WATCHIC LAKE

Observations of Physical Parameters from Continuous Monitoring

Maggie Burns & Amanda Gavin

FB Environmental Associates

FB environmental

Watchic Lake Association

AGENDA

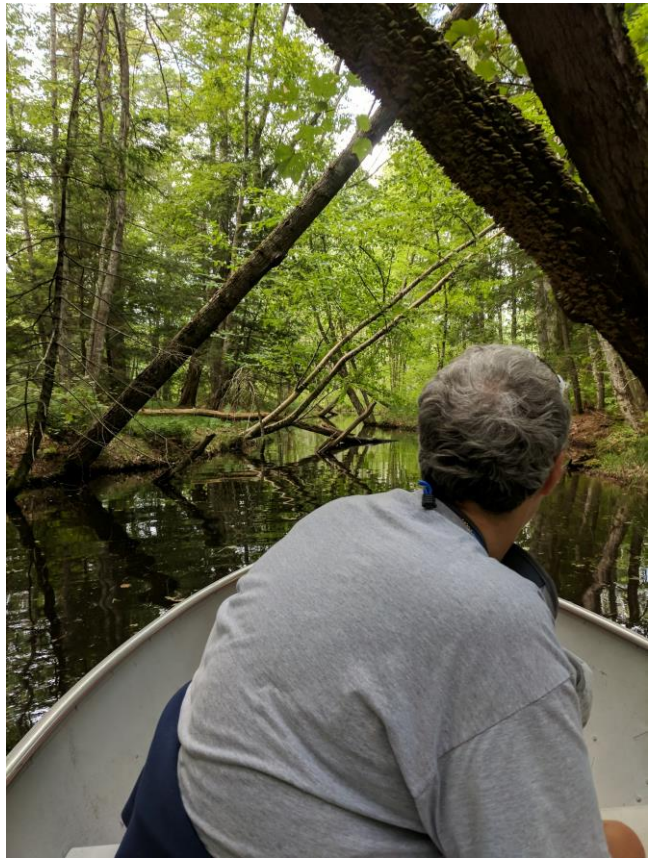
1. Site Introduction

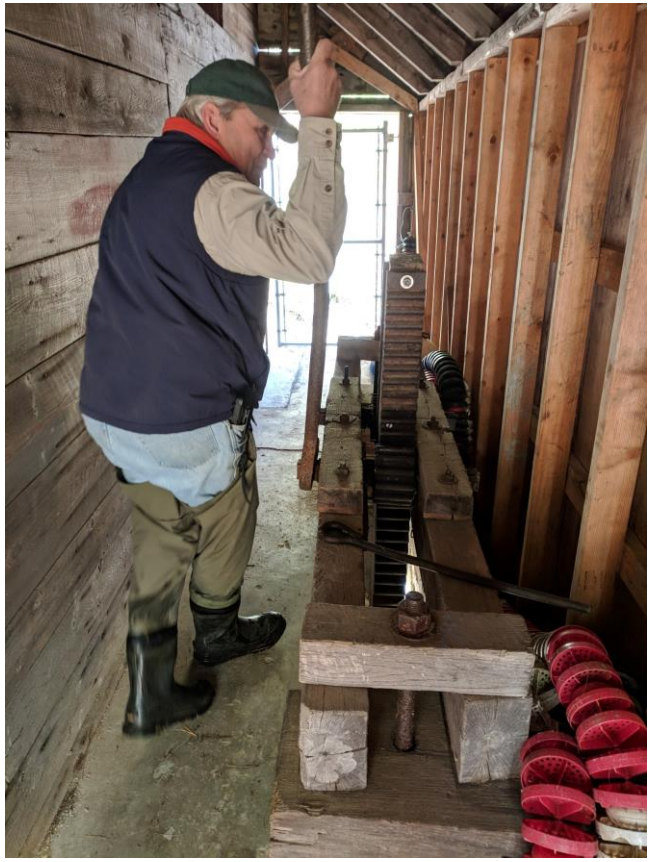
2. Water Quality Monitoring Methods

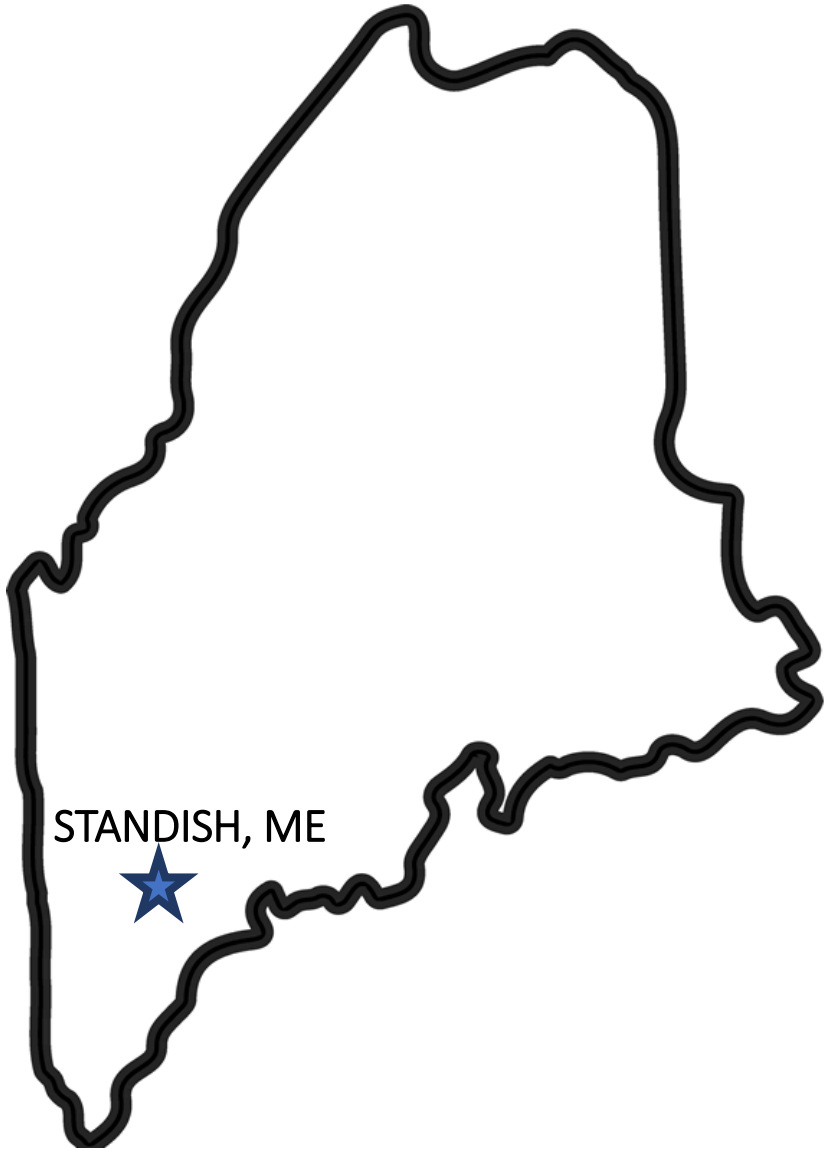
3. Monitoring Lake Response to Climate Change:
    - Stratification Dynamics
    - Extreme Weather Events
    - Winter Limnology

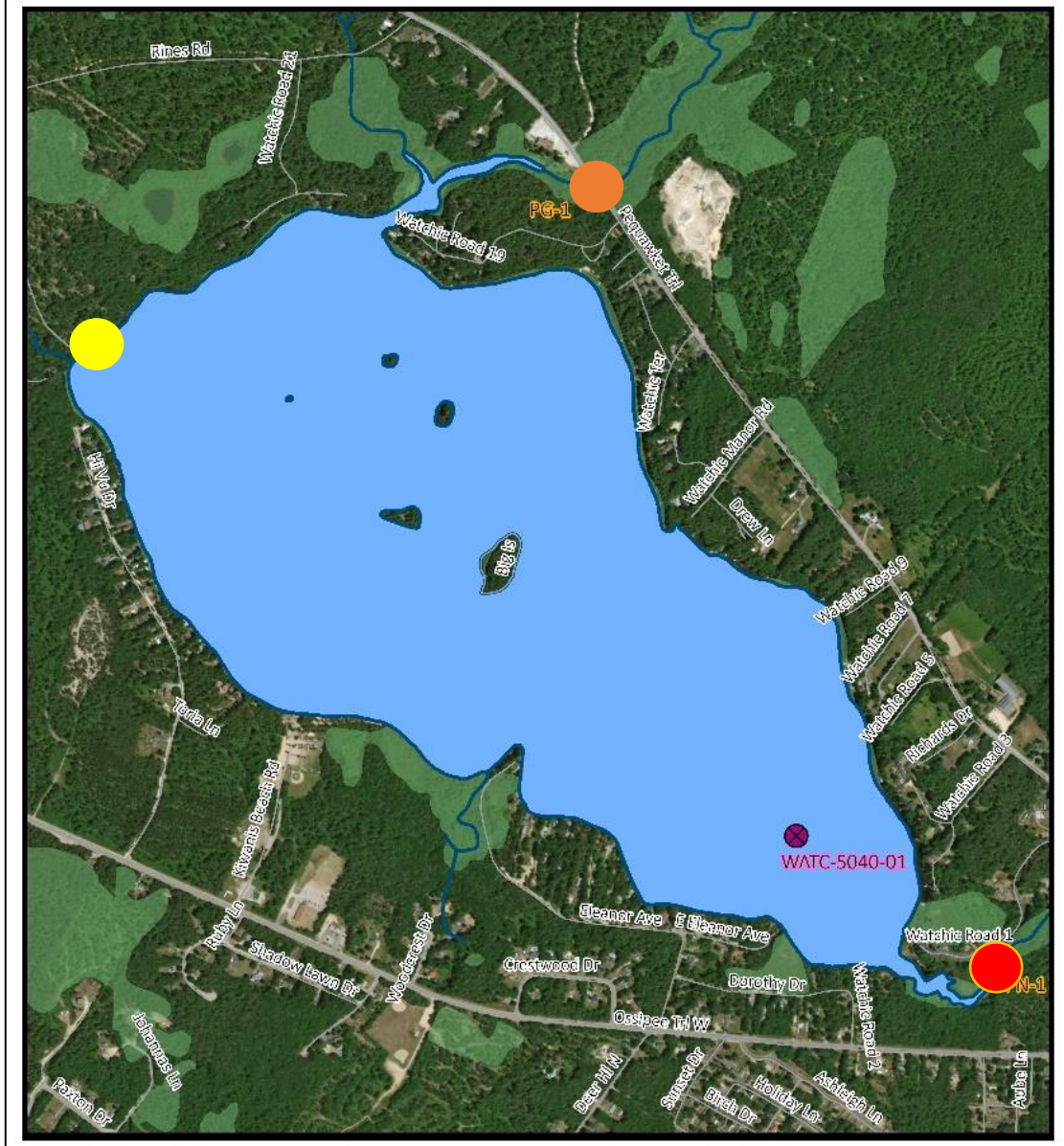
VOLUNTEER FIELD SUPPORT

Watchic Lake Association









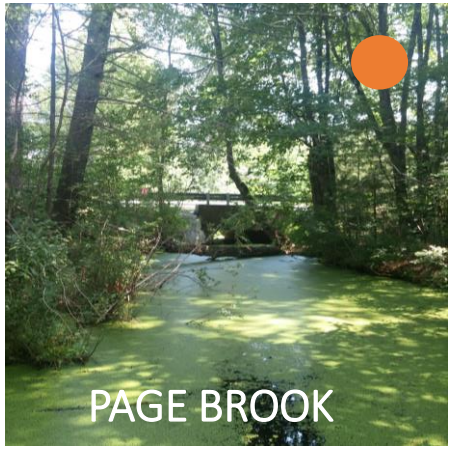
WATCHIC LAKE

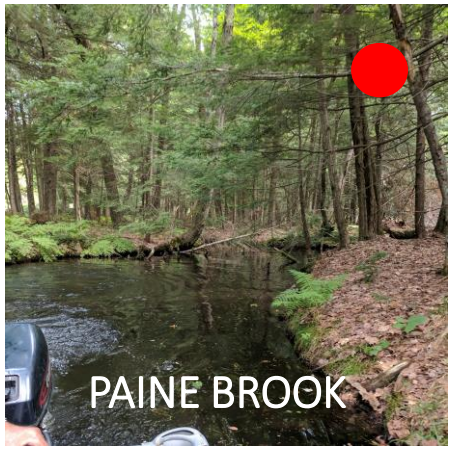
Road
Watchic Lake Deep Spot
Tributary Site
Flowline
Wetland
Watchic Lake

