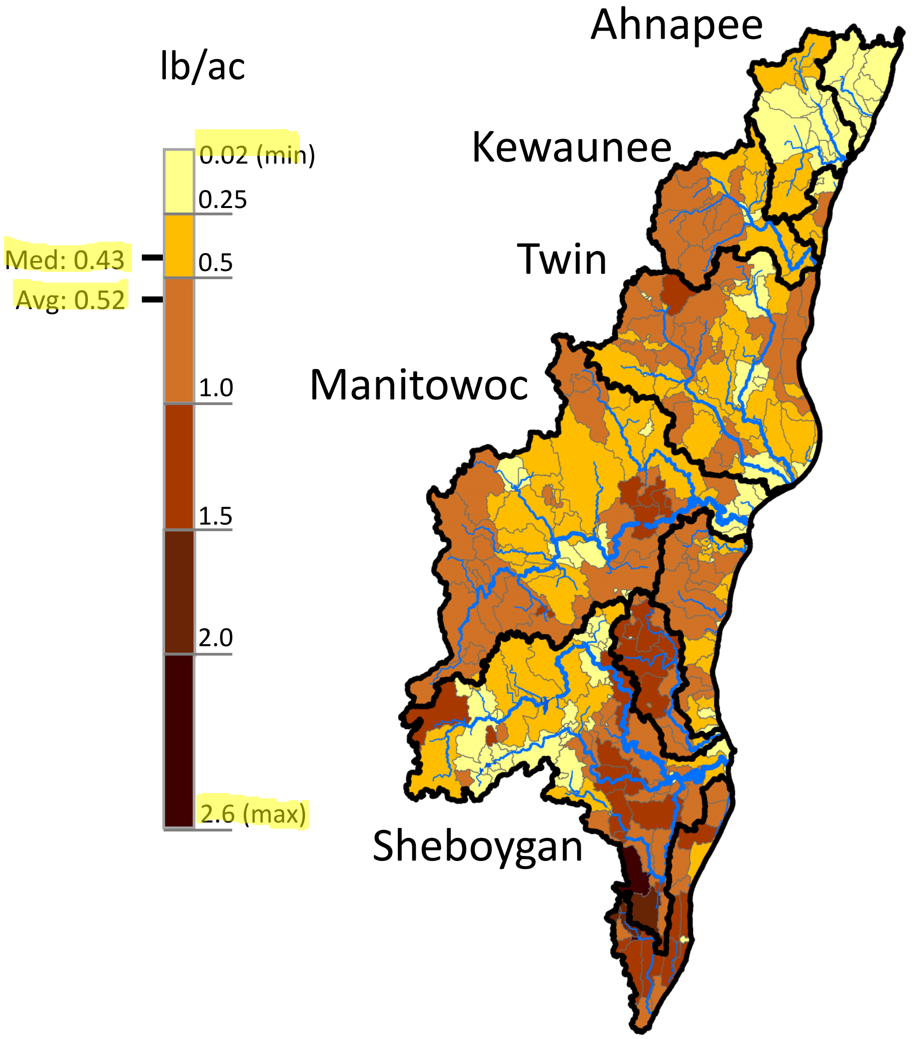
SWAT modeled results

Nonpoint Source (agricultural, urban, natural)

TP Rate (lb/ac)

SWAT modeled results

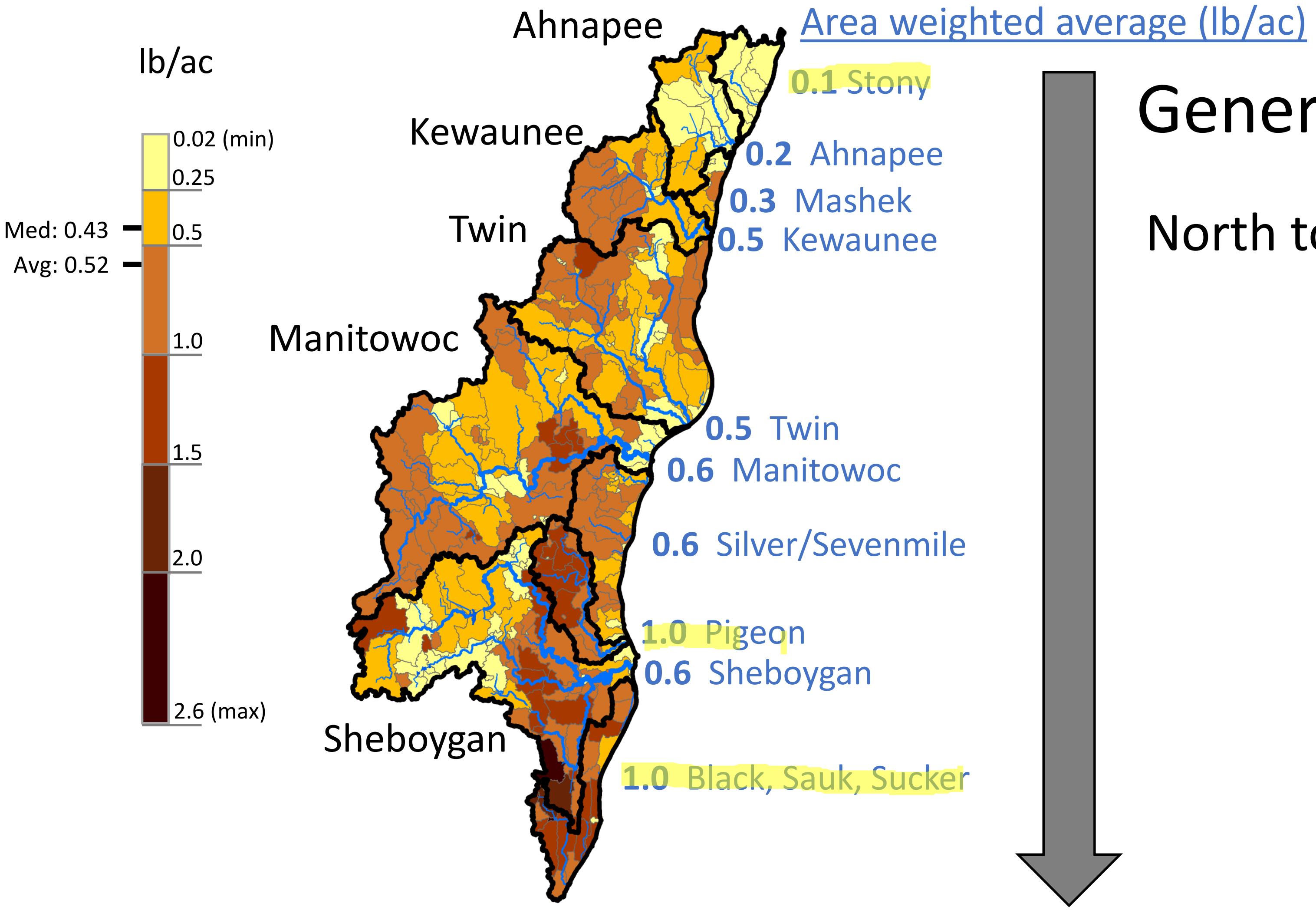
Nonpoint Sources (agricultural, urban, natural)



TP Rate (lb/ac)

SWAT modeled results

Nonpoint Sources (agricultural, urban, natural)



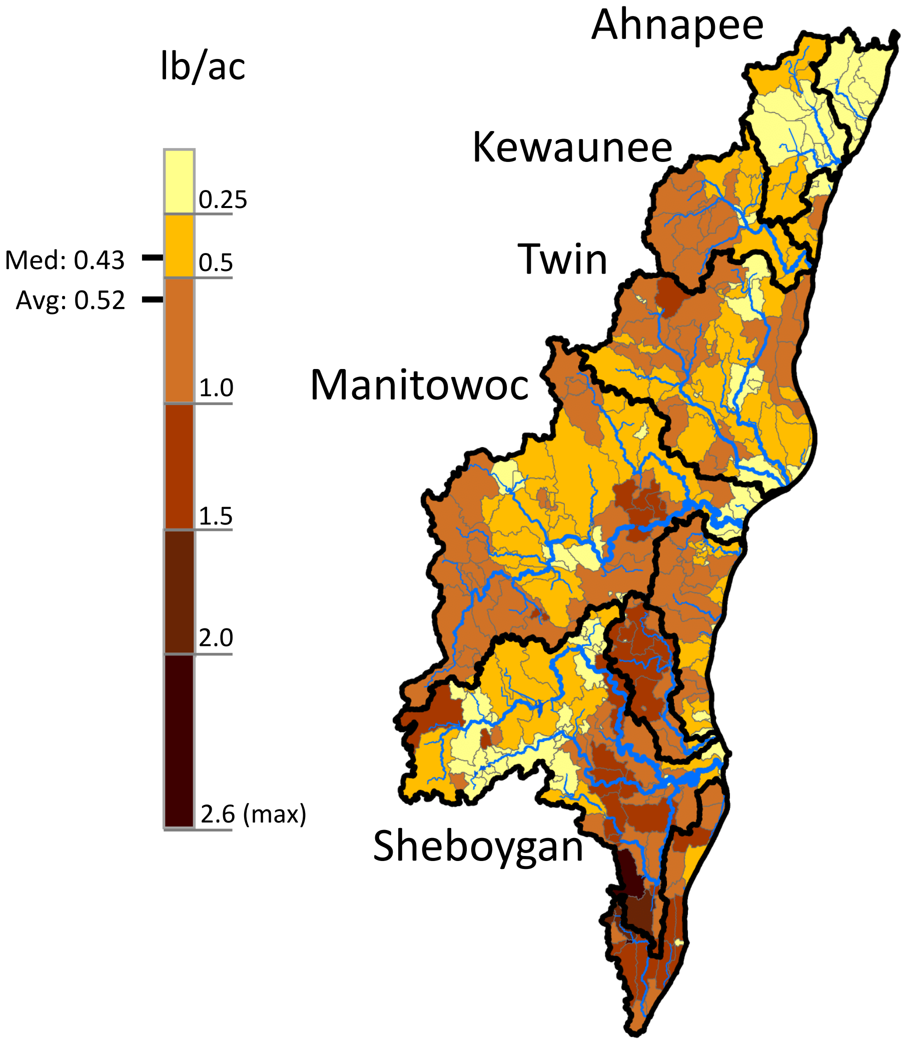
Generalized trends

North to South

TP Rate (lb/ac)

SWAT modeled results

Nonpoint Sources (agricultural, urban, natural)



Spatial variability generally explained by land cover

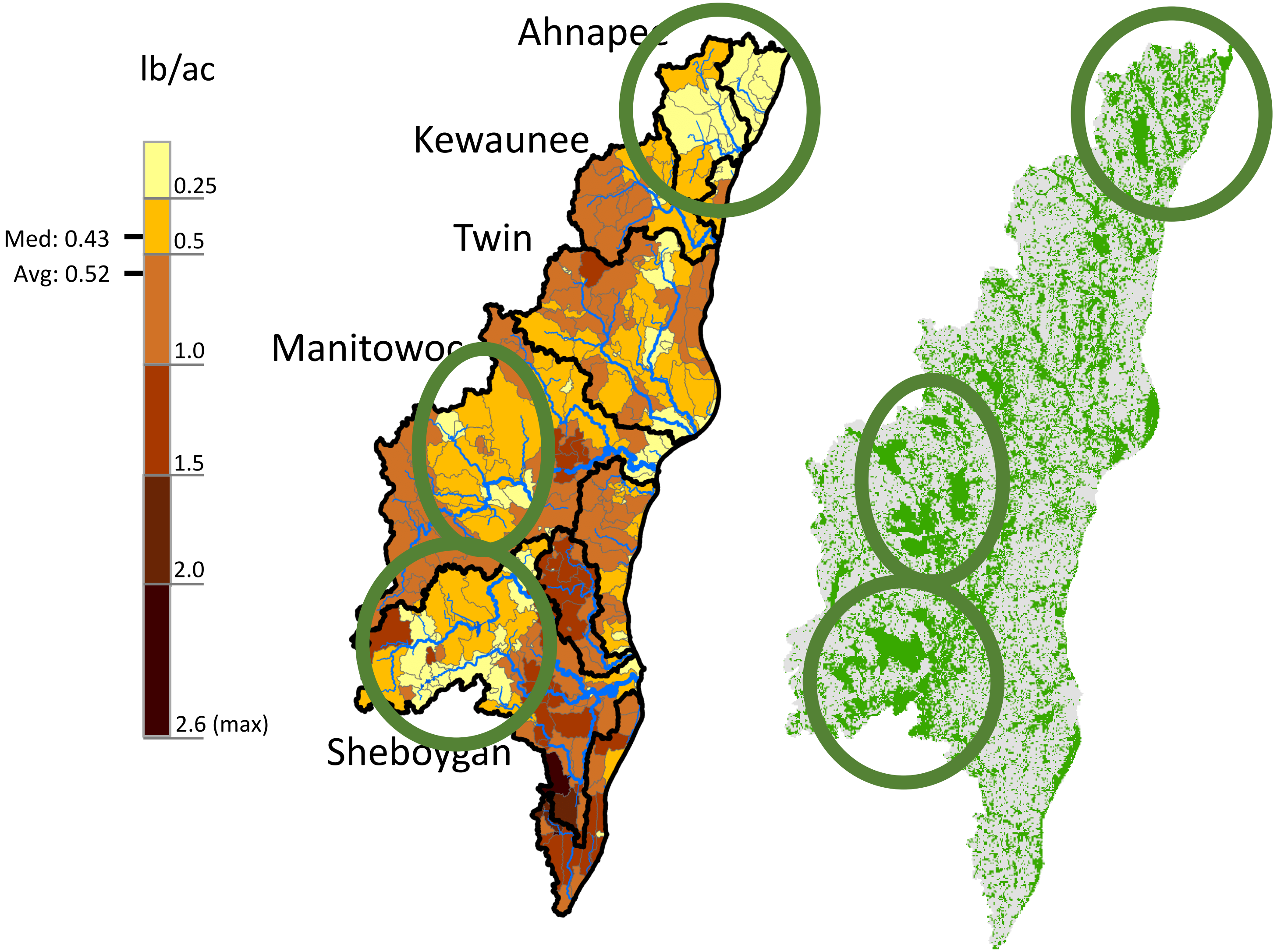
Natural Areas

Agricultural Areas

TP Rate (lb/ac)

SWAT modeled results

Nonpoint Sources (agricultural, urban, natural)



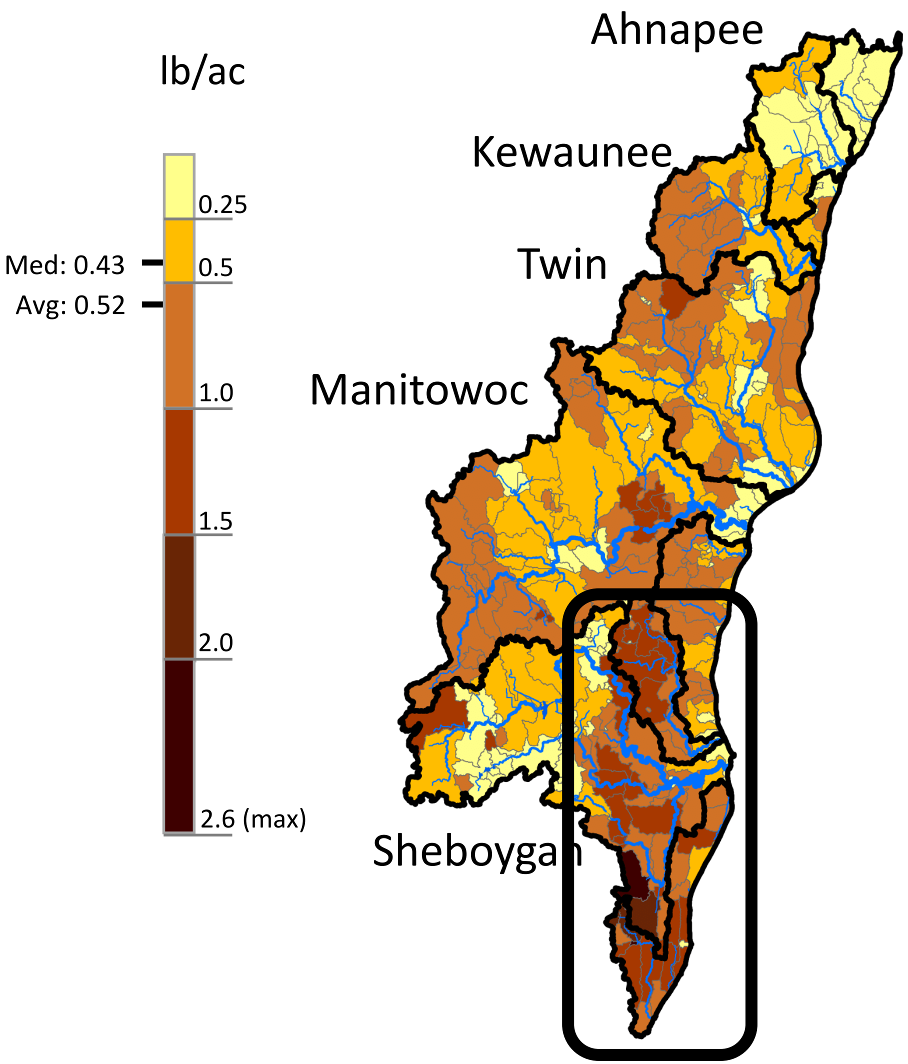
Generalized Trends

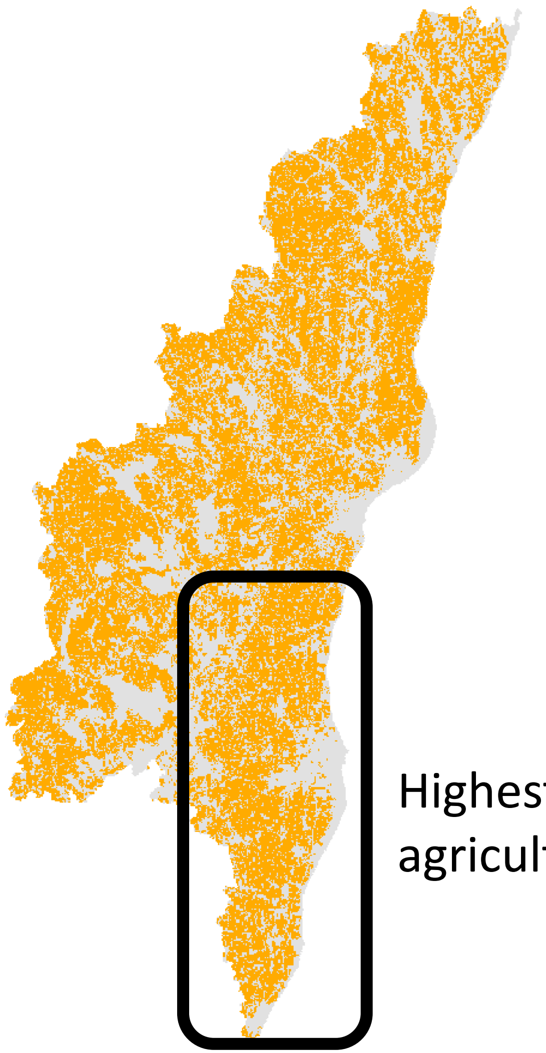
Lower loading rates generally occurred in subbasins with more **natural area**

TP Rate (lb/ac)

SWAT modeled results

Nonpoint Sources (agricultural, urban, natural)





Generalized Trends

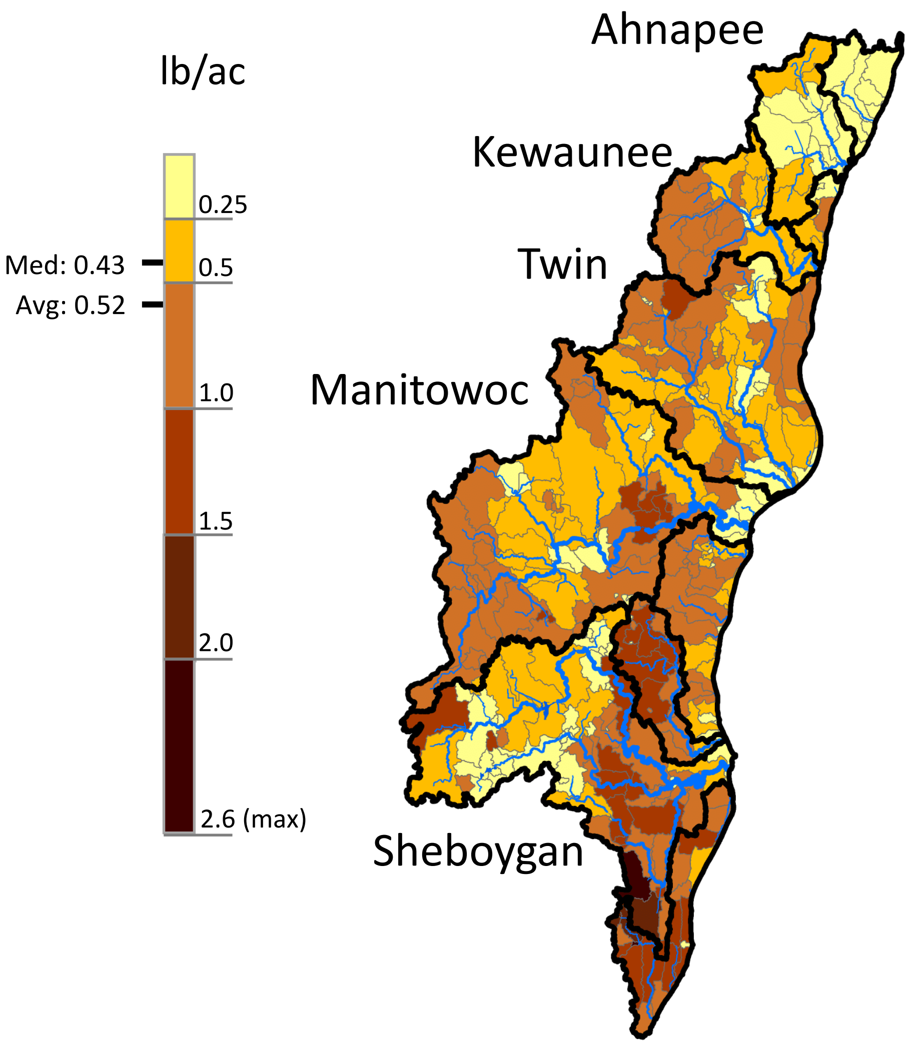
Higher loading rates generally occurred in subbasins with more **agricultural area**

Highest rates generally found in agricultural areas with Cash Grain farming

TP Rate (lb/ac)

SWAT modeled results

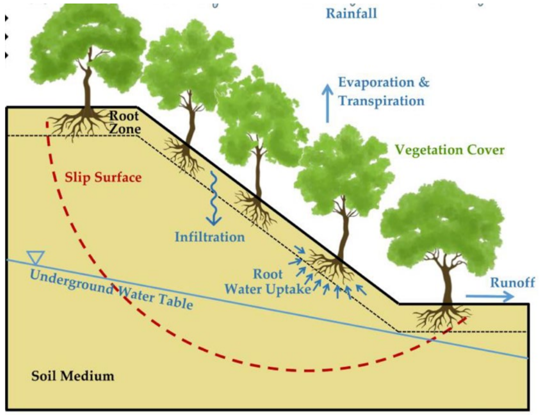
Nonpoint Sources (agricultural, urban, natural)



Soil type and slope also helps explain the variability of rates

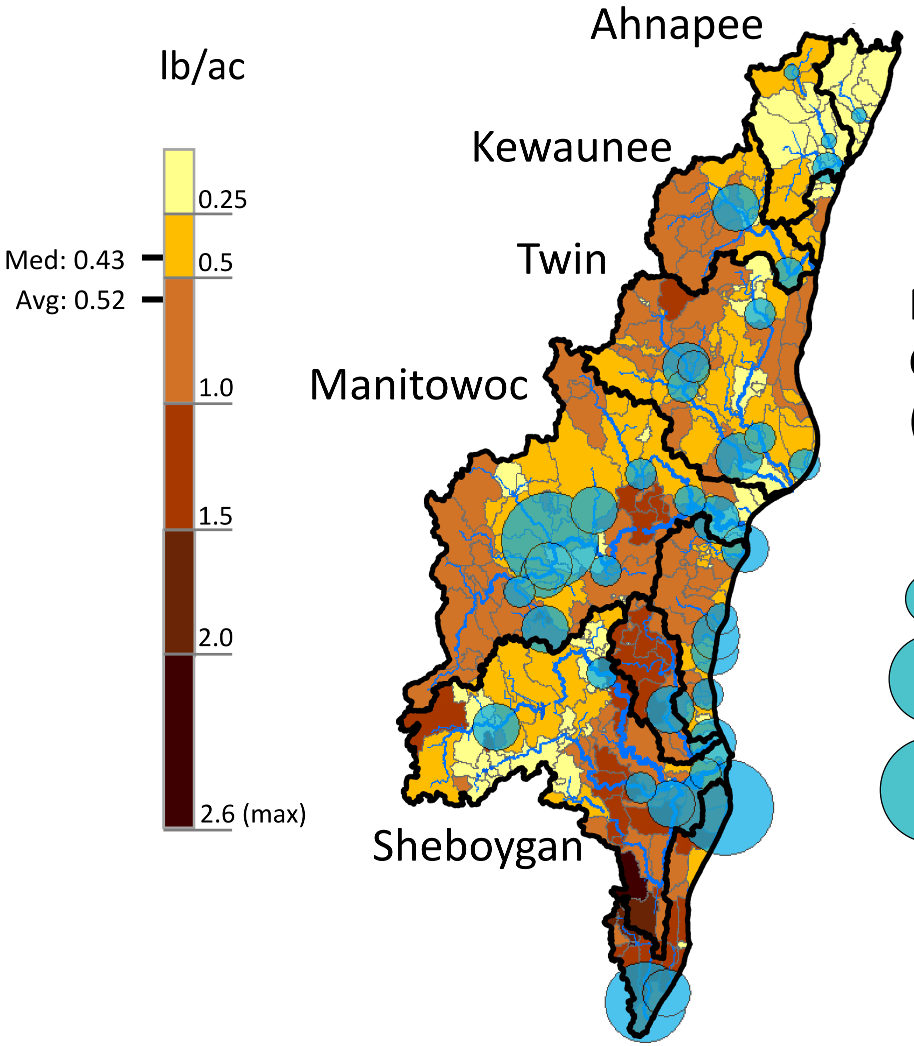
Soils with less infiltration (more runoff)

Areas with steeper slopes

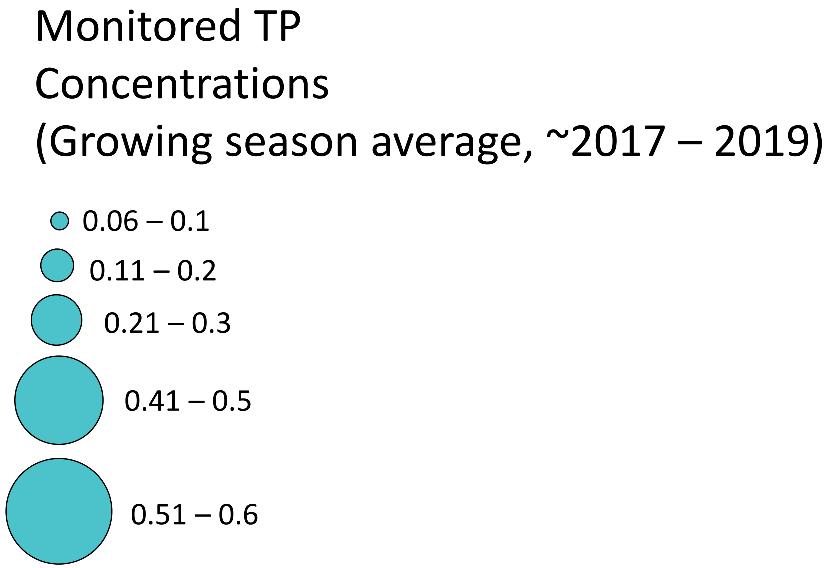


TP Rate (lb/ac)

