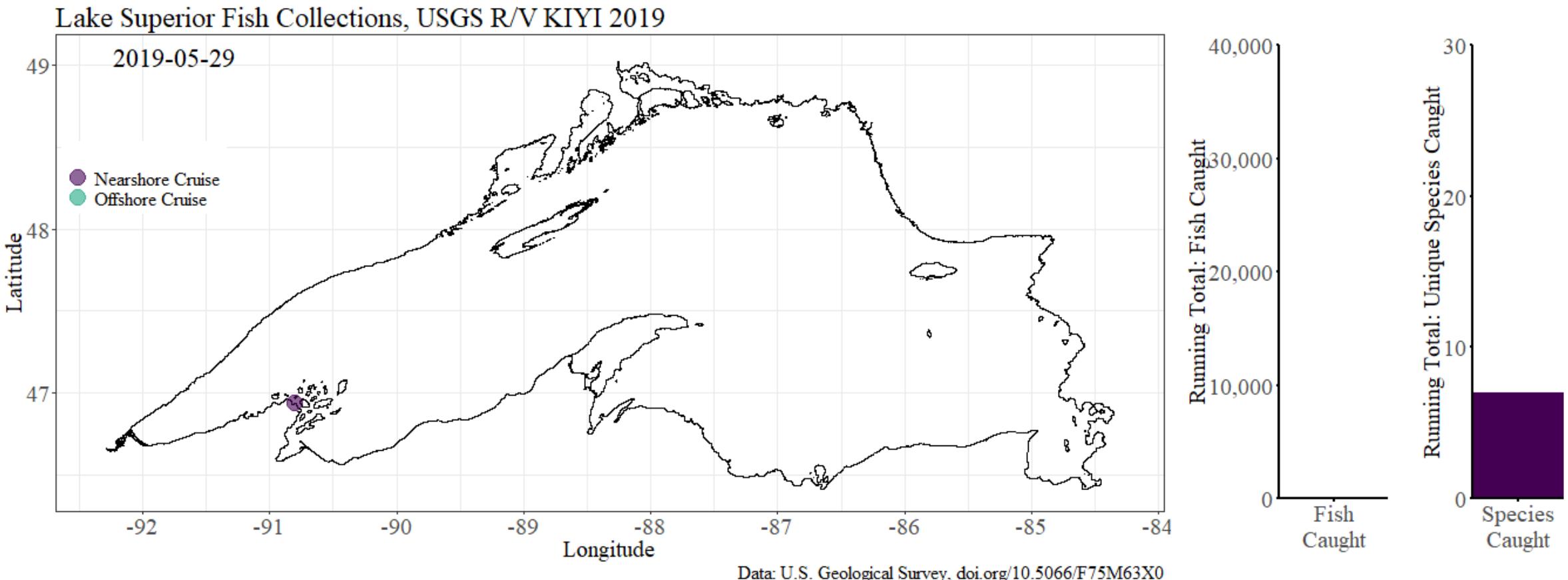


# Lake Superior Annual Bottom Trawl Surveys

## 2019 Status and Trends Report

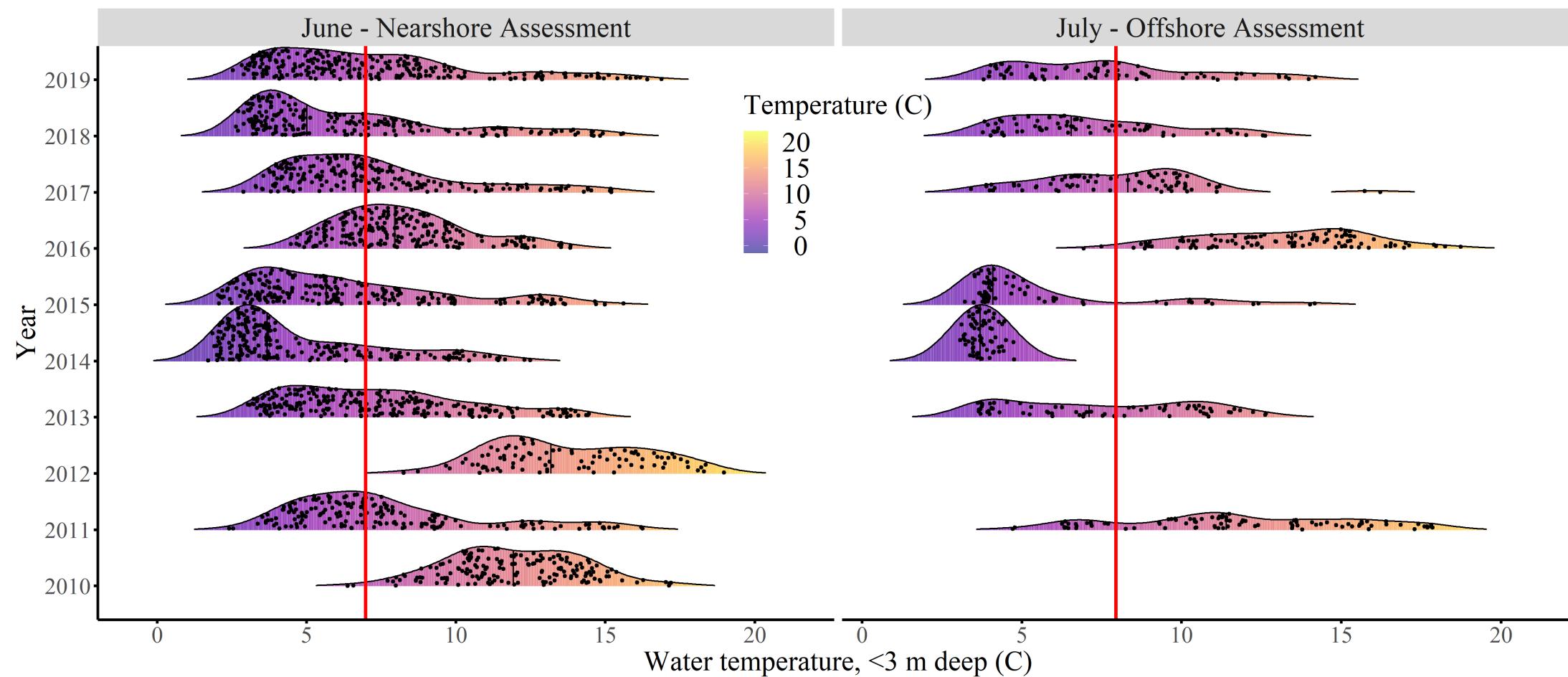


U.S. Geological Survey Lake Superior Biological Station  
Ashland, Wisconsin

# Water Temperatures

## Lake Superior Near Surface Water Temperatures

USGS bottom trawl assessments



Data: U.S. Geological Survey, doi.org/10.5066/F75M63X0

# Catch by Numbers

Lake Superior Fish Abundance  
USGS Bottom Trawl Assessment 2019

- Alewife
- Blackfin cisco
- Bloater
- Cisco
- Hatchery lake trout
- Lake whitefish
- Longnose sucker
- Ninespine stickleback

Rainbow smelt

Nearshore

- Lean lake trout
- Burbot
- Pygmy whitefish
- Round whitefish
- Ruffe
- Shortjaw cisco
- Spottail shiner
- Threespine stickleback
- Trout-perch
- Yellow perch
- Slimy sculpin
- Spoonhead sculpin