Data obtained from: The Maine Office of GIS, ESRI Digital Globe, FB Environmental
Created By: FB Environmental, Jan 2018

0 0.125 0.25 0.5 Miles

FB environmental





METHODS

1. DEEP SPOT CORE SAMPLING

2. TRIBUTARY MONITORING

3. CONTINUOUS LOGGER MONITORING

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CORE SAMPLING

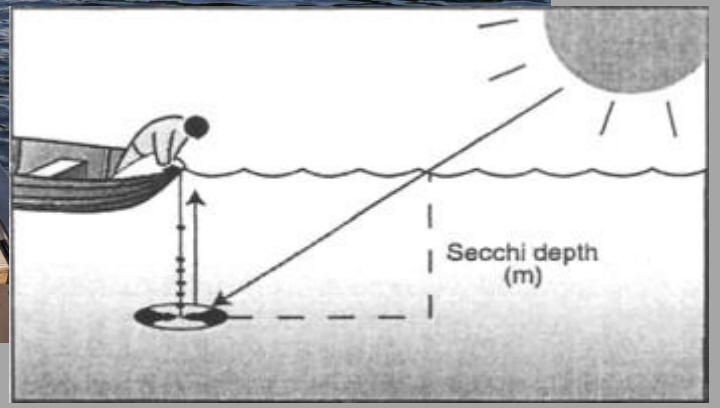


Image credit: Science Direct

- Alkalinity
- Chlorophyll-a
- Color
- Dissolved Organic Carbon
- Nitrogen
- Phosphorus
- pH
- Secchi Disk Transparency

Overall Water Quality is Good

METHODS

1. DEEP SPOT CORE SAMPLING

2. TRIBUTARY MONITORING

3. CONTINUOUS LOGGER MONITORING

TRIBUTARY MONITORING

PAGE BROOK

PAINE BROOK

Elevated nutrients

Low oxygen

Low pH (acidic)

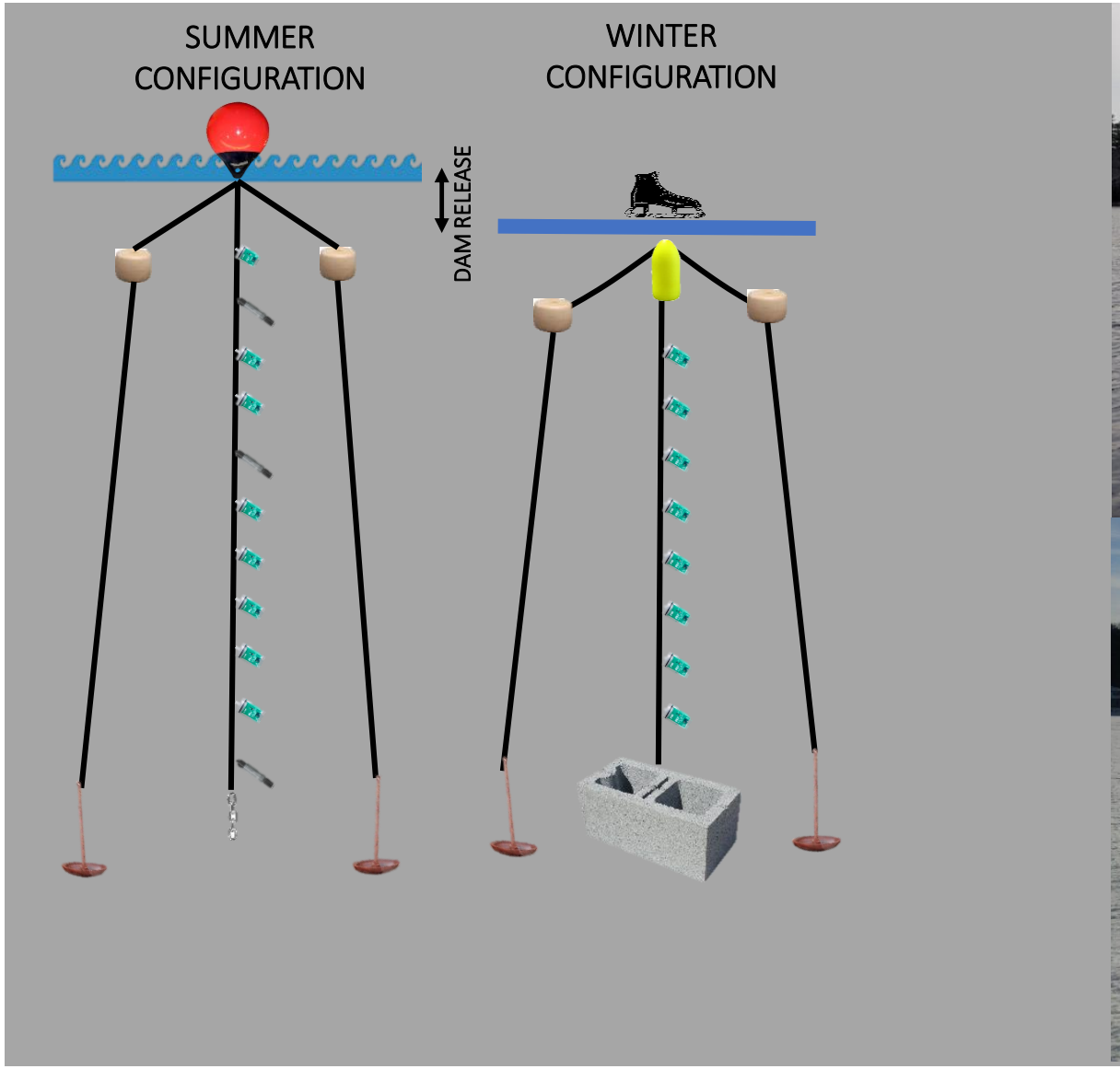
METHODS

1. DEEP SPOT CORE SAMPLING

2. TRIBUTARY MONITORING

3. CONTINUOUS LOGGER MONITORING

CONTINUOUS MONITORING



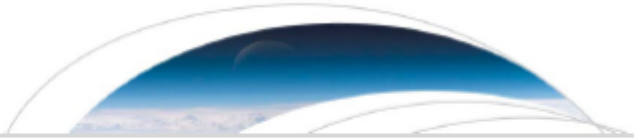
CONTINUOUS MONITORING
used to monitor lake response to climate change

AGU PUBLICATIONS

Geophysical Research Letters

RESEARCH LETTER
10.1002/2015GL066235

O'Reilly et al., 2015



Rapid and highly variable warming of lake surface waters around the globe

Abstract In this first worldwide synthesis of in situ and satellite-derived lake data, we find that lake summer surface water temperatures rose rapidly (global mean = 0.34°C decade^{-1}) between 1985 and 2009. Our analyses show that surface water warming rates are dependent on combinations of climate and local characteristics, rather than just lake location, leading to the counterintuitive result that regional consistency in lake warming is the exception, rather than the rule. The most rapidly warming lakes are widely geographically distributed, and their warming is associated with interactions among different climatic factors —from seasonally ice-covered lakes in areas where temperature and solar radiation are increasing while cloud cover is diminishing (0.72°C decade^{-1}) to ice-free lakes experiencing increases in air temperature and solar radiation (0.53°C decade^{-1}). The pervasive and rapid warming observed here signals the urgent need to incorporate climate impacts into vulnerability assessments and adaptation efforts for lakes.

CONTINUOUS MONITORING
used to monitor lake response to climate change

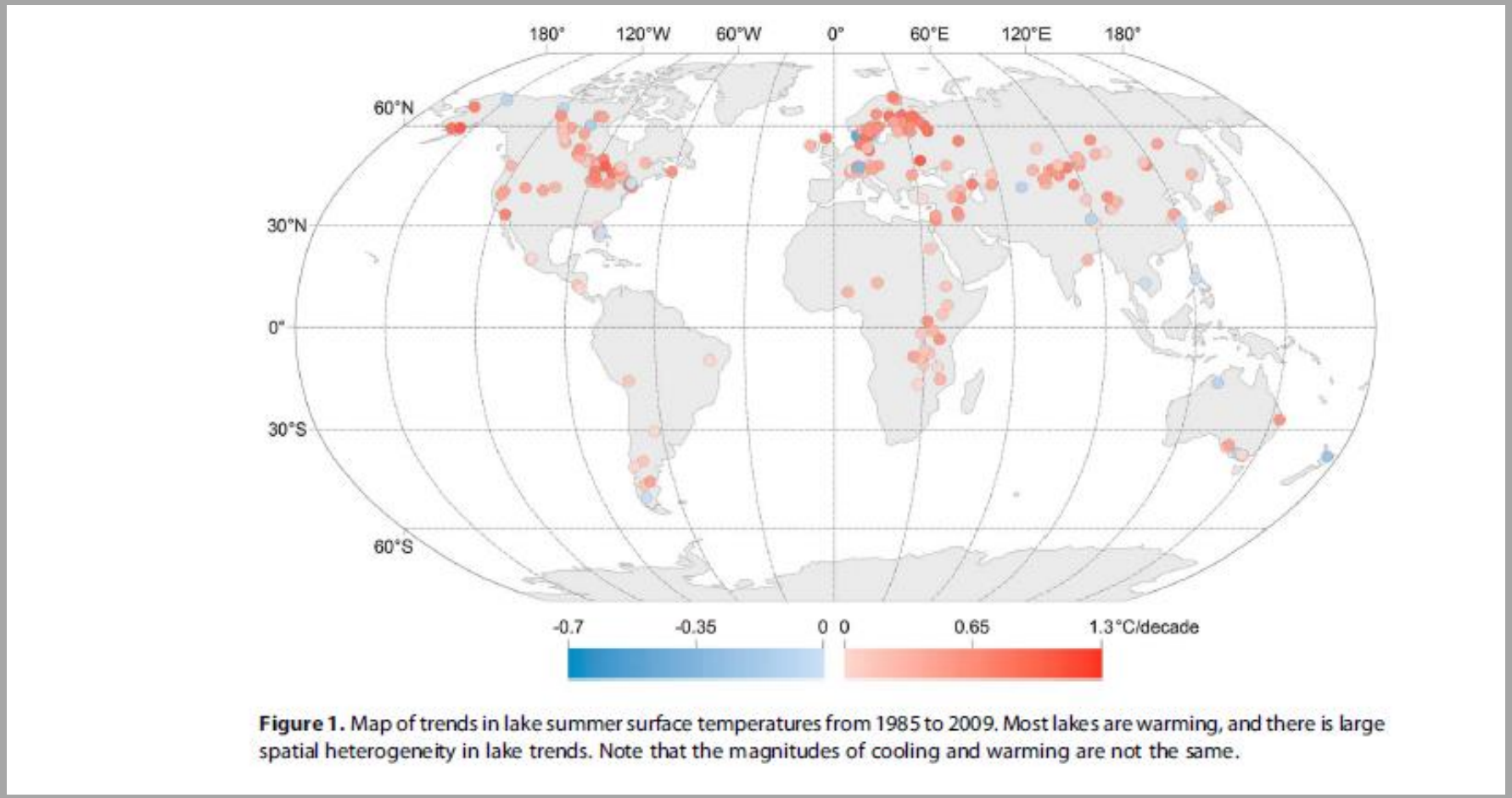


Figure 1. Map of trends in lake summer surface temperatures from 1985 to 2009. Most lakes are warming, and there is large spatial heterogeneity in lake trends. Note that the magnitudes of cooling and warming are not the same.

