Climate Change and Northern Michigan Fishes

Dave Clapp
Charlevoix Fish. Research Sta.
Michigan DNR

What I'll cover today…

- Terminology, Measurements, and Models
- General Effects
- Broad-scale Fisheries Effects
- Great Lakes / Michigan Studies
- Local Efforts

Some definitions…

- Climate change
  - (1956) *"…long-term change of the Earth's climate including changes in temperature, precipitation, and wind patterns over a period of several decades or longer."*
- Global warming
  - (1975) *"…the increase in the Earth's average surface temperature since the Industrial Revolution, primarily due to the emission of greenhouse gases from the burning of fossil fuels and land use change,…"*
- Causes

Leiserowitz et al. 2014. "What's in a Name? Global Warming vs. Climate Change."

Measurements

- Monitoring (100+ years)
- Surrogate measures (1000s years)
- Citizen science (10s – 100s years)

Wednesday, December 16, 2015 • News-Review

Climate researchers employ tool from 1800s: Whaling logs

MARK PRATT
Associated Press

Maritime historians, climate scientists and ordinary citizens are coming together on a project to study the logbooks of 19th-century whaling ships to better understand modern-day climate change and Arctic weather patterns.

Whaling ships kept meticulous daily logbooks of weather conditions during their often yearslong voyages searching the globe for whales, valued for their light-giving oil, said Michael Dyer, senior maritime historian at the New Bedford Whaling Museum, which is supplying much of the data.

Some logs include information about life on board, such as sailors falling overboard, or being disciplined for stealing or other transgressions, and of course, notations whenever whales are spotted. More important for this project, they include precise longitude and latitude measurements, weather conditions, the presence of icebergs and the edge of the ice shelf.

"If they're cruising in the Bering Strait and there's ice, there will be a notation in the logbook that ice fields are present," Dyer said.

The project, called Old Weather: Whaling, is led by the National Oceanic and Atmospheric Administration. The whaling museum is transcribing and digitizing its own logbooks, as well as original data sources from the Nantucket Historical Association, Martha's Vineyard Museum, Mystic Seaport in Connecticut, and the New Bedford Free Public Library.

The digitized logbooks are being posted online so ordinary "citizen-scientists" can help researchers sift through the vast amounts of information.

The museum has about 2,600 whaling logbooks dating from 1756 to 1965, but the project so far includes just about 300 logbooks related to whaling trips to the Arctic from the mid-1800s to the first decade of the 20th century.

One entry from the San Francisco-based whaler Beluga during a two-year voyage to the Bering, Chukchi and Beaufort seas from 1897 to 1899 is typical of the information in the logs.

Models!

Simple Model

Jaws breaker: Shark attacks set world record in 2015

Of 98 incidents, 59 were in the U.S.

Doyle Rice
USA TODAY

In the territorial dispute between sharks and humans, the toothy beasts bit off a record in 2015.

Sharks, unprovoked, chomped on humans 98 times worldwide last year, the most since records

attacks broke the previous record of 88 set in 2000.

Most folks in 2015 escaped with injuries, but the vicious fish killed six people worldwide, on par with previous years, said George Burgess, curator of the file housed at the Florida Museum of Natural History at the University of Florida.

The majority of the attacks occurred in the U.S., which logged a record 59 incidents. Australia recorded 18 attacks and South Africa followed with eight. The

JIM PARTINGTON, DISCOVERY CHANNEL

Shark attacks set a record last year, with the most since records began 57 years ago, data show.

more people spending time in the sea, giving sharks increasing op-

said in a statement.

Shark populations — like human ones — are also growing.

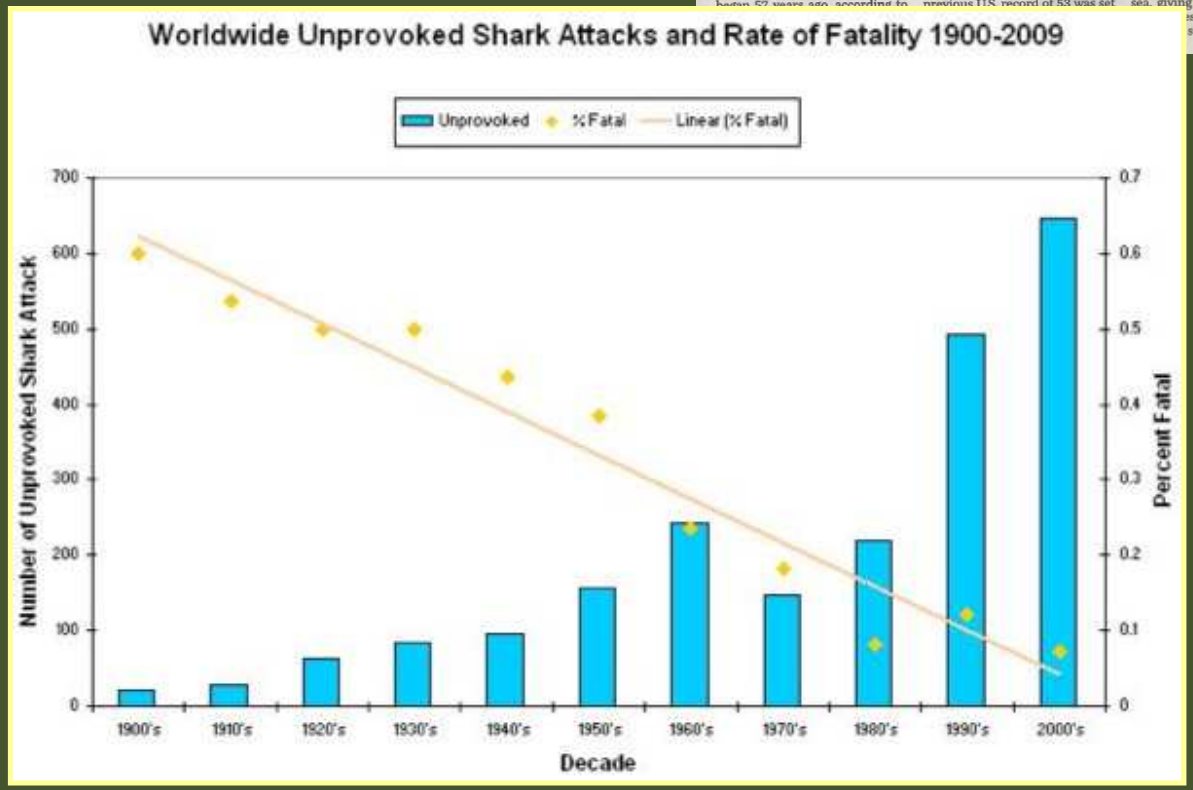
Most of the U.S. attacks — 30 — occurred in Florida, where long coastlines and inviting beaches attract both humans and sharks. The Carolinas each logged eight, followed by Hawaii with seven, and California and Texas with two apiece.

"Sharks plus humans equals attacks. As our population continues to rapidly grow and shark populations slowly recover, we're going to see more interactions," he said.

