Photo: Gretchen Hansen

10,000 Lakes -> 4 Indices: Minnesota Fish IBI Tools For Lakes

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DEPARTMENT OF NATURAL RESOURCES

SPORT FISH & WILDLIFE RESTORATION

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND

CLEAN WATER LAND & LEGACY AMENDMENT

Minnesota Fish IBI Development - Acknowledgments

- Melissa Treml and David Staples with MNDNR Fisheries research
- Don Pereira, Ray Valley formerly with MNDNR Fisheries research
- MNDNR Fish IBI Program Staff: Derek Bahr, Lucas Borgstrom, Jessica Moore, Kevin Mott, and Pete Malaty
- MNDNR Area Fisheries Staff: staff from 25 Minnesota Fisheries Management Areas

MINNESOTA

SPORT FISH & WILDLIFE RESTORATION

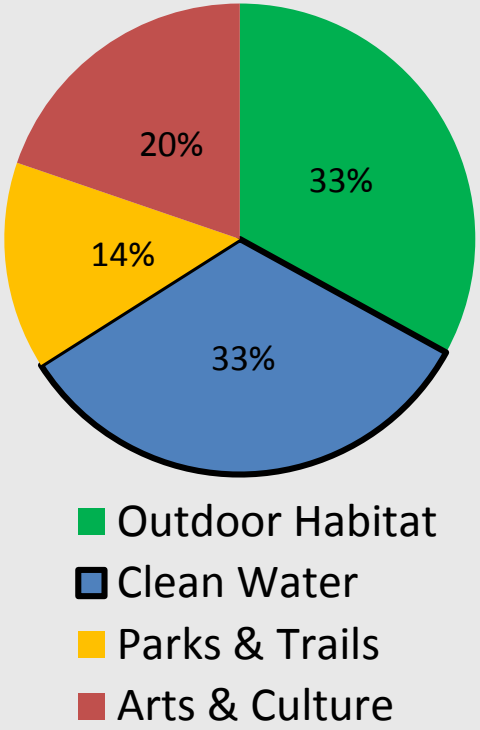
ENVIRONMENT AND NATURAL RESOURCES TRUST FUND

CLEAN WATER LAND & LEGACY AMENDMENT

Citizens of Minnesota passed a constitutional amendment in 2008

<u>Added ⅜ percent to state sales tax for 25 yrs</u>

- Clean Water: ~$100 Million/ Year
- A portion is used to systematically monitor, assess, and implement BMP projects on waters in 80 MN watersheds



Minnesota Clean Water Act Indicators

Beneficial Use	Streams	Lakes
Aquatic Life Use	Fish & Invert IBIs Water Chemistry Toxics MINNESOTA POLLUTION CONTROL AGENCY	Fish IBI Plant IBI (provisional) Chloride MINNESOTA DEPARTMENT OF NATURAL RESOURCES POLLUTION CONTROL AGENCY
Aquatic Recreation Use	E. coli (Bacteria) MINNESOTA POLLUTION CONTROL AGENCY	Eutrophication MINNESOTA POLLUTION CONTROL AGENCY
Aquatic Consumption Use	Fish Mercury, PCBs, and PFOS MINNESOTA DEPARTMENT OF HEALTH DEPARTMENT OF NATURAL RESOURCES POLLUTION CONTROL AGENCY	Fish Mercury, PCBs, and PFOS MINNESOTA DEPARTMENT OF HEALTH DEPARTMENT OF NATURAL RESOURCES POLLUTION CONTROL AGENCY

Building Fish IBI Tools for Minnesota Lakes

Group Similar Lakes for IBI Tools

Classify Fish Species (tolerance, habitat, feeding niche)

Metric Development:

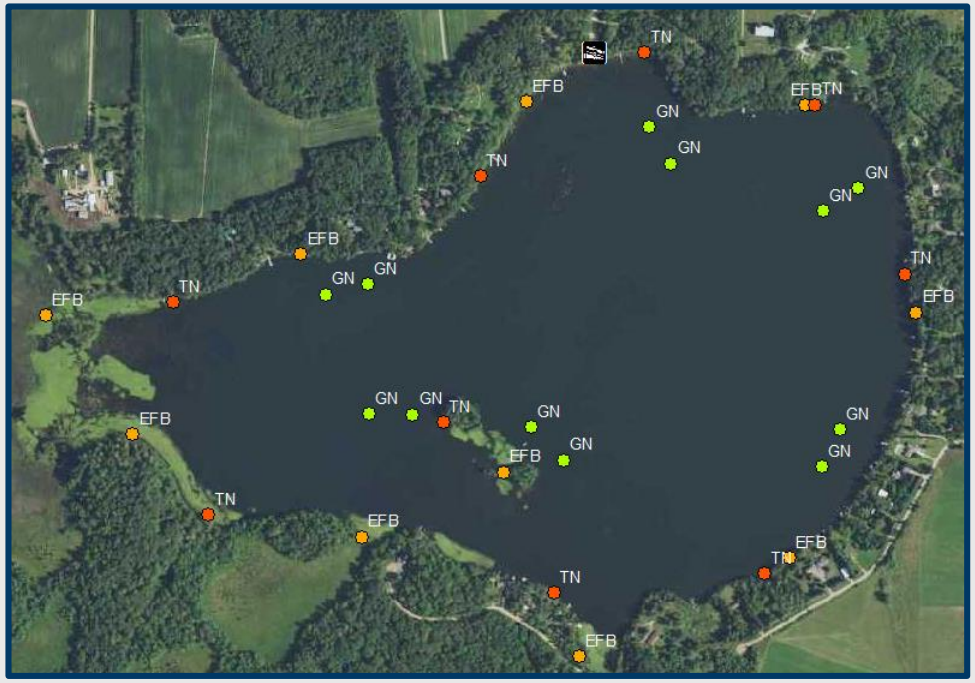
- Identify Potential Metrics (Based off of Drake & Pereira 2002)
- Identify important lake and stressor information that may influence the fish community
- Explore Metric relationships with each other, lake characteristics, and stressors
- Design Metric Scoring
- Select Metrics for each IBI Tool
- Remove Redundant Metrics & Metrics with high variability

Build IBI Tools with scoring

Identify Ecologically Meaningful Thresholds & Confidence Intervals

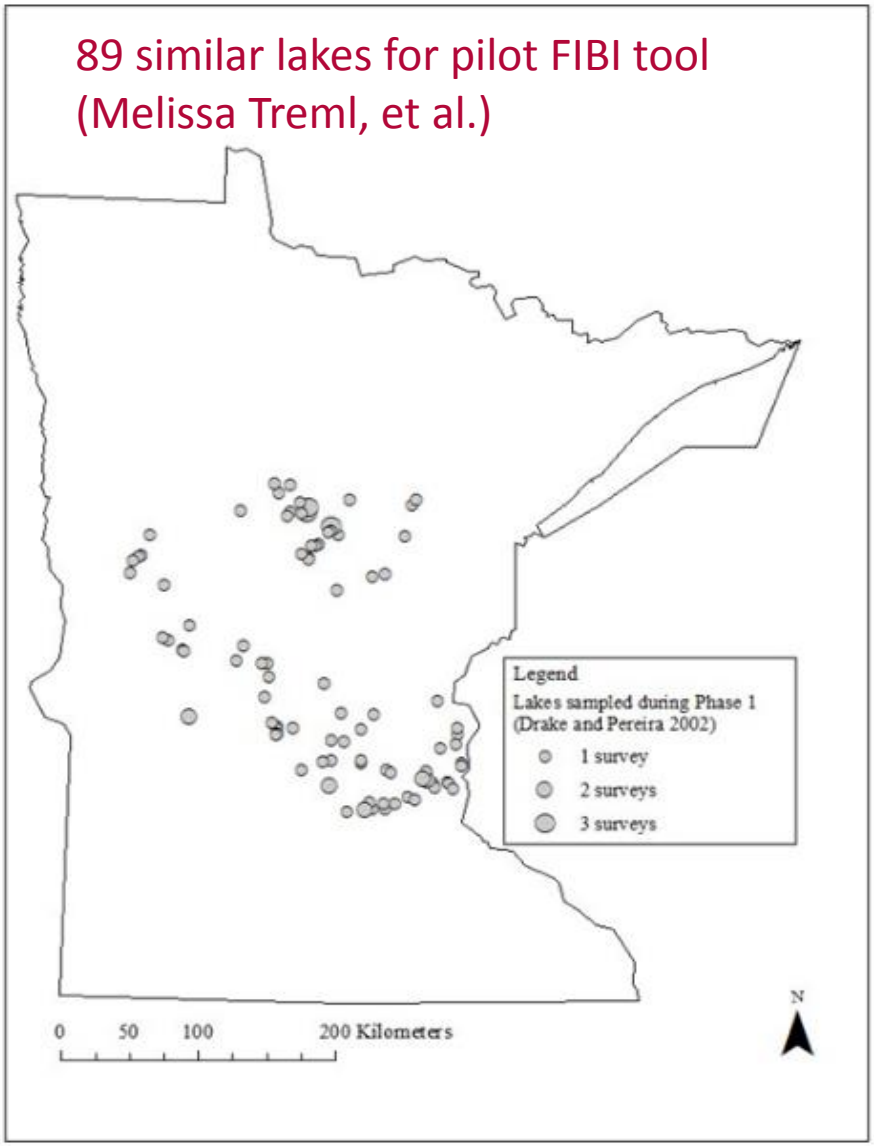
Fish IBI Sampling: 4 sampling gears with effort based on surface acreage