O'Reilly et al., 2015

STRATIFICATION DYNAMICS

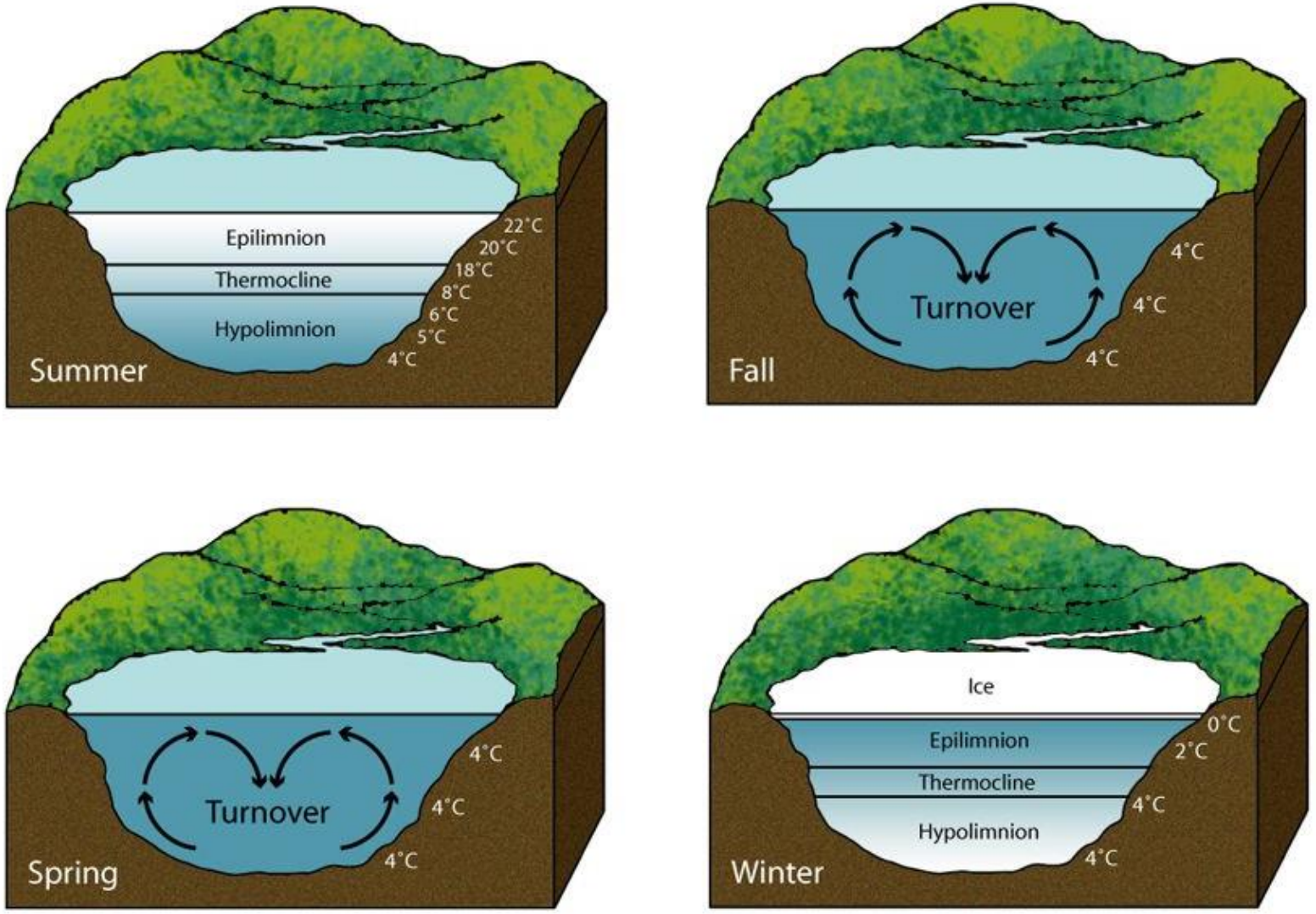
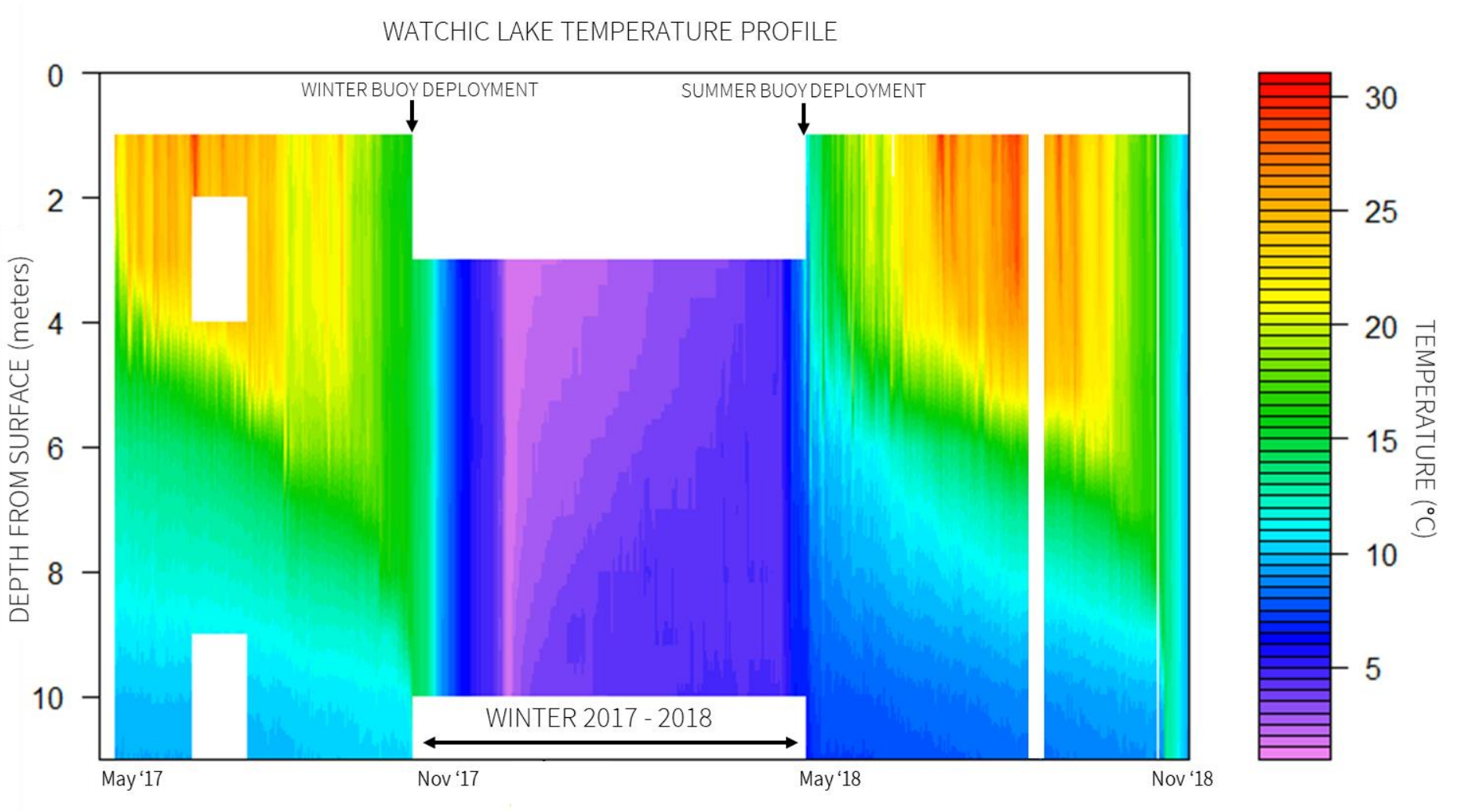
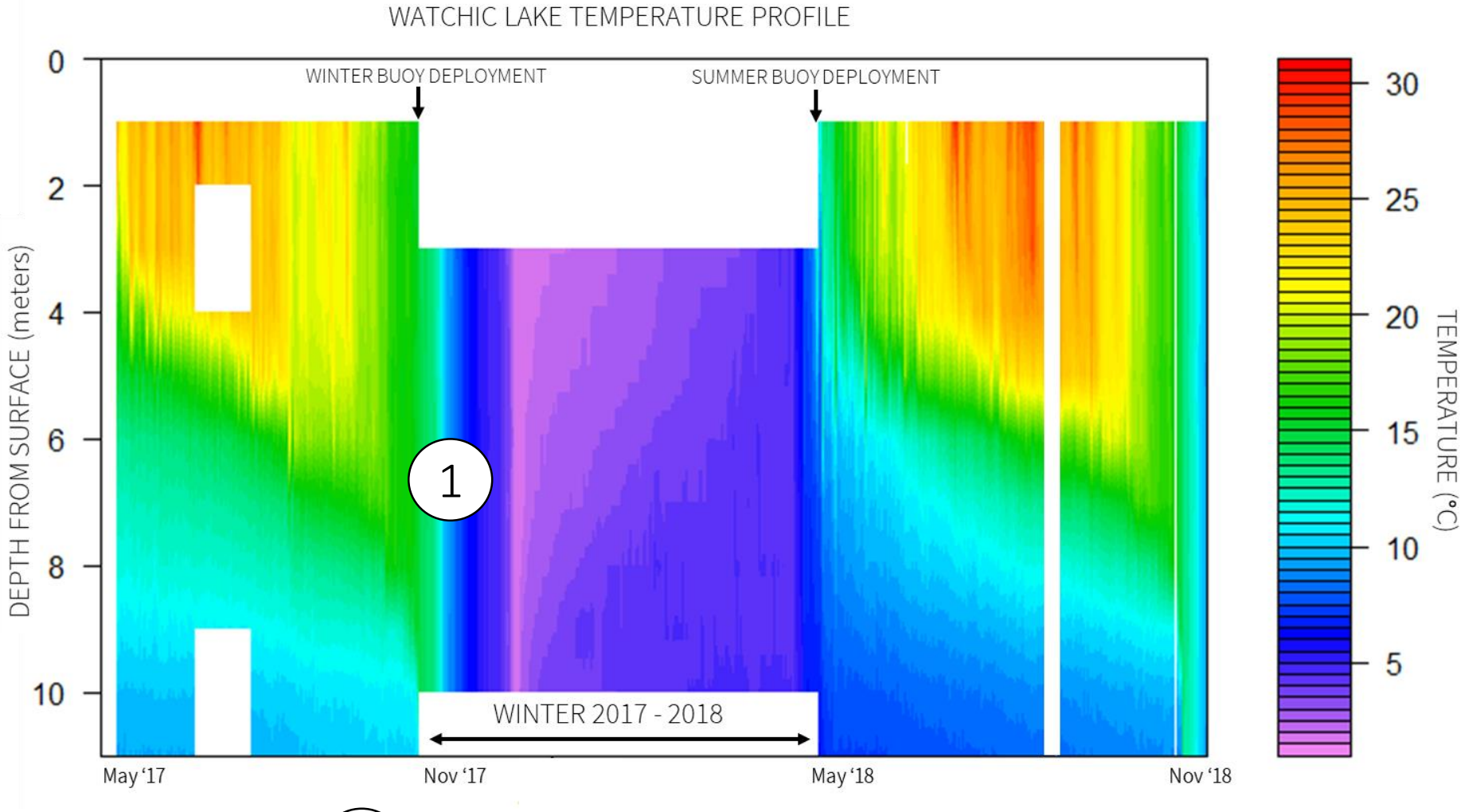