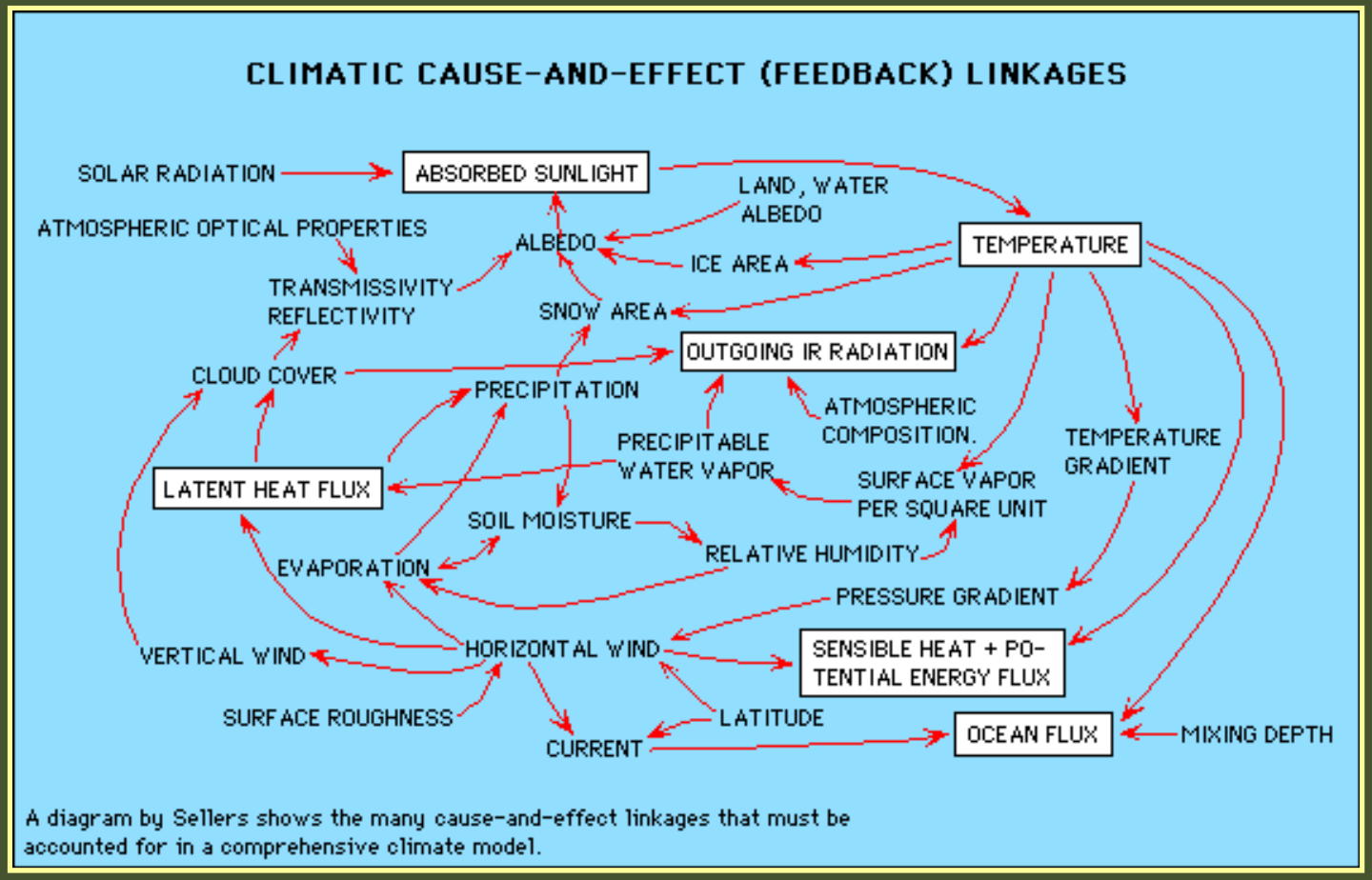
One attack occurred in New York, which points to warming oceans as another factor in the increase in incidents, Burgess said. Water temperatures spiked earlier in the season, which drew more sharks to the shallow water they prefer for feeding and where people also tend to play.

A team of federal researchers captured and tagged 2,800 sharks along the East Coast before summer began, recording the highest number in its 29-year history of monitoring the population.

"We can and should expect the number of attacks to be higher each year," Burgess said. "When we visit the sea, we're on their turf."