- 100 – 15,000 acre lakes
- June 15 – September 15



963 Fish IBI surveys were completed on 750 lakes for FIBI tool development 1997 - 2012

89 similar lakes for pilot FIBI tool
(Melissa Treml, et al.)



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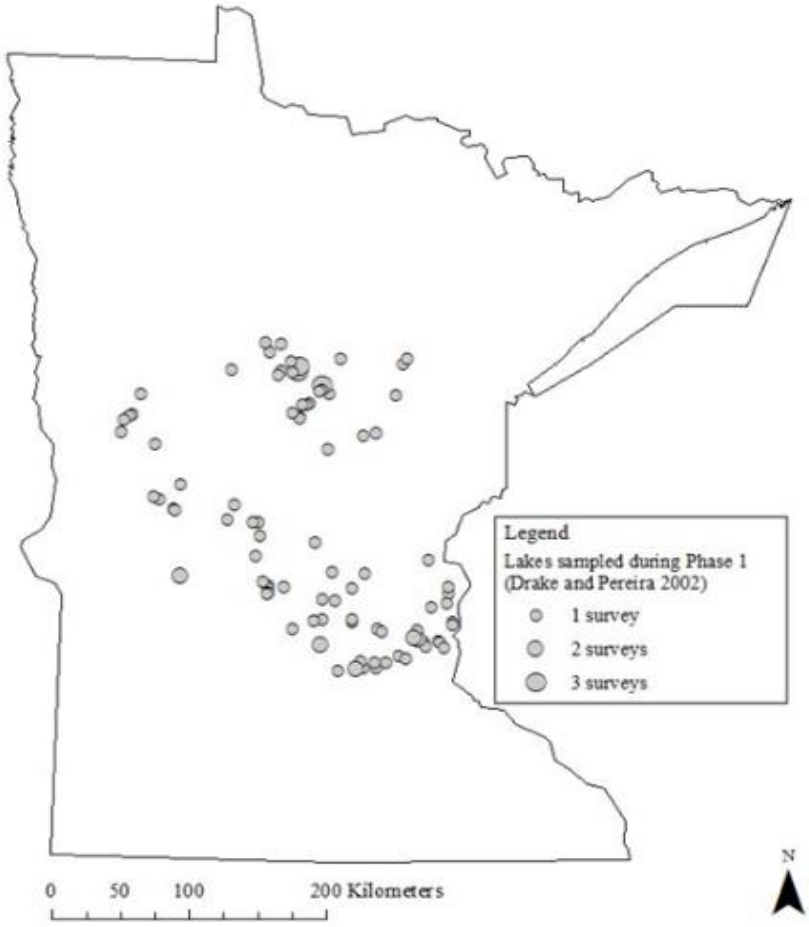
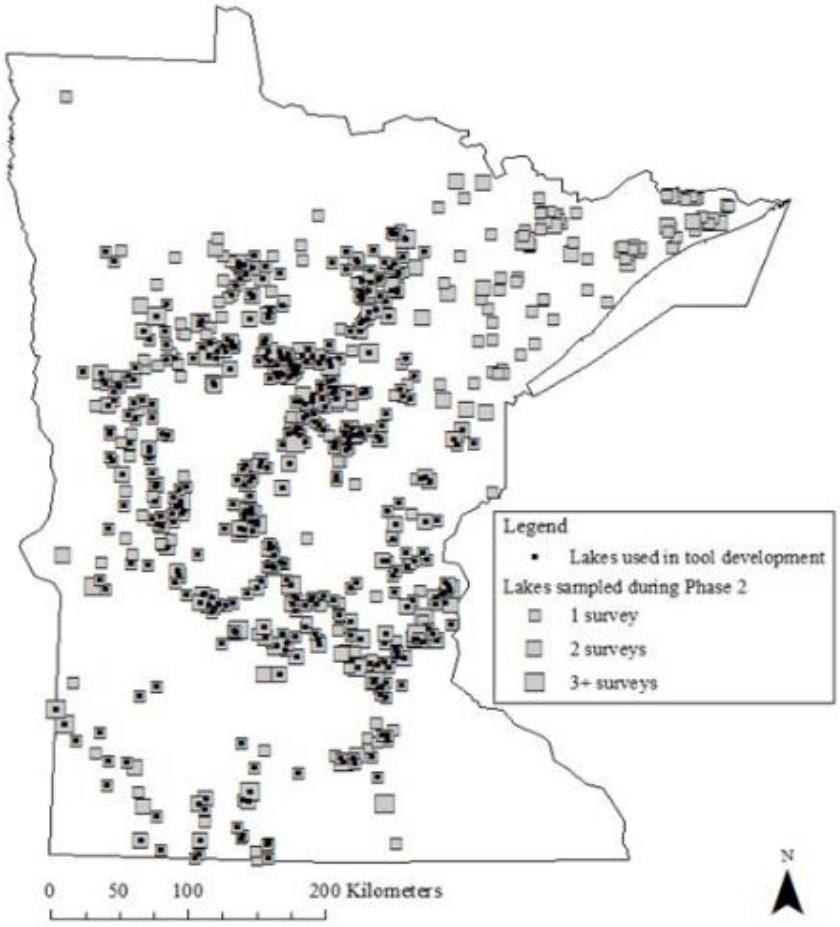


661 lakes sampled during development of 4 statewide FIBI tools



Hierarchical cluster analysis to group lakes based on 7 lake attributes & ecoregion

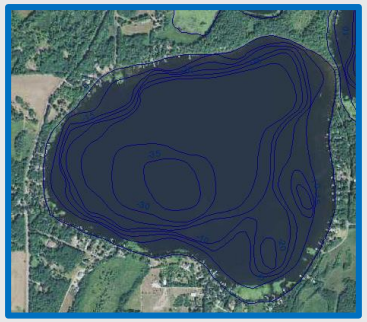
Four FIBI Tools developed for MN lakes:

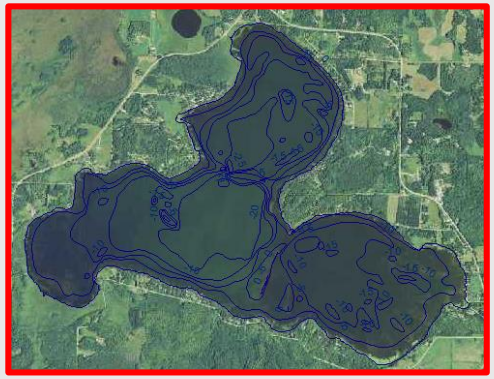
Deepest, complex shoreline (Tool 2)