Image credit: National Geographic Society

STRATIFICATION DYNAMICS

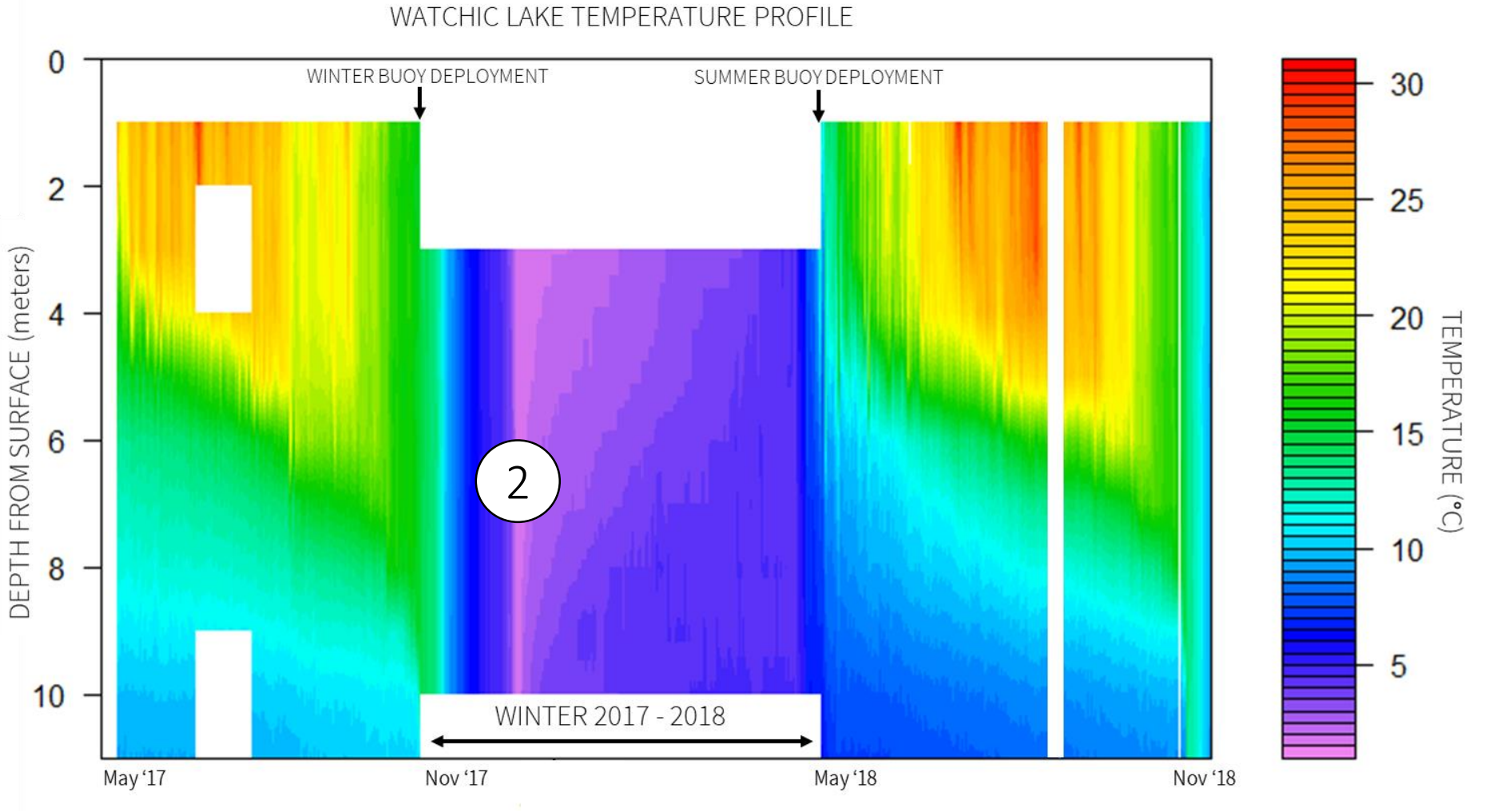


STRATIFICATION DYNAMICS



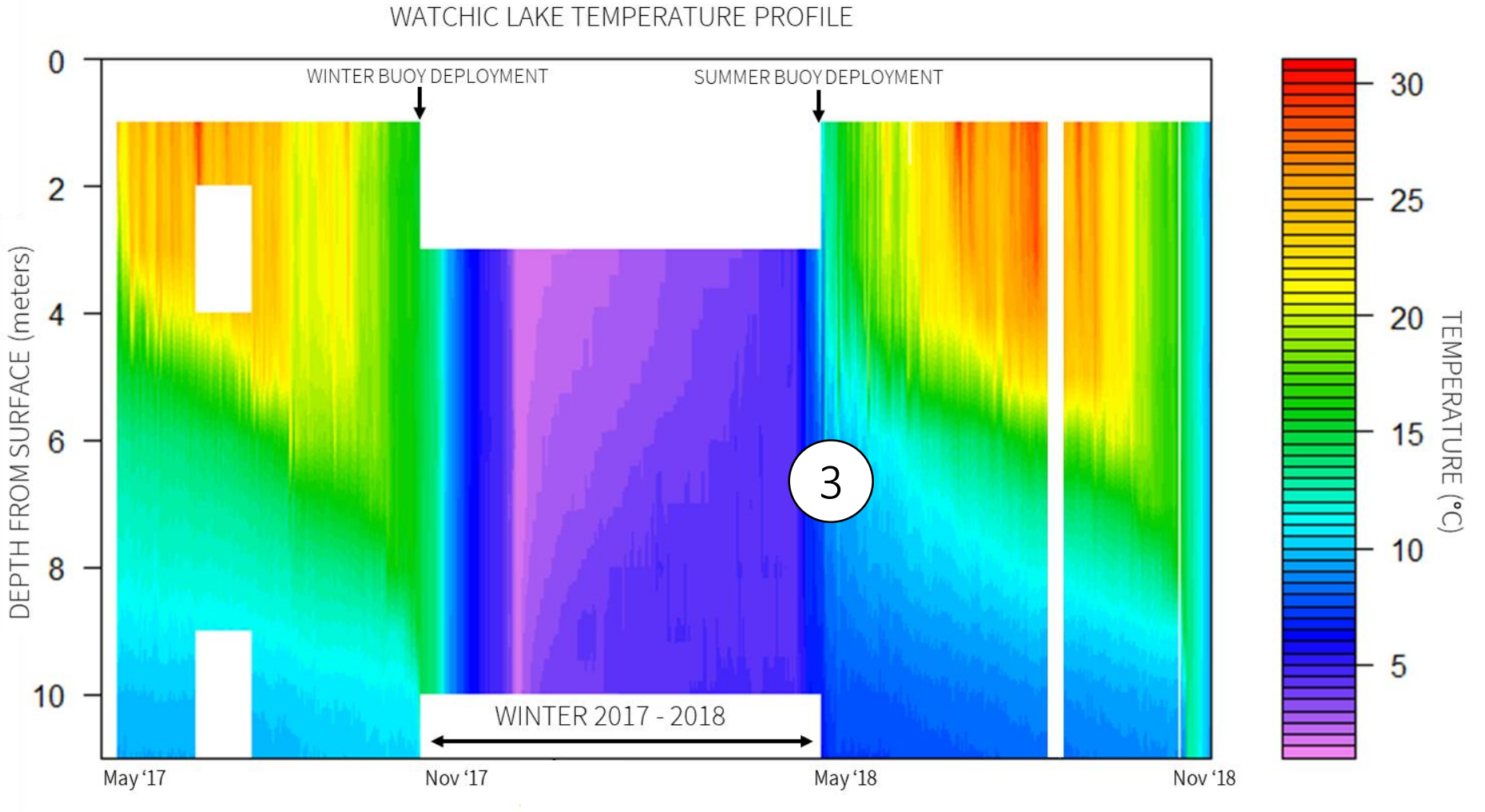
1 FALL TURNOVER ON 10/31/2017

STRATIFICATION DYNAMICS



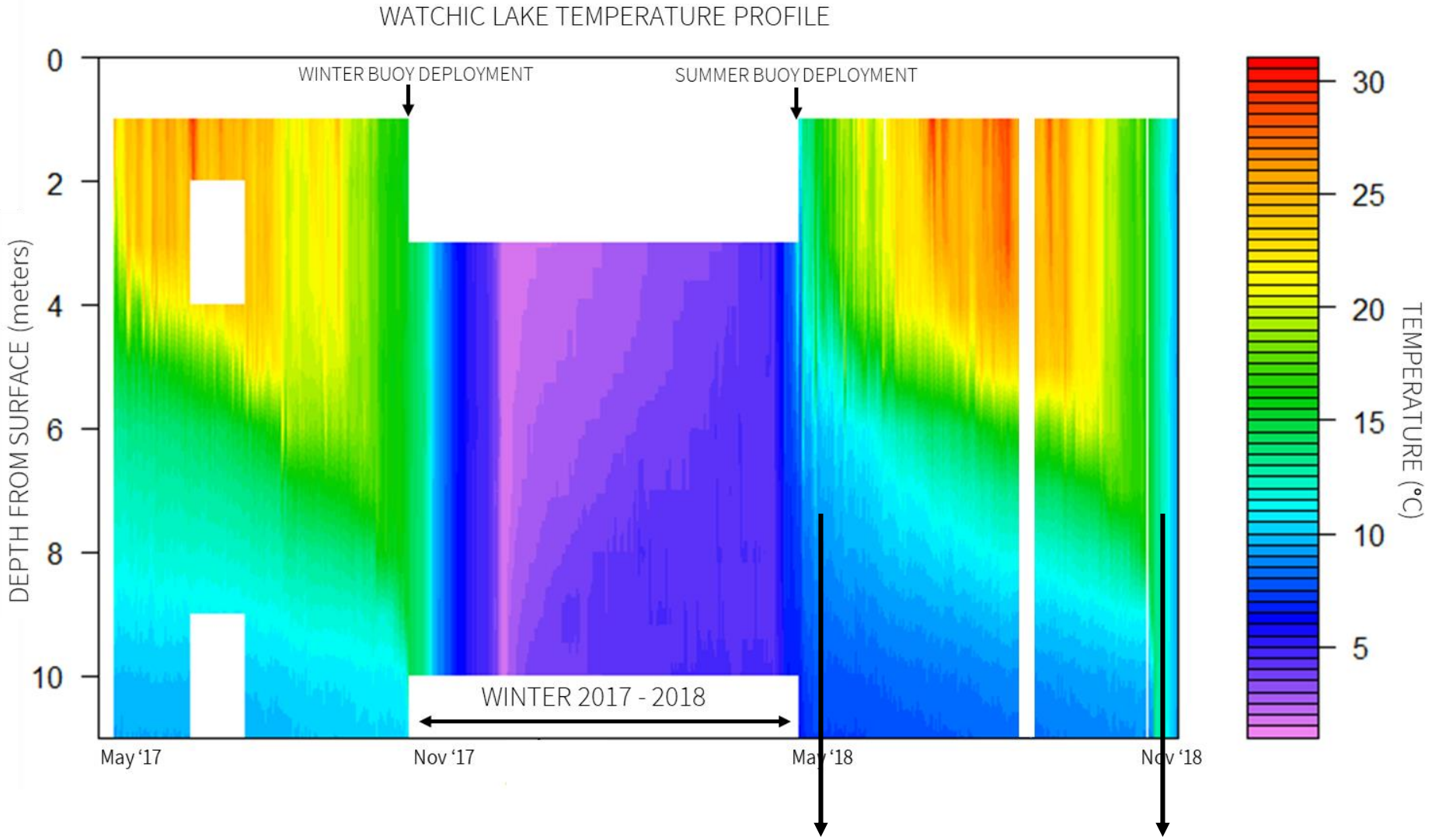
2 INVERSE STRATIFICATION BEGINS UNDER THE ICE IN WINTER

STRATIFICATION DYNAMICS



3 STRATIFICATION BEGINS ON 5/2/2018

STRATIFICATION DYNAMICS



LENGTH OF STRATIFICATION

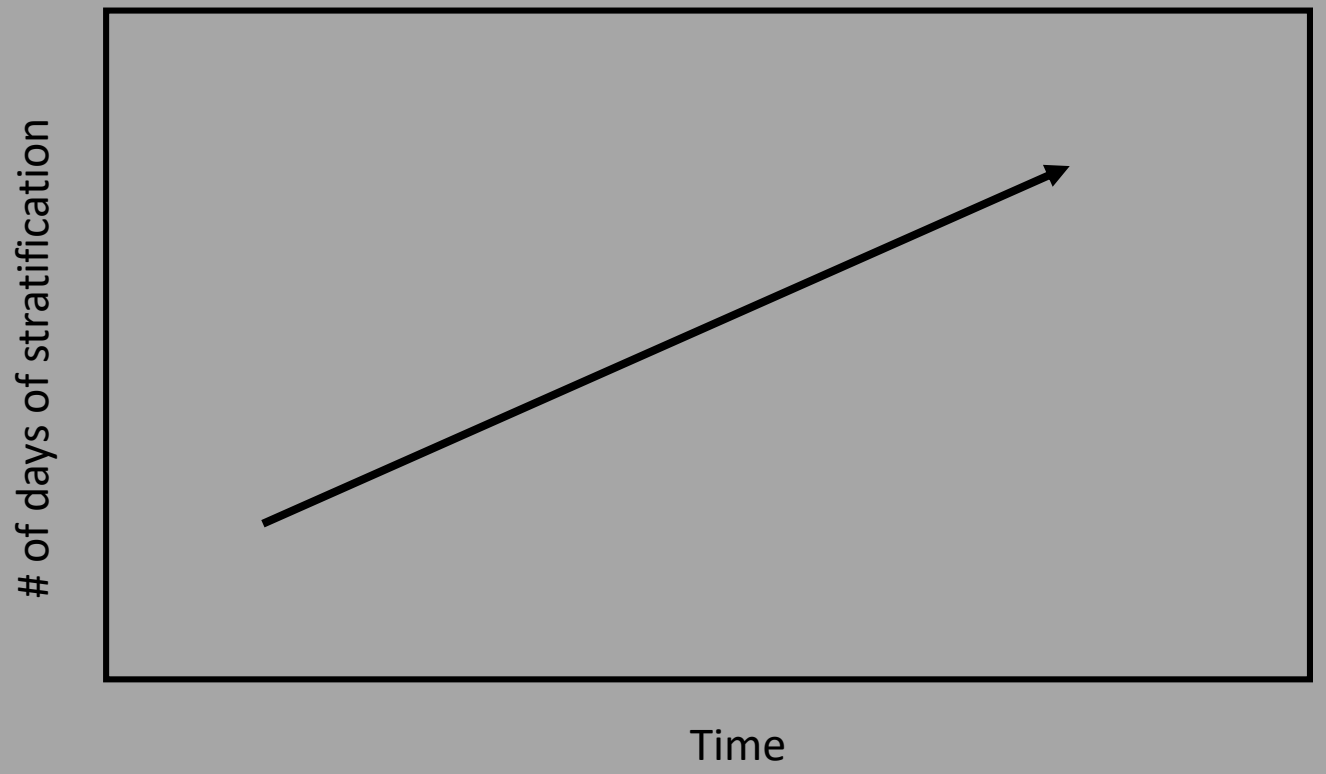
YEAR	ICE-OUT	ICE-IN	ONSET OF STRATIFICATION	DATE OF FALL TURNOVER	DAYS OF STRATIFICATION
2016	3/13/16	Not Recorded	5/10/16	10/23/16	166 days