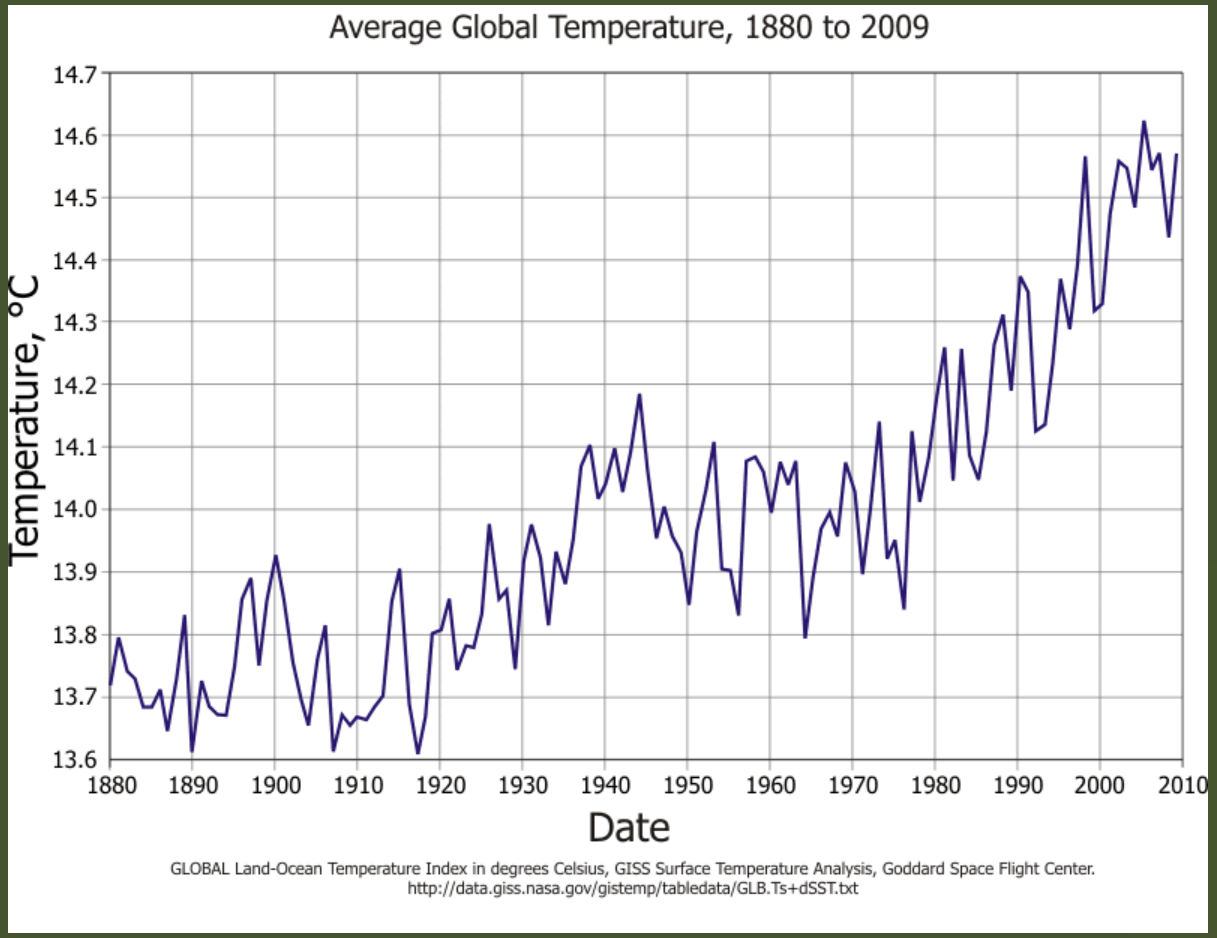
Complex Model



Climate Change…General

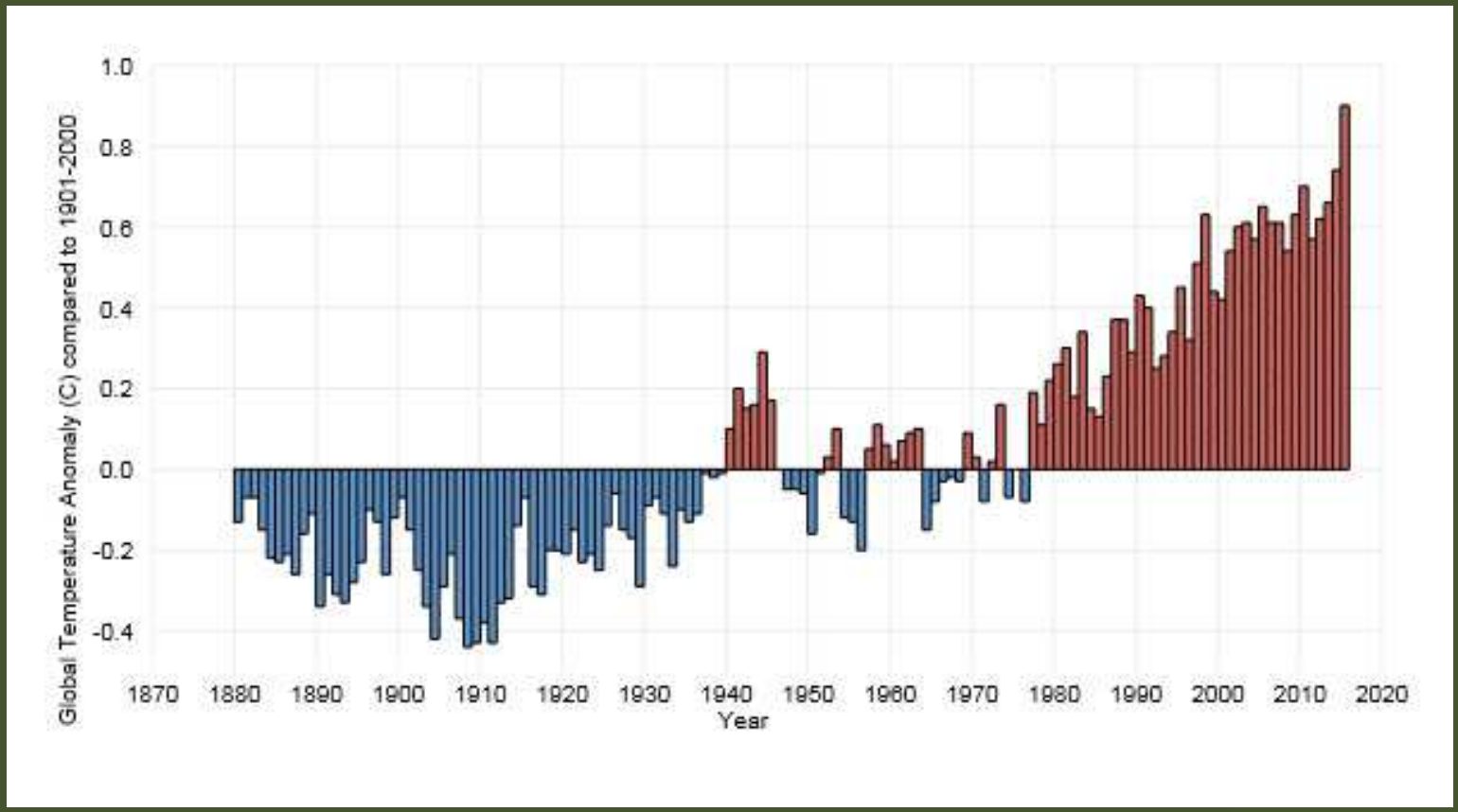
- Global temperature increase
- Lake temperature increase
- Changes in lake stratification
- Ice cover and lake-effect snow
- Other (e.g., acidification, erosion, water demand, invasive species)

