Metropolitan Water Reclamation District of Greater Chicago

Welcome to the February Edition of the 2024 M&R Seminar Series

NOTES FOR SEMINAR ATTENDEES

- Attendees' audio lines have been muted to minimize background noise.
- A question and answer session will follow the presentation.
- Please use the "**Chat**" feature to ask a question via text to "**Host.**" The presentation slides will be posted on the MWRD website after the seminar.
- This seminar is approved by the ISPE for one PDH and approved by the IEPA for one TCH. Certificates will only be issued to participants who attend the entire presentation.

James Bland, Director
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Mr. James Bland was the founder of Integrated Lakes Management (ILM), a full-service aquatic management firm with experience in watershed assessment, water quality modeling, water quality sampling, algae and rooted aquatic plant control, fisheries assessment, the use of GIS for land use analysis, dredging feasibility studies, shoreline stabilization, and the development of hydrologic and nutrient budgets. Mr. Bland sold ILM in 2005 and is currently the owner/director of EPS Inc. Jim formerly worked for the USEPA, where he was a coauthor of a phosphorus reduction plan for the lower Great Lakes and Saginaw Bay, and the first Project Officer for the Great Lakes Areas of Concern. Jim also volunteered for six years with the Research and Conservation Department of the Shedd Aquarium. In 2017, he traveled to Haiti to support an NGO that was developing wells for rural villages. Jim received the **Lake Guardian Award** in 2002 for creating the first successful sanctuary for endangered and threatened fish species in Illinois. In 2022, he received a **Life-time Achievement Award** from Illinois RiverWatch.

Test: What does this have to do with water quality?

5^{th} in series of fires on Cuyahoga River in Cleveland and impetus for the creation of the Clean Water Act in 1972

Global Climate Change Impacts on Aquatic Communities of the Chicago Wilderness and implications for restoration strategies

IMPERILED FRESHWATER SPECIES:

MUSSELS 199 (65%)

AQUATIC SNAILS 452 (64%)

FISHES 700 (39%)

CRAYFISH 172 (47%)

Chicago Wilderness = consortium of conservation groups addressing S.E. Wisconsin, N.E. Illinois and N.W. Indiana. Represents a transition zone between eastern deciduous forests and prairie communities. Indiana Dunes National Park has highest biodiversity of National Parks but poor inland aquatic communities. Continental divide (Mississippi and St. Lawrence), Eleven separate Tier III ecoregions within its boundaries.

Goal = Description of regional aquatic communities and species for purposes of adaptation to climate change and preservation of biodiversity

Quick regional run through

- Regional Projected climate patterns and trends (CMAP & 4th National Climate Assessment, Midwest Climate Center)

- Physiological and distributional responses to ambient temperature changes and modified flow regimes

- Management of regional aquatic communities

- Status of regional aquatic communities
  A. Lake Michigan
  B. Inland lakes and ponds
  C. Mainstem streams
  D. Headwater streams and aquatic communities

Snapshot of status

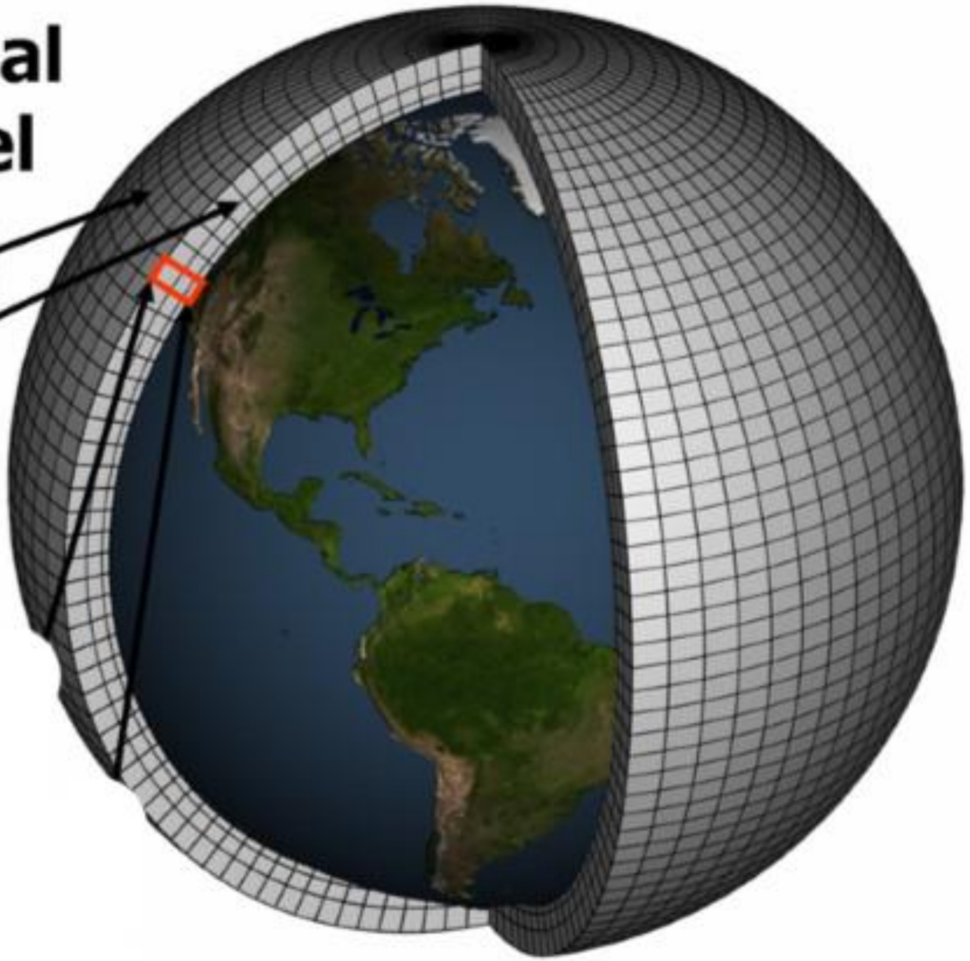
- Adaptation Strategies for sustainable aquatic communities

Problem of scale effects…translating to regional weather difficult on a spatial and temporal basis.

Schematic for Global Atmospheric Model

Horizontal Grid (Latitude-Longitude)

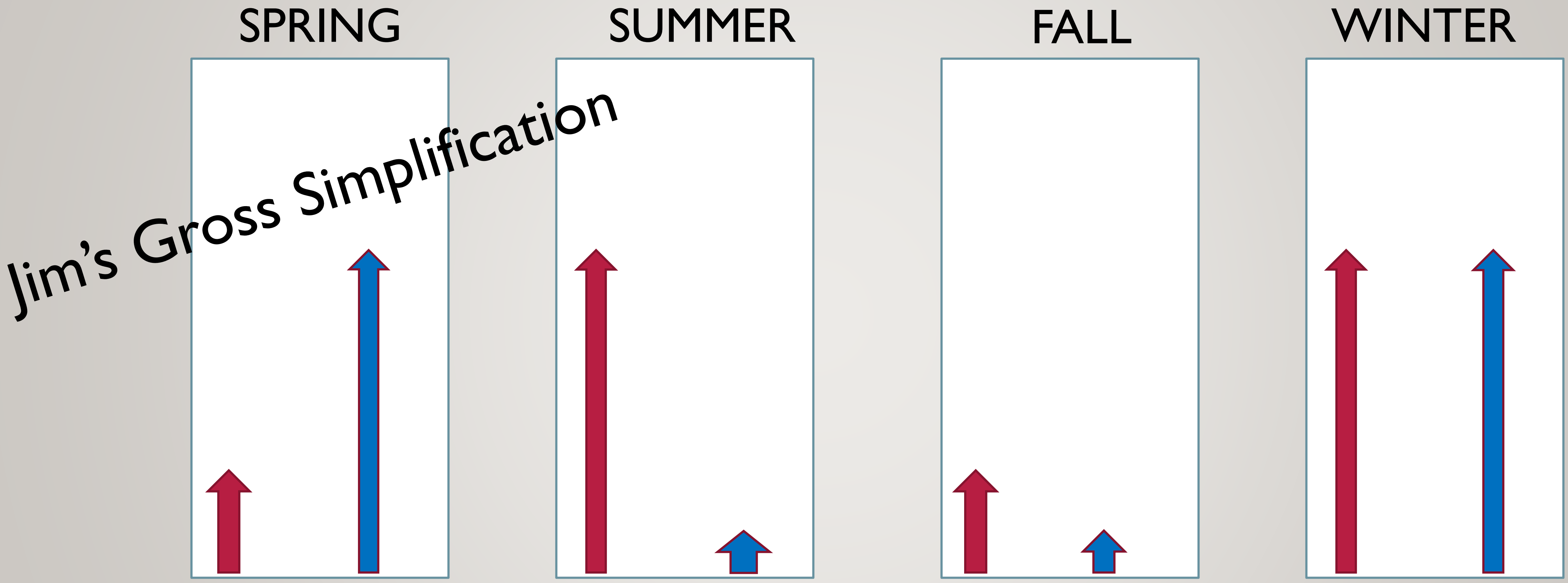
Vertical Grid (Height or Pressure)