2017	4/15/17	12/15/17	5/17/17	10/31/17	167 days
2018	4/22/18	12/13/18	5/2/18	10/18/18	169 days

LENGTH OF STRATIFICATION

YEAR	ICE-OUT	ICE-IN	ONSET OF STRATIFICATION	DATE OF TURNO	DAYS OF STRATIFICATION
2016	3/13/16	Not Recorded	5/10/16	10/23	166 days
2017	4/15/17	12/15/17	5/17/17	10/31	167 days
2018	4/22/18	12/13/18	5/2/18	10/18	169 days

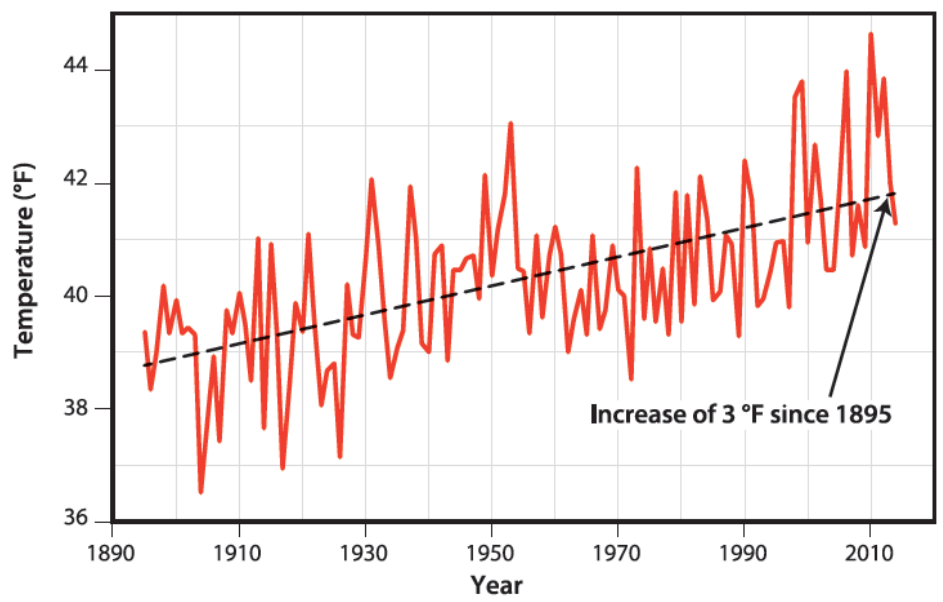
LENGTH OF STRATIFICATION

- More time for surface waters to warm
- More time that the hypolimnion is separated from oxygenated surface waters
- More time to oxygen to be depleted
- More time for algae blooms to flourish

