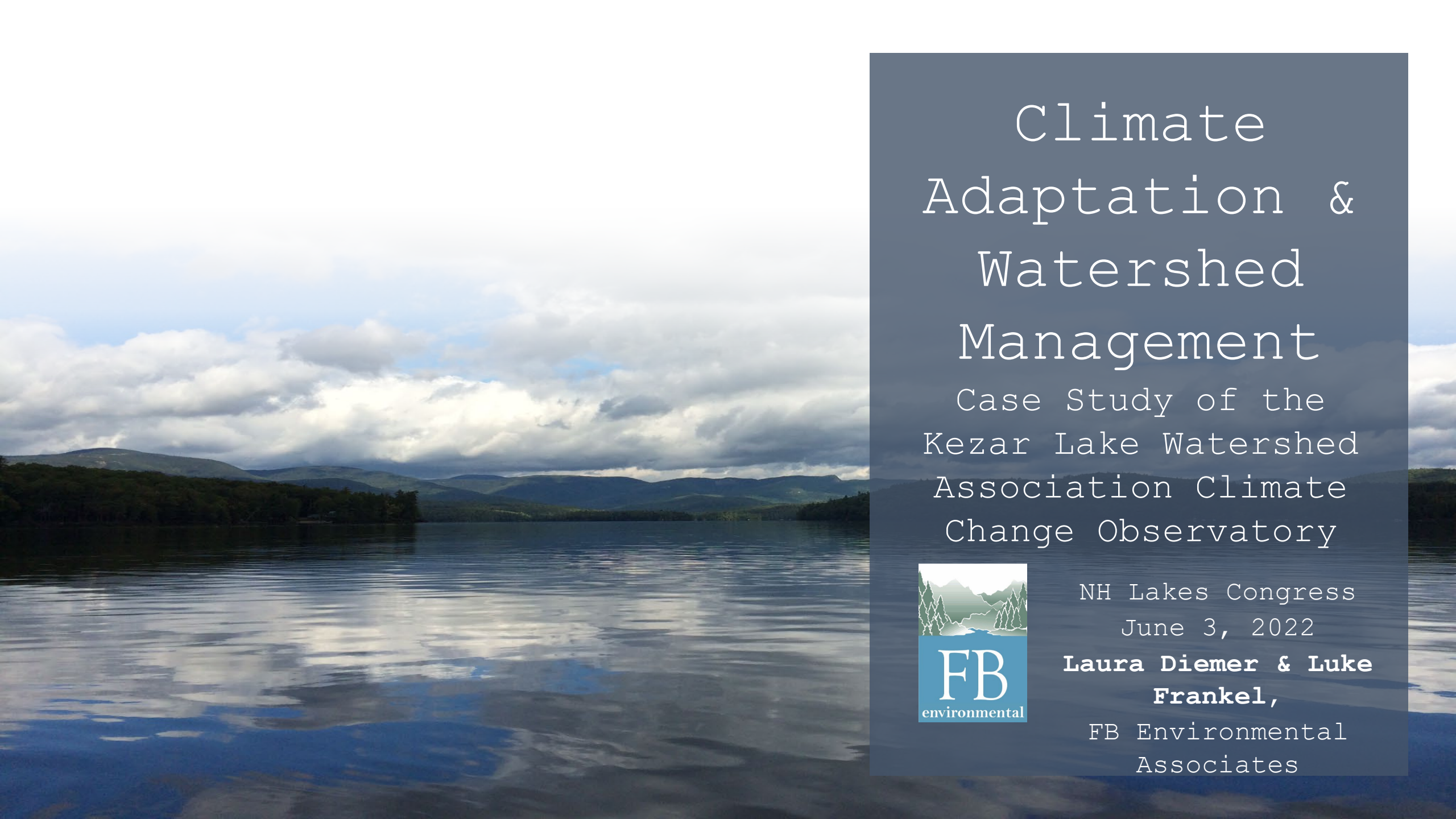


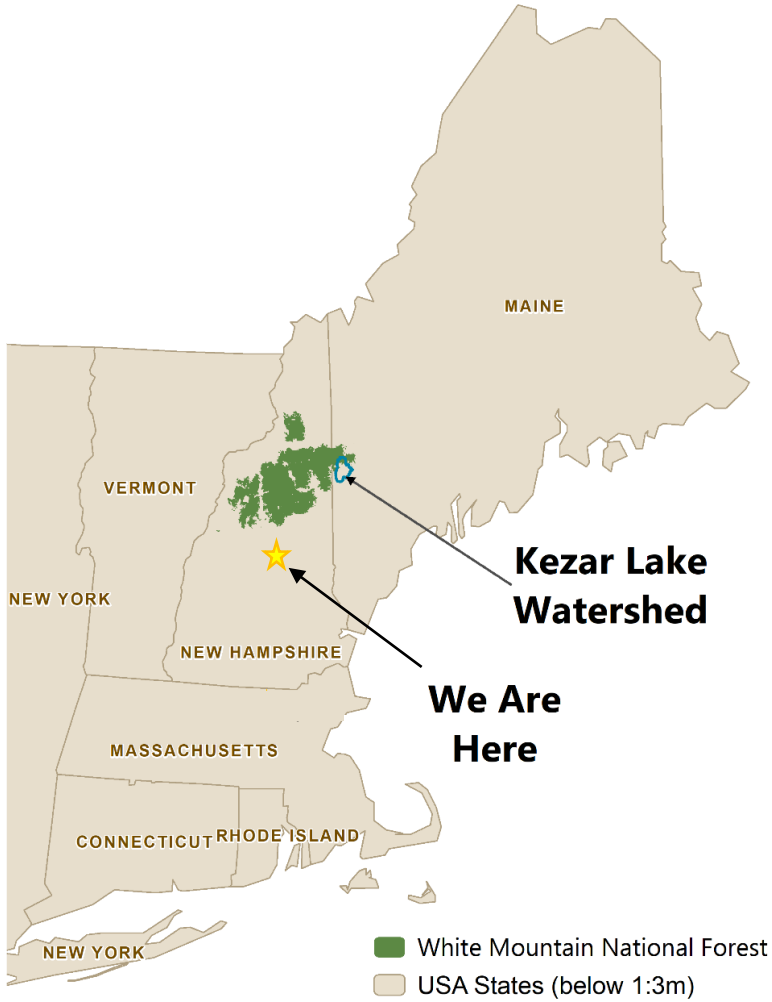
Climate Adaptation & Watershed Management

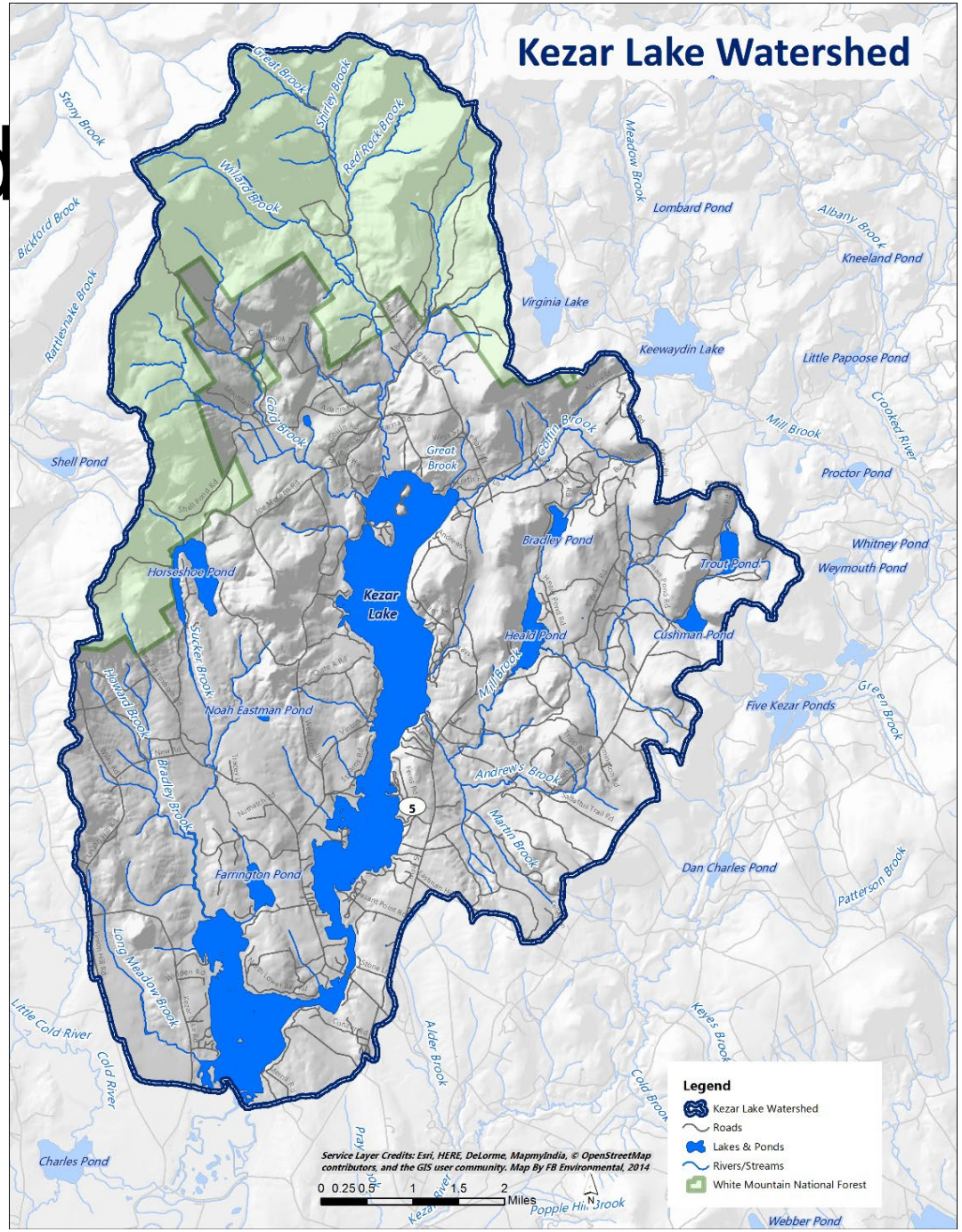
Case Study of the Kezar Lake Watershed Association Climate Change Observatory

NH Lakes Congress
June 3, 2022

Laura Diemer & Luke Frankel,
FB Environmental Associates

Kezar Lake Watershed





KLWA Climate Change Observatory

- KLWA recognized critical need to protect and monitor natural resources in the face of climate change
- Established 2013 with the mission *"to observe, measure, and analyze long-term climate change trends and to address their impact on the waters, lands, and wildlife of the Kezar Lake watershed."*
- The purpose of this work is to provide the **public, local government, and other stakeholder organizations** with:
  - 1) ongoing information related to the effects of climate change on community interests and
  - 2) recommendations for mitigating or adapting to these potential effects.
- Led by six-person steering committee
- Funded through grants, donations, KLWA General Fund
- Hosted 3 summer interns from PSU

Partner Collaboration Key

GREATER LOVELL LAND TRUST
WWW.GLLT.ORG

USDA FOREST SERVICE US DEPARTMENT OF AGRICULTURE

CLIMATE CHANGE INSTITUTE

MAINE DEPT. OF INLAND FISHERIES AND WILDLIFE

MANOMET Center for Conservation Sciences

Plymouth State UNIVERSITY

Kezar Lake
WATERSHED ASSOCIATION
P.O. Box 88, Lovell, ME 04051 www.klwa.us

FB environmental

Community Values Forum

What do you value most about Kezar Lake and its watershed?