Temperature Records



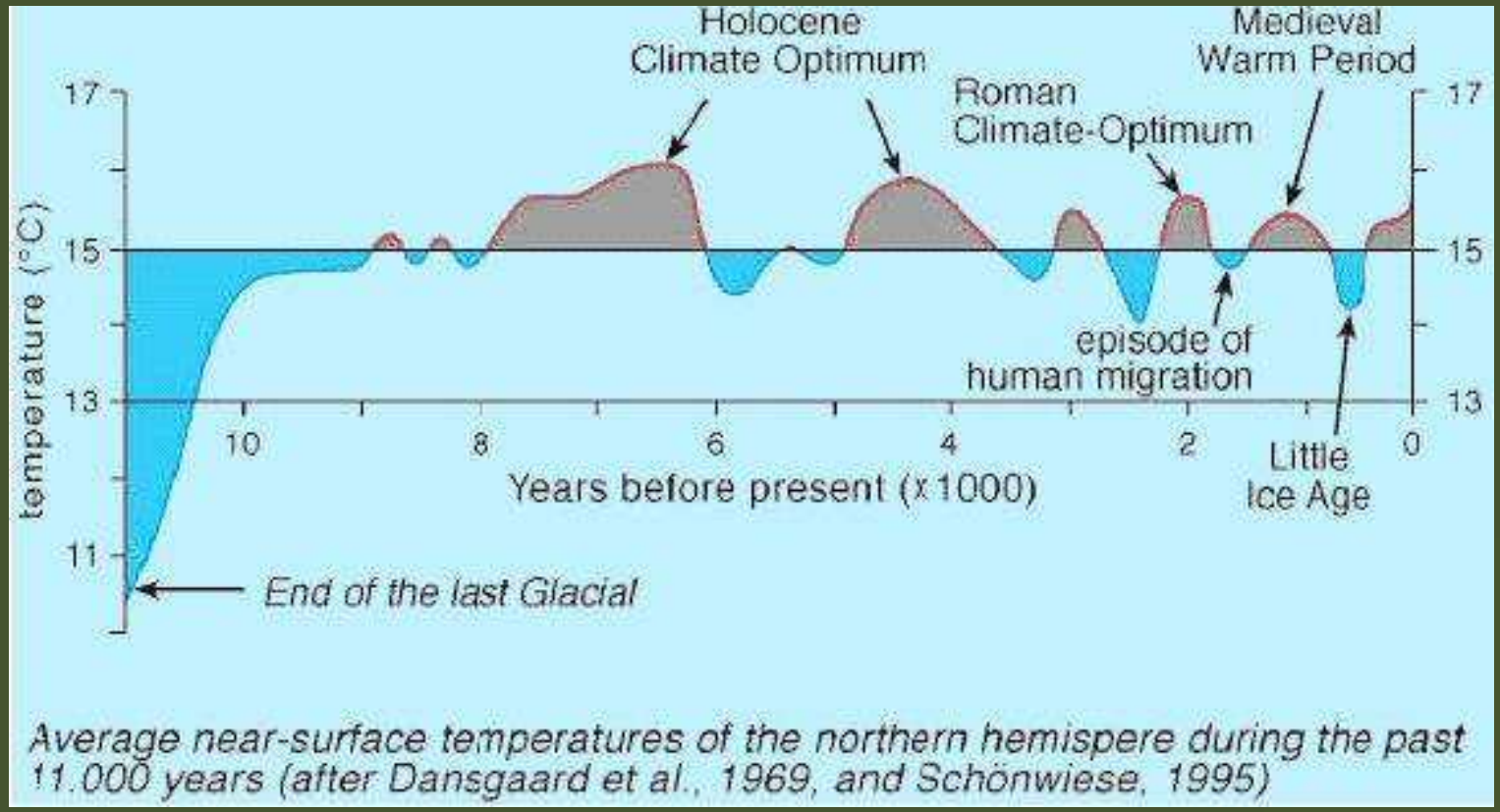
GLOBAL Land-Ocean Temperature Index in degrees Celsius, GISS Surface Temperature Analysis, Goddard Space Flight Center.
http://data.giss.nasa.gov/gistemp/tabledata/GLB.Ts+dSST.txt

Temperature Records



www.climate.gov (NOAA)

Temperature Records



Average near-surface temperatures of the northern hemispere during the past 11.000 years (after Dansgaard et al., 1969, and Schönwiese, 1995)

Great Lakes Changes

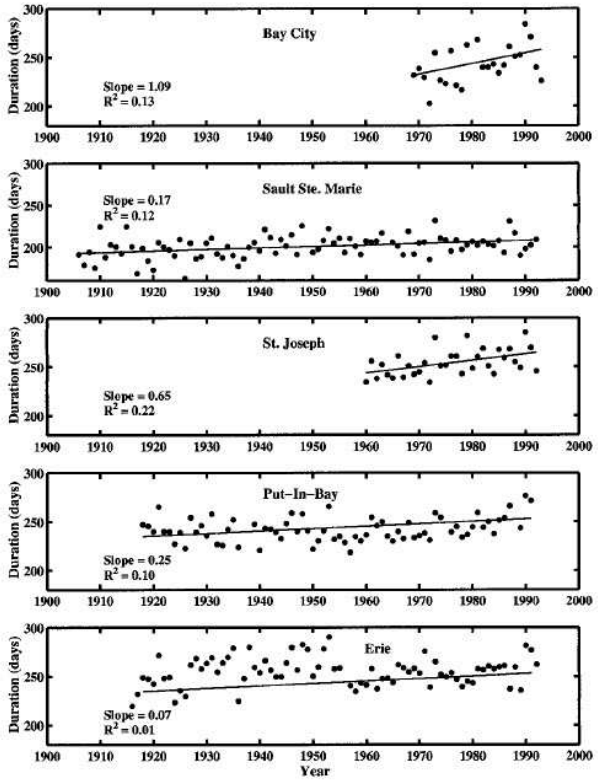


Fig. 7. Plot of maximum potential DSS data from sites showing significant trends over their entire data set (Table 2).

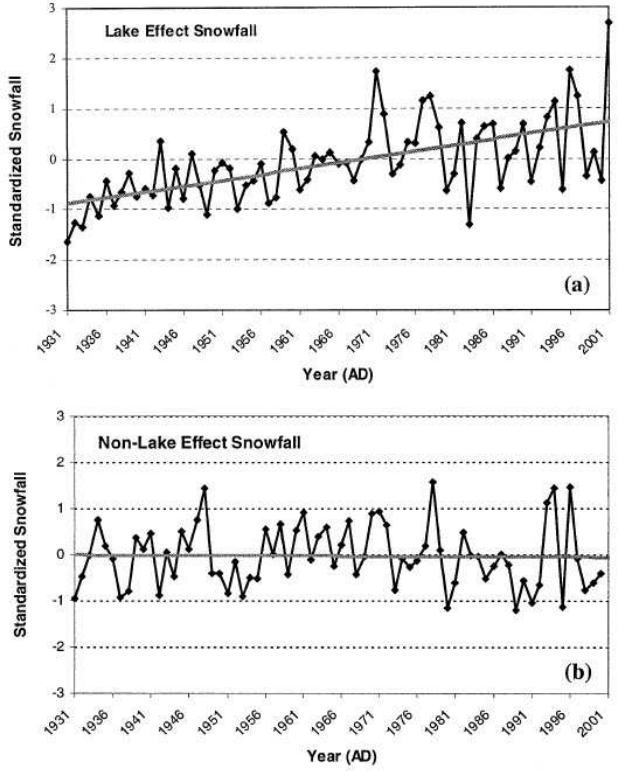


FIG. 3. (a) Composite standardized Oct–Apr total snowfall for lake-effect sites for 1931–2001. The gray line represents the linear trend in snowfall. (b) Same as (a) except for non-lake-effect sites.