Deepwater sculpin

Offshore

- Kiwi
- Siscowet lake trout

Data: U.S. Geological Survey; doi.org/10.5066/F75M63X0

# Catch by Biomass

Lake Superior Fish Biomass  
USGS Bottom Trawl Assessment 2019

Alewife  
Blackfin cisco  
Bloater  
Cisco  
Hatchery lake trout

Lake whitefish

Longnose sucker

Ninespine stickleback

Rainbow smelt

Lean lake trout

Round whitefish

Ruffe

Shortjaw cisco

Spottail shiner

Threespine stickleback

Trout-perch

Yellow perch

Spoonhead sculpin

Slimy sculpin

Burbot

Pygmy whitefish

Deepwater sculpin

Kiwi

Siscowet lake trout

Nearshore

24 "species"  
5.7 kg per ha

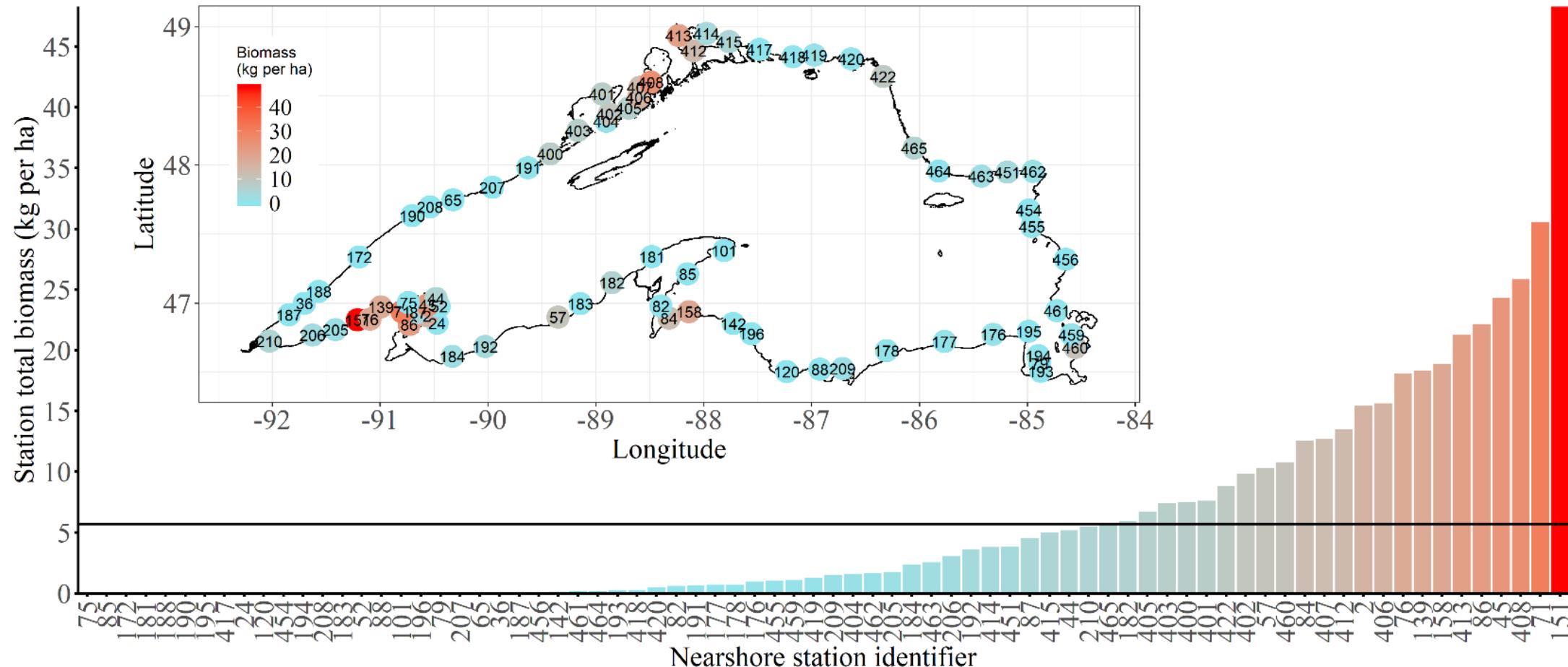
Offshore

10 species  
7 kg per ha

# 2019 Nearshore Station Biomass

Lake Superior Total Fish Biomass at Nearshore Stations

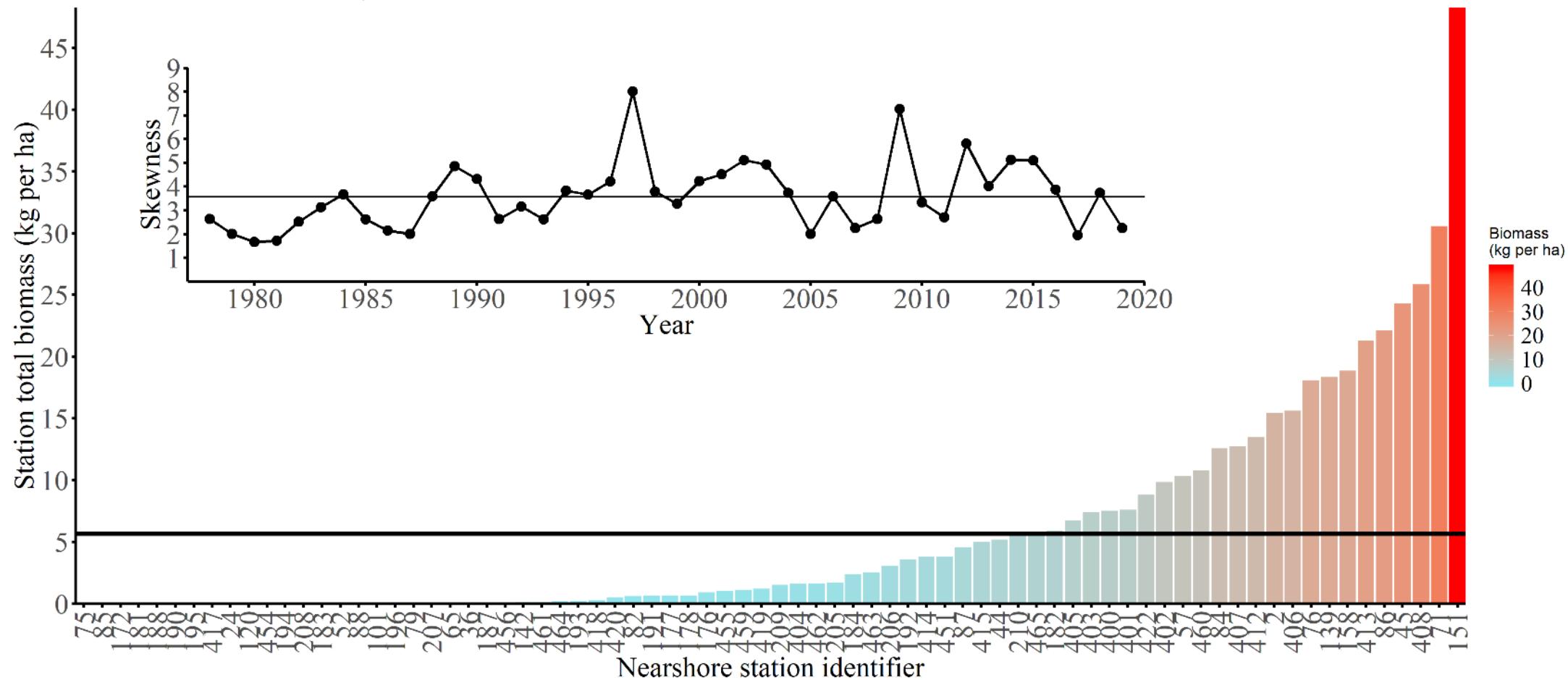
USGS bottom trawl assessment, 2019



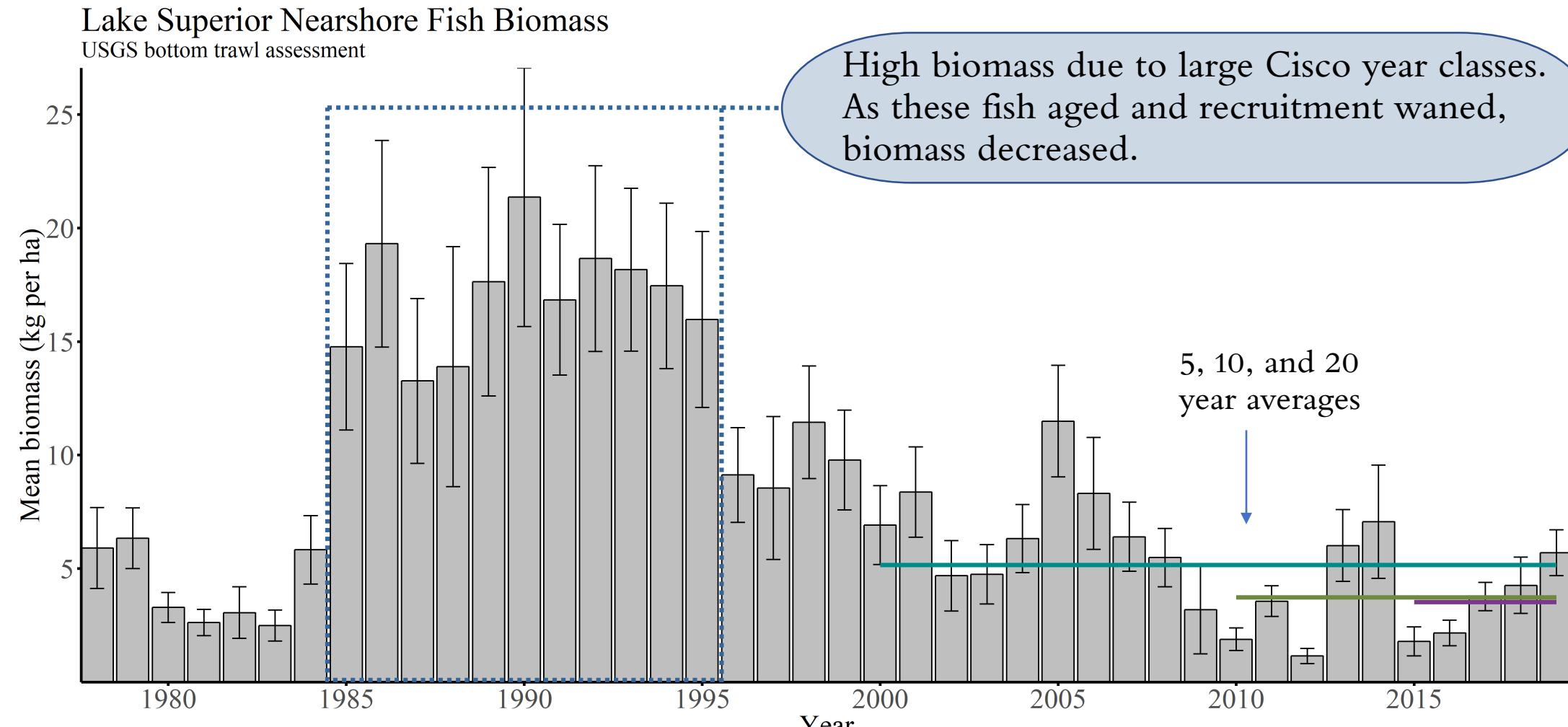
Data: U.S. Geological Survey, doi.org/10.5066/F75M63X0

# 2019 Nearshore Station Biomass

Lake Superior Total Fish Biomass at Nearshore Stations and Annual Skewness  
USGS bottom trawl assessment, 2019