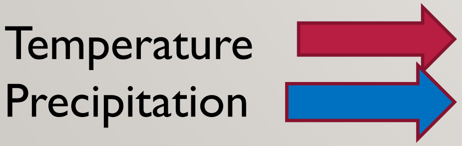


Climate models are systems of differential equations based on the basic laws of physics, fluid motion, and chemistry. To “run” a model, scientists divide the planet into a 3-dimensional grid, apply the basic equations, and evaluate the results. Atmospheric models calculate winds, heat transfer, radiation, relative humidity, and surface hydrology within each grid and evaluate interactions with neighboring points.

Different outcomes based on different working assumptions

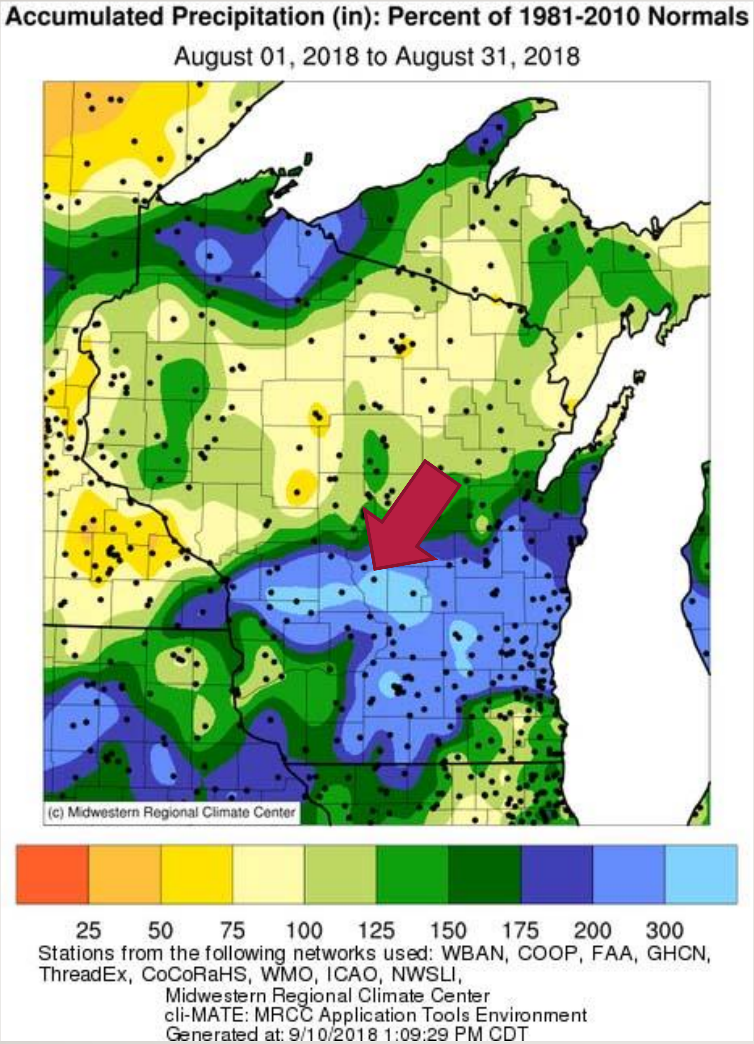
CLIMATE PATTERNS

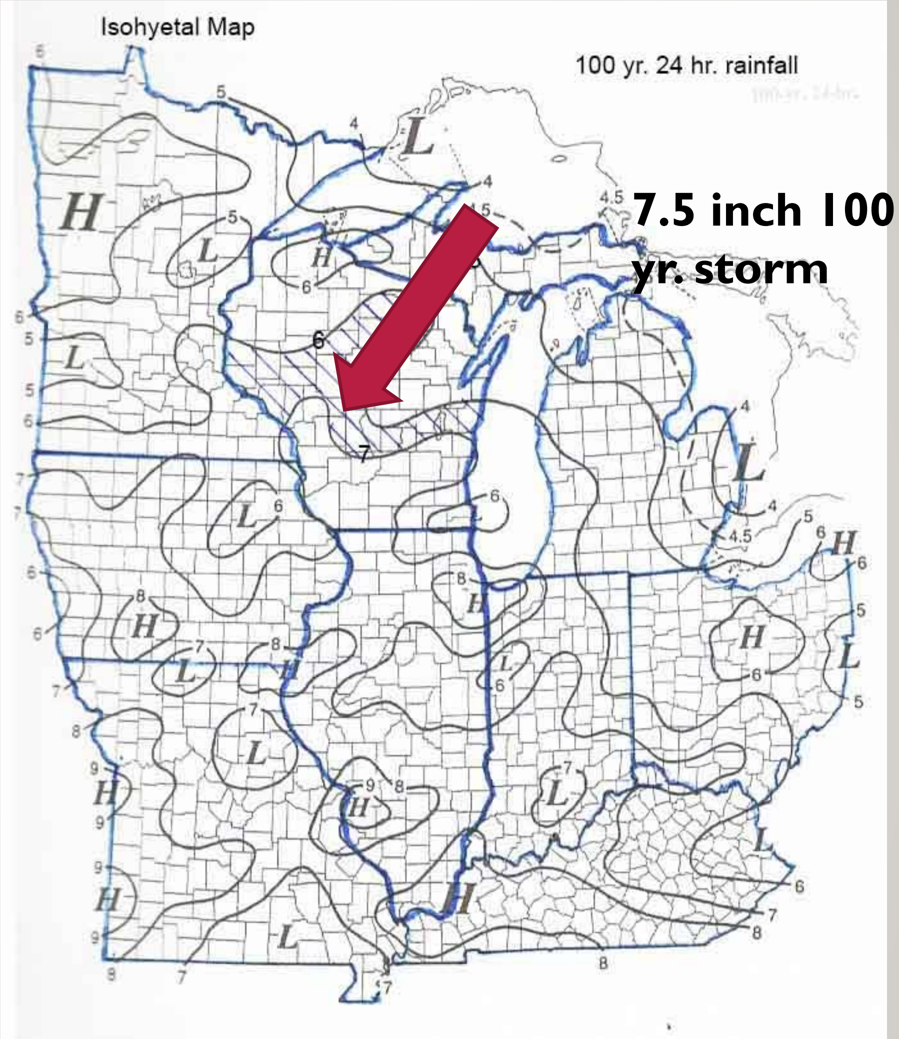




Relative increases by comparison with average seasonal values.

August 2018 - 12” and 15” rainfall in a day across most of central Wisconsin





7.5 inch 100 yr. storm

Use of Rain Atlases =

- Sizing of infrastructure
- Sizing of STP plants
- NPDES Permits
- Stormwater planning and flood zones
- MS4 Permits
- TMDL analysis
- Watershed planning
- Regional modeling
- All types of load allocations

Bulletin 70

Bulletin 70 modified

Bulletin 71

Bulletin 75

NOAA Atlas 14

Dilemma No. 1 Inadequate Characterization of Regional Rainfall and Extreme Weather Events

Rainfall Atlases include those generated by the Illinois State Water Survey (ISWS) and the National Oceanic and Atmospheric Administration (NOAA). By definition they are backward looking, seeking to define historic distribution patterns for storm intensity, duration, frequency and spatial distribution. Climate change , by its very nature, is a "disruption" of historic patterns. As a consequence the Atlases no longer have the predictive power that they once had . This is problematic because the Atlases were a critical tool for engineering and environmental management. They were a first stop for stormwater assessment, sizing of detention ponds, sizing of sewage treatment facilities, sizing of urban and suburban infrastructure, setting dimensions for urban development, identifying lake levels, setting dimensions for dams, setting criteria for NPDES permits, and assessing water quality impacts of all types. Critical hydrologic and hydraulic planning started with the identification of the 100 year-24 hr. design storm. Preservation of aquatic communities will require better characterization of flow regimes and responses to extreme weather events including both flooding and drought. Ensemble modeling which relates global atmospheric models to smaller regions may substitute as a planning tool in the future. It is a transition period and the level of uncertainty will remain high in the immediate future.