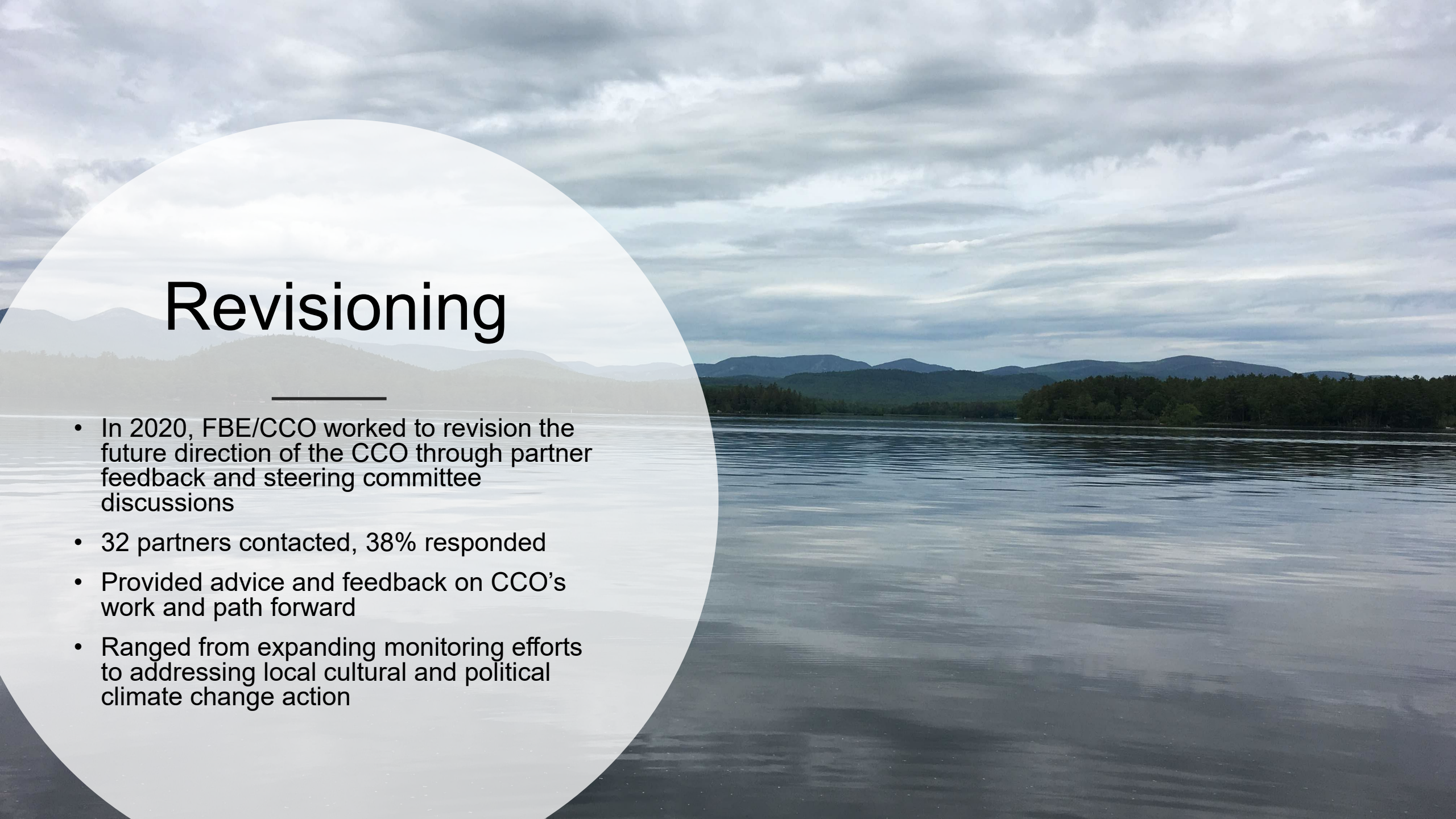
List & Prioritize Values

✓**COLD-WATER FISHERIES**

Identify Threats to Top Values

✓**CLIMATE CHANGE**

✓**LAND MANAGEMENT**

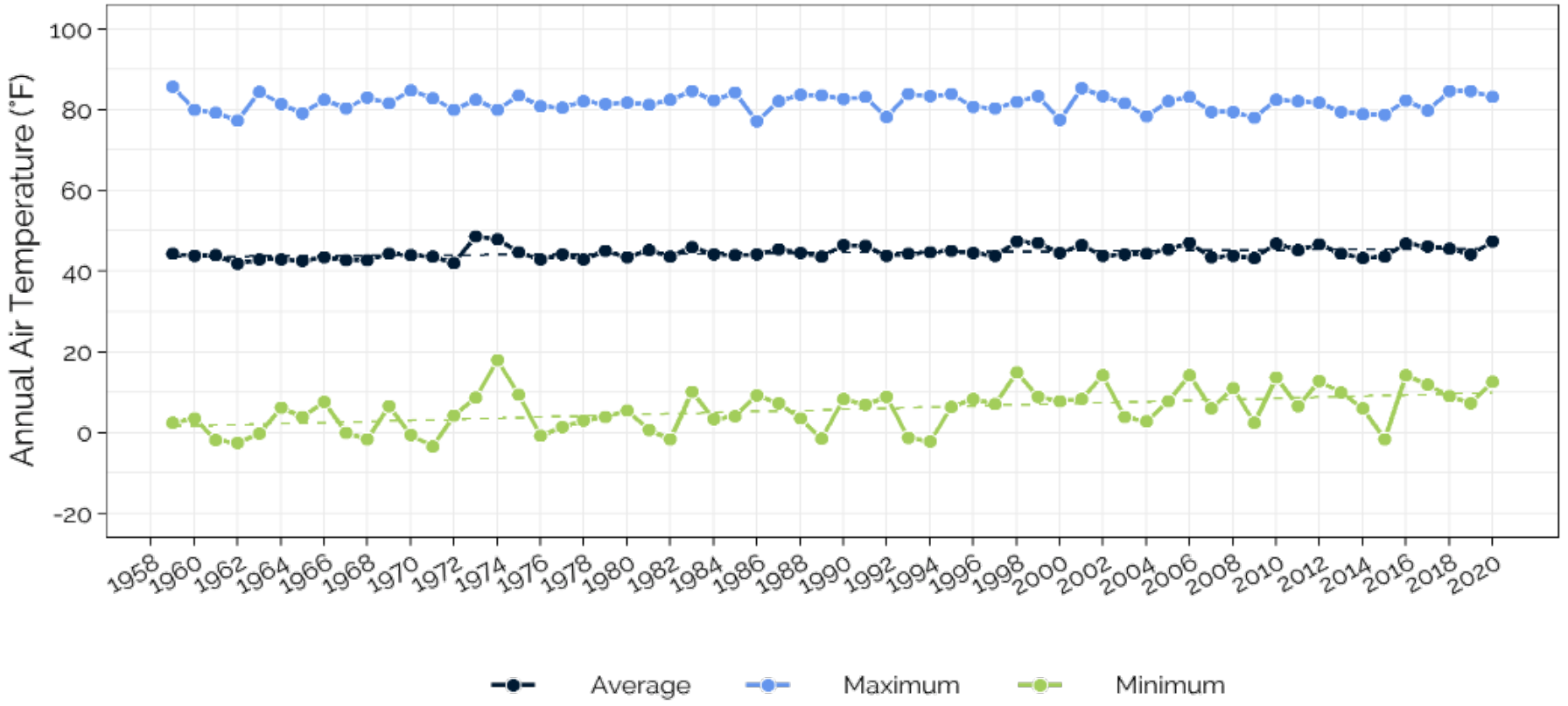


Revisioning

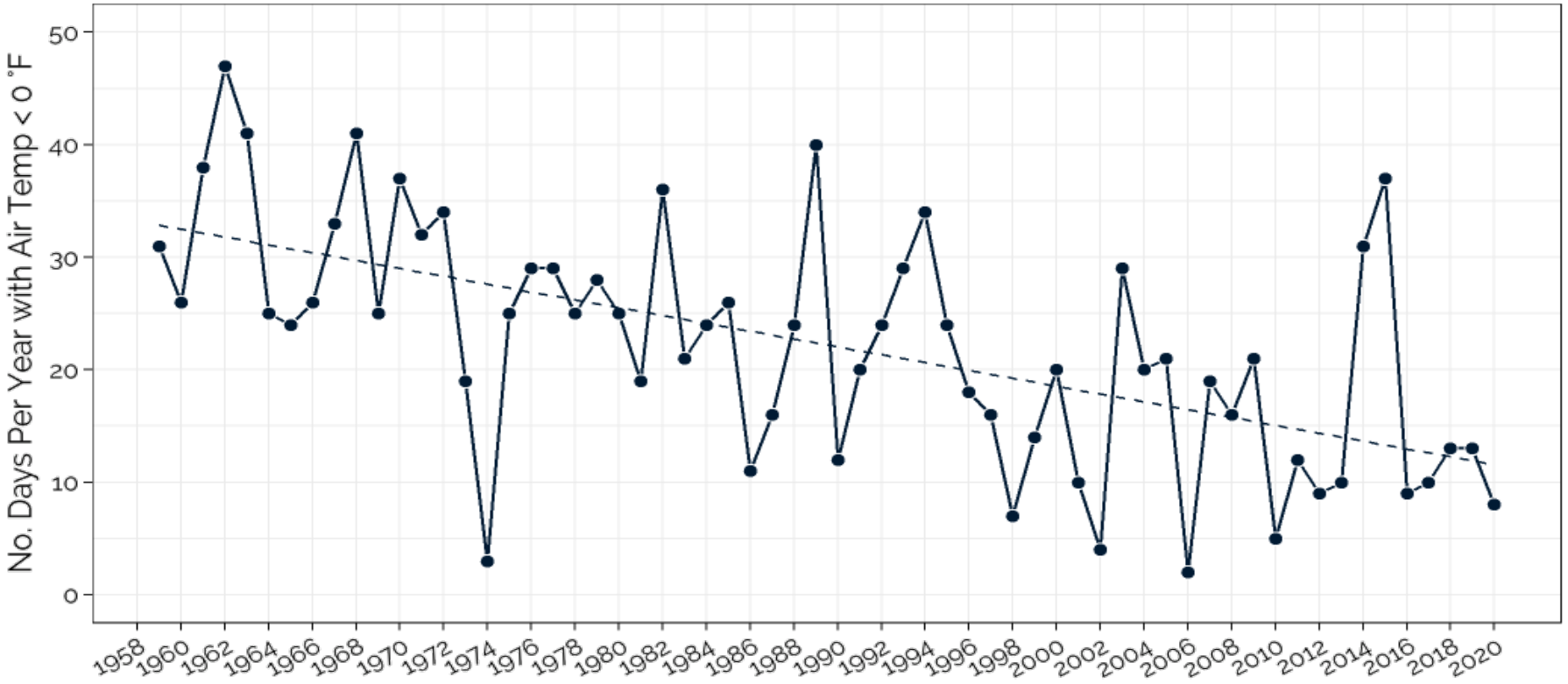
- In 2020, FBE/CCO worked to revision the future direction of the CCO through partner feedback and steering committee discussions
- 32 partners contacted, 38% responded
- Provided advice and feedback on CCO's work and path forward
- Ranged from expanding monitoring efforts to addressing local cultural and political climate change action

