

# Freshwater Initiative

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Stakeholder Meeting 1 – Nauset, Chequessett,  
Pamet, Pilgrim Lenses

WELLFLEET LIBRARY | MARCH 19, 2024



CAPE COD  
COMMISSION

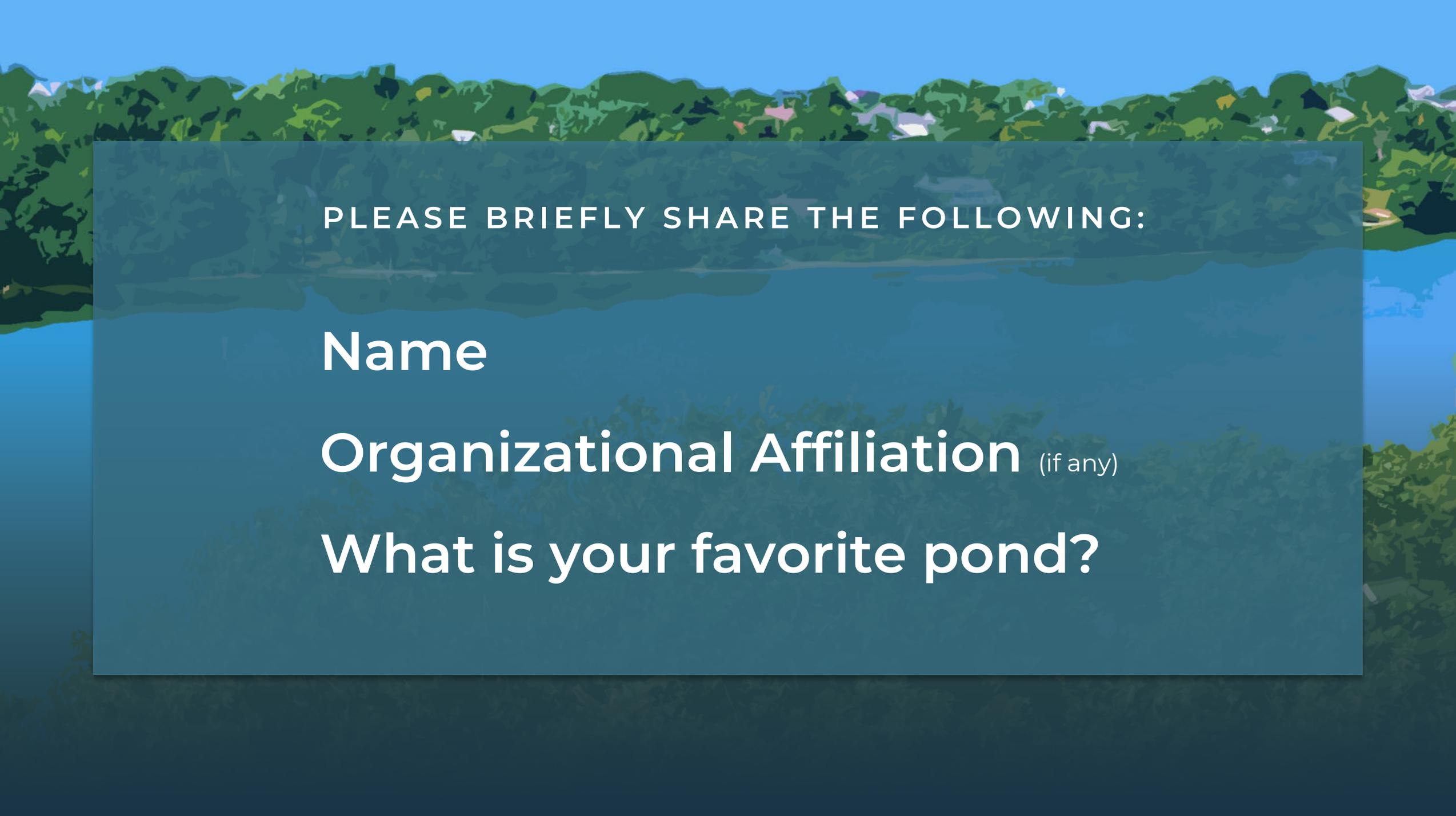
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FRESHWATER  
INITIATIVE

# Agenda

## Meeting 1

- Welcome
- Introductions
- Freshwater Initiative Overview
- Cape Cod Ponds and Lakes in Context
- Understanding Economic Impacts of Cape Cod's Freshwater
- The Data
- Discussion
- Next Steps



PLEASE BRIEFLY SHARE THE FOLLOWING:

**Name**

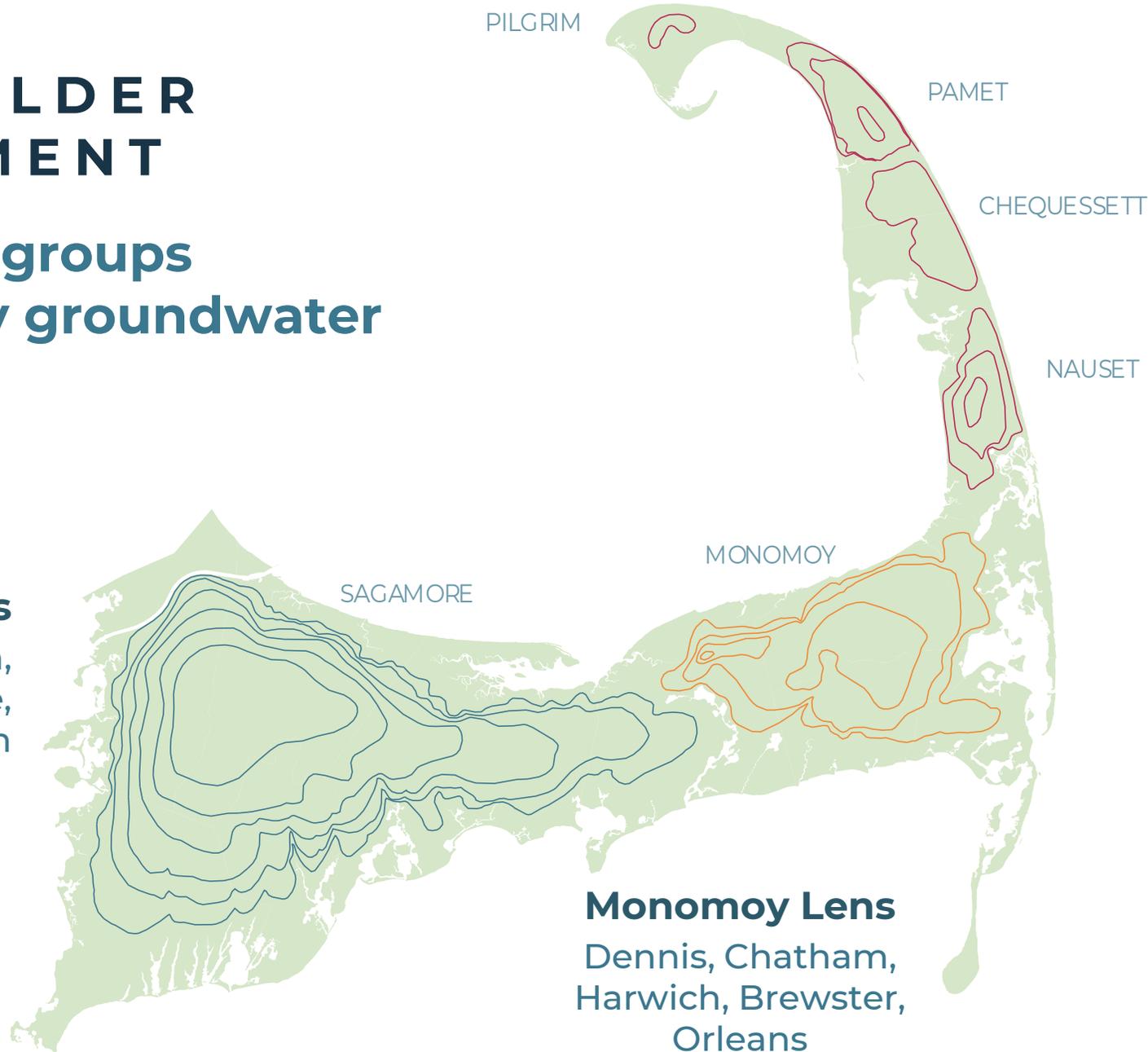
**Organizational Affiliation** (if any)

**What is your favorite pond?**

# STAKEHOLDER ENGAGEMENT

Stakeholder groups  
organized by groundwater  
lenses

**Sagamore Lens**  
Bourne, Falmouth,  
Sandwich, Mashpee,  
Barnstable, Yarmouth



**Outer Cape  
Lenses**  
Eastham,  
Wellfleet, Truro,  
Provincetown

**Monomoy Lens**  
Dennis, Chatham,  
Harwich, Brewster,  
Orleans

# Stakeholder Meetings

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MARCH 19 AND 20

Meeting 1  
**Defining the Problem**

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Establish a shared understanding of freshwater systems, the Freshwater Initiative, and stakeholder perspectives

APRIL 22 AND 23

Meeting 2  
**Exploring Strategies and Priorities**

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Highlight existing pond management strategies, review breadth of potential strategies and identify priorities, discuss future pond management prioritization

JUNE 3 AND 4

Meeting 3  
**Reviewing the Implementation Plan**

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Discuss recommendations and implementation plan; solicit stakeholder feedback

## Properly Functioning Ponds and Lakes Play an Important Role in Preserving and Restoring Coastal Water Quality

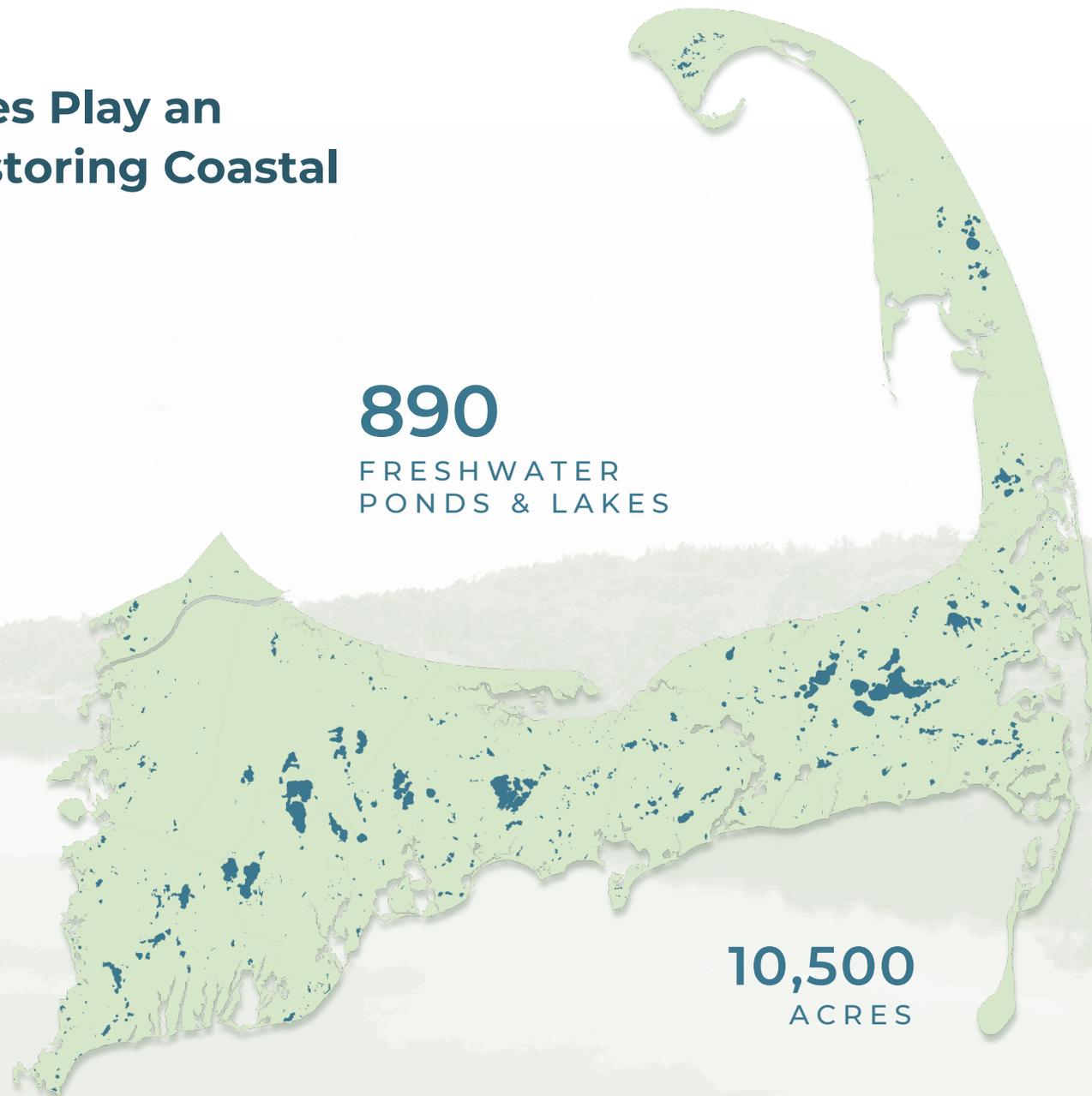
Ponds are credited with reducing up to 50% of the nitrogen that passes through them on its way to coastal embayments.