REGIONAL PROJECTED CLIMATE PATTERNS AND TRENDS

- FREEBOARD ON DETENTION PONDS (24 HR. 100 YR. FRQ.)
- SIZING OF INFRASTRUCTURE; PROTECTION STP
- CHANGES IN FLOOD PLAINS
- INCREASED NUTRIENT AND POLLUTANT LOADING
- PROMOTION OF RIPARIAN FLOODING; PROMOTION OF URBAN FLOODING
- HISTORIC INFRASTRUCTURE BASED ON OLD BULLETIN 70 DATA

BY DEFINITION WE ALREADY HAVE UNDERSIZED INFRASTRUCTURE

- INTEGRATION WITH PROBLEM OF IMPERVIOUS COVER ISSUES

BY DEFINITION WE EXCEED IMPERVIOUS COVER VALIDATED TO IMPACT BIOTIC INTEGRITY OF STREAMS

- WE DON'T PLAN OR MODEL FOR DROUGHT CONDITIONS

DROUGHT MORE DESTRUCTIVE TO AQUATIC FAUNA AND FLORA THAN FLOODING

PHYSIOLOGICAL AND DISTRIBUTIONAL RESPONSES

cold

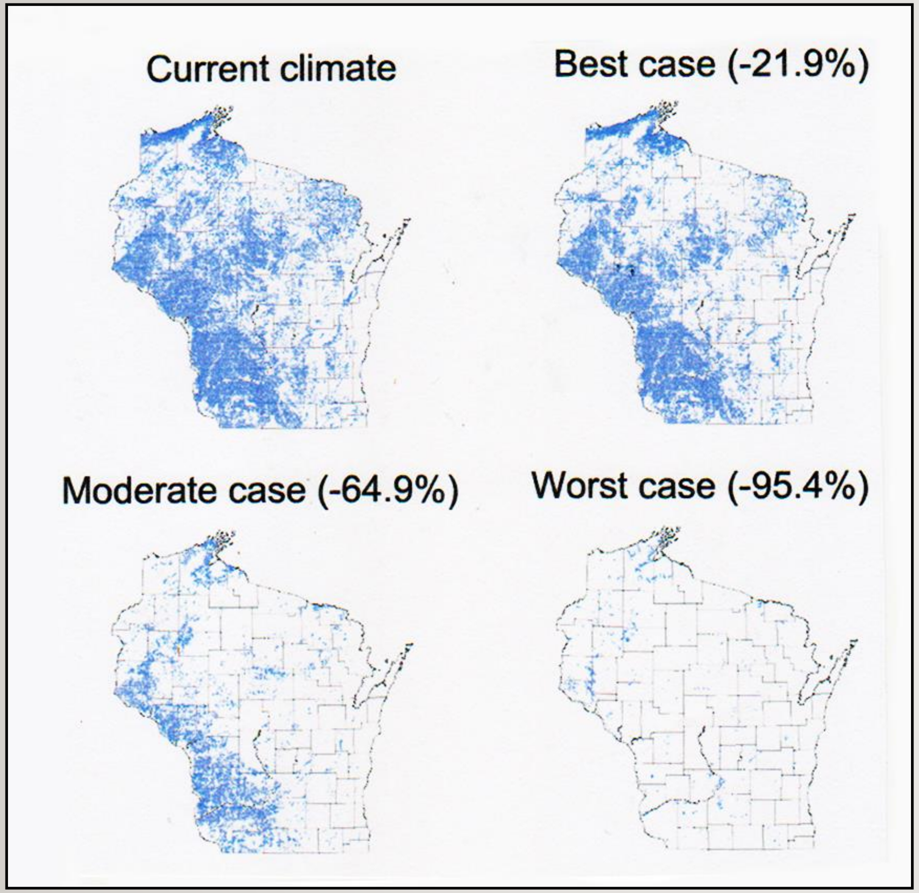
cool

warm

Common name *Scientific name*	Temperature Optimum C° (F°)	Lethal Extremes C°(F°)
Coho salmon *Oncorhynchus kisutch*	4-13 C° embryos (39– 55 F°) 8-16 C° parr (47– 60.8 F°)	25 C° (77 F°)
Walleye *Sander vitreus*	10-18 C° spawning (50– 64 F°) 22-26 C° adult (72– 79 F°)	31C° adult (88 F°)
Carp *Cyprinus carpio*	18-24 C° spawning (64-74 F°) 22-32 C° juveniles (72– 90 F°) 20-26 C° adults (68-79 F°)	34.5 C° adult (94 F°)

Different species are adapted to different temperature ranges. Differences exist among eggs, larva, juveniles and adults. Temperatures tolerances will dictate spatial distribution. Larger fish will be more sensitive to DO and temperature extremes. Fish use movement to colder parts of habitat to adapt. Thermal bottlenecks exist in fish life histories. Cf. *Science* July 2020; *When Do Fish Succumb to Heat?*

PHYSIOLOGICAL AND DISTRIBUTIONAL RESPONSES

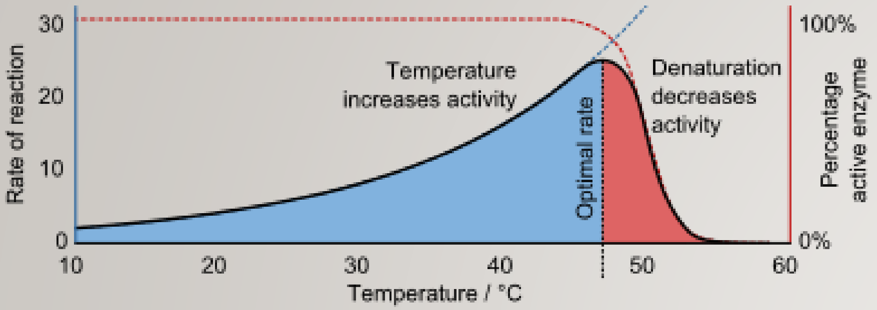


Mottled Sculpin Distribution Changes Under Different Scenarios of Climate Change

Fish found in headwater communities with cold water habitat. Climate shifts are impacting availability of spring fed headwaters.