Nonpoint sources, SWAT modeled results

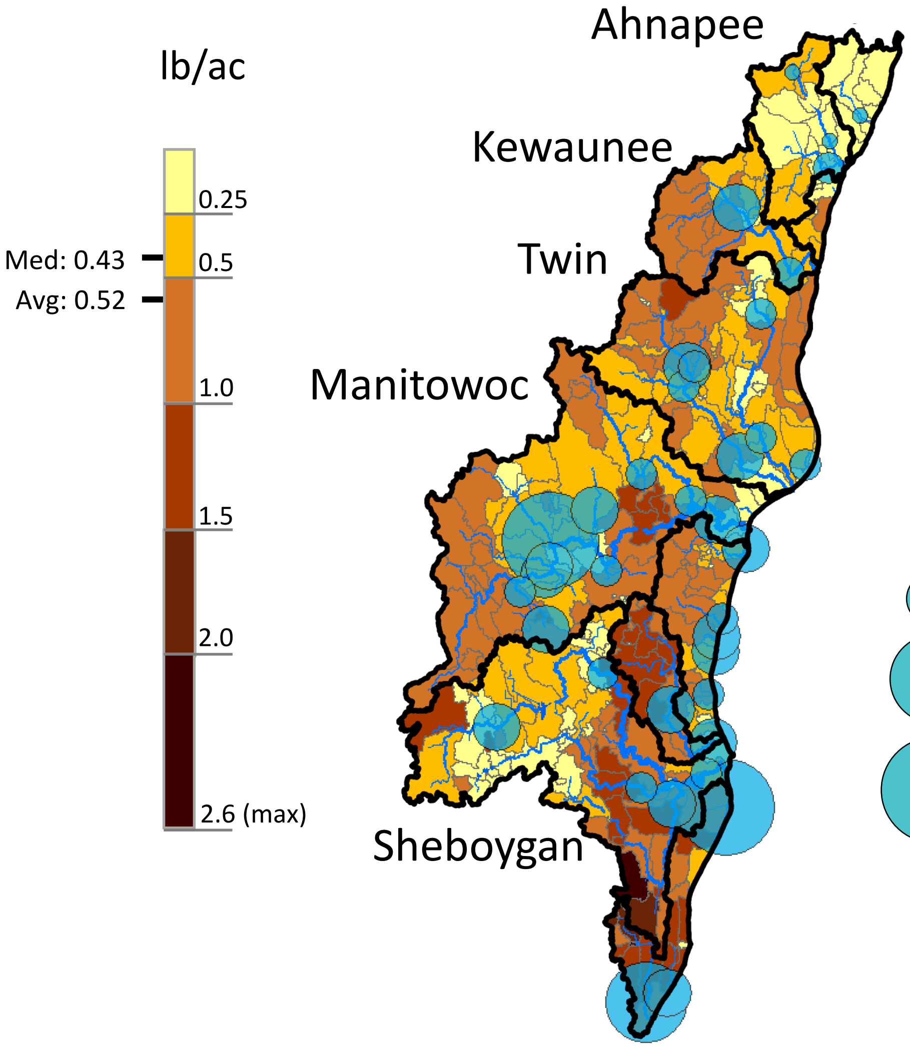


Water quality monitoring shows similar trends as modeling

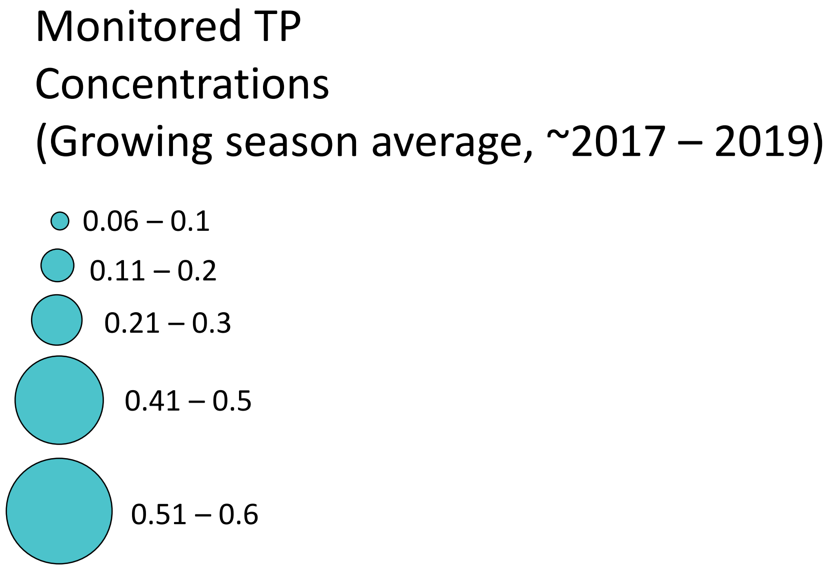


TP Rate (lb/ac)

Nonpoint sources, SWAT modeled results



Water quality monitoring shows similar trends as modeling

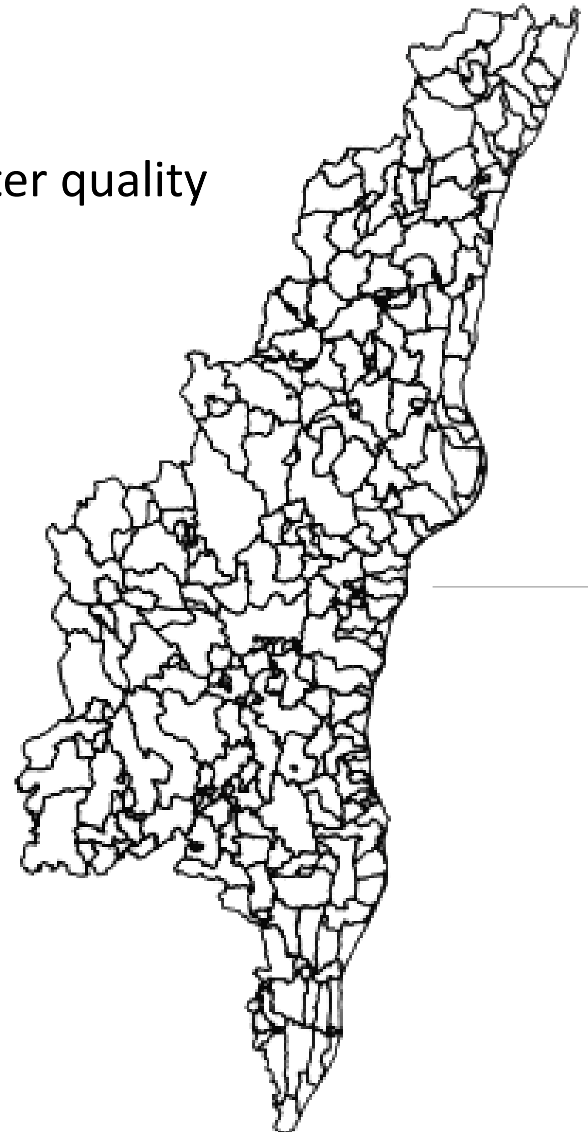


TP Load (lb per year)

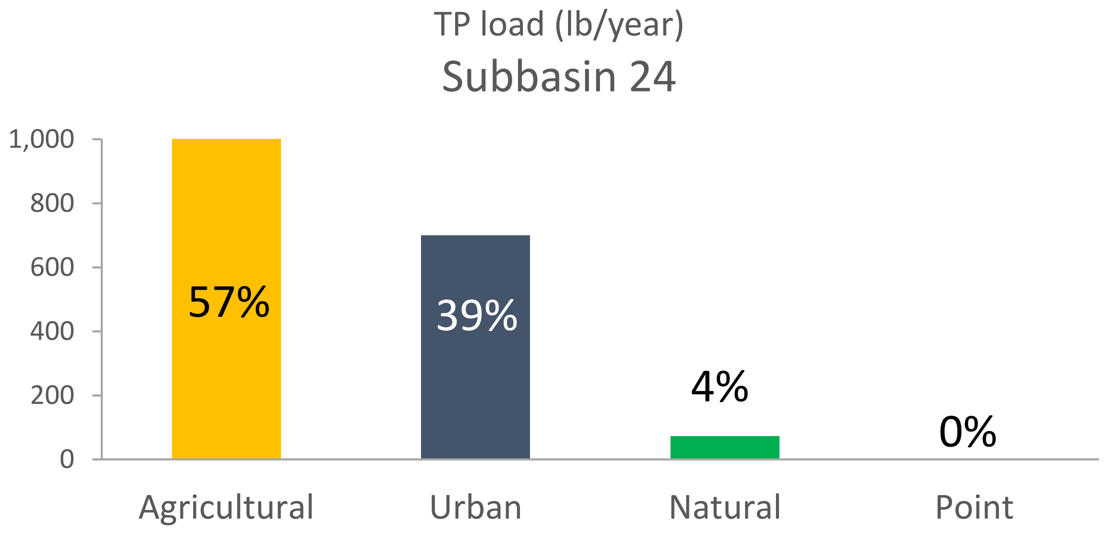
SWAT modeled loads

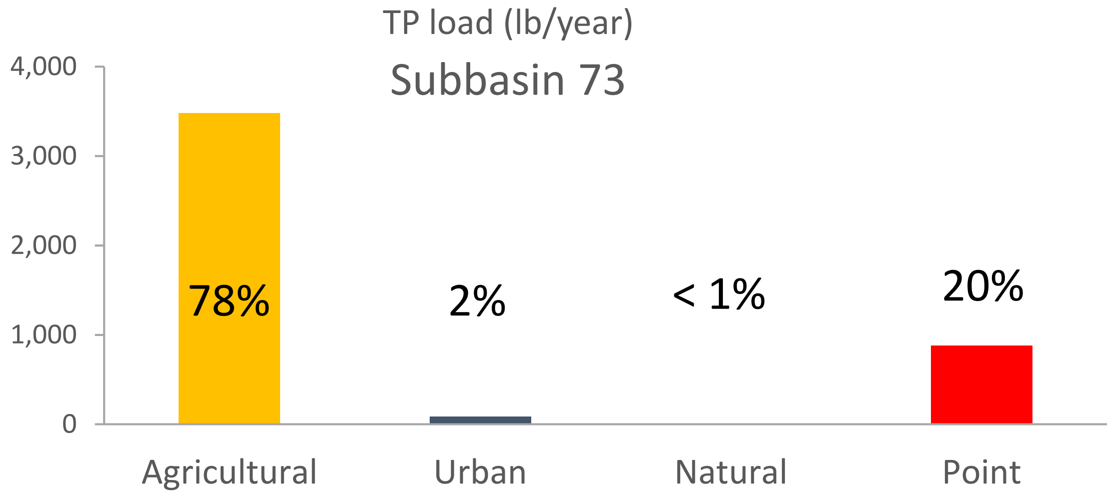
Subbasin Scale

- Used for allocations
- Protects for local water quality



Sources contributions vary among subbasins



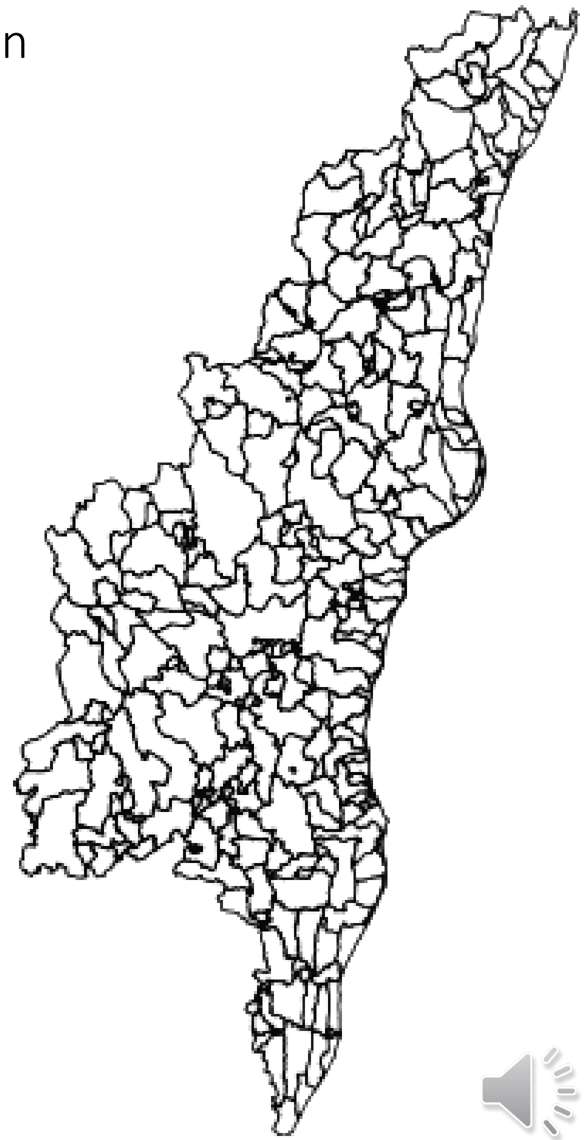


Baseline Load Tables

- Provide a detailed breakdown of the contributions of each source, in each subbasin
- Baseline load tables are not in the watershed model report
- Baseline load tables anticipated for Summer 2021 (with draft allocations)

Example of a baseline load table from Upper Fox Wolf TMDL

TMDL	Subbasin ID and Name	Background TP	Agricultural Nonpoint TP	Non-Regulated Urban TP	General Permits TP	Regulated MS4 Urban TP	Individual Permits TP	Total TP
1	Upper Neenah Creek	1,085	3,881	209	21	0	195	5,391
2	Tributary to Mason Lake	181	806	19	2	0	0	1,008
3	Mason Lake	202	3,202	135	13	0	0	3,552
4	Neenah Creek	1,039	6,982	388	39	14	0	8,462
5	Park Lake	522	9,630	291	29	0	0	10,472
6	Swan Lake	172	925	209	21	0	0	1,327
7	Buffalo Lake Inflow	1,901	9,736	534	53	174	0	12,398
8	Westfield Creek	1,111	4,123	316	32	0	865	6,447
9	Buffalo Lake	1,083	4,731	688	69	0	168	6,739
10	Montello River	1,882	8,452	637	64	0	0	11,035
11	Little Green Lake	6	320	88	9	0	0	423
12	Upper Grand River	25	8,929	84	8	0	1,263	10,309
13	Tributary to Grand River	51	4,085	50	5	0	81	4,272
14	Middle Grand River	220	3,442	87	9	0	61	3,819
15	Lower Grand River	1,092	7,673	281	28	0	0	9,074

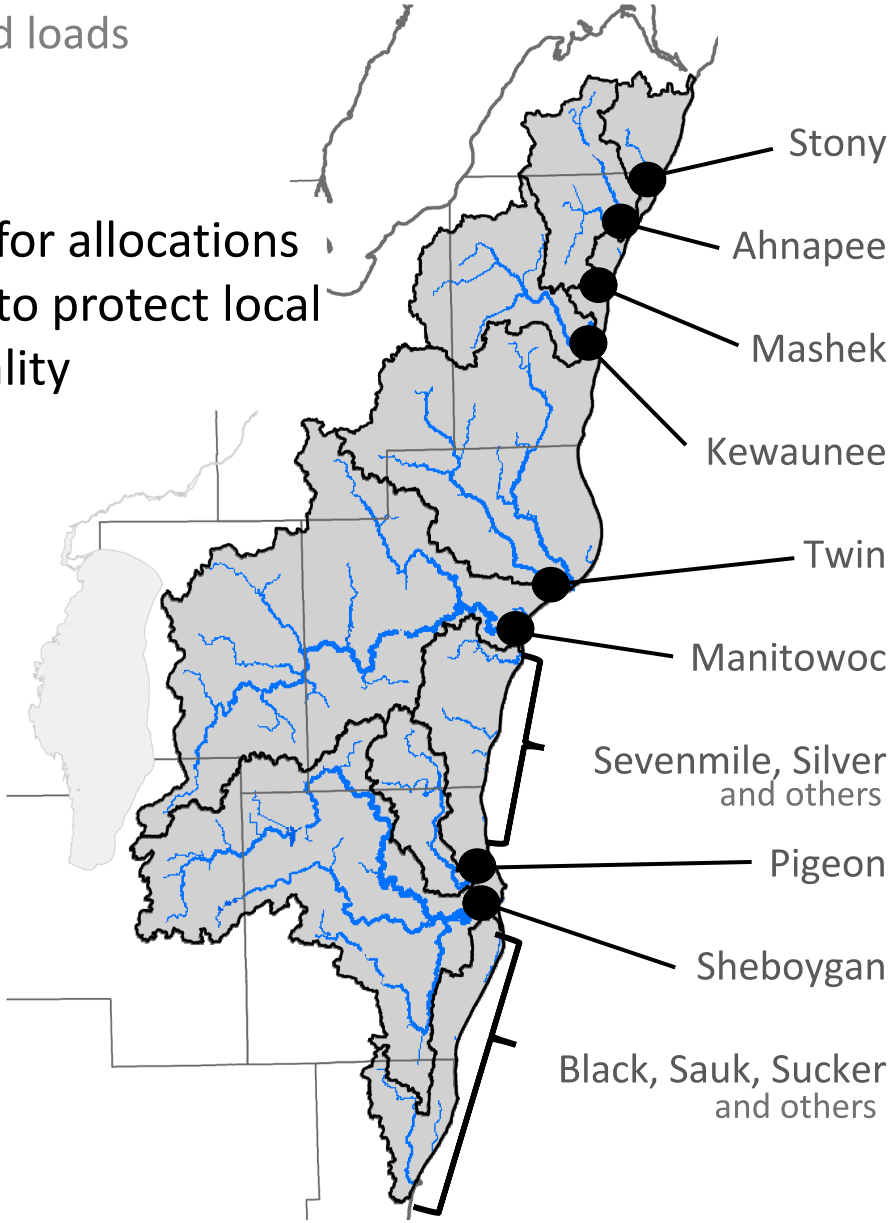


TP Load (lb per year)

SWAT modeled loads

Basin Scale:

- Not used for allocations
- Too large to protect local water quality

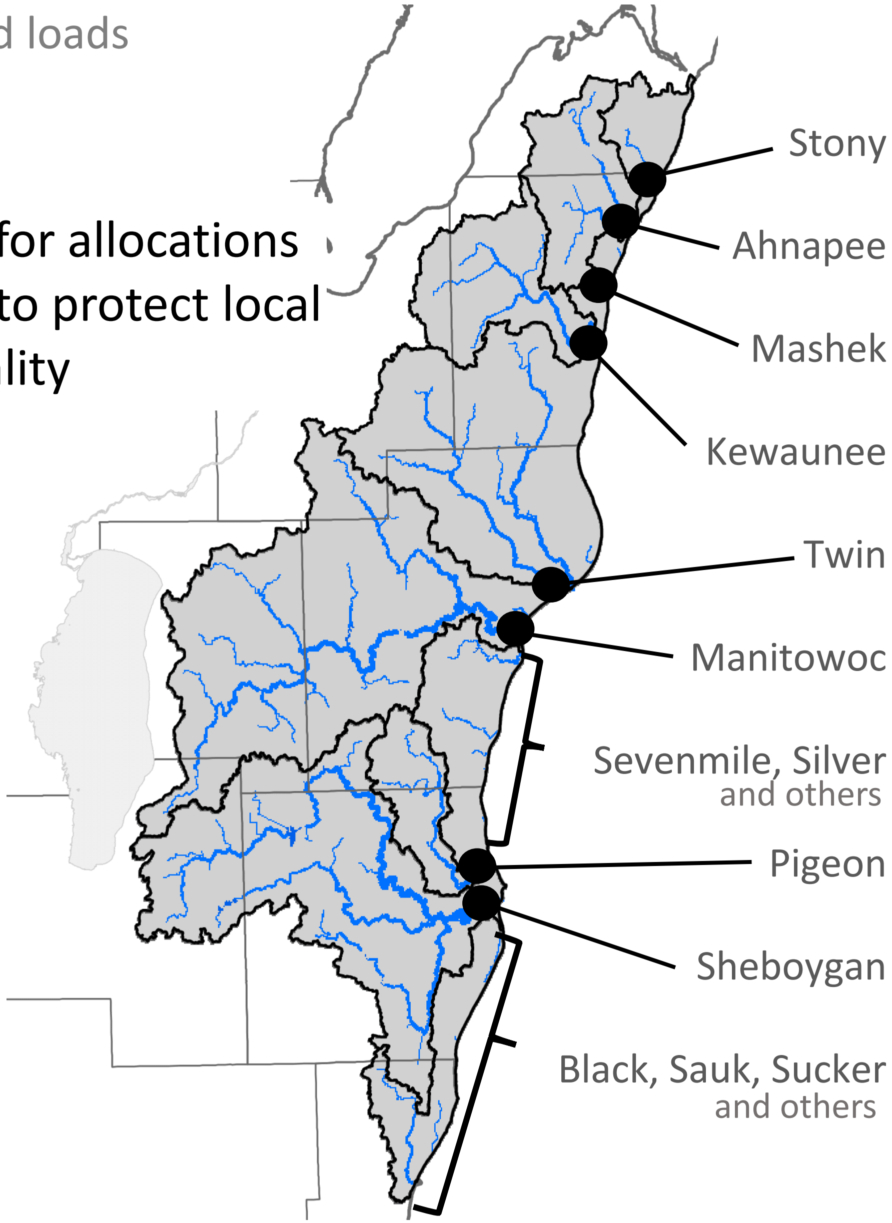


TP Load (lb per year)

SWAT modeled loads

Basin Scale:

- Not used for allocations
- Too large to protect local water quality

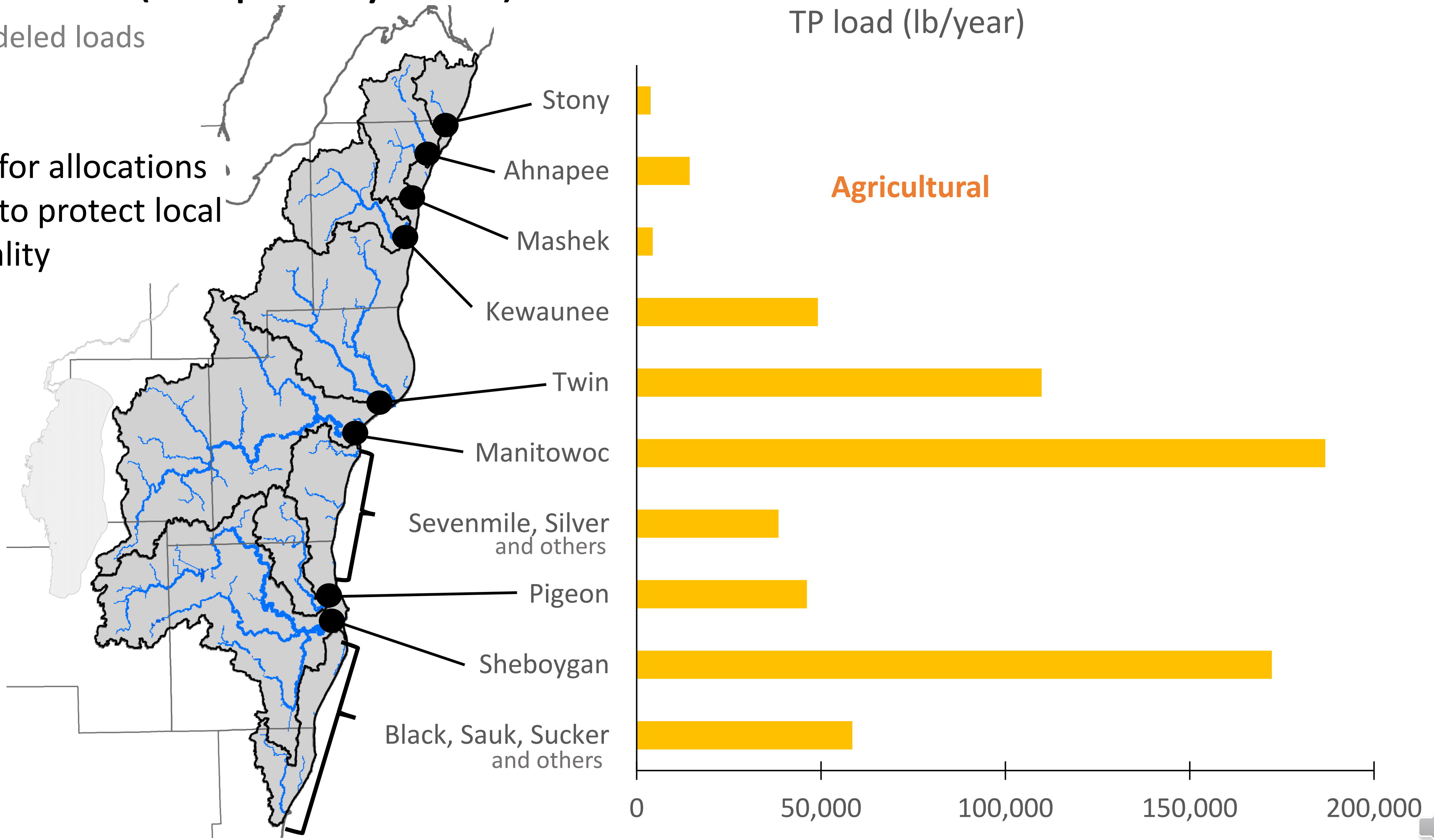


TP Load (lb per year)

SWAT modeled loads

Basin Scale:

- Not used for allocations
- Too large to protect local water quality

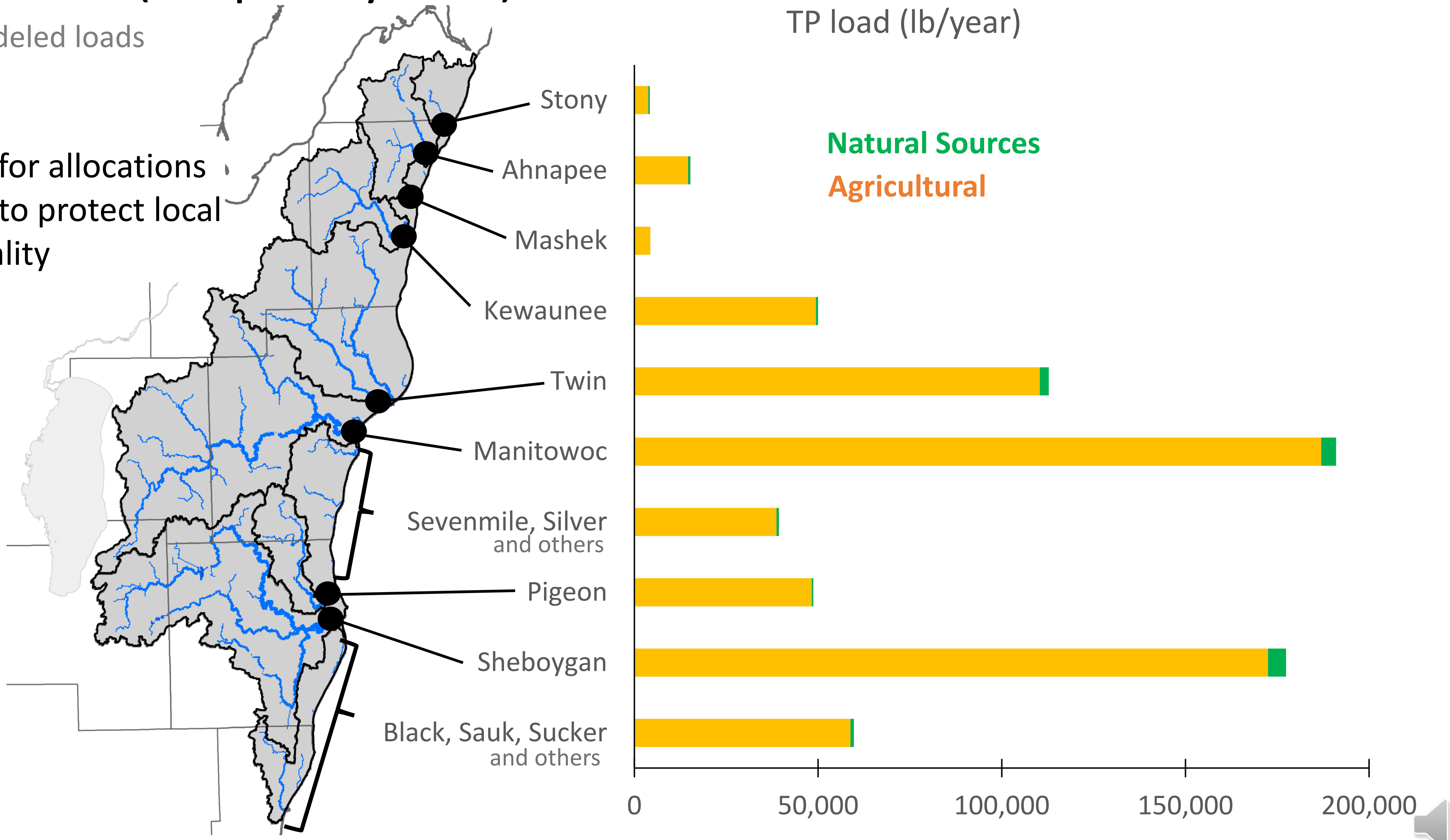


TP Load (lb per year)

SWAT modeled loads

Basin Scale:

- Not used for allocations
- Too large to protect local water quality

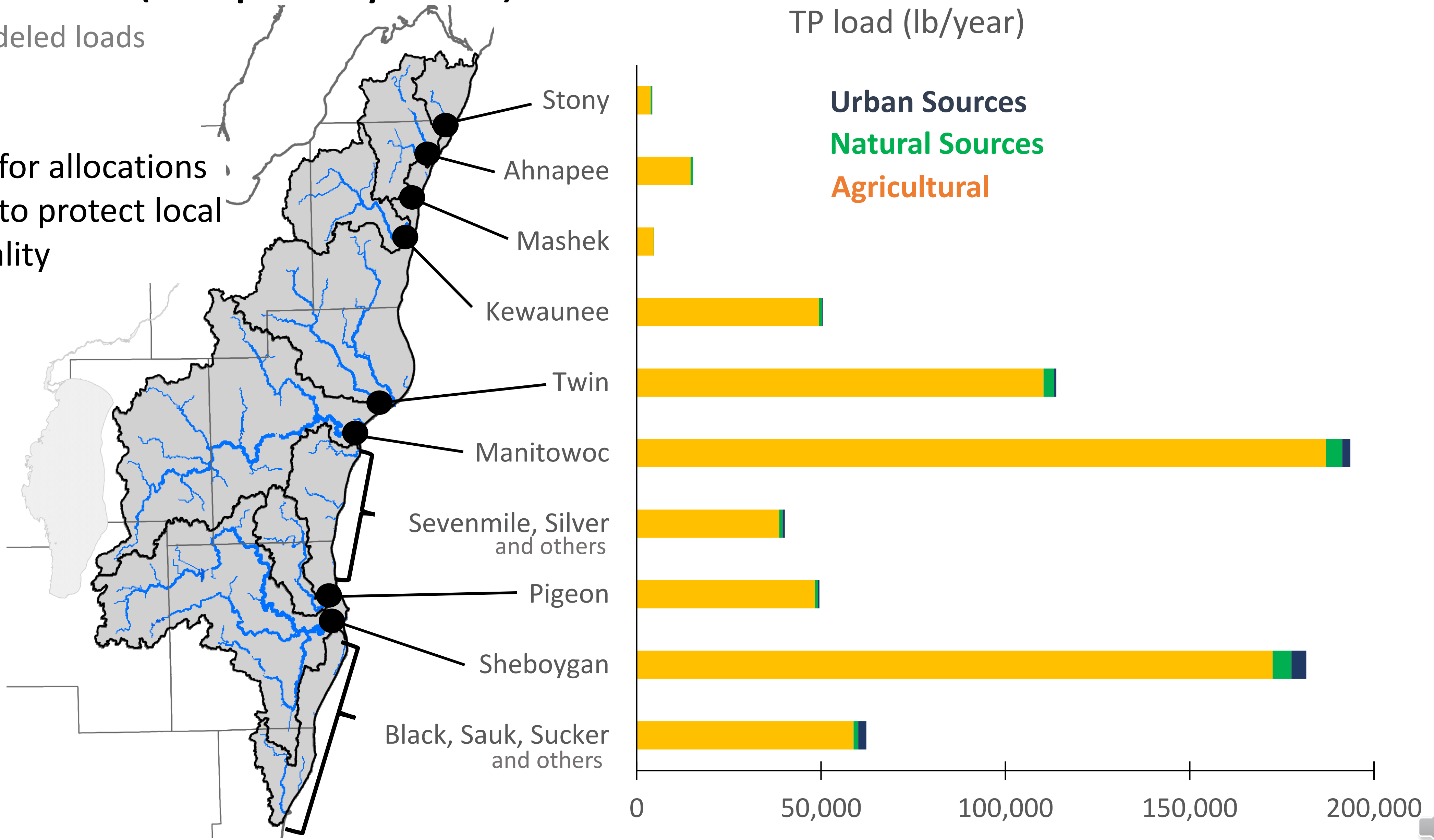


TP Load (lb per year)

SWAT modeled loads

Basin Scale:

- Not used for allocations
- Too large to protect local water quality

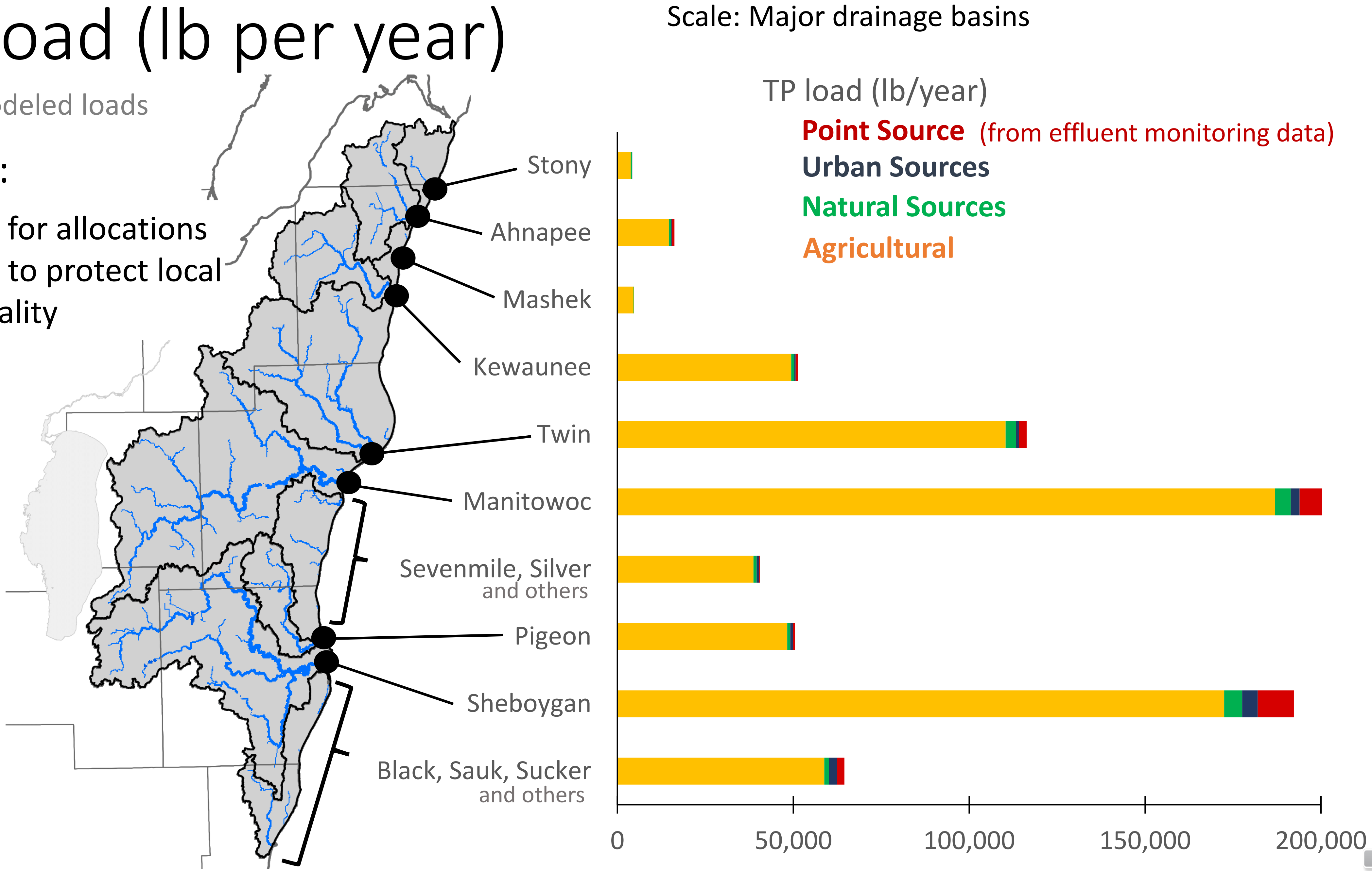


TP Load (lb per year)

SWAT modeled loads

Basin Scale:

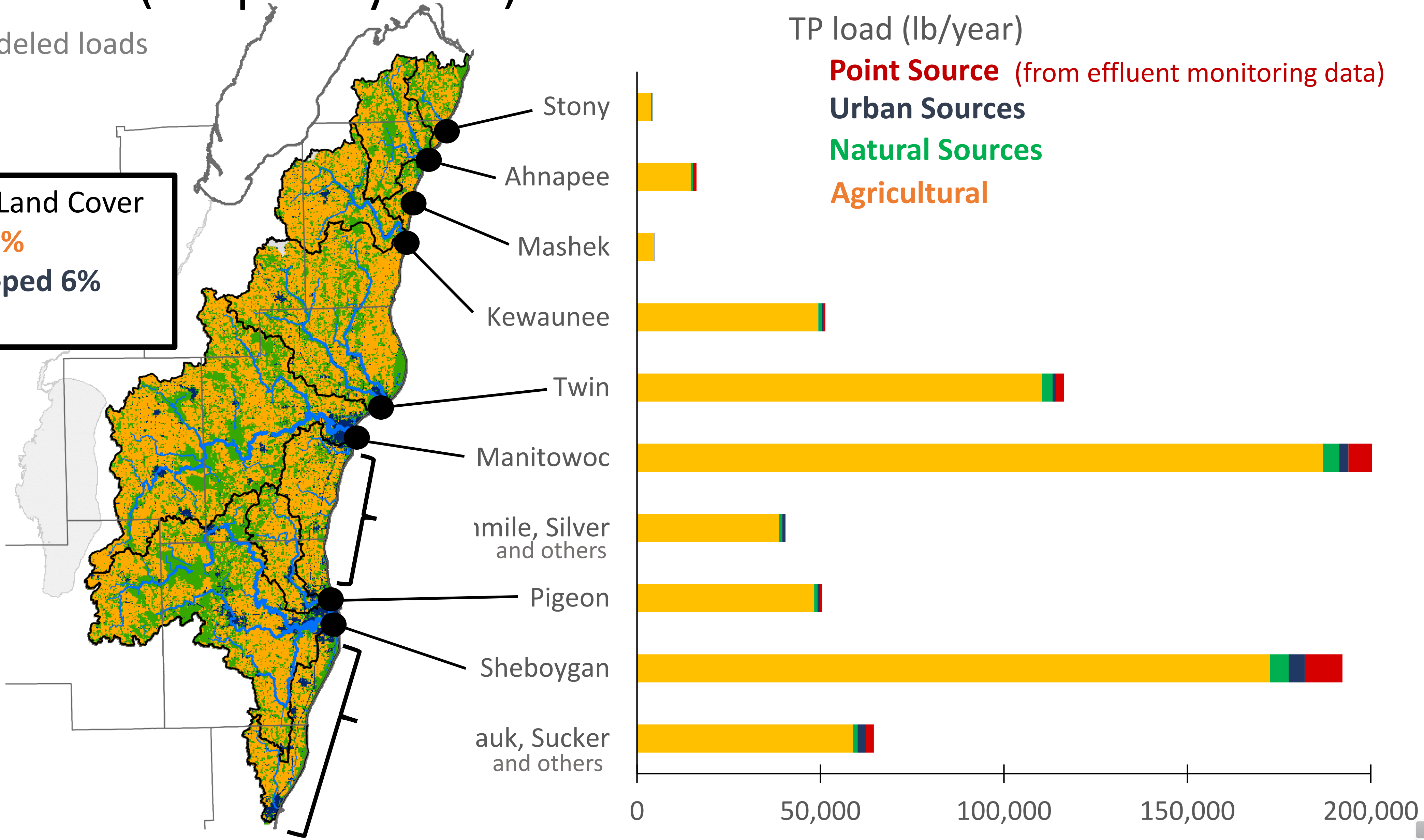
- Not used for allocations
- Too large to protect local water quality



TP Load (lb per year)

SWAT modeled loads

NE Lakeshore Land Cover
Agriculture 60%
Urban/Developed 6%
Natural 34%



Summary: Total Phosphorus

Variability in TP rates generally explained by variations in land cover, soils, and slope

Subbasin scale, used for allocations:
Relative contributions varied among sources (ag, urban, point source)

Basin scale:
Agricultural sources are predominant, as is agricultural land cover

TSS Rate (lb/ac)

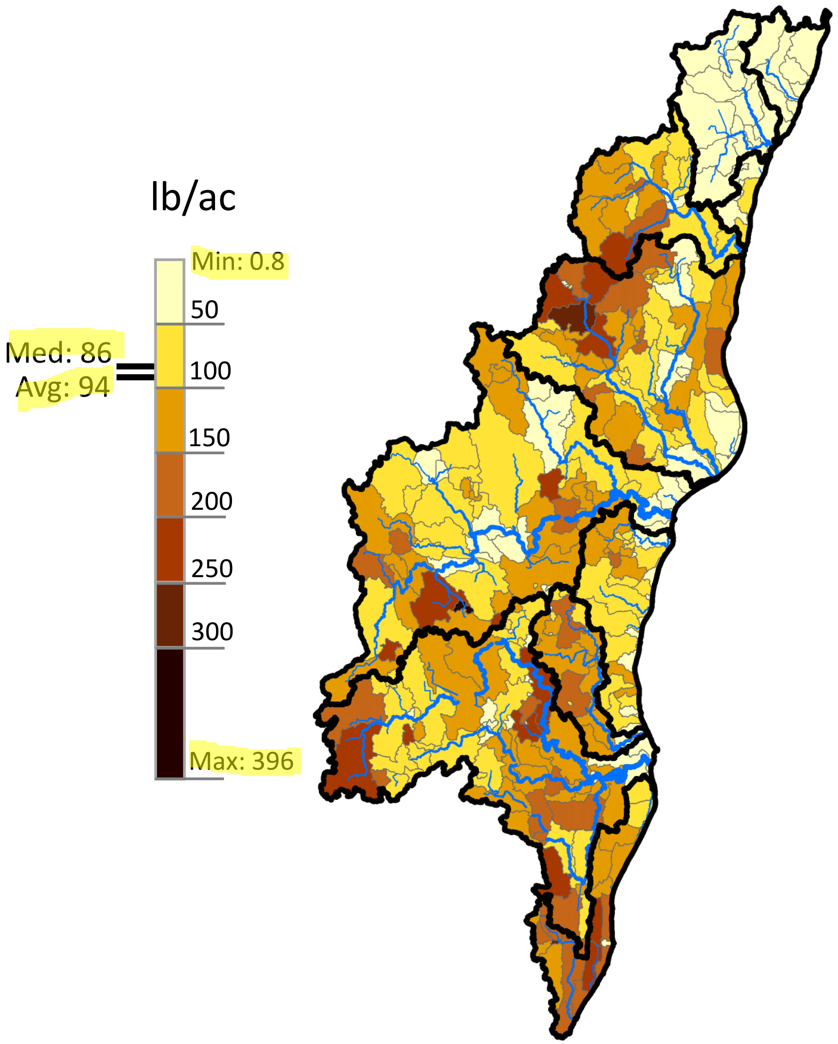
SWAT modeled results

Nonpoint Sources (agricultural, urban, natural)

TSS Rate (lb/ac)

SWAT modeled results

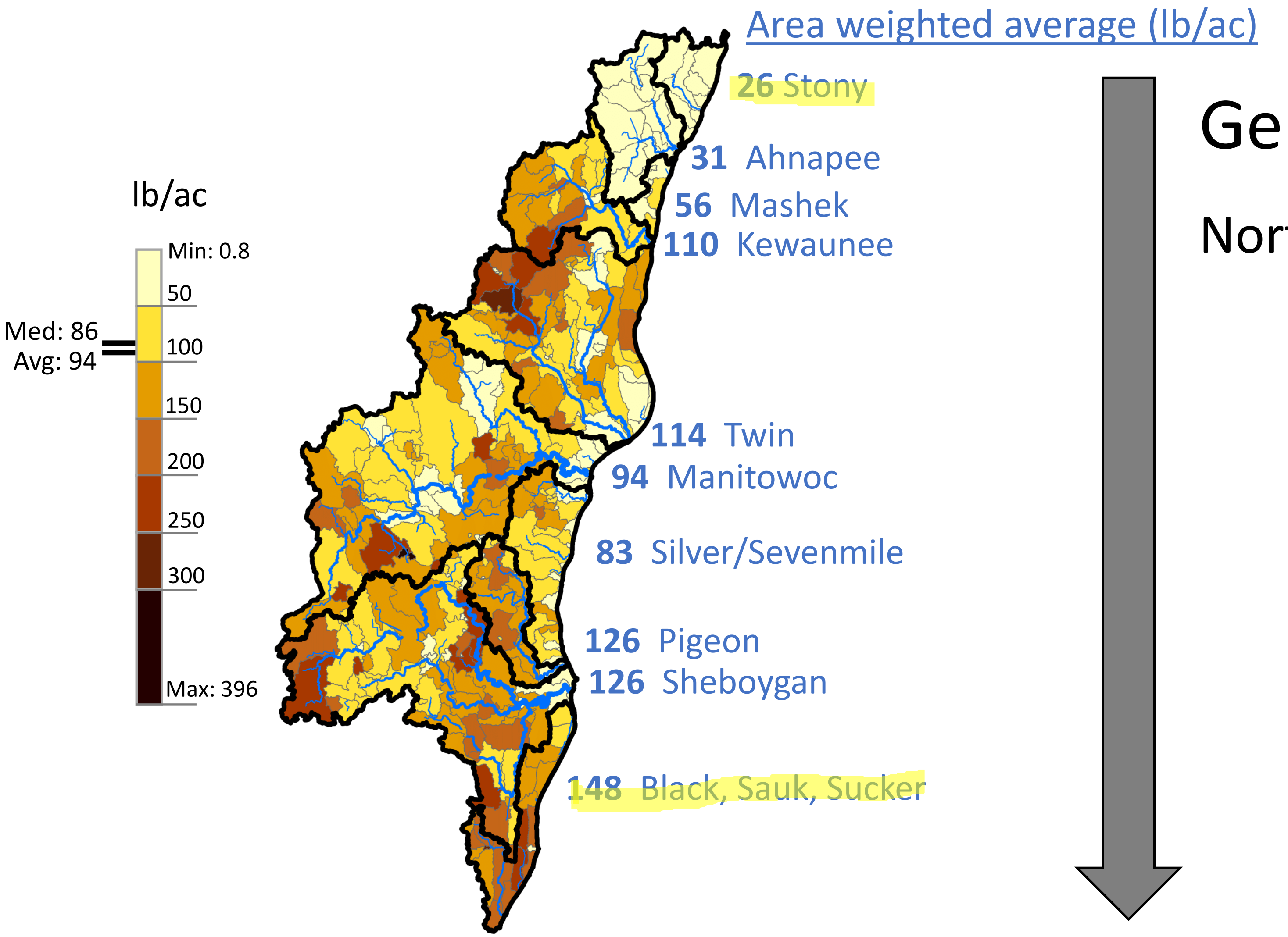
Nonpoint Sources (agricultural, urban, natural)



TSS Rate (lb/ac)

SWAT modeled results

Nonpoint Sources (agricultural, urban, natural)



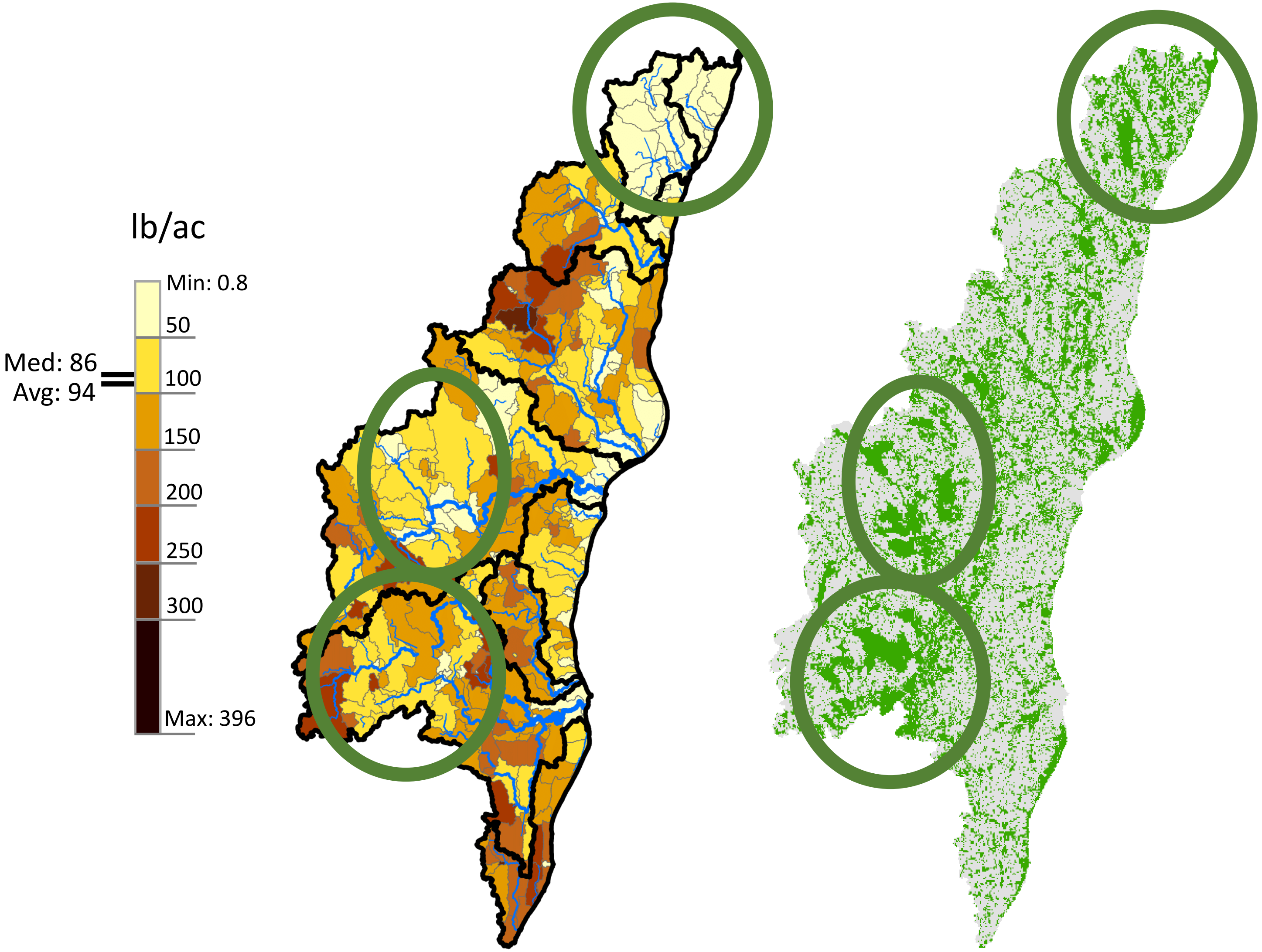
Generalized Trends

North to South

TSS Rate (lb/ac)

SWAT modeled results

Nonpoint Sources (agricultural, urban, natural)



Generalized Trends

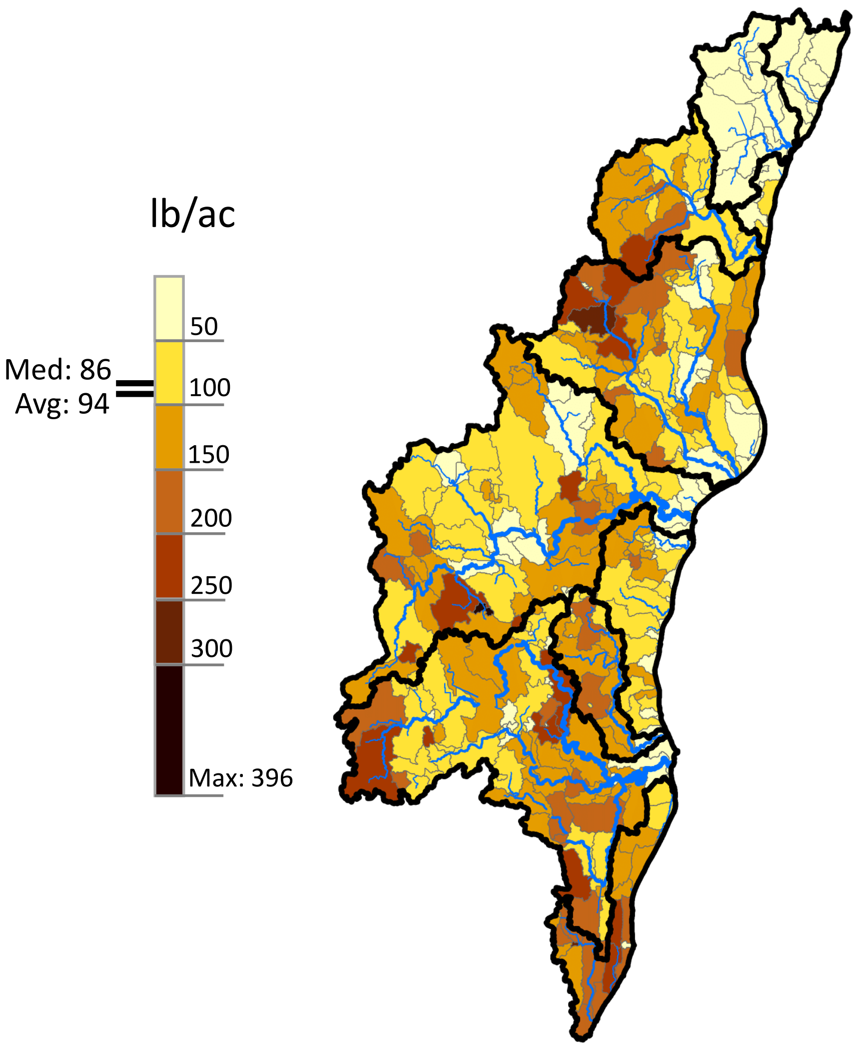
very similar to phosphorus

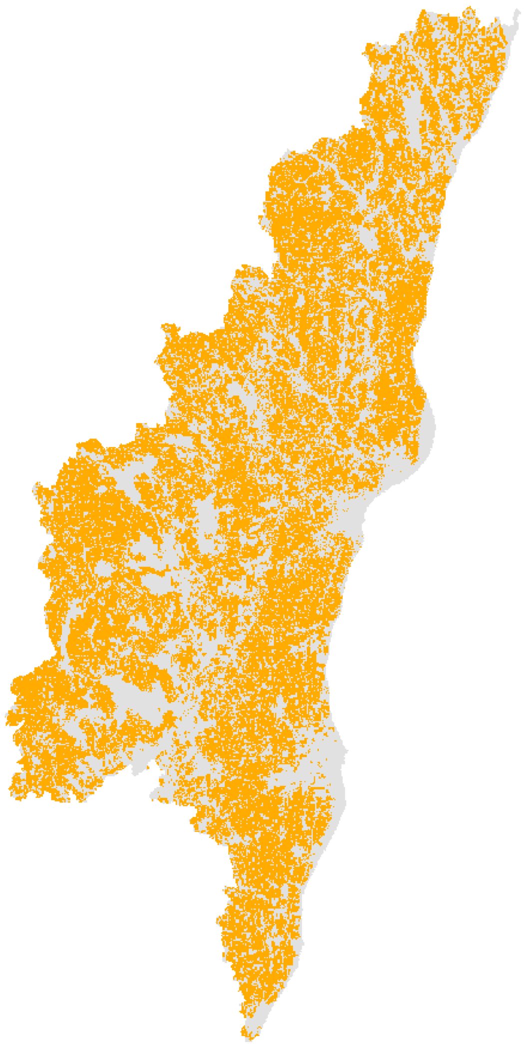
Lower loading rates generally occurred in subbasins with more **natural area**

TSS Rate (lb/ac)

SWAT modeled results

Nonpoint Sources (agricultural, urban, natural)





Higher loading rates generally occurred in subbasins with more **agricultural area**

TSS Rate (lb/ac)