McCormick and Fahnenstiel. 1999. Limnol. Oceanogr.
Burnett et al. 2003. Journal of Climate

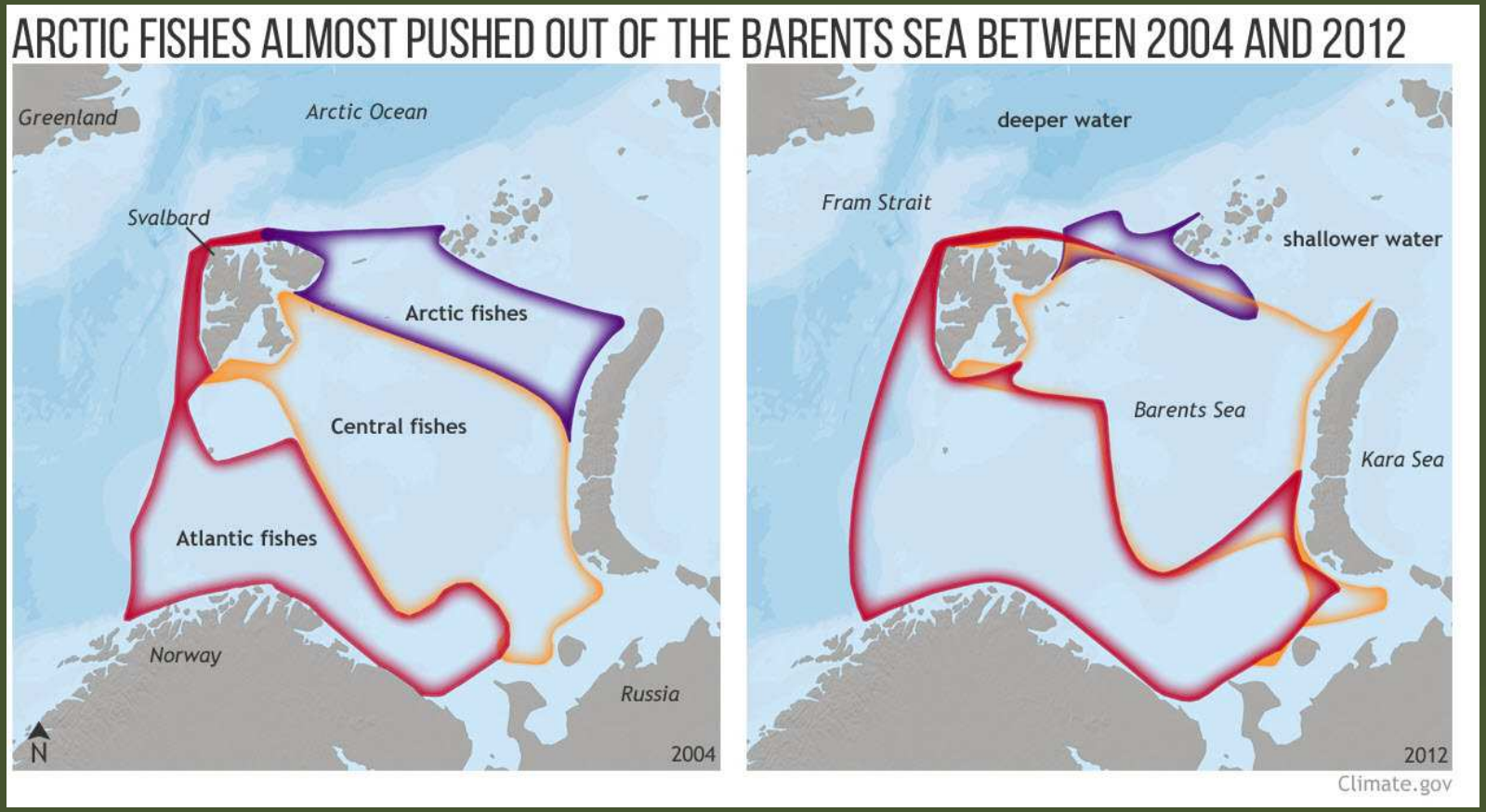
Climate Change…Fisheries

- American Fisheries Society Policy Statement
  - Lake fishes, fisheries, and habitats
  - River and stream
  - Coastal and estuarine
  - Marine
  - Arctic and sub-arctic
  - Arid regions