- Adapt
- Move north
- Disappear

Physiological and distributional responses

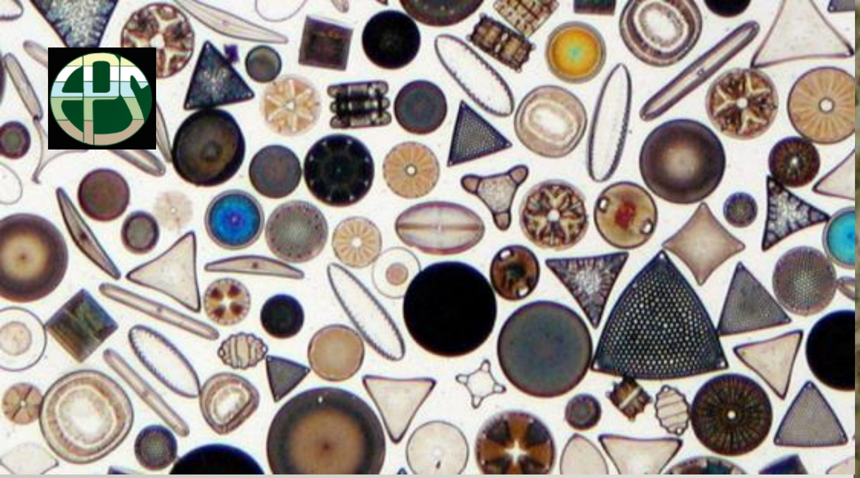


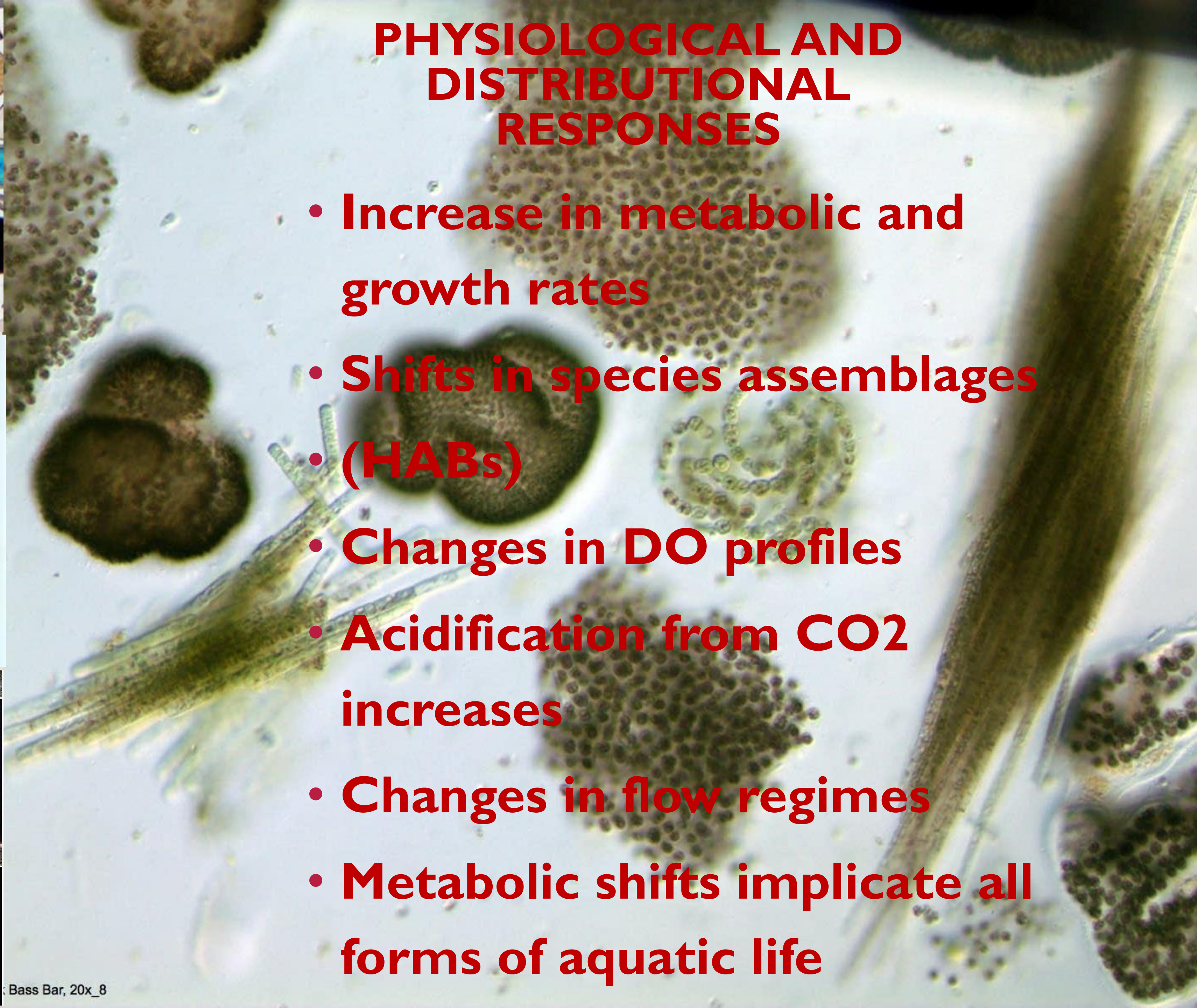
Metabolic rates for all life processes impacted by and driven by temperature. Cardiorespiratory adaptations will be different for different fish species but all responsive to physical limits.

Q10 law of biochemistry = 10°C increase = 2 to 3 fold rate increase in enzyme activity. As ceiling is reached enzyme proteins denature and system shuts down. Lethal extremes are reached much earlier for fish and other things living in water.

Temp DO Met. need

Larger fish affected first





PHYSIOLOGICAL AND DISTRIBUTIONAL RESPONSES

- Increase in metabolic and growth rates
- Shifts in species assemblages
- (HABs)
- Changes in DO profiles
- Acidification from CO2 increases
- Changes in flow regimes
- Metabolic shifts implicate all forms of aquatic life

Dilemma 2 : Genetics and evolution

Preservation of biodiversity assumes that ambient environmental conditions stay within bounds that have sustained communities and species in the past. Temperature and flow regimes are principal environmental drivers for flora and fauna of aquatic communities. While rapid changes in population tolerances are possible for species it is not necessarily the norm. Aquatic communities and species are already the most highly endangered of our biological heritage. Goals of preservation, especially for individual species, may not be realistic in light of projected climate change. This begs the question of how and what to preserve. The creation of artificial sanctuaries is a possibility but preserving the full range of genetic variability is not likely. Goals for future conservation will need to recognize adaptative resources, distributional data, characterization of genomic data, and habitat profiling.

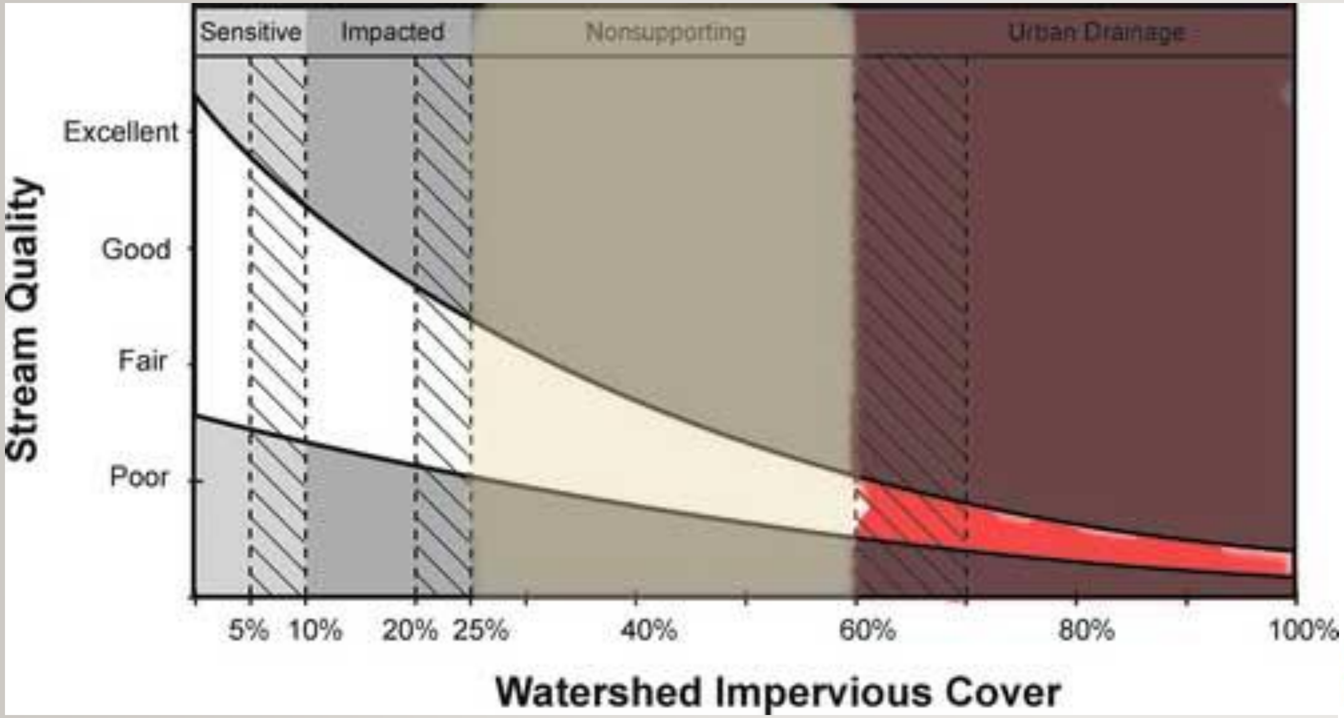
III. Management of regional aquatic communities

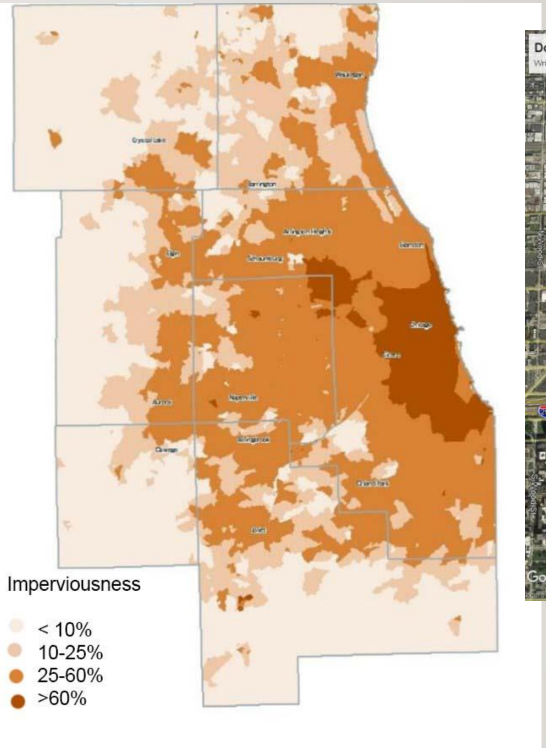
Partial list of federal, state, and regional agencies involved in the management of aquatic communities of Chicago Wilderness. Several hundred more exist.