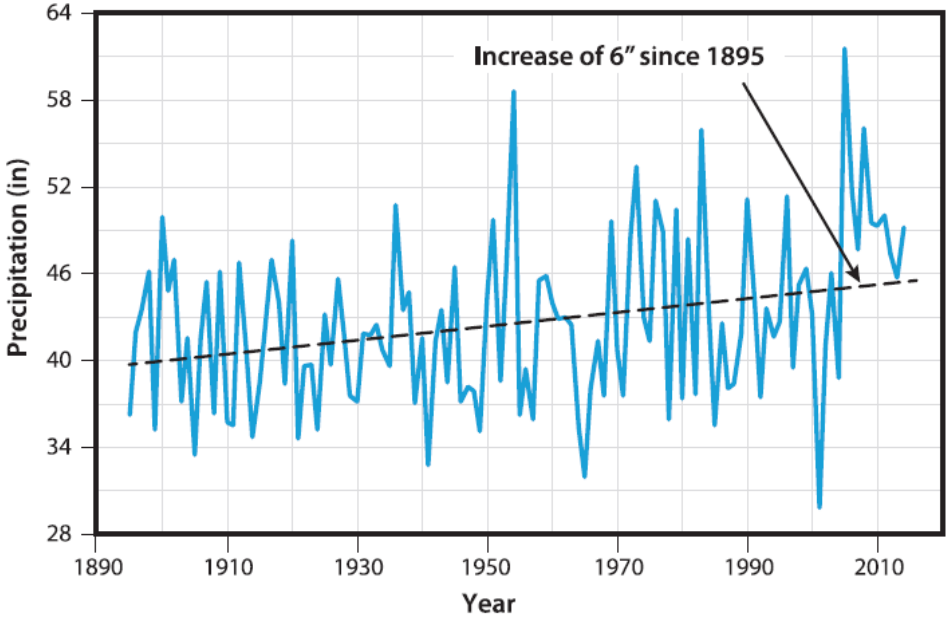


RESPONSE TO EXTREME WEATHER PATTERNS

Maine's Average Annual Air Temperature



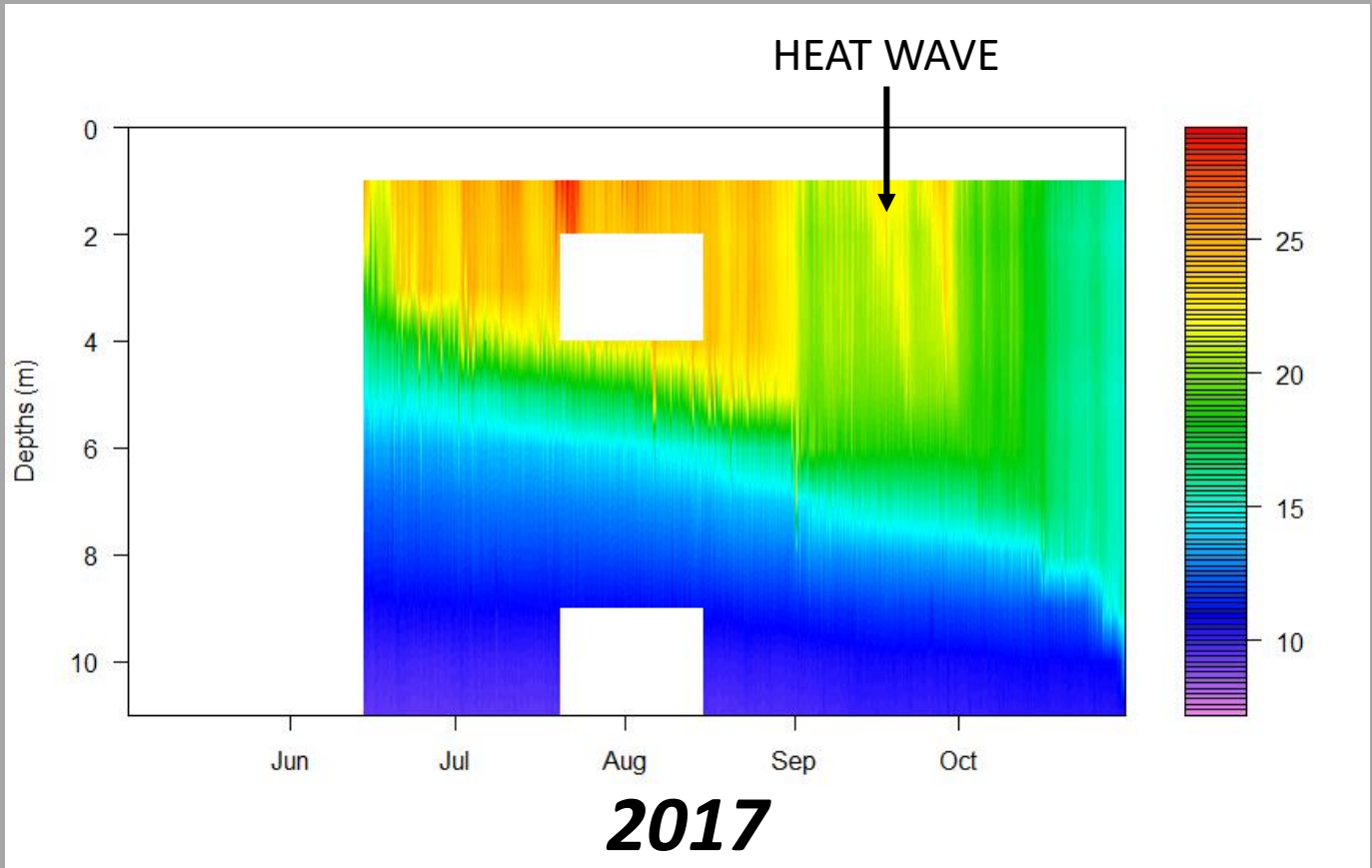
Maine's Total Annual Precipitation

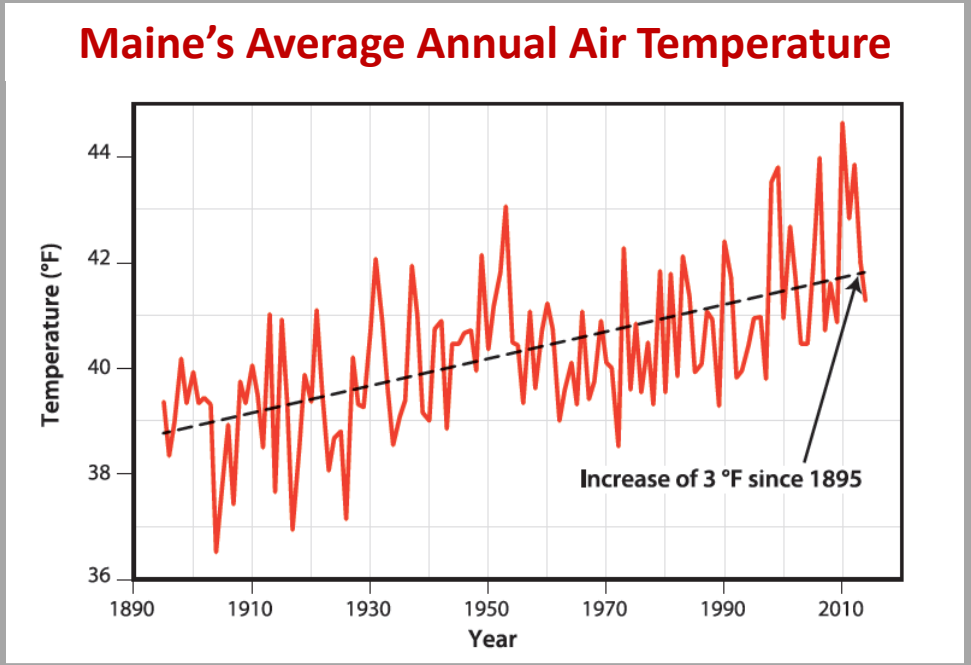


Fernandez, I.J., C.V. Schmitt, S.D. Birkel, E. Stancioff, A.J. Pershing, J.T. Kelley, J.A. Runge, G.L. Jacobson, and P.A. Mayewski. 2015. Maine's Climate Future: 2015 Update. Orono, ME: University of Maine. 24pp.

RESPONSE TO EXTREME WEATHER PATTERNS

Temperature





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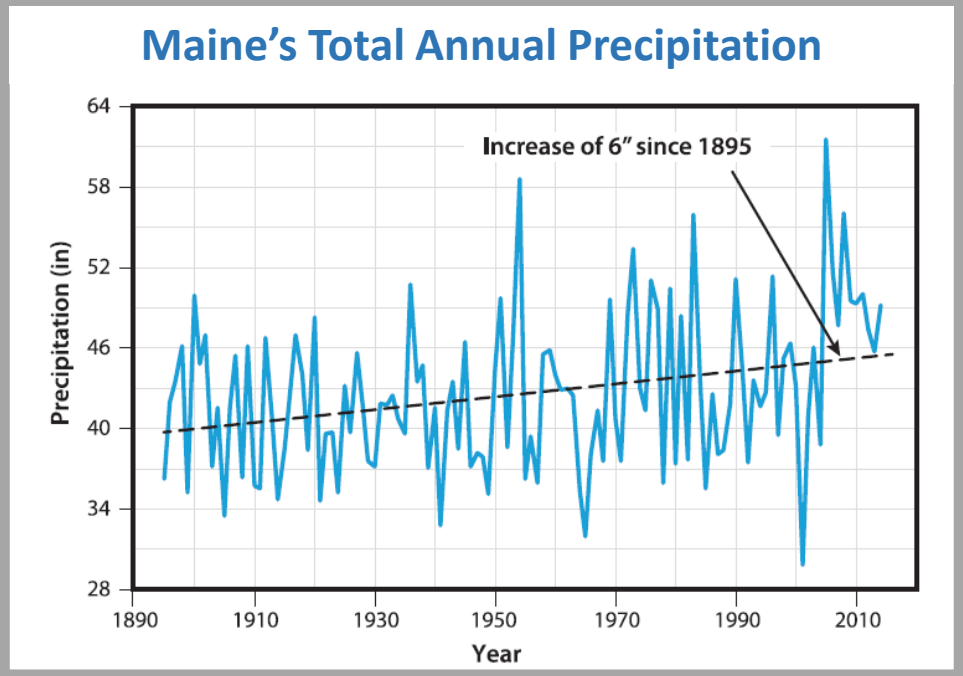
RESPONSE TO EXTREME WEATHER PATTERNS

Precipitation

- Increased runoff → more nutrients → more algae blooms → fuels decomposition
- More organic matter loading → fuels decomposition