# Annual Trends in Nearshore Biomass

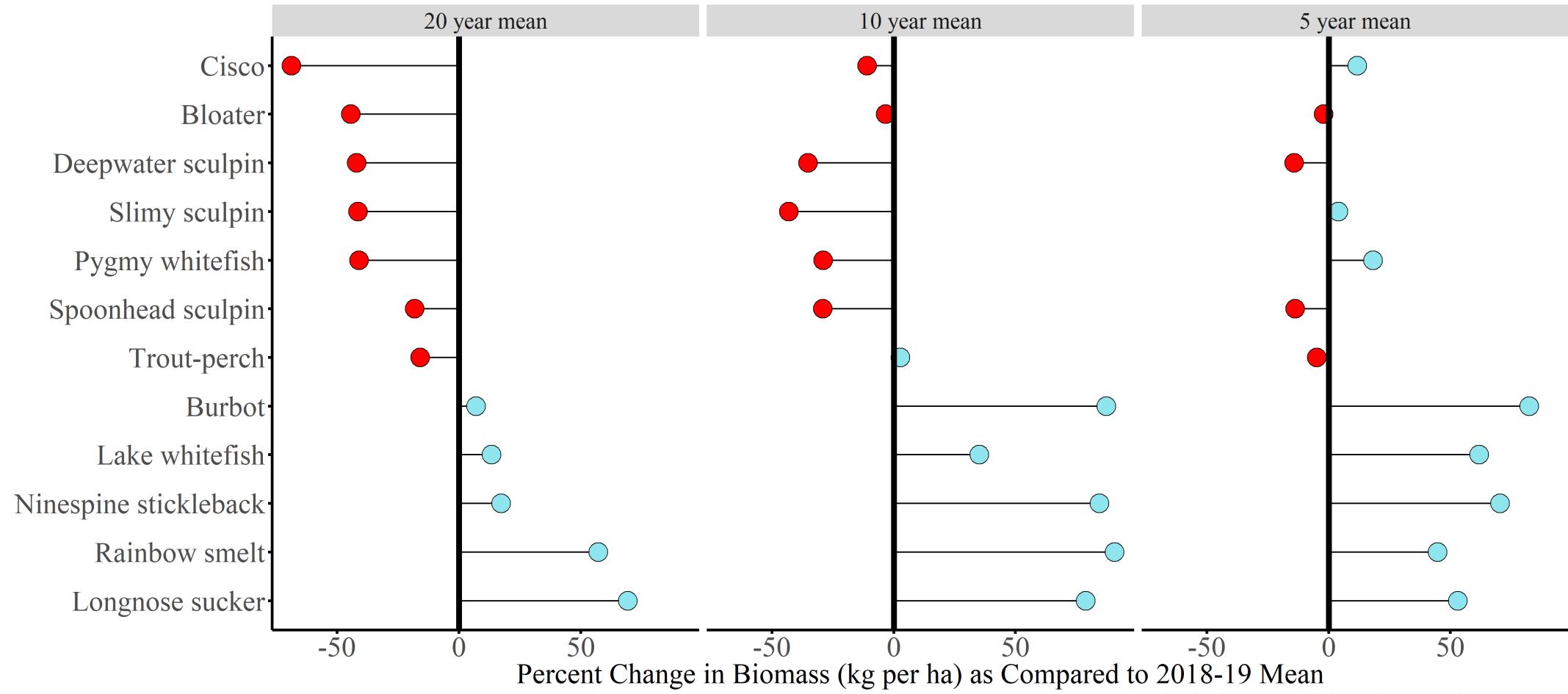


Data: U.S. Geological Survey, doi.org/10.5066/F75M63X0

# Nearshore Species Temporal Trends

## Lake Superior Nearshore Fish Biomass Trends

USGS bottom trawl assessment

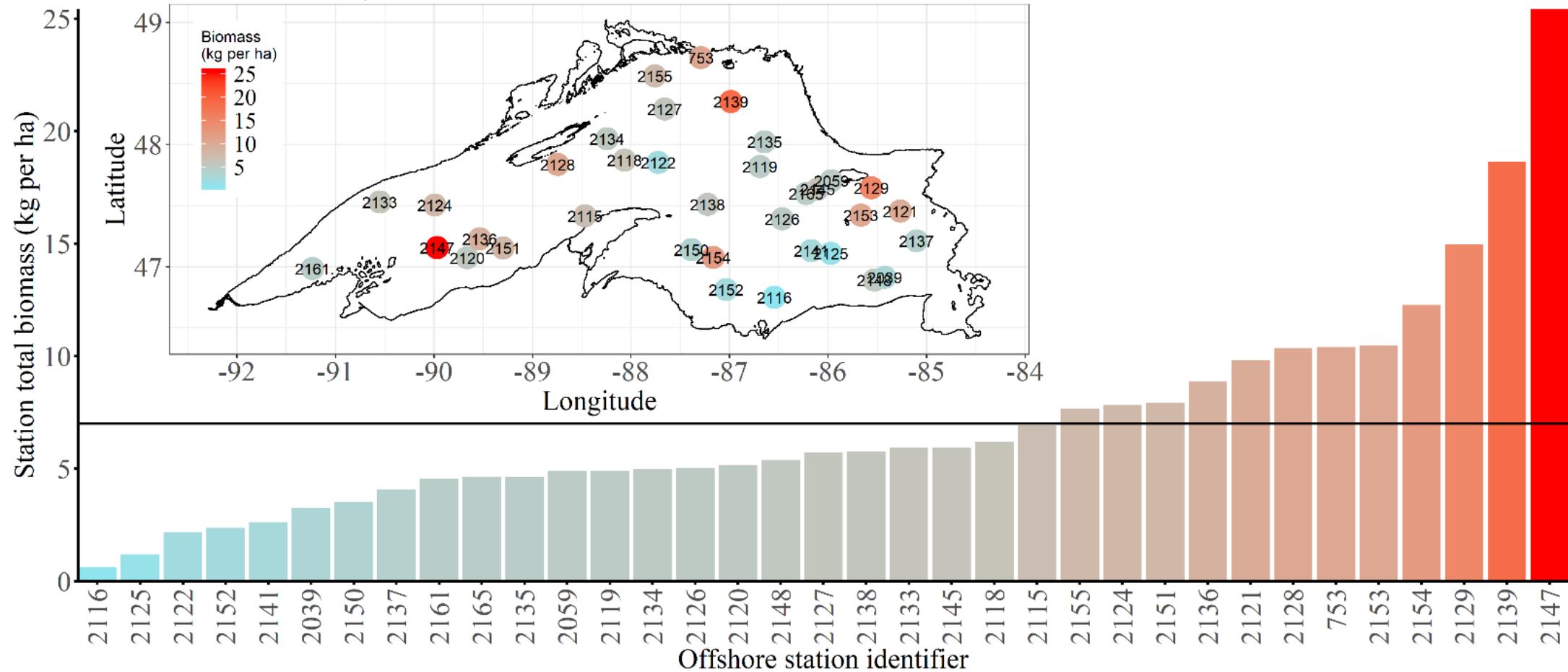


Data: U.S. Geological Survey, doi.org/10.5066/F75M63X0

# 2019 Offshore Station Biomass

Lake Superior Total Fish Biomass at Offshore Stations

USGS bottom trawl assessment, 2019

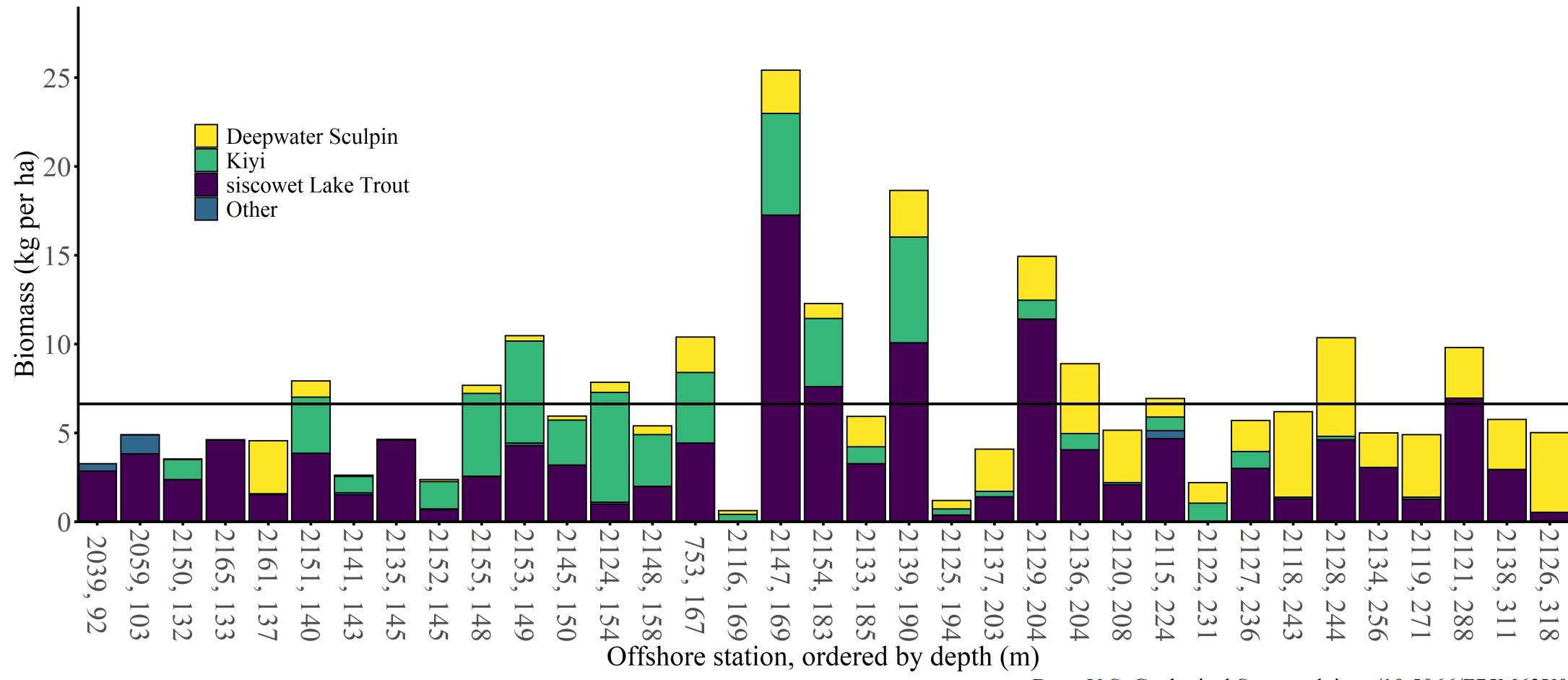


Data: U.S. Geological Survey, doi.org/10.5066/F75M63X0

# 2019 Offshore Station Biomass

## Lake Superior Offshore Fish Biomass

USGS bottom trawl assessment, 2019

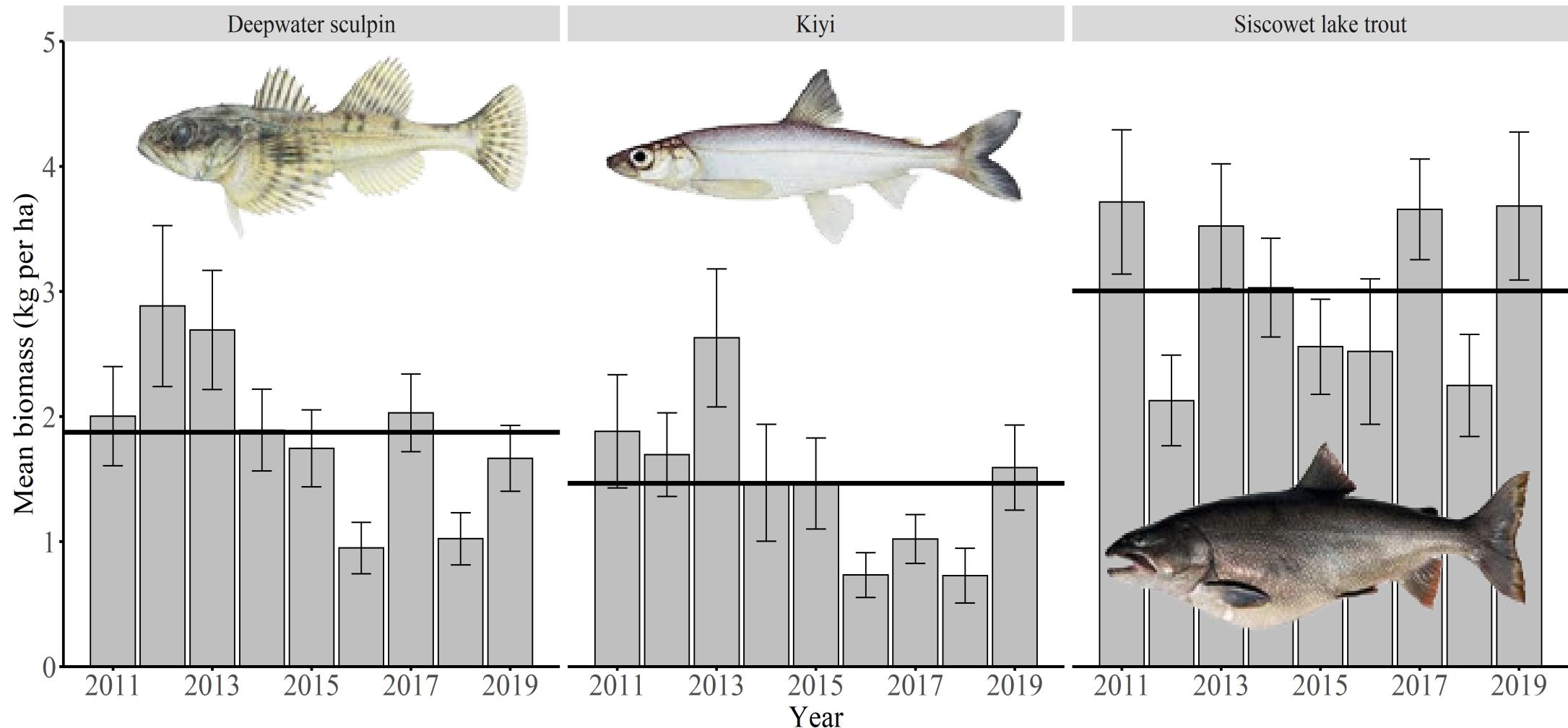


Data: U.S. Geological Survey, doi.org/10.5066/F75M63X0

# Annual Trends in Offshore Biomass

## Lake Superior Offshore Fish Biomass

USGS bottom trawl assessment

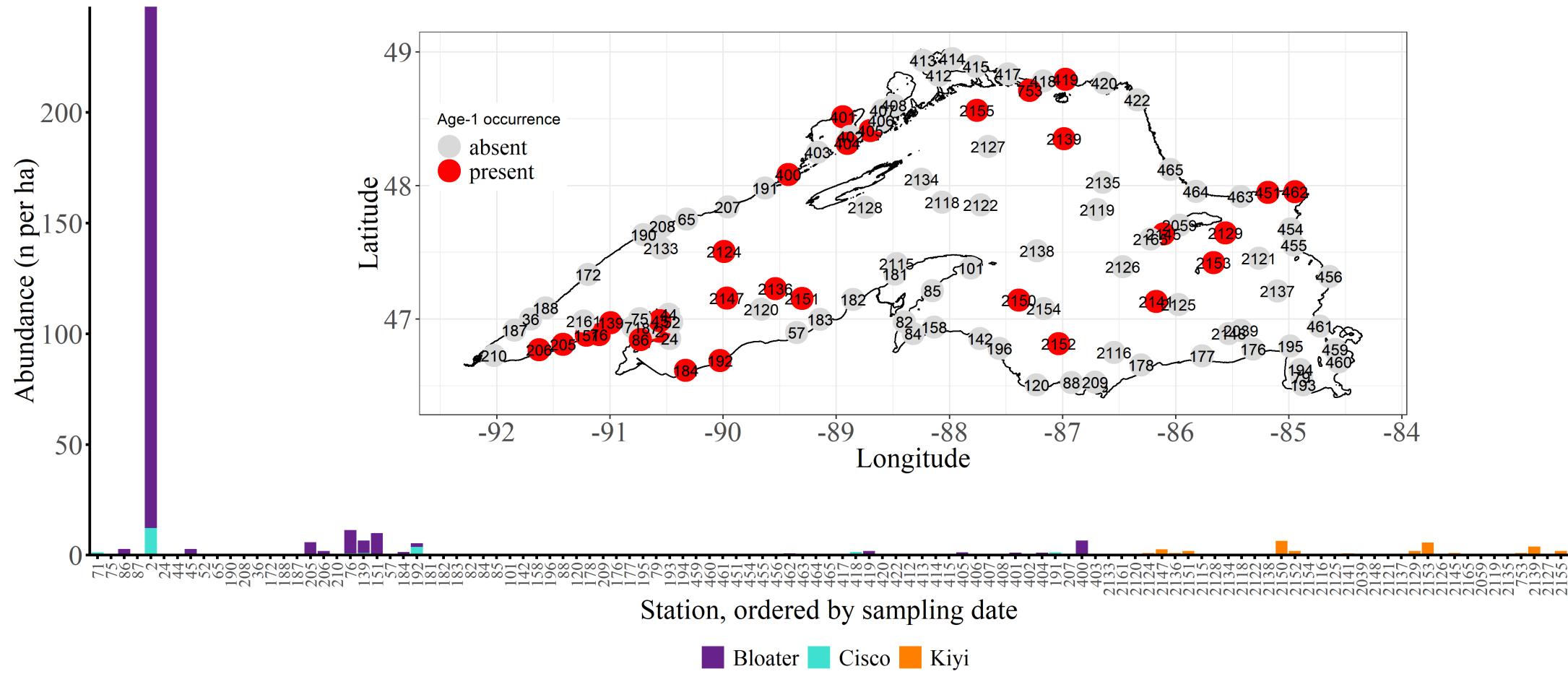


Data: U.S. Geological Survey, doi.org/10.5066/F75M63X0