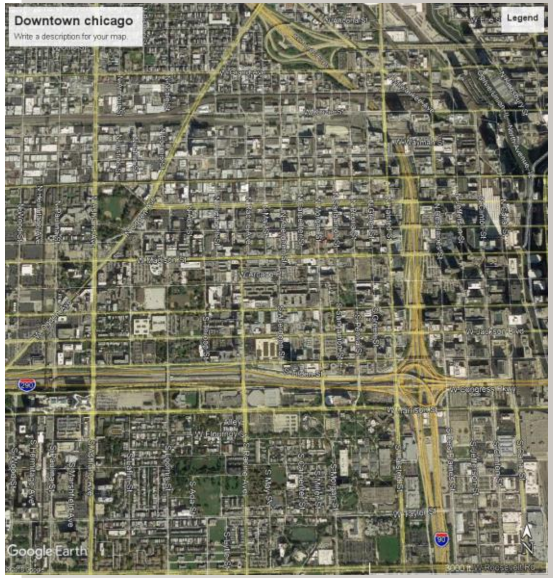
Dilemma 3 Multiple Uncoordinated Management Agencies

The chapter graphic represents a partial list of the federal, state and regional agencies involved in the planning and management of aquatic resources for the Chicago Wilderness Region. One of the obvious difficulties is the coordination of both planning and management throughout the region. Each of these entities have different but overlapping responsibilities . Regional agencies also include county based forest preserve districts, stormwater agencies, drinking water utilities, and sewage management authorities. Coordination between states remains difficult. We believe that there are well over 200 different institutional entities with some mandate to do planning and/or management of the water resource. DuPage County and Lake County have undertaken the development of watershed based planning consortiums. Some form of global water information clearinghouse would seem valuable.

Watershed Planning: Urbanization Coupled with Climate Change







Dilemma: Should the State and USEPA downgrade some stream sections in order to prioritize high quality reaches ?? Concept= Tiered Aquatic life Uses or TALU

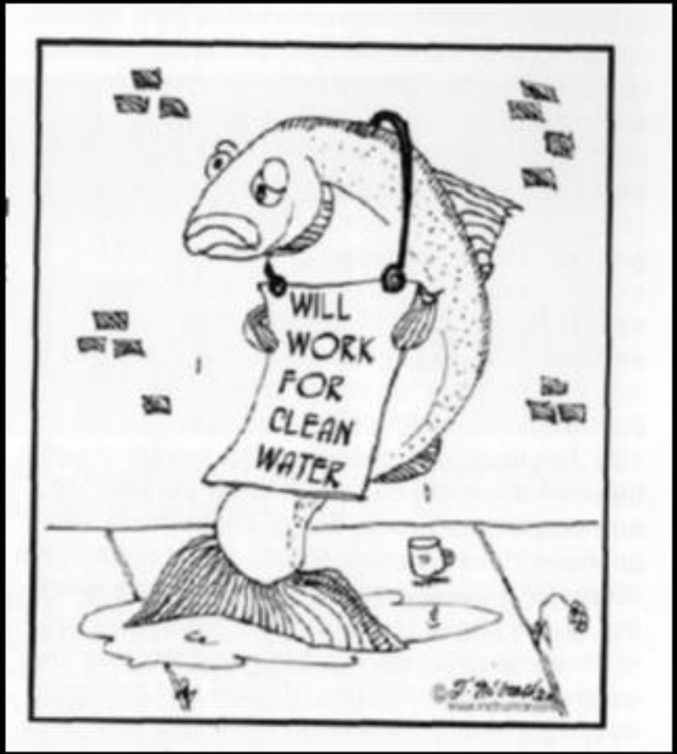
- Goals: fishable, swimmable, drinkable
- Water Quality Standards
  (historically chemical)
- Designated Uses
- Antidegradation (1972)
- Use Attainability Analyses

- Sec. 303 listings= impaired
- Sec. 305b biannual reports

Dilemma: Disjunct data base between 305 B chemical records vs. detailed biological profiling

Goal of the Clean Water Act

Biological Integrity = *"....the capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat of the region."*