→ Low dissolved oxygen

Erosion on Gravel Road in Watchic Lake Watershed

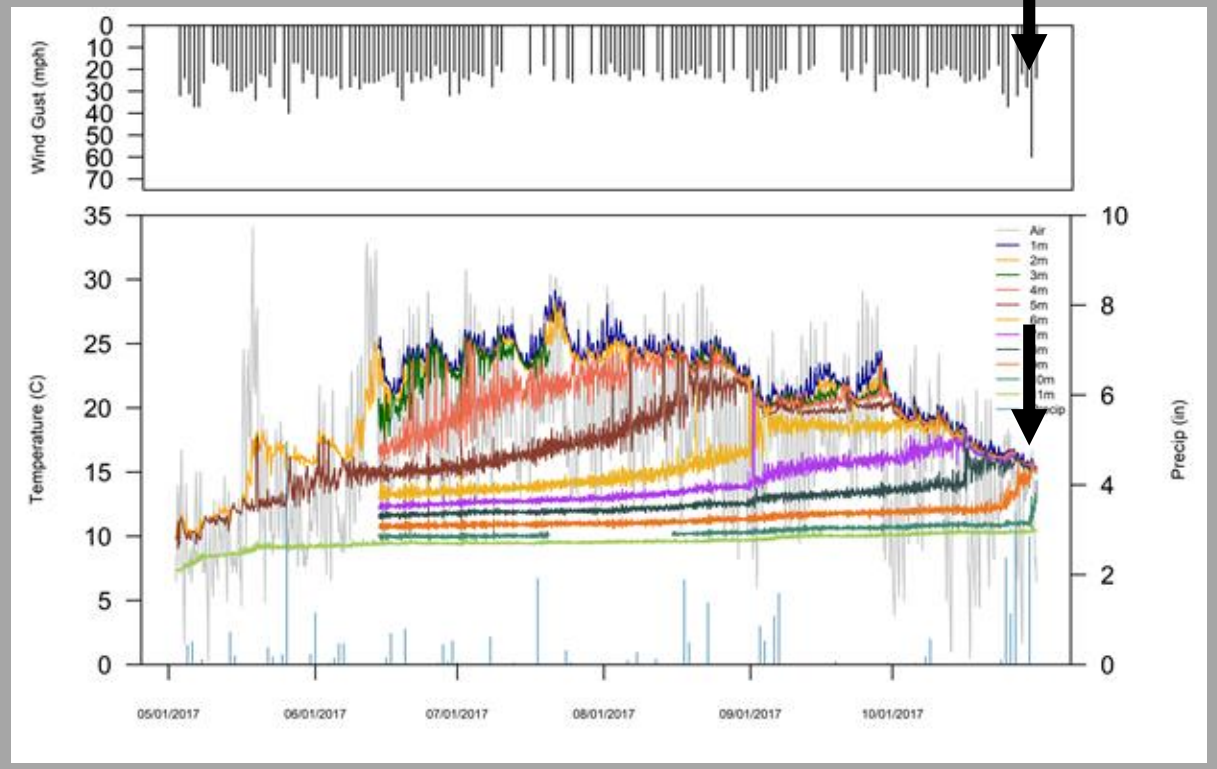


RESPONSE TO EXTREME WEATHER PATTERNS

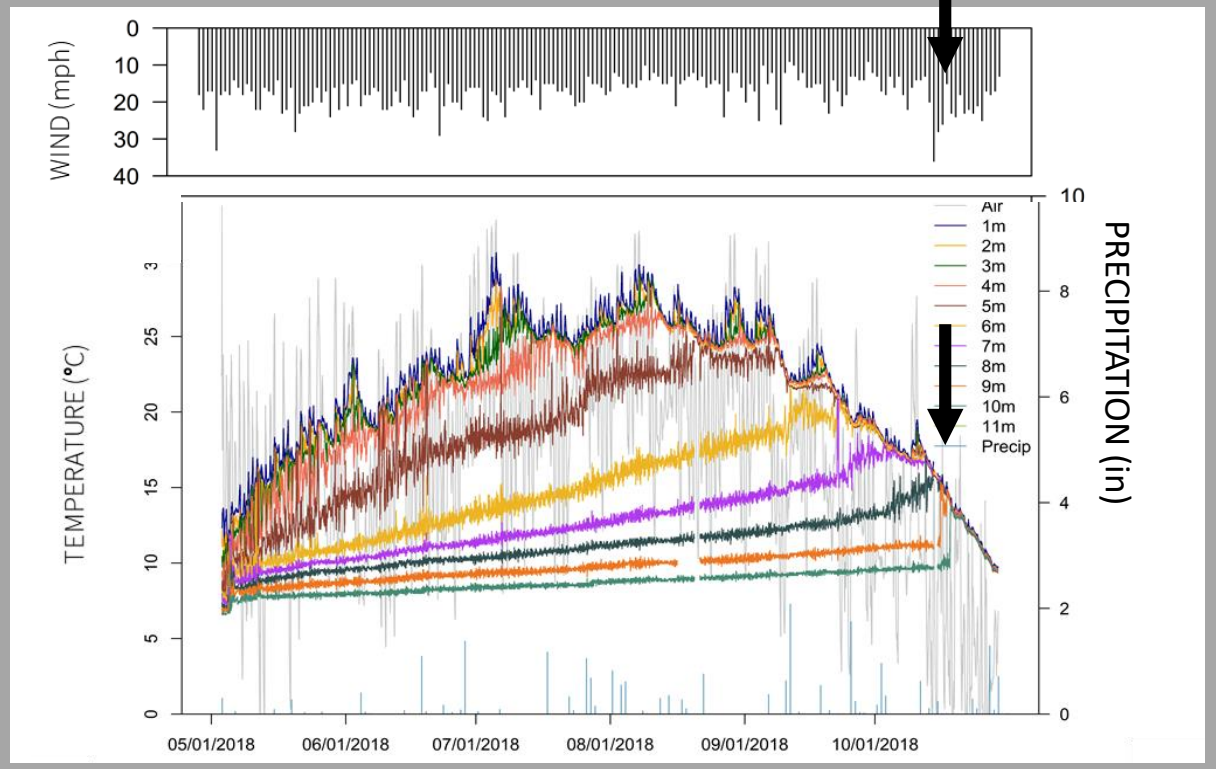
Wind

= HIGH WINDS

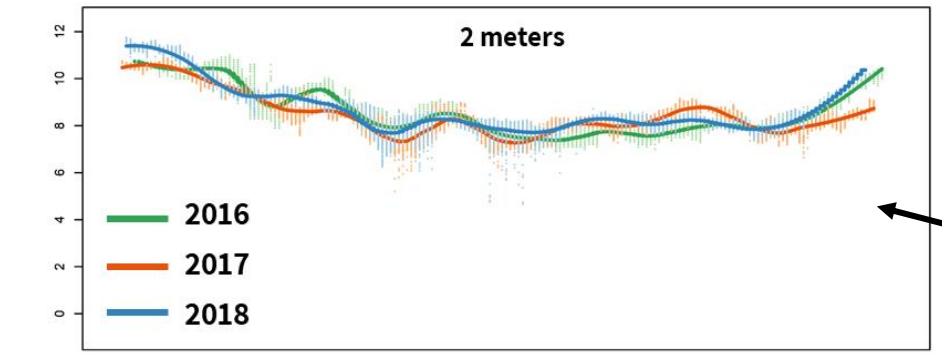
2017

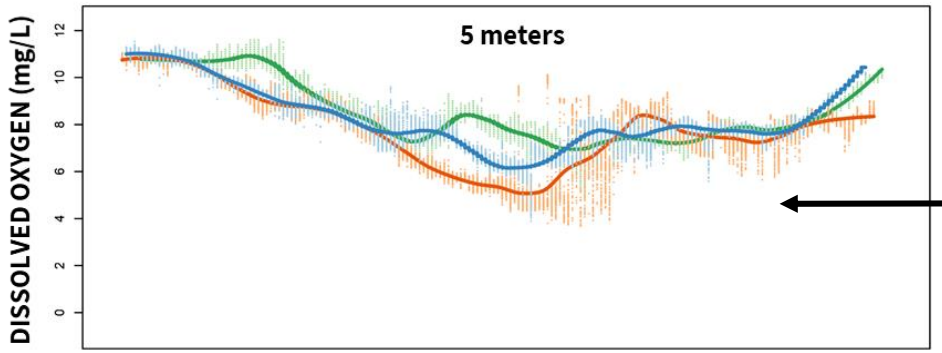


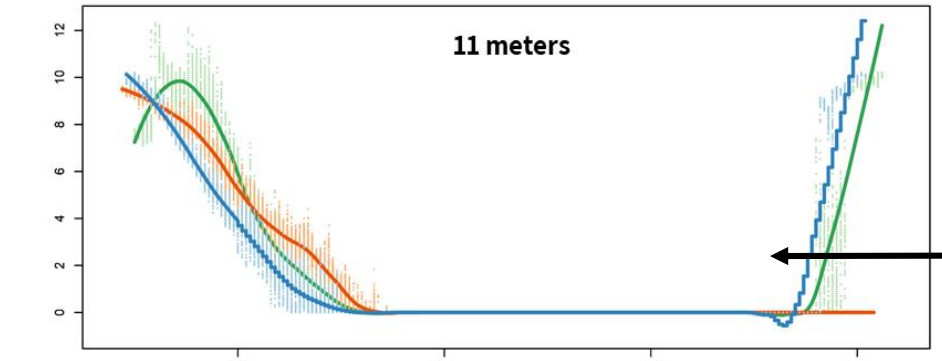
2018



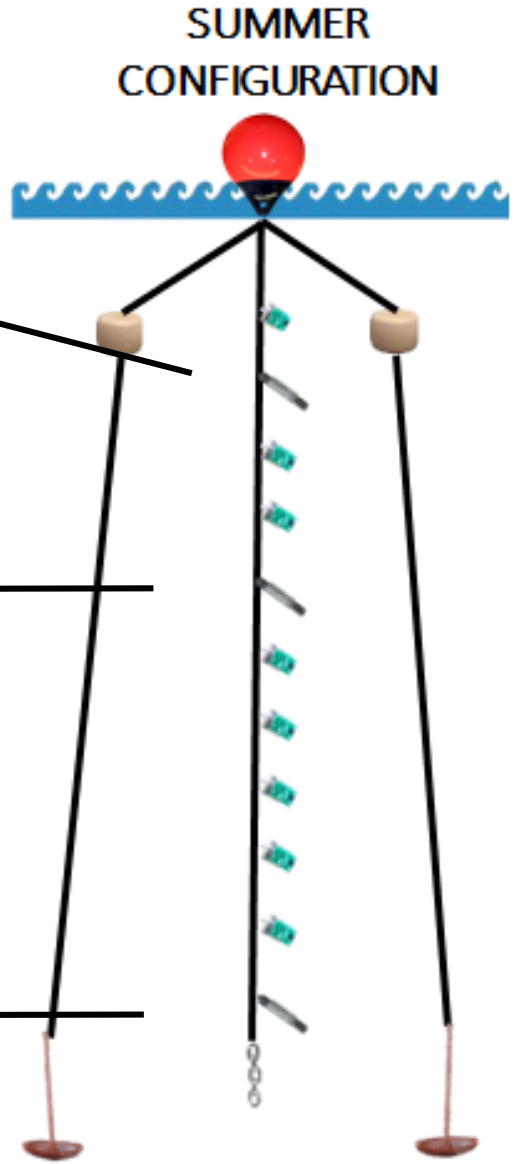
INTERANNUAL COMPARISONS



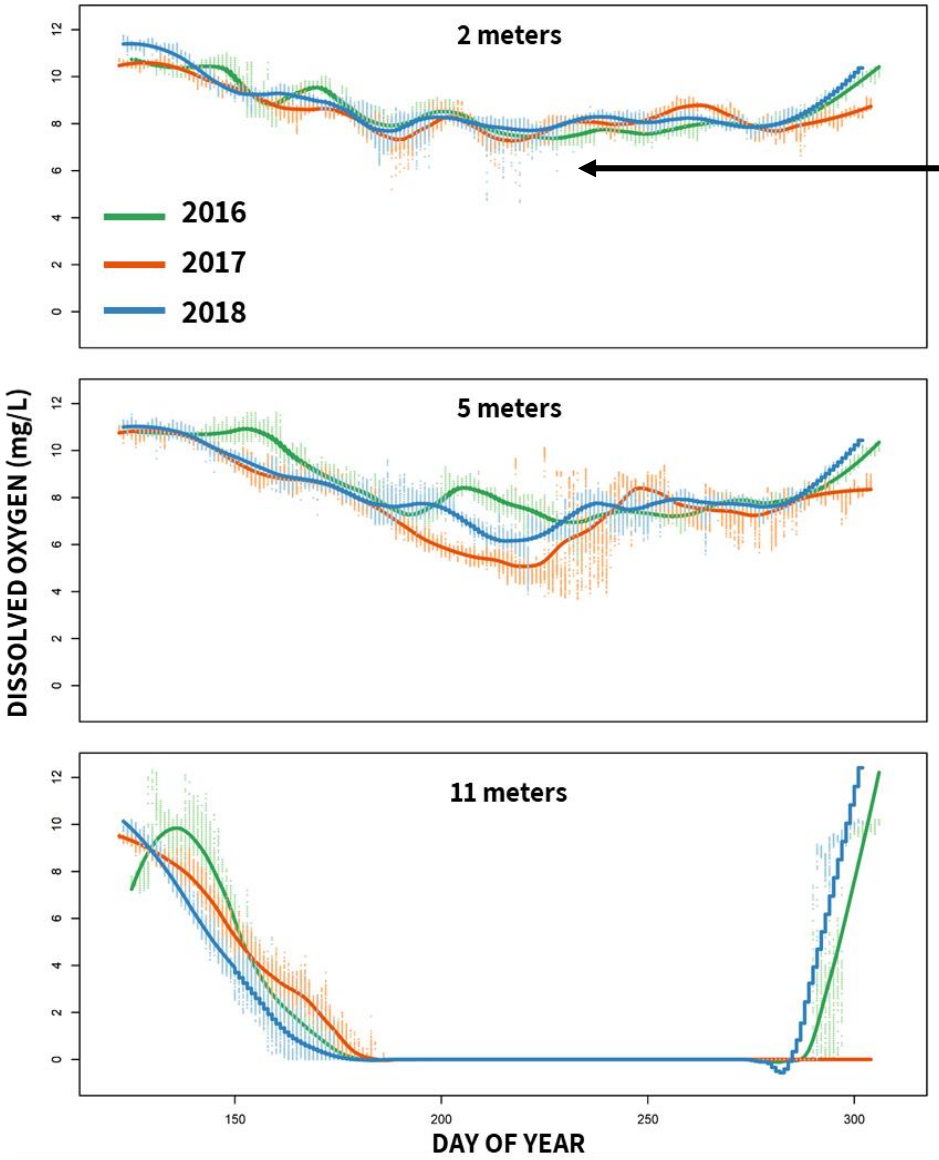




DISSOLVED OXYGEN (mg/L)