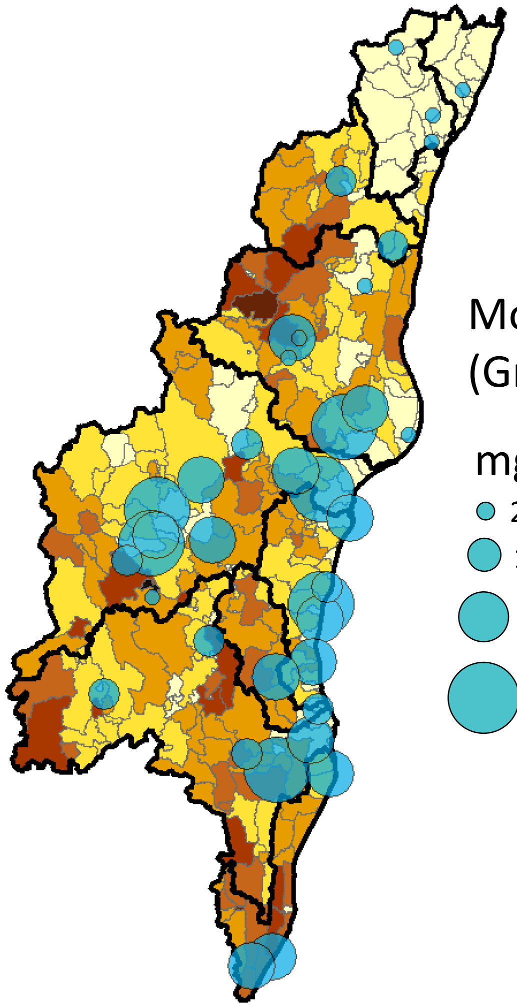
SWAT modeled results

Nonpoint Sources (agricultural, urban, natural)

lb/ac

Med: 86
Avg: 94

50
100
150
200
250
300
Max: 396



Water quality monitoring shows similar trends as modeling

Monitored Concentrations TSS
(Growing season average, ~2017 – 2019)

mg/L

2 – 10
10.1 – 20
20.1 – 30
30.1 – 40

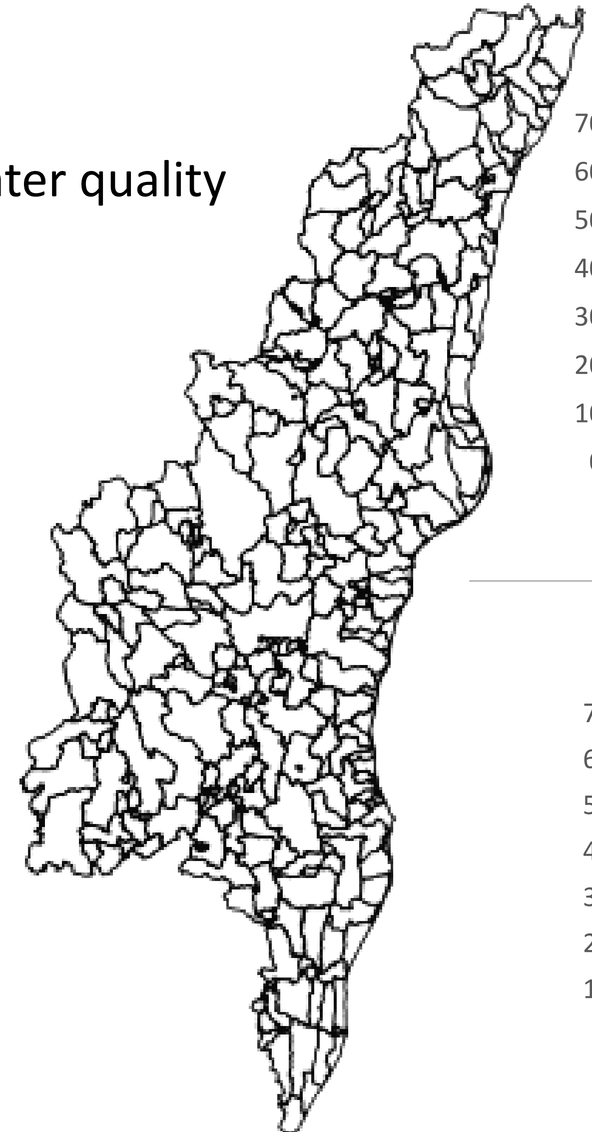
TSS Load (tons per year)

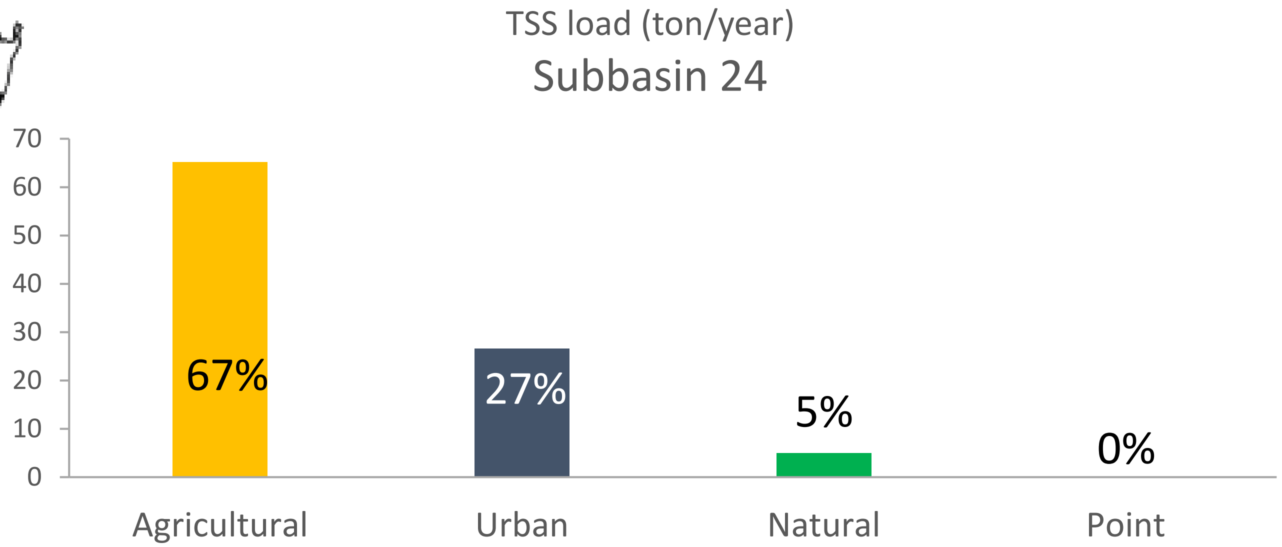
SWAT modeled loads

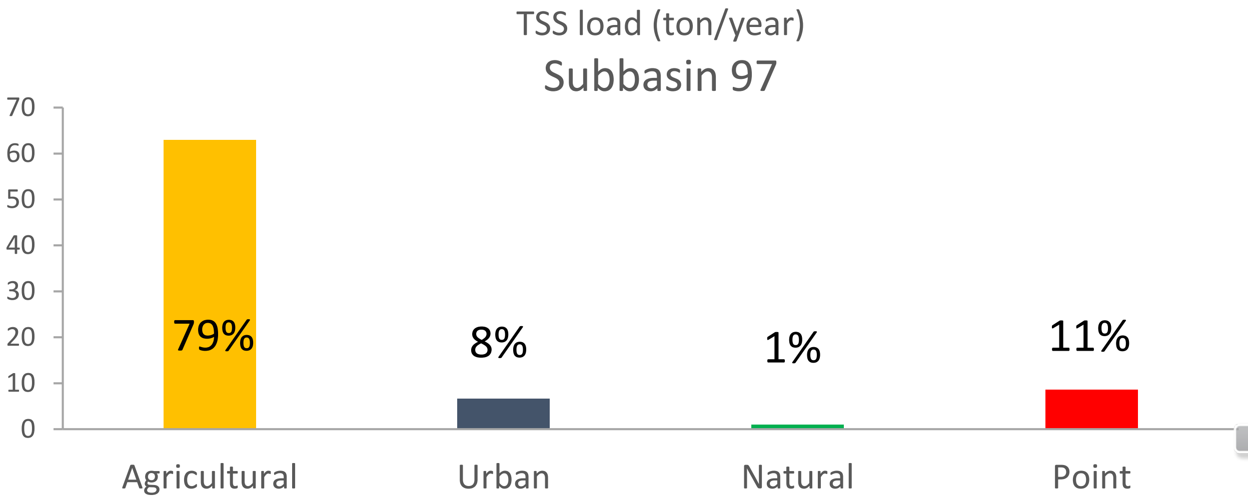
Sources contributions vary among subbasins

Subbasin Scale

- Used for allocations
- Protects for local water quality

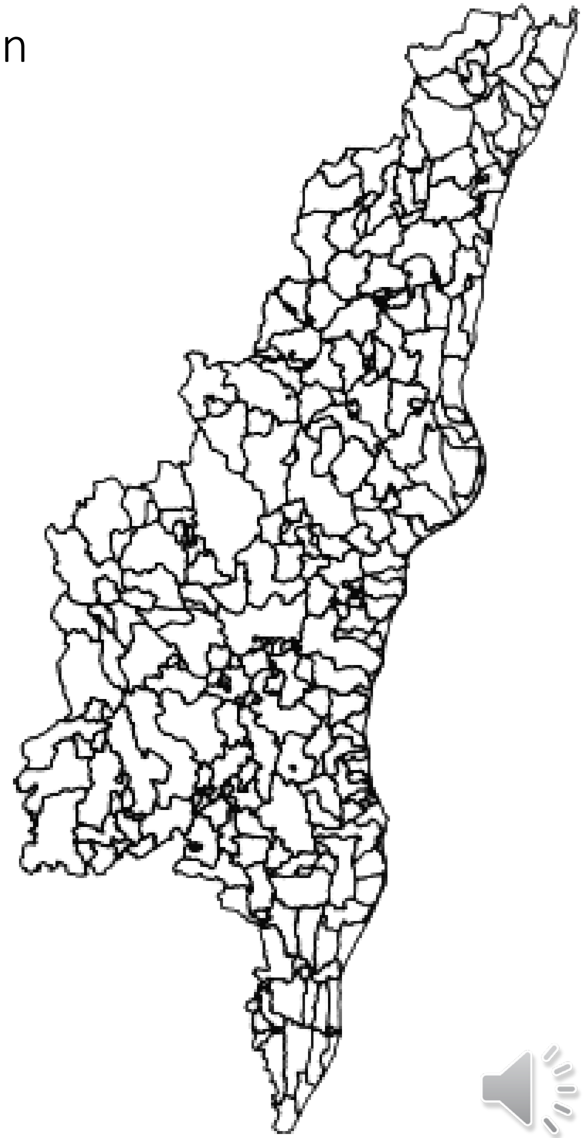






Baseline Load Tables

- Provide a detailed breakdown of the contributions of each source, in each subbasin
- Baseline load tables are not in the watershed model report
- Baseline load tables anticipated for Summer 2021 (with draft allocations)



Example of a baseline load table from Upper Fox Wolf TMDL

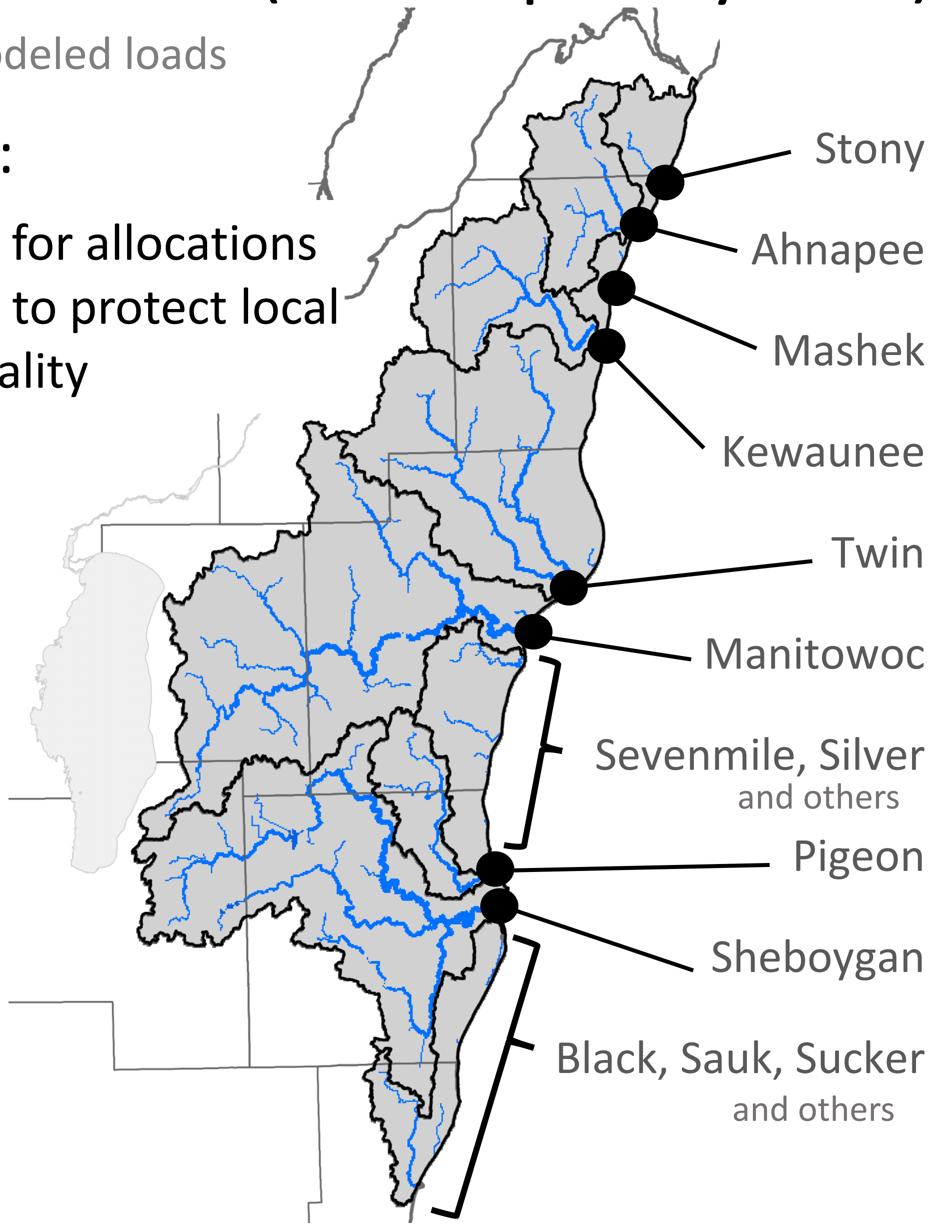
TMDL	Subbasin ID and Name	Background TP	Agricultural Nonpoint TP	Non-Regulated Urban TP	General Permits TP	Regulated MS4 Urban TP	Individual Permits TP	Total TP
1	Upper Neenah Creek	1,085	3,881	209	21	0	195	5,391
2	Tributary to Mason Lake	181	806	19	2	0	0	1,008
3	Mason Lake	202	3,202	135	13	0	0	3,552
4	Neenah Creek	1,039	6,982	388	39	14	0	8,462
5	Park Lake	522	9,630	291	29	0	0	10,472
6	Swan Lake	172	925	209	21	0	0	1,327
7	Buffalo Lake Inflow	1,901	9,736	534	53	174	0	12,398
8	Westfield Creek	1,111	4,123	316	32	0	865	6,447
9	Buffalo Lake	1,083	4,731	688	69	0	168	6,739
10	Montello River	1,882	8,452	637	64	0	0	11,035
11	Little Green Lake	6	320	88	9	0	0	423
12	Upper Grand River	25	8,929	84	8	0	1,263	10,309
13	Tributary to Grand River	51	4,085	50	5	0	81	4,272
14	Middle Grand River	220	3,442	87	9	0	61	3,819
15	Lower Grand River	1,092	7,673	281	28	0	0	9,074

TSS Load (tons per year)

SWAT modeled loads

Basin Scale:

- Not used for allocations
- Too large to protect local water quality

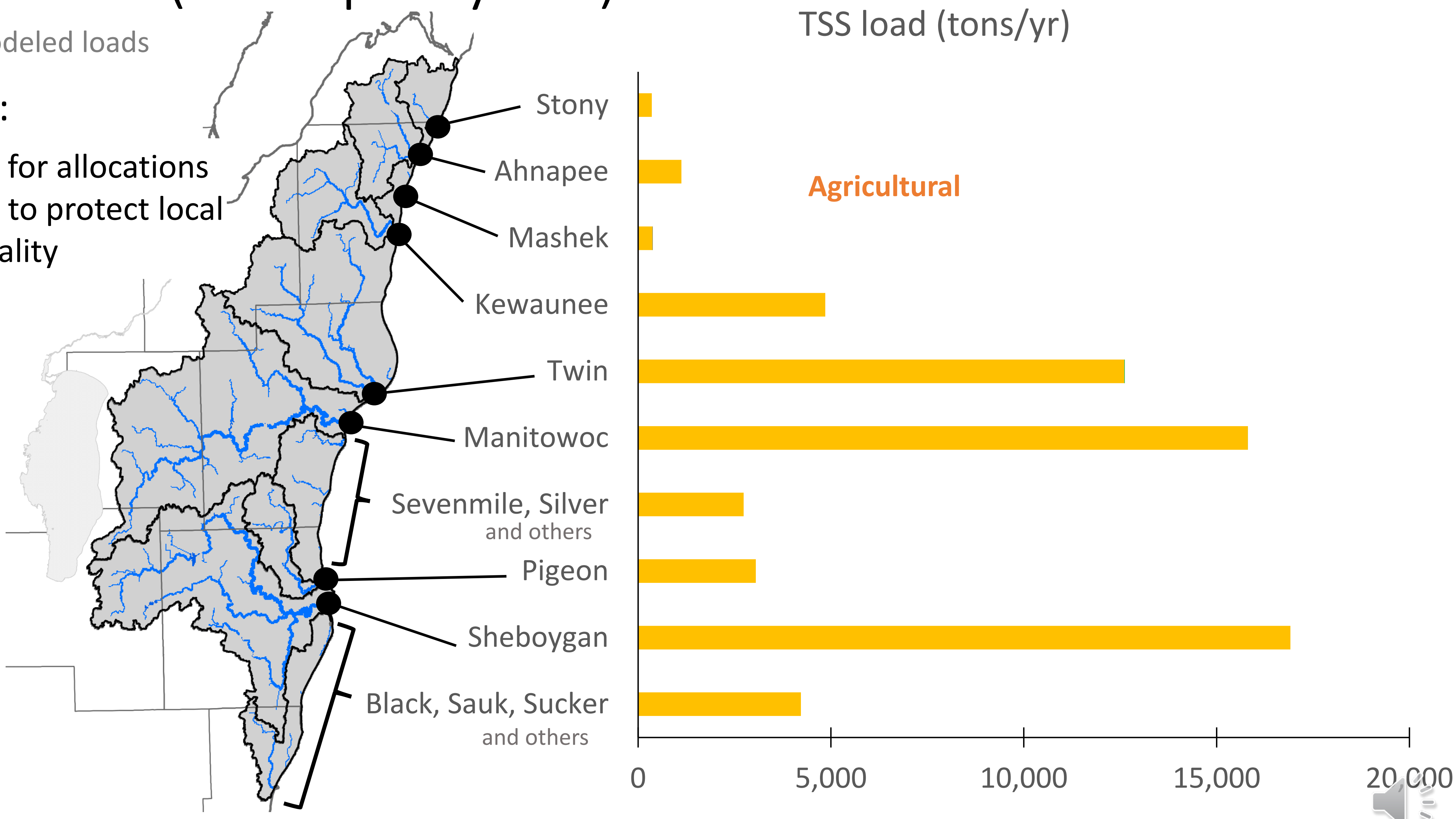


TSS Load (tons per year)

SWAT modeled loads

Basin Scale:

- Not used for allocations
- Too large to protect local water quality

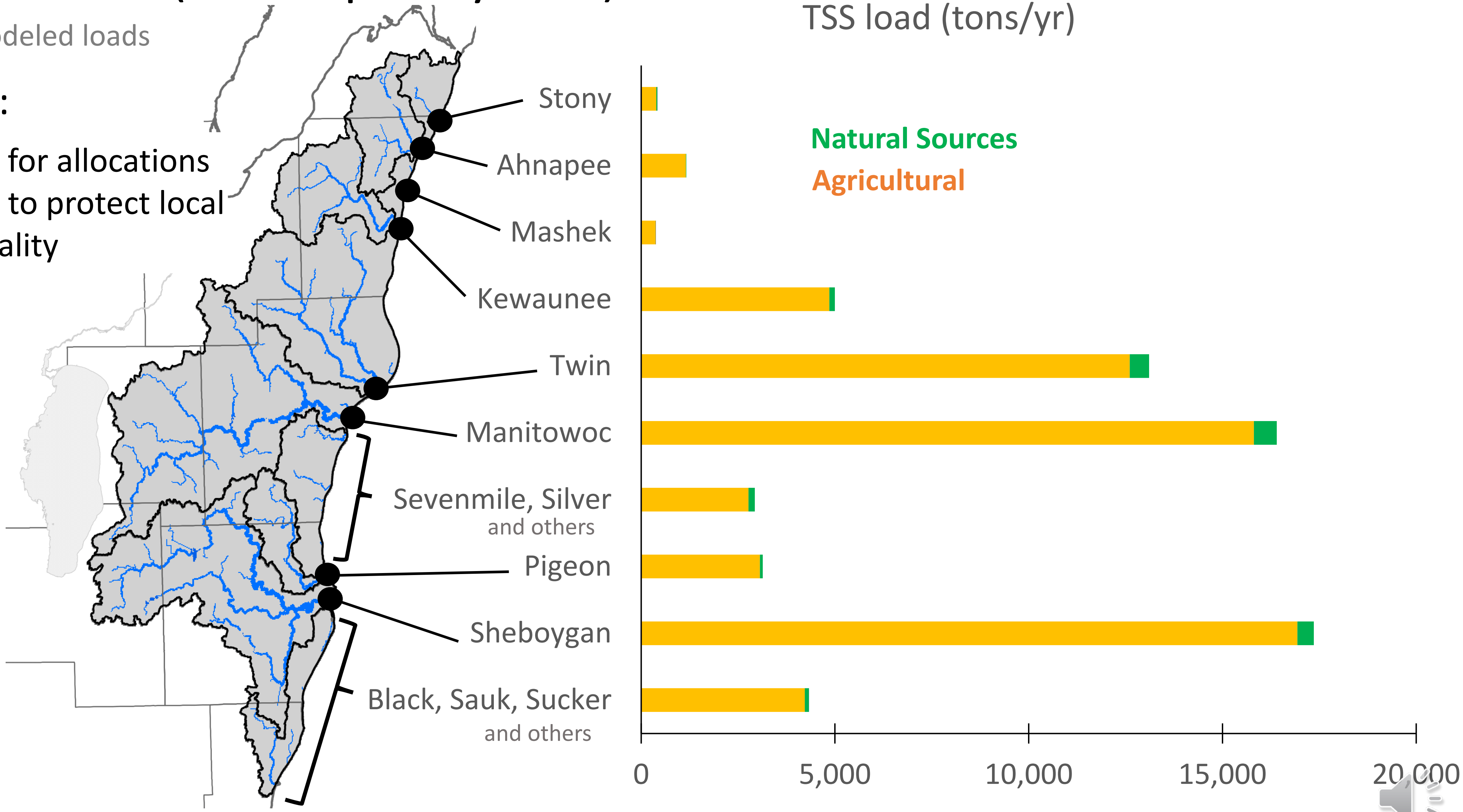


TSS Load (tons per year)

SWAT modeled loads

Basin Scale:

- Not used for allocations
- Too large to protect local water quality

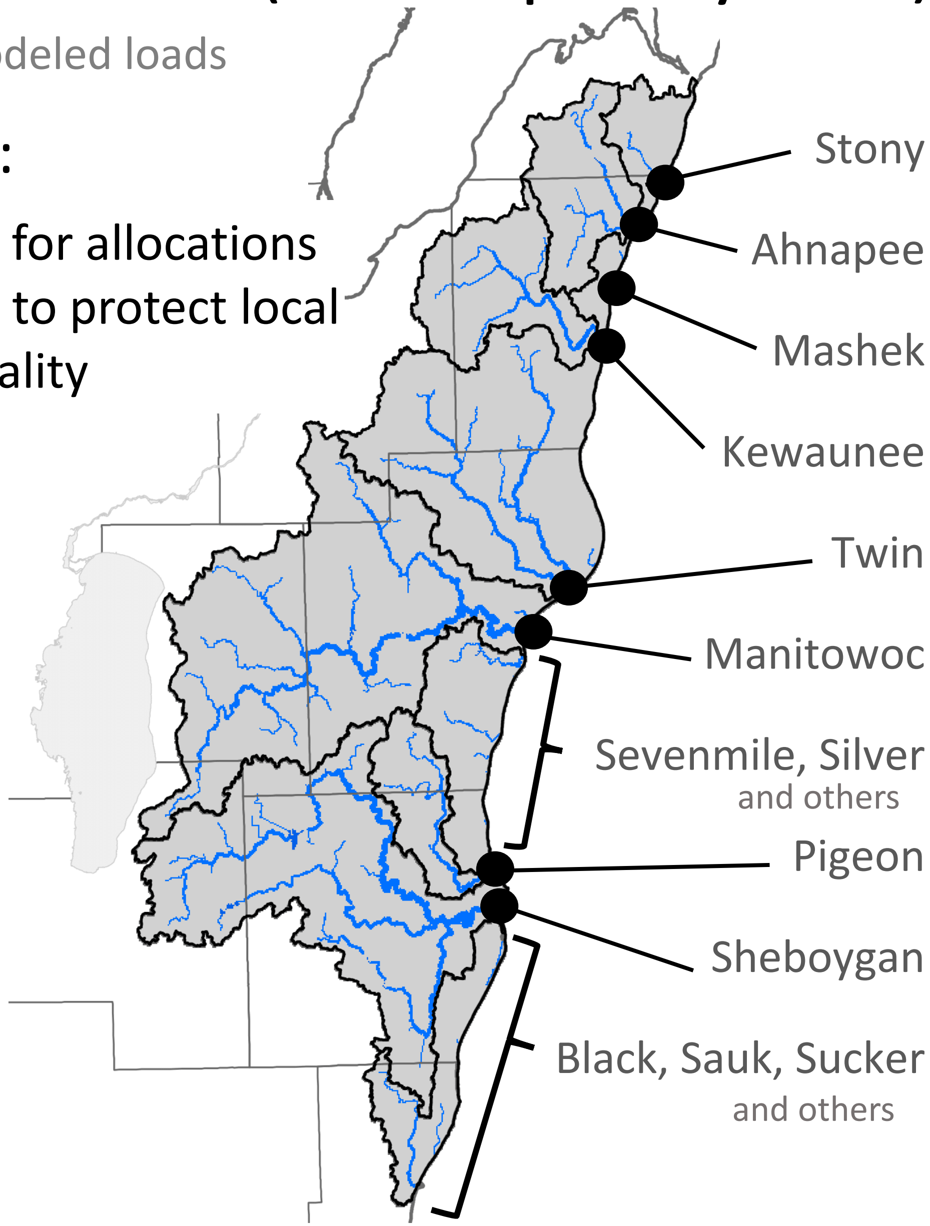


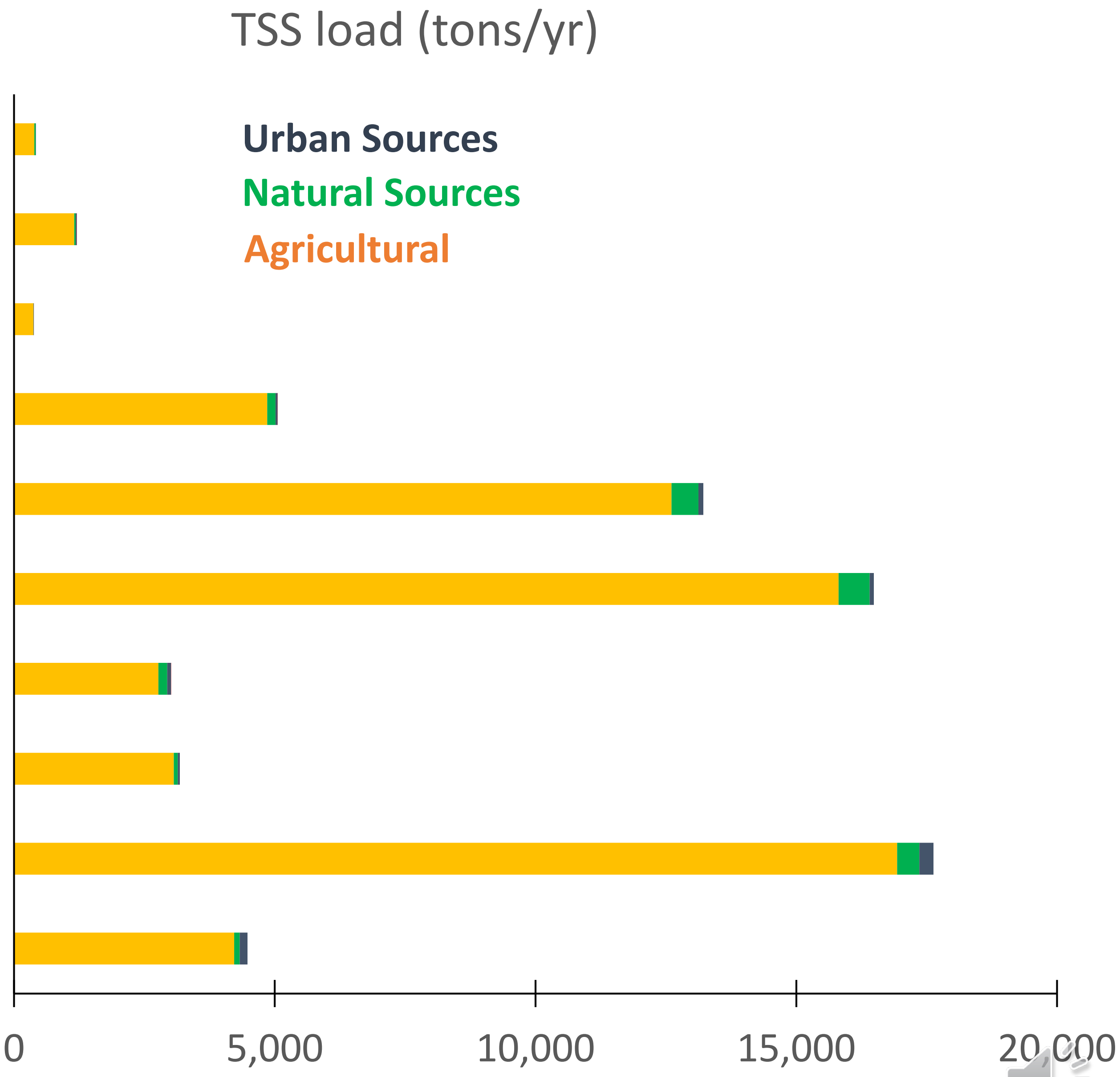
TSS Load (tons per year)