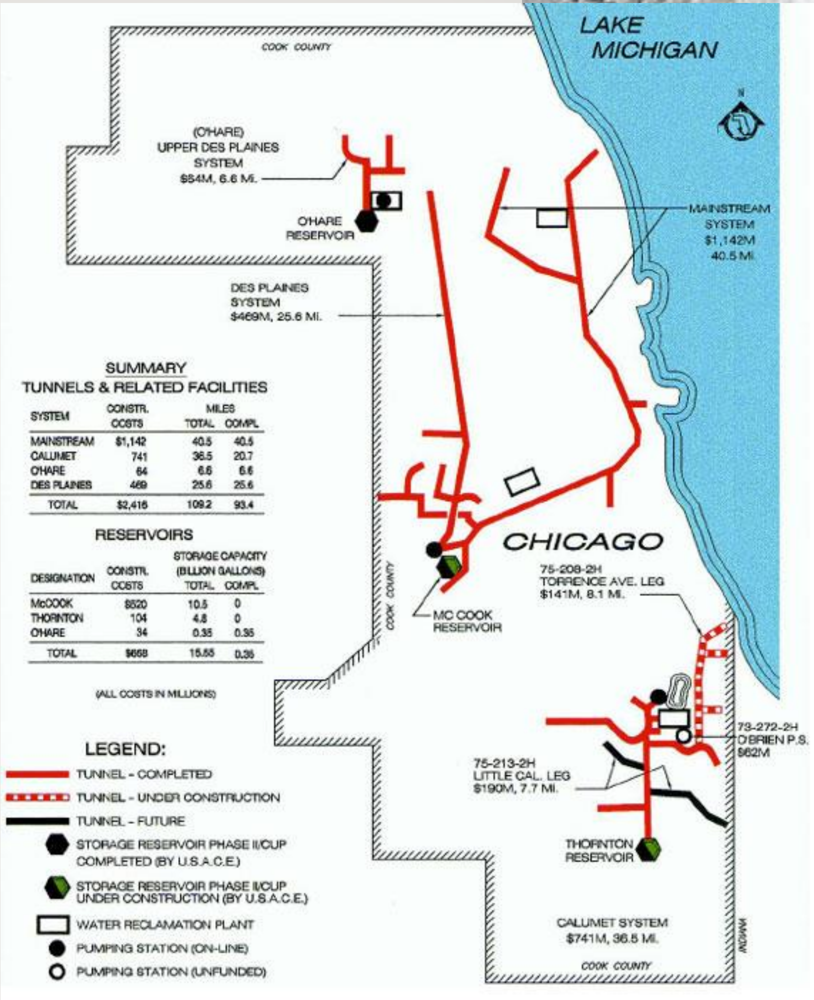


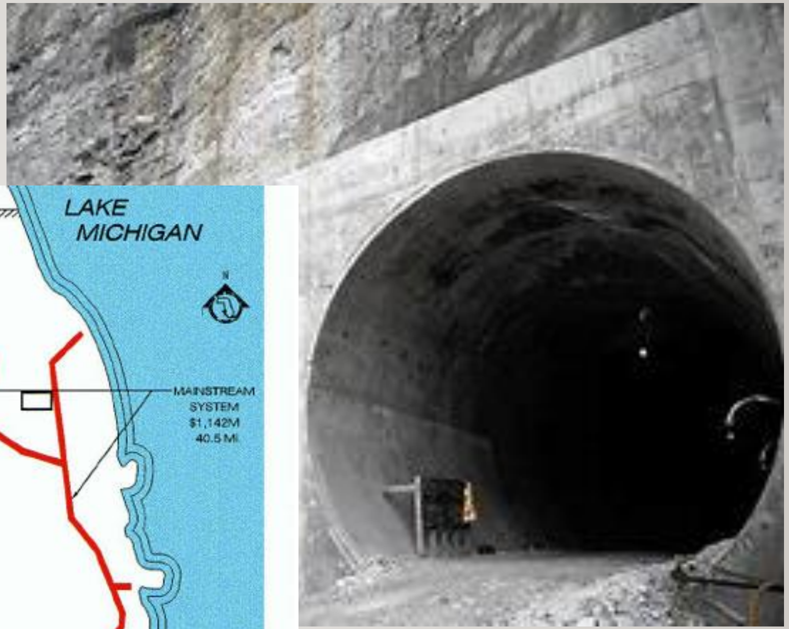
In order to accomplish this must use

1. Systems science
2. Bioassessment......i.e. RiverWatch, fishIBI

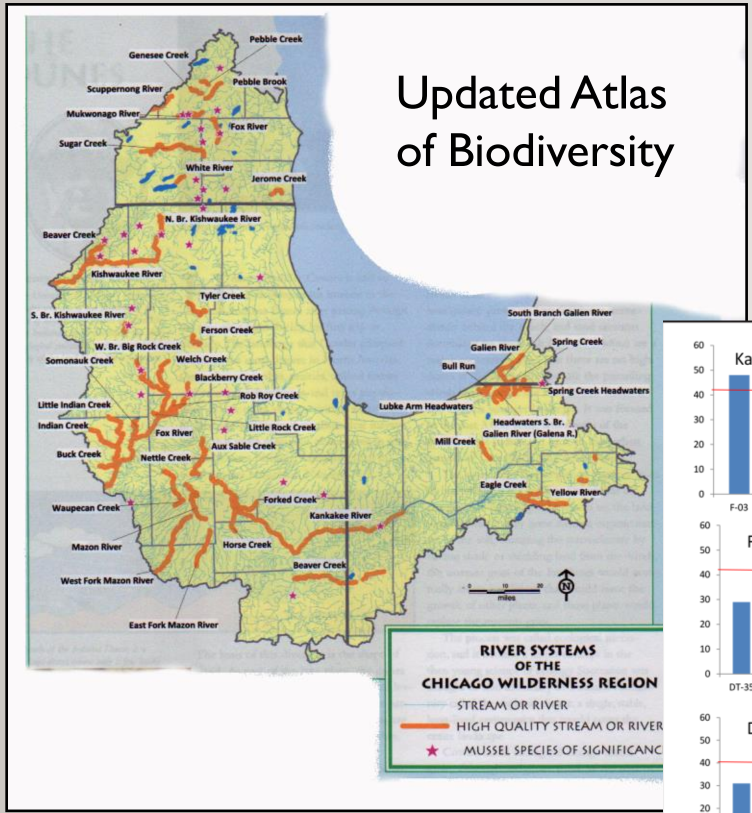
METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

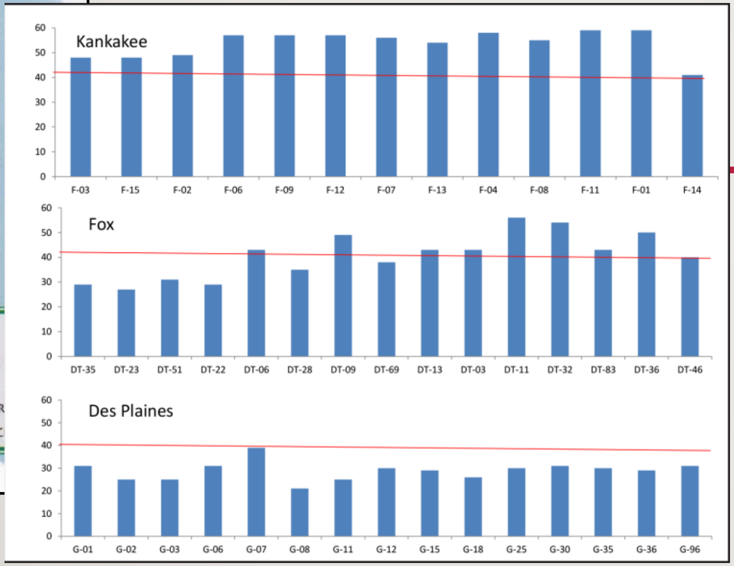
- Largest secondary STP in world (Stickney WRP)
- Seven STPs (WRPs)
- Run a stormwater program for Cook County
- Maintain TARP program with City and County
- Improvement in fisheries
- Continued innovation and technical leadership
- Promotion of Green Infrastructure
- Impacts CAWS
- Continue to have CSO problems and discharges to Lake Michigan
- Continue to be a source of nutrient loading and export





