



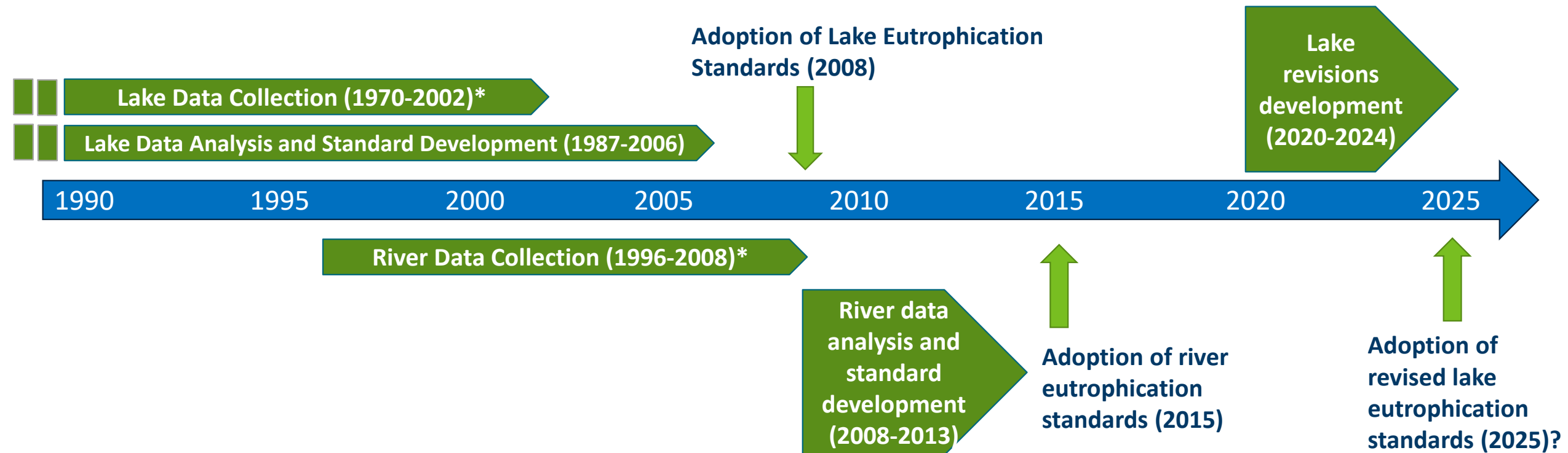
Minnesota's eutrophication standards

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**EPA Region 10 Virtual Nutrients Meeting
October 2, 2024**

Minnesota's eutrophication standards

- Minnesota adopted statewide lake eutrophication standards in 2008
- Minnesota adopted statewide river eutrophication standards in 2015
- Currently developing revisions to the lake eutrophication standards



Minnesota's current lake eutrophication standards

Lake type*	Total phosphorus (µg/L)	Chlorophyll- <i>a</i> (µg/L)	Secchi depth (m)
Northern lake trout lakes	12	3	≥4.8
Northern stream trout lakes	20	6	≥2.5
Northern lakes	30	9	≥2.0
Central stream trout lakes	20	6	≥2.5
Central (dimictic) lakes	40	14	≥1.4
Central shallow (polymictic) lakes	60	20	≥1.0
Southern (dimictic) lakes	65	22	≥0.9
Southern shallow (polymictic) lakes	90	30	≥0.7

- Impairment requires TP and at least one response variable (chl-a, Secchi depth) to exceed the criteria
- Requires a minimum of 8 samples during the summer index period (June to September) over 2 years