SWAT modeled loads

Basin Scale:

- Not used for allocations
- Too large to protect local water quality



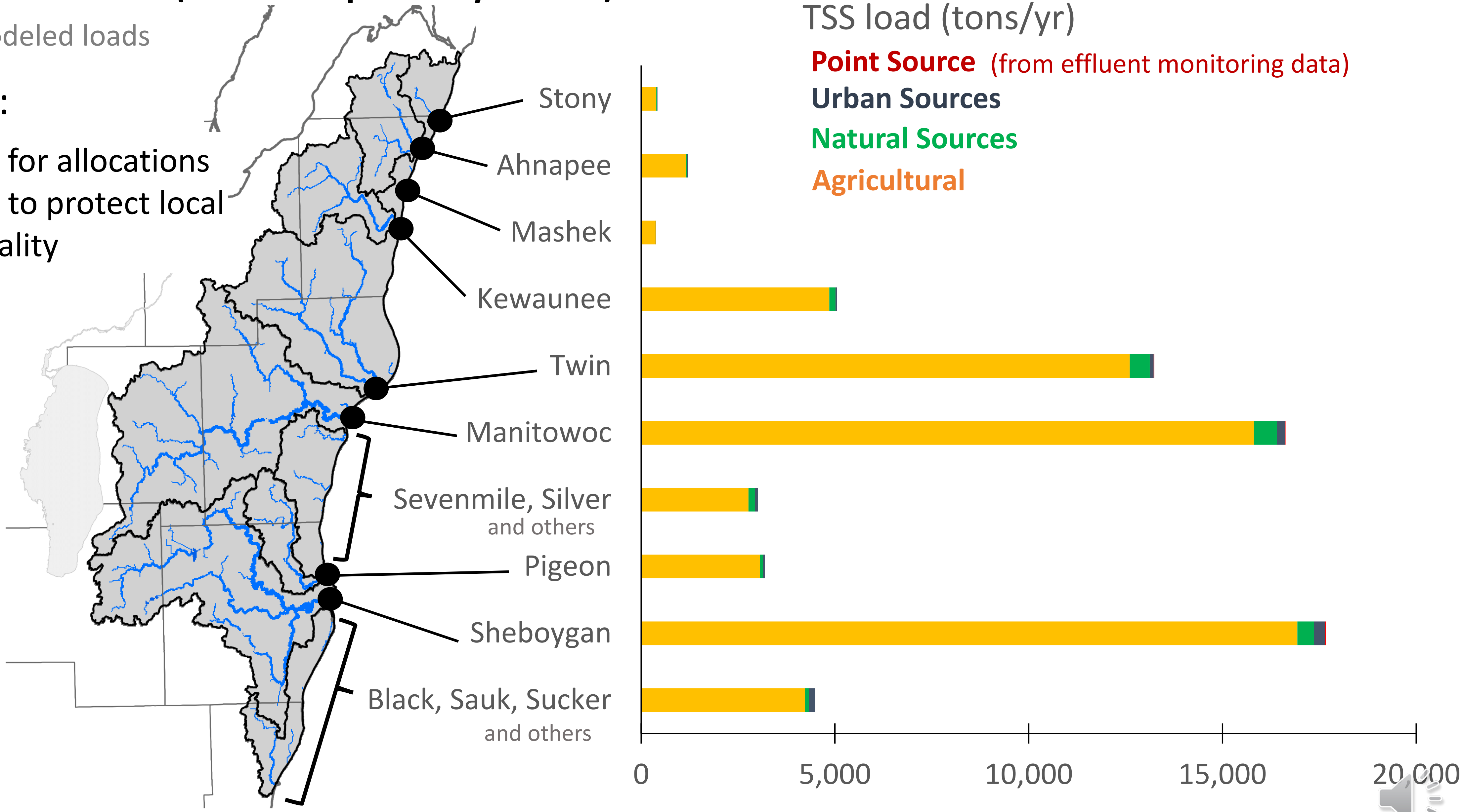


TSS Load (tons per year)

SWAT modeled loads

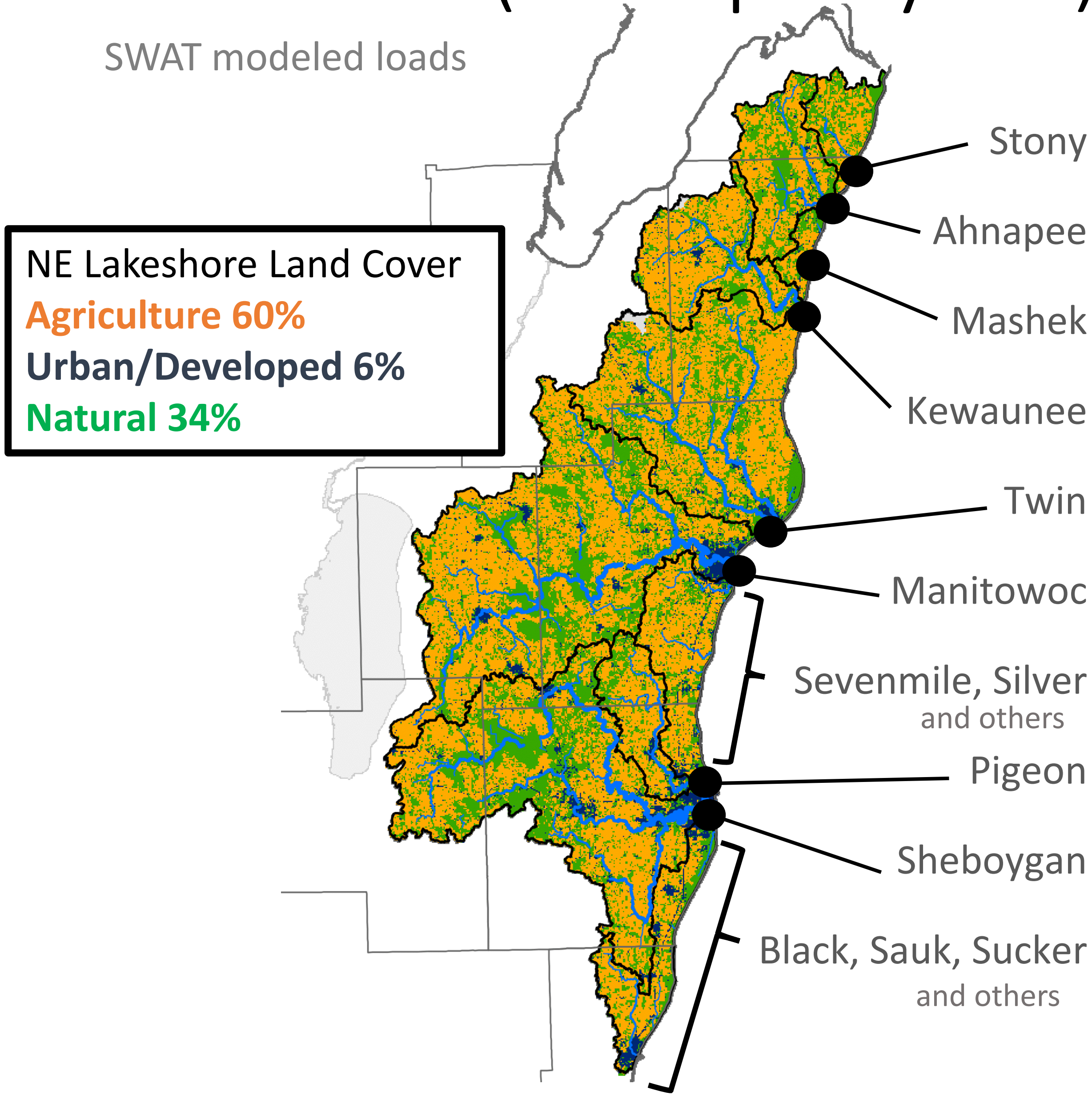
Basin Scale:

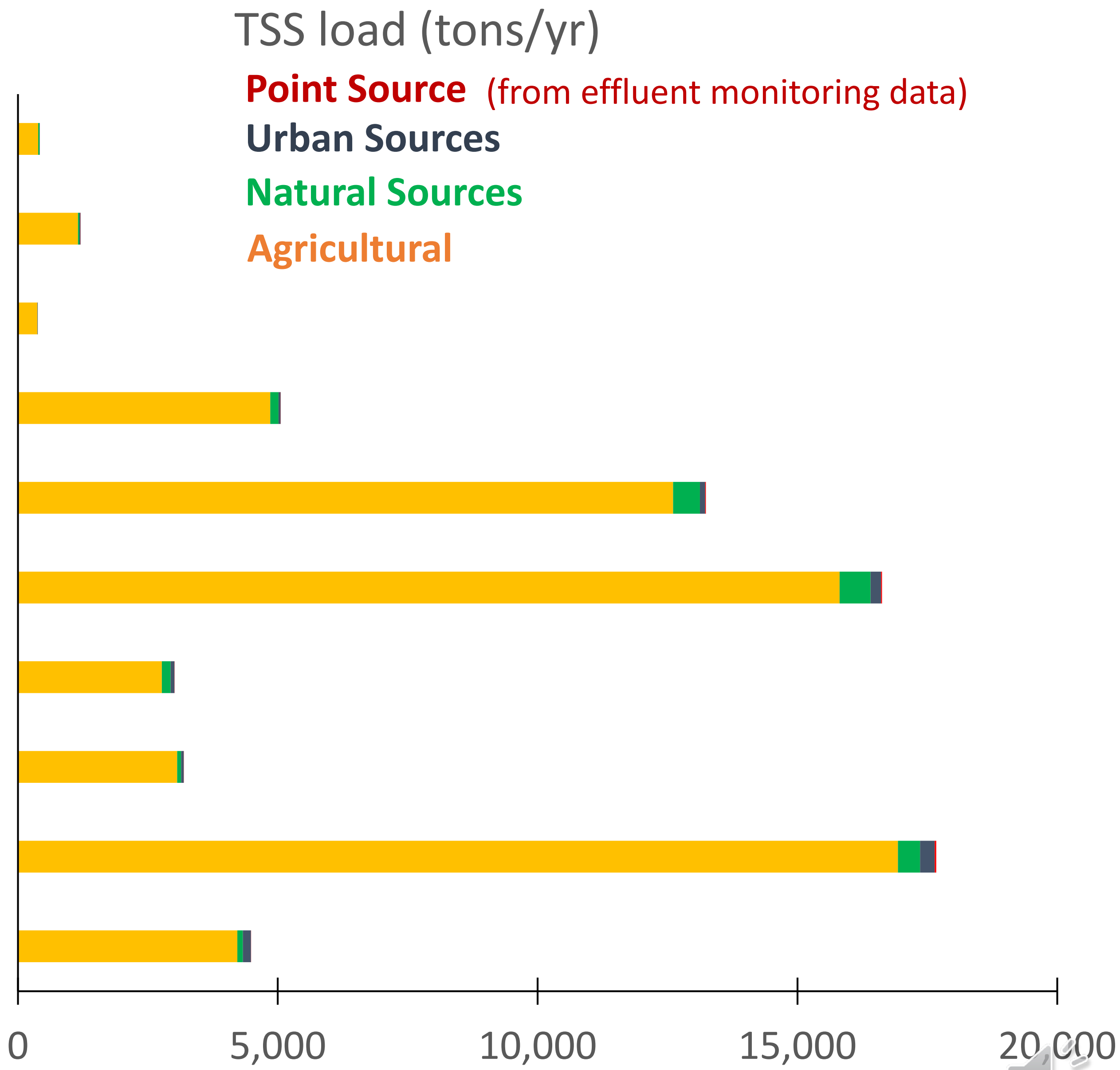
- Not used for allocations
- Too large to protect local water quality



TSS Load (tons per year)

SWAT modeled loads





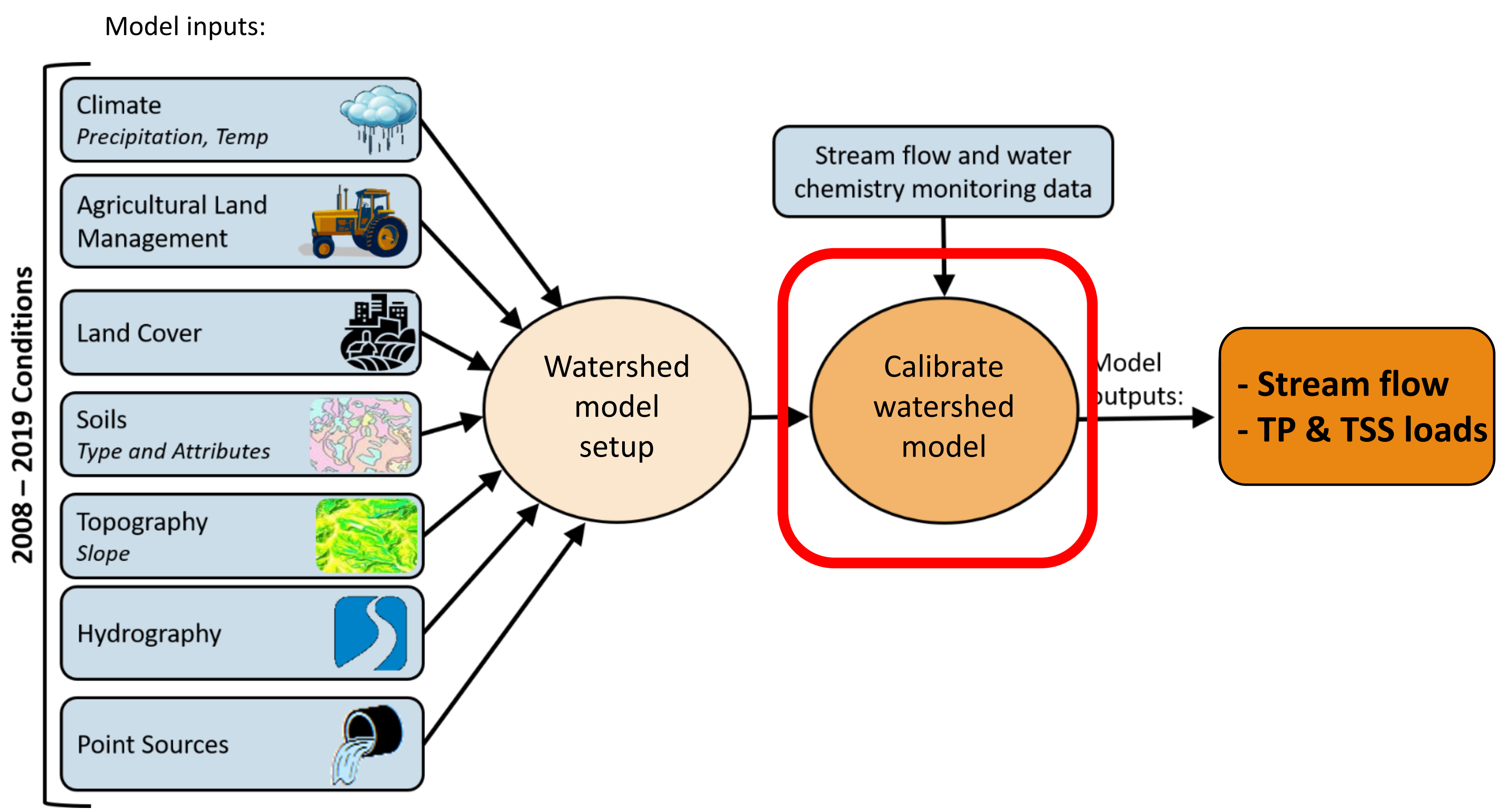
Summary: Total Suspended Solids

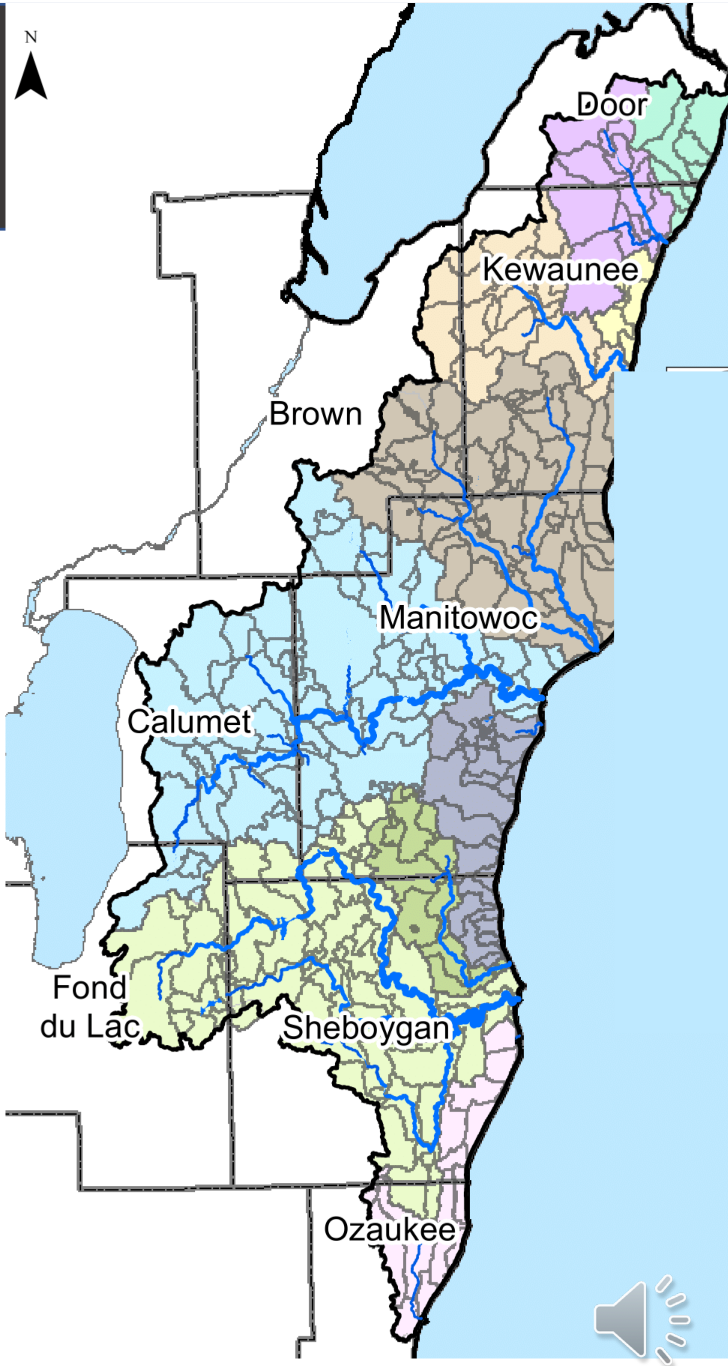
Variability in TSS rates generally explained by variations land cover, soils, and slope

Subbasin scale, used for allocations:
Relative contributions varied among sources (ag, urban, point source)

Basin scale:
Agricultural sources were predominant, as is agricultural land cover

Calibration and Validation





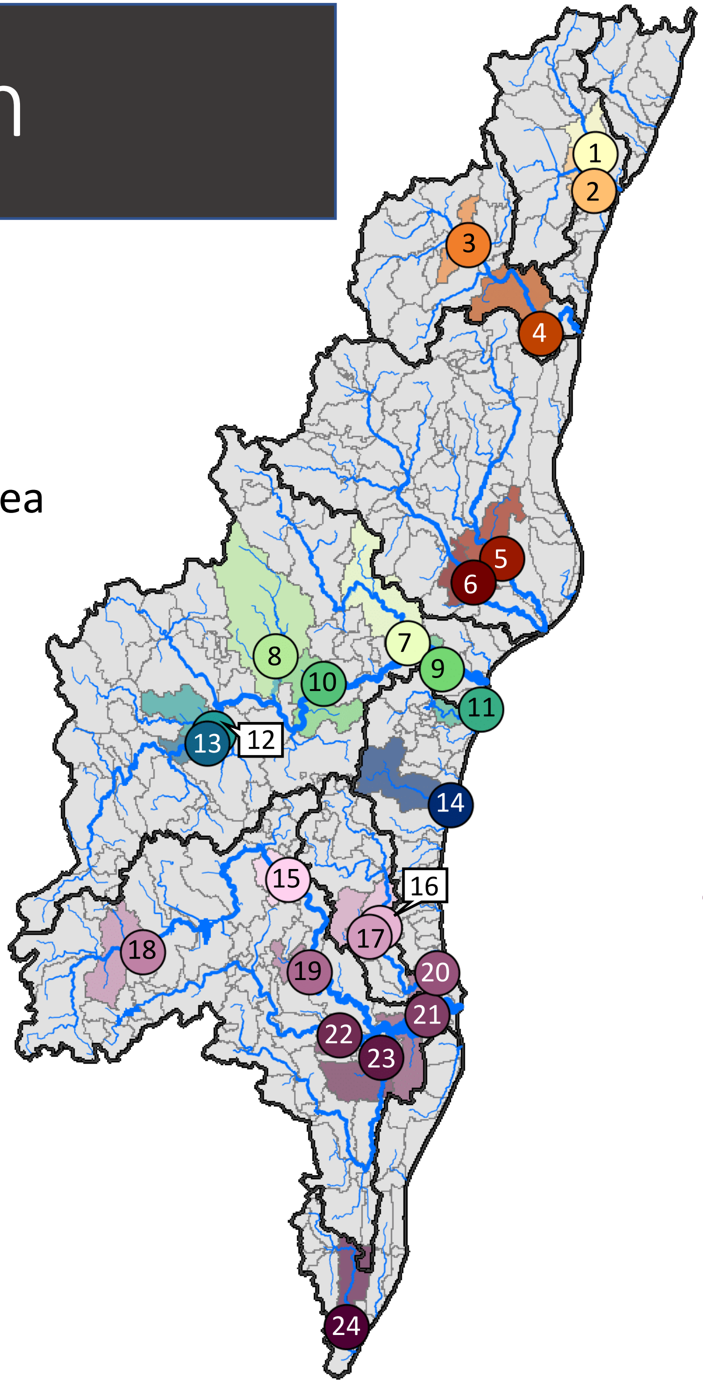
Calibration and Validation

Sites

- 22 sites used for calibration or validation
- Captured stream flow from 84% of the TMDL area
- 2 monitoring sites not used
    - Mud Creek
    - Killsnake at Lemke

Objective

- Improve the agreement of modeled outputs and real-world measurements
- Increases confidence in model estimates in subbasins without monitoring data



Kewaunee model basin

1. Ahnapee at CTY J
2. Silver Creek at Willow Dr
3. Kewaunee at Hillside Rd
4. Kewaunee near Kewaunee (USGS)
5. East Twin at Steiners Corners Rd
6. West Twin at CTH V

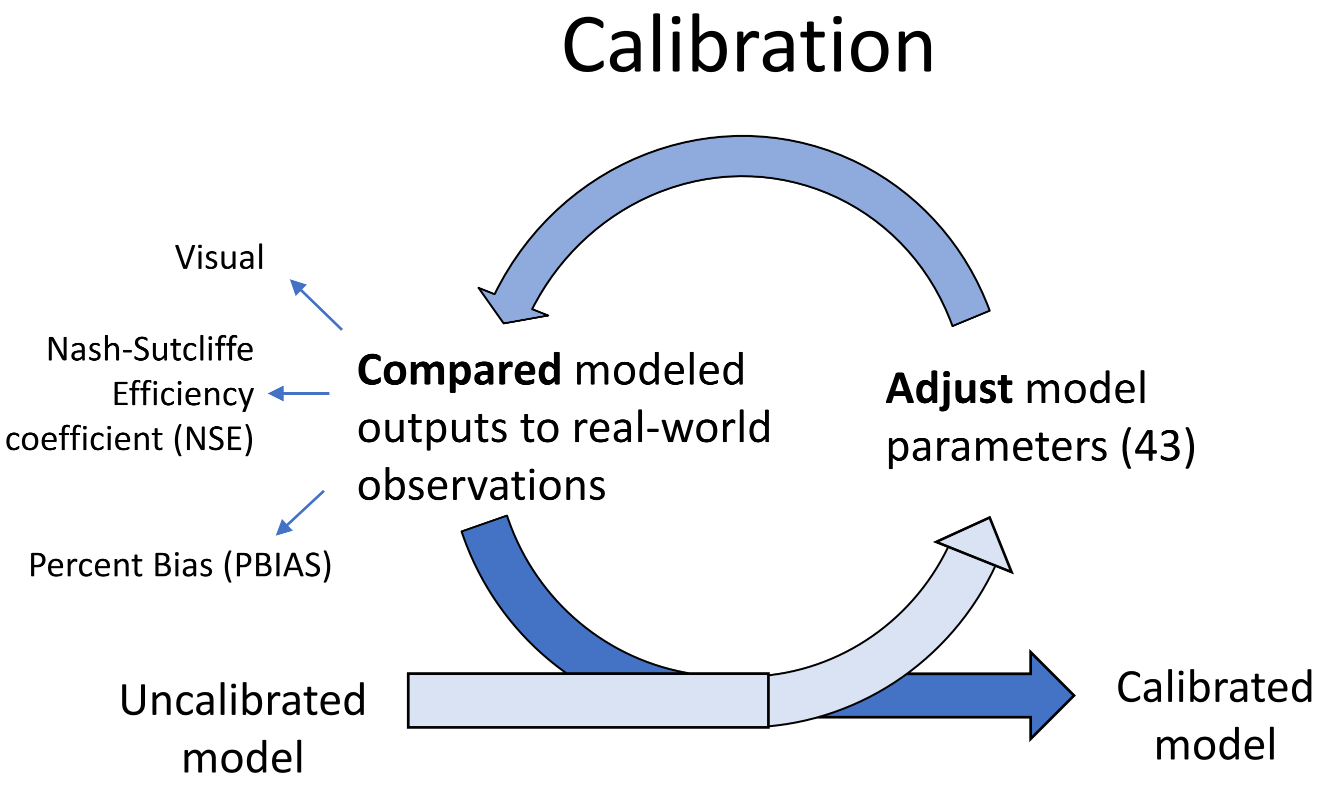
Manitowoc model basin

7. Branch River at N. Union Road
8. Mud Creek at Hilltop Rd
9. Manitowoc in Manitowoc (USGS)
10. Manitowoc River at Leist Rd
11. Silver Creek at CTH LS
12. Killsnake at Lemke Rd
13. Manitowoc South Branch at Lemke Rd
14. Point Creek at Centerville Rd