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## Lack of Consistent and Consecutive Data Collection

*less than* **10%**

of Cape Cod's ponds and lakes are monitored



# Cape Cod Freshwater Initiative

A science-based, information-driven planning process that will engage stakeholders and enable action to protect and restore Cape Cod's freshwater ponds

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## ESTABLISHING THE BASELINE

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Ponds And Lakes Atlas Update



Physical Characteristics



Data Management And Analysis



Remote Sensing

## STRATEGY DEVELOPMENT

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Engagement and Outreach



Strategies Database



Economic Analysis



Legal Analysis

## ONGOING MONITORING AND ANALYSIS

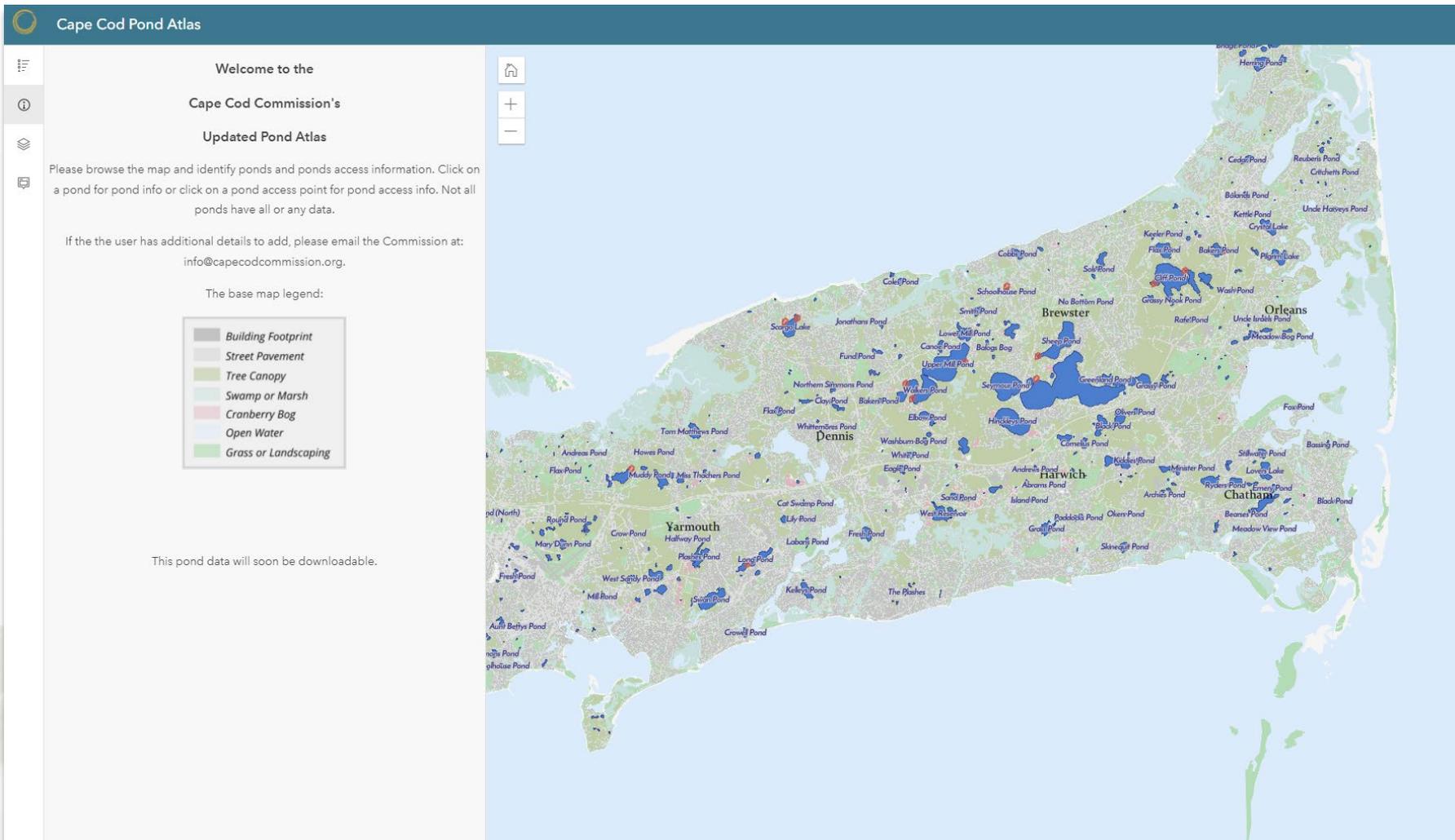
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Monitoring Program



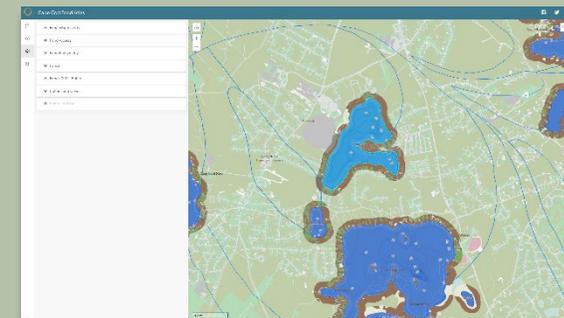
Ongoing Data Management and Analysis



This pond data will soon be downloadable.

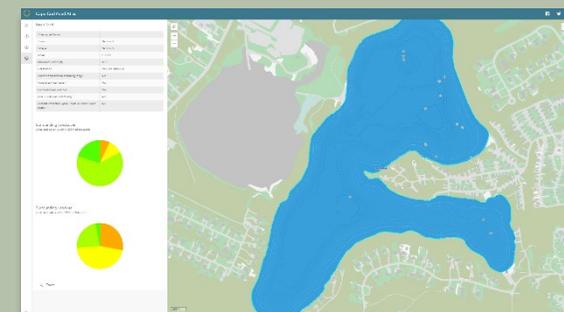
# Cape Cod Pond Viewer

The Pond Viewer serves as a companion to the Atlas and can be used to explore Cape Cod's ponds, ecology, and the challenges they face.



## MAP LAYERS

Available map layers include access points, pond watershed delineations, bathymetry data, 300 ft. pond buffer area, and other pond and surrounding land use characteristics.



## POND CHARACTERISTICS

Select a pond and open the Info Panel to view related characteristics including acreage, depth, and more. Users can also explore surrounding land cover and land use summaries within a 300 ft. pond buffer area.

EXPLORE: [cccom.link/pond-atlas](https://cccom.link/pond-atlas)

# Pond Profiles

Expanded Pond Profiles provide a snapshot of regional and town-by-town pond information, including physical characteristics, existing monitoring efforts, watersheds, strategies, and more.

**Barnstable County Ponds Profile**  
A RESOURCE OF THE CAPE COD FRESHWATER INITIATIVE

**Provincetown Ponds Profile**  
A RESOURCE OF THE CAPE COD FRESHWATER INITIATIVE

**Cape Cod**  
LAND AREA: 263,985 acres

**Provincetown**  
TOWN AREA: 6,443 acres

**Pond Watersheds**  
The land area that contributes to freshwater ponds and lakes is referred to as a pond watershed. Relatively few pond watersheds have been delineated across the Cape. Land area within pond watersheds is much larger than the water bodies themselves. On Cape Cod, 17% of the region's total land area is within a delineated pond watershed.

**Land Use In Pond Buffer Area**  
Understanding the way that land is used around our freshwater ponds contributes to a better understanding of potential pond impacts, stressors, and viable strategies to protect or restore pond health. 556 acres (or 9%) of the town's total land area is within 300 feet of a freshwater pond.

**Top 5 Largest Ponds**

POND	AREA
1. Long Pond (Brewster)	742.0
2. Mashpee-Wakeby Pond	735.0
3. Wequaquet Lake	673.0
4. Johns Pond	336.0
5. Upper Mill Pond	260.0

**Top 5 Deepest Ponds**

POND	DEPTH
1. Cliff Pond	8.0
2. Ashumet Pond	8.0
3. Flax Pond	7.0
4. Long Pond (Brewster)	7.0
5. Higgins Pond	6.0

**Documented Town Reports and Actions**

16 Town Specific Freshwater Reports | 41 Pond Specific Freshwater Reports

**Local Pond Organizations**  
Independent groups, organizing around a single or multiple ponds, voluntarily conduct educational and advocacy efforts and collect water quality monitoring data, which is not always available or sufficient for regional analysis.

40 Local Pond Organizations

**Documented Town Reports and Actions**  
There are 0 town or pond specific freshwater reports in the regional dataset.

**Local Pond Organizations**  
Independent groups, organizing around a single or multiple ponds, voluntarily conduct educational and advocacy efforts and collect water quality monitoring data, which is not always available or sufficient for regional analysis.

There are 0 local pond organizations in the regional dataset.

**Pond Strategies Implemented**  
Updates and additional projects will be added as information becomes available. Review project details at: [cccom.link/pond-restoration-projects](https://cccom.link/pond-restoration-projects)

There are 0 implemented pond strategies in the regional dataset.

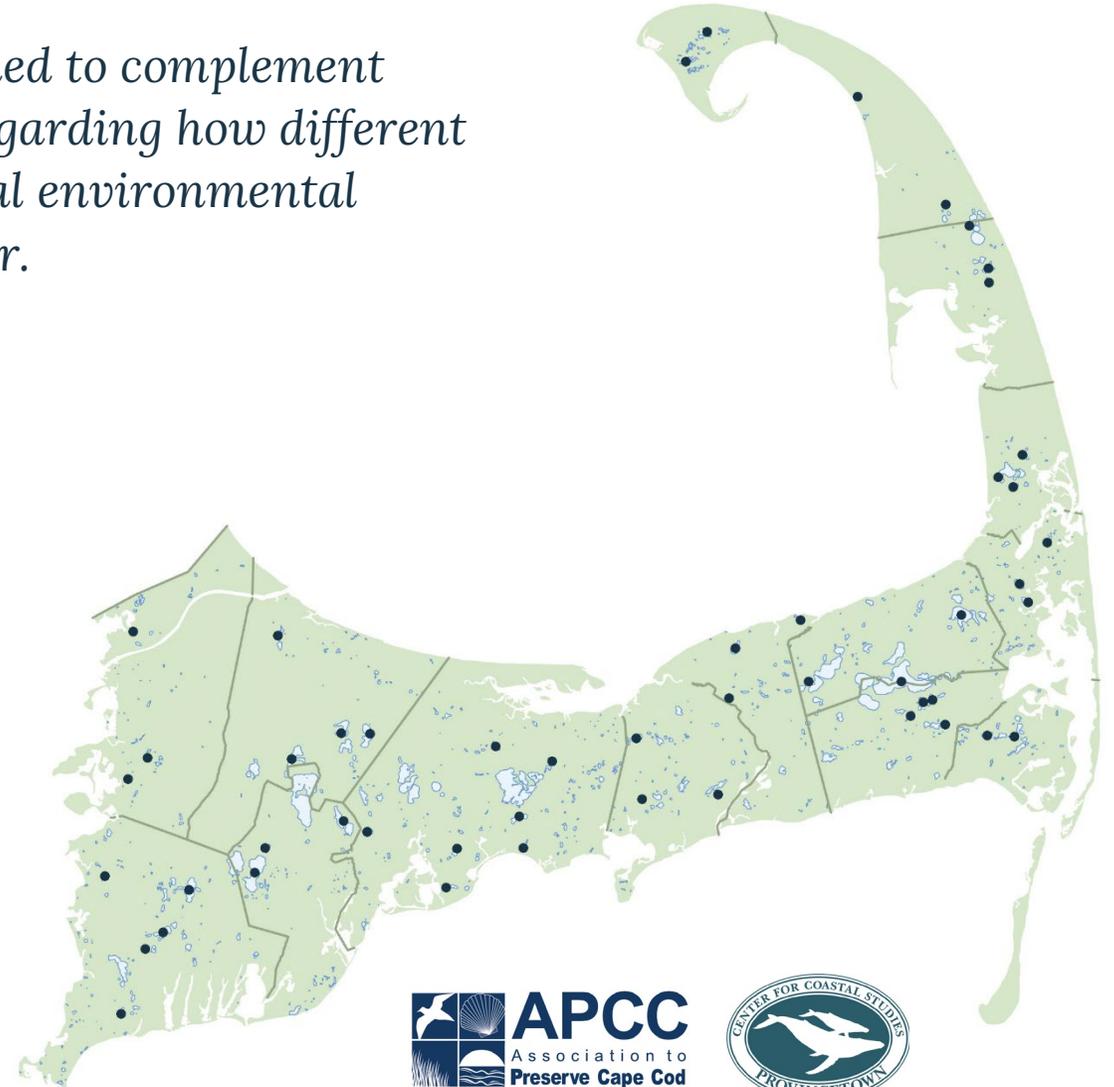
Learn more about the region's freshwater resources in the Cape Cod Pond and Lake Atlas at: [capecodcommission.org/freshwater](https://capecodcommission.org/freshwater)

# REGIONAL POND MONITORING PROGRAM

*The Regional Pond Monitoring Program has been designed to complement existing monitoring efforts and provide baseline data regarding how different types of ponds on Cape Cod respond to changing regional environmental conditions throughout the summer and from year to year.*

## **Pond selection criteria:**

- Spatial coverage across all towns and aquifer lenses
- Range of pond physical characteristics (e.g., size, depth, level of watershed development)
- Stream/herring run connections, implementation projects, and Coastal Plain Pondshores
- Water quality status
- Public uses of ponds
- Located in or adjacent to environmental justice area



# REGIONAL POND MONITORING PROGRAM

## First season of monitoring program complete

- **50 ponds** monitored from April to November
- **346 pond visits** by staff and volunteers
- **3,113 sample bottles** sent to the lab for processing and analysis
- **Over 500 volunteer hours** spent monitoring ponds

Center for Coastal Studies analyzed samples

Monitoring efforts will resume in March 2024



# | ENGAGEMENT AND OUTREACH



## Pond Network

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Coalition of pond groups and associations or pond water quality monitors to invite connection, collaboration, and shared resources



## Technical Advisory Groups

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Technical experts will advise components of the Initiative such as the water quality improvement strategies database



## Community Outreach and Input

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Engage the broader community to understand public perception, awareness, and priorities



## Stakeholder Engagement

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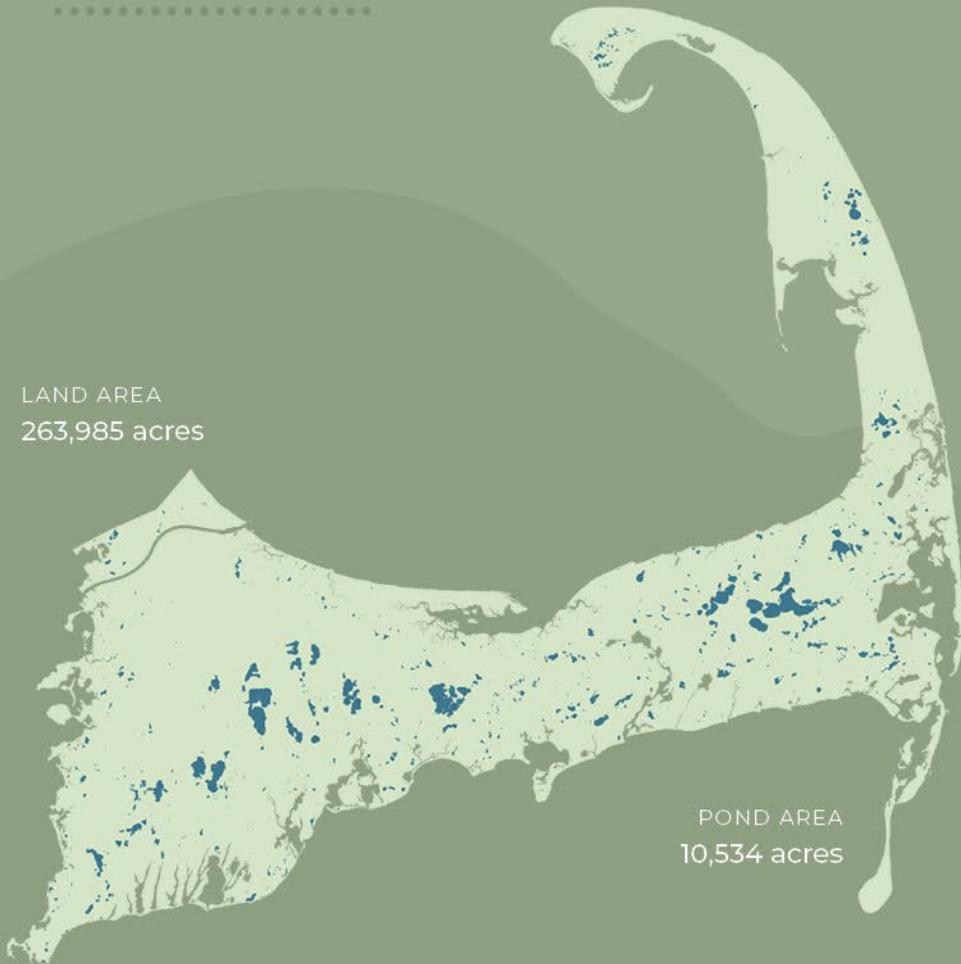
Engagement that incorporates broad stakeholder representation to understand priorities, the range of potential solutions, and build consensus on a framework for action



# Cape Cod Ponds and Lakes in Context

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# Cape Cod Ponds by the Numbers