AMERICAN FISHERIES SOCIETY

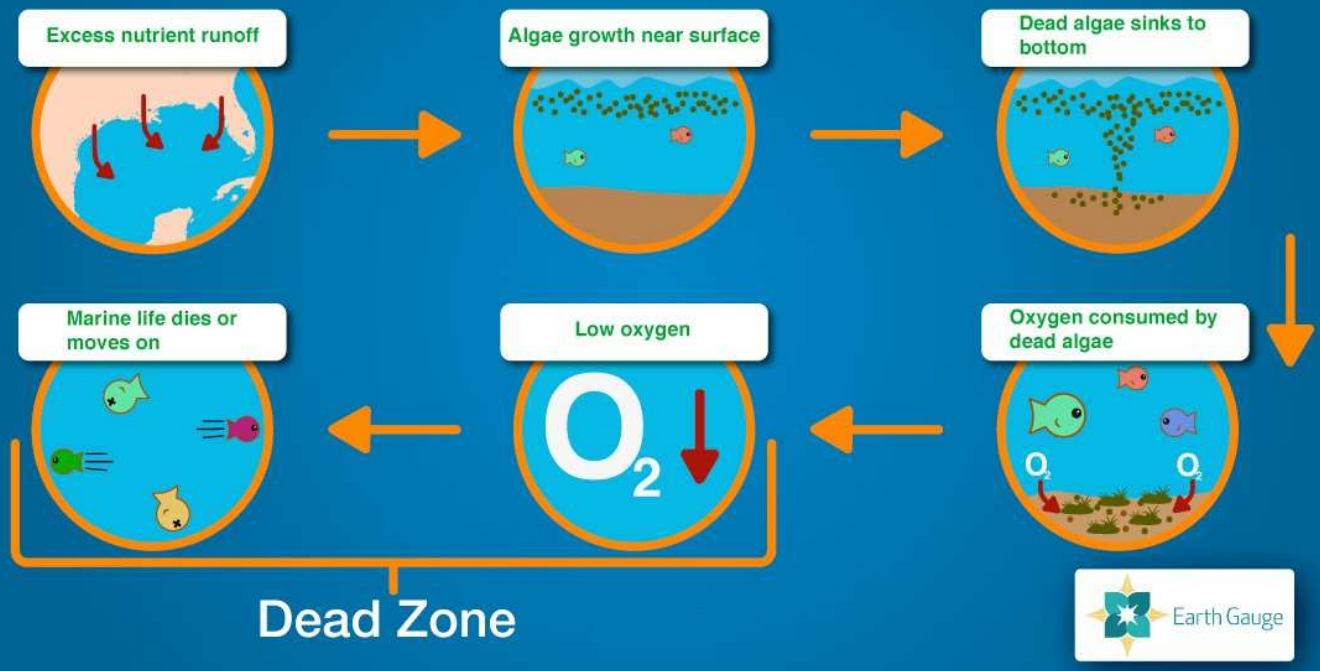
Fisheries…Broad-Scale Effects

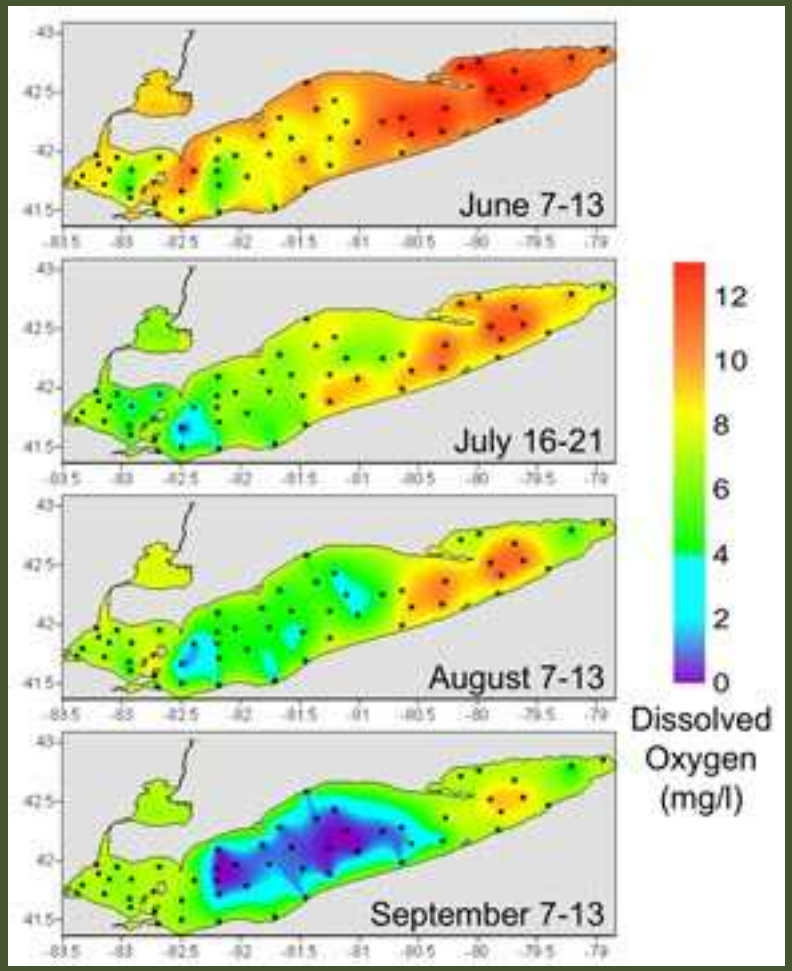
- Changes in species distribution
- Habitat change (e.g., "dead zones")
- Species / Fisheries collapse (e.g., brook trout)



Fossheim et al. 2015. “Climate change is pushing boreal fish northwards to the Arctic.”

What is a Dead Zone?




June 7-13
July 16-21
August 7-13
September 7-13
12
10
8
6
4
2
0
Dissolved Oxygen (mg/l)


Missouri
Upper Mississippi
Ohio
Arkansas-Red-White
Tennessee
Lower Mississippi
Hypoxic Zone
Gulf of Mexico

Fisheries…Great Lakes Studies (Broad-Scale)

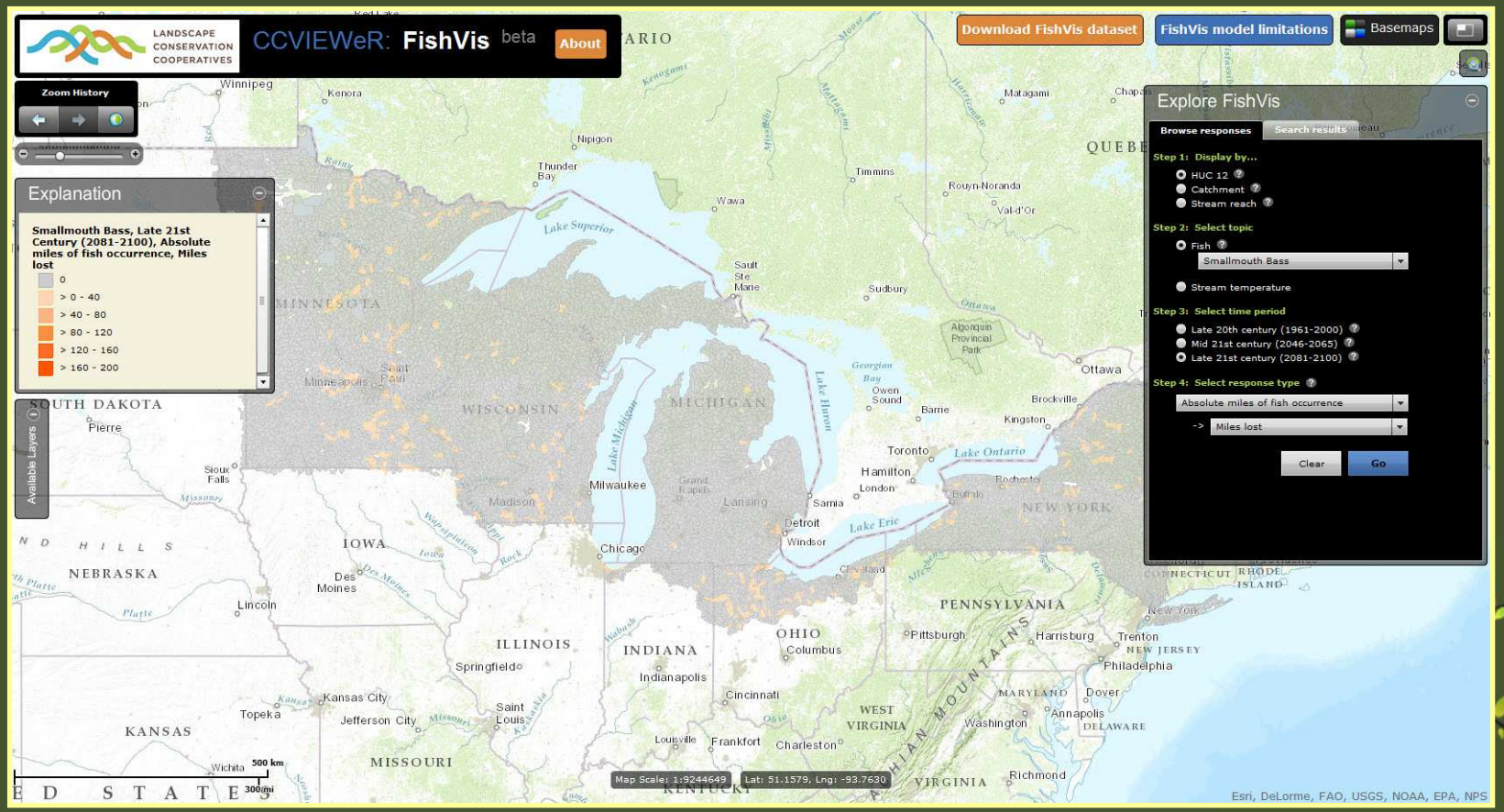
- State Wildlife Action Plan
  - Vulnerability of coastal communities (WLD)
  - Stream fish communities and temperature change (FIS)
- Great Lakes assessments
  - Change in species abundance and distribution
- Dam removals

State Wildlife Action Plan

Brook Trout Habitat Loss

(Dr. Dana Infante, MSU, Partnership for Ecosystem Research and Management)

Smallmouth Bass Habitat Loss



(Dr. Dana Infante, MSU, Partnership for Ecosystem Research and Management)

Great Lakes Fish Assessments

Changing GL Fish Distribution

Table 4. Summary table of temporal trends in Hill numbers and species richness based on ecological guilds. Significant positive (+) and negative (-) trends were identified based on an $\alpha = 0.05$. Regression coefficients and model results are found in Table S1-S3.