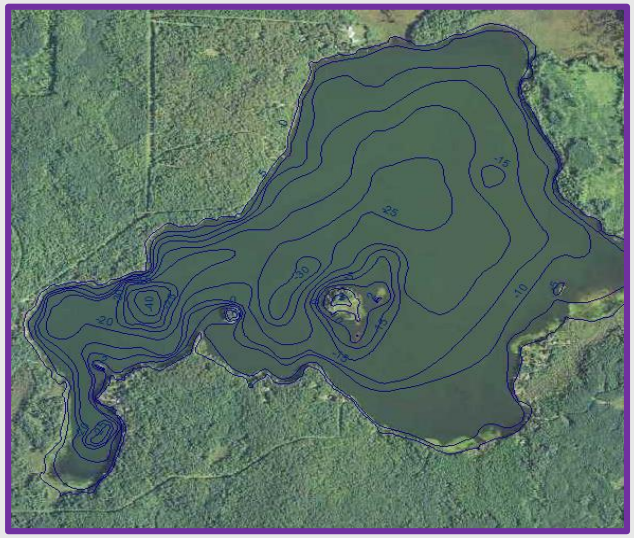
Deep, rounder, central & northern (Tool 4)

Moderate depth, central & northern MN (Tool 5)

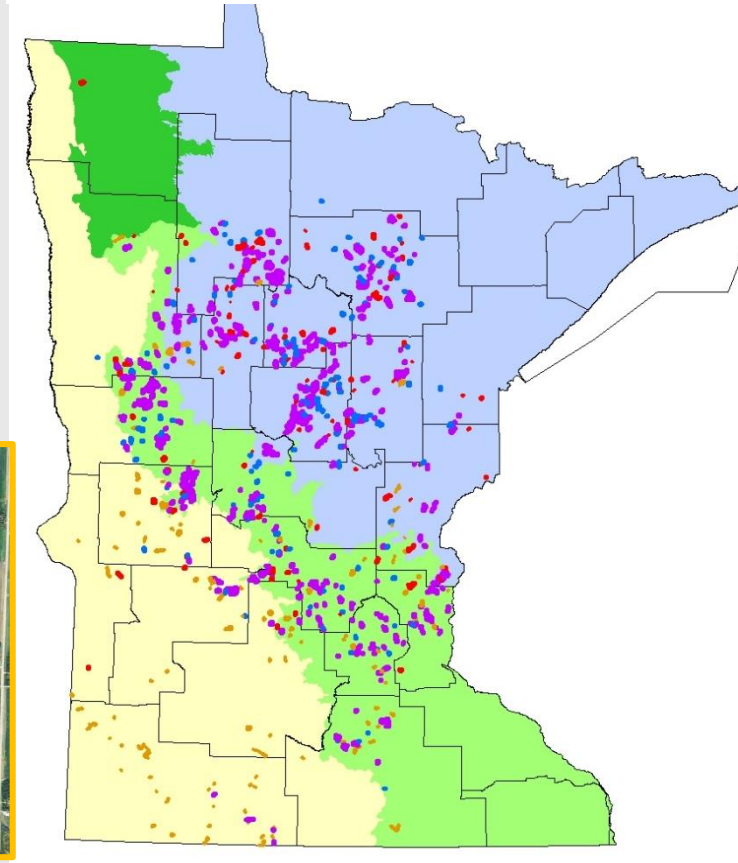
>80% littoral, southern & western MN (Tool 7)





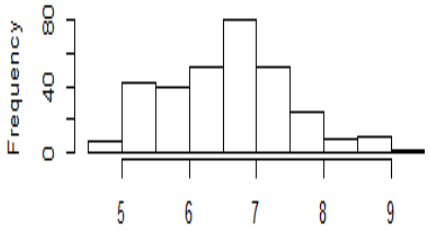


Lakes Used for FIBI Tool Development

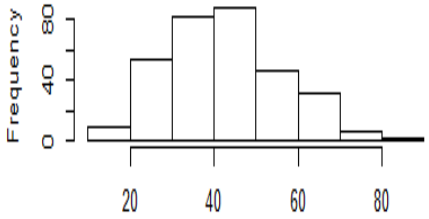


Lake and Stressor Characteristics – FIBI Development lakes

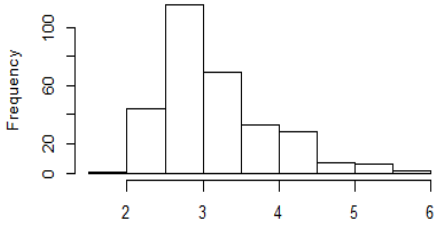
Log acres



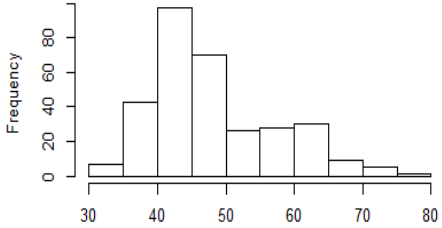
% littoral



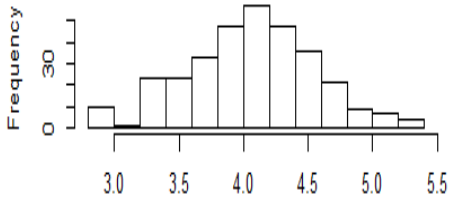
log Total Phosphorus



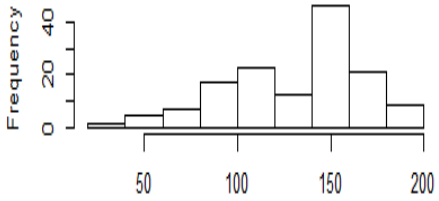
Trophic State Index



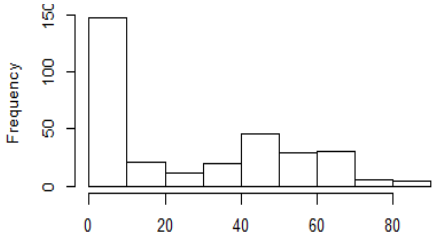
Max Depth (ft)