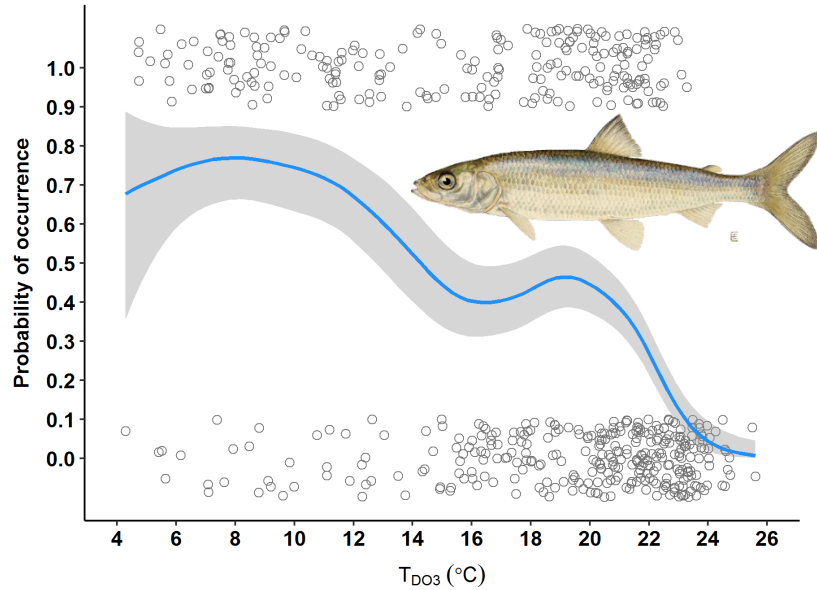
Lake water quality standards revisions

- 1) Development of a separate eutrophication standards for northern polymictic (shallow) and dimictic lakes
- 2) Protections for non-trout, cold water fishes in lakes – oxythermal habitat and lake eutrophication