Sheboygan model basin

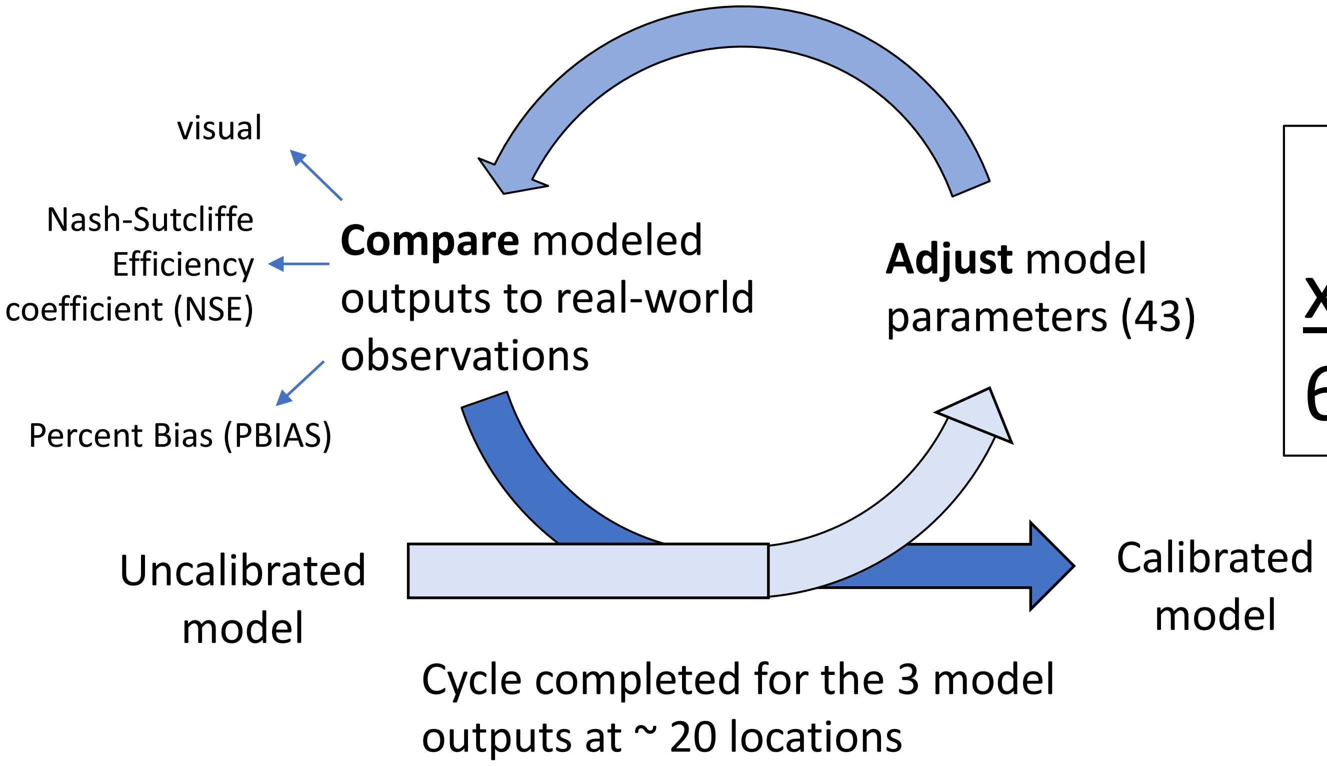
15. Sheboygan at Hwy 57
16. Pigeon at CTH A and River Rd
17. Fisher Creek at Howards Grove (USGS)
18. Sheboygan at Palm Tree Rd
19. Otter Creek near Plymouth (USGS)
20. Pigeon at Mill Rd
21. Sheboygan at Sheboygan (USGS)
22. Mullet at Sumac Rd
23. Onion River at Ourtown
24. Sauk at Mink Ranch Rd

Calibration and Validation Process

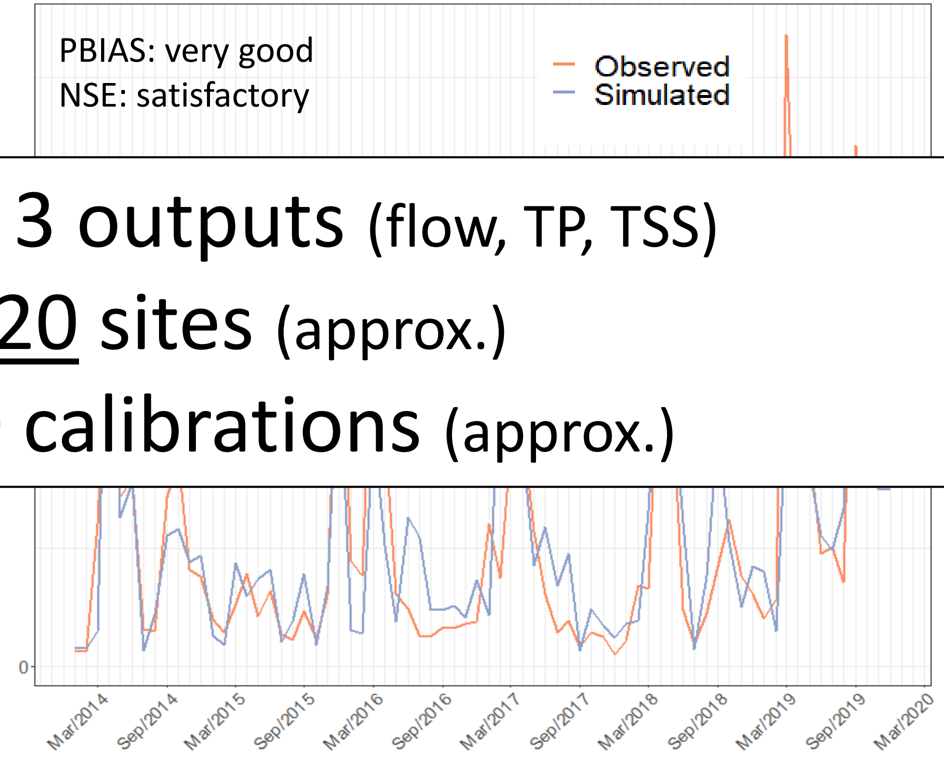


Calibration and Validation Process

Calibration



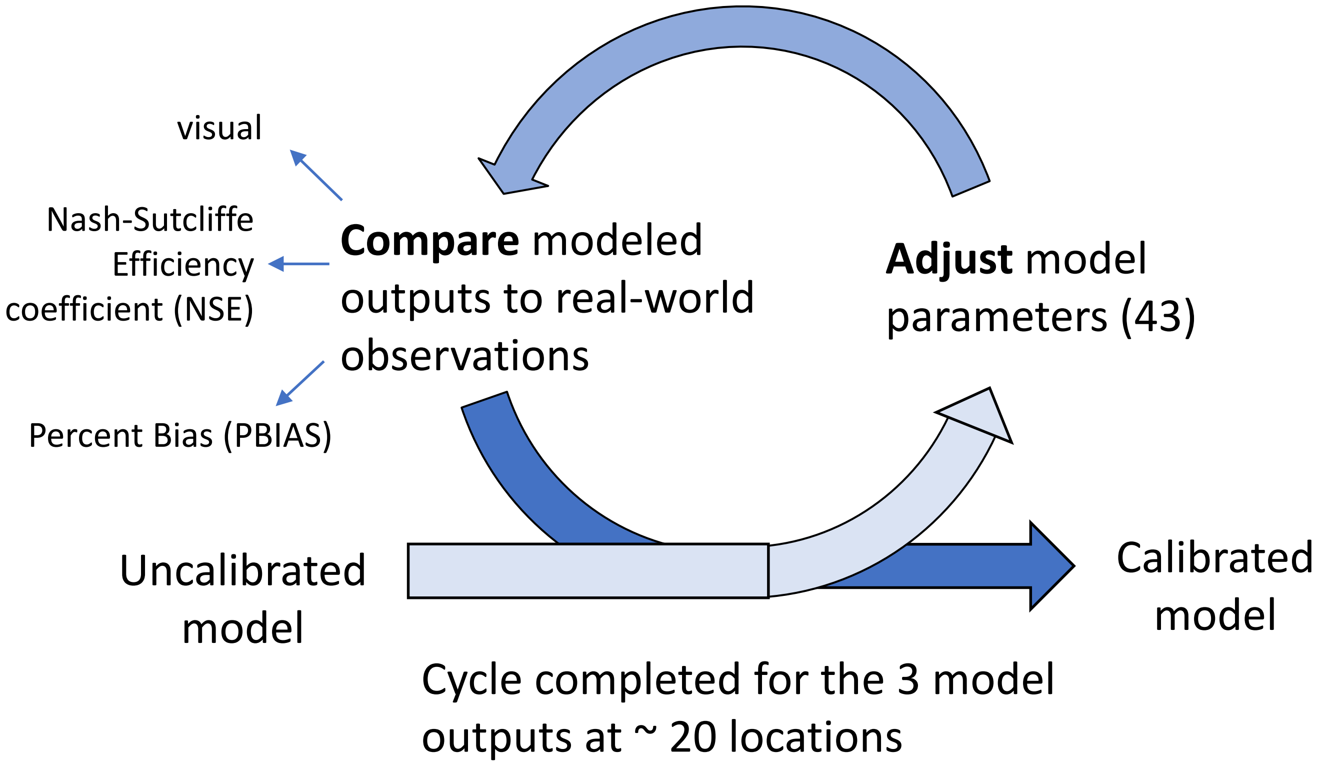
Streamflow
Kewaunee at Brummerville park (USGS)



3 outputs (flow, TP, TSS)
x 20 sites (approx.)
60 calibrations (approx.)

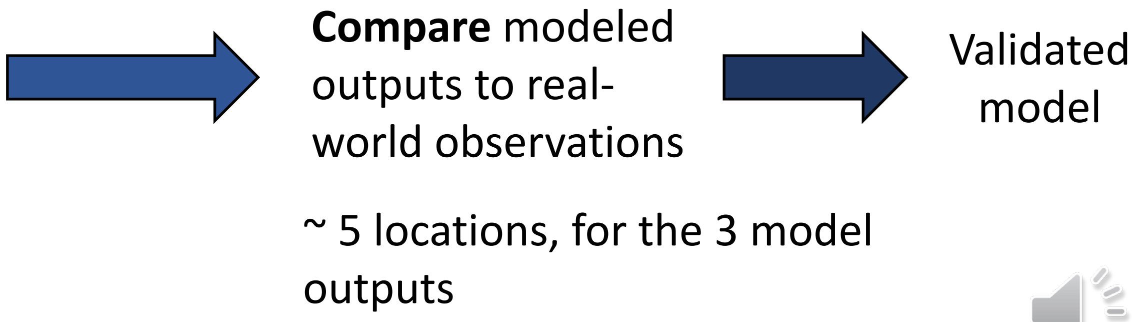
Calibration and Validation Process

Calibration



Validation

- Uses monitoring data not used for calibration
- Demonstrates that the model is accurately predicting throughout the study area



Calibration and Validation Results

What you will find in the report…

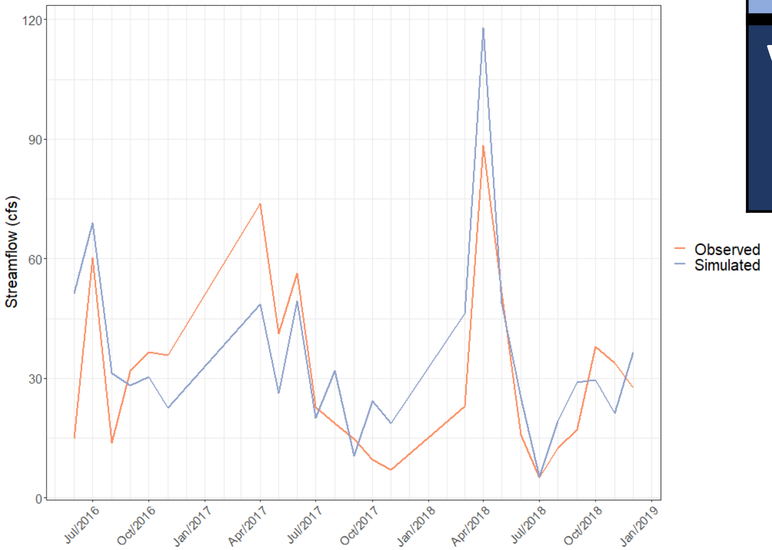
1) Tables of calibration statistics (R2, NSE, PBIAS) for each site and output (stream flow, TP, sediment)

Site ID	Site Name	R^2	NSE	PBIAS
153027	Ahnapee River at CTH J	0.61	0.50	12.2%
10008207	East Twin River at Steiners Corners Rd.	0.79	0.70	-14.2%
10020779	Silver Creek (Algoma) at Willow Drive	0.70	0.55	-9.4%
10029482	West Twin River at CTH V	0.70	0.70	-4.9%
10029954	Kewaunee River at Hillside Road	0.69	0.60	26.5%
04085200	Kewaunee River Near Kewaunee, WI	0.68	0.67	-10.7%
363228	Silver Creek (Manitowoc) at Cth Ls	0.72	0.71	3.8%
363313	Branch River at Branch River Rd	0.75	0.73	12.7%

Interpretation	Parameter	NSE	PBIAS
Satisfactory	Flow	0.75 or greater	±10 % or less
	TP	0.75 or greater	±15 % or less
	TSS	0.75 or greater	±25 % or less
Good	Flow	0.65 or greater	±15 % or less
	TP	0.65 or greater	±30 % or less
	TSS	0.65 or greater	±40 % or less
Very Good	Flow	0.5 or greater	±25 % or less
	TP	0.5 or greater	±55 % or less
	TSS	0.5 or greater	±70 % or less

Moriasi et al. 2007

2) Plots of modeled and observed results for each site and output (stream flow, TP, Sediment)



Calibration and Validation Results

What you will find in the report…

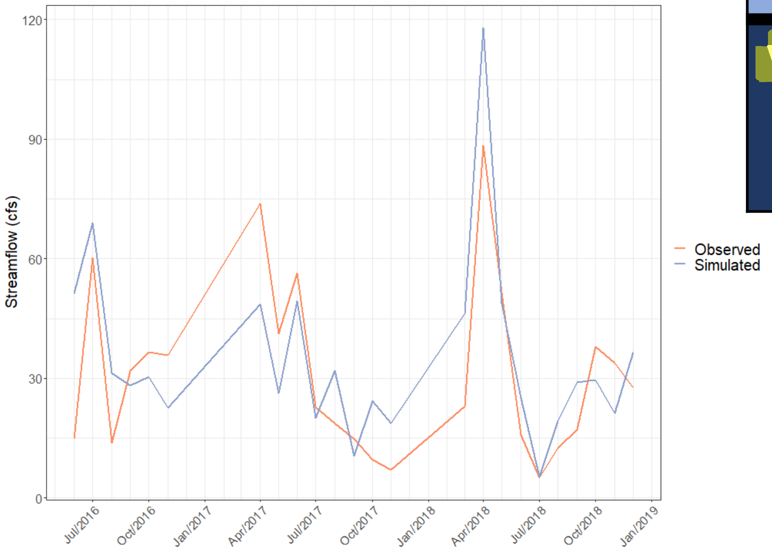
1) Tables of calibration statistics (R2, NSE, PBIAS) for each site and output (stream flow, TP, sediment)

Site ID	Site Name	R^2	NSE	PBIAS
153027	Ahnapee River at CTH J	0.61	0.50	12.2%
10008207	East Twin River at Steiners Corners Rd.	0.79	0.70	-14.2%
10020779	Silver Creek (Algoma) at Willow Drive	0.70	0.55	-9.4%
10029482	West Twin River at CTH V	0.70	0.70	-4.9%
10029954	Kewaunee River at Hillside Road	0.69	0.60	26.5%
04085200	Kewaunee River Near Kewaunee, WI	0.68	0.67	-10.7%
363228	Silver Creek (Manitowoc) at Cth Ls	0.72	0.71	3.8%
363313	Branch River at Branch River Rd	0.75	0.73	12.7%

Interpretation	Parameter	NSE	PBIAS
Satisfactory	Flow	0.75 or greater	±10 % or less
	TP	0.75 or greater	±15 % or less
	TSS	0.75 or greater	±25 % or less
Good	Flow	0.65 or greater	±15 % or less
	TP	0.65 or greater	±30 % or less
	TSS	0.65 or greater	±40 % or less
Very Good	Flow	0.5 or greater	±25 % or less
	TP	0.5 or greater	±55 % or less
	TSS	0.5 or greater	±70 % or less

Moriasi et al. 2007

2) Plots of modeled and observed results for each site and output (stream flow, TP, Sediment)



Calibration and Validation Results

Streamflow summary

		Calibration			Validation		
Model	**Site Name**	**PBIAS**	**NSE**	**Years (months)**	**PBIAS**	**NSE**	**Years**
Kewaunee	Ahnapee River at CTH J	Good	Satisfactory	June 2016 - Dec 2018 (24)			
	East Twin River at Steiners Corners Rd.	Good	Good	July 2017 - Oct 2019 (21)			
	Silver Creek (Algoma) at Willow Drive	Very good	Satisfactory	June 2016 - Oct 2019 (30)			
	West Twin River at CTH V	Very good	Good	July 2017 - Oct 2019 (20)			
	Kewaunee River at Hillside Road	Poor	Satisfactory	April 2018 - Oct 2018 (7)			
	Kewaunee River Near Kewaunee, WI (USGS)	Good	Good	2008 - 2013 (72)	Very Good	Satisfactory	2014 - 2019 (72)
Manitowoc	Silver Creek (Manitowoc) at Cth Ls	Very good	Good	July 2017 - Oct 2019 (22)			
	Branch River at Branch River Rd	Good	Good	July 2017 - Oct 2019 (20)			
	Point Creek at Centerville Rd.	Good	Satisfactory	May 2018 - Oct 2019 (10)			
	Manitowoc River South Branch at Lemke Road	Very good	Satisfactory	July 2017 - May 2019 (15)			
	Manitowoc River at Leist	Very good	Good	Aug 2017 - Oct 2019 (19)			
	Manitowoc River at Manitowoc, WI (USGS)	Satisfactory	Very good	2014 - 2019 (72)	Satisfactory	Very Good	2008 - 2013 (72)
Sheboygan	Sauk Creek at Mink Ranch Rd (Bi)	Very good	Very good	Dec 2017 - Nov 2019 (19)			
	Pigeon River at Mill Road	Very good	Very good	April 2018 - Aug 2018 (5)			
	Pigeon River at Cth A -And River Rd	Very good	Satisfactory	April 2018 - Nov 2019 (18)			
	Onion River at Ourtown Rd 5m Bi	Very good	Very good	May 2018 - Nov 2019 (16)			
	Sheboygan R. - Hwy 57 Crossing	Very good	Satisfactory	April 2018 - Dec. 2019 (18)			
	Sheboygan River at Palm Tree Rd	Very good	Satisfactory	April 2018 - Dec 2019 (9)			
	Mullet River at Sumac Road	Very good	Very good	April 2018 - Nov 2019 (16)			
	Fisher Creek at Howards Grove, WI (USGS)	Satisfactory	Very good	2011 - 2014 (39)	Very Good	Satisfactory	2014 - 2018 (39)
	Otter Creek at Willow Road Near Plymouth, WI (USGS)	Very good	Very good	2011 - 2015 (44)	Very Good	Satisfactory	2015 - 2018 (44)
	Sheboygan River at Sheboygan, WI (USGS)	Good	Very good	2014 - 2019 (64)	Very Good	Very Good	2008 - 2013 (65)

Calibration and Validation Results

Sediment summary

Overall, most sites were good to very good

		Calibration			Validation		
Model	Site Name	PBIAS	NSE*	Years (months)	PBIAS	NSE*	Years (months)
Kewaunee	Ahnapee River at CTH J	Very good		June 2016 - Dec 2018 (24)			
	East Twin River at Steiners Corners Rd.				Very good		July 2017 - Oct 2019 (21)
	Silver Creek (Algoma) at Willow Drive				Very good		June 2016 - Oct 2019 (27)
	West Twin River at CTH V	Very good		July 2017 - Oct 2019 (19)			
	Kewaunee River at Hillside Road	Good		April 2018 - Oct 2018 (7)			
	Kewaunee River Near Kewaunee, WI (USGS)	Very good	Poor	2008 - 2013 (71)	Good	Poor	2013 -2019 (71)
Manitowoc	Silver Creek (Manitowoc) at Cth Ls	Very good		July 2017 - Oct 2019 (21)			
	Branch River at Branch River Rd	Very good		July 2017 - Oct 2019 (20)			
	Point Creek at Centerville Rd.	Satisfactory		May 2018 - Oct 2019 (10)			
	Manitowoc River South Branch at Lemke Road				Poor		July 2017 - May 2019 (15)
	Manitowoc River at Manitowoc, WI (USGS)	Very good	Good	2014 - 2019 (71)	Good	Very good	2014 - 2019 (71)
Sheboygan	Sauk Creek at Mink Ranch Rd (Bi)				Satisfactory		April 2018 - Oct 2019 (16)
	Pigeon River at Mill Road	Very good		April 2018 - Aug 2018 (5)			
	Pigeon River at Cth A -And River Rd	Good		April 2018 - Oct 2019 (17)			
	Onion River at Ourtown Rd 5m Bi	Satisfactory		May 2018 - Oct 2019 (15)			
	Sheboygan R. - Hwy 57 Crossing	Good		April 2018 - Nov. 2019 (17)			
	Sheboygan River at Palm Tree Rd	Very good	Very good	April 2018 - Nov 2019 (8)			
	Mullet River at Sumac Road	Good		April 2018 - Oct 2019 (15)			
	Otter Creek at Willow Road Near Plymouth, WI (USGS)	Good	Satisfactory	2011 - 2016 (63)			
	Sheboygan River at Sheboygan, WI (USGS)	Good	Good	2014 - 2019 (68)	Good	Good	2008 - 2013 (68)

*NSE not appropriate for datasets with less than 3 years of data. Therefore, only PBIAS evaluated for theses sites.

Calibration and Validation Results

Total Phosphorus Summary

		Calibration			Validation		
Model	**Site Name**	**PBIAS**	**NSE***	**Years (months)**	**PBIAS**	**NSE***	**Years (months)**
Kewaunee	Ahnapee River at CTH J	Satisfactory		June 2016 - Dec 2018 (24)			
	East Twin River at Steiners Corners Rd.	Very good		July 2017 - Oct 2019 (21)			
	Silver Creek (Algoma) at Willow Drive				Satisfactory		June 2016 - Oct 2019 (27)
	West Twin River at CTH V	Very good		July 2017 - Oct 2019 (19)			
	Kewaunee River at Hillside Road	Very good		April 2018 - Oct 2018 (7)			
	Kewaunee River Near Kewaunee, WI (USGS)	Very good	Poor	2008 - 2013 (72)	Very good	Poor	2013 -2019 (71)
Manitowoc	Silver Creek (Manitowoc) at Cth Ls	Very good		July 2017 - Oct 2019 (21)			
	Branch River at Branch River Rd	Good		July 2017 - Oct 2019 (20)			
	Point Creek at Centerville Rd.	Good		May 2018 - Oct 2019 (10)			
	Manitowoc River South Branch at Lemke Road				Good		July 2017 - May 2019 (15)
	Manitowoc River at Manitowoc, WI (USGS)	Very good	Good	2014 - 2019 (72)	Very good	Very good	2014 - 2019 (72)
Sheboygan	Sauk Creek at Mink Ranch Rd (Bi)	Satisfactory		April 2018 - Oct 2019 (16)			
	Pigeon River at Mill Road	Very good		April 2018 - Aug 2018 (5)			
	Pigeon River at Cth A -And River Rd				Very good		April 2018 - Oct 2019 (17)
	Onion River at Ourtown Rd 5m Bi	Very good		May 2018 - Oct 2019 (15)			
	Sheboygan R. - Hwy 57 Crossing	Very good		April 2018 - Nov. 2019 (17)			
	Sheboygan River at Palm Tree Rd				Very good		April 2018 - Nov 2019 (8)
	Mullet River at Sumac Road	Satisfactory		April 2018 - Oct 2019 (15)			
	Fisher Creek at Howards Grove, WI (USGS)	Very good	Very good	2011 - 2015 (50)			
	Otter Creek at Willow Road Near Plymouth, WI (USGS)	Very good	Good	2011 - 2016 (63)			
	Sheboygan River at Sheboygan, WI (USGS)	Very good	Good	2014 - 2019 (68)	Good	Very good	2008 - 2013 (68)

*NSE not appropriate for datasets with less than 3 years of data. Therefore, only PBIAS evaluated for theses sites.

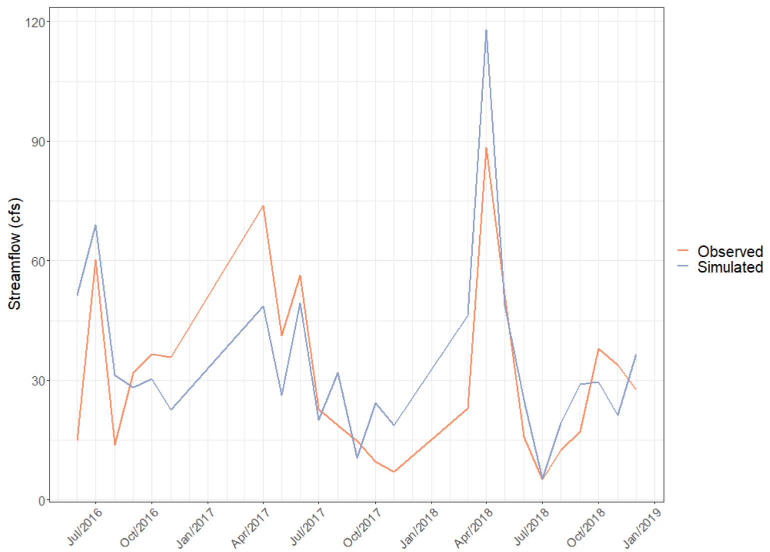
Calibration and Validation Results

What you will find in the report…

1) Tables of calibration statistics (R2, NSE, PBIAS) for each site and output (stream flow, TP, sediment)

Site ID	Site Name	R^2	NSE	PBIAS
153027	Ahnapee River at CTH J	0.61	0.50	12.2%
10008207	East Twin River at Steiners Corners Rd.	0.79	0.70	-14.2%
10020779	Silver Creek (Algoma) at Willow Drive	0.70	0.55	-9.4%
10029482	West Twin River at CTH V	0.70	0.70	-4.9%
10029954	Kewaunee River at Hillside Road	0.69	0.60	26.5%
04085200	Kewaunee River Near Kewaunee, WI	0.68	0.67	-10.7%
363228	Silver Creek (Manitowoc) at Cth Ls	0.72	0.71	3.8%
363313	Branch River at Branch River Rd	0.75	0.73	12.7%

2) Plots of modeled and observed results for each site and output (stream flow, TP, Sediment)



Remaining TMDL Development Steps

TMDL Development Steps

Public outreach/communication

1 Calculate Baseline Loads

What are the current pollutant loads and how much is coming from each source?

2 Determine Loading Capacity (TMDL)

What amount of pollutant can a waterbody receive?

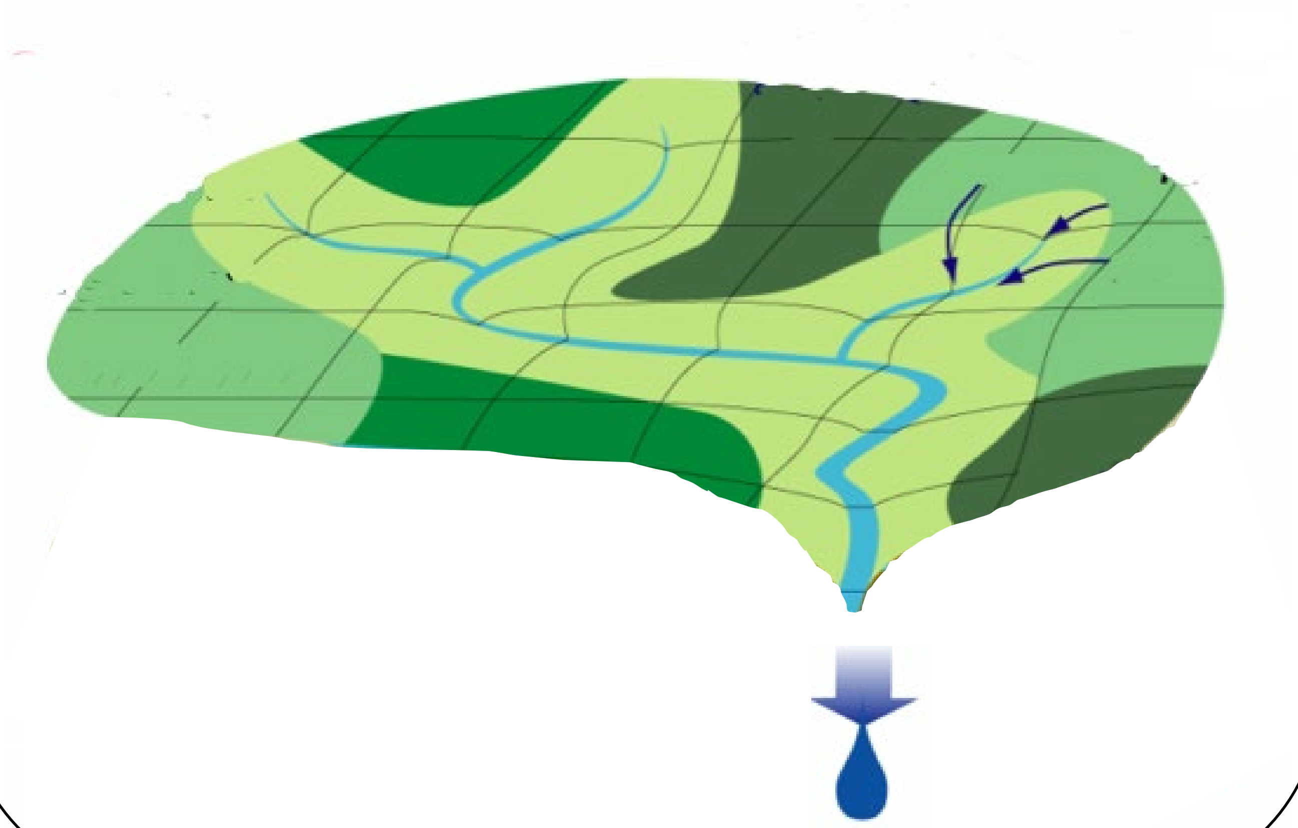
3 Allocate load among sources

What amount of pollutant reduction is needed from each source?