CAPE COD PONDS AND LAKES

**890**  
POND S

**171**  
10+ Acre Ponds

**395**  
Named Ponds

## LARGEST PONDS *by area*

1. Long Pond  
Brewster and Harwich
2. Mashpee-Wakeby Pond  
Mashpee and Sandwich
3. Wequaquet Lake  
Barnstable

## DEEPEST PONDS *with data available*

1. Cliff Pond  
Brewster
2. Hamblin Pond  
Barnstable
3. White Pond  
Chatham

**27** 

Fish Stocked Ponds

**107** 

Ponds Adjacent to Cranberry Bogs

**22** 

Ponds that Cross Town Boundaries

**96** 

Ponds with Public Access\*

**30%** 

Protected Open Space within pond 300ft buffer

**14%** 

Impervious Surfaces within pond 300ft buffer

\*Includes public beaches, boat ramps, and launches

C A P E C O D  
**REGIONAL**  
P O L I C Y P L A N

FRAMING THE FUTURE

CAPE COD COMMISSION | 2019

RECOMMENDED ACTION

**Update and Expand Understanding  
of Freshwater Resources Data**

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*Compile available freshwater resources water quality data into a regional database.*

*Seek funding to update **the Cape Cod Ponds and Lakes Atlas** to reflect current water quality data collected by the Ponds and Lakes Stewardship Program.*



*Cape Cod's freshwater ponds are fragile systems especially vulnerable to pollution and human activity.*

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*Despite data gathered by citizen monitoring groups and assessments that document water quality impairment, the state has listed only a few freshwater ponds on the 303d list for impaired waters for nutrients under the Clean Water Act. **Additional dialogue is needed** between the towns, state and county to evaluate the best use of the information collected and how it should be incorporated into the Commonwealth's clean water program.*



# Cape Cod Pond Ecology

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Liz Moran – Anchor QEA, LLC



# Kettle Ponds: Unique Ecosystems

- Remnants of glacial ice retreat, 14,000 – 17,000 years ago
- Varied ecology based on landscape position, depth, and soil texture
- Provide terrestrial, wetland, and aquatic habitat to a diverse assemblage of native species

# Unique but Interconnected

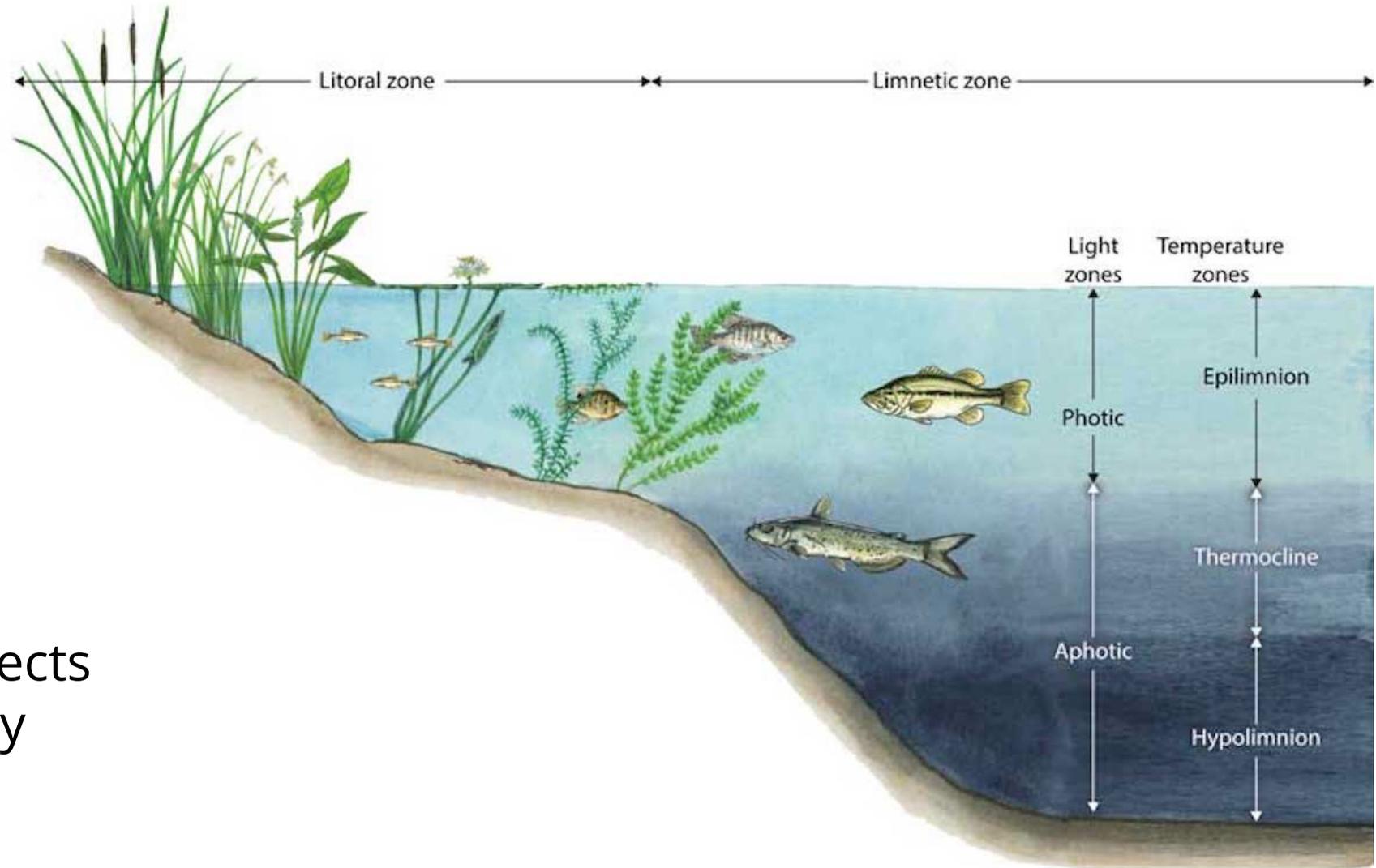
- Surface water and groundwater connections
- Discharge to coastal estuaries
- Conditions influenced by local actions and regional trends
  - Nutrient sources
  - Changing climate
  - Water level/sea level rise



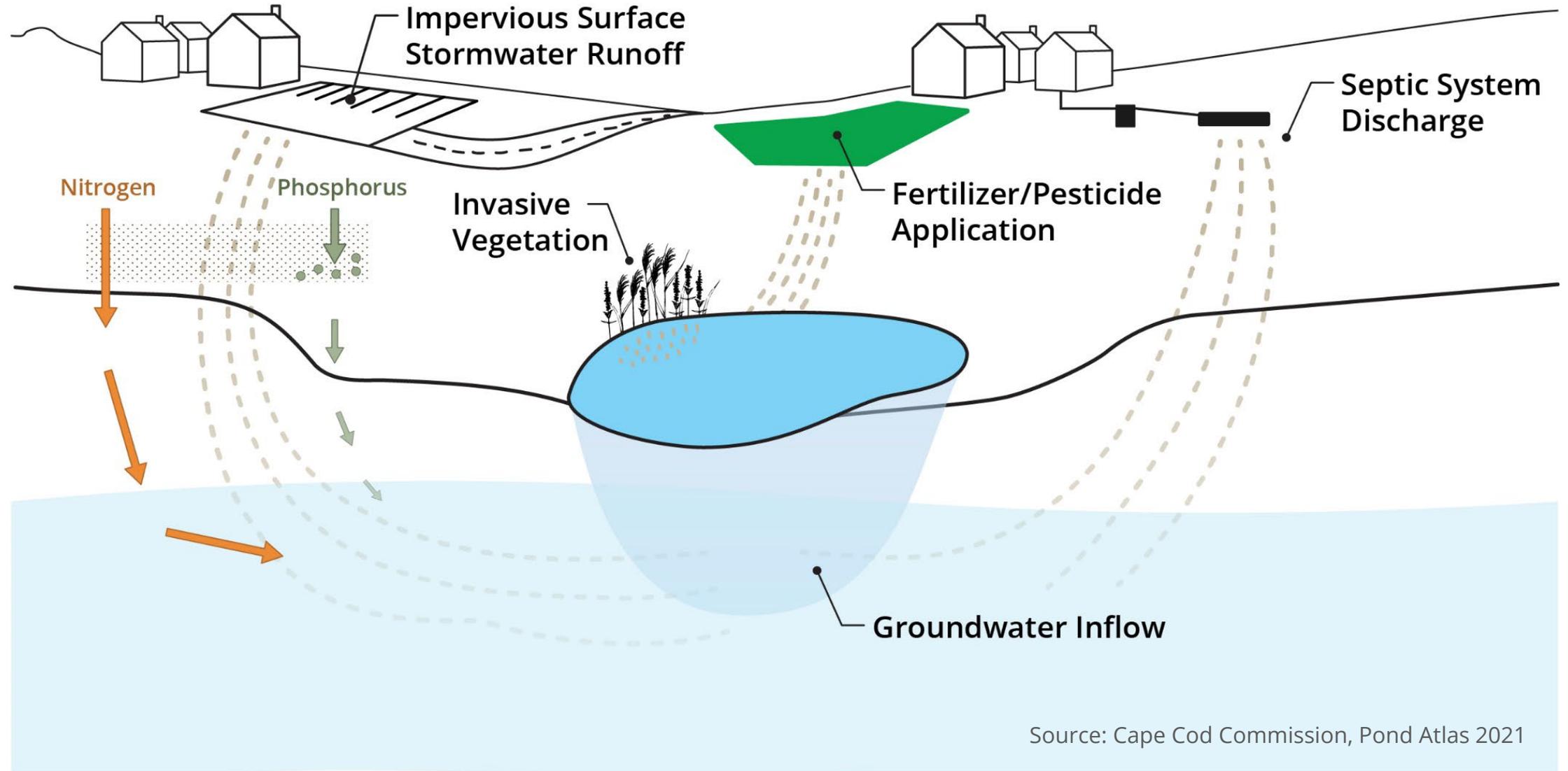
Source: Cape Cod Commission Pond Atlas, 2021

# Phosphorus (P) is Key to Pond Ecology

- Limiting nutrient
- Accumulates in ponds
- P cycle affected by pond depth, thermal stratification, and productivity
- Dissolved oxygen affects habitat and chemistry



# LANDSCAPE CONDITIONS AFFECT NUTRIENT FLUX



Source: Cape Cod Commission, Pond Atlas 2021

# POND CHARACTERISTICS AFFECT THEIR RESPONSE

## Morphometry

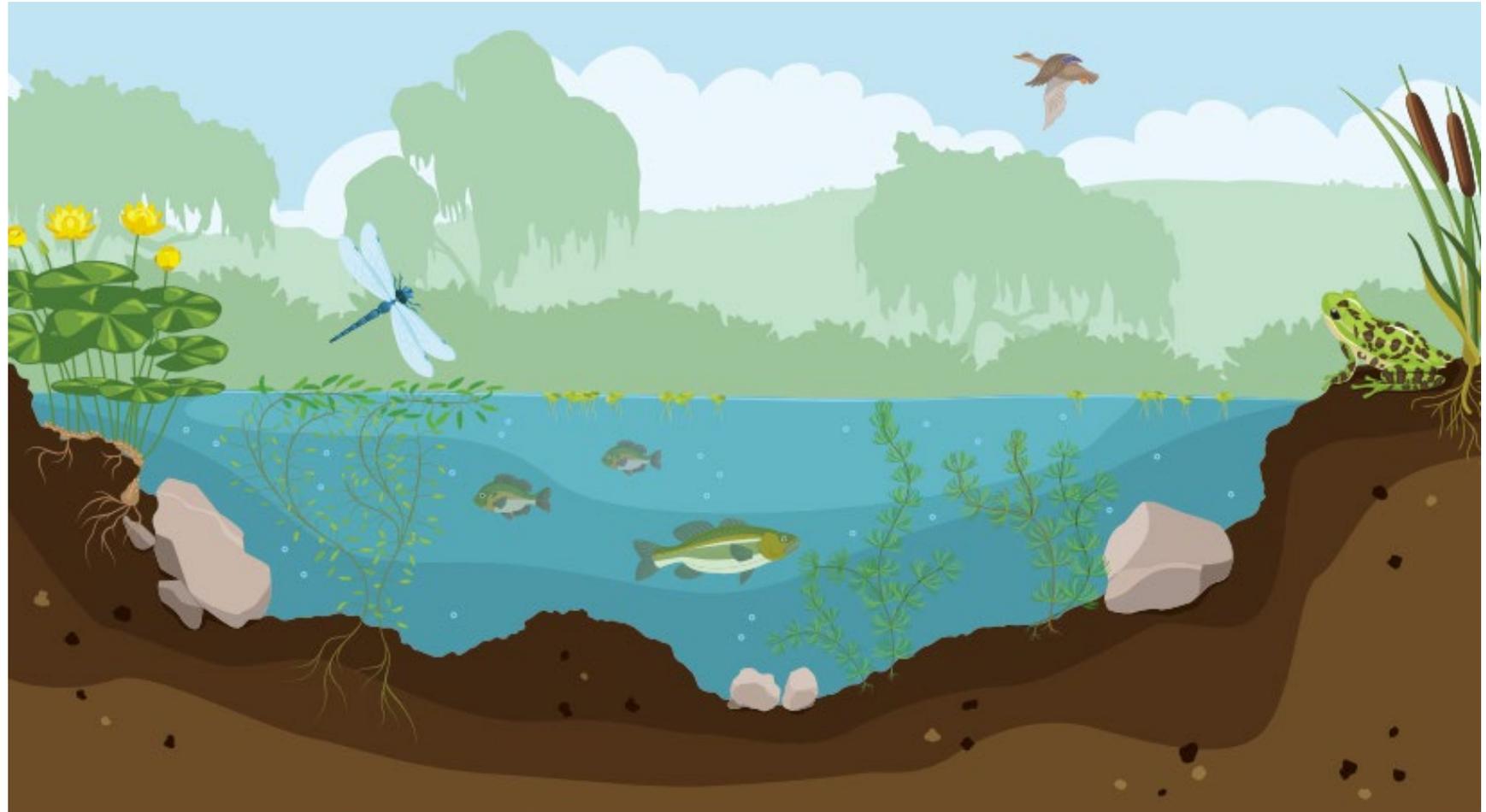
- Depth
- Surface Area
- Water Residence Time
- Connectivity

## Ecology

- Fish community
- Invasive species

## Management

- Fish stocking
- Interventions



# POND CHARACTERISTICS



## Jemima Pond

Alternative Name	
CCC-GIS-ID	EA-100
Town	Eastham
Village	Eastham
Acres	6.53
Maximum Depth (ft)	15.0
Great Pond	No
Watershed Delineated	Yes
Ponds stocked with fish	No
NHESP Natural Community	No
Percent Protected Open Space in Pond's 300ft. buffer	14%
Cranberry Bogs within 300ft Buffer	No
Golf Course within 300ft Buffer	No

## Surrounding Landcover

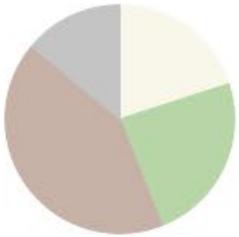


# POND CHARACTERISTICS



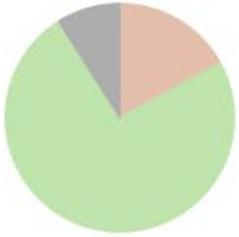
## Surrounding Landcover

what land cover is within 300 ft of the selected pond



## Surrounding Landuse

what land use is within 300 ft of the selected pond



Zoom



# Ponds Support Human Well-being

- Sense of Place
- Recreation
- Aesthetics
- Environmental education
- Denitrification – coastal estuary goals
- Angling – food and recreation
- Economy – tourism and tax base