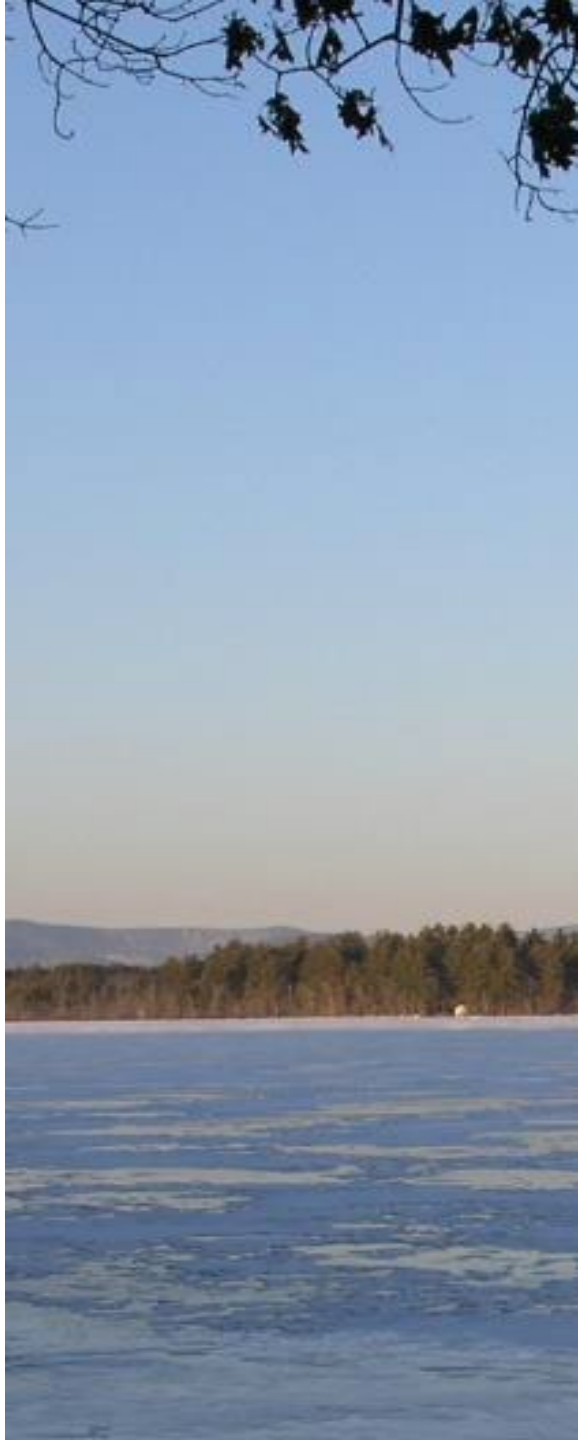
Local Climate Trends

Annual Air Temperatures

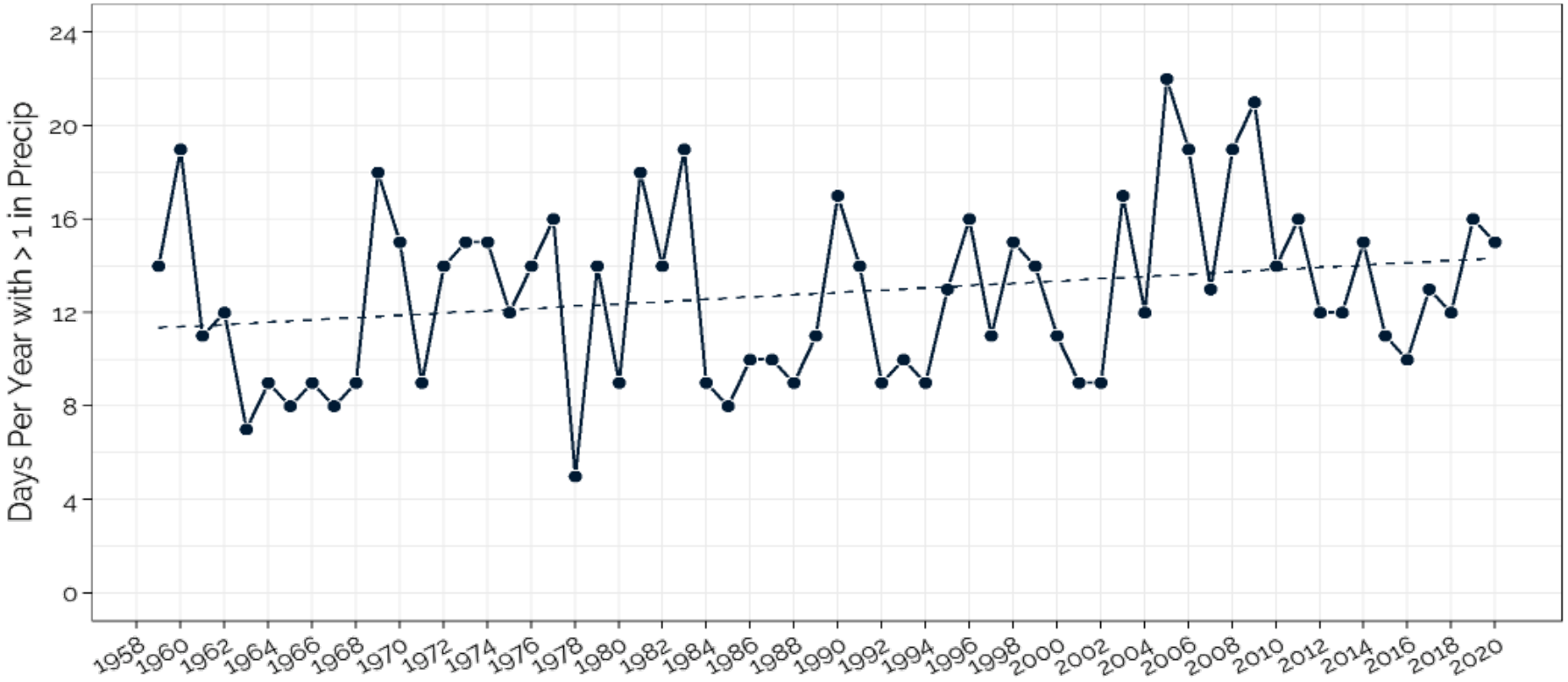


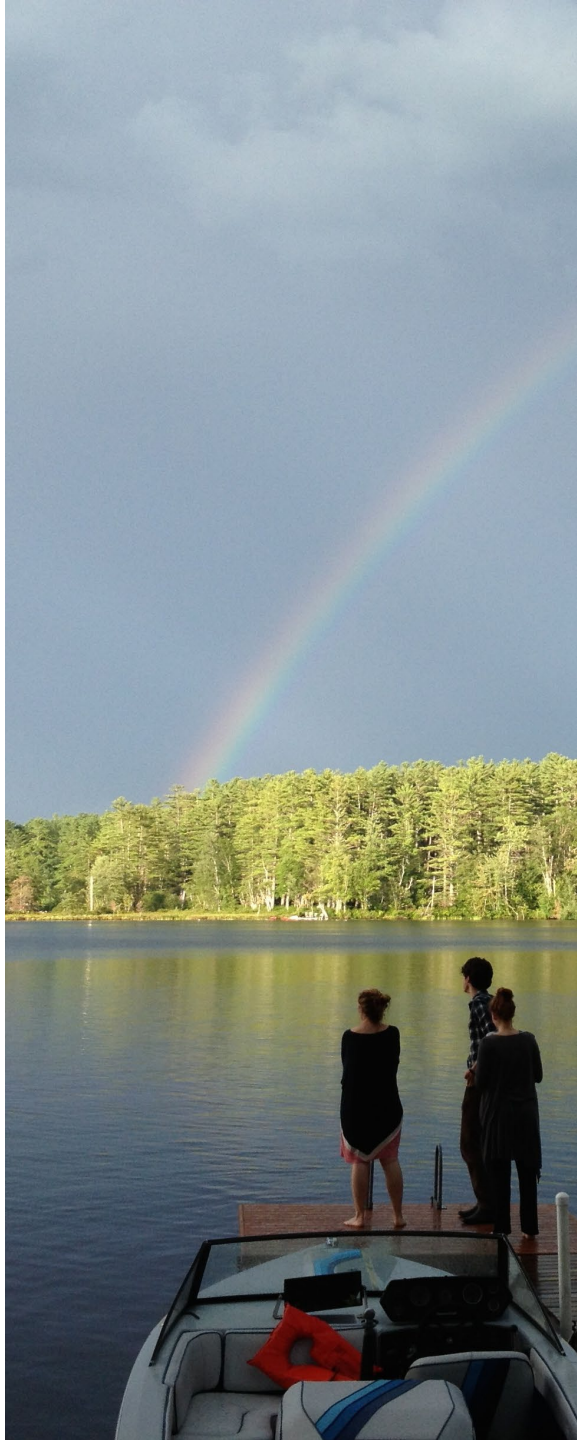
Extreme Cold Days



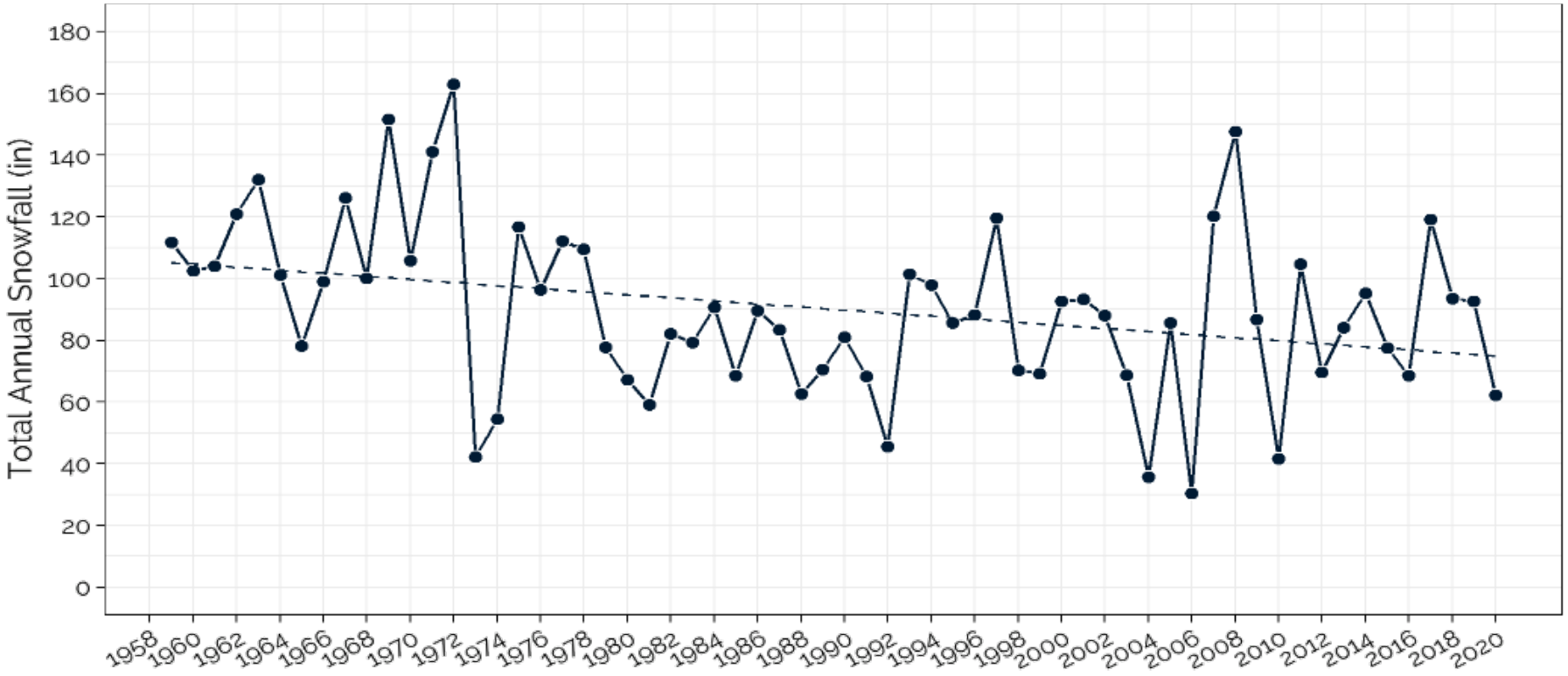


One Inch Precipitation Events

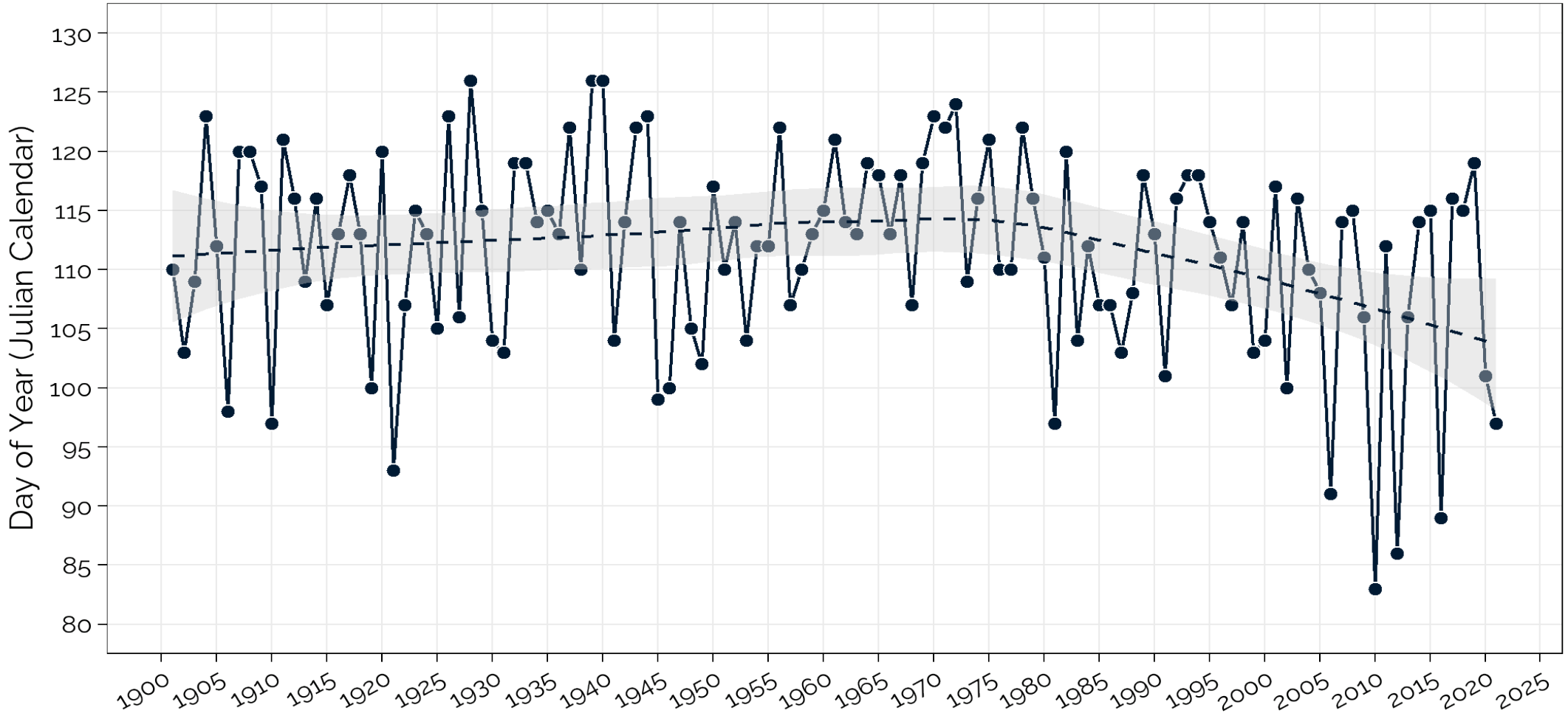




Snowfall Accumulation



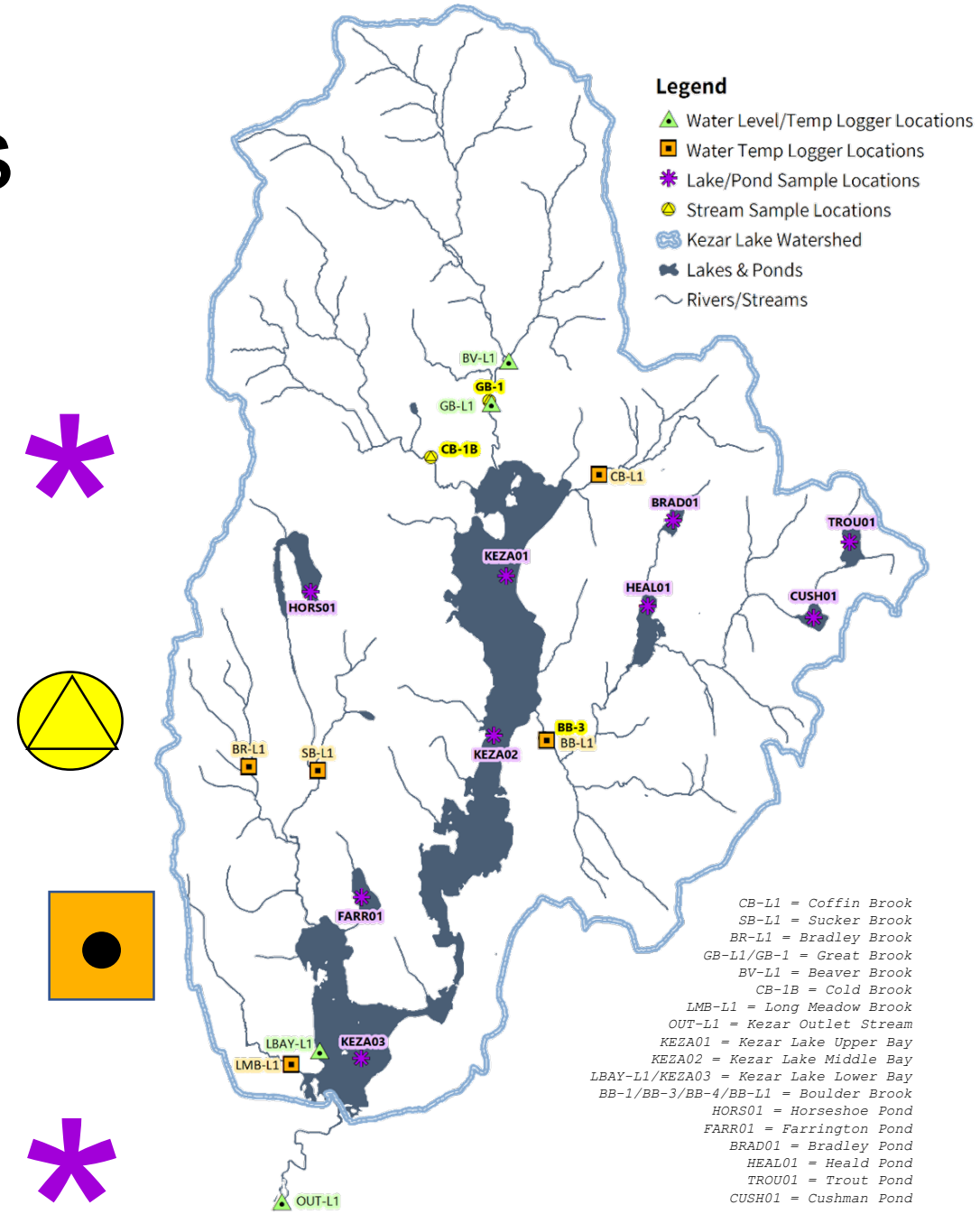
Ice-Out


Day of Year (Julian Calendar)
130
125
120
115
110
105
100
95
90
85
80
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025

Monitoring

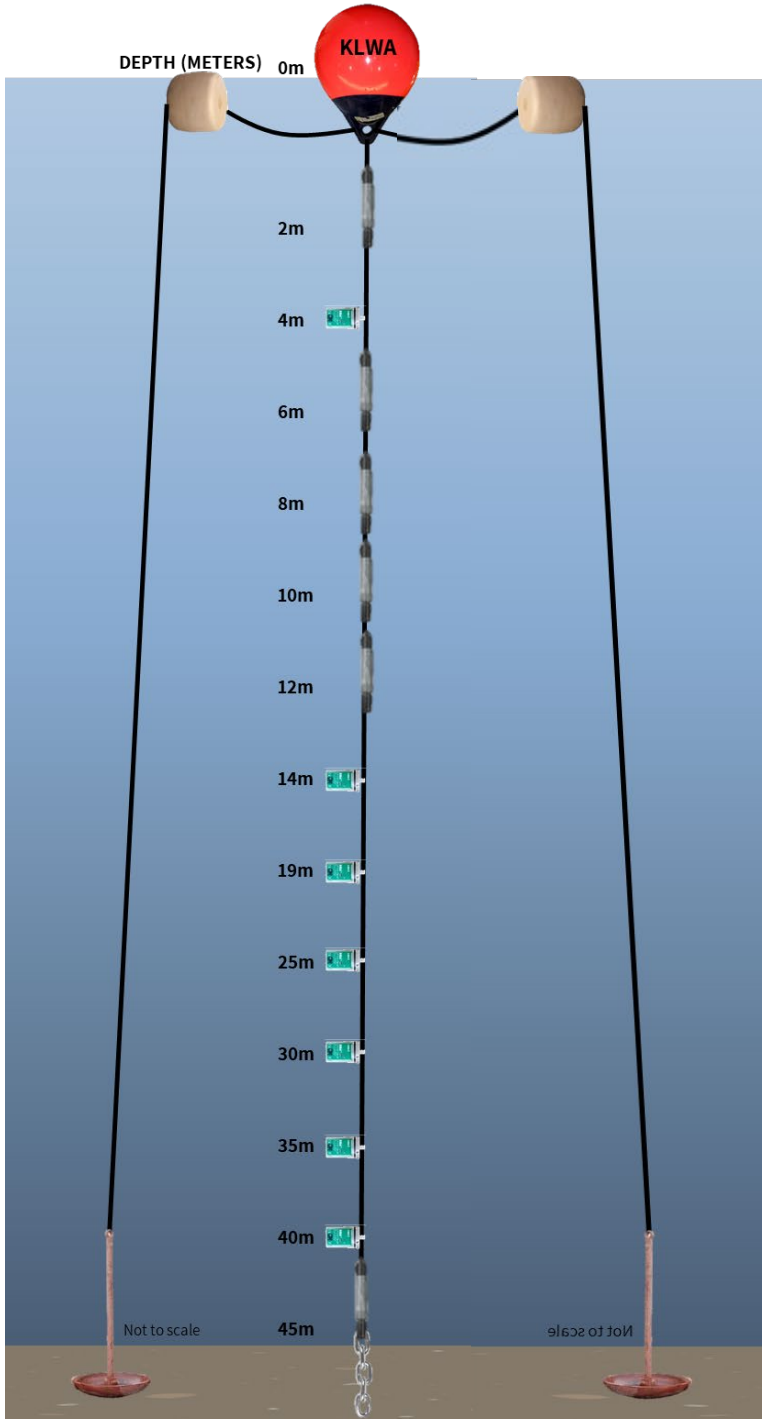
Stations & Parameters

- Lake & ponds sampling (9 stations)
  - DO/temp, SDT, grab samples for TP, Chl-a, color, alkalinity, pH
  - Lake (June, August, Sept); ponds (June, August)
- Trib sampling (3 stations)
  - DO/temp, grab samples for TP, E. coli, pH
  - Twice per season (June, Sept)
- Trib/lakeshore loggers (9 stations)
  - 4 Water level, 5 temp
  - Apr-Nov
- Upper & lower bay buoy loggers
  - DO/temp at various depths
  - DO May-Nov; Temp year-round