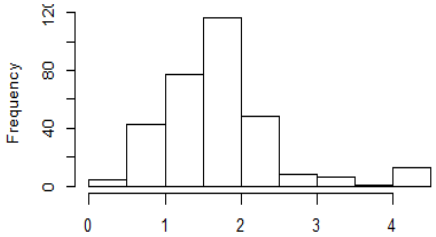
Alkalinity



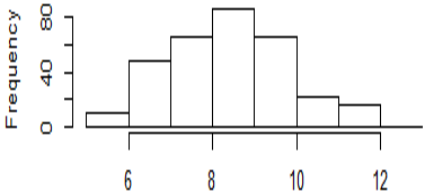
% Agriculture



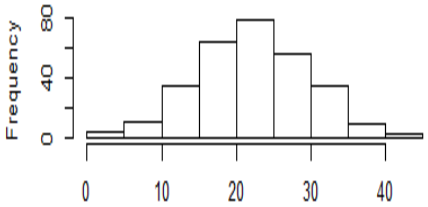
log % urban



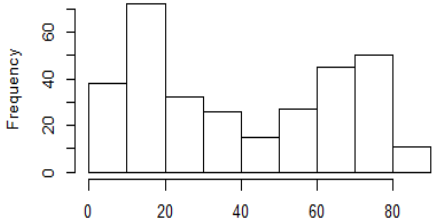
Log watershed acres



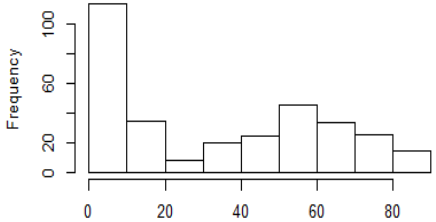
Aquatic Plant Richness



% Forest

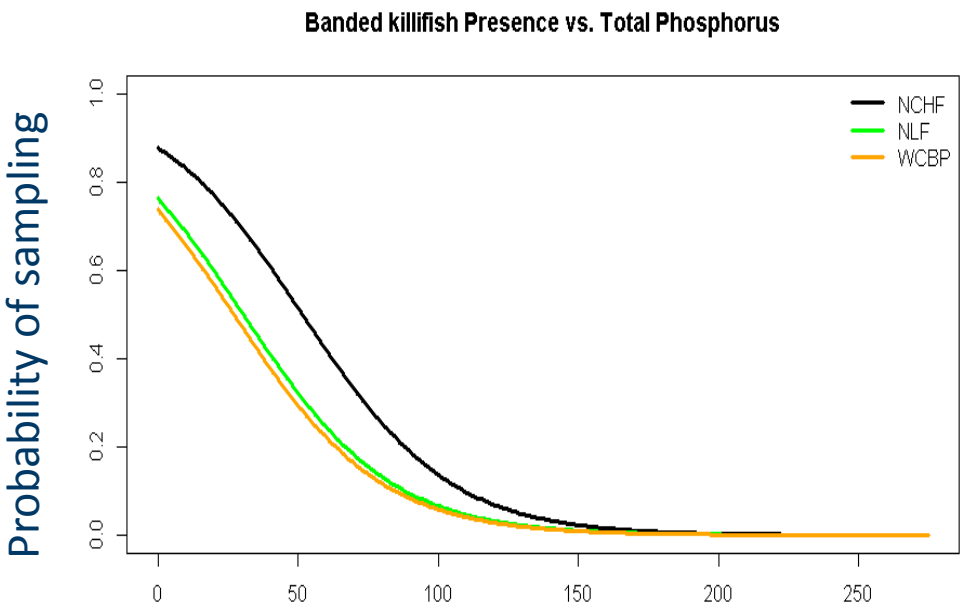


% Disturbance

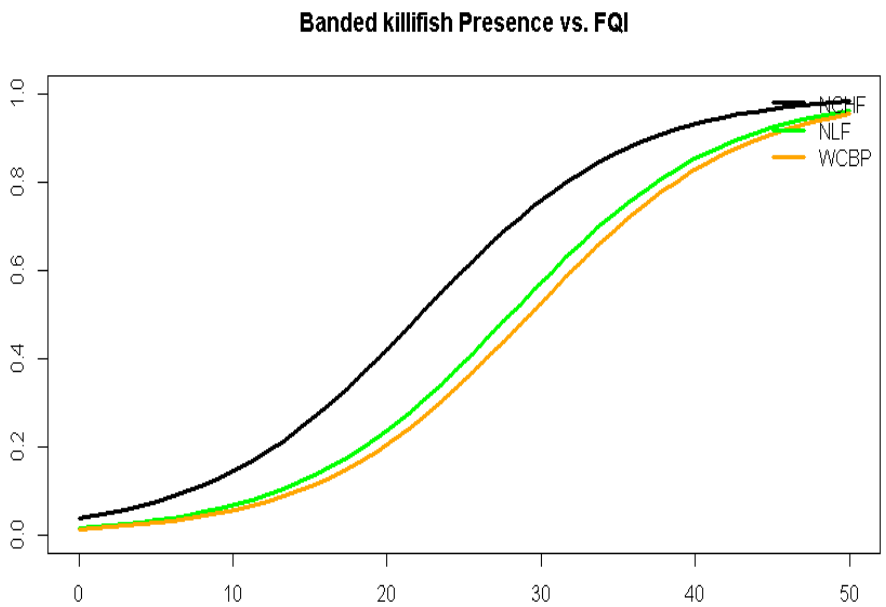


Classification of Fish Species (tolerance, habitat, feeding niche assignments)

- Literature review for feeding niche assignments
- Species Probability Models and random forest classification trees for tolerance and habitat-use assignments (with lit review)



Total Phosphorus



Plant Community Quality (FQI)

FIBI Metrics Considered

Richness Metrics

- Native
- Intolerant
- Tolerant (-)
- Insectivore
- Omnivore (-)
- Cyprinid
- Small benthic dweller
- Vegetation specialist

Composition Metrics

- Intolerant (relative # in nearshore)
- Small benthic (relative # in nearshore)
- Vegetation specialist (relative # in nearshore)
- Insectivore (relative biomass in trap net)
- Omnivore (-) (relative biomass in trap net)
- Tolerant (-) (relative biomass in trap net)
- Top carnivore (relative biomass in gill net)
- Intolerant (presence/absence in gill net)

Group Similar Lakes
Classify Fish Species
Metric Development
Build IBI Tools
Identify Thresholds

Select FIBI Metrics responsive to watershed and shoreline disturbance

Physical Structure

Properties
- vegetation
- woody habitat
- substrate

Water Quality

Properties
- sedimentation
- epiphytic algae
- hypolimnetic oxygen
- regime shifts

Primary Disturbance Drivers

Shoreline disturbance from development

Watershed disturbance from urbanization and agriculture

Table courtesy of Pete Jacobson, MNDNR Fisheries Habitat Plan

FIBI Metric Relationships

Lake Characteristics

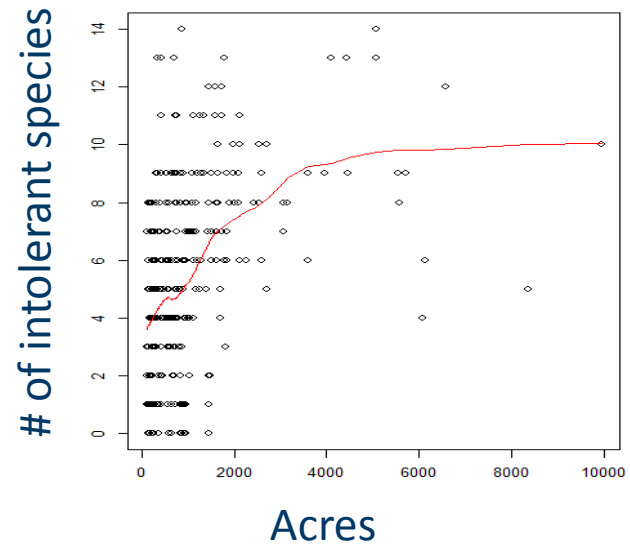
- Size *
- Maximum Depth *
- Percent littoral *
- Shoreline Development Index
- Watershed size
- Catchment size
- Connectivity
- Alkalinity

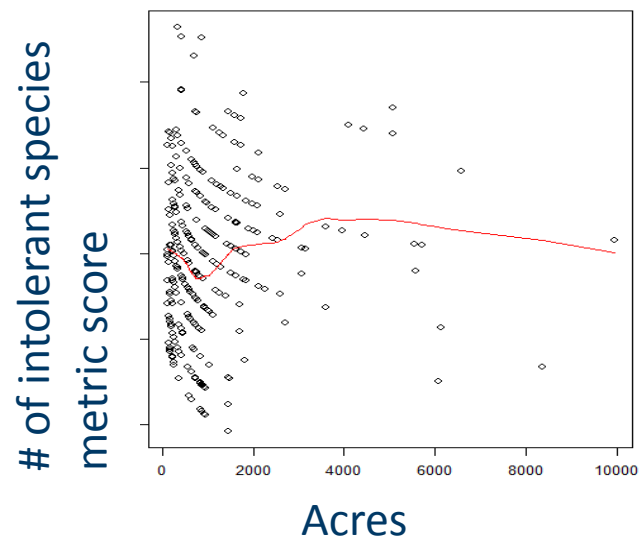
Stressor Variables

- % Agriculture *
- % Urban *
- % Forest *
- Floristic Quality Index (FQI) *
- Plant Spp. Richness *
- Dock Density *