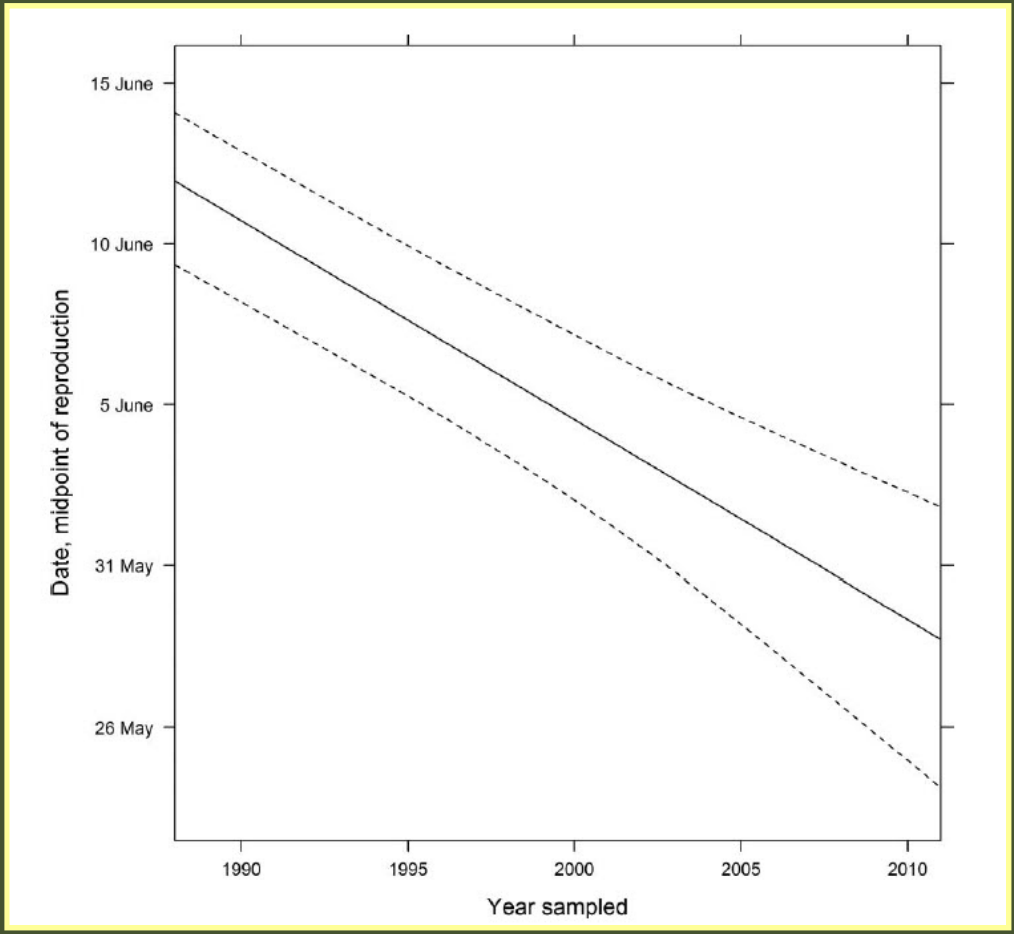
	Hill numbers			Eutrophication tolerance			Thermal tolerance		
Site	q = 0	q = 1	q = 2	Intolerant	Moderate	Tolerant	Warm	Cool	Cold
Les Cheneaux	+	+		+	+	+	+	+	-
Bays de Noc	-				-				-
Saginaw Bay				-					-
St. Marys					+		+		
South Haven						+		+	
Saugatuck	+			-	+		+	+	
Grand Haven									
Arcadia						+			-
Leland						+		+	
Charlevoix								+	
Grindstone City	-				-	-		-	-
AuSable	-	-			-			-	-
Sturgeon Pt.	-			-	-	-			-
Thunder Bay	-	-	-		-			-	-
Presque Is.		-	-						-

Fetzer et al. 2016. “Spatial and temporal dynamics of near-shore fish communities in the Great Lakes.”

Fisheries…Great Lakes Studies (Species-Focused)

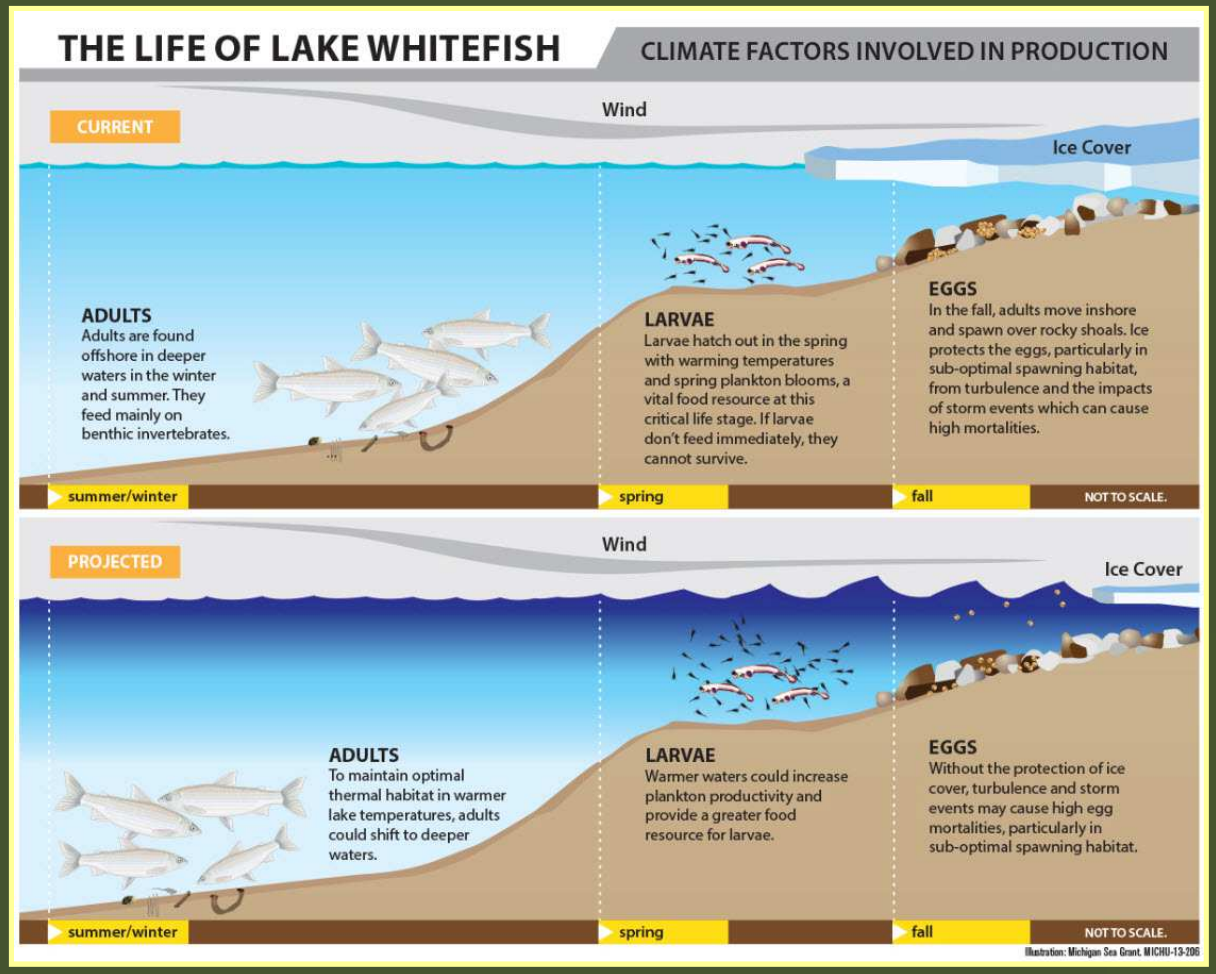
- Yellow perch
  - Reproduction and recruitment
- Lake whitefish
  - Decision support tools for commercial fisheries management