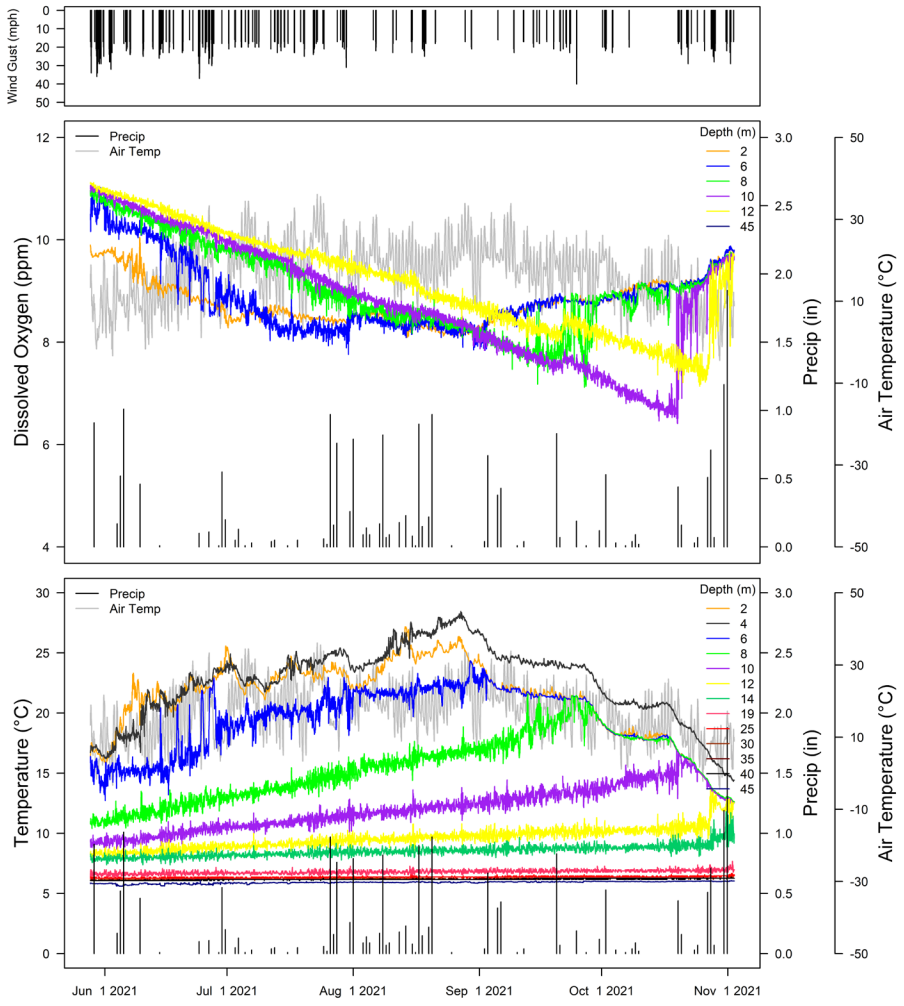


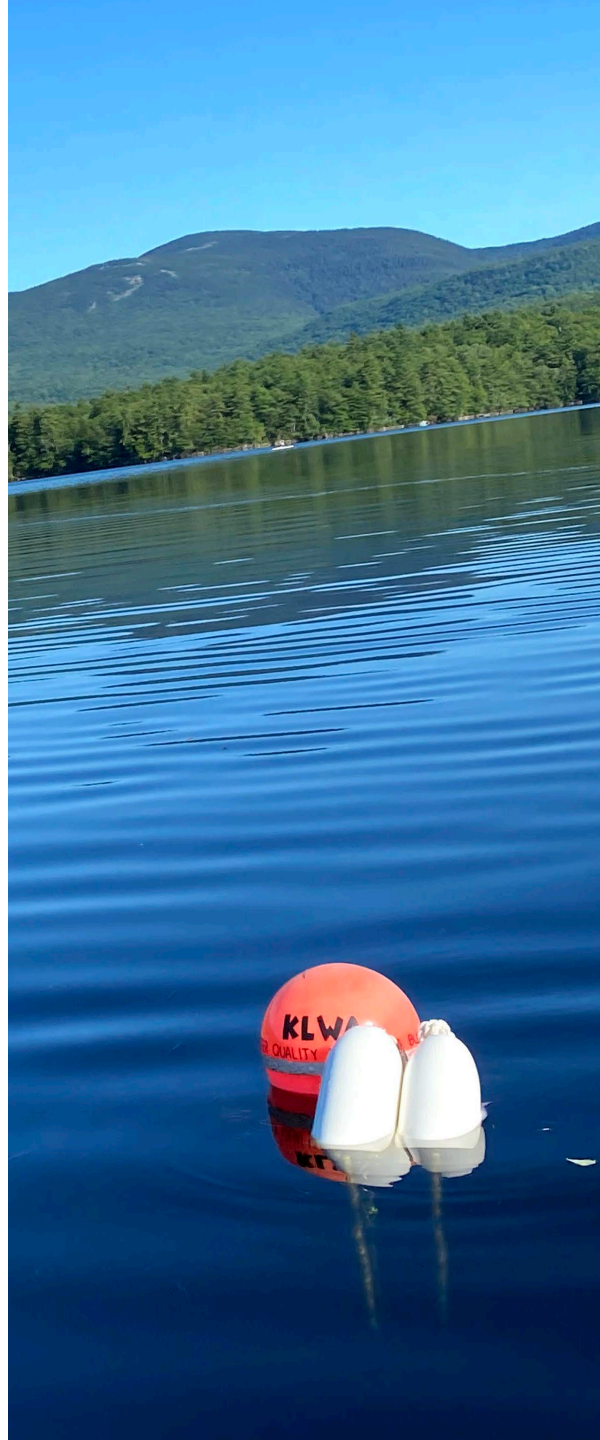
Kezar Lake Buoy Loggers

- Upper Bay: 13 loggers
  - 6 DO/temp loggers
  - 7 temp loggers
- Lower Bay: 3 loggers
  - 1 temp logger at 1 m
  - 1 DO/temp logger at 2 m
  - 1 cond/temp logger at 2m
- Tracking onset and duration of thermal stratification, depletion of oxygen in bottom waters
- Important for climate change as earlier ice-out and warming summers extend growing seasons

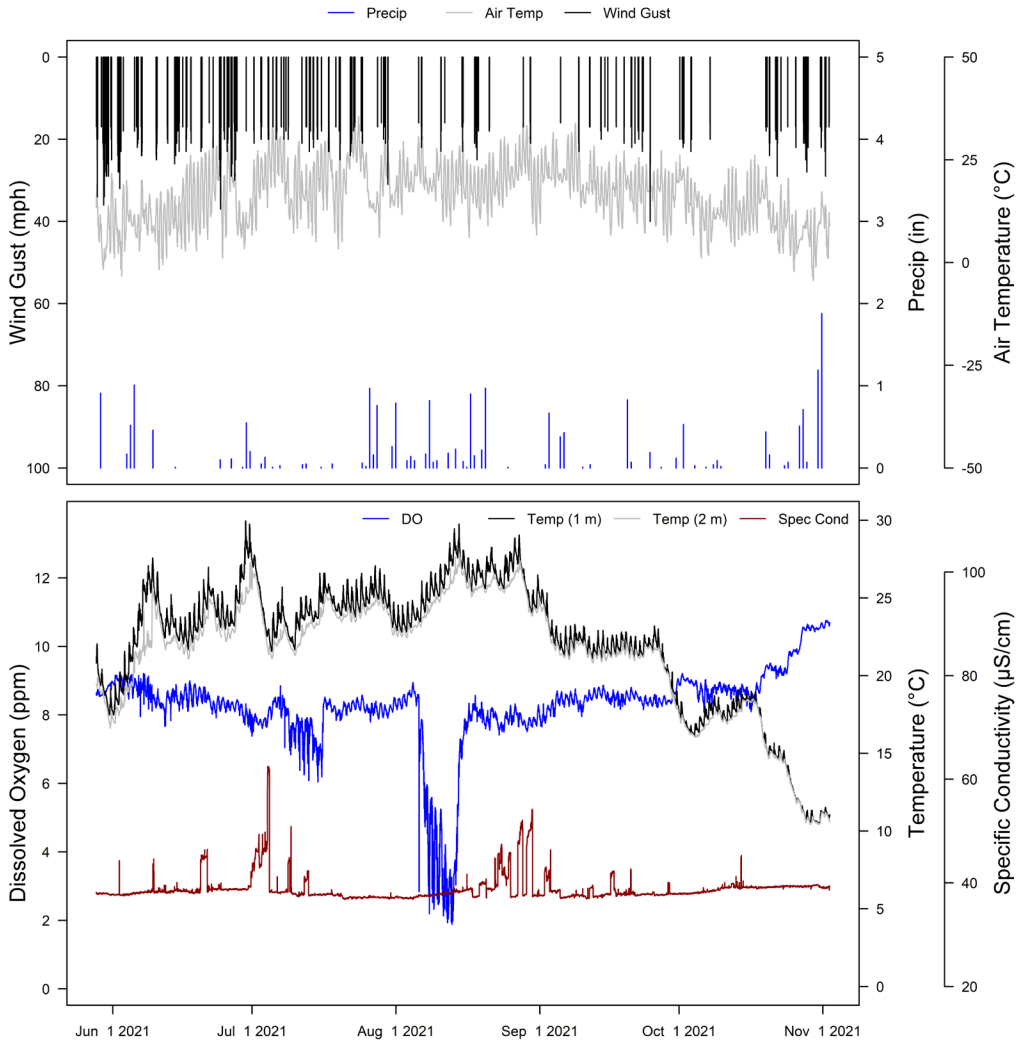


Upper Bay Buoy Loggers

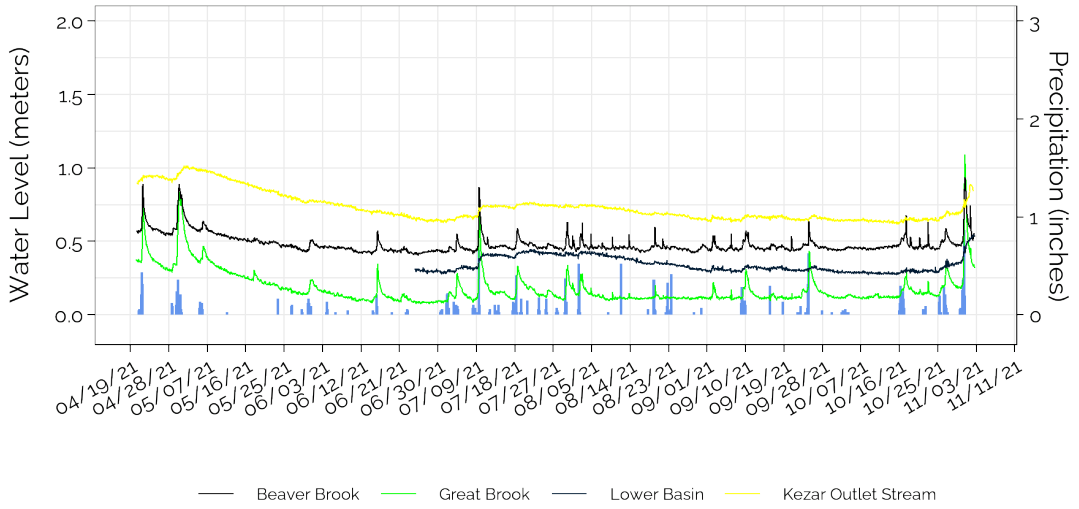


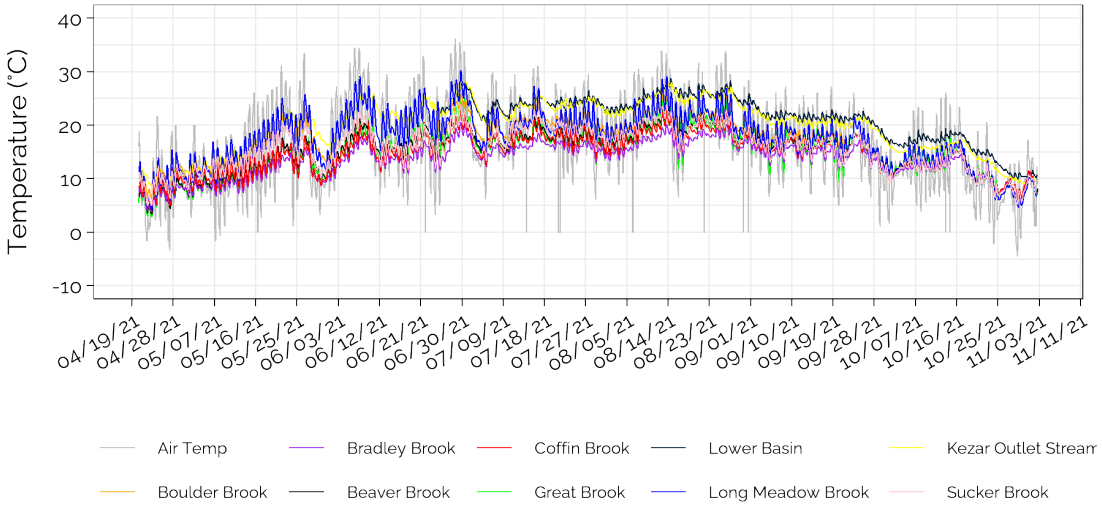


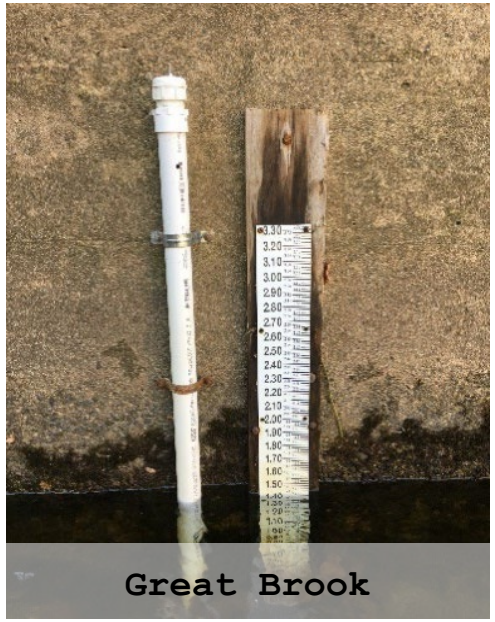
Lower Bay Buoy Loggers



Tributary Loggers






Great Brook


Lower Bay


Beaver Brook


Kezar Outlet Stream

Other Efforts

Weather Station

- Purchased 2017, installed nearshore in middle bay
- Columbia Weather Systems Pulsar 600 with an Axis M-3025 VE HD dome camera
- Connected to KLWA webpage and Weather Underground in real time, 2,000+ hits per day on average

KLWA Station Weather Conditions

Observations powered by a Columbia Weather Pulsar 600

Last Updated May 31, 2022, 1:40:00 PM

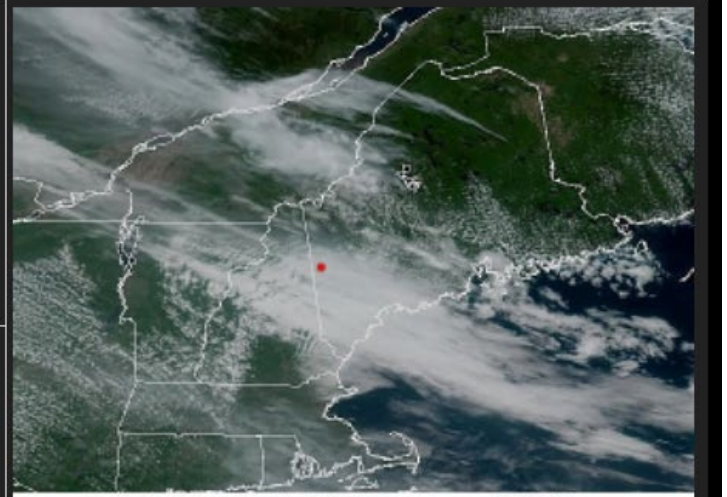
55.6 °F

Feels like: 55.7 °F

High	Low
78.3 °F	54.3 °F

Water: 65.3 °F

Barometer	30.020 inHg
Dew Point	52.3 °F
Heat Index	56.0 °F
Wind Chill	55.6 °F
Humidity	88%
Rain	0.00 in | 0.00 in/hr
Snow (est)	N/A



WSW 249°

Speed	Gust
1	2

mph

Sun & Moon

5:03 AM

8:19 PM

New

1% visible

More Almanac Information

Weather Record Snapshots [View all records]

Tuesday, May 31, 2022			
High:	78.3 °F	**Low:**	54.3 °F
Average Wind:	2 mph	**Highest Wind:**	23 mph
Today's Rain:	0.00 in	**Highest Rate:**	0.01 in/hr

May 2022			
High:	91.6 °F	**Low:**	30.8 °F
Average Wind:	2 mph	**Highest Wind:**	27 mph
Total Rain:	2.16 in	**Highest Rate:**	1.08 in/hr