Loading capacity (TMDL)

Unique value for each of the 321 subbasins

Stream flow from watershed model



x

Water quality criteria or target

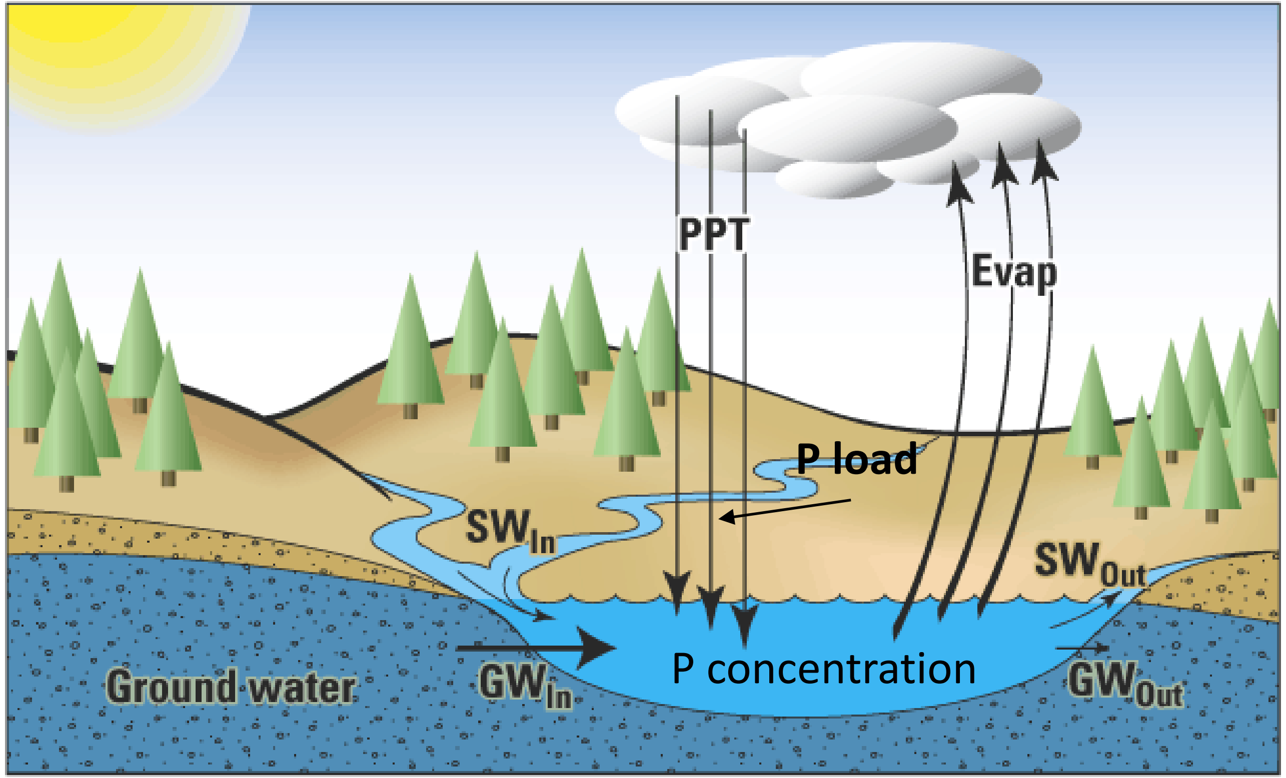
Total phosphorus (NR 102.06)

- Most streams and rivers in NE Lakeshore area 75 ug/L
- Manitowoc River 100 ug/L
- Sheboygan 100 ug/L

Loading capacity (TMDL)

Unique value for each of the 321 subbasins

Lakes: loading capacity from lake model



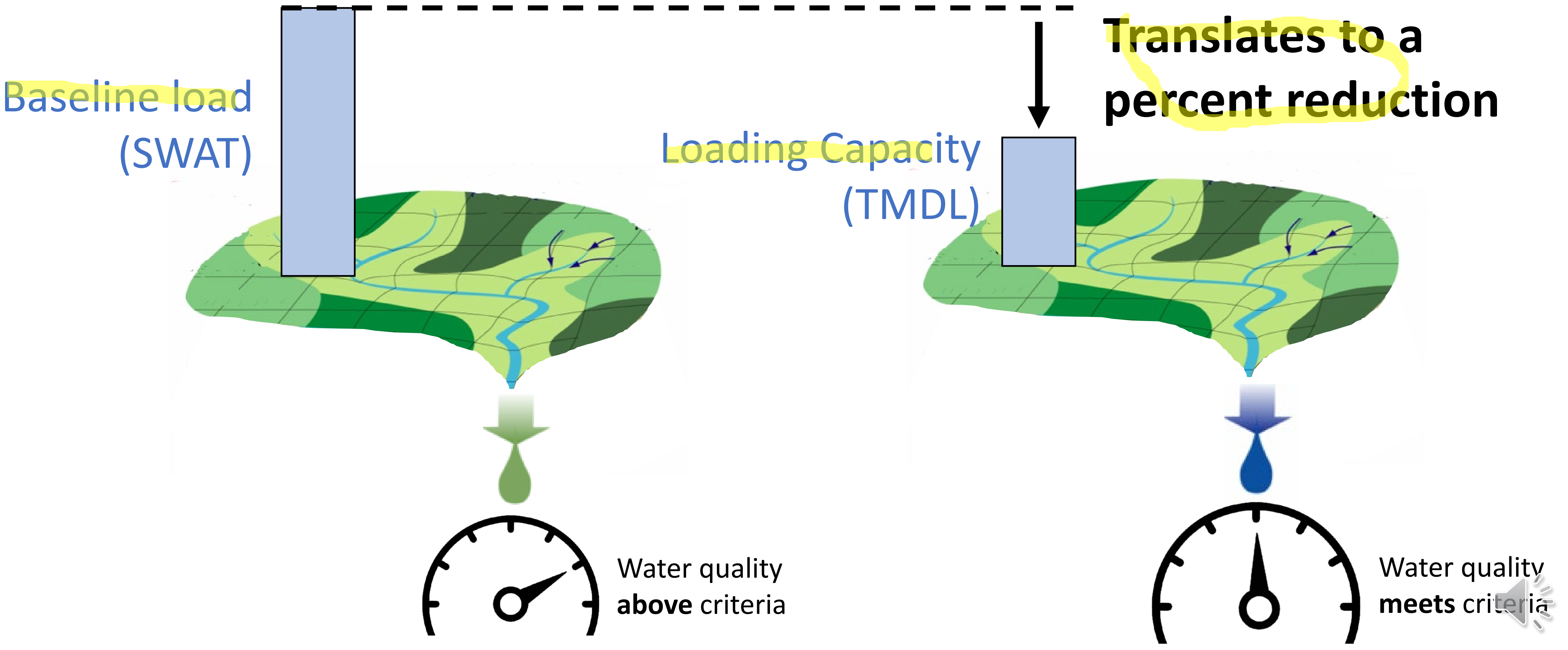
Water quality criteria or target

Total phosphorus (NR 102.06)

- Most streams and rivers in NE Lakeshore area 75 ug/L
- Manitowoc River 100 ug/L
- Sheboygan 100 ug/L
- NE Lakeshore lakes 20 – 30 ug/L
  - Use WiLMS (lake model) to determine loading capacity

Percent Reduction

Unique value for each of the 321 subbasins



TMDL Development Steps

Public outreach/communication

1 Calculate Baseline Loads

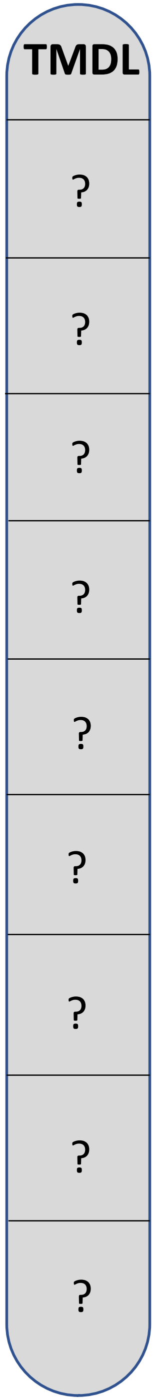
What are the current pollutant loads and how much is coming from each source?

2 Determine Loading Capacity (TMDL)

What amount of pollutant can a waterbody receive?

3 Allocate load among sources

What amount of pollutant reduction is needed from each source?



Allocation Process

Divides the TMDL among sources

Allocation Process

Divides the TMDL among sources

TMDL

What are the sources?

1) Load allocation

Nonpoint sources

2) Wasteload allocation

Point sources

3) Margin of Safety

Accounts for uncertainty in the data and modeling used to develop the TMDL
Required by EPA as part of the TMDL process

4) Reserve Capacity

Included in each TMDL subbasin to account for new and expanding dischargers

Allocation Process

Divides the TMDL among sources

TMDL

What are the sources?

1) Load allocation

Controllable sources

- Agricultural
- Non-permitted Urban

Uncontrollable sources

- Natural

2) Wasteload allocation

Controllable sources

- Permitted Urban
- Industrial Wastewater
- Municipal Wastewater
- CAFO production areas
- General Permits

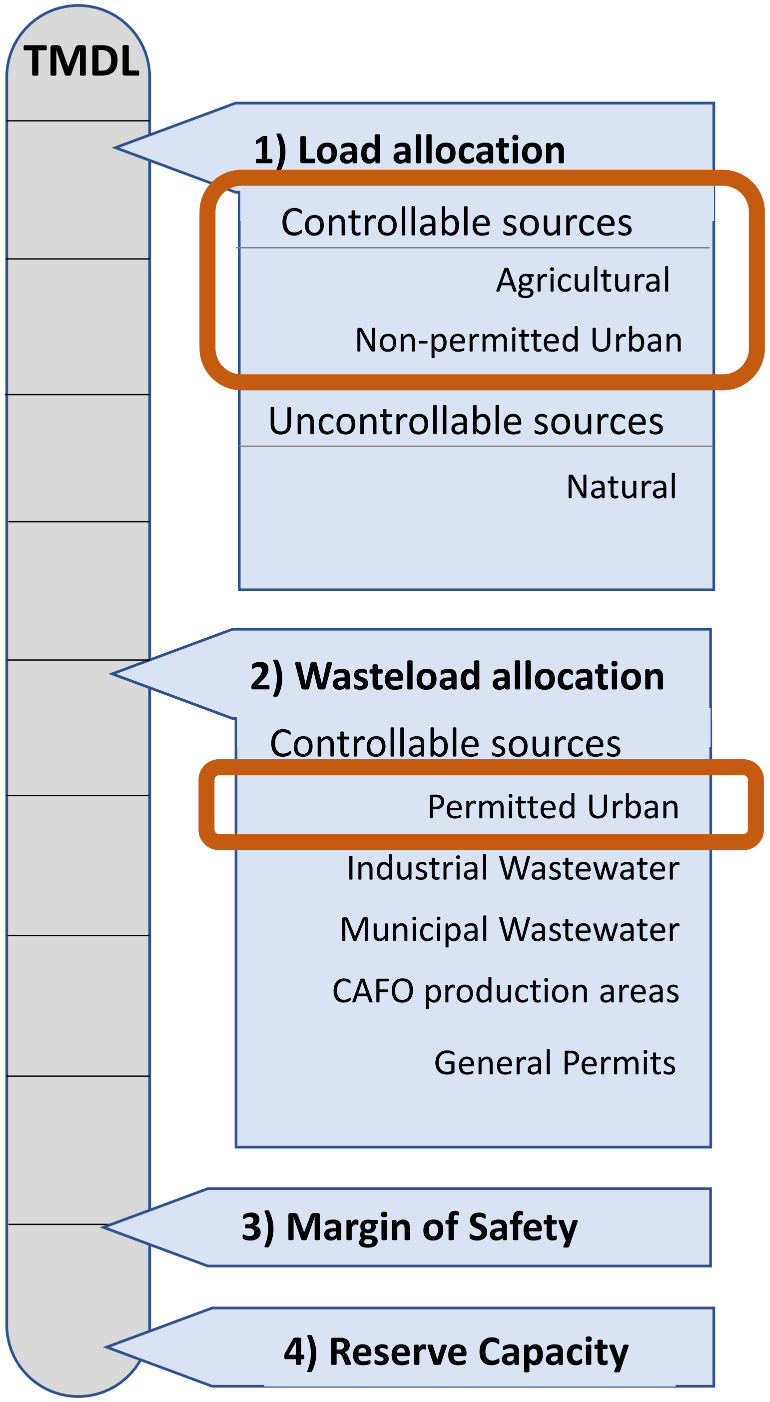
3) Margin of Safety

Accounts for uncertainty in the data and modeling used to develop the TMDL
Required as part of the TMDL process

4) Reserve Capacity

Included in each TMDL subbasin to account for new and expanding dischargers

Allocation Process



Controllable sources:

Agricultural, non-permitted urban, permitted urban (MS4)

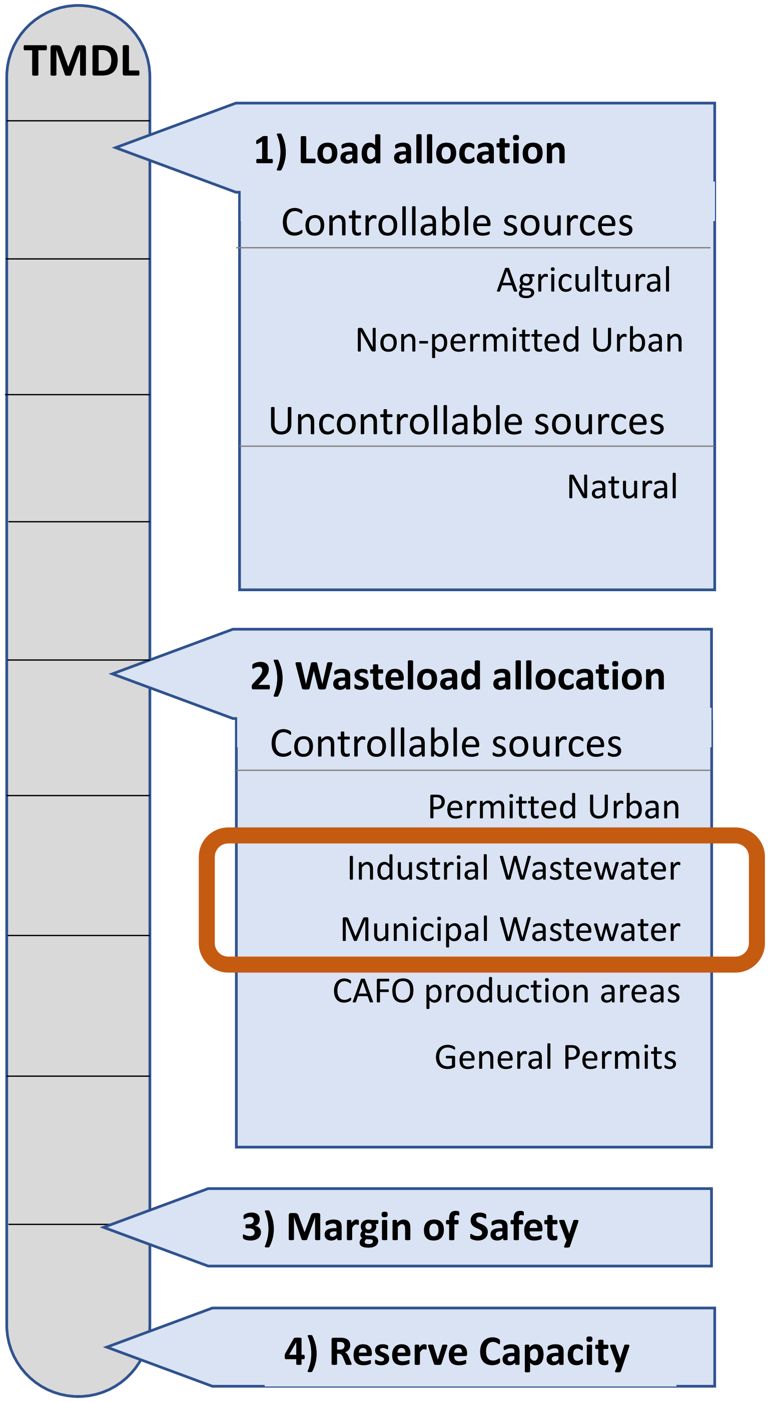
How is it allocated?

Receive an allocation proportional to their baseline load

How are baseline loads determined?

Modeled

Allocation Process



Controllable sources:

Industrial Wastewater & Municipal wastewater

How is it allocated?

Receive an allocation proportional to their baseline load

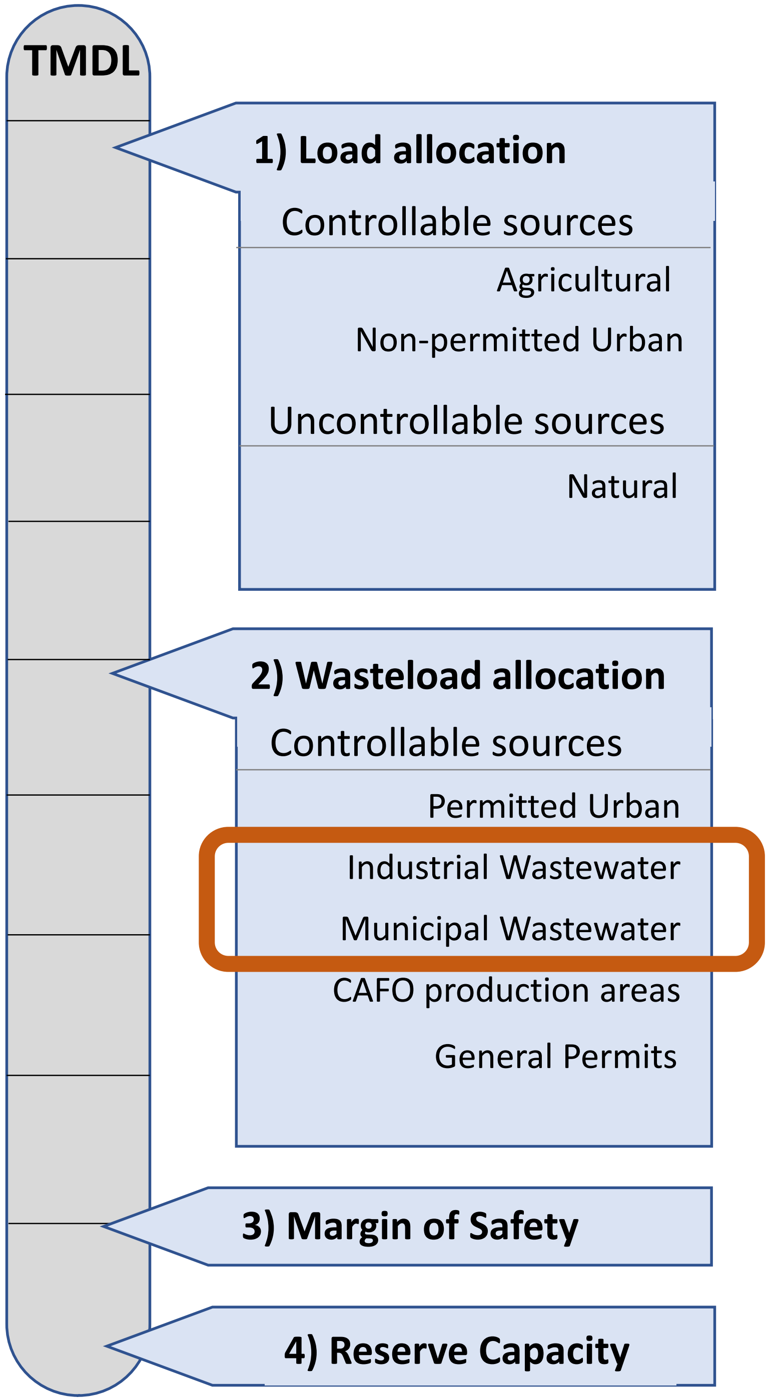
How are baseline loads determined?

Industrial Wastewater

- Baseline flow = Max annual average flow between 2015 - 2020
- Baseline TP conc. = 1 mg/L or effluent average if NCCW
- Baseline TSS conc. = current permitted limit or effluent average

Municipal wastewater

- Baseline flow = 1) Design flow or 2) Max annual average flow between 2015 – 2020 (which ever is highest)
- Baseline TP conc = 1 mg/L
- Baseline TSS conc = current permitted limit



Allocation Process

Controllable sources:

Industrial Wastewater & Municipal wastewater

How is it allocated?

Receive an allocation proportional to their baseline load

How are baseline loads determined?

Industrial Wastewater

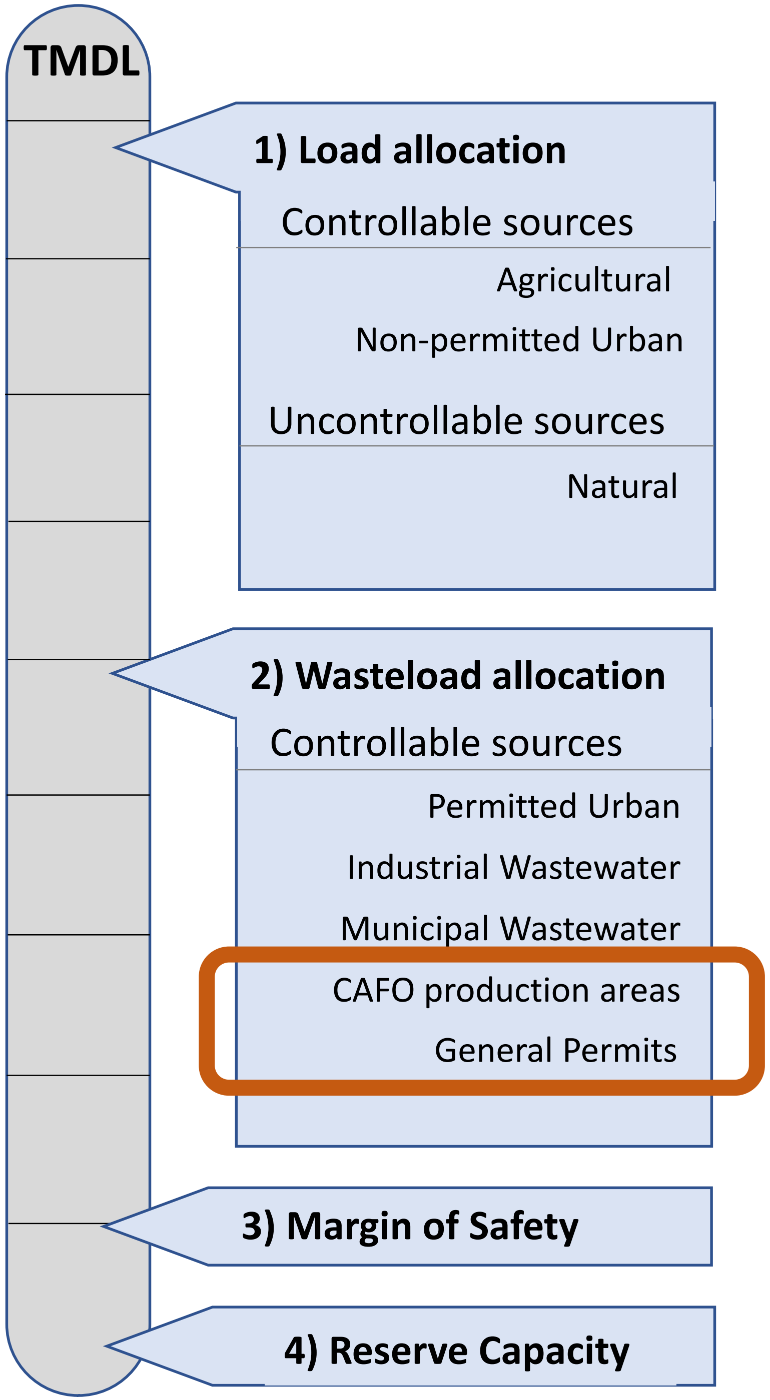
- Baseline flow = Max annual average flow between 2015 - 2020
- Baseline TP conc. = 1 mg/L or effluent average if NCCW
- Baseline TSS conc. = current permitted limit or effluent average

Municipal wastewater

- Baseline flow = 1) Design flow or 2) Max annual average flow between 2015 – 2020 (which ever is highest)
- Baseline TP conc = 1 mg/L
- Baseline TSS conc = current permitted limit

Baseline loads for industrial and municipal wastewater will be provided for review when draft allocations are ready (Summer 2021)

Allocation Process



Controllable sources:

CAFO production areas and General Permits

How is it allocated?

Receive an allocation equal to their baseline load

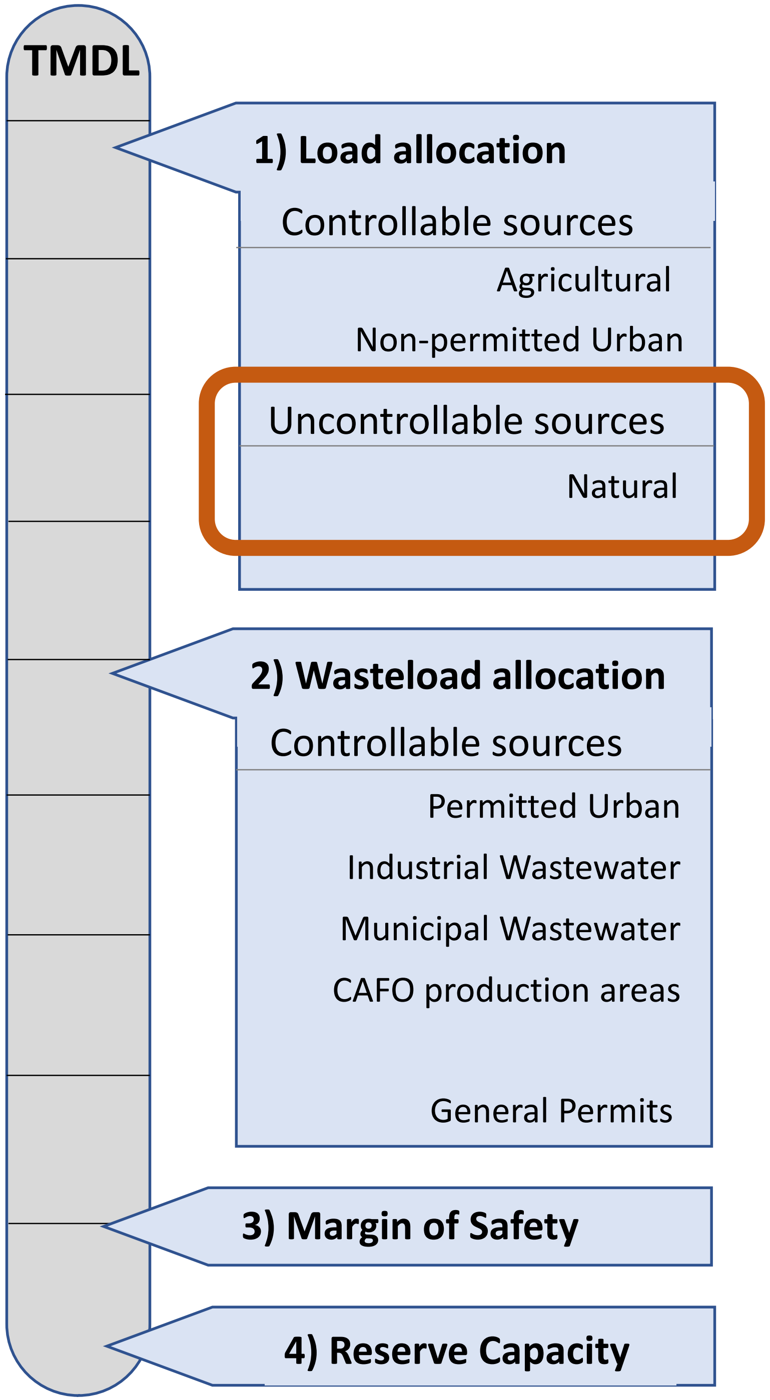
How are baseline loads determined?