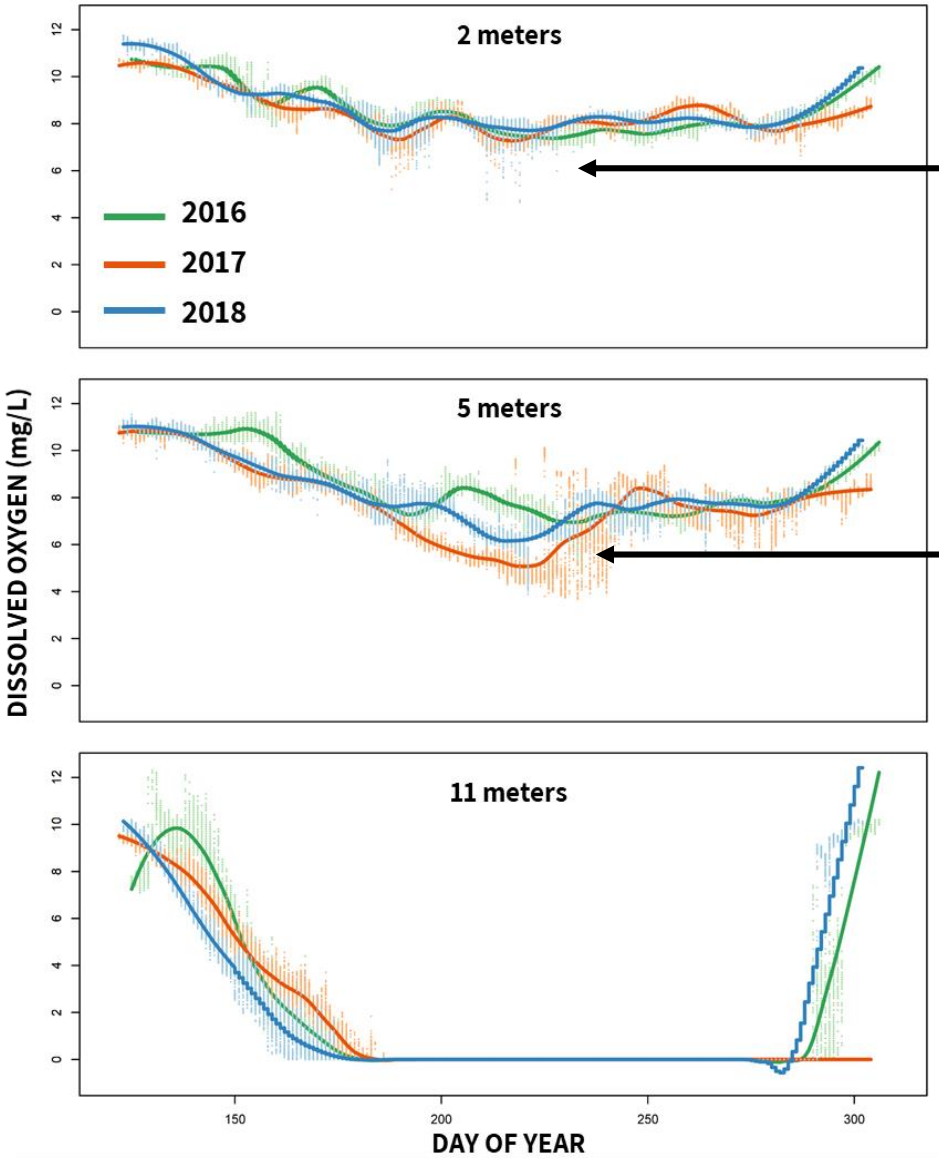


INTERANNUAL COMPARISONS



Similar trends over three years

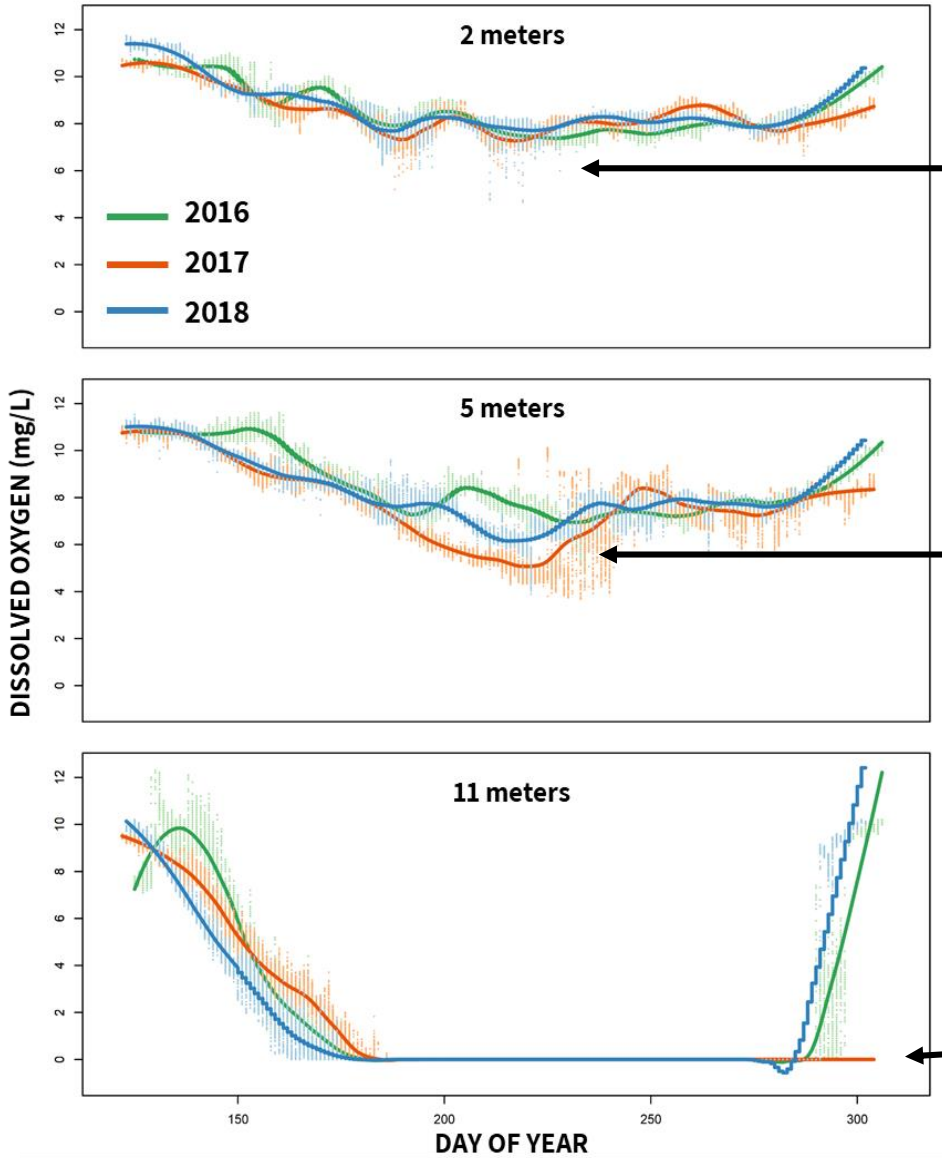
INTERANNUAL COMPARISONS



Similar trends over three years

Dissolved oxygen in 2017 is lower at the thermocline.

INTERANNUAL COMPARISONS

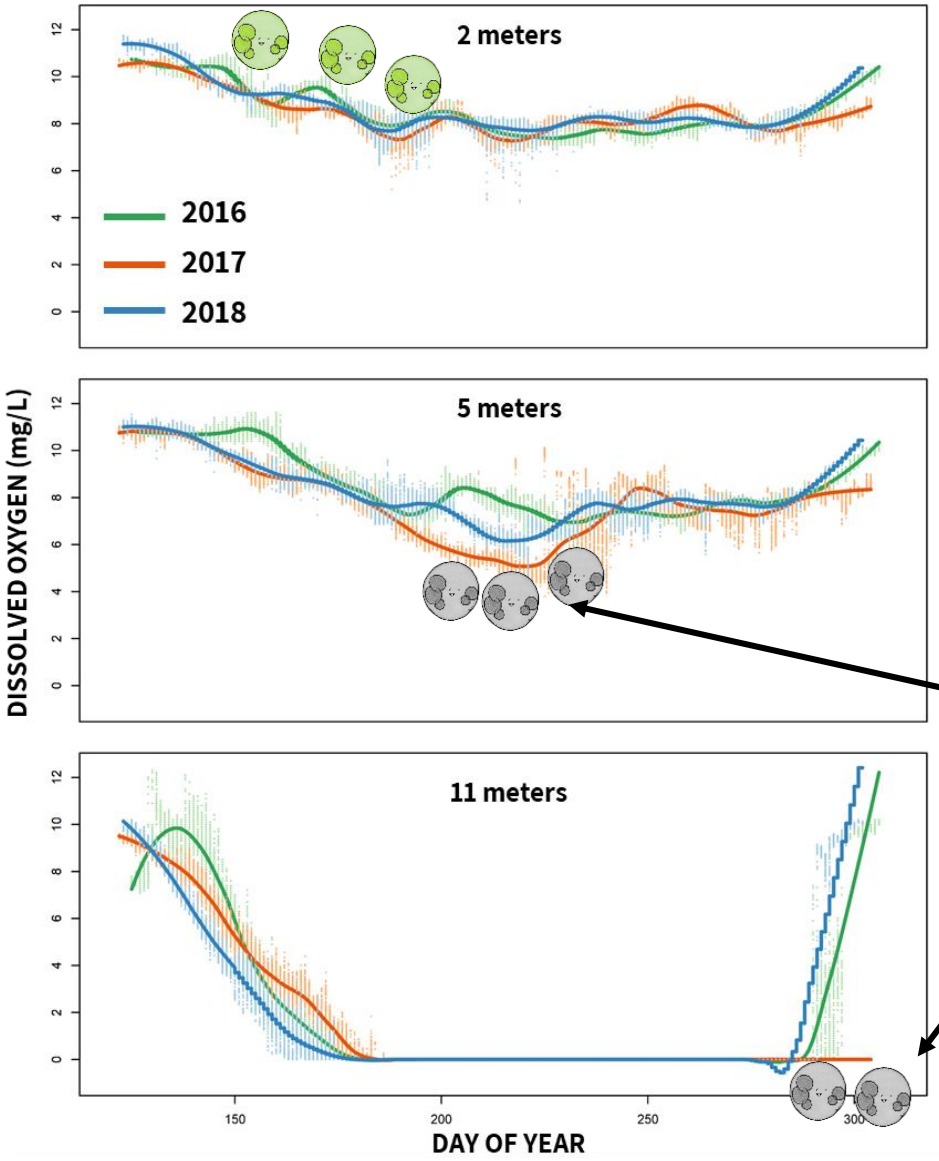


Similar trends over three years

Dissolved oxygen in 2017 is lower at the thermocline.

Dissolved oxygen at the bottom of the lake recovers later in 2017.

INTERANNUAL COMPARISONS



In 2017…

= Live Algae

= Dead Algae

Greater Precipitation → Increased Runoff → Elevated Nutrients → More Algae (high Chl-a)

As algae die and sink, decomposition process consumes oxygen

WINTER MONITORING

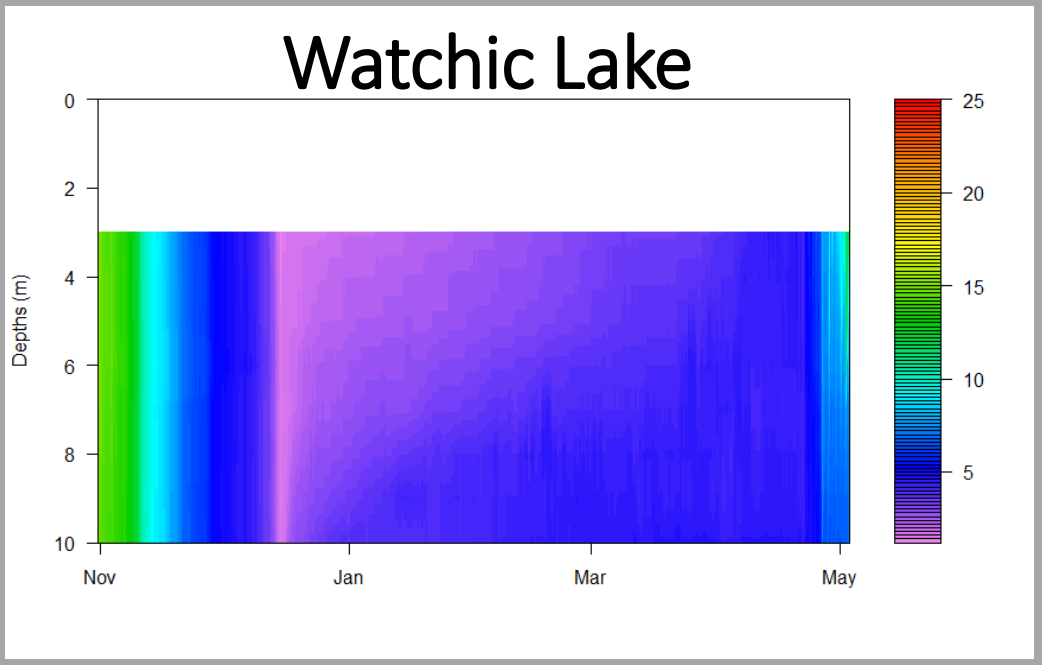
Winter Limnology as a New Frontier

Stephen M. Powers and Stephanie E. Hampton

WINTER MONITORING

Winter Limnology as a New Frontier

Stephen M. Powers and Stephanie E. Hampton



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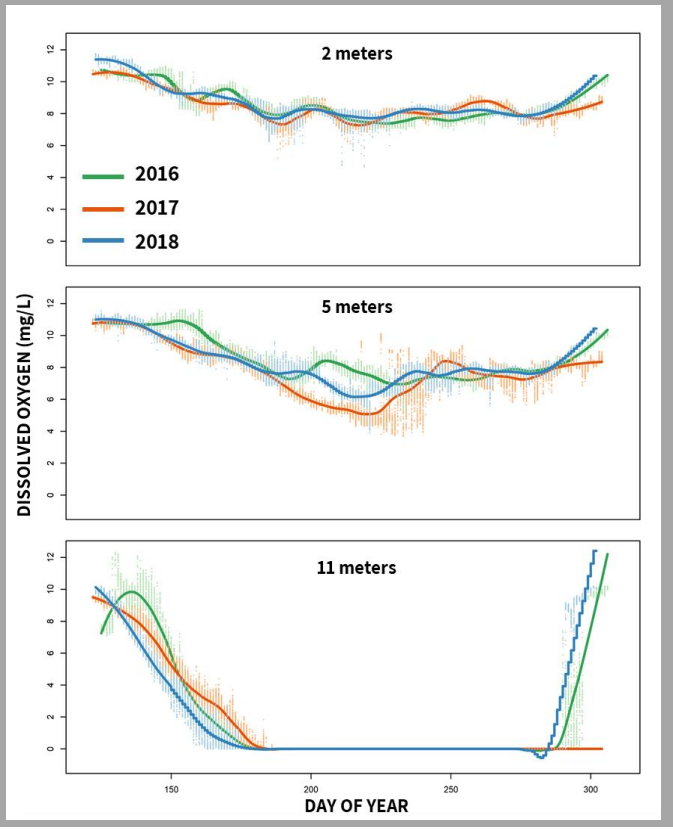

QUESTIONS?

https://watchiclake.org/2019/03/08/2018-water-quality-report-available/