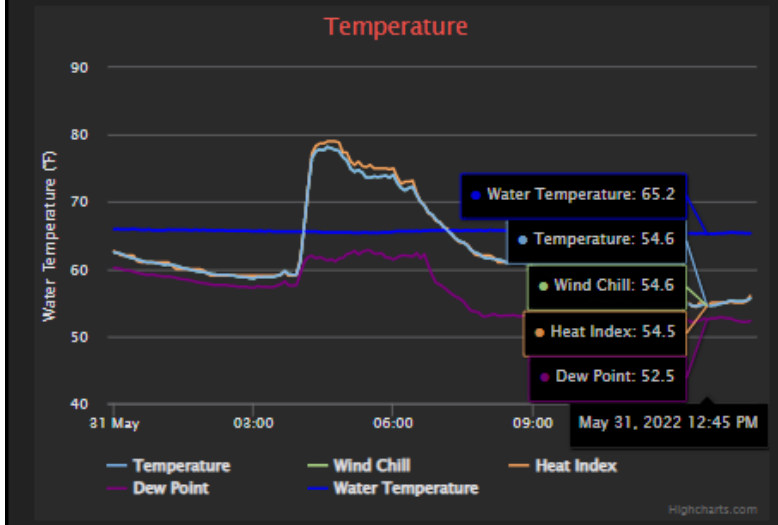
Recent Local Earthquake

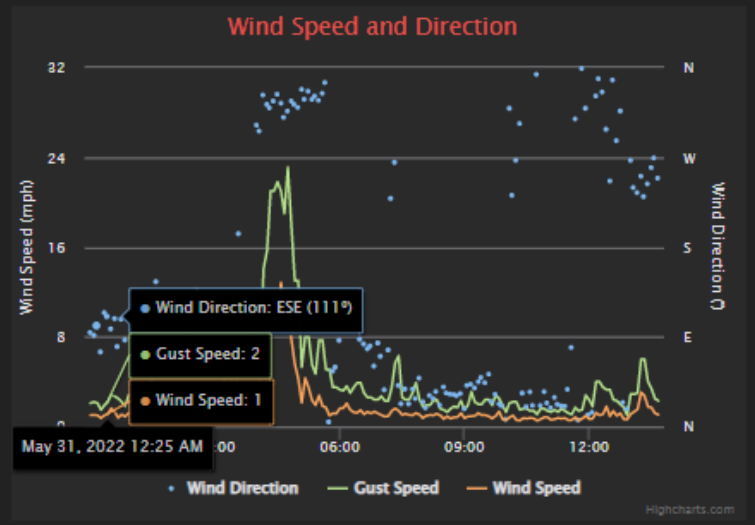
May 29, 2022 10:03 PM

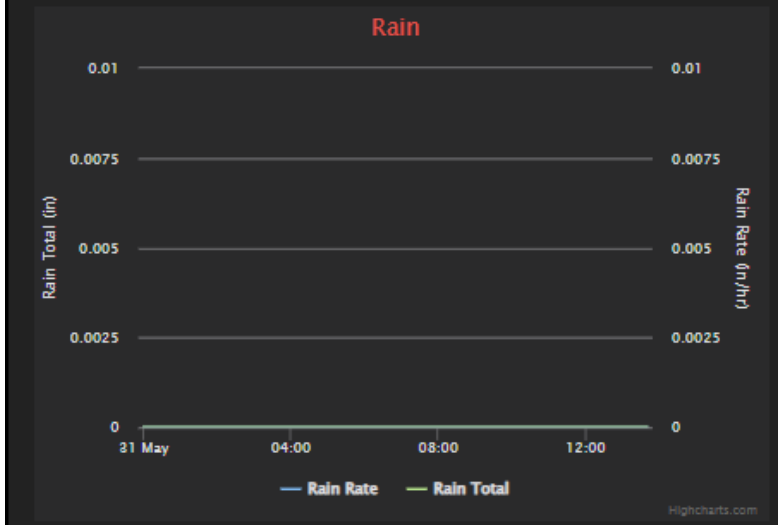
15 km S of Louisa, Virginia

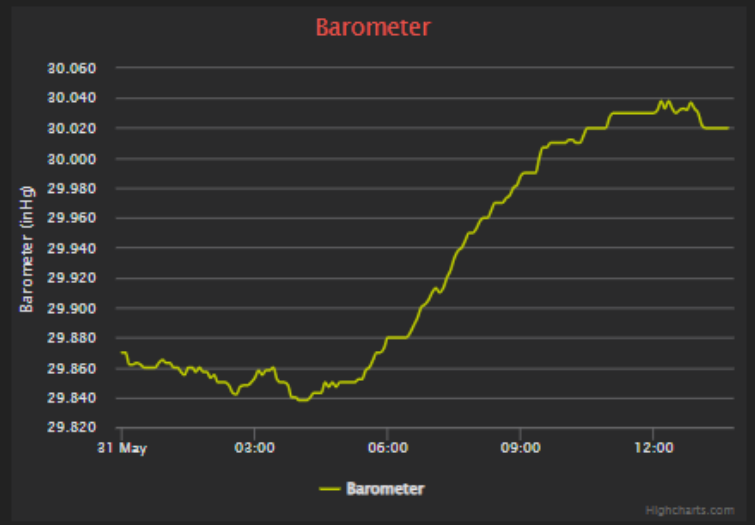
Magnitude	-78.0352 °
2.3	37.8887 °

Today [View all graphs]



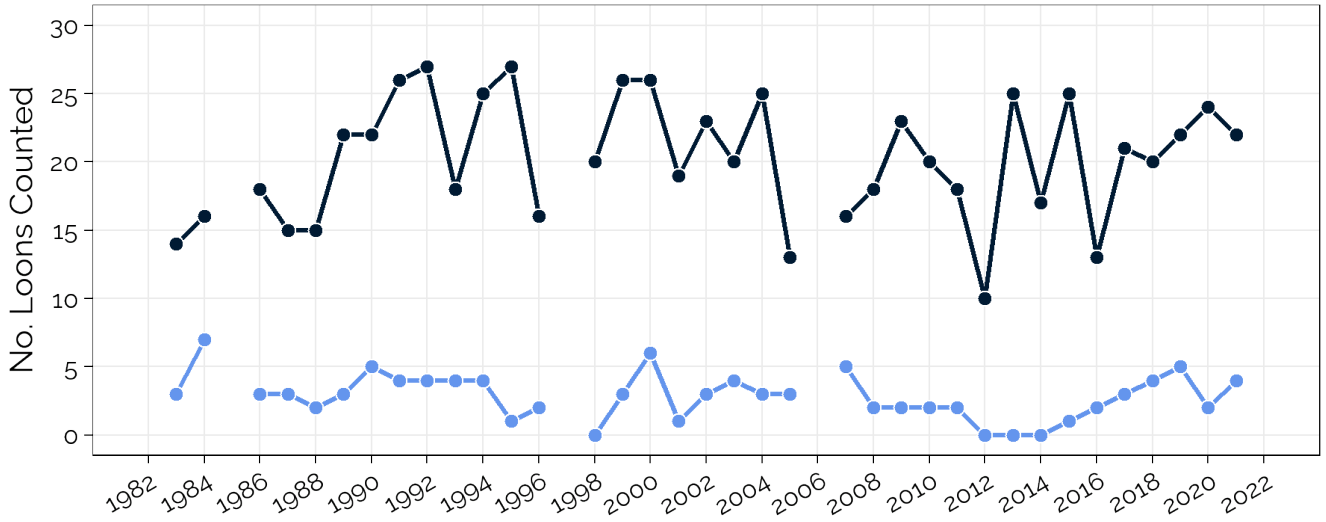






Loon Studies

- Warming air temps too hot for adult loons and eggs (overheat or leave eggs vulnerable to predation or disease)
- Long-term loon monitoring in lake and ponds by volunteers
- 2018-21 KLWA worked with Loon Conservation Associates to capture, band, and monitor loons
- 15 territorial pairs; 12 nested in 2021 with 7 successful; overall doing well in recent years
- Finding higher fledging success on raft nests
- High Hg in blood of upper bay adult loons

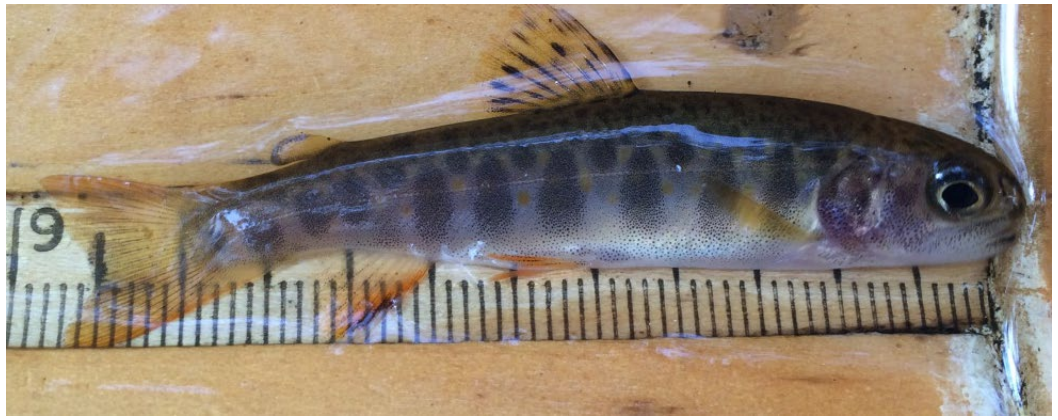


Fish Studies

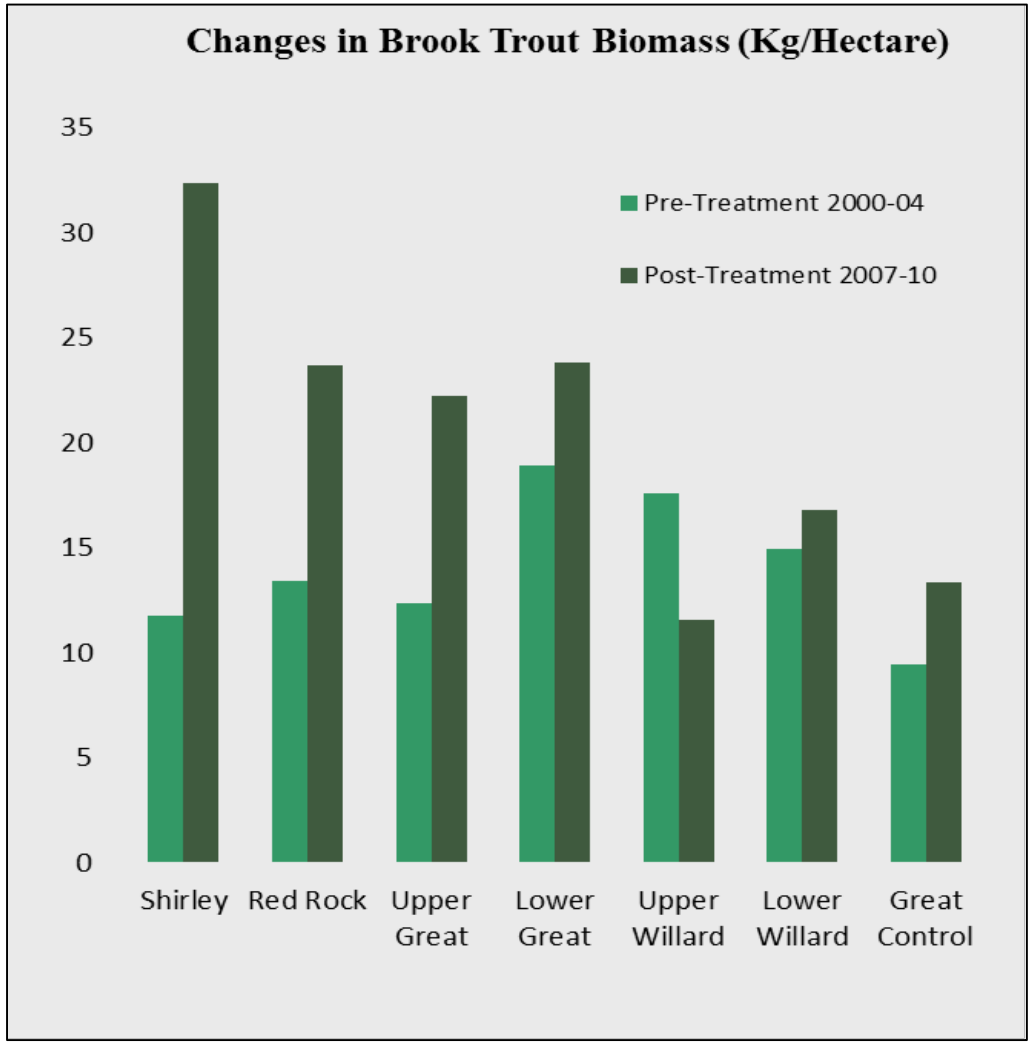
- Coldwater fish in Kezar Lake and tributaries: **landlocked salmon** and **lake trout** (designated as trophy lake)
- Great Brook and Boulder Brook are key landlocked salmon spawning and rearing habitat
- Great Brook harbors some of the last remaining wild populations of **brook trout** in western Maine

Fish Studies

- USFS, KLWA, Stantec have completed nearly annual fish surveys (to assess climate change, harvesting impacts over time)
- Electrofishing depletion sampling in 300 ft rep. reaches



Habitat Restoration

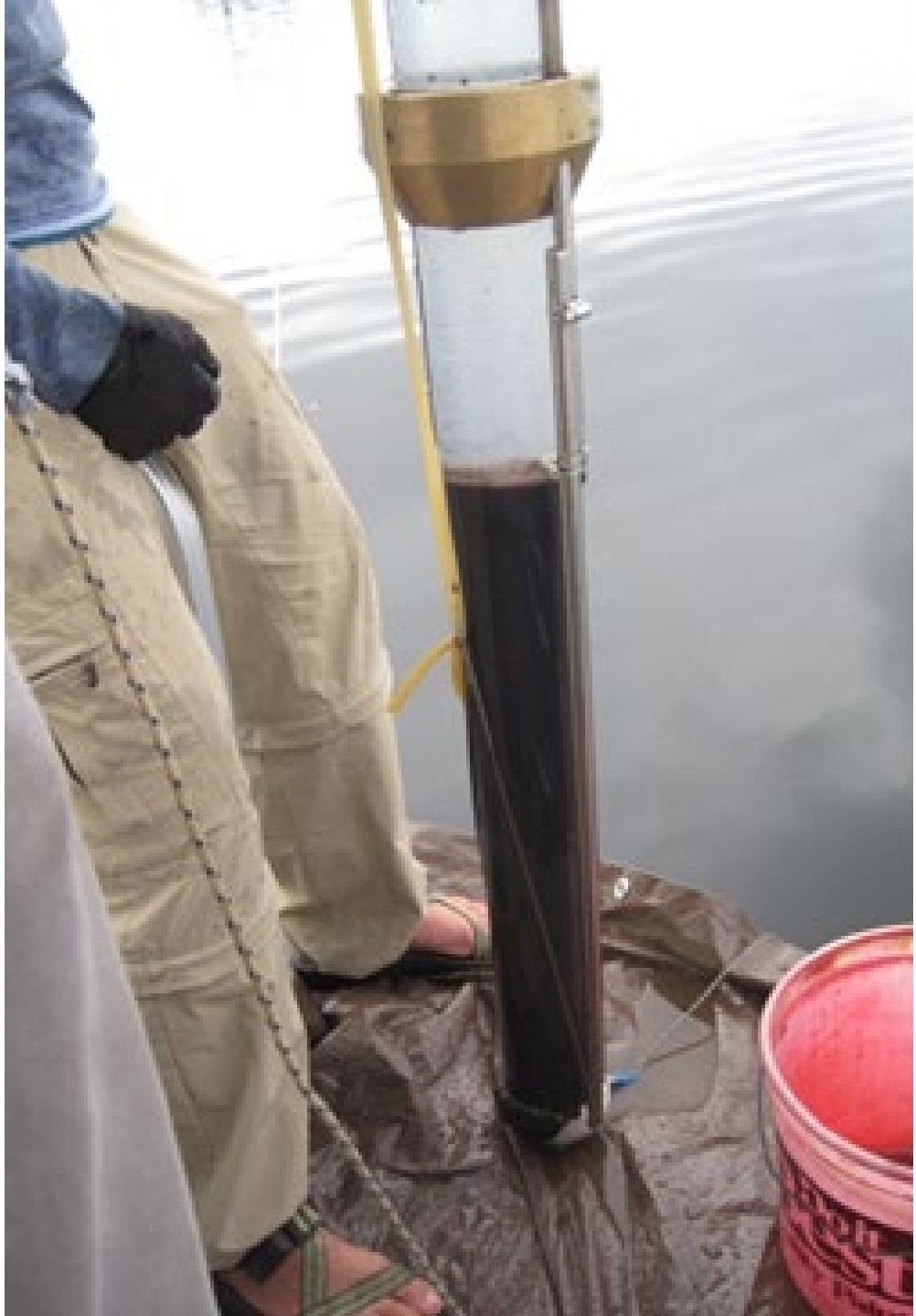


2004 “BEFORE”

2009 “AFTER”

Sediment Core Studies

- Long-term effects of climate change and human disturbance on lakes found in sediments
- Provides sequential record of past conditions
- Link water quality with climate and land use
- 2015 and 2019 cores collected and analyzed by PSU, Dr. Lisa Doner

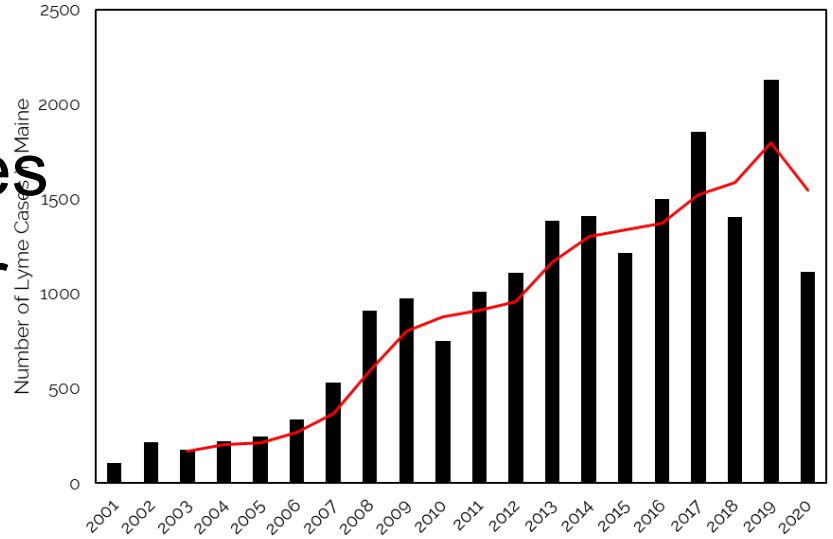


Sediment Core Studies

- Evidence of marked change in shoreline erosion in Kezar Lake in 1980's coinciding with earlier ice-out and increase in boat traffic
- 2000-2015 rapid sediment and organic accumulation in Kezar Lake, likely from intensified watershed runoff and erosion following larger-scale rain/flood events
- Marked change in algal composition after 2008
- Steady rise in lead and zinc until 1970's after ban of leaded gas

Existing Data Compilation

- Lovell Invasive Plant Prevention Committee – compilation of aquatic and terrestrial plants in area
- Zooplankton and crayfish study in 2008 by Dr. Karen Wilson of USM
- State moose permit and harvest data
- Air pollutants – greenhouse gases
- State/regional literature research summaries
- Invasive insect threats – emerald ash borer
- Ticks & Lyme disease awareness



Education & Outreach

Kezar Lake
WATERSHED ASSOCIATION

P.O. Box 88, Lovell, ME 04051 www.klwa.us

CLIMATE CHANGE OBSERVATORY

2015 ANNUAL REPORT

TABLE OF CONTENTS

CONTRIBUTING AUTHORS: LAURA DIEMER, ELLIOTT BOARDMAN (FB Environmental Associates), DON GRIGGS, WES HUNTRESS (KLWA/CCO).