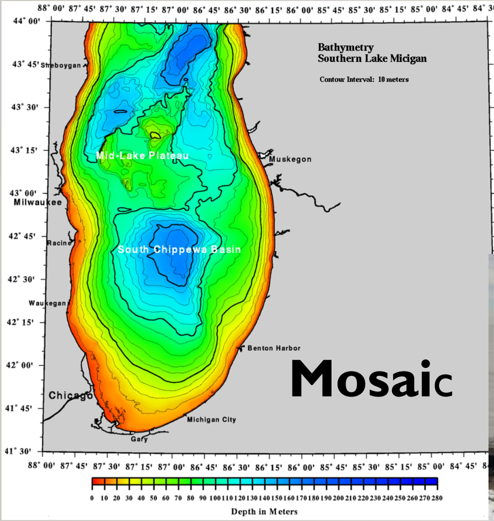
STATUS OF REGIONAL AQUATIC COMMUNITIES : MAINSTEM STREAMS

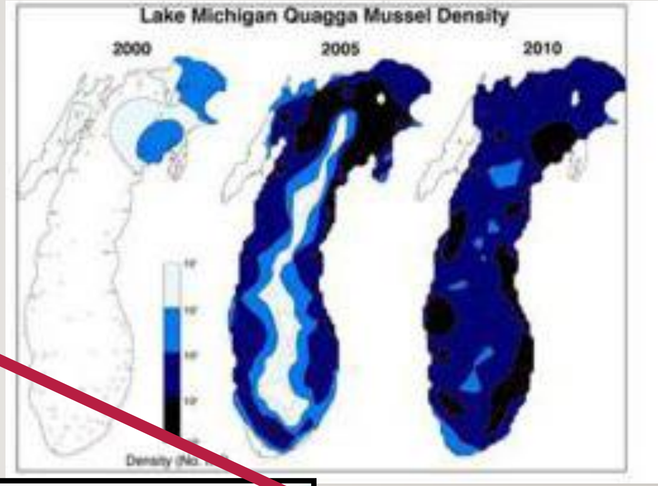


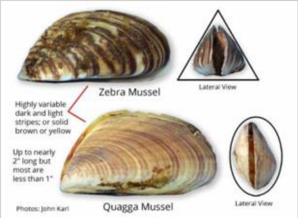


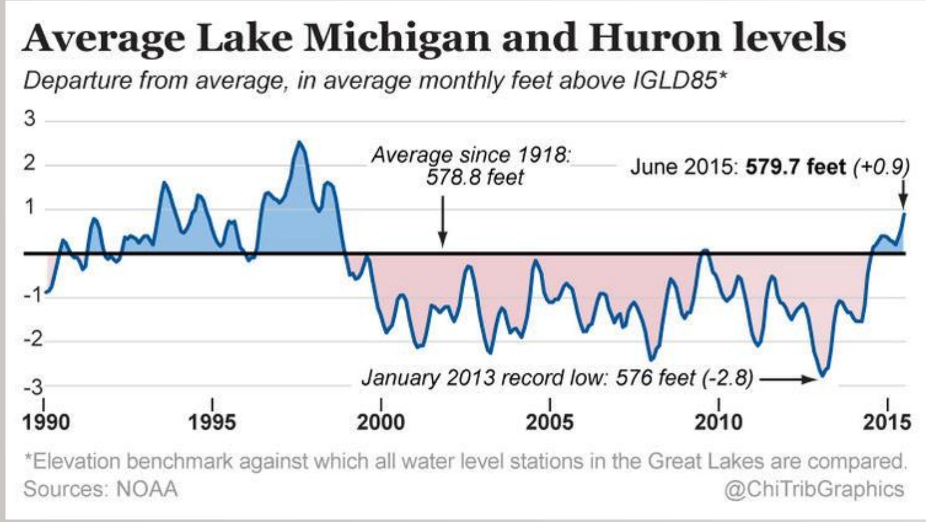
STATUS OF REGIONAL AQUATIC COMMUNITIES : LAKE MICHIGAN

Depth
Substrate
Current
Embayments
Limestone outcrops
Near shore
Open Water



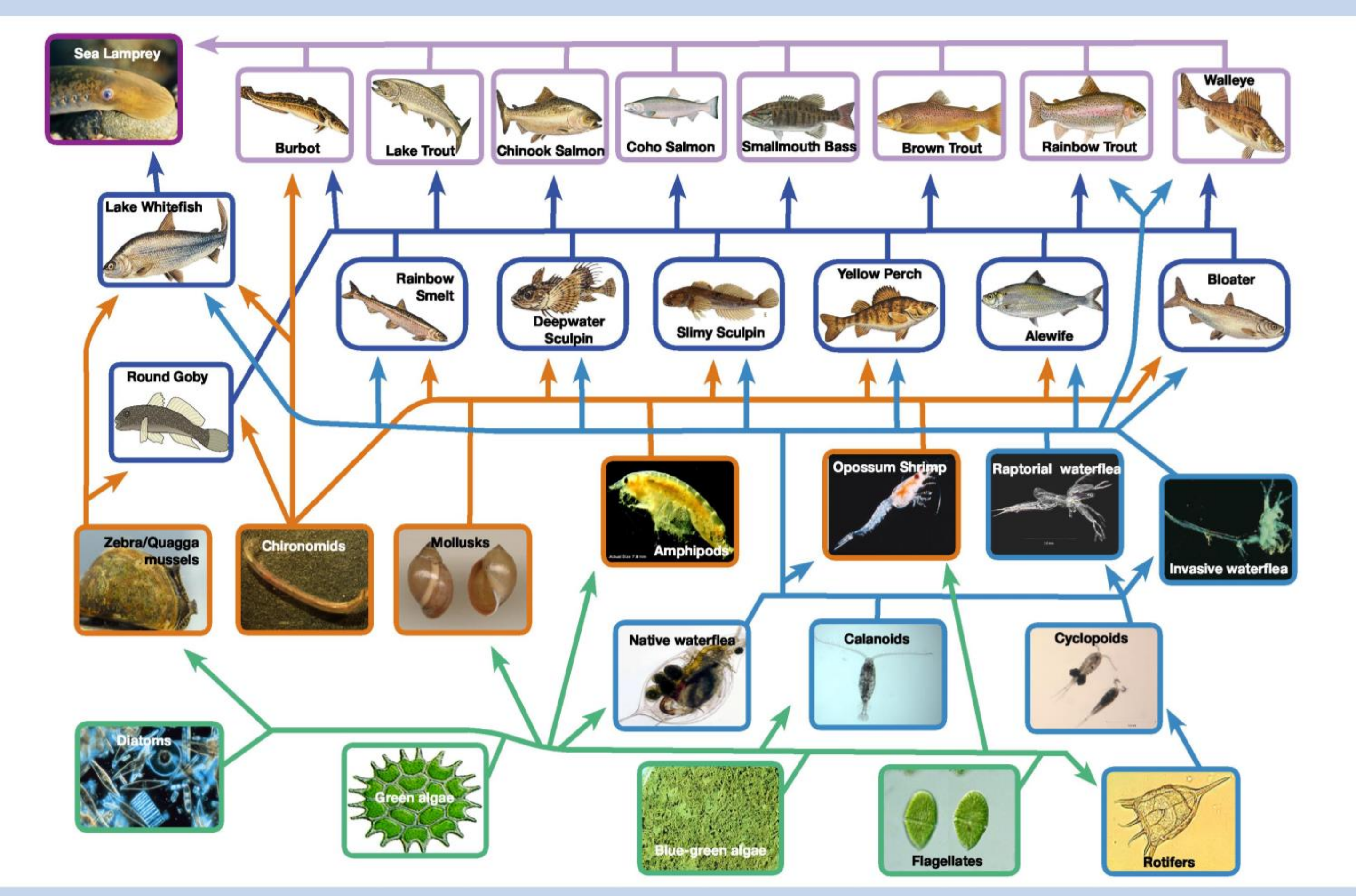


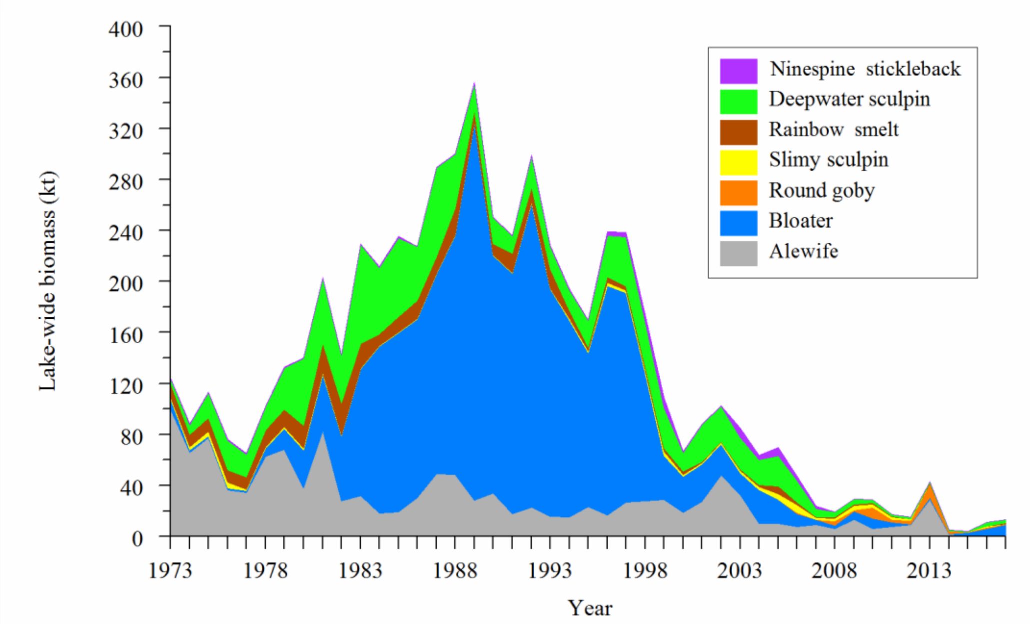




Variability/modeling problems/ small watershed

STATUS OF REGIONAL AQUATIC COMMUNITIES : LAKE MICHIGAN





Future Change in Rise of the Great Lakes Water Levels Under Climate Change

General Circulation Model

Regional Circulation downscaling

3d hydrodynamic lake and ice model

Net Basin Supply
- over lake rainfall
- lake evaporation
- runoff

Ensemble modeling

Lake Michigan-Huron

-.13 to +.8 meters

= + .5 meter rise in next decades

STATUS OF REGIONAL AQUATIC COMMUNITIES : INLAND LAKES AND PONDS

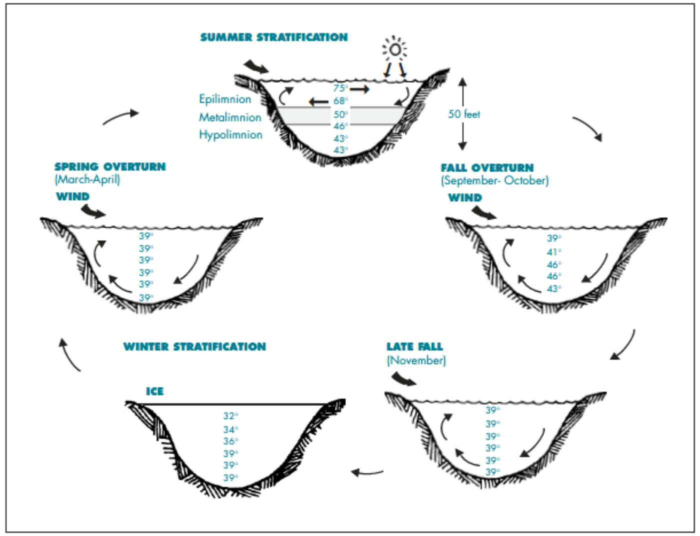
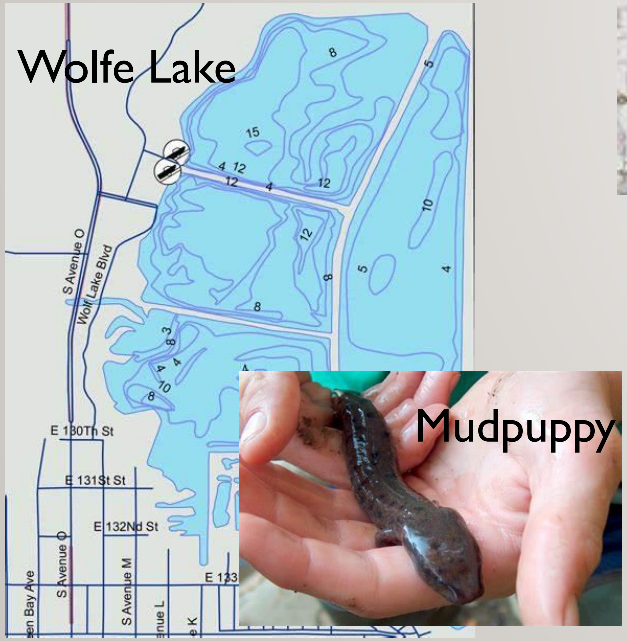
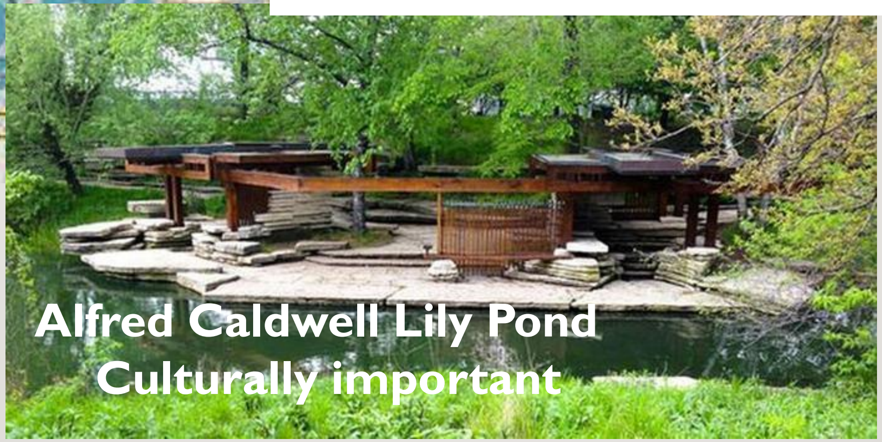


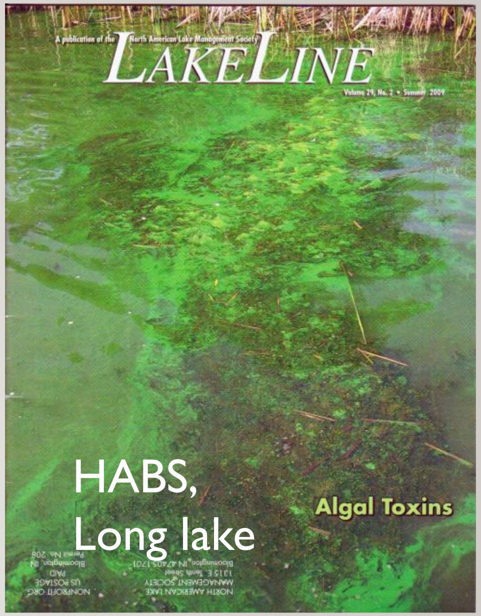
FIGURE 2. Annual temperature cycles in stratified lakes.





*1000's of detention ponds

- Hazardous Blue-green Algal Blooms (HABs Cyanophyta)

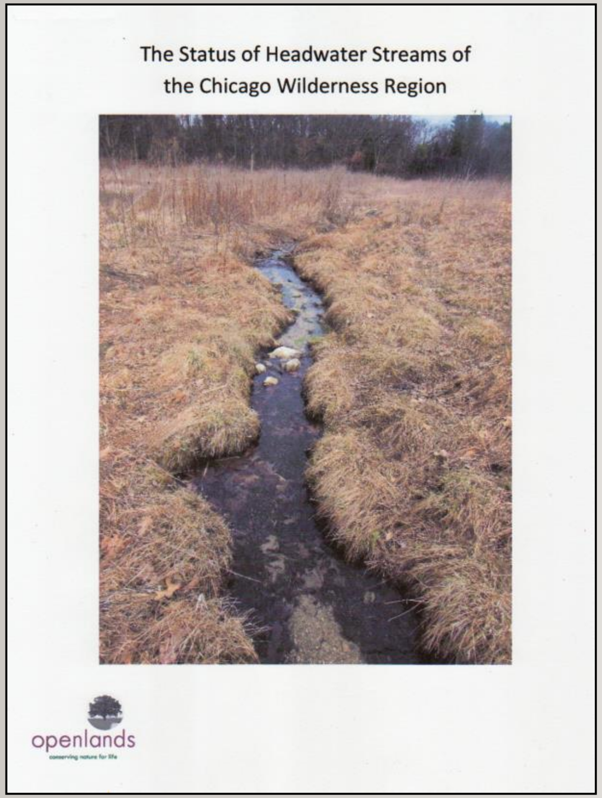


- Microcystin concentration 20,000 ug/l
- WHO recreational guideline= 20 ug/l
- Children vs adults
- 40 yr. history
- Internal vs. external loading

Dilemma 4. Prioritization of Multiple Grading Systems

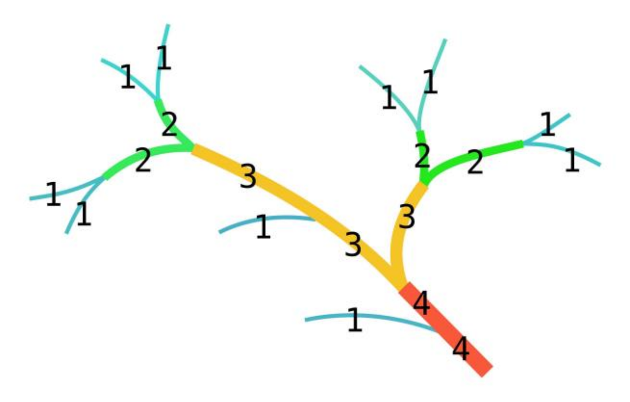
In addition to different methods for assigning biological value to aquatic communities, reference sites, and species clusters there also exist multiple methods for grading, prioritizing and assigning management methods to stream reaches, lakes and ponds. This includes **Green Infrastructure Vision (GIV), watershed planning, stormwater planning, lake assessment, freshwater fishing programs, regulatory requirements and adaptive management.** Some of these methods operate on a regional scale, others on a site specific basis. While they are not mutually exclusive there are circumstances where they will not reach the same conclusions. Different methods for grading biological performance are incorporated into these programs. The dilemma exists in knowing how to prioritize grading of biological value and how to frame it within a management context with the recognition of limited availability of financial and institutional resources.