CAFO production area = 0 assigned to production areas (fields covered by ag nonpoint)

General Permits

- Within a permitted MS4 boundary = included within the Permitted Urban (MS4)
- Outside a permitted MS4 boundary = 5 % of the non-permitted urban load per subbasin

Allocation Process



Uncontrollable sources:

Natural

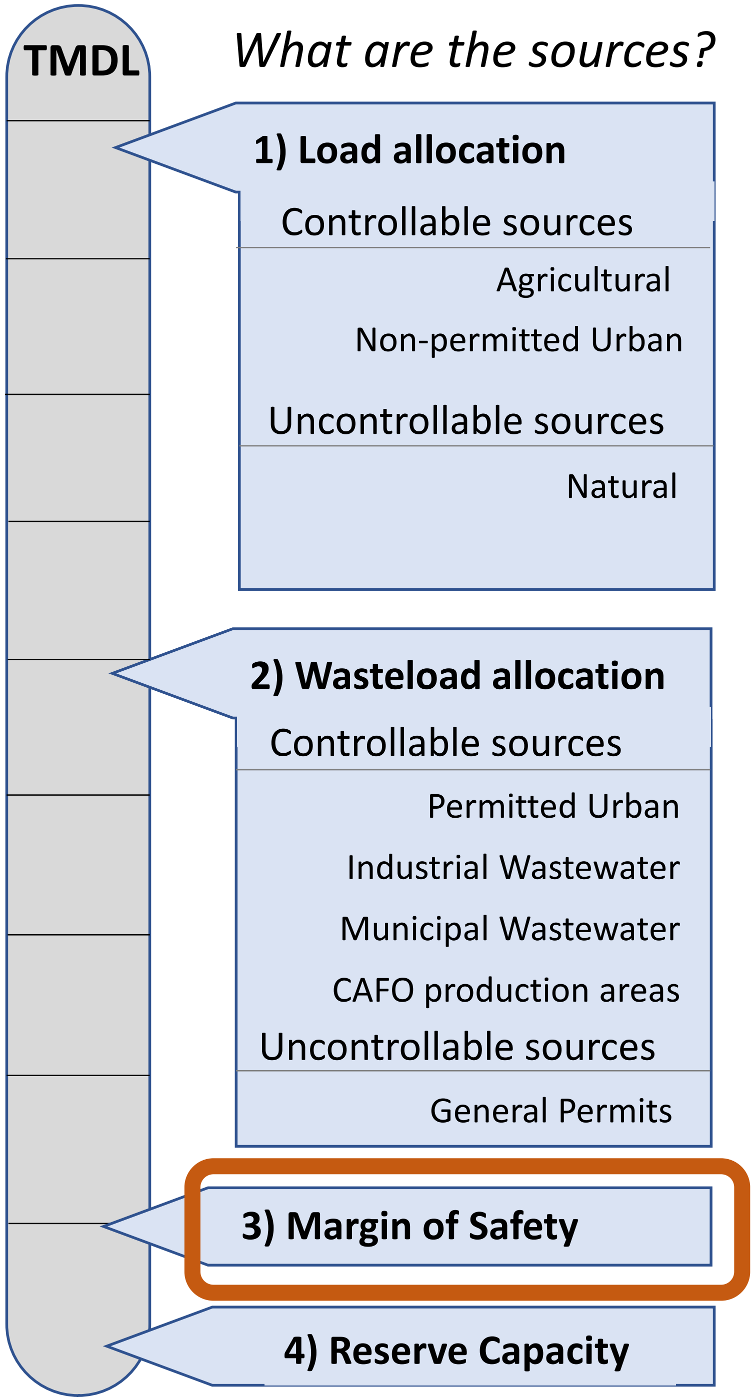
How is it allocated?

No percent reduction from their baseline load

How are baseline loads determined?

Modeled

Allocation Process



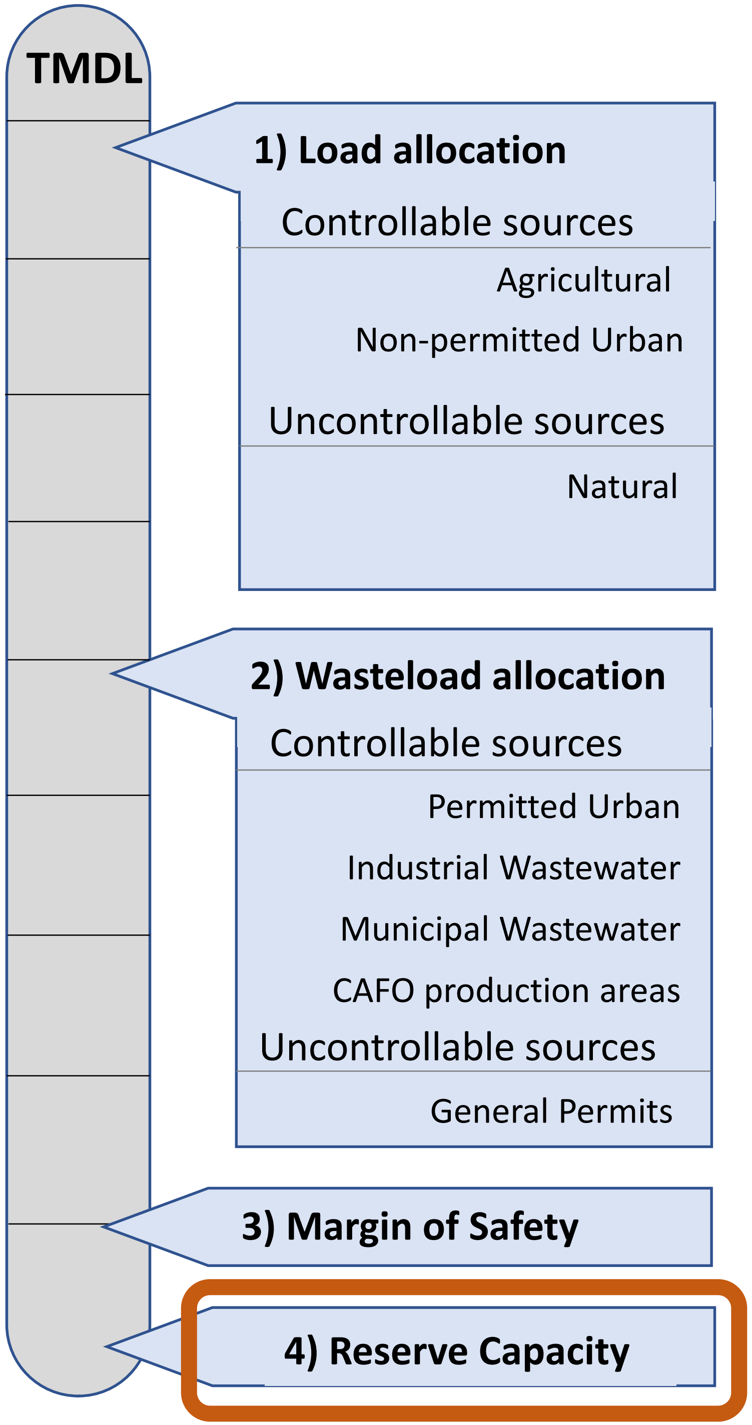
Margin of Safety:

- Required by EPA as part of the TMDL
- Accounts for uncertainty in the data and modeling using to develop the TMDL

How is it allocated?

- Implicit, through conservative model assumptions
- Explicit, such as direct percent of the allocation being set aside

Allocation Process



Reserve Capacity:

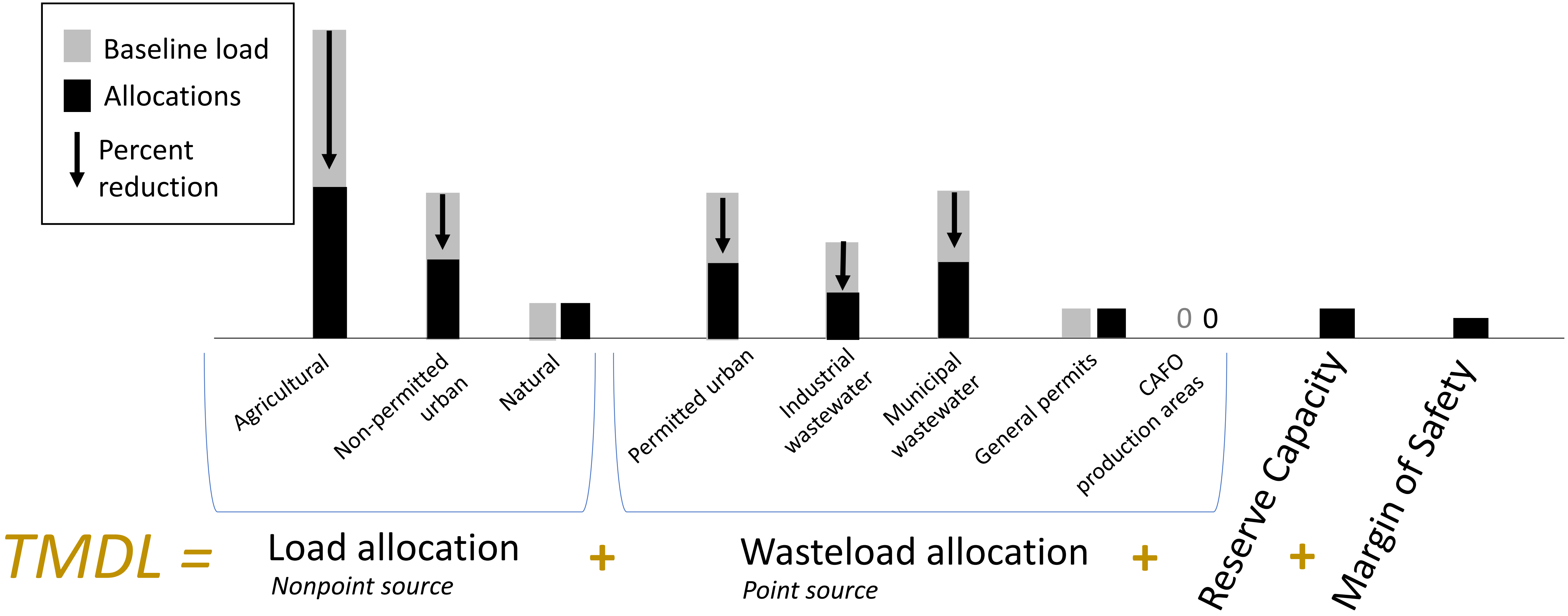
- Included in each subbasin to account for new or expanding dischargers

How is it allocated?

- Indirectly, through the use of facility design flows
- Directly, with an additional set aside
  - 5% of the controllable allowable load

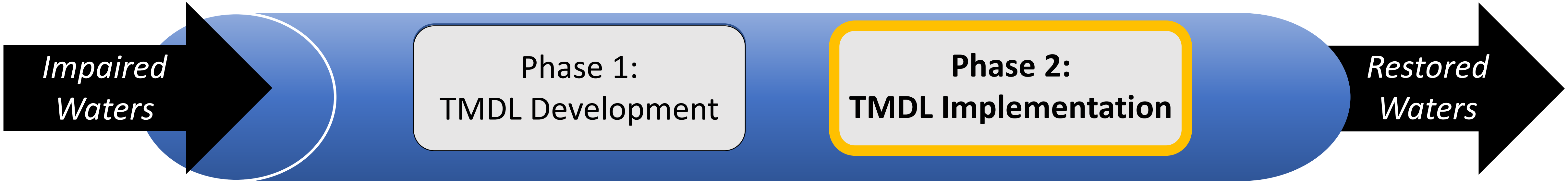
Allocation Process Summary

How is the TMDL divided among sources?

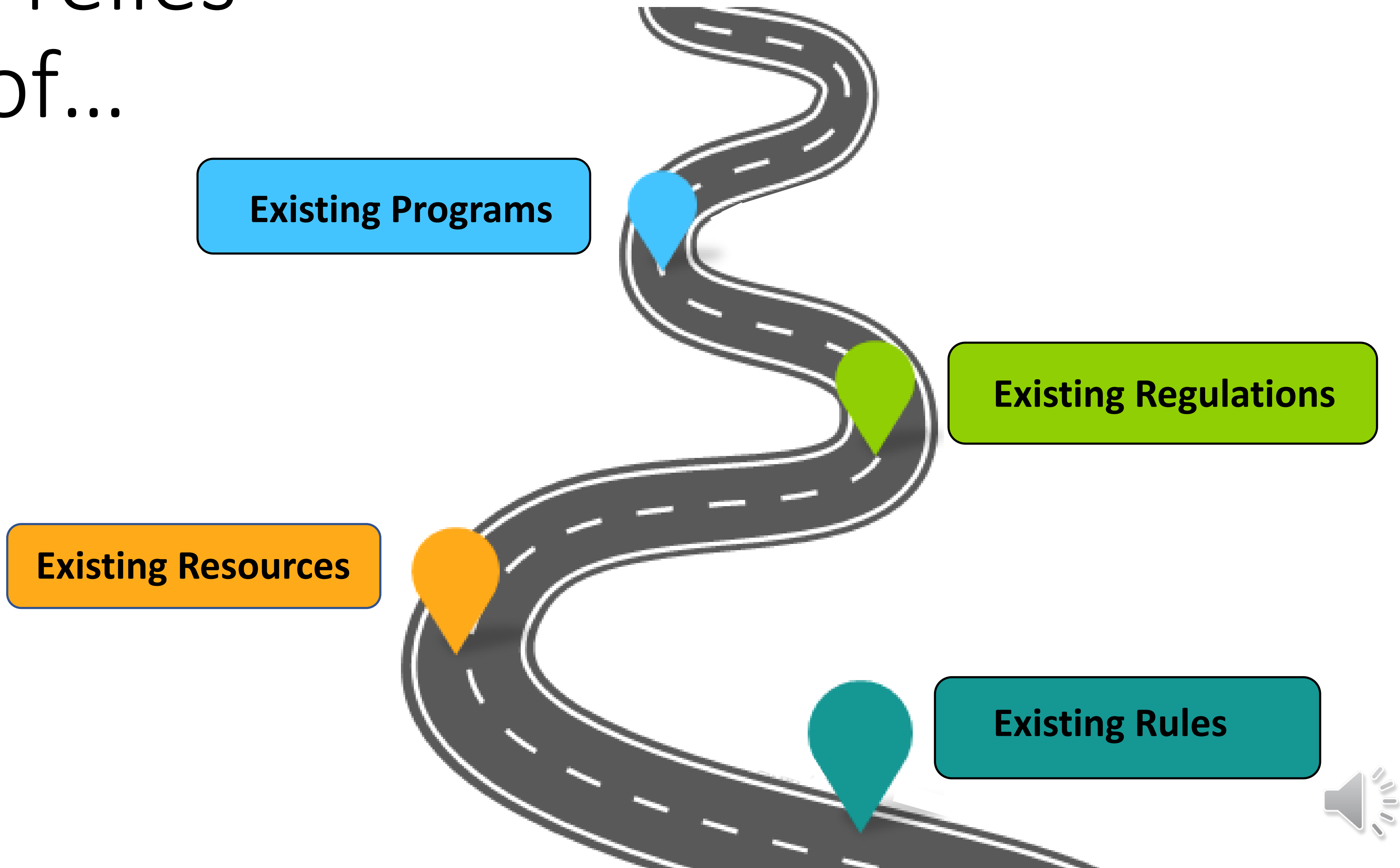


Implementation Summary

Total Maximum Daily Load Process



Implementation of TMDL plans relies on the use of…



Implementation Overview

Agricultural

Wastewater

MS4

Existing programs and standards

- Existing County and Federal programs (NRCS)
- NR 151 performance standards

Two phases

1. All farms and cropland – meet NR 151 (this may meet the TMDL goals)

2. Critical fields – may to do more to meet TMDL targets

   Compliance with TMDL agricultural targets is voluntary unless promulgated through NR 151.004.
   Cost share requirements still in place

Implementation Overview

Agricultural

Wastewater

MS4

Edge of field targets

Translates TMDL allocations into a value that can easily be compared to nutrient management plans

SNAPPLUS
WISCONSIN'S NUTRIENT MANAGEMENT PLANNING SOFTWARE

Implementation Overview

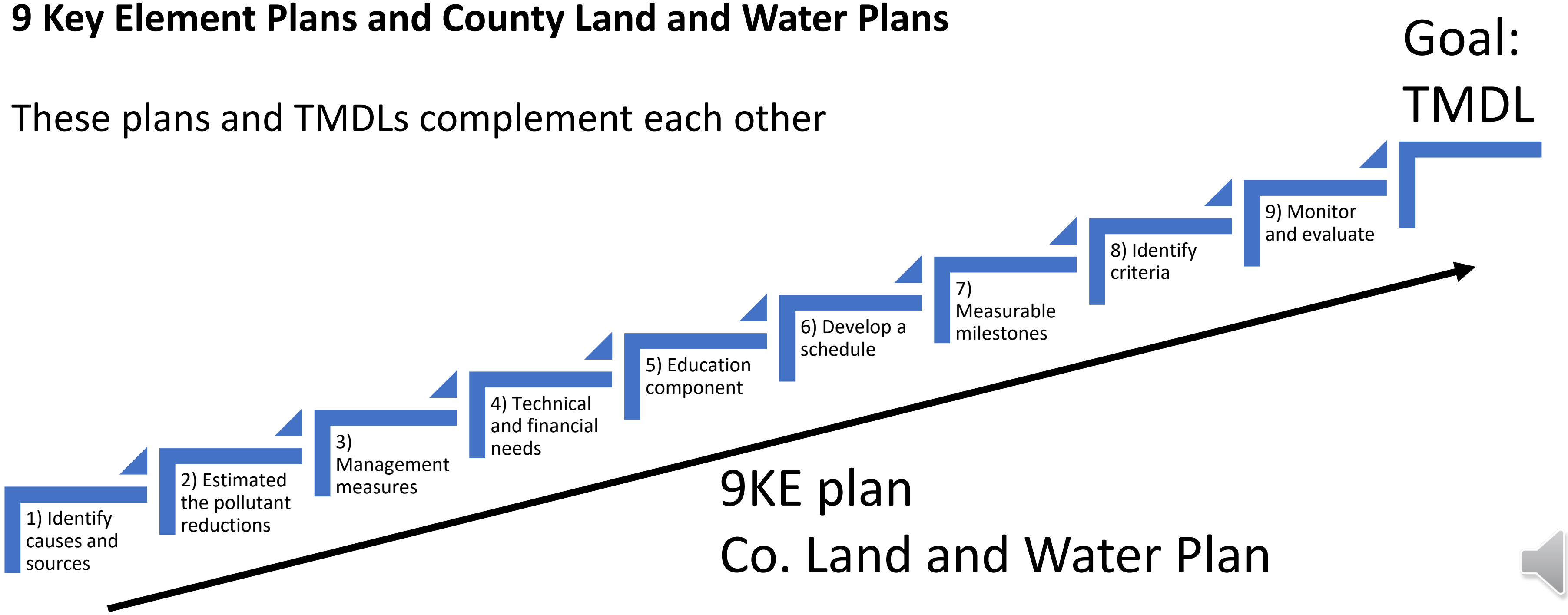
Agricultural

Wastewater

MS4

9 Key Element Plans and County Land and Water Plans

These plans and TMDLs complement each other



Implementation Overview

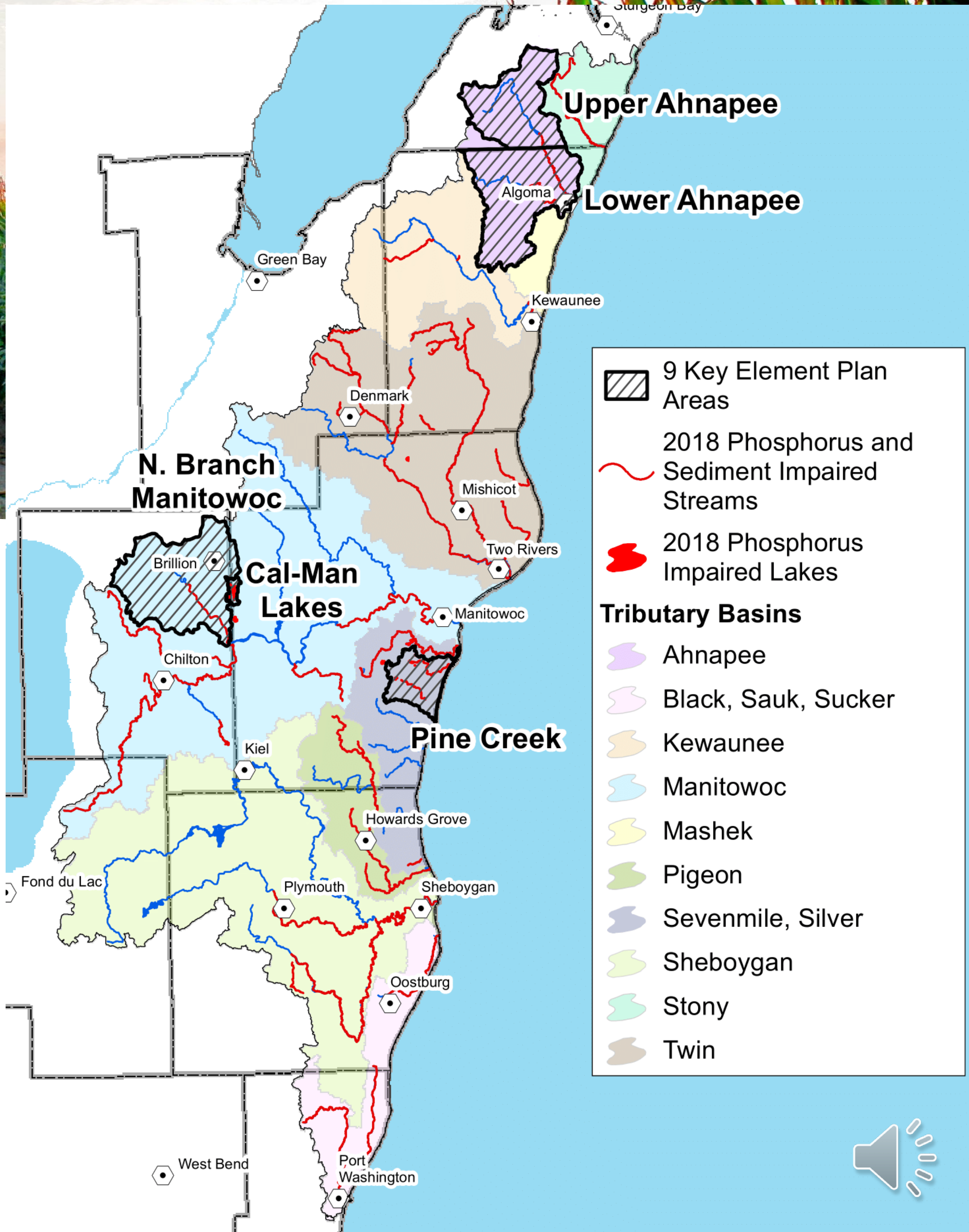
Agricultural

Point Source

MS4

9 Key Element Plans

- Agricultural implementation and planning does not have to wait for an approved TMDL
- Five 9KE plans already approved
- Kewaunee River in development



Implementation Overview

Agricultural

Wastewater

MS4

- Implemented through NR 217 and WPDES permits.
- Once EPA has approved the TMDL (anticipated 2023), implementation can begin.
- Typically, the TMDL limit will become effective upon the next permit reissuance
- Reserve capacity will be included in this TMDL.

Implementation Overview

Agricultural

Wastewater

MS4

FAQ

- What is my TMDL limit?
- When does the limit become effective?

Specific answers for each facility are not yet available.

Answers anticipated for mid to Late 2021

TMDL staff will be in contact once draft allocations are available

Implementation Overview

Agricultural

Wastewater

MS4

- Assigned individual allocations for each subbasin.
- Implemented in an MS4 permit with an extended compliance schedule with specified benchmarks.

NE Lakeshore TMDL

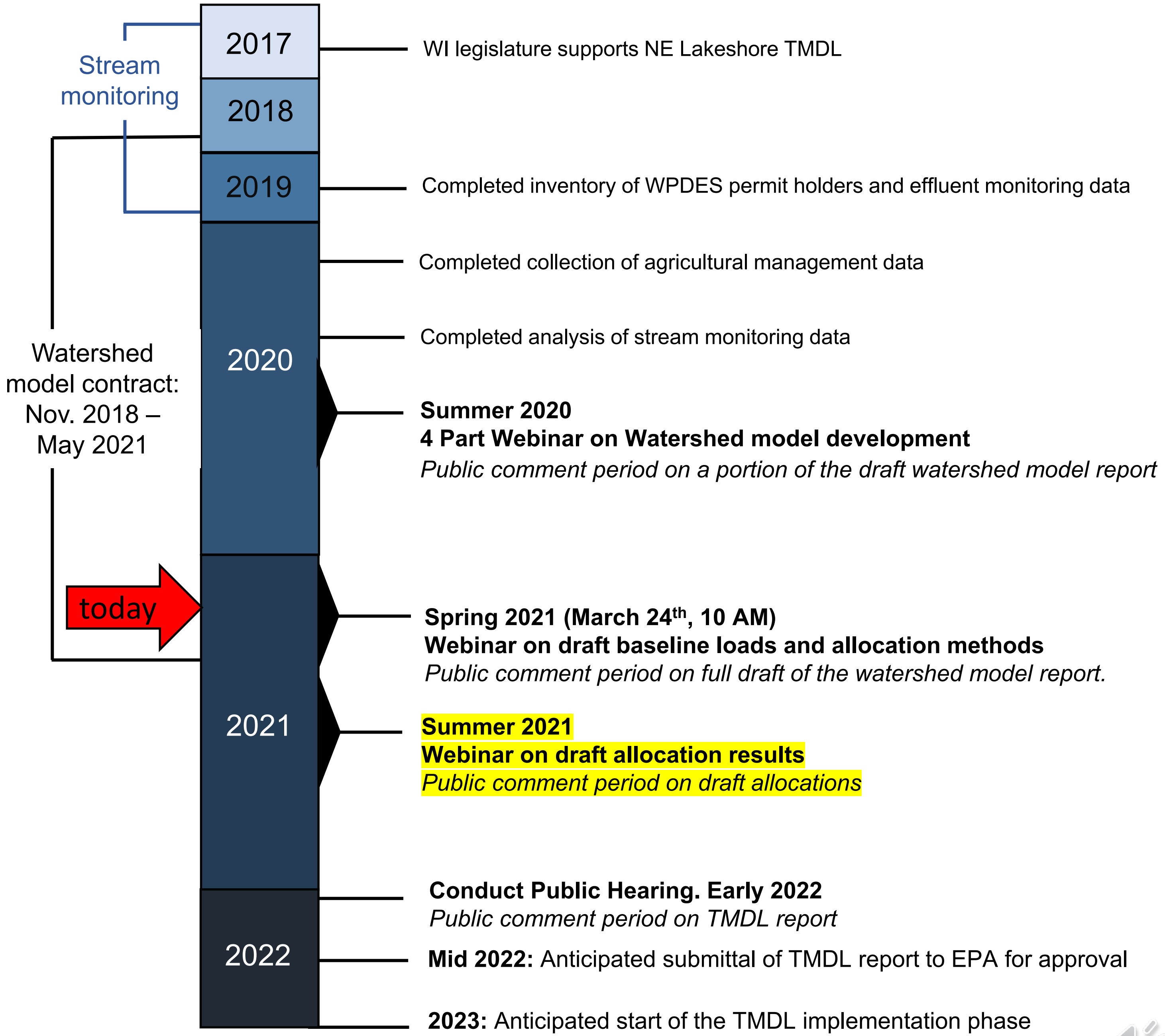
anticipated timeline

NORTHEAST LAKESHORE TMDL

A FRAMEWORK FOR WATER QUALITY IMPROVEMENT

South Branch of the Manitowoc River

Subscribe to receive email updates about the Northeast Lakeshore TMDL.



Comment Period

Watershed Model Report

Prepared by The Cadmus Group through an EPA contract

Find report on the NE Lakeshore TMDL webpage

Send Comments to Kim Oldenborg kimberly.oldenborg@wisconsin.gov

Comment Period	Topic
October 2020 (past)	Watershed Model Report 1. Overview 2. Model Setup
March 24 – April 16	Watershed Model Report 3. Calibration and Validation **Approach** 4. Calibration and Validation **Data** 5. Calibration and Validation **Results** 6. **Discussion** of Calibration and Validation 7. Summary of Model Results 8. References
Anticipated summer 2021	Draft Allocations (including inland lake modeling results)