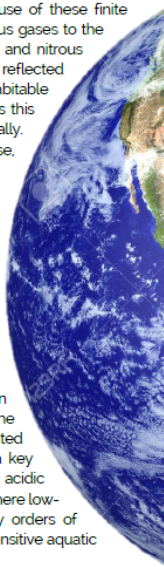
Design by Laura Diemer (FB Environmental Associates)

ANNUAL REPORT ON OBSERVED TRENDS

CLIMATE

Air Pollutants

We rely on the burning of fossil fuels (i.e., gasoline, coal, and natural gas) for nearly all aspects of our everyday lives. This heightened energy demand for and use of these finite resources over the last century has introduced an excess of noxious gases to the atmosphere. Some of these gases (e.g., carbon dioxide, methane, and nitrous oxide), also known as greenhouse gases, are responsible for trapping reflected heat from the earth's surface. This process is vital to maintaining a habitable planet, but excess greenhouse gases in the atmosphere enhances this effect by trapping more heat and increasing air temperatures globally. Warmer air temperatures impact rain and snow patterns, sea level rise, and species migrations.



Fossil fuel combustion also emits sulfur dioxide and nitrogen oxides to the atmosphere. These gases react with water vapor, oxygen, and other gases in the atmosphere to form sulfuric and nitric acids, which fall on water and land surfaces as acid rain. Acid rain lowers the pH of aquatic and terrestrial systems, causing reduced reproductive capacity of sensitive aquatic organisms, lower body weight of fish, decreased species diversity, and forest mortality. Substantial effort was made to reduce acid rain deposition through the 1970 Clean Air Act, which established national ambient air quality standards for controlling these noxious emissions. While emissions have decreased and the damaging short-term effects of acid rain have been minimized, many waterbodies are still recovering from the long-term effects of acidification. In particular, the northeastern United States has thin soils with granite geology that lack carbonates, a key component of a system's buffering capacity or ability to neutralize acidic compounds. We see this in streams of the Kezar Lake watershed where low-pH rain (4.3) temporarily decreases the pH of surface waters by orders of magnitude. These swings in pH create stressful environments for sensitive aquatic organisms.

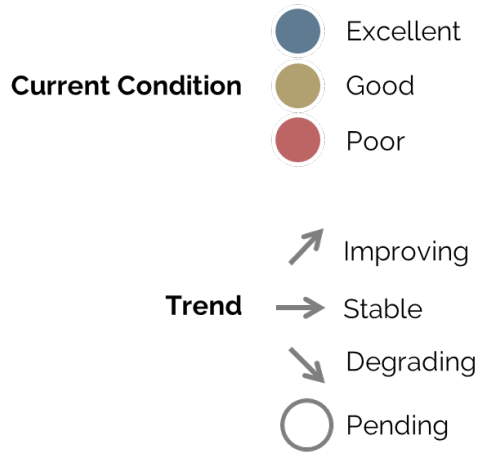
Air Temperature

Climate change is expected to increase global air temperatures, an effect that we have observed in the last century. An important point to understand about climate change is the di between "climate" and "weather." Climate change observations and predications are ba "climate," which is long-term averages of weather observations across regional or global sp example, the State of Maine has seen a 3 °F increase in annual air temperatures in the last and we expect an additional 1.4 to 3.0 °F increase in annual air temperatures by 2040. Local

Lakes and Ponds Trends

Waterbody	Water Clarity	Total Phosphorus	Chl-*a*	Anoxic Extent	Temp	pH	Alkalinity	Color
Kezar Lake Upper Bay								
Kezar Lake Middle Bay								
Kezar Lake Lower Bay								
Bradley Pond								
Cushman Pond								
Farrington Pond								
Heald Pond								
Horseshoe Pond								
Trout Pond								

Key for Data Symbols



Brooks and Streams Trends

Waterbody	Total Phosphorus	pH	Dissolved Oxygen	*E. coli*	Temp	Flow
Great Brook	→	→	→	↘	●	●
Boulder Brook	→	●	→	→	●	
Cold Brook	●	●	●	●	●	
Beaver Brook					●	●
Lower Bay					●	●
Kezar Outlet Stream					●	●
Coffin Brook					●	
Bradley Brook					●	
Sucker Brook					●	
Long Meadow Brook					●	

Key for Data Symbols

Current Condition

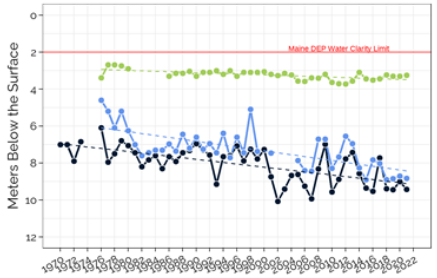
- Excellent
- Good
- Poor

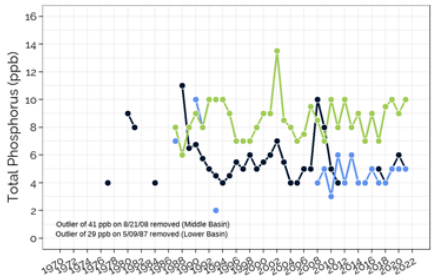
Trend

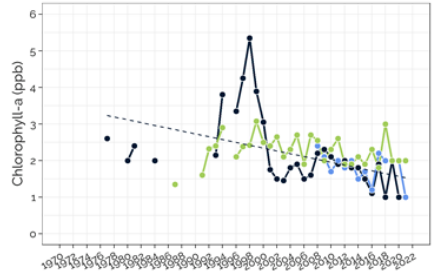
- ↗ Improving
- → Stable
- ↘ Degrading
- ○ Pending

KEZAR LAKE
WATER QUALITY TRENDS

Kezar Lake (Midas #0097) is a non-colored waterbody located in the Town of Lovell, Oxford County, Maine. The lake stretches 9 miles from north to south, covering 2,665 acres (4.16 square miles) and has a maximum depth of 160 feet (49 meters) and a mean depth of 34 feet (10 meters). Water quality monitoring data have been collected since 1970 at Station 1 (upper), 1976 at Station 2 (middle), and 1976 at Station 3 (lower). Note: "stoplight" symbols ordered from left to right show status of upper, middle, and lower basins.







WATER CLARITY

Since the early 1970's, water clarity at all three basins of Kezar Lake has improved with the upper and middle basins improving by nearly 1 meter. The slight, but statistically significant, improvement at the lower basin is an artifact of changing lake depth since nearly all readings hit bottom.

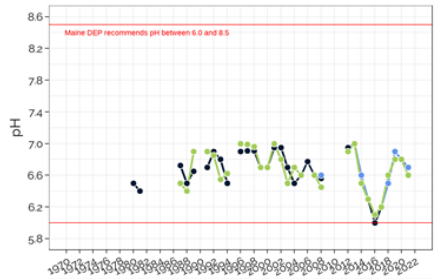
TOTAL PHOSPHORUS

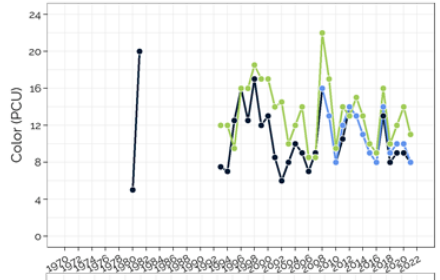
Since the late 1970's, total phosphorus at all three basins of Kezar Lake has revealed no statistically significant trend over time. The generally higher median annual total phosphorus observed at the lower basin is an artifact of its shallow depth, where wave action can disturb bottom sediments that release phosphorus into the water column.

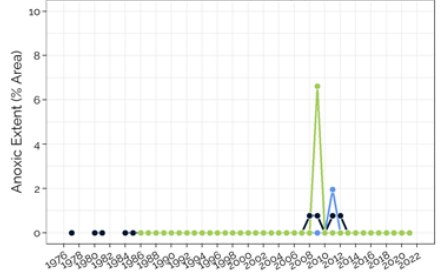
CHLOROPHYLL-A

Since the late 1970's, chlorophyll-a at the upper basin of Kezar Lake has improved, while chlorophyll-a at the middle and lower basins has revealed no statistically significant trend over time. The period from 1994 to 1999 saw a marked rise in chlorophyll-a at the upper basin, but chlorophyll-a has remained at or below 3 ppb since then. Nutrient-rich runoff entering the lake during wetter years, combined with warmer air temperatures, can fuel algae growth.

KEZAR LAKE
WATER QUALITY TRENDS







TOTAL ALKALINITY

Since the early 1980's, total alkalinity at the upper and lower basins of Kezar Lake has degraded by nearly 3 ppm, while total alkalinity at the middle basin has improved by 2 ppm. The region has naturally-low alkalinity (or buffering capacity) as a result of its contributing geology (i.e., granite) that lacks carbonates, bicarbonates, and carbonic acid.

pH

Since the early 1980's, pH at Kezar Lake has revealed no statistically significant trend over time. Generally, pH becomes more acidic as total alkalinity in the epilimnion declines. Low alkalinity makes Kezar Lake susceptible to changes in pH, particularly from acidic deposition in the form of rain or snow, which can jeopardize the health of freshwater fish species.

COLOR

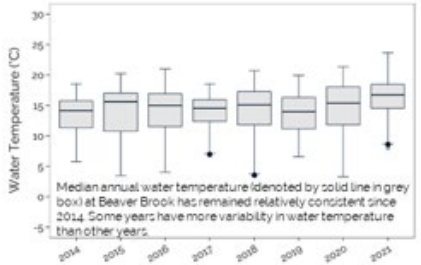
Since the early 1980's, color at Kezar Lake has revealed no statistically significant trend over time. Color is highly related to summer precipitation; wetter years show higher color as more materials are washed off the landscape to the lake. The lack of trend in color is despite the increase in regional precipitation observed in the last century, suggesting that more data are needed to confirm the trend.

ANOXIC EXTENT

Dissolved oxygen profiles show good oxygenation throughout the water column over the collection period. The extent and duration of anoxia is excellent at all three basins.

BEAVER BROOK
WATER QUALITY TRENDS

Beaver Brook is a major tributary to Great Brook, located on the northwest end of Kezar Lake off West Stoneham Road. Beaver Brook drains a portion of the White Mountain National Forest. Water quality monitoring data have been collected since 2014.



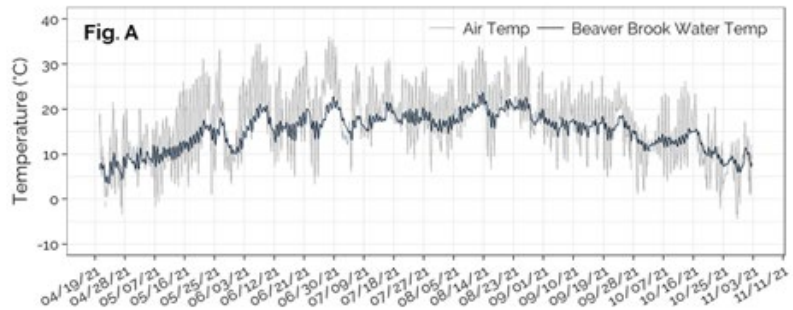
Median annual water temperature (denoted by solid line in grey box) at Beaver Brook has remained relatively consistent since 2014. Some years have more variability in water temperature than other years.

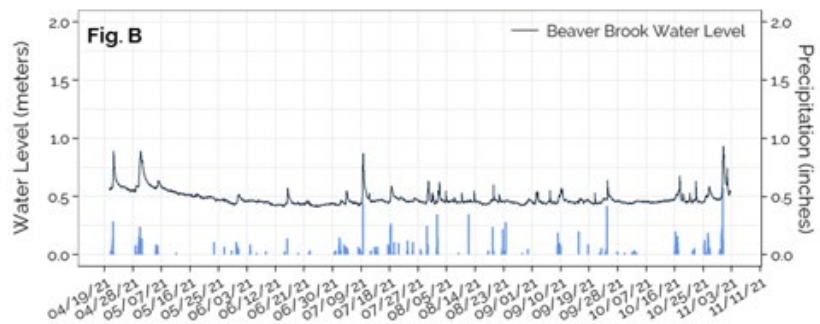
WATER TEMPERATURE

Water temperature (Fig. A) increased at Beaver Brook from May to August and then steadily declined until retrieval in November, following closely with air temperature (data obtained from Fryeburg weather station).

STREAM FLOW

Water level data (Fig. B) collected at Beaver Brook shows that the stream responds quickly to precipitation (daily data obtained from Fryeburg weather station).



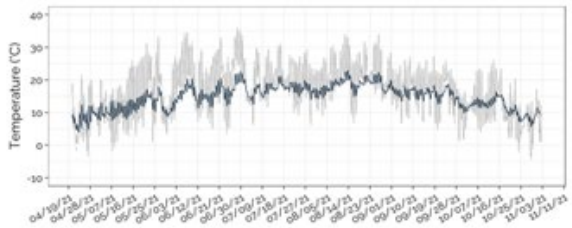


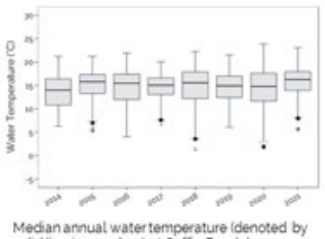
COFFIN BROOK
WATER QUALITY TRENDS

Coffin Brook drains to the eastern side of the upper basin of Kezar Lake, crossing Rt. 5 just south of West Stoneham Road. Water quality data have been collected since 2014.

WATER TEMPERATURE

Water temperature (below, left fig.) increased at Coffin Brook from May to August and then steadily declined until retrieval in November, closely tracking air temperatures (data obtained from Fryeburg station).





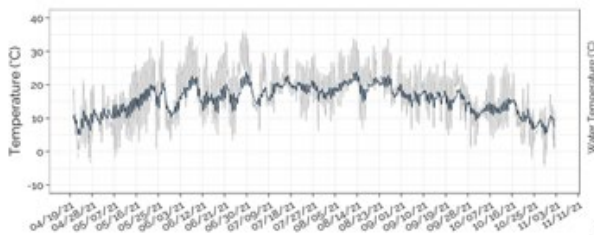
Median annual water temperature (denoted by solid line in grey box) at Coffin Brook has remained relatively consistent since 2014. Some years have more variability in water temperature than other years.

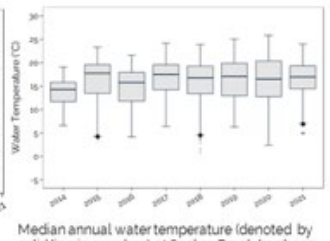
SUCKER BROOK
WATER QUALITY TRENDS

Sucker Brook begins at the outlet to Horseshoe Pond and drains to the western side of the lower basin of Kezar Lake after converging with Bradley Brook. Water quality data have been collected since 2014.

WATER TEMPERATURE

Water temperature (below, left fig.) increased at Sucker Brook from May to August and then steadily declined until retrieval in November, closely following air temperatures (data from Fryeburg station).





Median annual water temperature (denoted by solid line in grey box) at Sucker Brook has been more variable since 2014 than other streams.