STATUS OF REGIONAL AQUATIC COMMUNITIES : HEADWATERS



Headwater Types

- Solitary seeps and springs
- Bedrock seeps
- Vernal ponds
- Bordering wetlands
- Groundwater surcharged lakes and ponds
- Farm tile wetlands
- Detention ponds
- 1st and 2nd order tributaries



- 50 to 70% of drainage area
- Critical to biology of higher order streams
- Functional zones for nutrients/denitrification

RESILIENCE IN AN ERA OF UNCERTAINTY

How should we organize problem solving?

Lake Michigan	Inland Lakes	Main Stem	Headwaters
Shoreline protection(new methods needed)	New empirical models (i.e. upgrade of WILMs)	Increased monitoring	Characterization and mapping of types of headwaters
Tributary profiling	Tracking and addressing HABs	Consistent biological prioritization TALU	Increased regional biological surveys
Physical monitoring	Changes in NARP	AI application for watershed assessment	Protection of riparian buffers
Changes in stocking patterns	Support of VLMP	Use of impervious cover in planning	Groundwater recharge mapping
Artificial reefs	E/T management and prioritization	Protection of coldwater and coolwater habitat	Regulatory changes in support of headwaters
Modeling upgrade	Park district lagoons	Increased use of flow regimes and habitat profiling	Land use control
Increased allocation of funds	Increased allocation of funds	Increased allocation of funds	Increased allocation of funds
Species specific conservation planning (IWAP)	Urban detention ponds	Renewed emphasis on watershed as basic planning unit	Habitat renewal projects
Quagga mussel studies	Changes in TMDL modeling	Restoration projects	Stream connectivity
Substitution for historic rain atlases	Substitution for historic rain atlases	Substitution for historic rain atlases	Substitution for historic rain atlases
		Mussel and macroinvertebrate mapping	Mussel and macroinvertebrate mapping

QUESTIONS?

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Thank you!