**What qualities of ponds are  
important to you or your work?**

*What do you value about ponds?*



# Understanding Economic Impacts of Cape Cod's Freshwater

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Charles Goodhue – ERG

# Core Components of the Economic Analysis

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## Perceptions Survey

Identifies preferences, perceptions and attitudes towards freshwater

## Intercept Survey

Assesses the economic impact of freshwater ponds on the economy

## Hedonic Analysis

Quantifies the impact of freshwater ponds on property values

## Discrete Choice Experiment

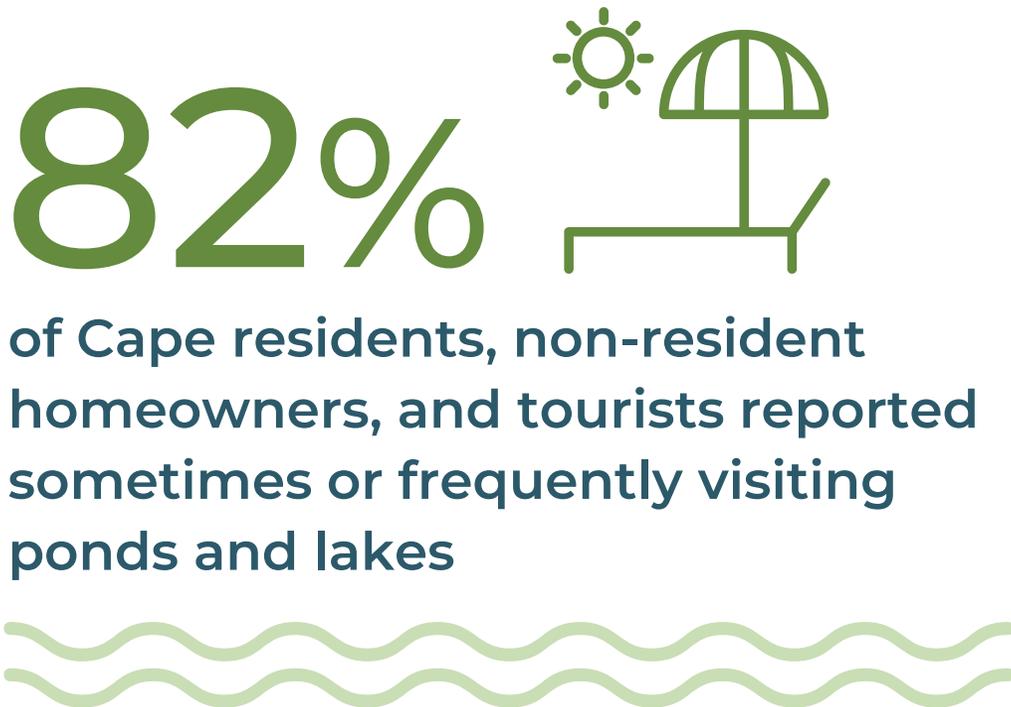
Estimates the value of certain freshwater attributes based on “willingness to travel”

# Perception Survey Methods

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<b>What:</b>	Web-based survey using Qualtrics panel
<b>Why:</b>	Attitudes, recreation, visitation rates
<b>Details:</b>	<b>827 respondents</b> <ul style="list-style-type: none"><li>▪ 587 visitors</li><li>▪ 154 residents</li><li>▪ 86 non-resident homeowners</li></ul>

## Cape Cod ponds and lakes are popular destinations.



**1.3 to 1.7 million**  
Estimated visits to Cape Cod ponds and lakes annually



**66%**  
of visits come between June and August

## Cape residents and non-resident homeowners support targeted pond improvements.



The **most impaired** ponds and lakes, the ones with the **highest support** for improvement, and the **most used/visited should be prioritized.**



Cape residents and NROs also overwhelmingly indicated that pond improvement projects with **ecosystem benefits should be prioritized.**

# Discrete Choice Experiment Methods

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<b>What:</b>	"Stated preference" survey asking about preferences for specific attributes
<b>Why:</b>	Understand value of water quality signs, bacterial issues, beach size, litter, shoreline development, amenities, and time to travel
<b>Details:</b>	<p>382 respondents</p> <ul style="list-style-type: none"><li>▪ 102 residents</li><li>▪ 13 non-resident owners</li><li>▪ 267 visitors</li></ul>

## People prefer to visit ponds and lakes with clean water and clean beaches.

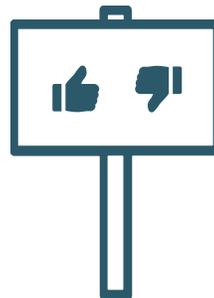


Visitors are **1.8 TIMES** more likely to visit

A pond that rarely or never has bacterial issues than a pond with issues every summer.



Visitors are **2.5 TIMES** more likely to visit a pond that has little to no litter than a pond with a noticeable amount of litter.



Visitors are **1.2 TIMES** more likely to visit a pond that has signs about recent water testing than one with no sign.

# Discrete Choice Experiment

We Asked Cape Cod Residents and Visitors What Attribute They Considered **Most Important** When Deciding to Visit a Lake or Pond:



**37%**  
said bacterial issues



**20%**  
said signs of water quality



**14%**  
said litter or garbage



**11%**  
said amenities (picnic tables,  
bathrooms)



**8%**  
said beach size



**4%**  
said shoreline development



**4%**  
said time to drive to pond



**2%**  
said none in particular

# Hedonic Property Price Analysis Methods

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<b>What:</b>	Value of attributes of a property
<b>Why:</b>	Value of proximity to ponds and pond water quality
<b>Details:</b>	<ul style="list-style-type: none"><li>▪ 21,000+ home sales</li><li>▪ 8,000 rental properties</li></ul>

## Cape residents and non-resident homeowners value clean ponds.

A **home** near a pond with clear water will sell for **\$22,300 more\*** than a similar home near a pond with algal issues.

*(5 percent more than the median sales price)*



A **rental property** near a pond with clear water will rent for **\$189 MORE** per week than a similar rental property near a pond with algal issues.

*(8 percent increase over median weekly rental value)*

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*91% either “agree” or “strongly agree” that ponds and lakes are important to the Cape Cod environment, and they are willing to pay a premium to live near them.*

# Intercept Survey Methods

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<b>What:</b>	In-person survey of people at ponds
<b>Why:</b>	Counts and spending to get economic contribution
<b>Details:</b>	<ul style="list-style-type: none"><li>▪ 75 unique ponds</li><li>▪ 606 surveys covering spending of 2,252 people</li><li>▪ 20 days of data collection</li></ul>

## Lakes and ponds are important to the Cape Cod economy.

84%

of Cape residents and non-resident homeowners either “agree” or “strongly agree” that **ponds and lakes are important to the Cape Cod economy**

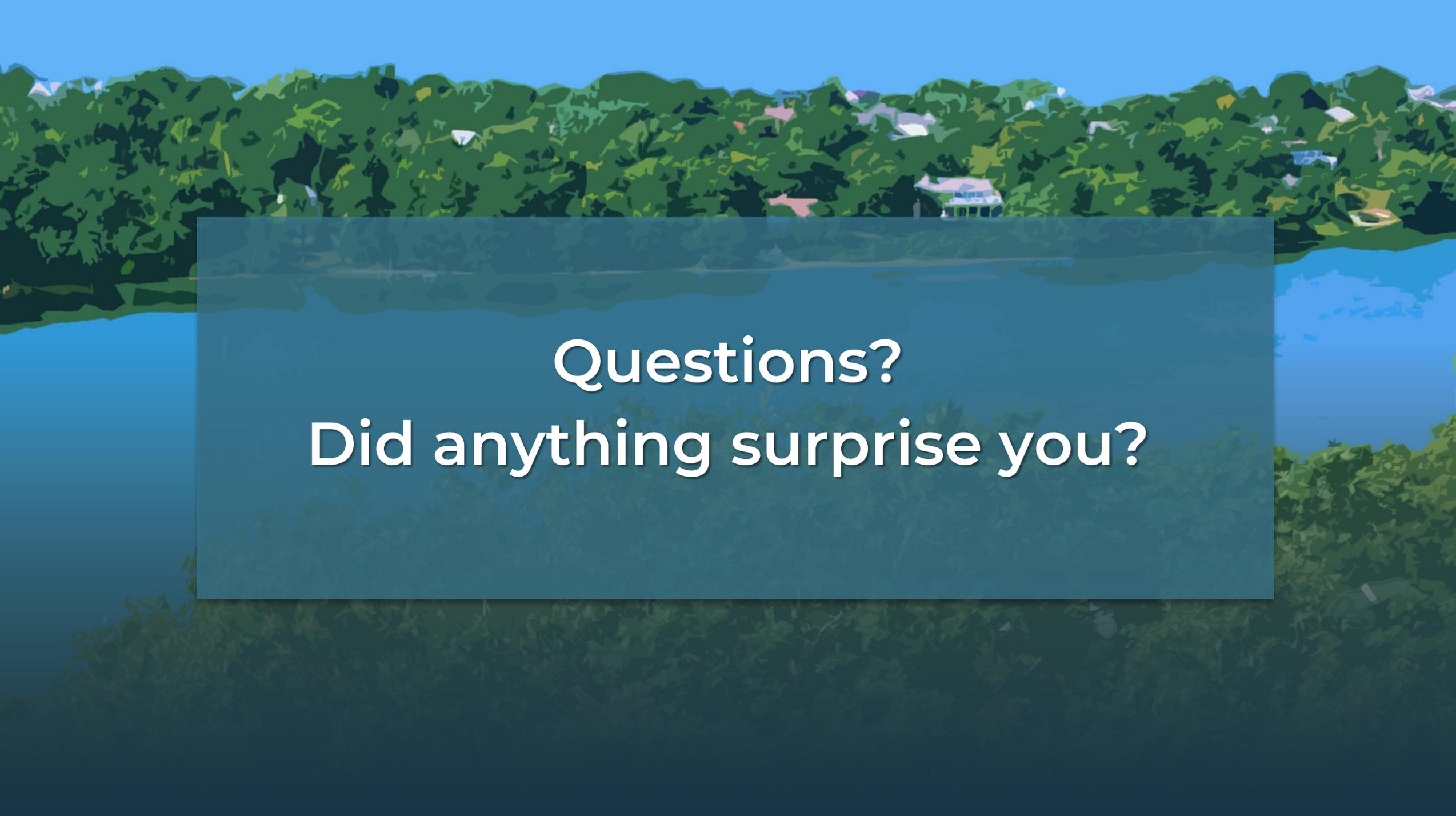


**660 to 830 jobs** annually can be attributed to spending associated with visits to lakes and ponds



**\$70 - \$89 million** of the region’s GDP is associated with visits to lakes and ponds

Visitors **spend an average of \$50** locally per visit



**Questions?**  
**Did anything surprise you?**

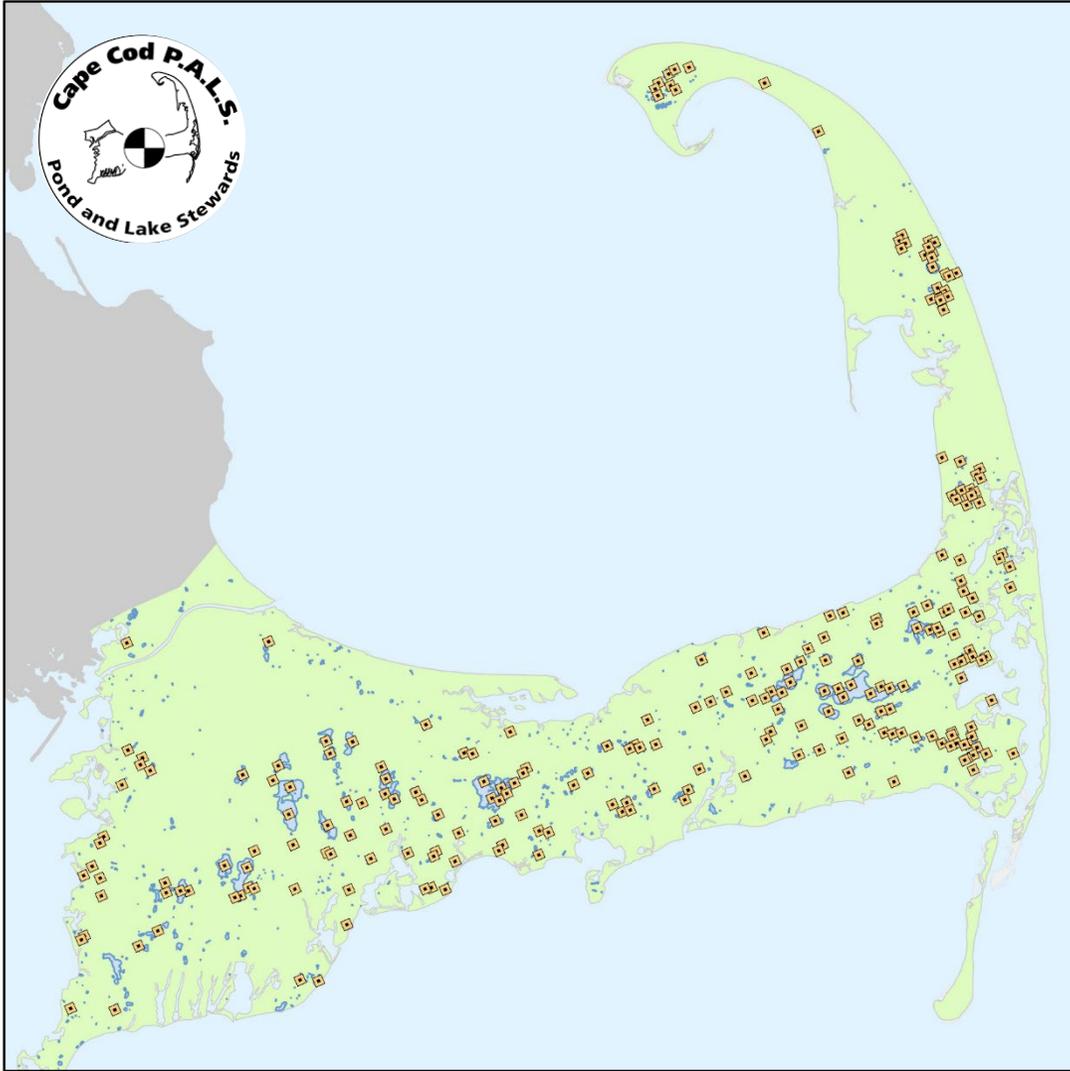


# Water Quality Data

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Tim Pasakarnis – Cape Cod  
Commission