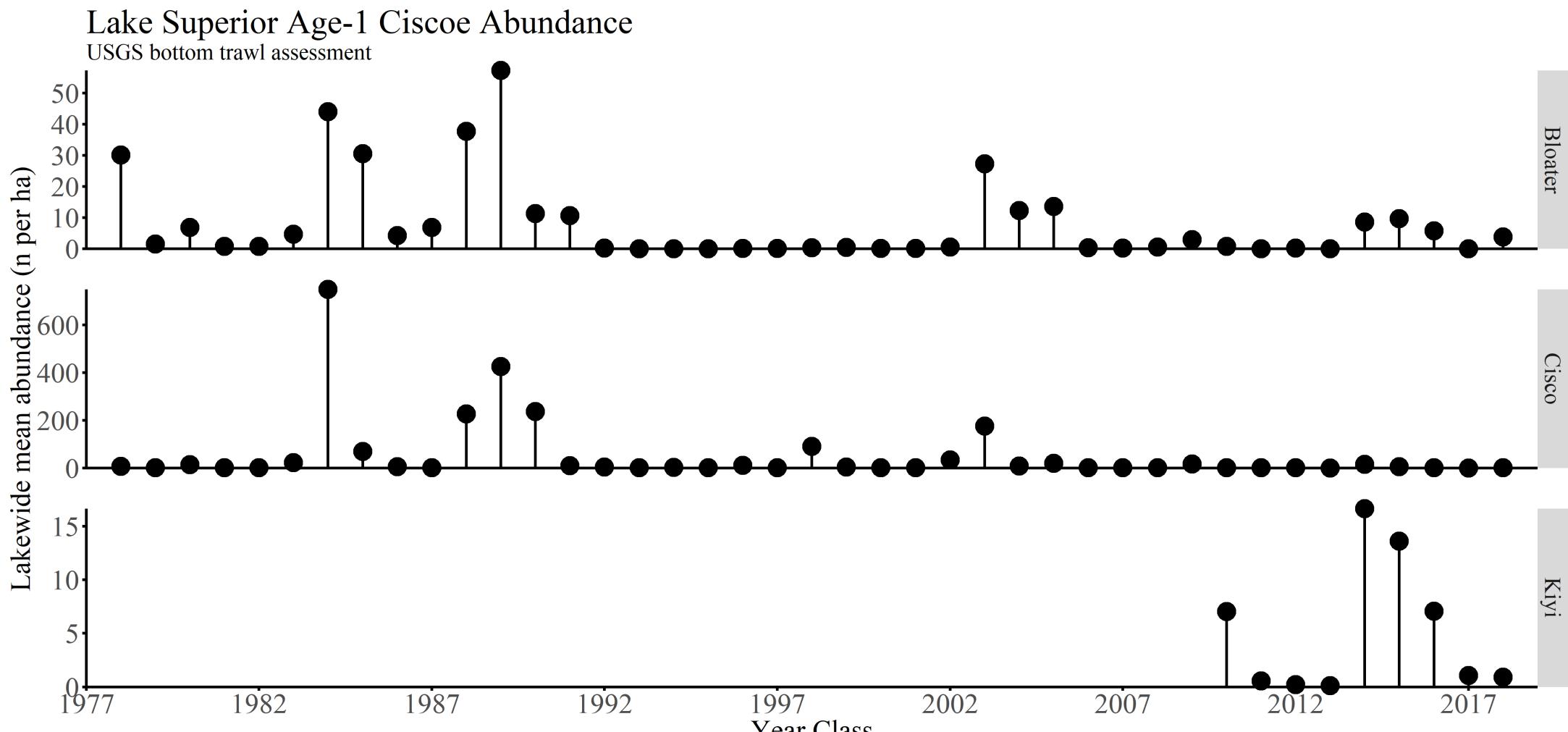
# 2019 Age-1 Ciscoe Occurrences

## Lake Superior Age-1 Ciscoe Abundance

USGS bottom trawl assessment, 2019



# Age-1 Ciscoe Trends

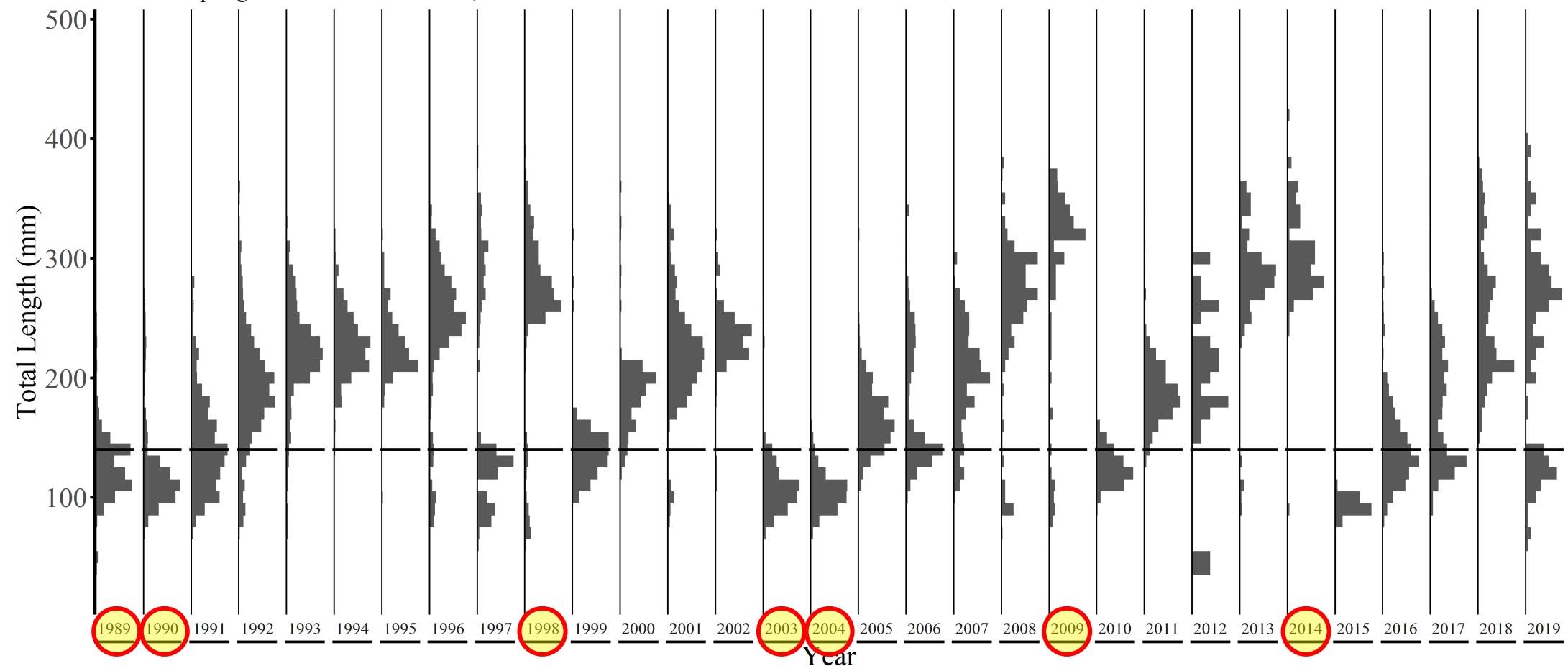


Data: U.S. Geological Survey, doi.org/10.5066/F75M63X0

# Temporal Patterns in Cisco Length Frequency

Lake Superior Cisco Length Frequency

Nearshore spring bottom trawl collections, 1989-2019

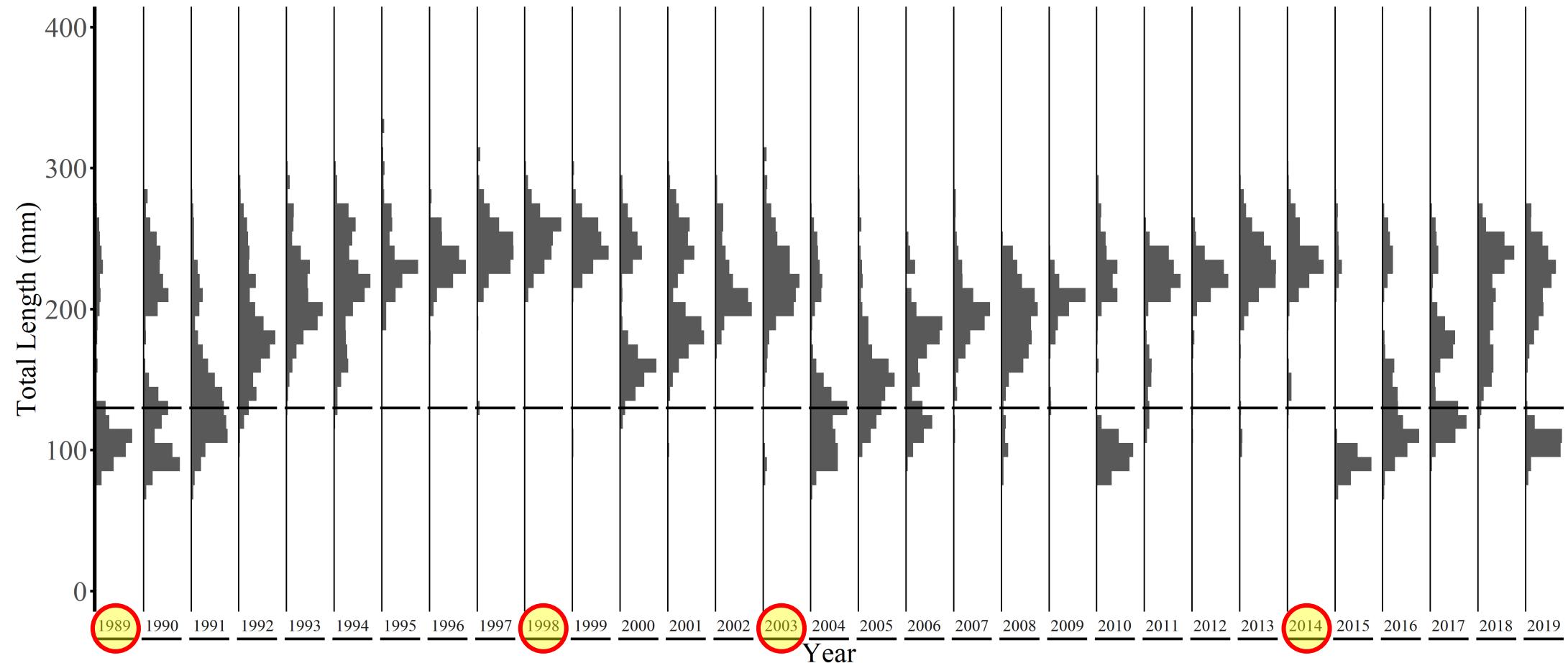


Data: U.S. Geological Survey, doi.org/10.5066/F75M63X0

# Temporal Patterns in Bloater Length Frequency

## Lake Superior Bloater Length Frequency

Nearshore spring bottom trawl collections, 1989-2019

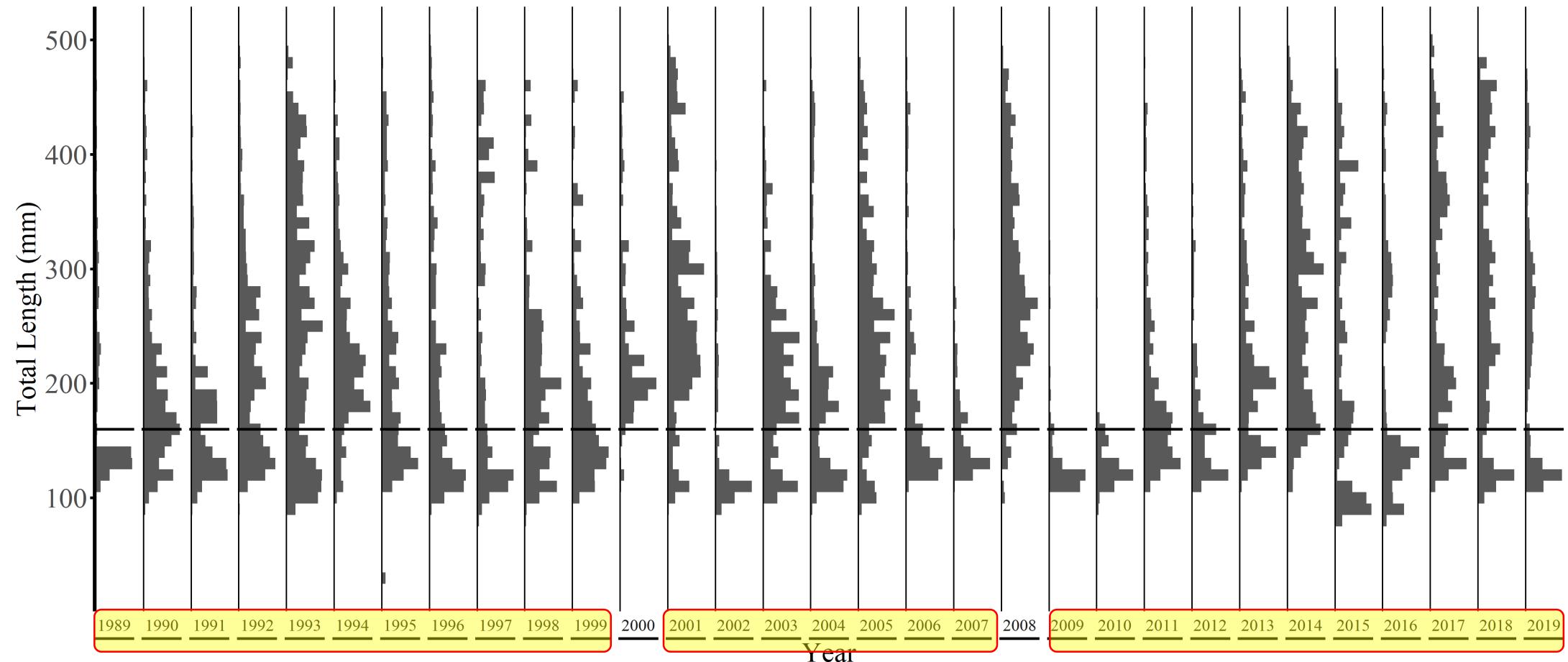


Data: U.S. Geological Survey, doi.org/10.5066/F75M63X0

# Temporal Patterns in Lake Whitefish Length Frequency

Lake Superior Lake Whitefish (<500 mm) Length Frequency

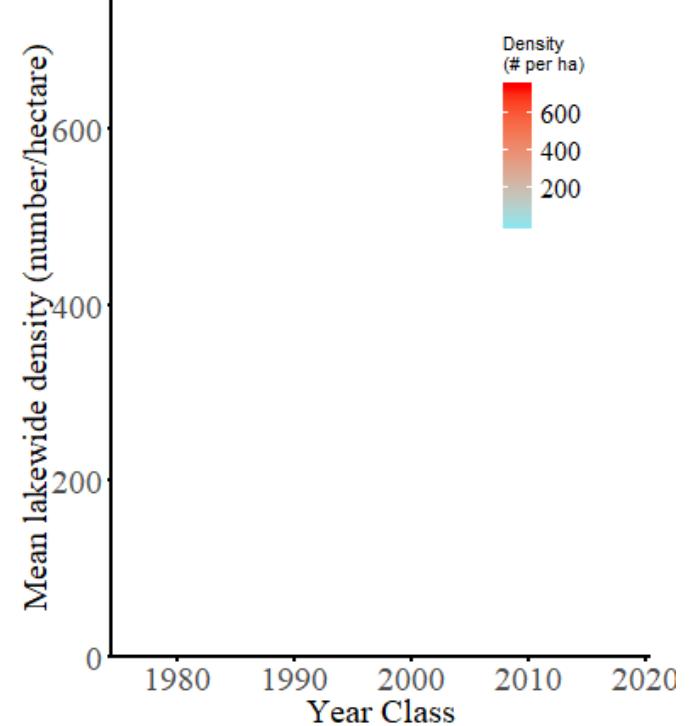
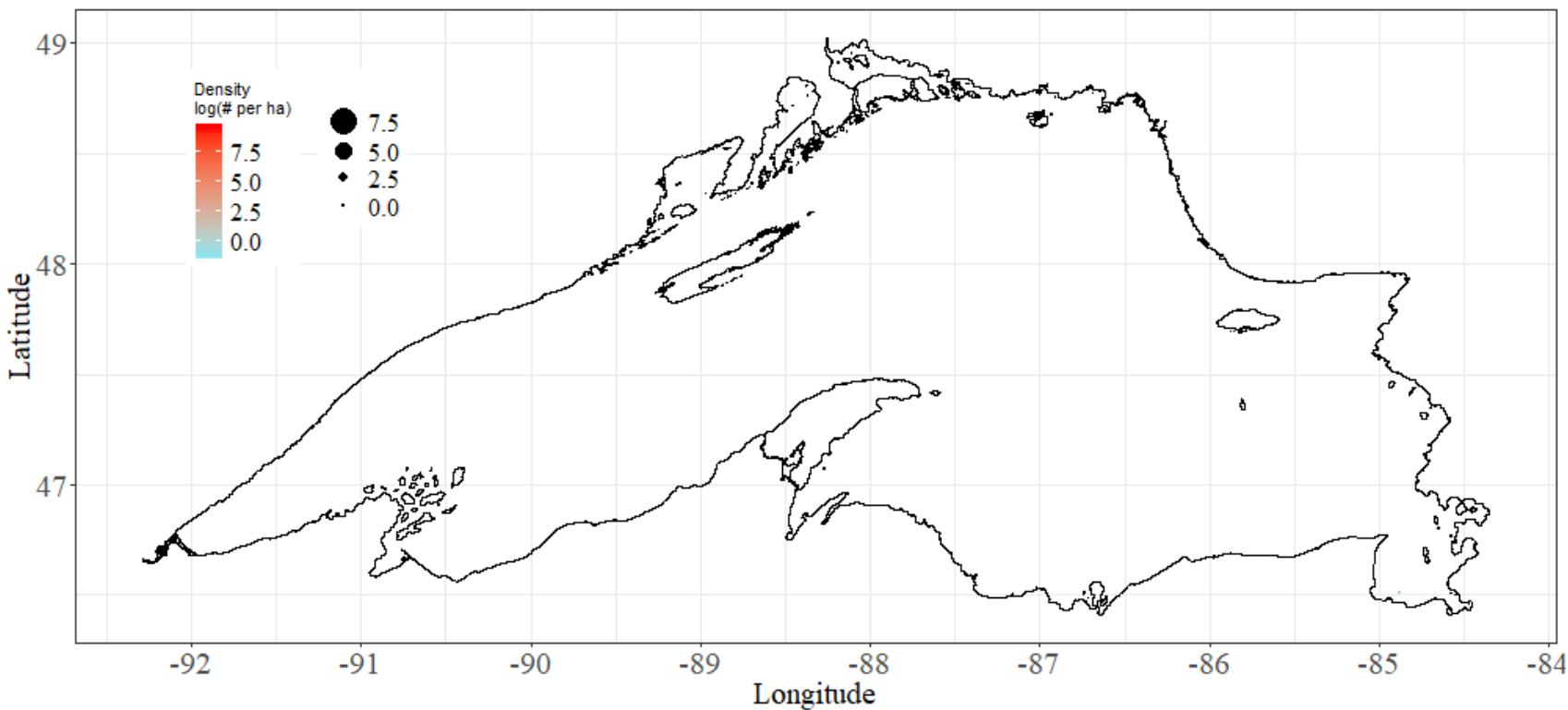
Nearshore spring bottom trawl collections, 1989-2019