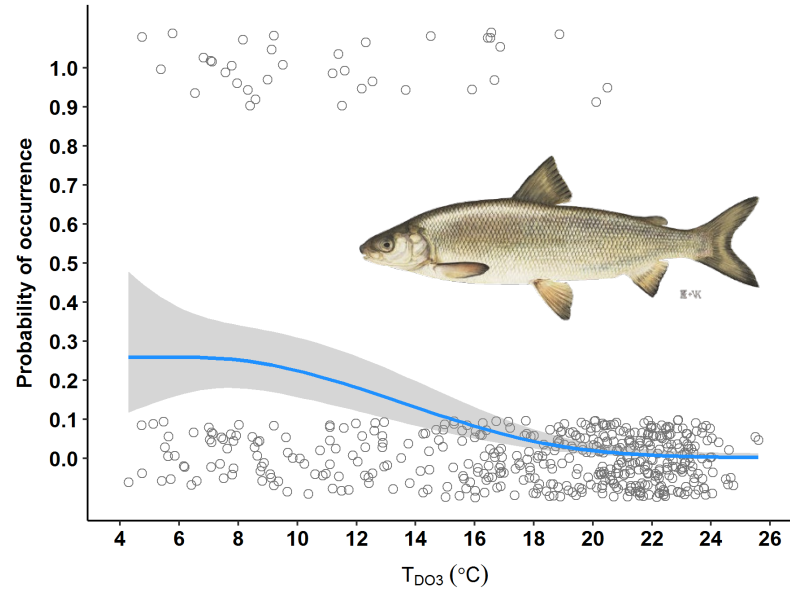


Oxythermal habitat - T_{DO3}

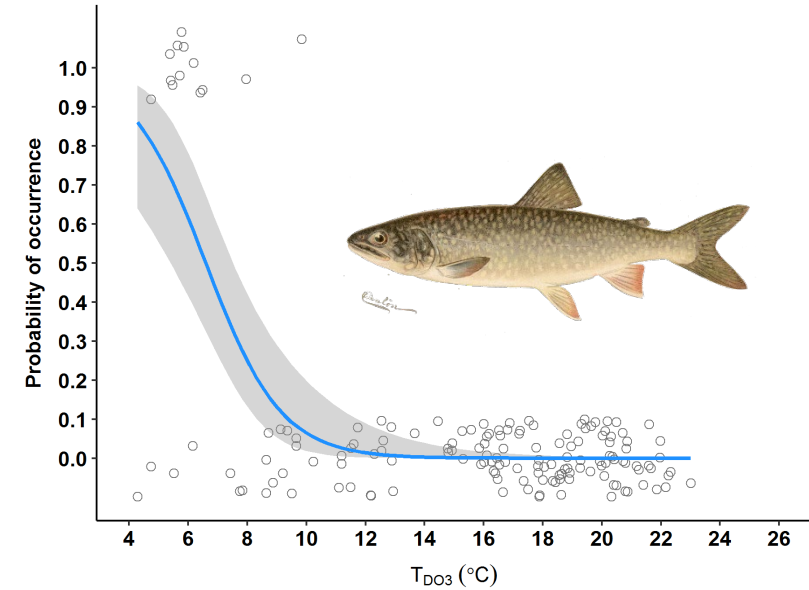
Cisco



Lake whitefish



Lake trout

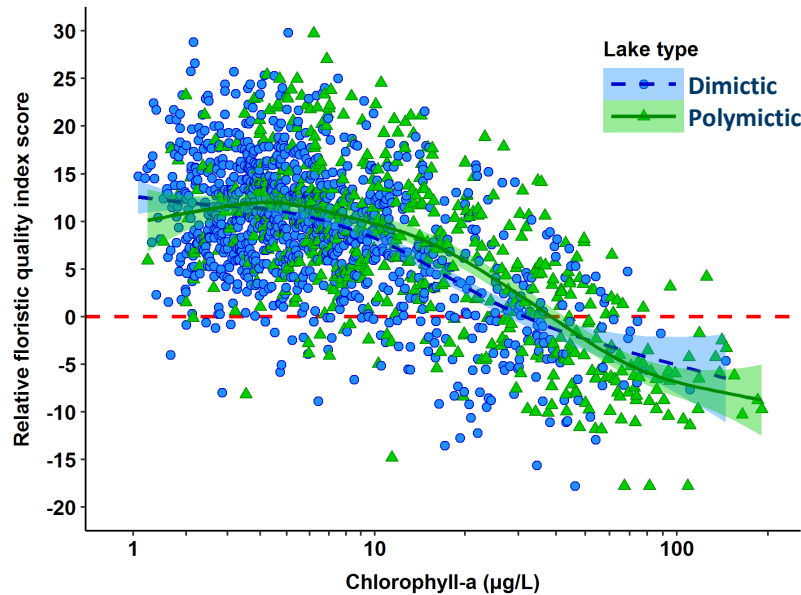


Generalized additive model using a logistic link function

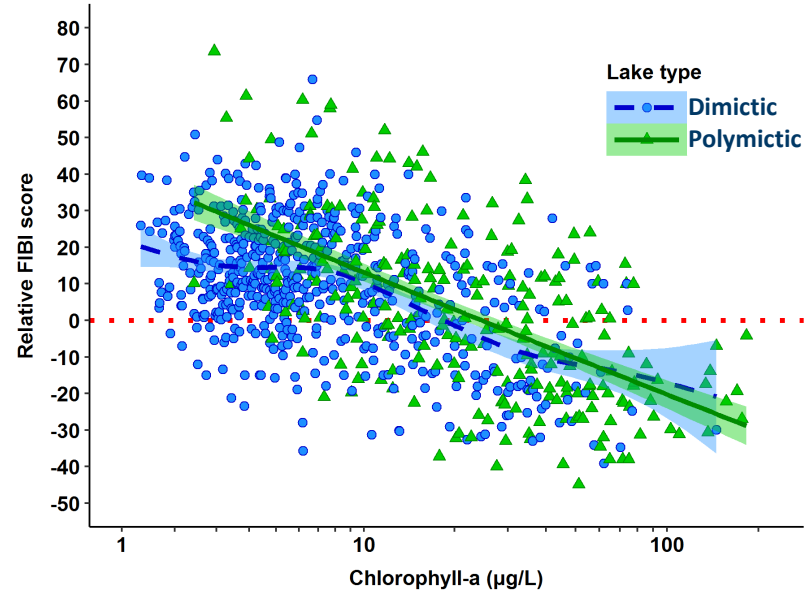
Beneficial use endpoints used for standards development