# CAPE COD'S HISTORY OF POND MONITORING



1+ data sheet  
per town  
per year

x



15 towns

x



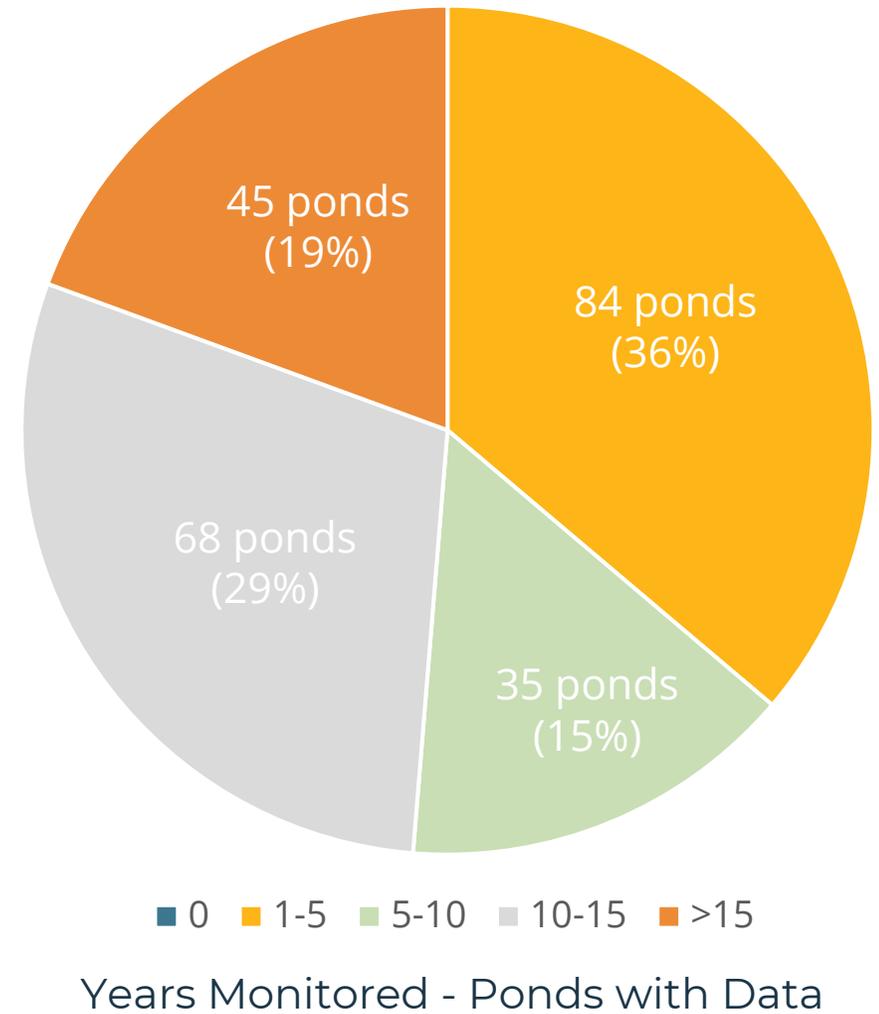
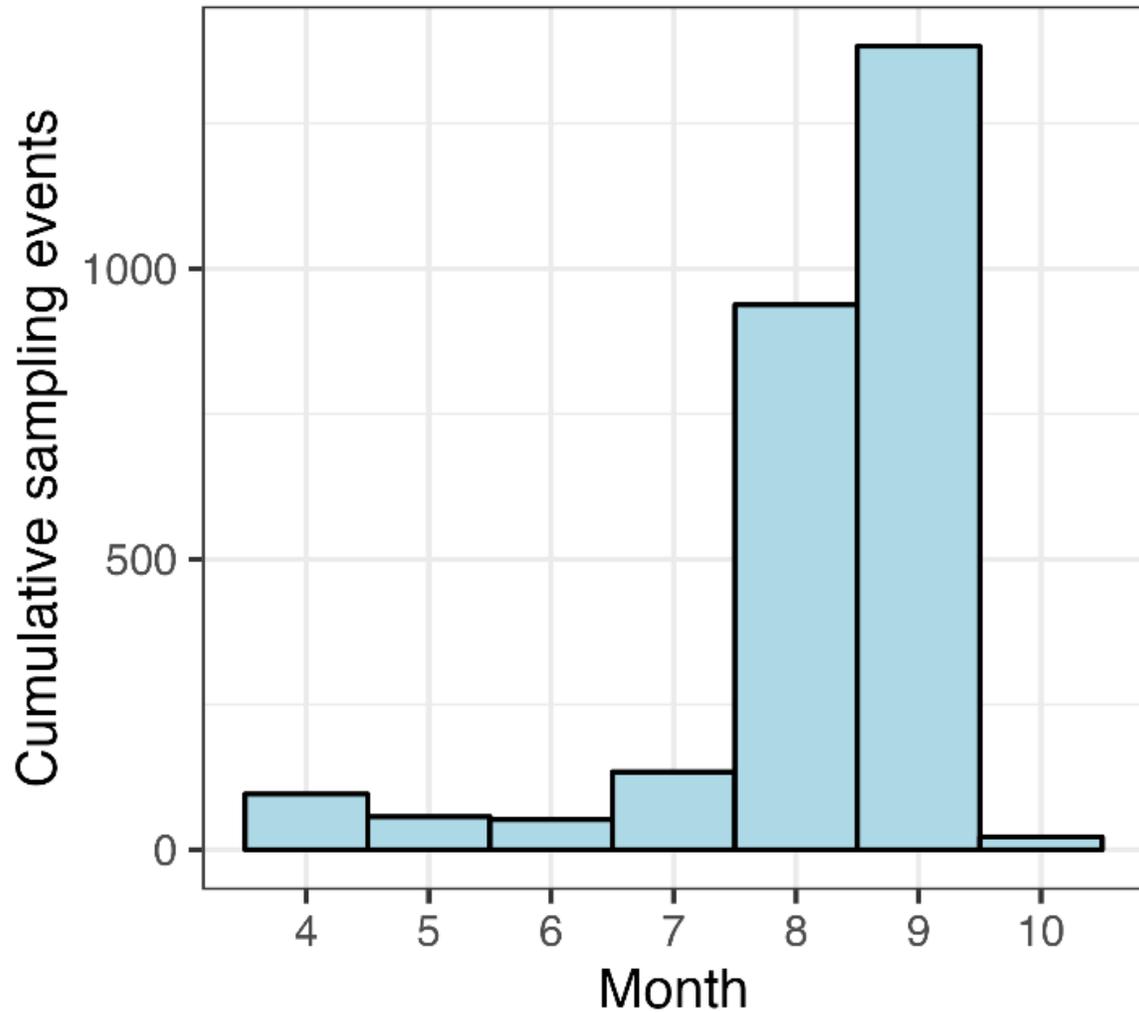
20+ years of  
pond monitoring