Data: U.S. Geological Survey, doi.org/10.5066/F75M63X0

# Spatial Patterns in Age-1 Cisco and Bloater

Lake Superior Age-1 Cisco Density, USGS Bottom Trawl Assessment  
Year Class: 1977

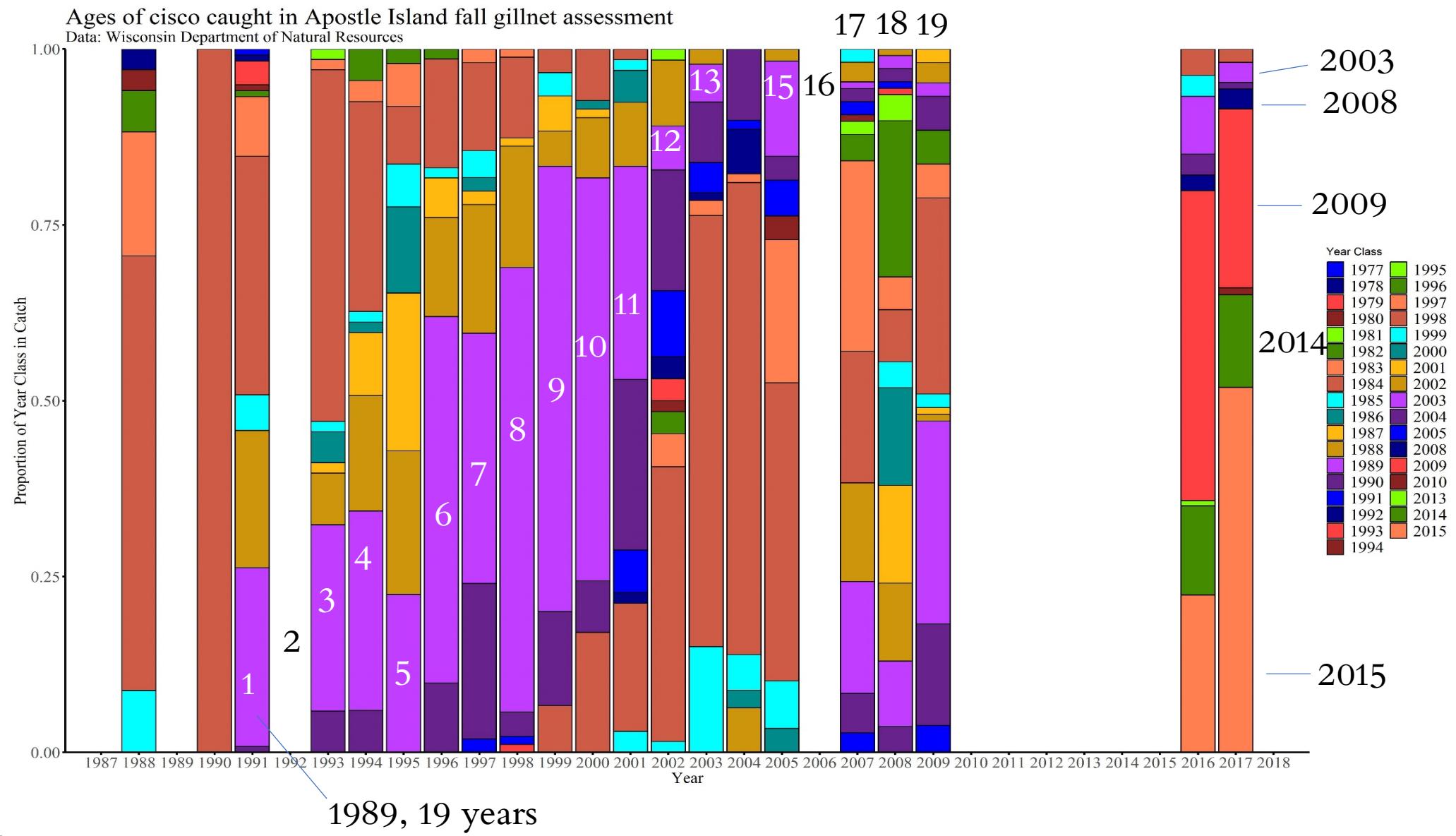


Data: U.S. Geological Survey, doi.org/10.5066/F75M63X0

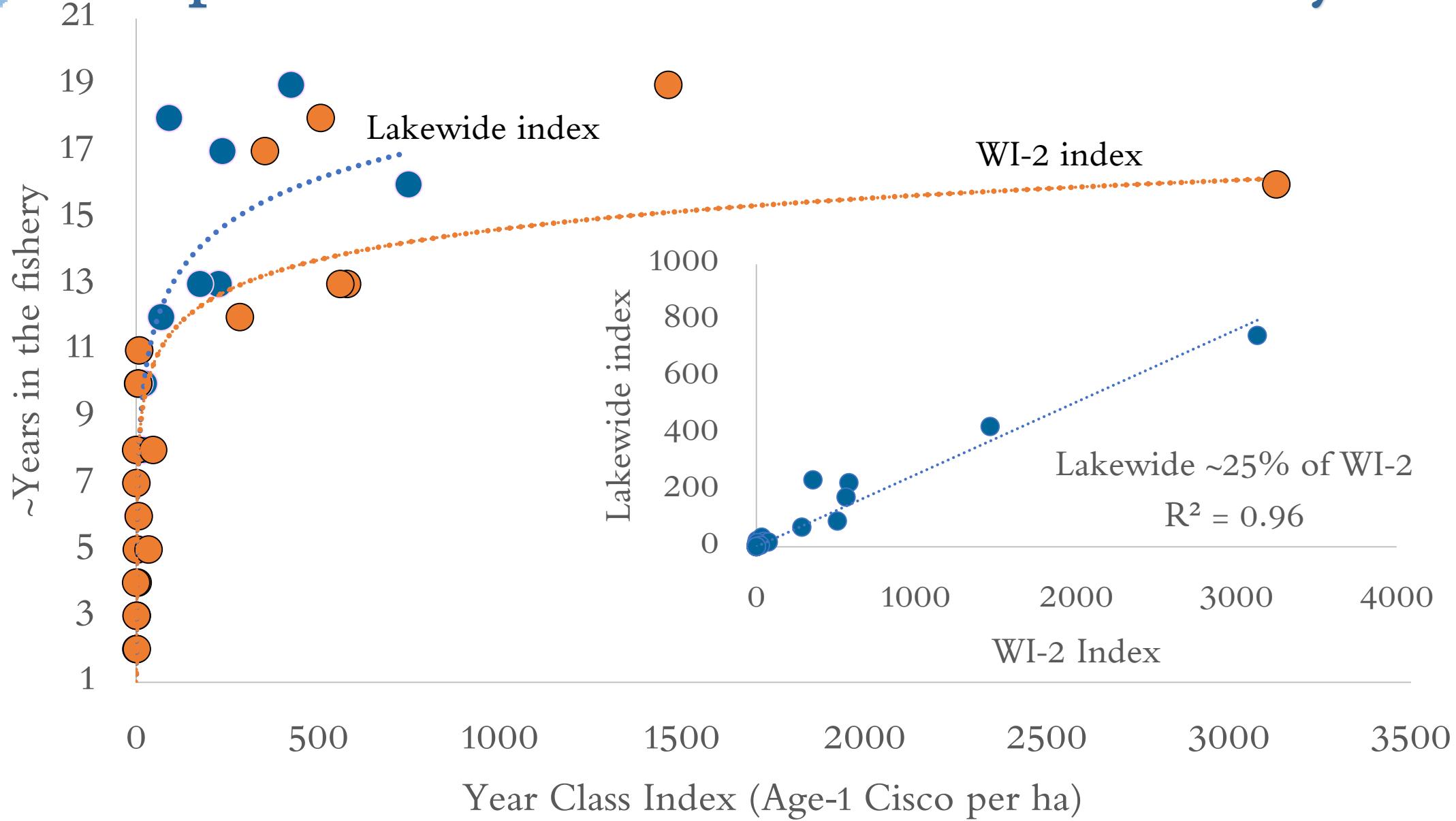
# How Many Age-1 Cisco Does It Take To See A Return To The Fishery?



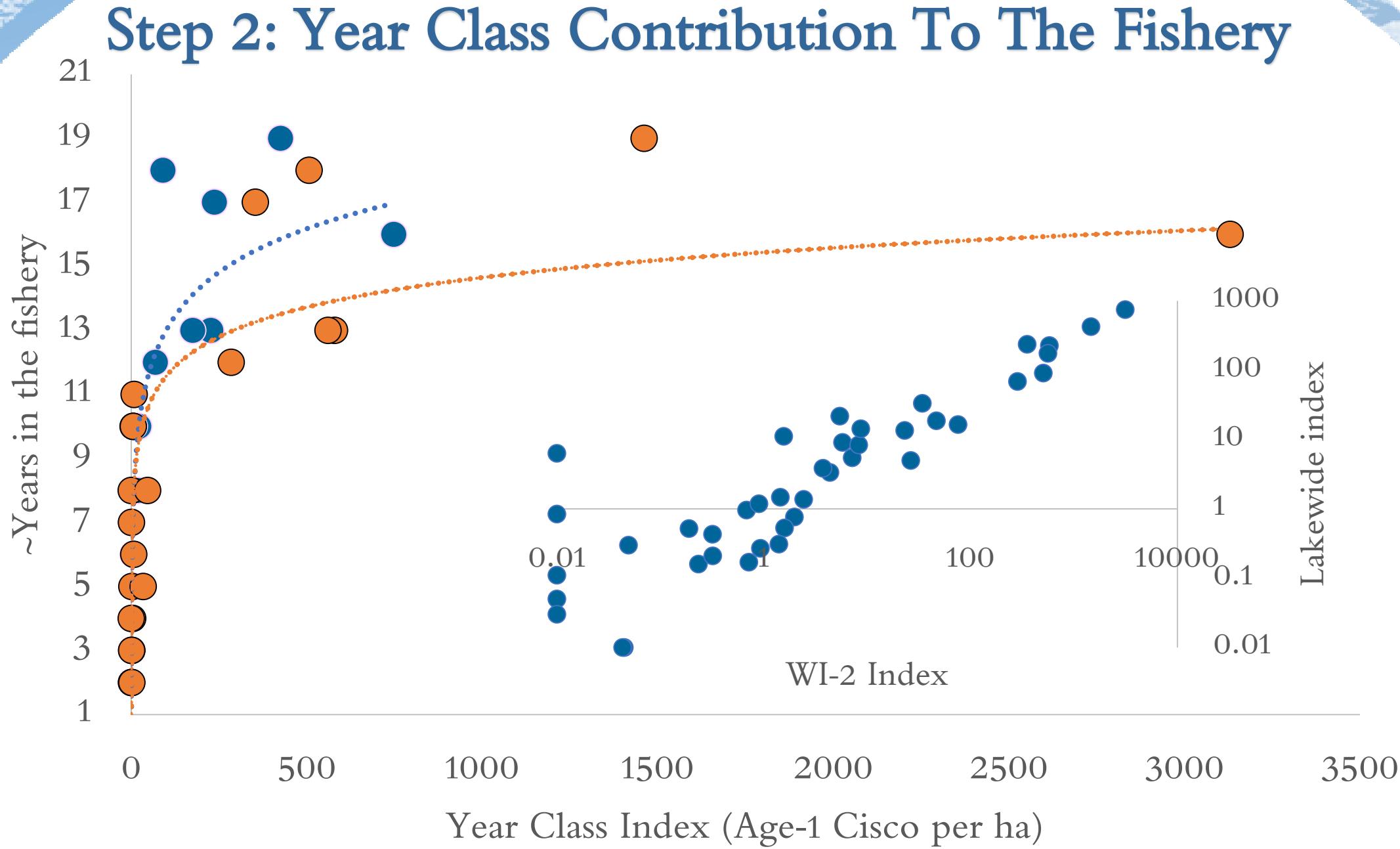
# Step 1: Age Composition of the Wisconsin Fishery