Metric Development for each FIBI tool

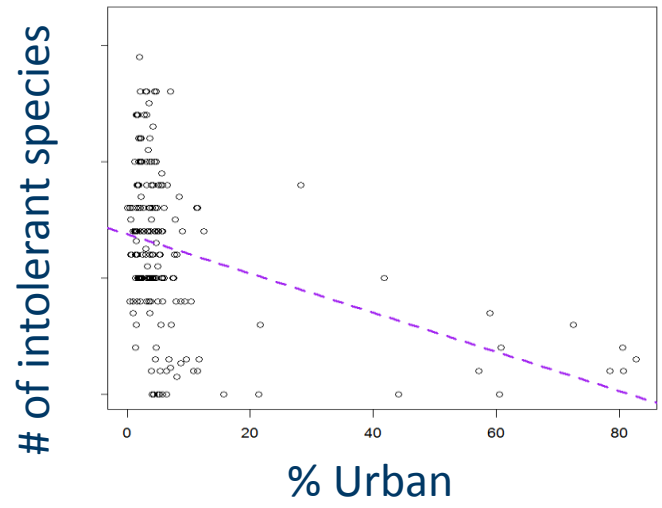
- Raw and log transformed metrics considered
- Mixed effect model used to account for lake size



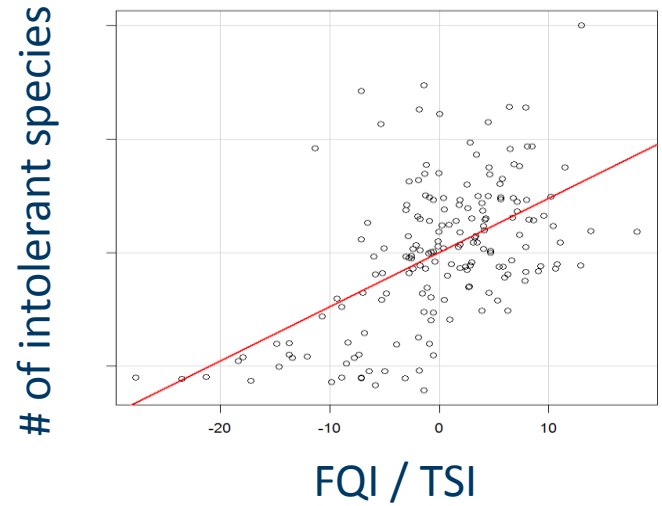


Metric Development for each FIBI tool

- Raw and log transformed metrics considered
- Mixed effect model used to account for lake size
- Potential metrics evaluated with:
  - Spearman rank correlations with stressors
  - Principle Components Analysis with stressors and lake variables
  - Added Variable Analyses & Generalized Additive Models used to examine individual contribution
- Removed redundant metrics
- Ecologically meaningful & low variability



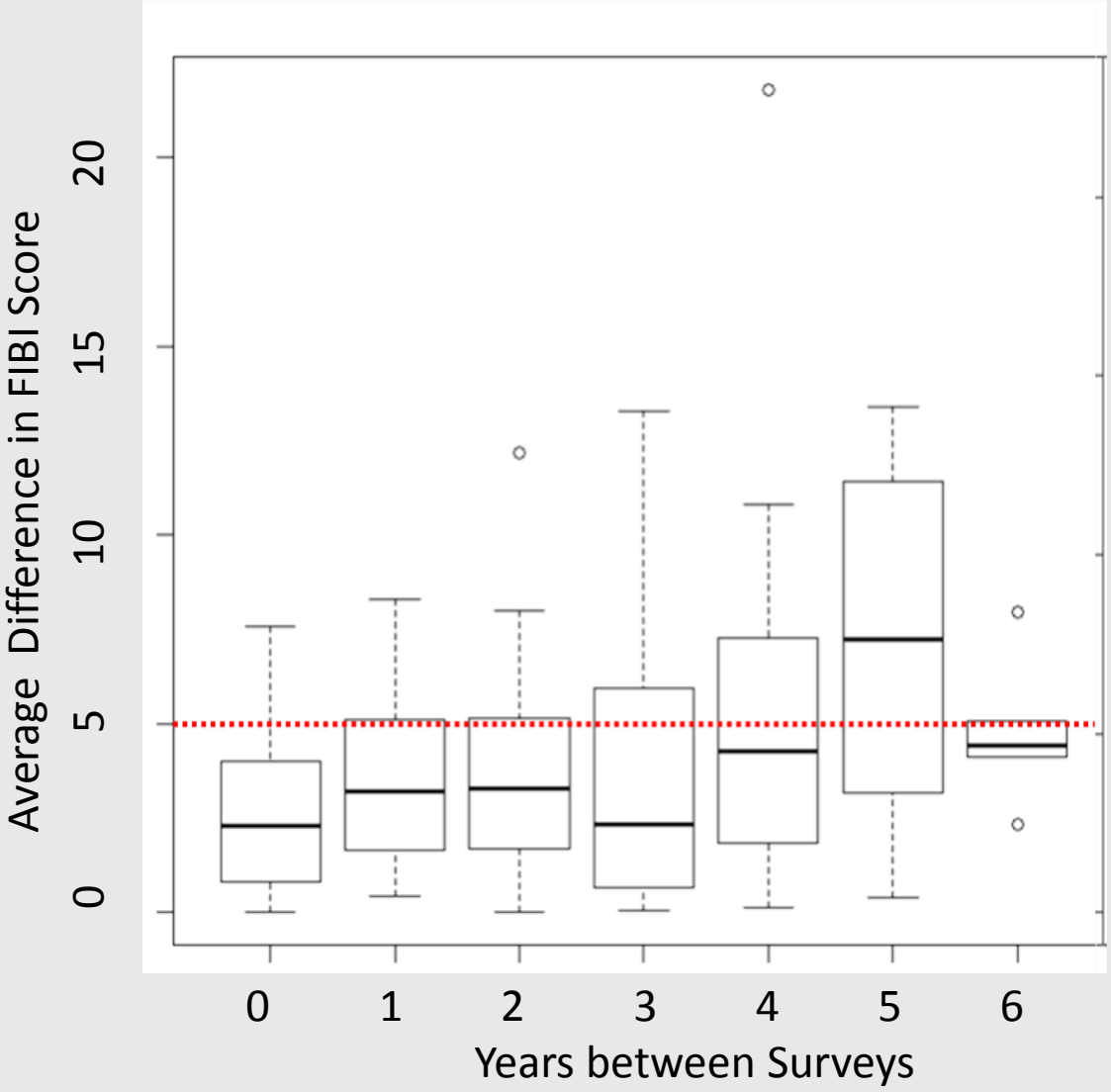
Added variable plot: FQI



FIBI Metrics By Tool

	Lake FIBI Tool			
Lake FIBI Metrics	**2**	**4**	**5**	**7**
# native species captured in all gears	+			
# intolerant species captured in all gears	+	+	+	
# tolerant species captured in all gears	-	-	-	-
# insectivore species captured in all gears	+			+
# omnivore species captured in all gears	-	-	-	
# cyprinid species captured in all gears	+			
# small benthic dwelling species captured in all gears	+	+		+
# vegetative dwelling species captured in all gears	+	+		+
Relative abundance intolerant species in nearshore sampling	+		+	
Relative abundance small benthic dwelling species in nearshore	+	+		
Relative abundance vegetative dwelling species in nearshore				+
Proportion of biomass in trap nets from insectivore species	+	+	+	+
Proportion of biomass in trap nets from omnivore species	-	-	-	
Proportion of biomass in trap nets from tolerant species	-	-	-	-
Proportion of biomass in gill nets from top carnivore species	+	+	+	+
Presence/absence of Intolerant species captured in gill nets	+	+		
Total number of metrics used to calculate FIBI	**15**	**11**	**8**	**8**

Variability between FIBI development Surveys: FIBI Scores for 221 Repeat Surveys on 91 Lakes