**= 125,000+ sample results**

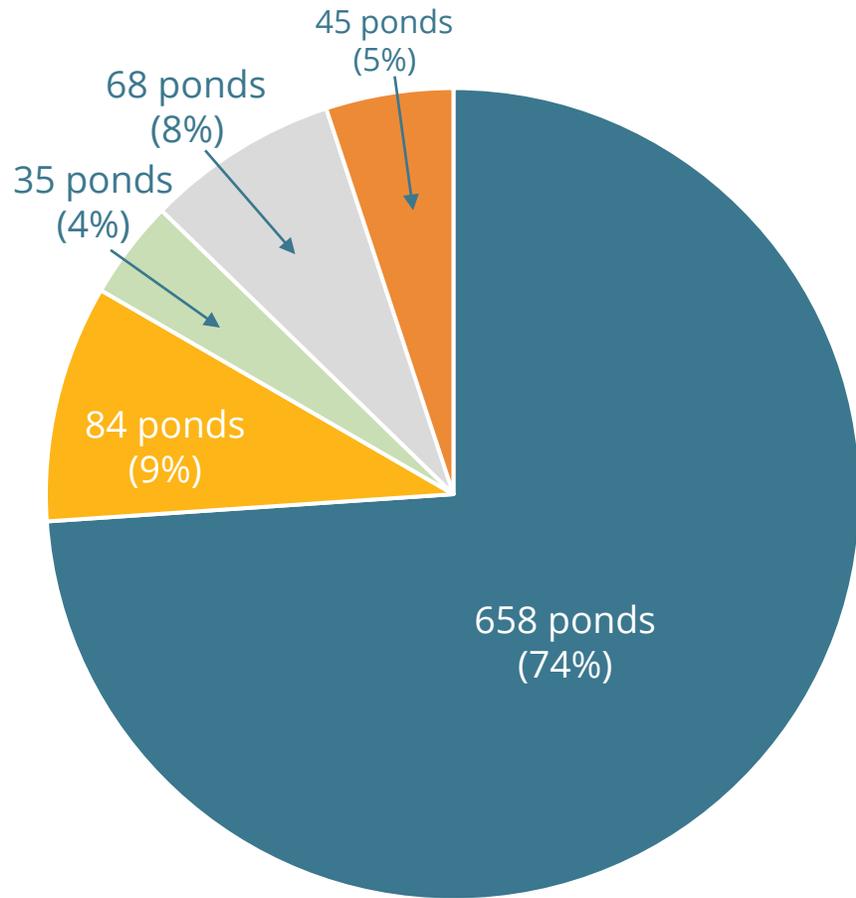
**= 200+ ponds**

**= 100+ spreadsheets**

# PONDS MONITORED

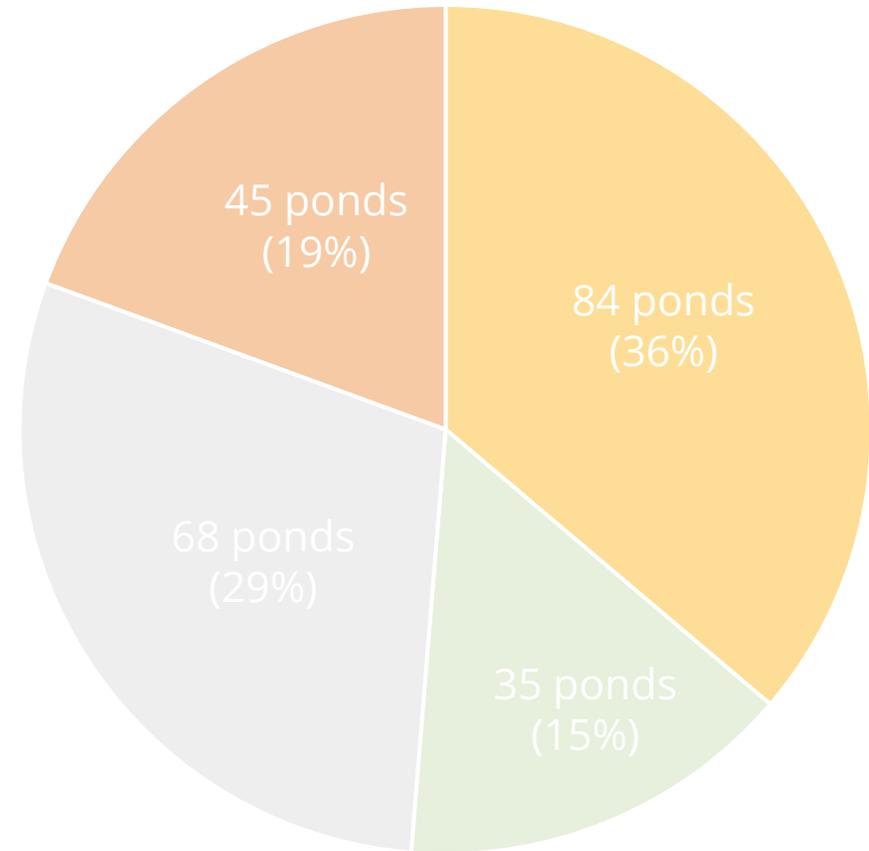


# | PONDS MONITORED



■ 0 ■ 1-5 ■ 5-10 ■ 10-15 ■ >15

Years Monitored - All Ponds

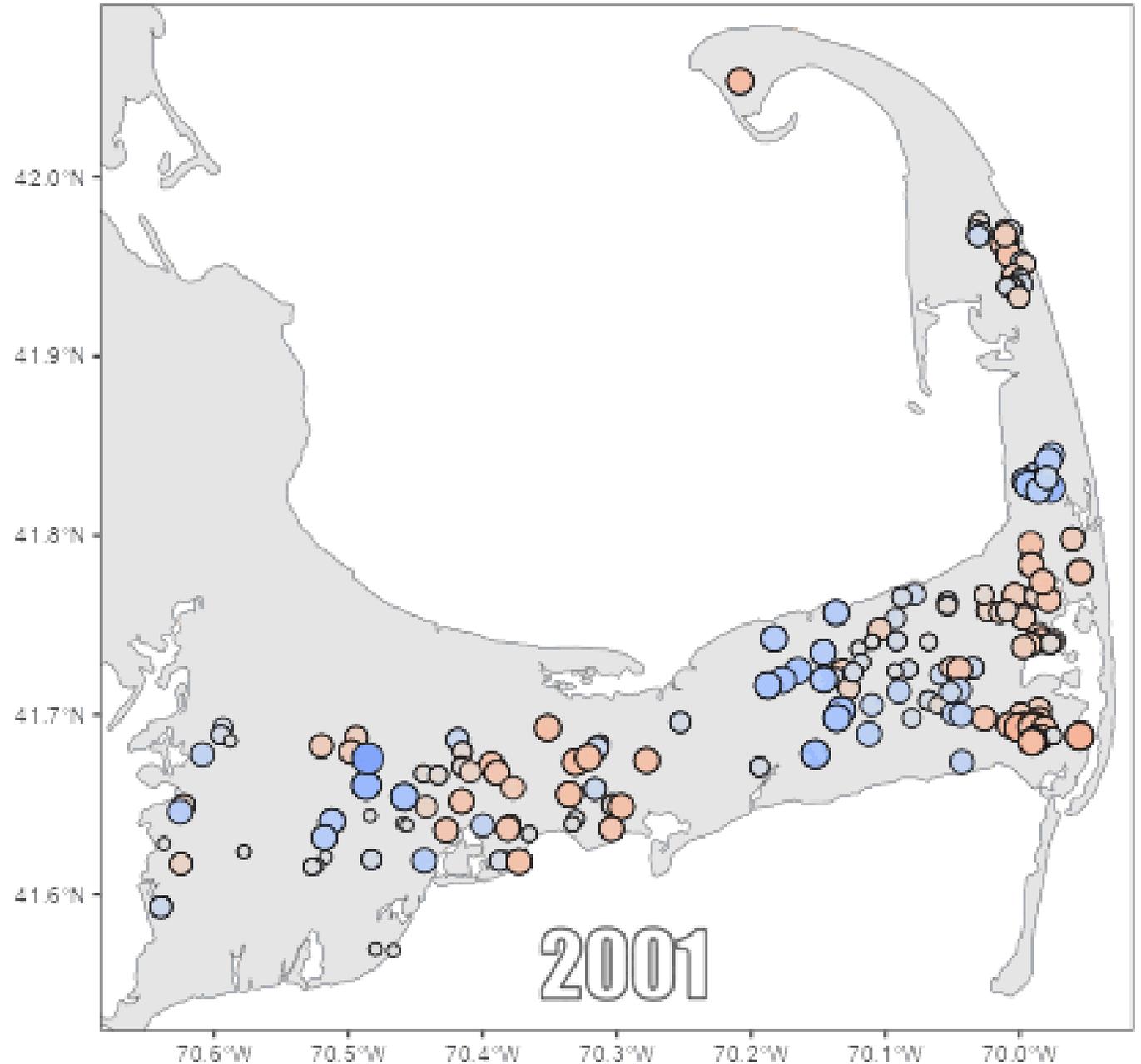


■ 0 ■ 1-5 ■ 5-10 ■ 10-15 ■ >15

Years Monitored - Ponds with Data

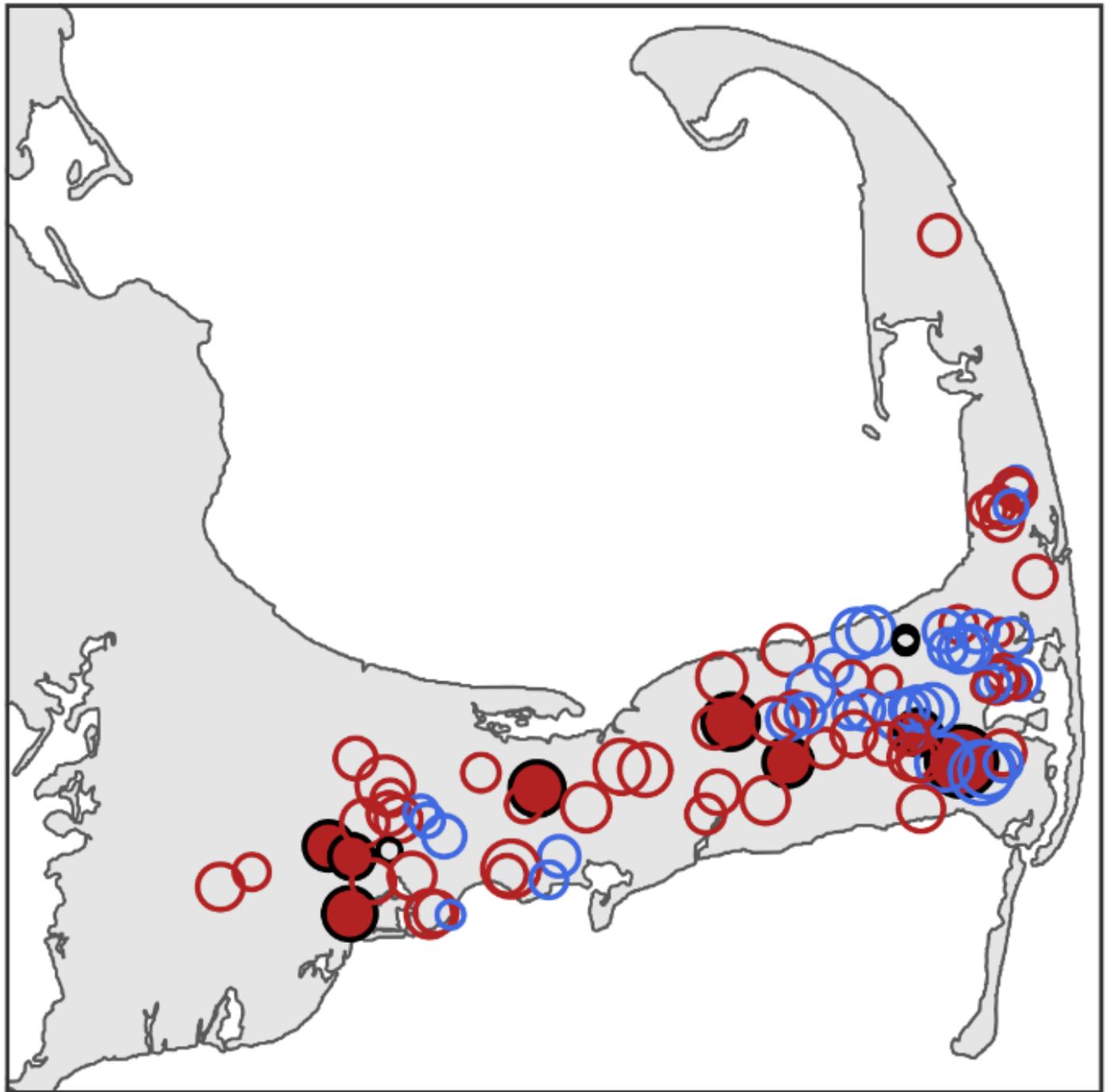
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# Ponds Monitored



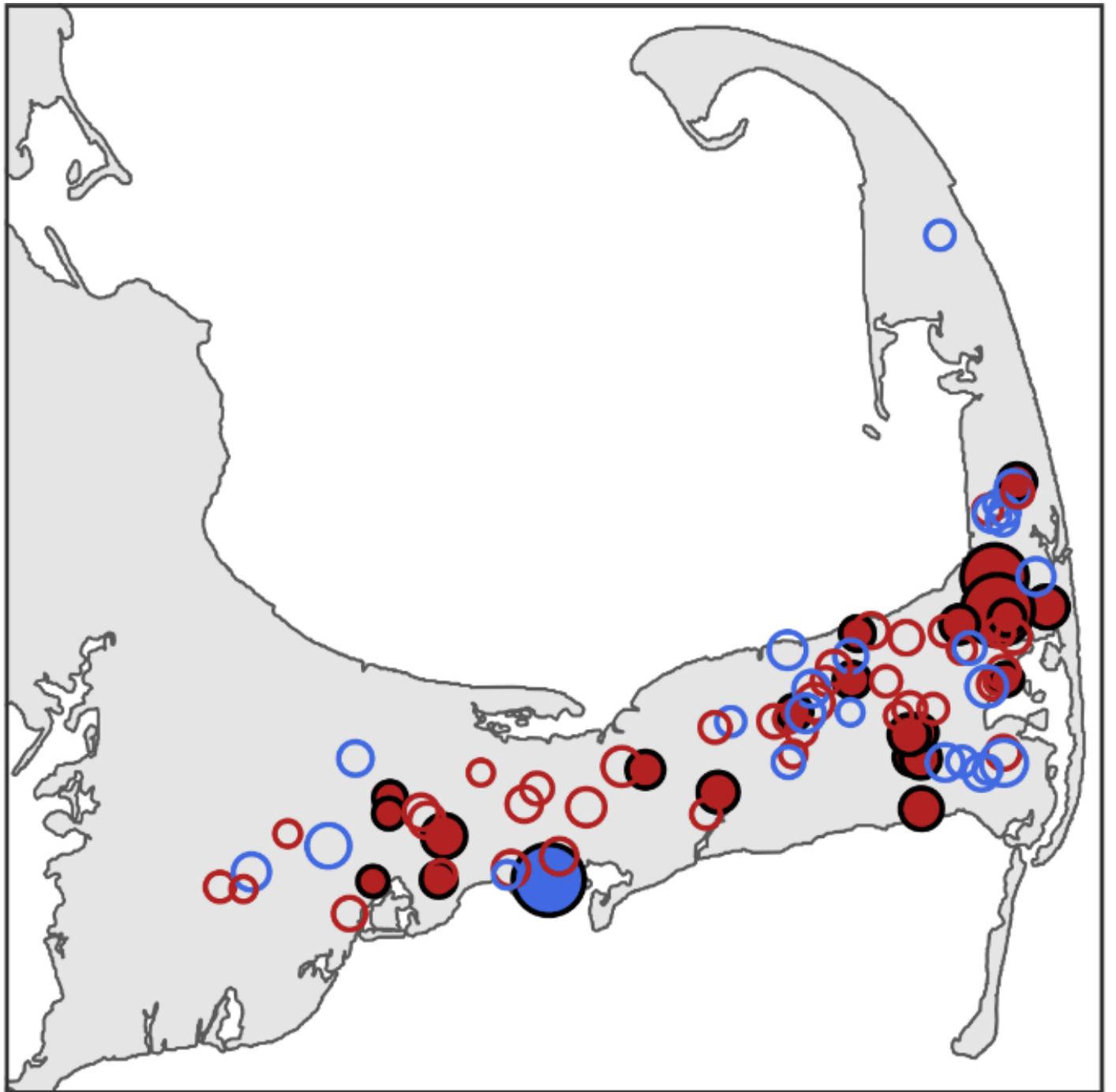
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# Regional Trends in Surface Temperature



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# Regional Trends in Phosphorus



## Pond Water Quality Monitoring Program

Develop and implement a plan for coordinated and consistent regional pond monitoring

### Data Collection

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Collect and manage data from representative ponds under EPA-approved Quality Assurance Project Plan

### Centralized Database

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Report data directly to Water Quality Database

### Integrated Planning

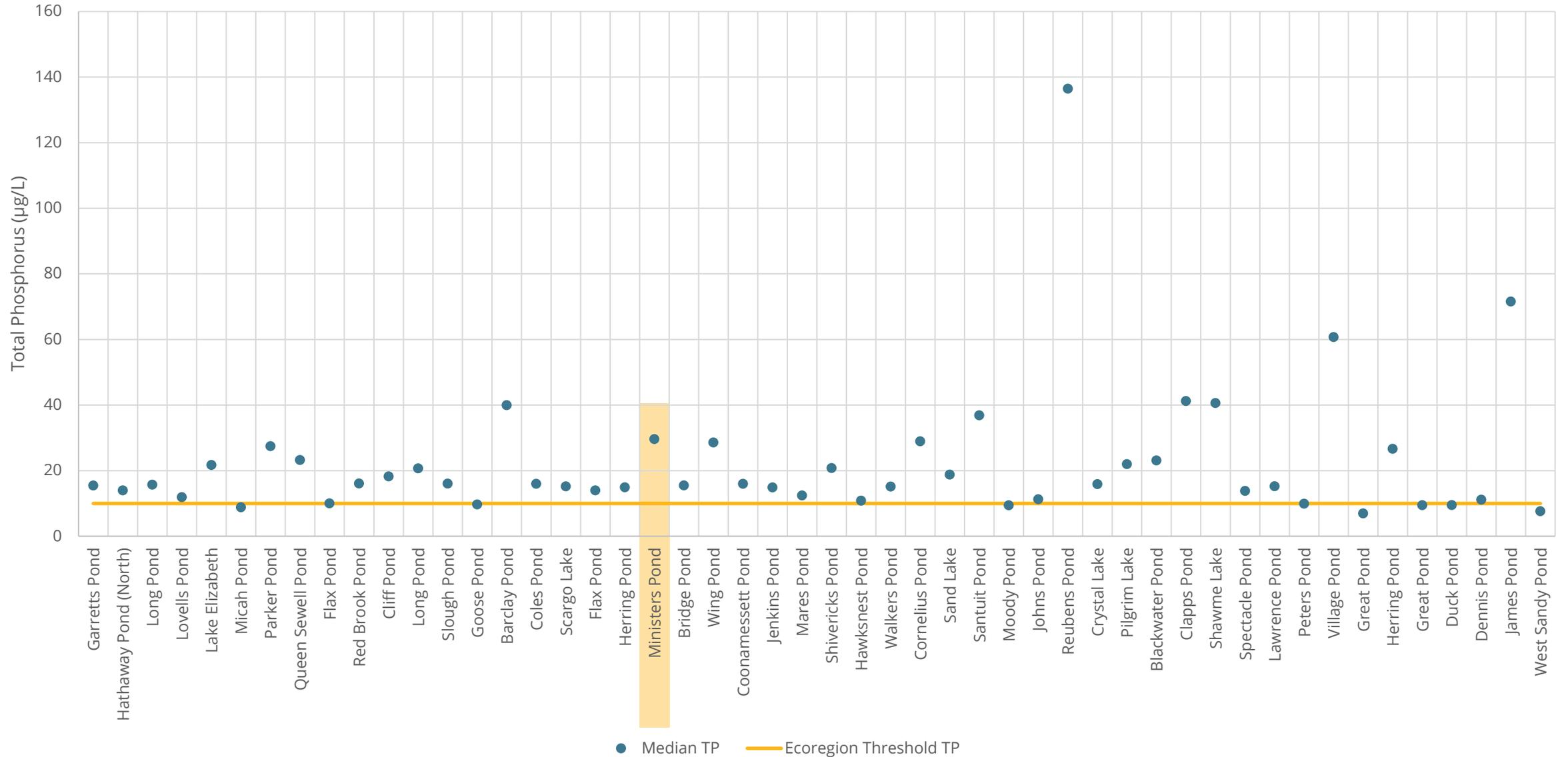
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Coordinate with other Freshwater Initiative elements (regional trend analysis, GIS screening)