## Step 2: Year Class Contribution To The Fishery



## Step 2: Year Class Contribution To The Fishery

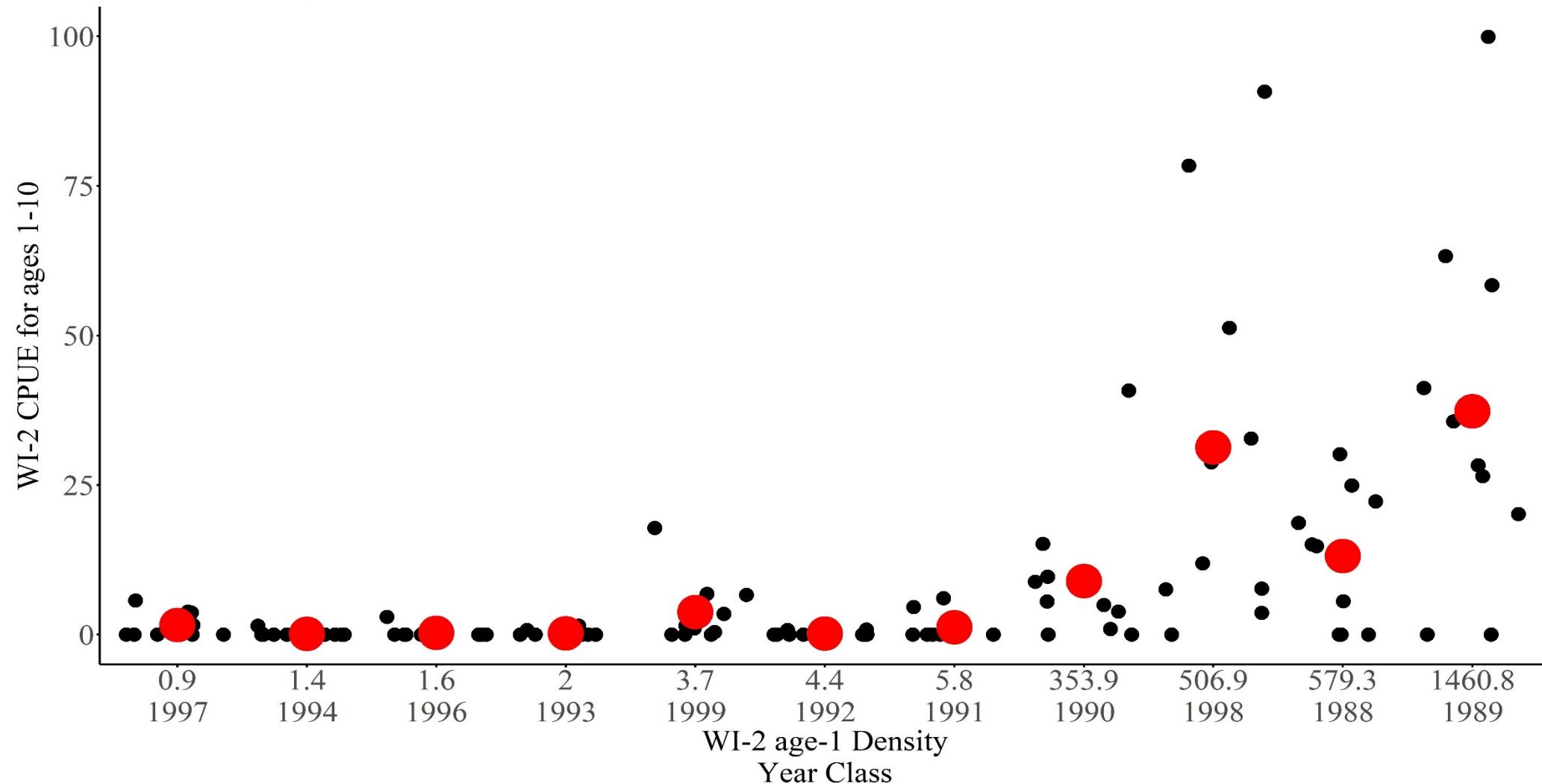


## Step 2: Year Class Contribution To The Fishery

CPUE of cisco year classes in Wisconsin waters of Lake Superior

Data: Age-1--USGS bottom trawl surveys in WI2

CPUE--WI-DNR fall cisco assessment



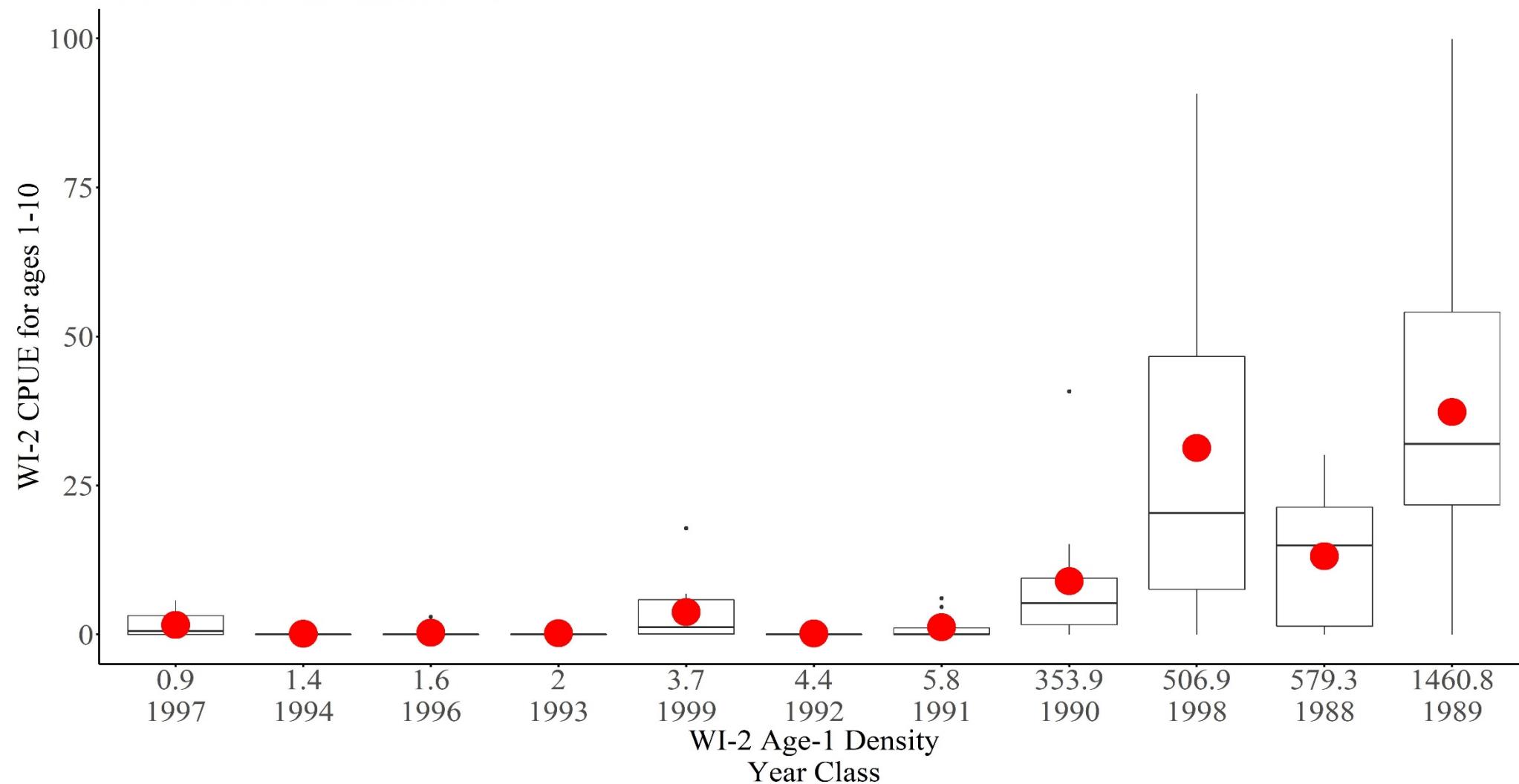
CPUE = Number of age 1-10 fish per 1200 feet of net per hour

## Step 2: Year Class Contribution To The Fishery

CPUE of cisco year classes in Wisconsin waters of Lake Superior

Data: Age-1--USGS bottom trawl surveys in WI2

CPUE--WI-DNR fall cisco assessment



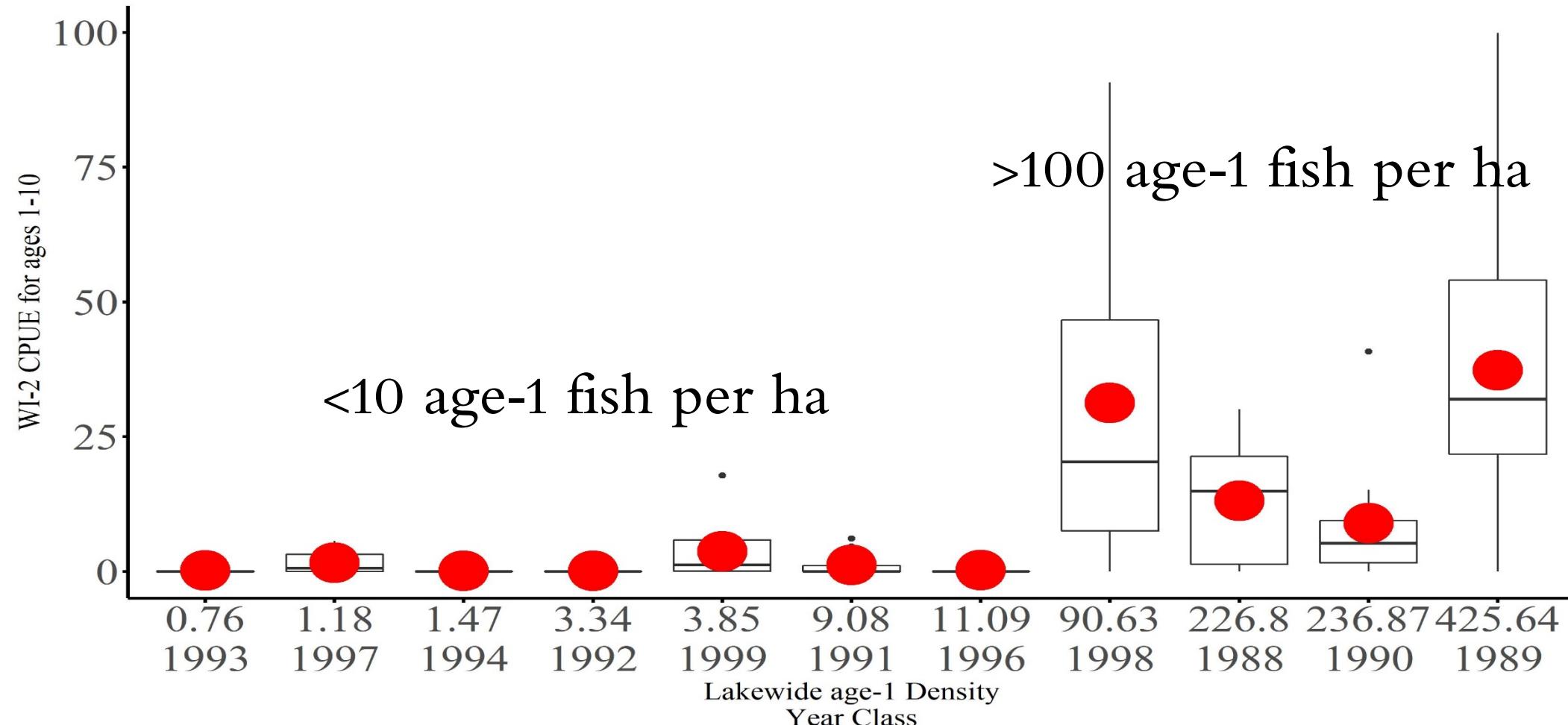
CPUE = Number of age 1-10 fish per 1200 feet of net per hour

## Step 2: Year Class Contribution To The Fishery

CPUE of cisco year classes in Lake Superior

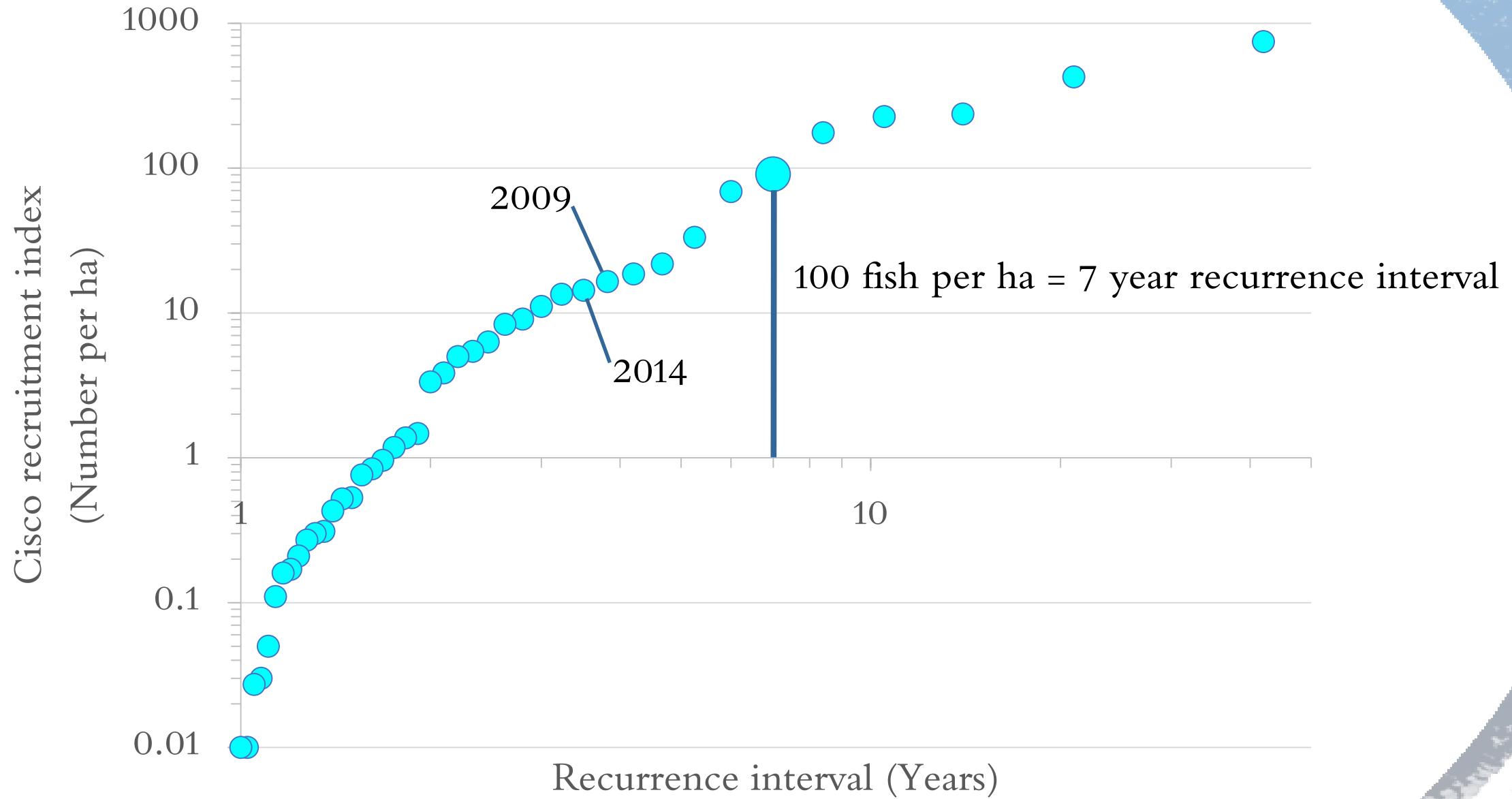
Data: Age-1--USGS lakewide bottom trawl surveys