Aquatic life

Macrophytes

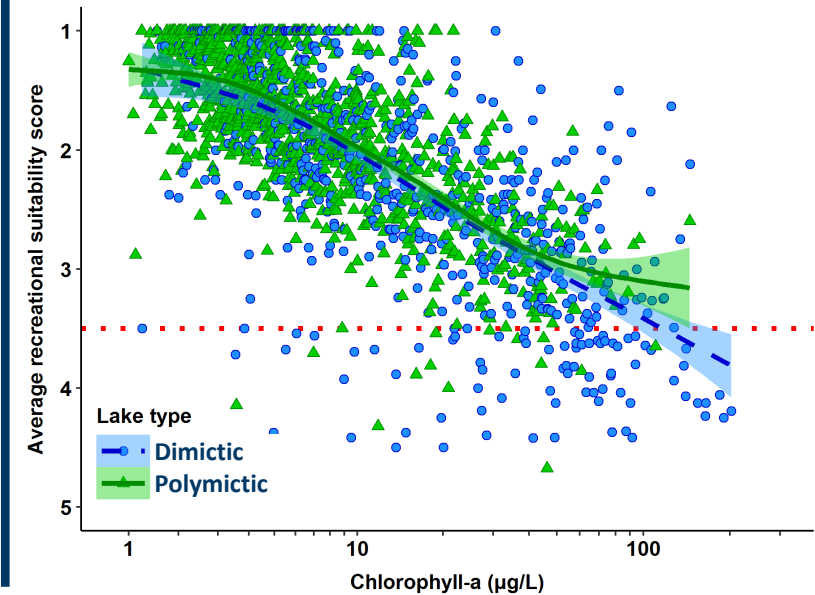


Fish



Recreation

Recreational suitability



Statewide dataset

Generalized additive models (GAM) with 90% confidence intervals

R version 3.6.3 [R Development Core Team 2020]; "mgcv" package (Wood 2019)

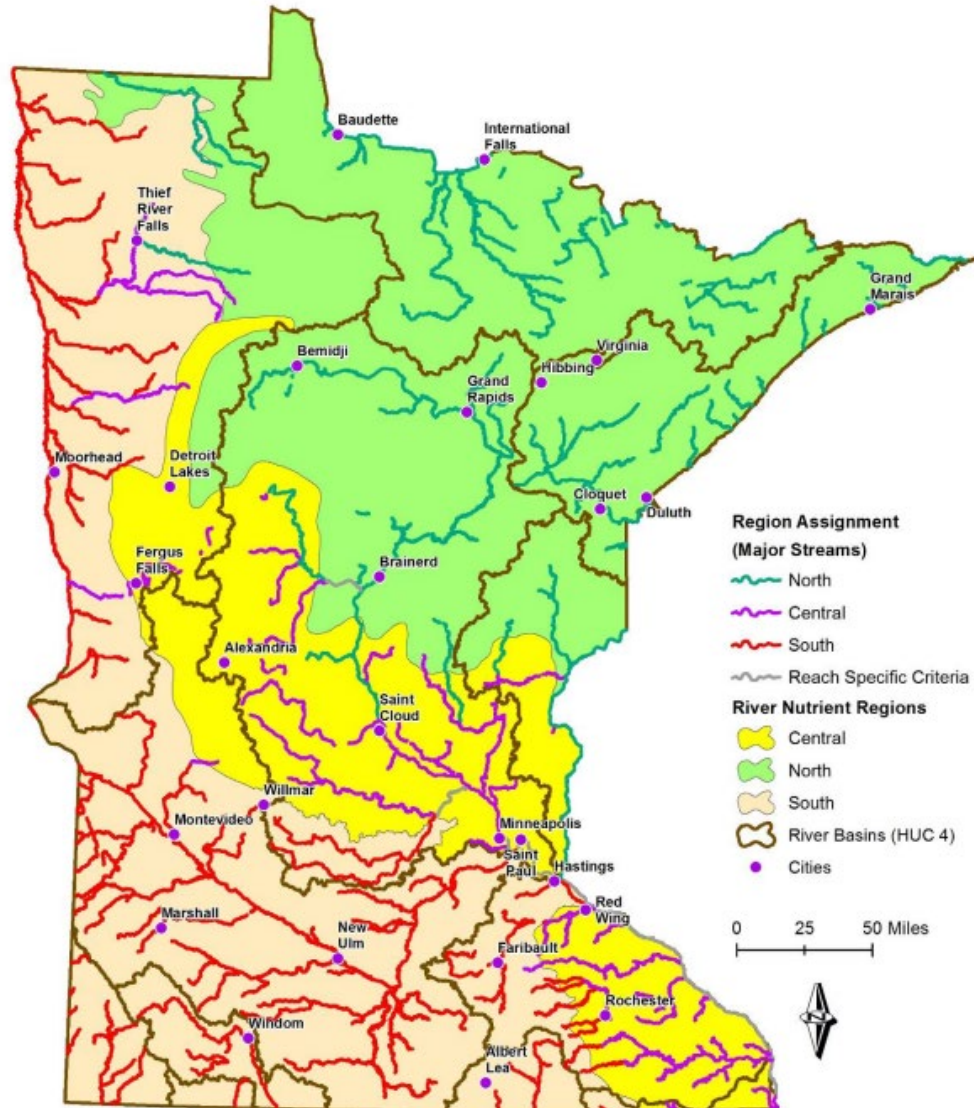
Draft revised lake eutrophication criteria framework