# | POND MONITORING PROGRAM RESULTS

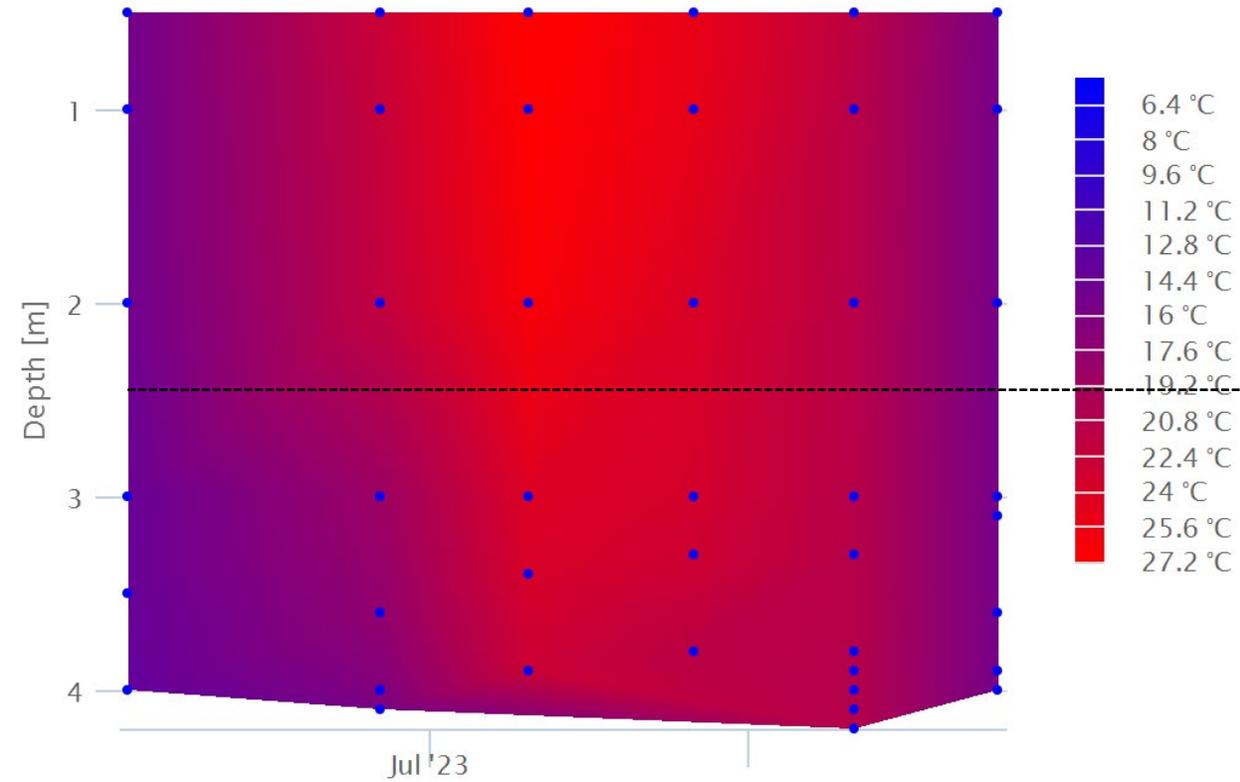


# POND MONITORING PROGRAM RESULTS

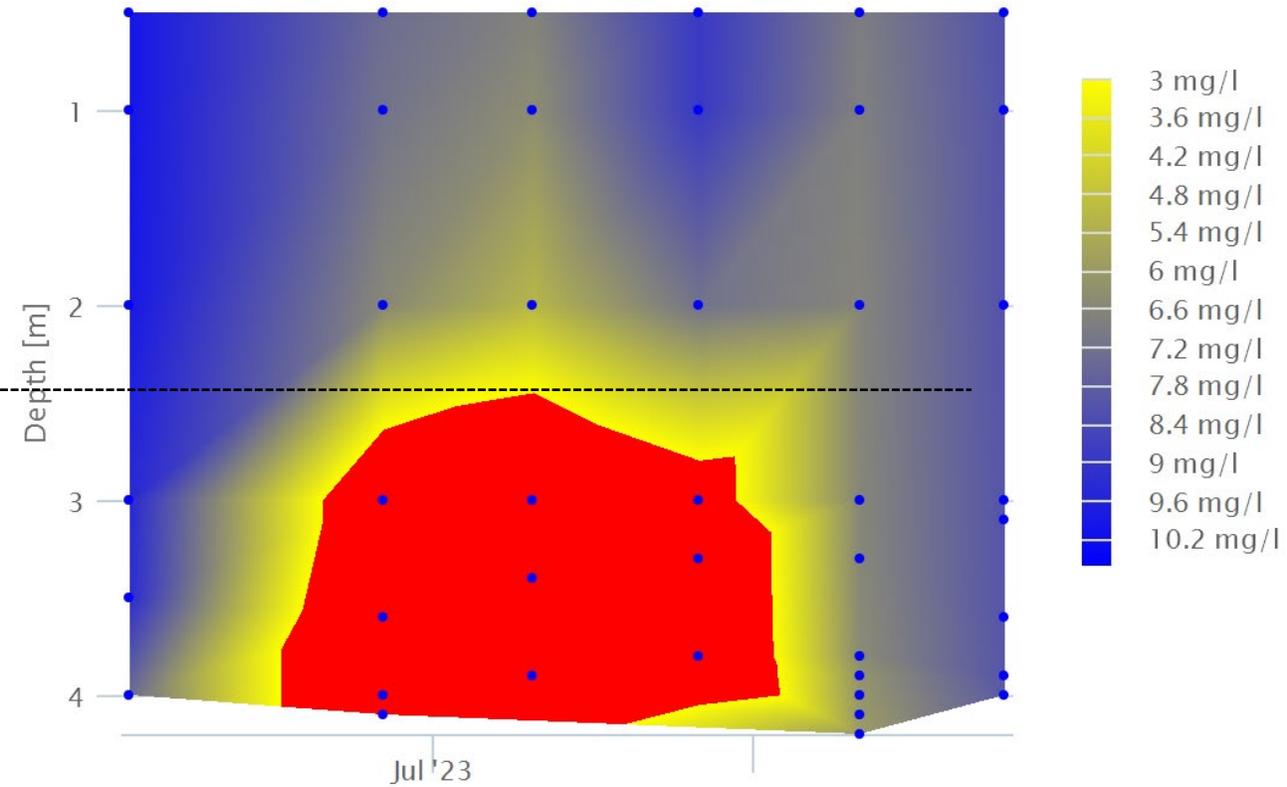


## Ministers Pond - Eastham

### Water Temperature

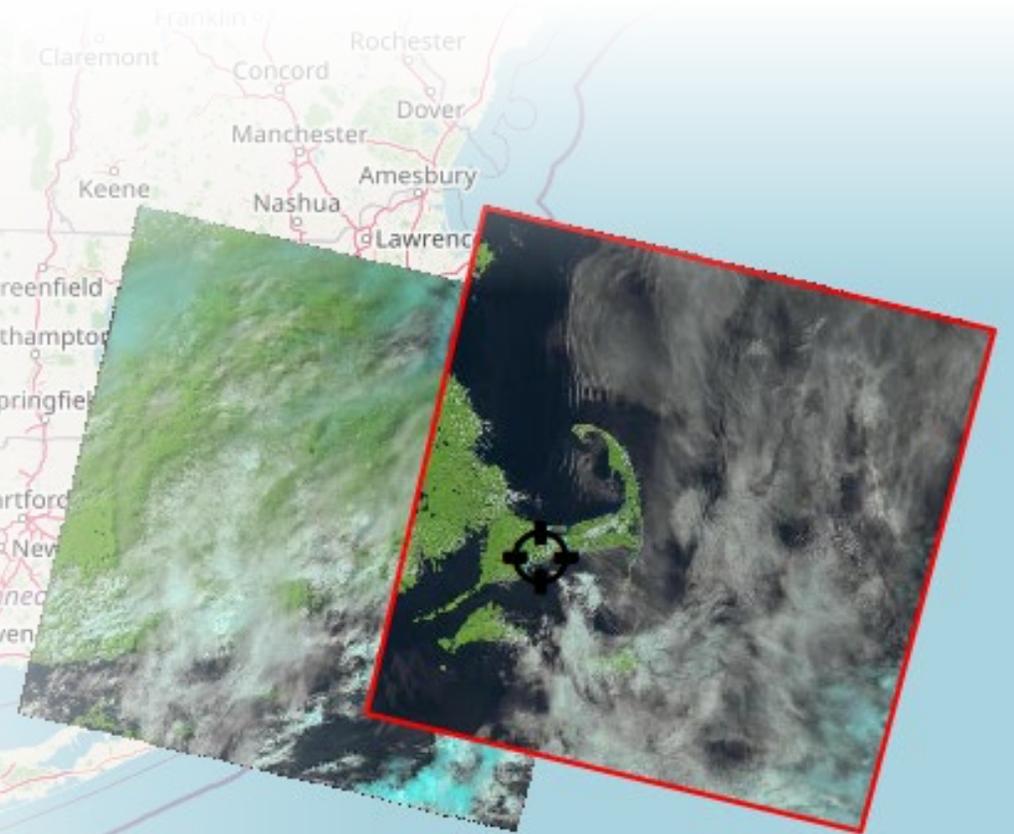


### Dissolved Oxygen



*How can satellite-derived imagery and existing pond water quality data help quantify changes in pond characteristics?*

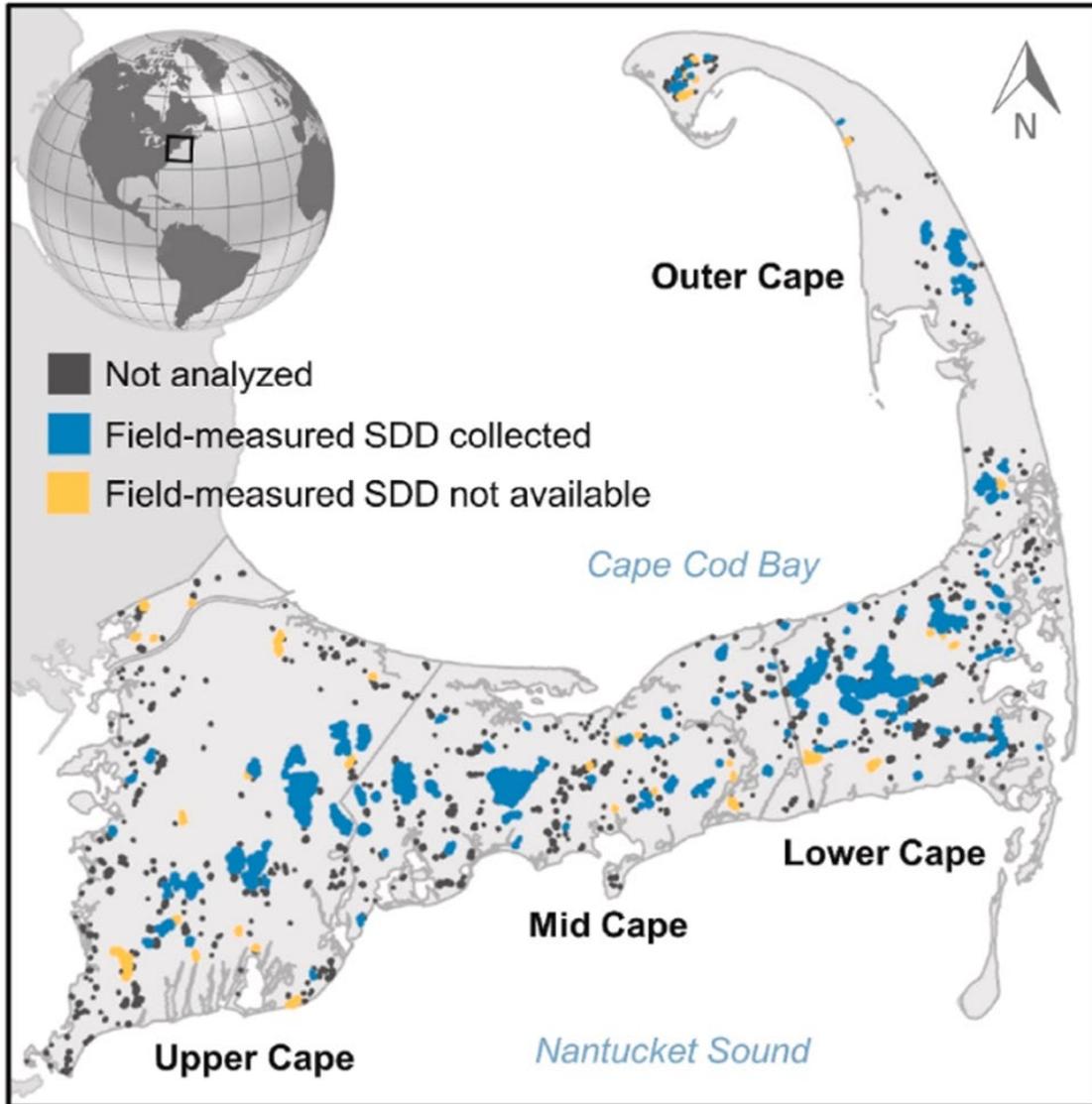
- Two projects using satellite imagery to estimate water quality characteristics in ponds and lakes
- Field data used to calibrate satellite predictive model
  - gathering information about additional ponds



THE UNIVERSITY OF RHODE ISLAND



# REMOTE SENSING

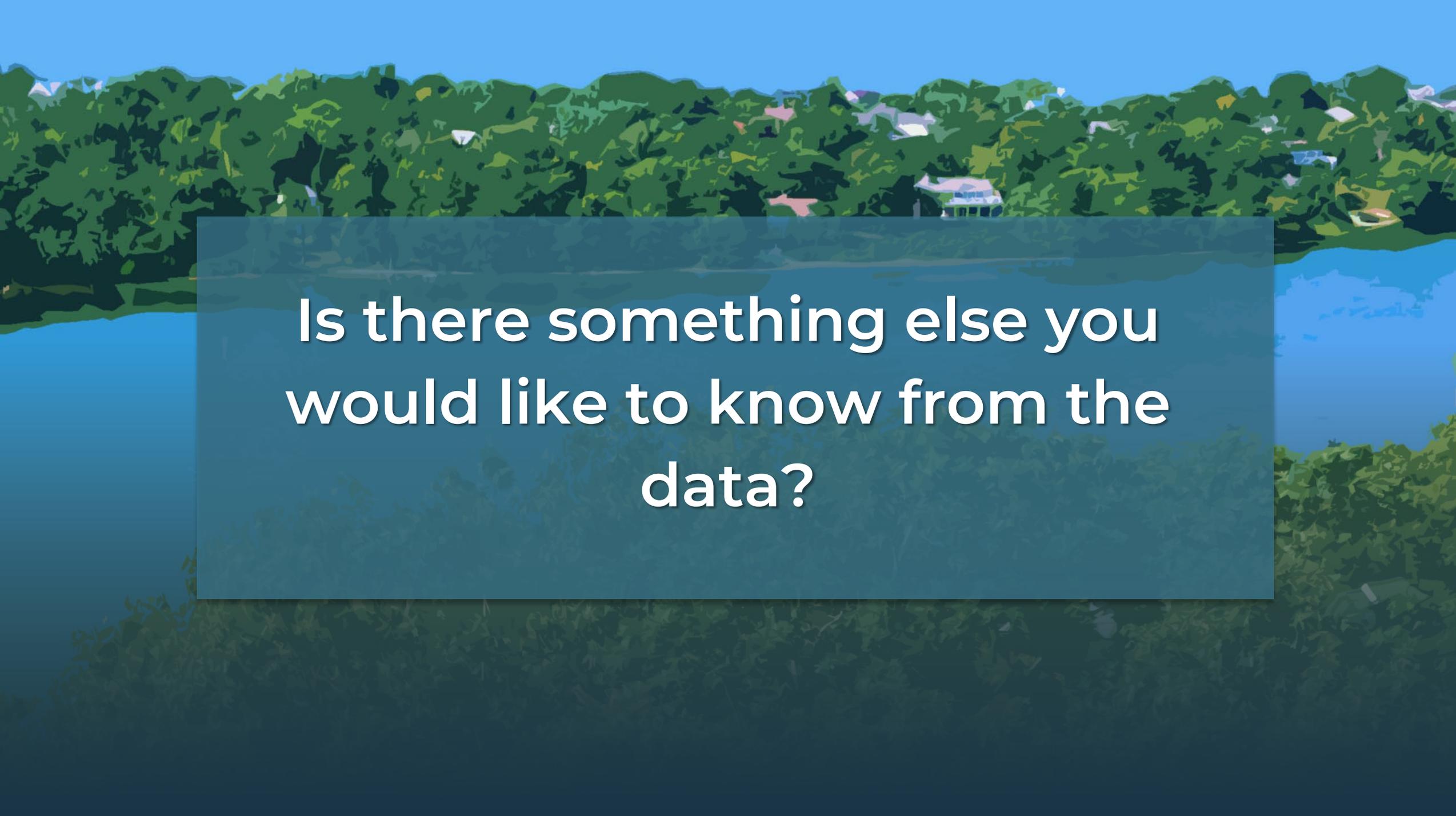


- ~40% of Cape Cod's ponds were large enough for analysis by satellite (> 1 hectare)
- Analyzed 193 ponds for long-term (1984-2022) water clarity trends
- Observed substantial interannual variability in water clarity, long-term water clarity generally improved across the Cape.
- Water Clarity  $\neq$  Quality

# REMOTE SENSING – NEXT STEPS

- Utilizes pond/lake field data from Cape Cod, MA, RI
- Will generate monthly estimates of:
  - Water clarity
  - Chlorophyll a
  - Colored dissolved organic matter
- Time Period: 2017-2026