CPUE--WI-DNR fall cisco assessment

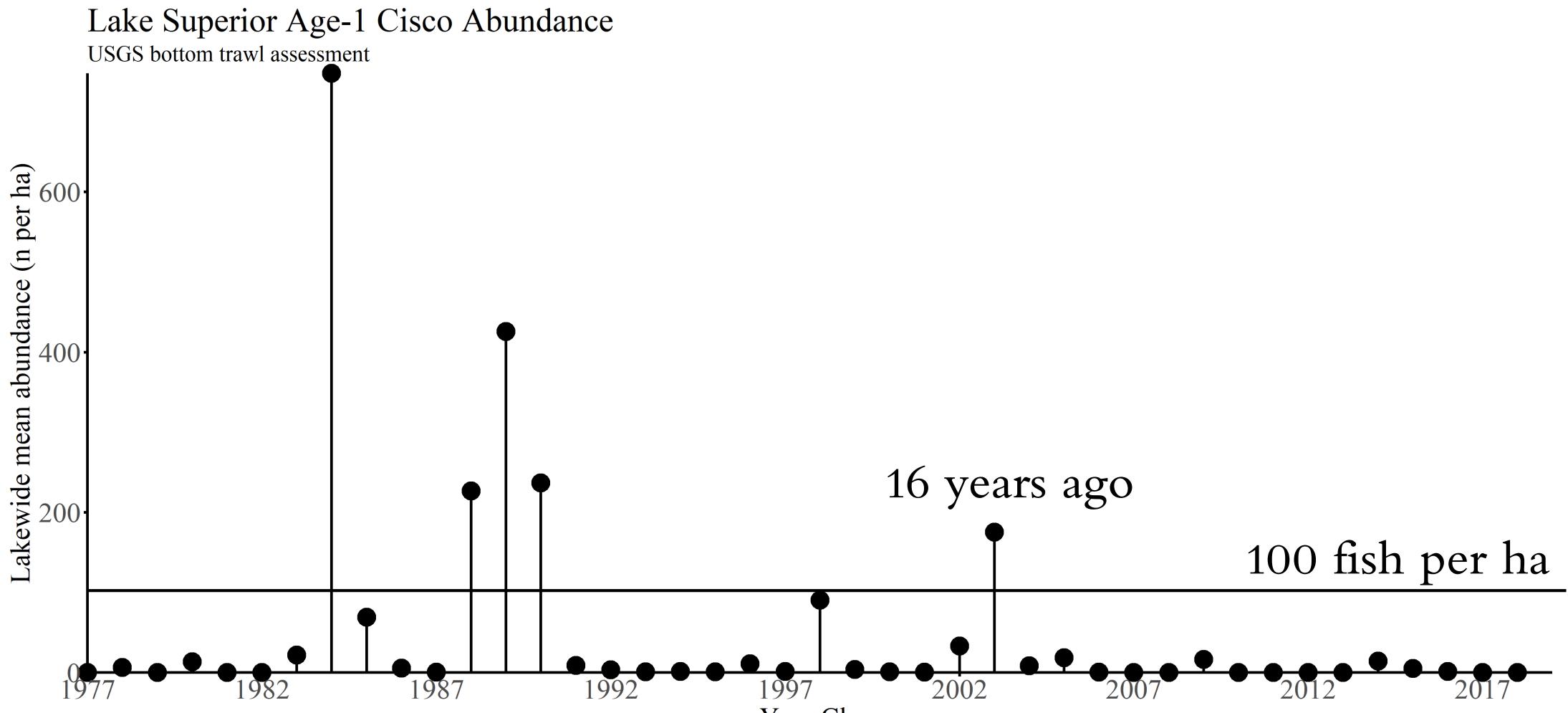


CPUE = Number of age 1-10 fish per 1200 feet of net per hour

# Cisco Year Class Recurrence Interval



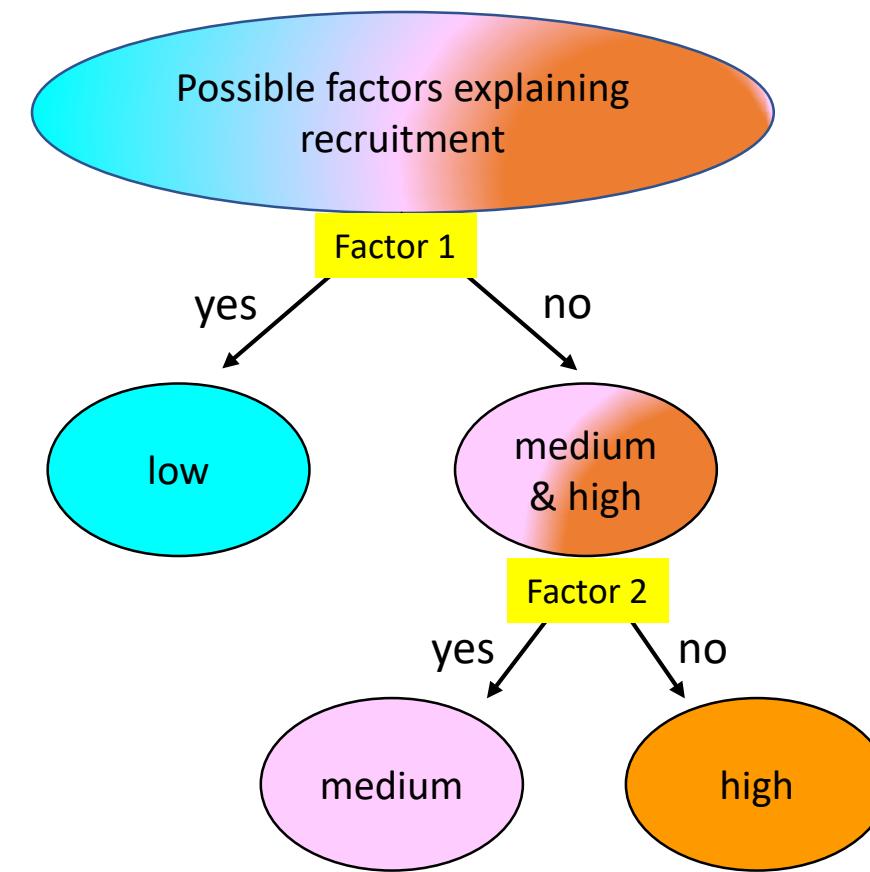
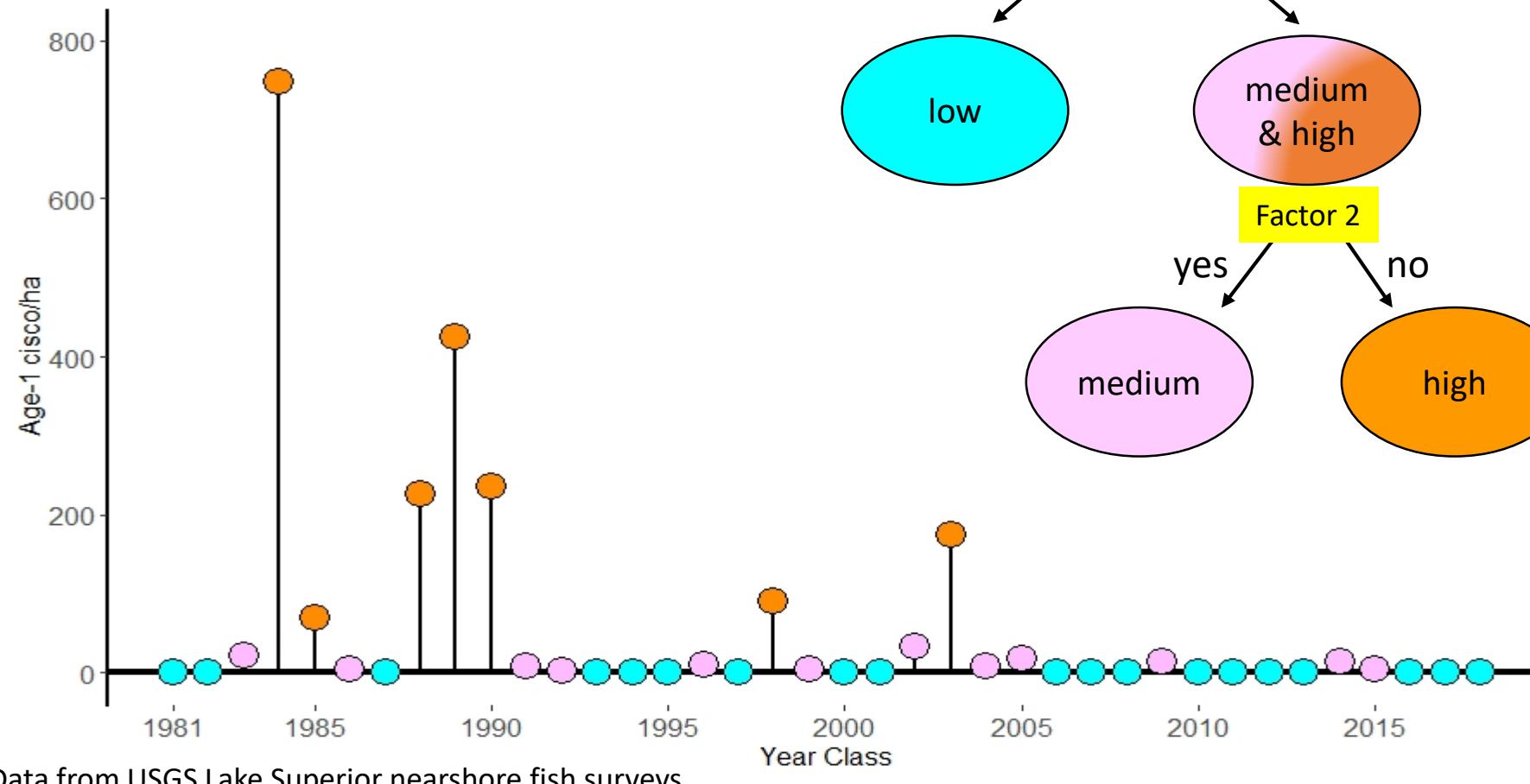
# Cisco Year Class Strength



Data: U.S. Geological Survey, doi.org/10.5066/F75M63X0

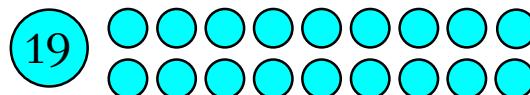
# Ciscoe age-1 Recruitment Predictive Model

Recruitment group	Years	Index value
None-Low	19	<2 fish / ha
Measurable	12	3-33 fish / ha
High	7	68-750 fish / ha

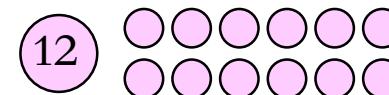


# Ciscoe age-1 Recruitment Predictive Model

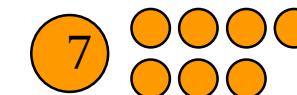
None-Low recruitment



Low-moderate recruitment



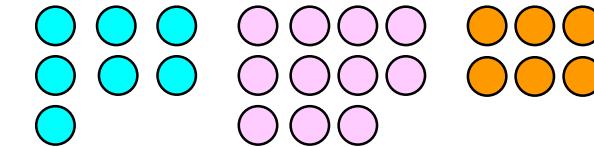
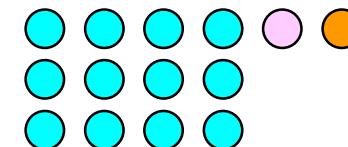
High recruitment