Thermal habitat	Region/type	Stratification	T _{DO3} (°C)	Total phosphorus (µg/L)	Chlorophyll- <i>a</i> (µg/L)	Secchi depth (m)
Cold	Lake trout	Dimictic	8.8	12 → 7	3	4.8 → 3.3
Cold	Lake whitefish	Dimictic	17.2	12	5	2.6
Cold	Cisco (north/central)	Dimictic	21.5	25	12	1.4
Cold	Stream trout	-	-	20 → 15	6	2.5 → 2.4
Warm	Northern	Dimictic	-	30 → 20	9	2.0 → 1.8
Warm	Northern	Polymictic	-	30	9 → 16	2.0 → 1.1
Warm	Central	Dimictic	-	40	14	1.4
Warm	Central	Polymictic	-	60	20	1.0
Warm	South	Dimictic	-	65	22	0.9
Warm	South	Polymictic	-	90	30	0.7

Blue highlight = new standard or lake type

Yellow highlight = modification to existing standard

Minnesota's River Eutrophication Standards



Region	TP ($\mu\text{g/L}$)	Chl-a ($\mu\text{g/L}$)	DO Flux (mg/L)	BOD ₅ (mg/L)
North	50	7	3.0	1.5
Central	100	18	3.5	2.0
South	150	35	4.5	3.0

- Impairment requires TP and at least one response variable (chl-a, DO Flux, or BOD₅) to exceed the criteria
- Requires a minimum of 12 samples during the summer index period (June to September) over 2 years

Site-specific eutrophication standards

- Site-specific standards are developed for reservoirs (<14 d residence time) and lakes in Lake Agassiz Plains, Northern Minnesota Wetlands, or Driftless Area ecoregions
- A small subset of rivers and lakes have site-specific standards