Group Similar Lakes
Classify Fish Species
Metric Development
Build IBI Tools
Identify Thresholds

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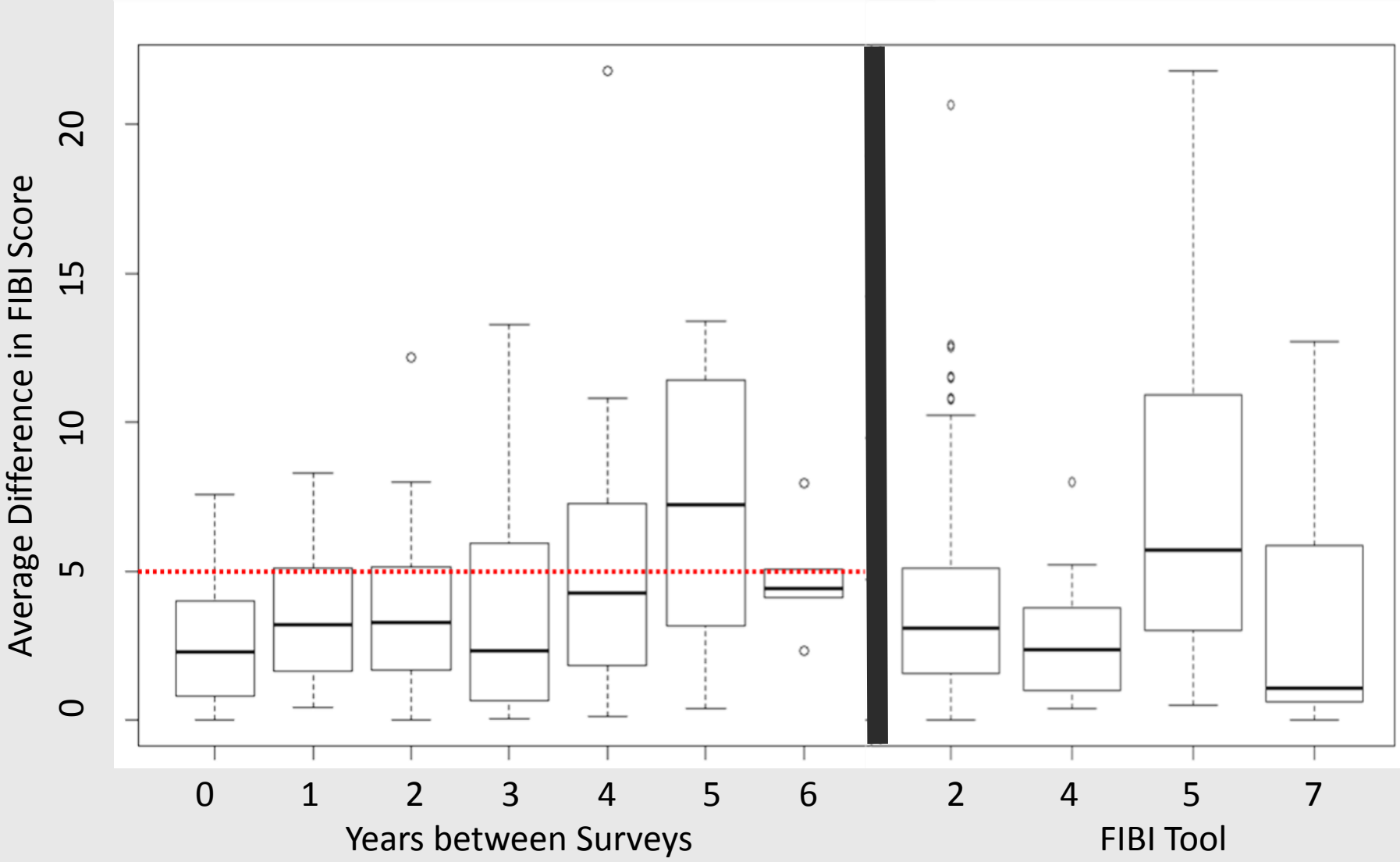
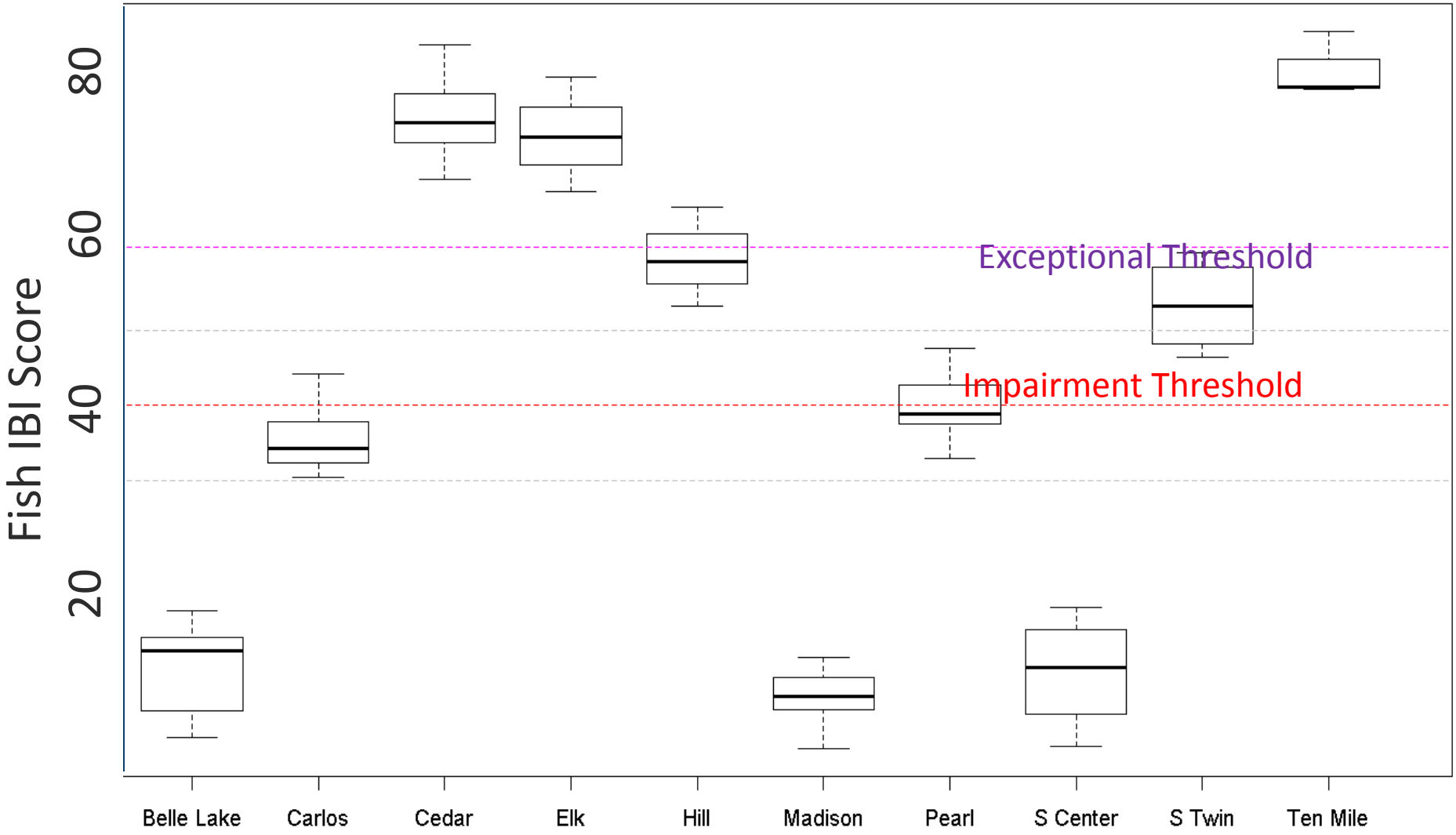
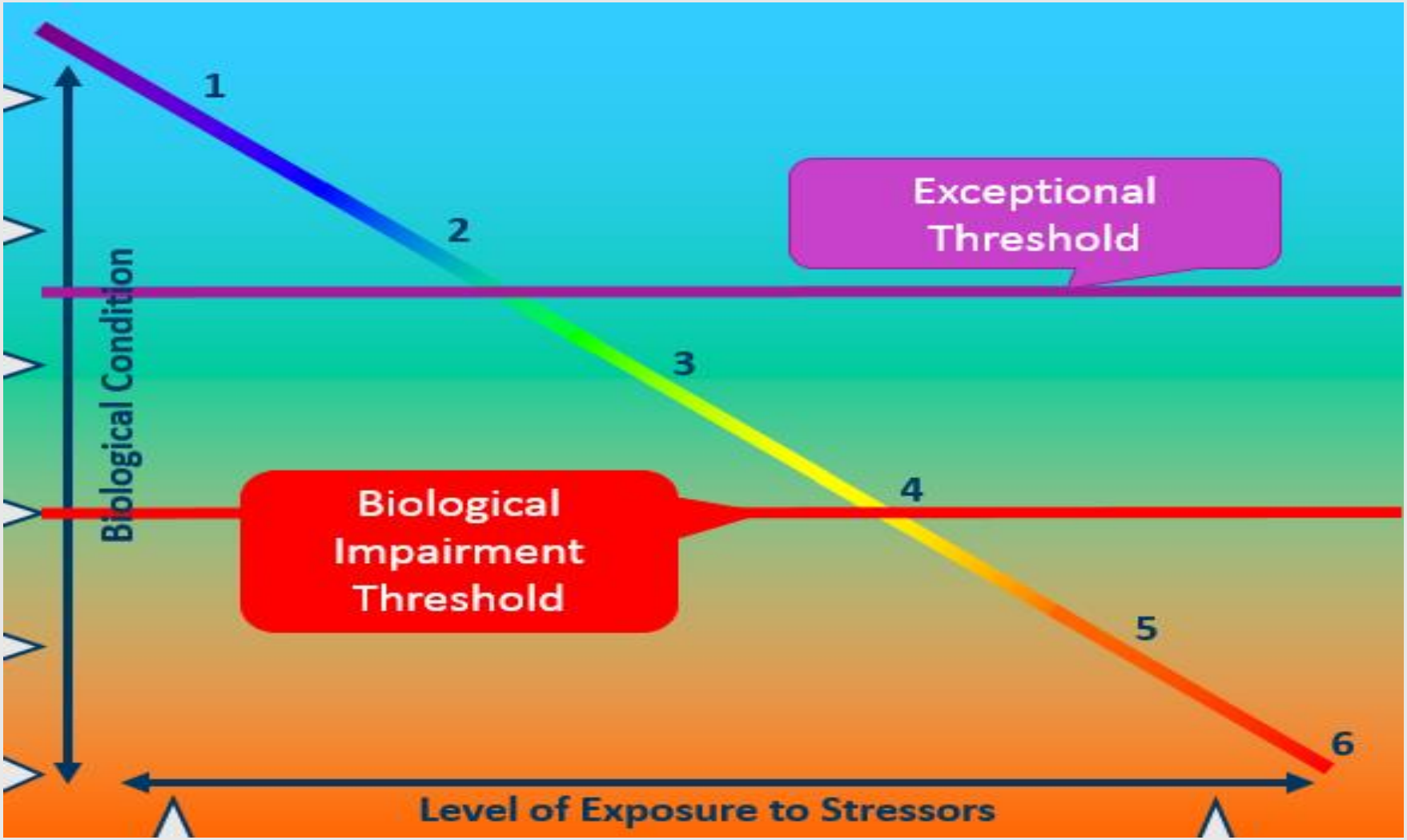