**Is there something else you  
would like to know from the  
data?**



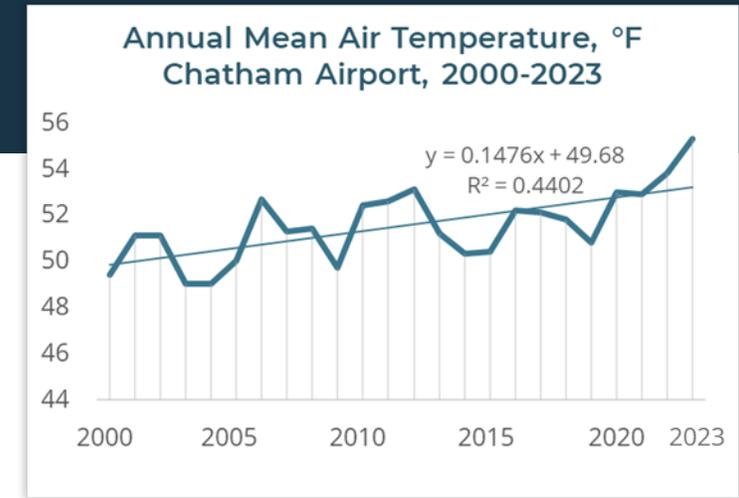
# Regional Drivers of Change

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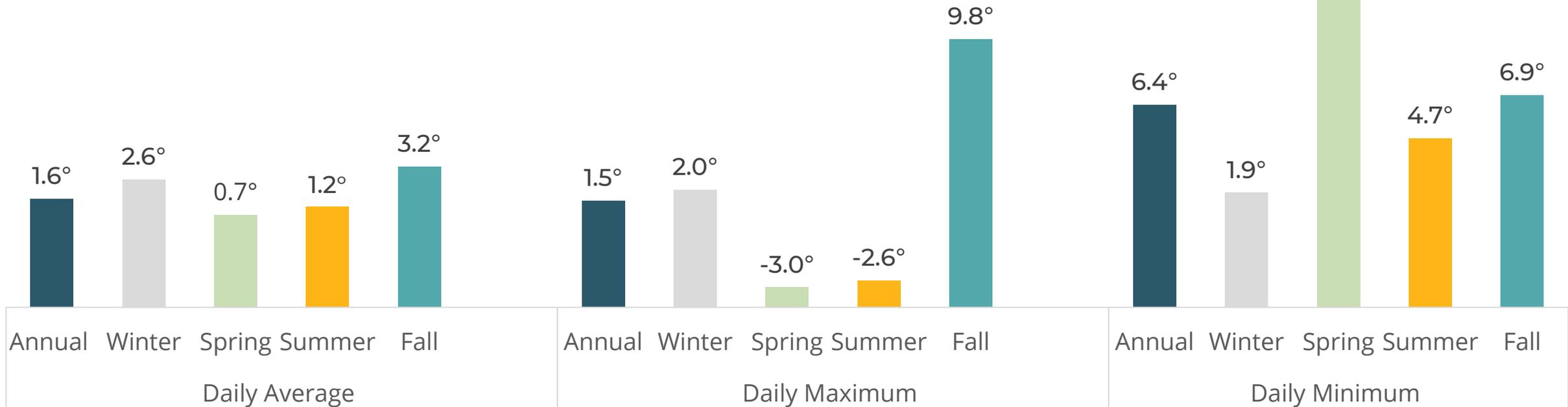
Liz Moran

# CLIMATE IMPACTS: PHYSICAL

- Stratification and Mixing Regime
- Warming waters- Seasonal Impacts

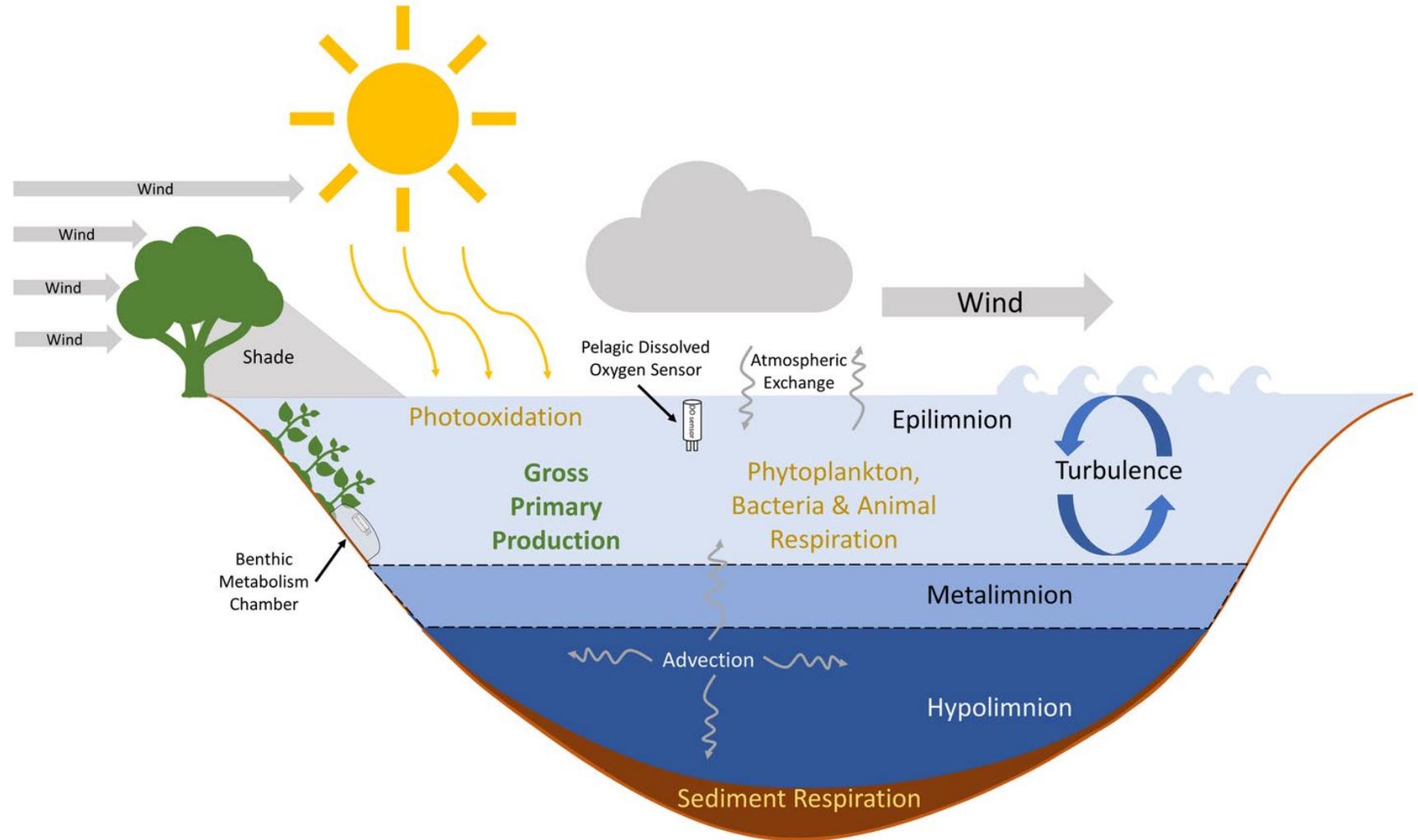


## Air Temperature Change, Chatham Airport 1970 - 2000 compared with 2001 - 2023



Longer duration of stratification-  
increased risk of oxygen depletion

Chemical changes at sediment surface-  
phosphorus mobilization



- Warmer waters affect biochemical reaction rates
- Habitat impacts on aquatic biota – temperature and oxygen
- Expanding range for invasive species
- Cyanobacterial advantages: buoyancy, nitrogen-fixation, less grazing pressure



# | CULTURAL DRIVERS OF CHANGE

- Population
- Wastewater
- Impervious Surfaces
- Emerging Contaminants

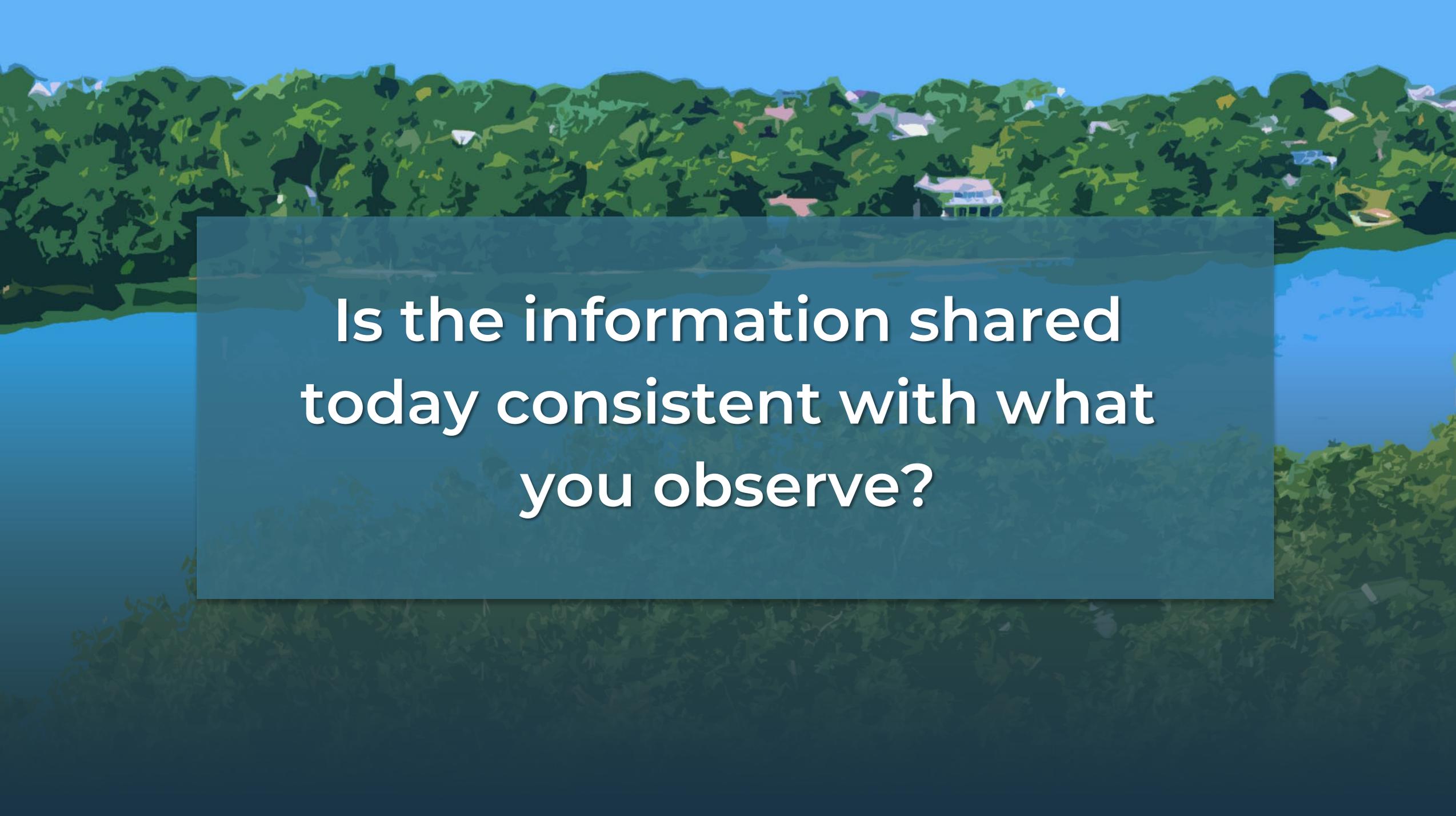
96,656  
1970

222,230  
2000

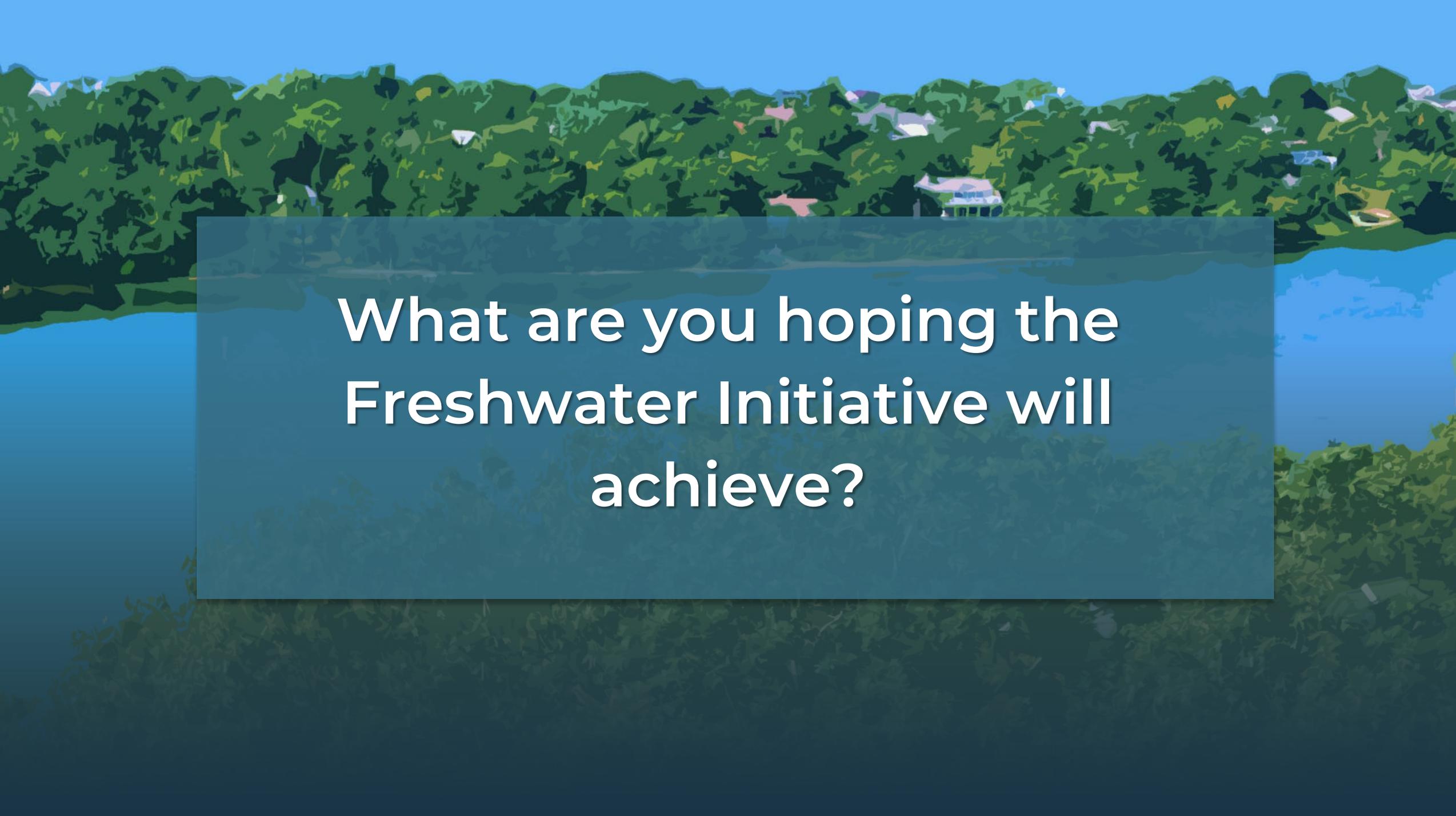
228,996  
2020

COUNTY BARNSTABLE  
POPULATION  
(1970-2020)





**Is the information shared  
today consistent with what  
you observe?**



**What are you hoping the  
Freshwater Initiative will  
achieve?**

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# UPCOMING STAKEHOLDER MEETINGS

APRIL 22 AND 23

## Meeting 2

### Exploring Strategies and Priorities

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- Strategies Overview
- Identifying Priorities
- Comment and Discussion

JUNE 3 AND 4

## Meeting 3

### Reviewing the Implementation Plan

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- Incorporating Stakeholder Feedback
- Recommendations
- Implementation
- Discussion



**Other questions or feedback?**

**[www.capecodcommission.org/freshwater](http://www.capecodcommission.org/freshwater)**

# Thank you!

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STAKEHOLDER MEETING 1 | MARCH 2024



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