Yellow Perch Spawning – Lake Michigan



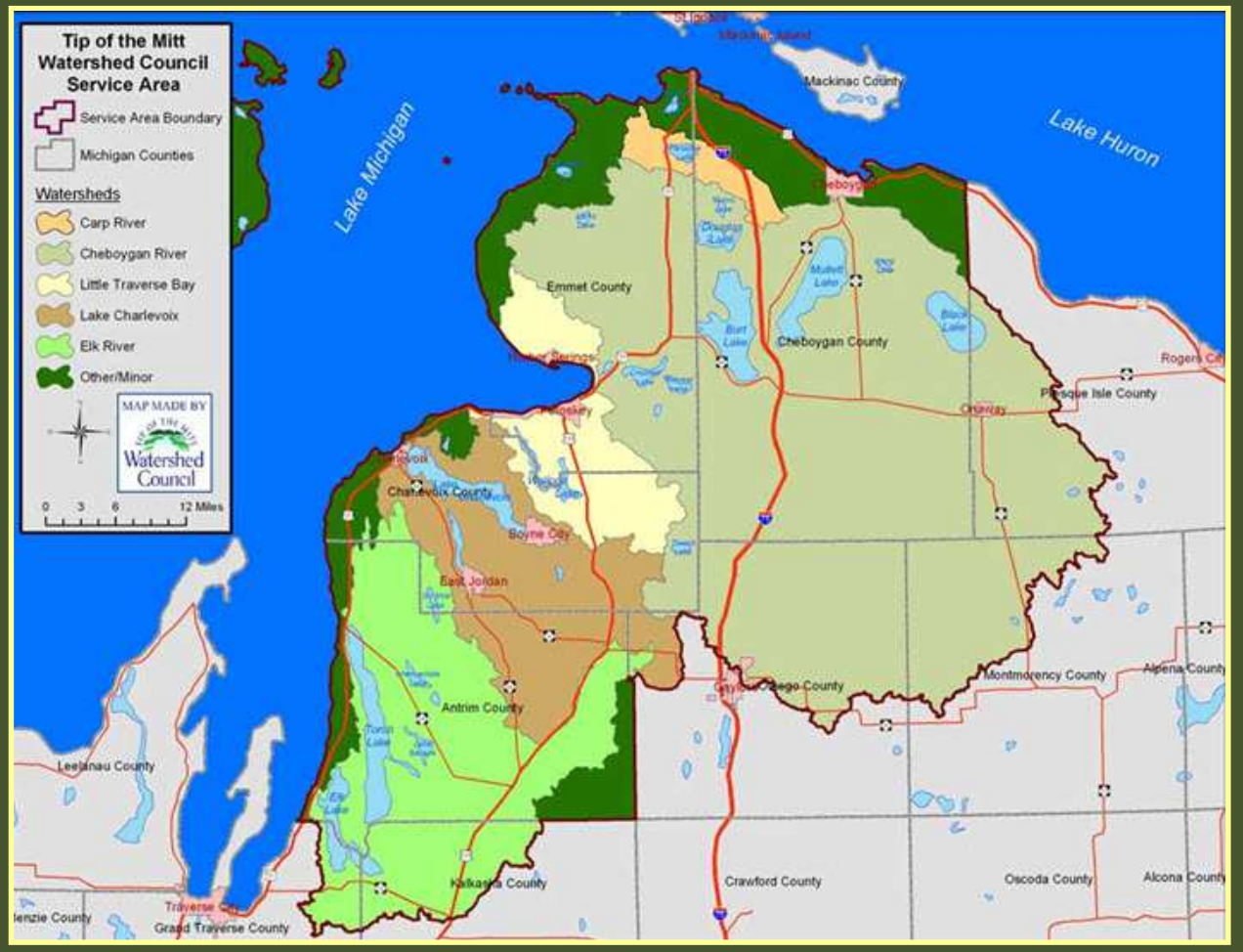
Lyons et al. 2015. “Trends in reproductive phenology of two Great Lakes fishes.” (TAFS)

Lake Whitefish Production



Lynch, A.J., W.W. Taylor, 2013. *Designing a Decision Support System for Harvest Management of Great Lakes Lake Whitefish in a Changing Climate.* In: *GLISA Project Reports.* D. Brown, D. Bidwell, and L. Briley, eds. Available from the Great Lakes Integrated Sciences and Assessments (GLISA) Center.

Local efforts…TOMWC



Local efforts…TOMWC Strategic Plan

- Goal 5 – Assess current impacts from Climate Changes and promote adaptation and remediation

Climate Change…Adaptive Strategies (lake fish / fisheries)

- Control sources of N and P
- Increase local infiltration of rain water
- Minimize destruction of shoreline and aquatic vegetation
- Maintain / restore balanced food webs
- Identify refugia for habitats / populations
- Restore natural hydrologic regimes
- System level management

AMERICAN FISHERIES SOCIETY

Climate Change…Adaptive Strategies (river fish / fisheries)

- Restore / protect geomorphological integrity of streams
- Provide historic flow regimes
- Provide connectivity of habitat
- Maximize local infiltration and absorption of rain water
- Provide incentives for riparian protection
- Incorporate prescription wildfire in forested areas

AMERICAN FISHERIES SOCIETY

Conclusions

- "There's nothing we can do!"

Conclusions

- ~~"There's nothing we can do!"~~
- Adaptive management
  - Fisheries
  - Watershed level processes
- Research
  - including remediation strategies
- Personal action

Additional Information…

- https://www.climate.gov/ (NOAA climate information)
- http://www.michigan.gov/dnr (State of Michigan State Wildlife Action Plan)
- http://fisheries.org/ (American Fisheries Society)
- http://www.watershedcouncil.org/ (Tip of the Mitt Watershed Council)