ANNUAL REPORT ON OBSERVED THREATS & RECOMMENDATIONS

CLIMATE CHANGE THREAT	ADAPTATION & MITIGATION RECOMMENDATIONS
ACTIONS FOR THE TOWN OF LOVELL	
⊗ Increased air temperatures, fewer extreme cold days, more frequent precipitation events, earlier ice-out since 1972, and decreased annual snowfall. ⊗ Potential degradation of stable or improving trends in water clarity, total phosphorus, chlorophyll-a, and dissolved oxygen.	⊕ Improve infrastructure (roads, ditches, swales, culverts) to accommodate higher and more frequent stormwater flow volumes. ⊕ Replace the remaining high priority culverts identified by the 2015 culvert study. ⊕ Establish a Climate Change Information link on the town website that links residents to important climate change information and the KLWA/CCO webpages. ⊕ In developing the next Comprehensive Plan: 1) include provisions to deal with projected climate change-induced weather events and conditions (e.g., upgrading infrastructure); 2) include language that ensures development occurs in a sustainable and low-impact way to increase watershed resiliency to extreme weather events and prevent potential polluted runoff; 3) include current and projected flood risk maps for residents with homes in low-lying areas; 4) consider rezoning the projected flood zone for non-development; 5) add Low Impact Development (LID) description to ordinance and require LID in site design, especially for lots with >20% imperviousness; 6) increase setback distances to at least 100 ft. around vernal pools, streams, and wetlands; and 7) encourage conservation subdivisions, where applicable, with common open space and require land trusts or conservation organizations (not homeowner's associations) to undertake stewardship of common open space in conservation subdivisions. ⊕ Review and update local septic ordinances to include the following: 1) require septic systems to be evaluated and upgraded to current code or replaced, as needed, for any sale or exchange of property ownership or upon a system failure; 2) require proof of septic system pump-outs every 3 years (unless given an approved waiver for limited use). ⊕ In conjunction with KLWA, conduct a shoreline survey of properties on Kezar Lake and ponds to identify conduits of stormwater runoff (e.g., driveways, boat ramps) and develop specific recommendations for mitigation of erosion.
⊗ Increased threat from invasive species.	⊕ Continue the outstanding progressive watch programs that help prevent and control invasive plants, especially the LIPPC program. ⊕ Encourage local foresters to lookout for infestations of the emerald ash borer. ⊕ Support state, county, and local efforts to prohibit use of out-of-state firewood to prevent the spread of the emerald ash borer.

CLIMATE CHANGE THREAT	ADAPTATION & MITIGATION RECOMMENDATIONS
⊗ Reduction in aquatic bird species, esp. loons.	⊕ Post signage to encourage anglers to use non-lead sinkers and to retrieve fishing line caught in shoreline vegetation. Install "Get the Lead Out" boxes at Town landings for disposing of lead-based fishing gear. Support KLWA guidelines for keeping large boat wakes 500 feet from shorelines to reduce shoreline erosion. Stay at least 200 feet away from loons and their nests.
ACTIONS FOR KLWA	
⊗ Potential degradation of stable or improving trends in water clarity, total phosphorus, chlorophyll-a, and dissolved oxygen.	⊕ Target stormwater management and septic system maintenance outreach to shorefront and riverfront residents. ⊕ Advocate and publicize the merits of achieving LakeSmart certification through the State of Maine. ⊕ Publicize the specific recommendations for sustainable lake shore living in the KLWA's Lake Dweller's Handbook.
⊗ Historic degrading trends in alkalinity and pH in multiple waterbodies.	⊕ Conduct another alkalinity and pH study to better assess the vulnerability of waterbodies to acid rain and watershed activities across years.
⊗ Reduction in coldwater fish populations.	⊕ Continue monitoring stream conditions for supporting coldwater fish species (e.g., temperature, flow, and population size). This will help target streams in need of restoration. Restoration techniques include increasing overhead vegetative cover to help cool stream water temperatures. ⊕ Petition IF&W to make Kezar Lake catch and release only for certain sensitive fish species. Debar all fish hooks and ensure proper fishing line strength to avoid fish injury and entanglement.
⊗ Increased threat from insects and pathogens.	⊕ Contact the Maine Center for Disease Control and Prevention to determine how public notices will be issued during peak tick and mosquito season to warn residents of potential diseases, including Lyme and follow-up to see that people in Lovell receive these notices. ⊕ Educate watershed residents on the threat of the emerald ash borer (along with other invasive species).
ACTIONS FOR GREATER LOVELL LAND TRUST	
⊗ Shifts in the habitat ranges of native plant, bird, and mammal species.	⊕ Continue to conserve and protect land areas that serve as wildlife corridors. ⊕ Work with the State to set up emerald ash borer monitoring sites and inventory ash trees on trust land.

George Weston, Local Farmer

Reg Gilbert, Local Forester

FARMING

- More difficult and costly with changes in seasonal temps and rainfall

FORESTRY

- Red Oaks producing acorns every year now instead of every 3-5 years due to warmer falls with later frosts
- Shorter winters with frozen ground limits timber harvesting operations

Ed Poliquin, Local Fisherman

Scott Davidson, Local Hunter

FISHING

- Observed declines in smallmouth bass populations (likely being outcompeted by northern migration of largemouth bass)
- Shorter ice cover in winter limits ice fishing
- Die-off of small 2-inch perch in lower bay following series of extreme warm days

HUNTING

- Overwhelming tick problem from warming winters
- Attack game animals like moose and deer

ABOUT THE CCO

Who we Are

The KLWA established a Climate Change Observatory (CCO) in 2013 to observe, measure, and analyze long-term climate change trends and to address their impact upon the waters, lands, and wildlife of the Kezar Lake watershed. The CCO is building upon decades of limited local data by expanding data collection activities in the Kezar Lake watershed. The purpose of the CCO work is to provide local governments, civic organizations, and the public with ongoing information concerning the effects of climate change on community interests and recommendations for mitigating or adapting to these potential effects. The CCO publishes an annual report summarizing climate change trends in the watershed.

A HEALTHY WATERSHED STARTS WITH US!

A Message from the Kezar Lake Watershed Association and the Selectmen of Lovell, Stow, and Stoneham, Maine

OUR CONNECTION

As residents or visitors of the watershed, we are intimately connected to all the plants, animals, and other natural resources in the area.

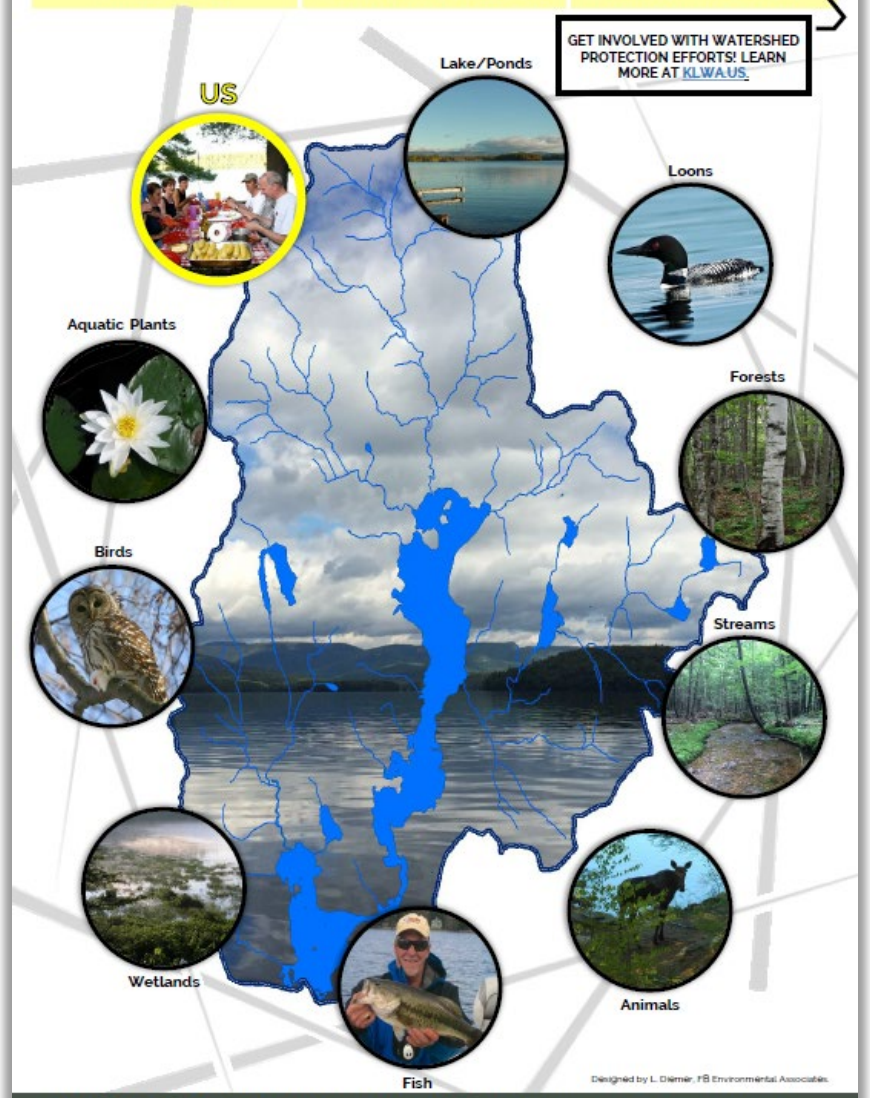
OUR IMPACT

Our actions have an impact on the health of these natural resources, the status of which drives quality of life for people and wildlife and influences property values.

OUR RESPONSIBILITY

We each must do our part to protect the quality of our lake, ponds, streams, and forests. See reverse side for specific actions that you can start doing now!

GET INVOLVED WITH WATERSHED PROTECTION EFFORTS! LEARN MORE AT KLWA.US.



Designed by L. Diemer, FB Environmental Associates.

BE A CONSCIENTIOUS CITIZEN OF THE WATERSHED: the pollutants that our actions generate within every square foot of the watershed will eventually make their way to our streams, ponds, and lake. KLWA is requesting that you do your part to minimize those pollutants and protect our watershed for future generations, particularly in light of already-apparent climate change effects.

WAYS WE CAN HELP PROTECT OUR LAKE, PONDS, AND STREAMS

THE PROBLEM

Human activities within the watershed can increase the amount and transport of harmful pollutants and can introduce dangerous foreign material to area surface waters.

THE CAUSE

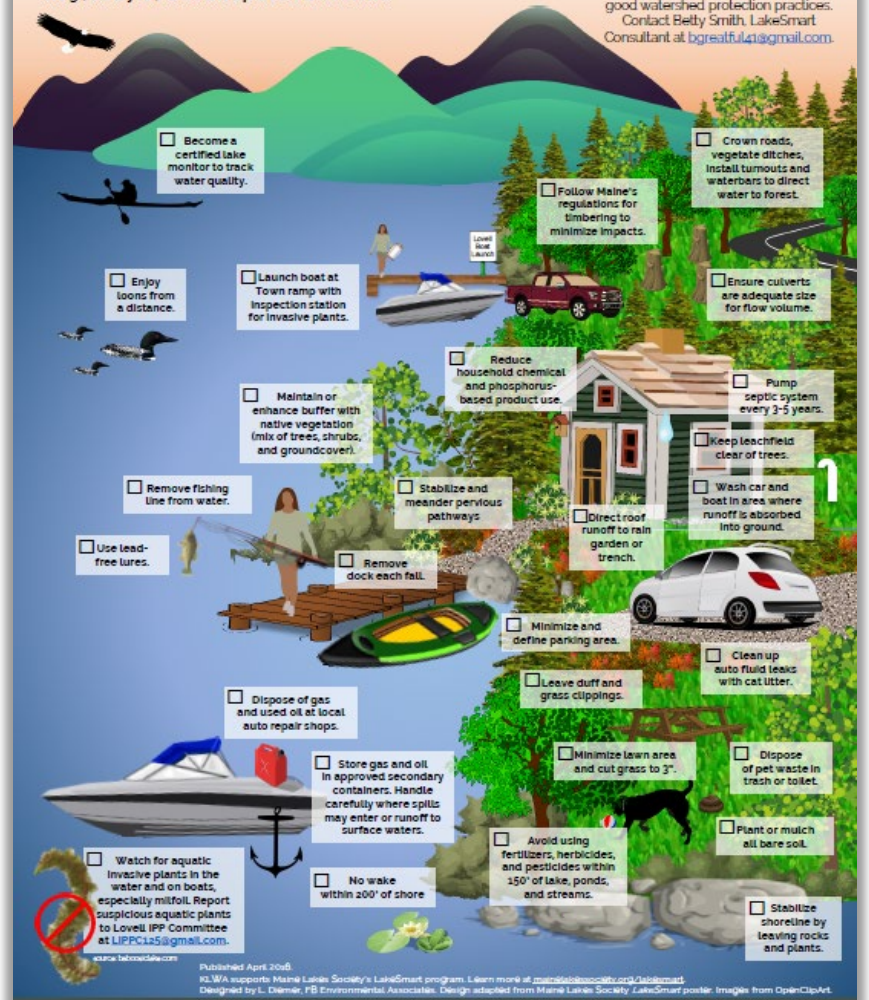
Pollutants can enter the lake and ponds directly or via streams in eroding sediment, groundwater (e.g., aging septic systems), or stormwater runoff (e.g., overland flow from hard surfaces).

THE SOLUTION

We can help protect our lake, ponds, and streams by reducing, diverting, and infiltrating surface runoff, minimizing pollutants, and maintaining shoreline, streamside, and wetland buffers.

☑ **Use the checkboxes to mark off actions you are already doing (thank you!) and make a plan to mark off more!**

FREE assistance is available to assess your property's condition in meeting good watershed protection practices. Contact Betty Smith, LakeSmart Consultant at bgreatful41@gmail.com.



Published April 2018.
KLWA supports Maine Lakes Society's LakeSmart program. Learn more at mainelakessociety.org/lakesmart.
Designed by L. Diemer, FB Environmental Associates. Design adapted from Maine Lakes Society *LakeSmart* poster. Images from OpenClipArt.

Kezar Lake
WATERSHED ASSOCIATION
P.O. Box 88, Lovell, ME 04051 www.klwa.us

MISSION STATEMENT
Our purpose is to preserve, protect and maintain the ecological, scenic and recreational resources of Kezar Lake and its watershed for the benefit and enjoyment of residents, summer residents, and visitors, now and in future generations.

lake dweller's HANDBOOK

Citizen's Guide to Protecting Water Quality in the Kezar Lake Watershed

Kezar Lake Watershed Association

January 2018

what's the big picture? why should we care?

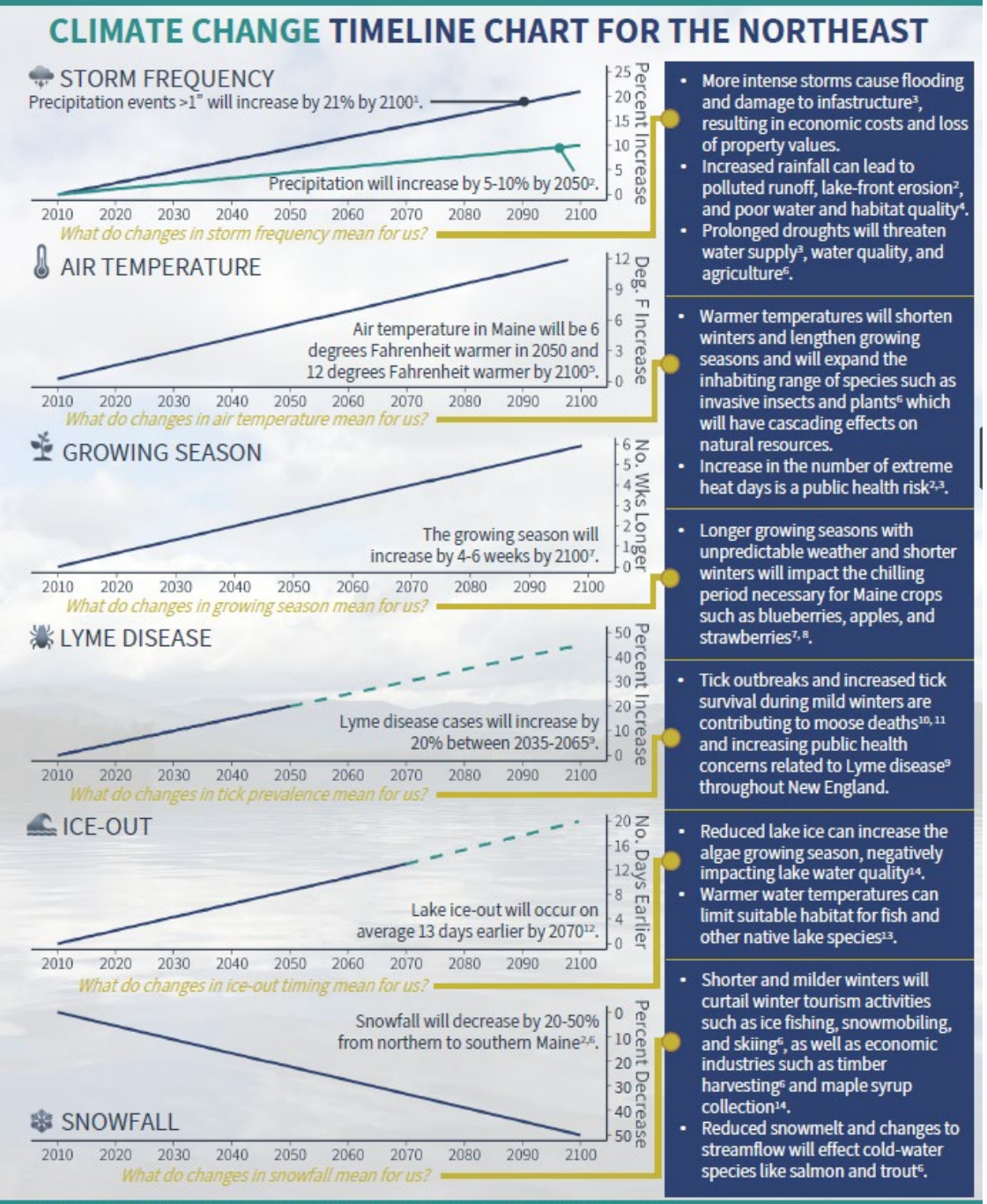
TAKE HOME MESSAGE: Pollutants on land eventually make their way to streams, which feed into the lake or ponds where they can threaten water quality, aquatic life, and personal enjoyment.