FACTOR 1: Early Ice

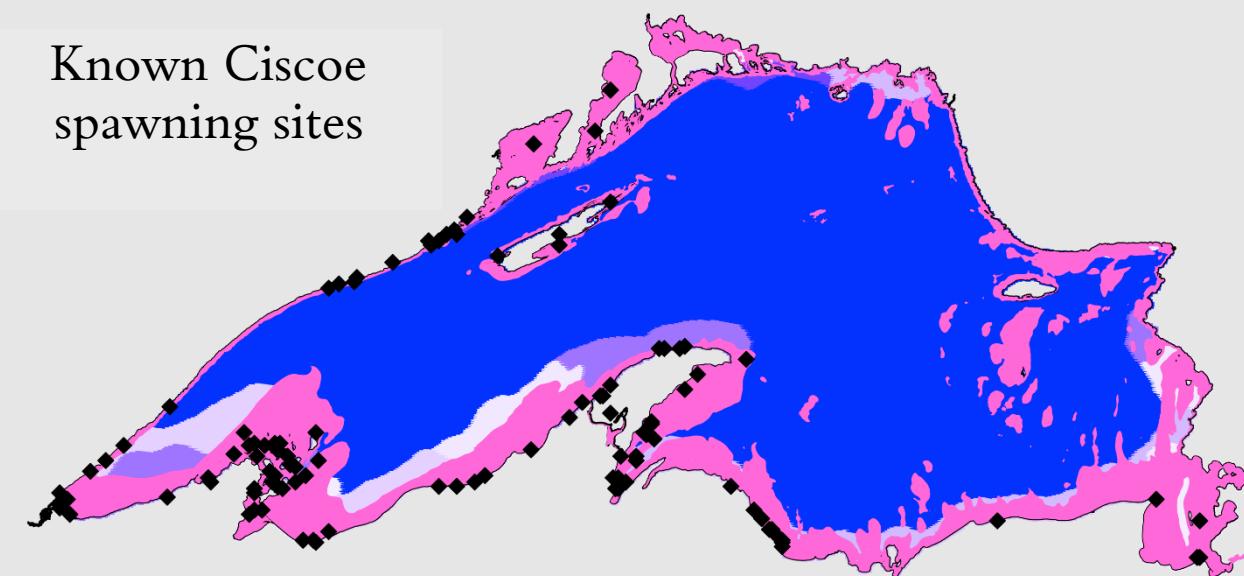
January ice cover <15%

January ice cover >15%

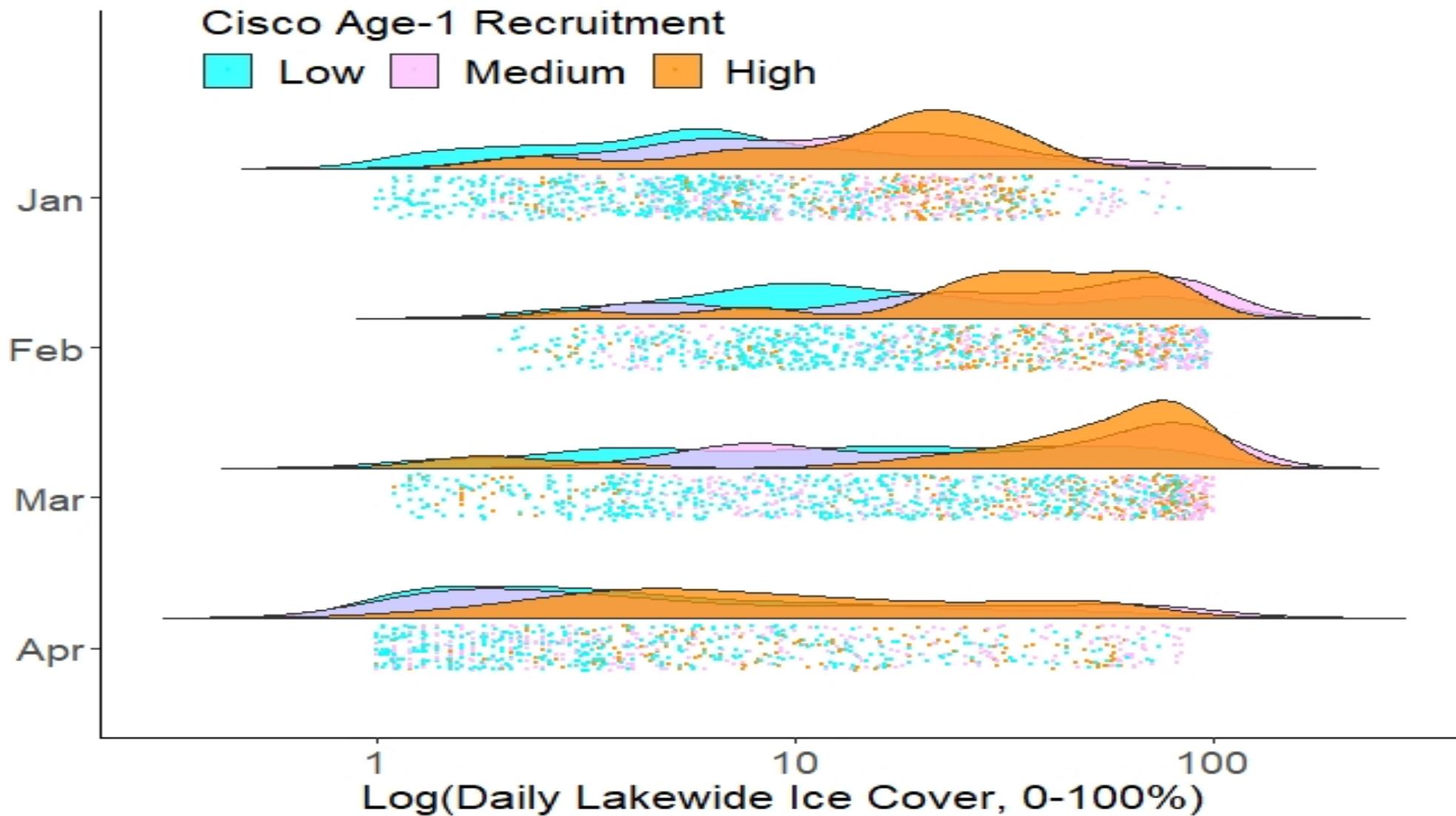


90% of measurable  
recruitment events

Known Ciscoe  
spawning sites

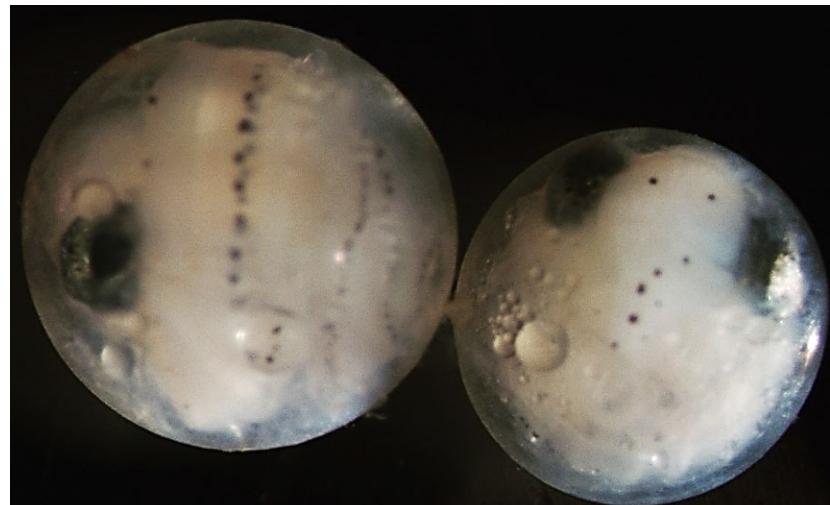
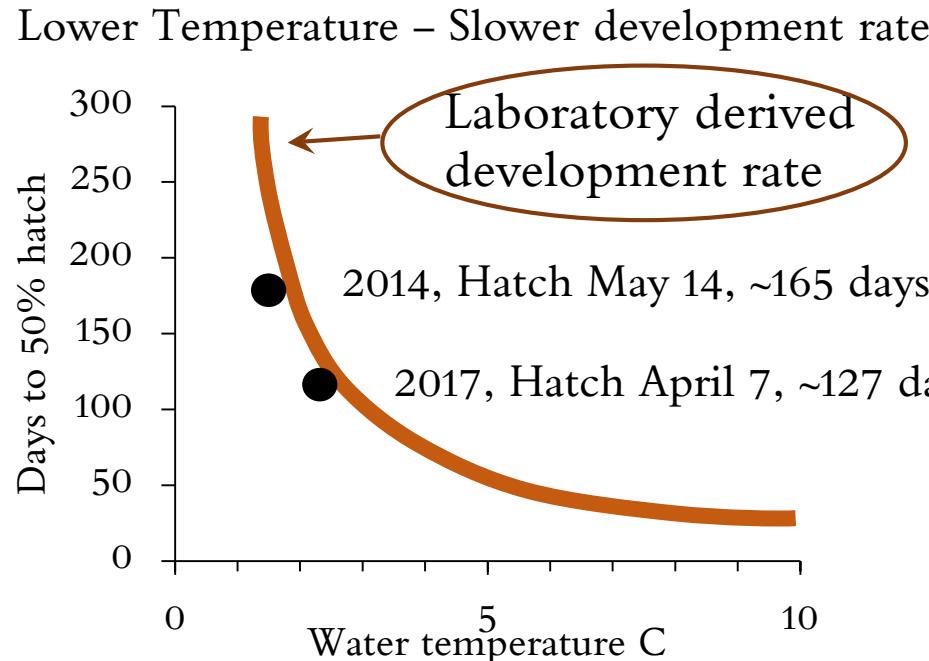


# Cisco age-1 Recruitment and Ice Cover

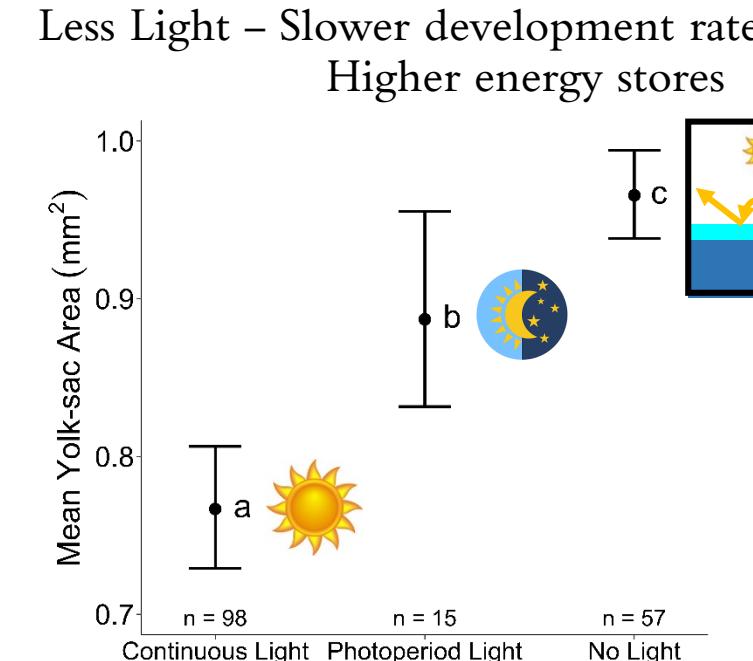


Data: Ice, NOAA GLERL. Fish, USGS

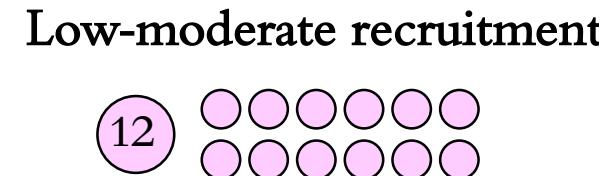
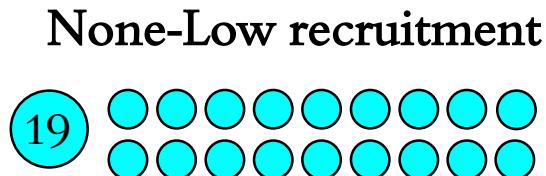
# Potential Mechanism Between Early Ice and Recruitment



Egg development curve from Colby and Brooke 1973. Yolk-sac area and images from Taylor Stewart, University of Vermont



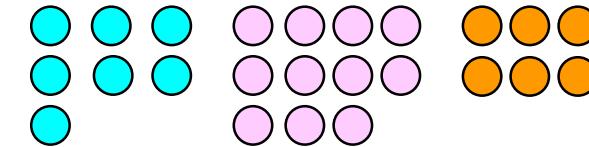
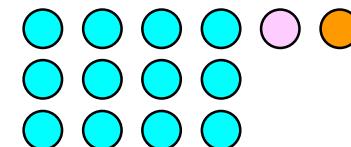
# Ciscoe age-1 Recruitment Predictive Model



FACTOR 1: Early Ice

January ice cover <15%

January ice cover >15%

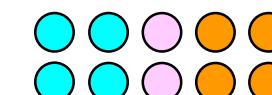
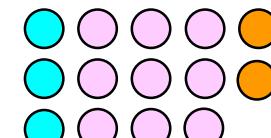


90% of measurable  
recruitment events

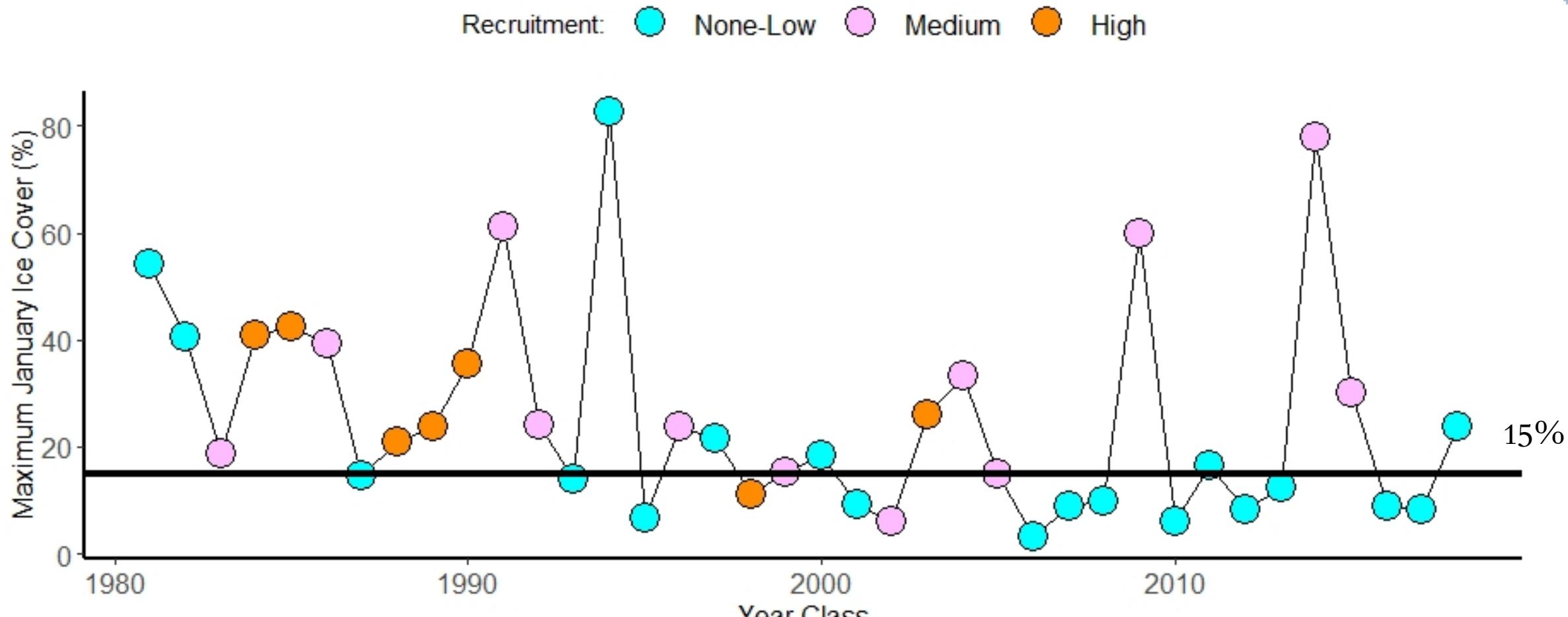
FACTOR 2: Spring warming

July >7°C

July <7°C



# Trend in January Ice Cover



Data: Ice, NOAA GLERL. Fish, USGS

# Trend in July Water Temperature