River site-specific standards

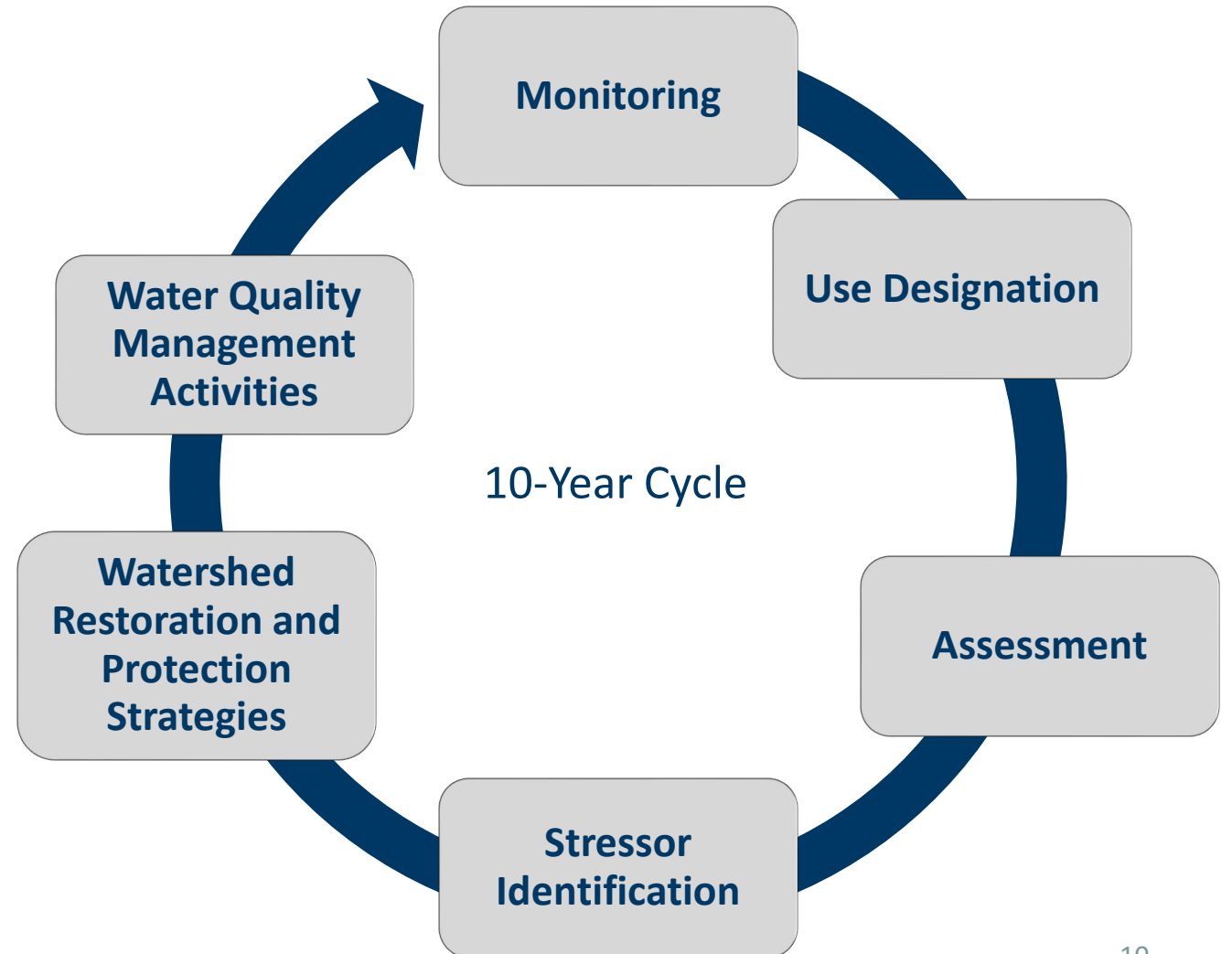
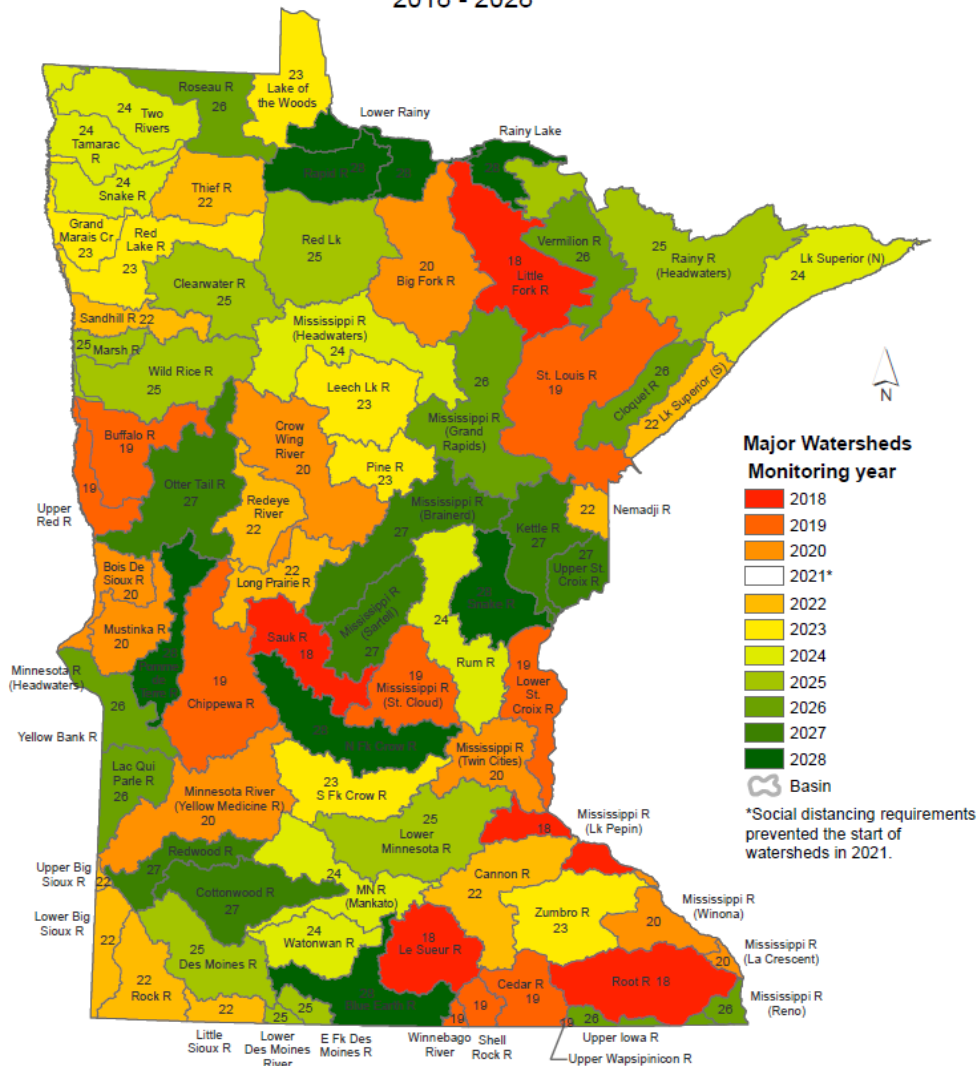
River Reach	TP (µg/L)	Chl-a (µg/L)	DO flux (mg/L)	BOD ₅ (mg/L)
Mississippi River - Pool 1	100	35	-	-
Mississippi River - Pool 2	125	35	-	-
Mississippi River - Pool 3	100	35	-	-
Mississippi River - Lake Pepin	100	28	-	-
Mississippi River - Pools 5-8	100	35	-	-
Crow Wing River	75	13	3.5	1.7
Crow River	125	27	4.0	2.5

Lake site-specific standards

Lake Byllesby
Lake Hiawatha
Lake Nokomis
Lake Winona
Lake Zumbro
Zumwalde Lake
Great Northern Lake
Knaus Lake
Krays Lake
Horseshoe North Lake
Koetter Lake
Bolfing Lake
Cedar Island Lake
Horseshoe South Lake
Horseshoe West Lake
Spring Lake

Intensive Watershed Monitoring (IWM)

Watershed Lake and Stream Monitoring Schedule
2018 - 2028



Thank You

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