Fish IBI Repeatability on Sentinel Lakes



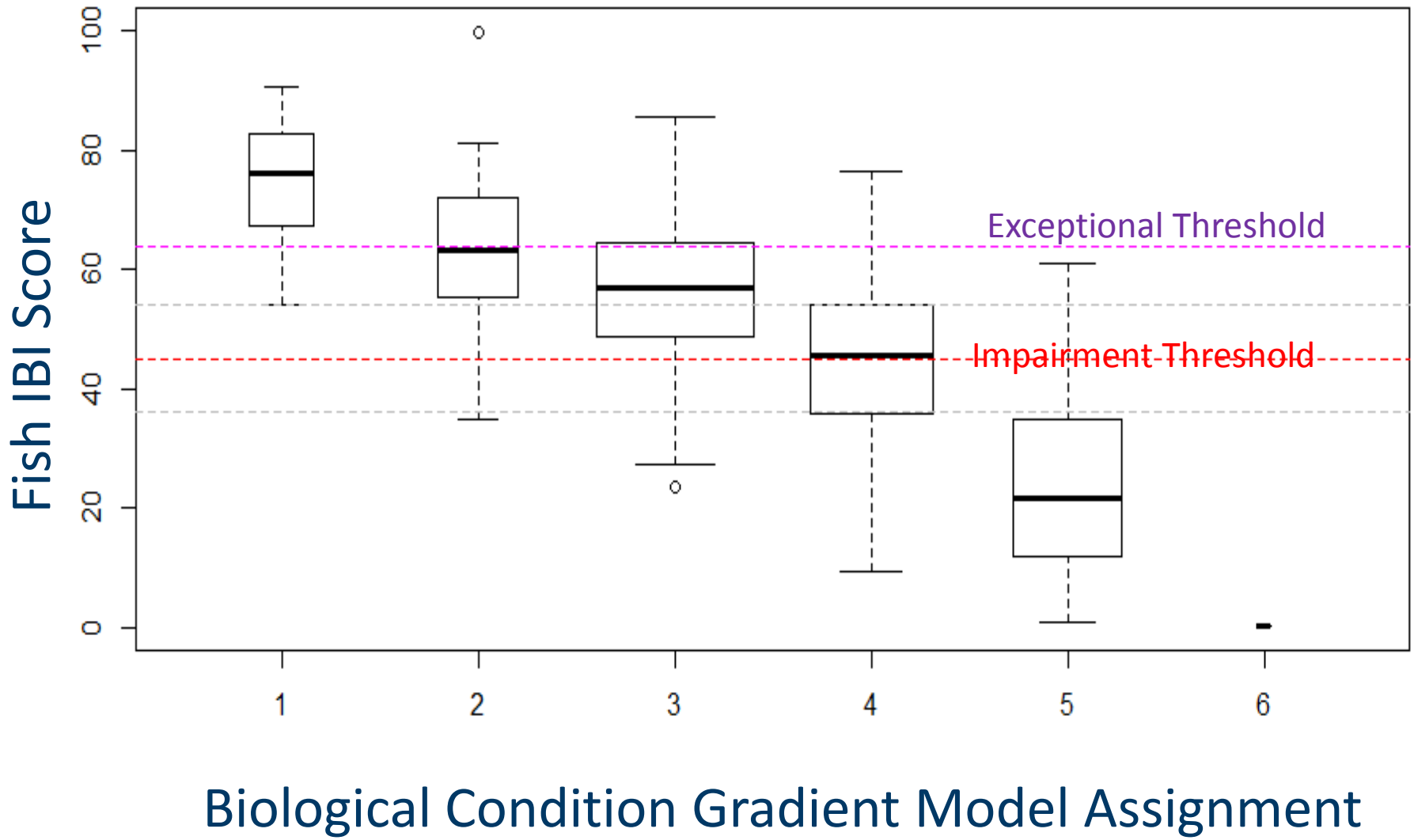
Biological Condition Gradient Model for MN Lakes – Slide modified from Tetratech Center for Ecological Sciences



Watershed, habitat, hydrology, and water chemistry as naturally occurs.

Watershed, habitat, hydrology, and water chemistry severely altered from natural conditions.