The Kezar Lake Watershed
Kezar Lake and its watershed form a uniquely-beautiful and sensitive ecosystem in western Maine. The lake is recognized for its clear waters, ecological diversity, recreational opportunities, and vital contribution to the local economy.

Our Connection
As residents or visitors of the watershed, we are intimately connected to the health of all the plants, animals, and other natural resources in the area. The health of the watershed and the water quality of our lake, ponds, and streams drives quality of life for people and wildlife and greatly influences property values.

Our Impact
Our actions can increase the amount and transport of harmful pollutants and can introduce dangerous foreign materials to surface waters. These pollutants eventually make their way to our streams, ponds, and lake where they can cause serious water quality issues.

? A watershed is the area of land that drains water to the outlet of a waterbody.



Developed **Climate Change Timeline Chart for the Northeast** and was distributed to municipal officials and watershed residents as a tool or resource for enhancing awareness of impacts and threats associated with climate change.

Maine's Year in Climate Change

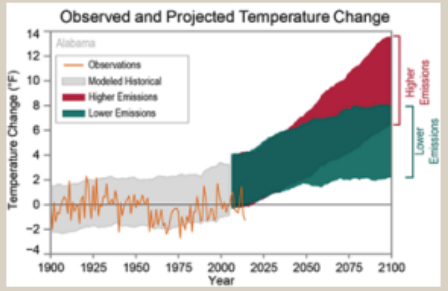
by DON GRIGGS

Maine's Climate Future 2020 Update

The University of Maine Climate Change Institute issued the *Maine's Climate Future - 2020 Update* to document important changes in Maine's climate since last recorded five years ago. The report also highlights examples of how our changing climate is and will continue to impact many aspects of Maine's economy, such as farms, forests, fisheries, tourism, and recreation. We must sound the call to action at every level—federal, state, municipal, and individual—to implement the mitigation and adaptation strategies necessary for the sustainability of our economy and the health of Maine people. We encourage you to read the report and find small but significant ways to change aspects of your daily lifestyle that will make a difference for the future of our children.

FMI: https://climatechange.umaine.edu/climate-matters/maines-climate-future/

Temperatures in Maine have risen about 3 degrees F since 1900. Winter temperatures have been increasing about twice as fast as summer temperatures. Under a higher emissions pathway, historically unprecedented warming is projected by 2100.



2019 was the second warmest year on record (following 2016) according to the World Meteorological Organization. Average global temperatures have risen approximately 1.1 °C since the age of pre-industrialization (1900). Maine's average annual air temperature is changing remarkably fast. Over the last 124 years, the annual average temperature across the state has increased 3.2 degrees Fahrenheit, and the warmest years on record have occurred since 1998. As a result of these warmer temperatures and later frosts in the fall, the growing season is more than two weeks longer than it was in 1950. Additionally, the warmer temperatures are shifting ice out in Maine anywhere from one day to three weeks earlier depending on changes to local climate conditions and individual lake characteristics. Climate change is also increasing the frequency and intensity of precipitation, causing inland flooding, damaging infrastructure, and impacting drinking water. Since 1895, average annual precipitation in Maine has increased by 15 percent, and it is coming more in the form of rain and less snow. Statewide average annual snowfall has decreased by an estimated 17 percent over the last century. During the winter season there are now more rapid shifts from freezing to thawing conditions, with Maine experiencing more days of bare ground and mud than snow, ice, and frost.

Addressing Climate Change Impacts Locally

There are many ways that individuals, businesses, groups, or towns can make a difference locally to mitigate and/or adapt to climate change. Refer to the *Lake Dwellers' Handbook* or the *"Do Your Part" Flyer* for more helpful tips. See also Publications on the **kezarwatershed.org** website.

Develop a climate adaptation strategy at the municipal level to set goals and strategies for mitigating and adapting to the impacts of climate change on our local infrastructure and natural resources.

- Encourage local leaders to incorporate projected climate change induced weather events and conditions to the next Comprehensive Plan update and/or create a climate adaptation strategy (for one or more towns) that assesses vulnerability of natural resources and infrastructure, sets goals, identifies, evaluates, and prioritizes actions, and builds off existing municipal programs and initiatives. An example of a priority action would be to improve roads, ditches, swales, and culverts to accommodate higher and more frequent stormwater flow volumes.

Donate to or become a member of local volunteer groups that help to protect the area's natural resources. Reducing threats to better protect our natural resources will have great economic benefit in the long-term.

- Join local volunteer groups such as LIPPC to continue the outstanding progressive watch programs that help prevent and control invasive aquatic plants.
- Become a member of KLWA and support ongoing activities and programs such as water quality monitoring.
- Donate to local land trusts such as GLLT to help manage existing conservation lands and purchase new properties. Consider putting a portion of your property in conservation.

Be aware of activities on your property and make any improvements that will reduce the amount or chance of sediment erosion and pollutant runoff to the lake or ponds. Protecting Kezar Lake's water quality now will make the lake more resilient to climate change induced impacts in the future.

- Enlist your shorefront property for evaluation by the LakeSmart Program and become LakeSmart certified. Maintain or enhance your property's shoreline buffer with native vegetation (mix of trees, shrubs, and groundcover). Crown private roads and driveways, vegetate ditches, and install turnouts and water bars to direct water to the forest for infiltration. Stabilize and meander pervious pathways. Direct roof runoff to a rain garden or trench. Minimize and define parking areas. Wash cars and boats in an area where runoff is absorbed into the ground. Leave duff and grass clippings. Minimize lawn area and cut grass to three inches. Plant or mulch all bare soil.
- Regularly maintain your septic system and follow good housekeeping practices.
- Limit the use of chemicals, fertilizers, and pesticides or herbicides on your property or in your household. Clean up any auto fluid leaks and dispose of gas and used oil at local auto repair shops.
- Follow state and local regulations for timber harvesting that minimize the impact to streams and retain shaded stream habitat for sensitive cold-water fish species.

Reduce your carbon footprint to help reduce global greenhouse gas emissions that are causing climate change.

- Conserve energy use by purchasing energy-efficient appliances and other machinery and limiting consumption. Setting your thermostat 1-2 degrees higher in the summer and lower in the winter can make a major difference in greenhouse gas emissions. Consider purchasing an electric vehicle for your next car.

Loon Nests: A Difficult Year

by LAURA ROBINSON

The summer of 2020 will be remembered for the new types of support that we were able to offer our loons. Yet between predation, habitat loss, fluctuating water levels, and large boat wakes, the number of chicks fledged remained our lowest yet.

The season began with territorial squabbles, breaking the pair bonds of our Northwest Cove and Trout Pond birds. While in the past these two pairs have been some of our most productive, with new mates in place, neither pair attempted to nest this season.

As in past summers, mammalian predation plagued the nests of our Middle and Upper Bay birds. For the first year ever, we built fences around the second nests of loons that had lost their first clutch of eggs to predators. Much to our surprise, we were able to construct the fences while the birds remained cooperatively on nest. Though fences did prove helpful in warding off predators—with fenced-in nests lasting several weeks rather than just a few days—ultimately two of those three nests succumbed to predation. We are looking at modifications for next year.

Even beyond fencing, 2020 was an unprecedented year for loon/human cooperation as the rising waters of early July threatened to submerge nests. In a most memorable assembly line, nesting materials were slung by the handful from volunteers to loon, as the receiving bird hoisted beakfuls of muddy roots and sticks straight onto its sinking nest. Likewise, team members were able to salvage a drowning nest that had been abandoned when the egg became partially


LAURA ROBINSON

submerged. After volunteers reconstructed the nest further back from the rising water and replaced the egg, the loons did resume nesting, although try as both humans and birds did, neither of these attempts ultimately led to a hatch.

In the end, of the watershed's sixteen territorial pairs, ten built nests, six of which had to re-nest after predators stole their eggs. Three of the seven chicks that subsequently hatched were lost to predators, most likely eagles or snapping turtles. This left just four chicks—our lowest productivity in recent years.

While we have two more years before our loon study is complete, it is certainly becoming clear that care must be taken to support our loons. With about 75% of successful chicks hatching on platforms, these rafts are playing a key role as we strive for a sustainable population. Yet predation, rising waters, habitat loss, and large boat wakes plague the uphill battle.

As the weather cools, I want to extend heartfelt thanks to our team of volunteers for their stalwart dedication throughout another intensive season. Do check out the loon page on our website to see the reward for these efforts: the Great Brook chick trying its best to become airborne, as its parent looks on. Fingers crossed that our 2020 fledglings will soon be ocean-bound!

BE WAKE WISE

CONCERNS

Wake surfing and wake boarding have increased substantially in recent years. While the challenges and excitement of these sports are undeniable, they do require large wakes which can have side effects on Kezar Lake.

SIDE EFFECTS

Large wakes can damage docks, moored boats, loon nests and limit enjoyment of small watercraft like paddleboards, canoes and kayaks. Large wakes also erode the shoreline and stir up bottom sediment which often has a high phosphorous content. Phosphorous can cause algae blooms. Sediment can clog fish gills and suffocate fish eggs.

CAUSES

While large wakes are often associated with high speed boating, you may be surprised that slow-speed boating (6 to 12 mph) creates the largest wakes. Off plane, a boat's bow angles up and the propeller angles down which creates large wakes and stirs up bottom sediment in shallow water. This is known as "plowing the water" as shown below.

Kezar Lake
WATERSHED ASSOCIATION
P.O. Box 88 Lovell, ME 04051
www.klwa.us

PROTECT WATER QUALITY. BE CONSIDERATE OF OTHER BOATERS. RESPECT AQUATIC HABITAT AND WILDLIFE.

HOW TO HELP

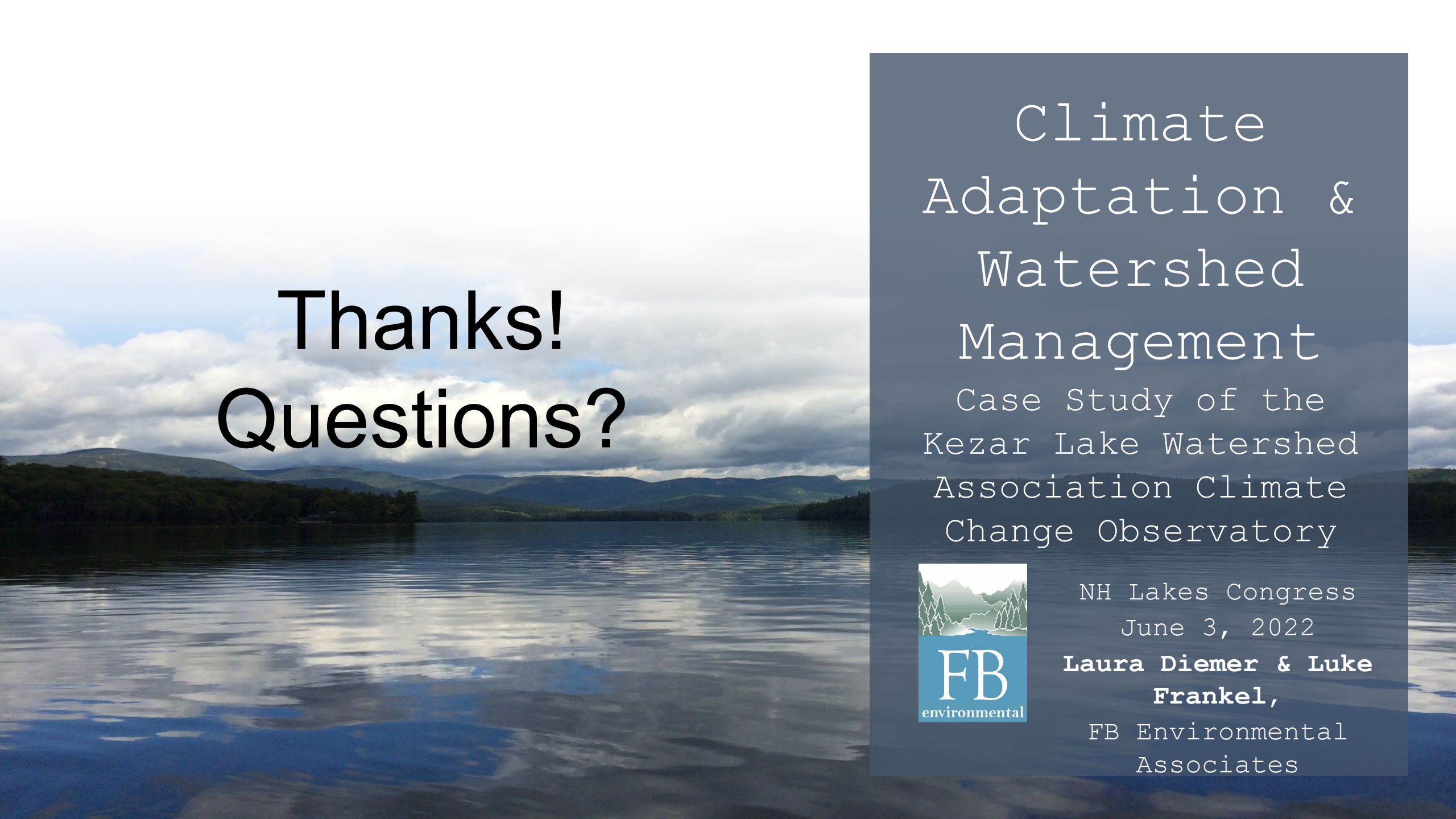
- Find large water areas where wakes will diminish before reaching shore and where propeller wash won't scour the bottom.
- Operate your boat at least 500 feet from shore.
- Operate in water more than 20 feet deep.
- Avoid small bays, channels and enclosed areas, especially during high water periods.
- Avoid marshy areas where fish and loon habitat is likely to exist.
- Leave and approach shore in a straight line. Turning makes large wakes.
- Operate at least 500 feet from small water craft.

Kezar Lake
Lovell, Maine

Areas in yellow are best for boating that causes large wakes.

Conclusion

- CCO has been highly successful at collecting, analyzing, and distributing climate change related information for their watershed.
- Success was achieved because of:
  - Strong local leadership
  - Sustainable funding source
  - Collaboration with diverse partners
- Climate change impacting all our lakes and altering their ability to provide aesthetic, recreational, and ecosystem services.
- Understanding how and why lakes are changing allows us to be better prepared to adapt and/or mitigate to those impacts.



Thanks!
Questions?

Climate Adaptation & Watershed Management

Case Study of the Kezar Lake Watershed Association Climate Change Observatory

NH Lakes Congress
June 3, 2022

Laura Diemer & Luke Frankel,
FB Environmental Associates