Fish IBI Score v. Biological Condition Gradient Model Assignment



Work towards additional Biological Standards for MN lakes

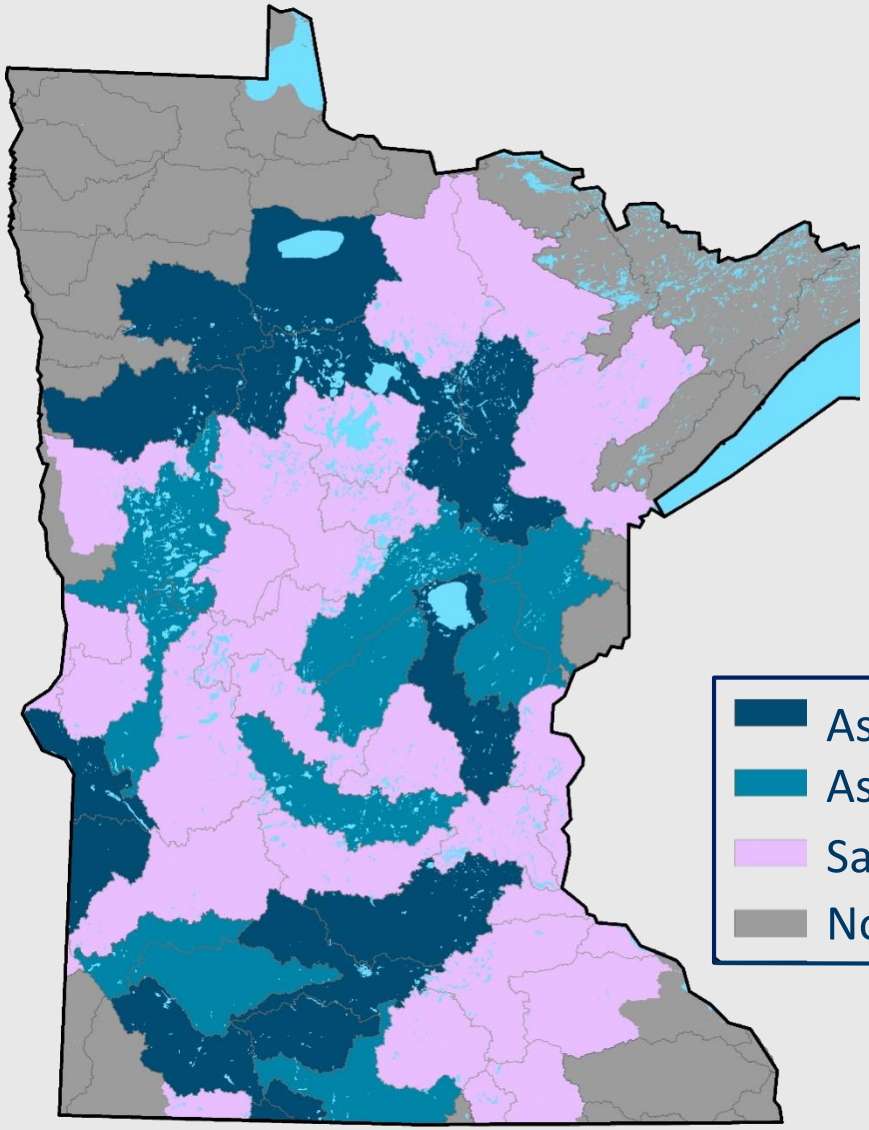
- Existing Fish IBI standards are suitable for most lakes, but may not adequately protect those that support unique fish communities

- <u>Work continues to:</u>

1) implement a higher standard for exceptional lakes

2) implement cold-water species protections for lakes supporting cold-water fish species (cisco, lake whitefish, stream trout, and lake trout)

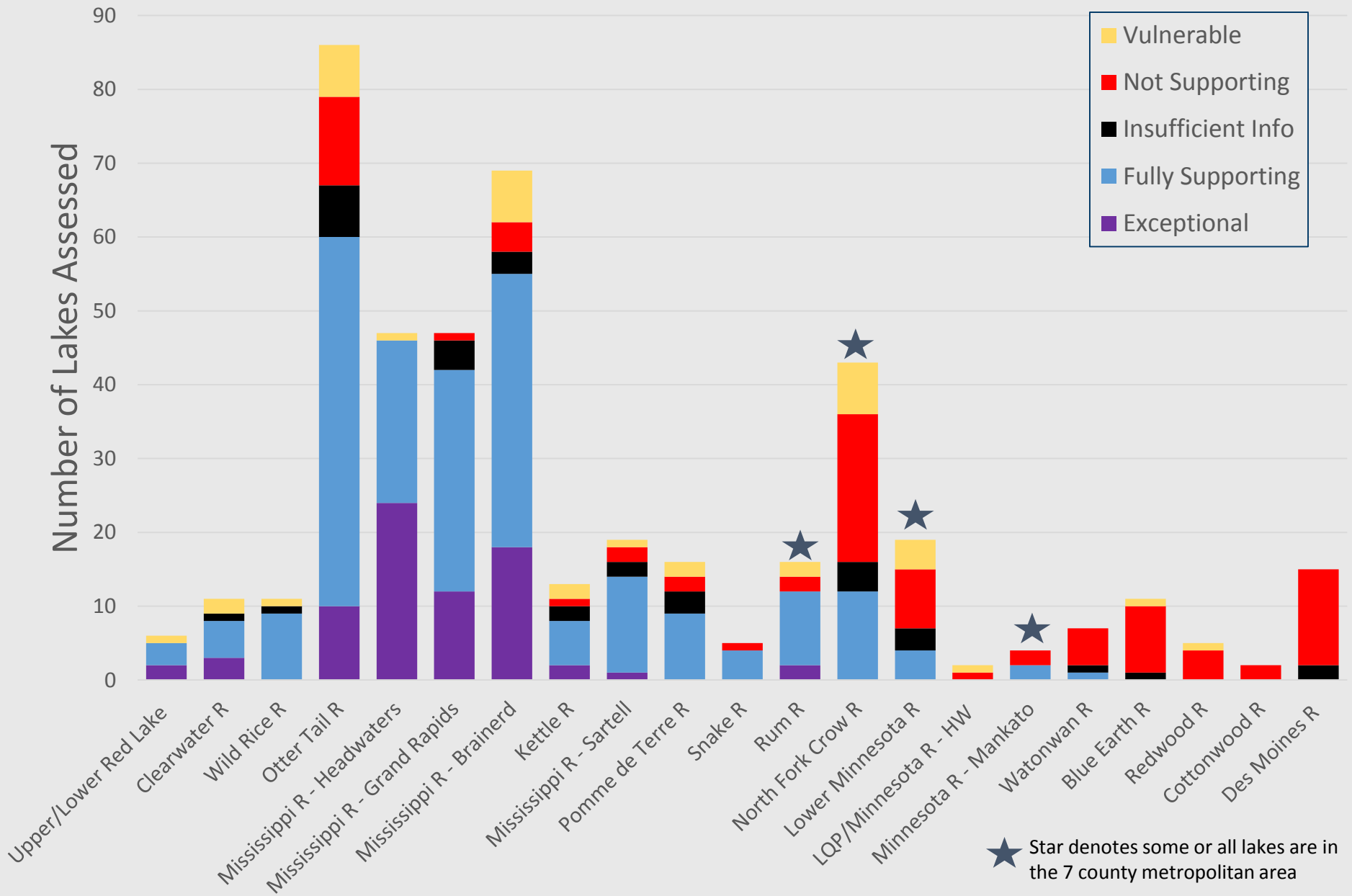
Implementation of FIBI Monitoring and Assessment in Lakes



- 454 lakes in 24 MN watersheds assessed using FIBI data
- Hundreds of lakes in 26 additional watersheds currently being sampled and data summarized for assessment in the next five years

Assessments & Stressor ID complete
Assessments complete
Sampling in progress
No lakes suitable for FIBI

Watersheds Assessed with the Fish IBI: 2015 - 2019



Thank You!

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218-203-4315

Find us on the web, google “MN lake IBI”