

Resilient Shorelines: Adapting to Climate Change



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Road map

- Global overview
- Regional trends in the Northeast:
Warmer and Wetter
- Time for Action: A Renewed Focus on
Shoreline and Riparian Zone
Management

117 Million Lakes on the Planet



Lakes Important for Biological Diversity



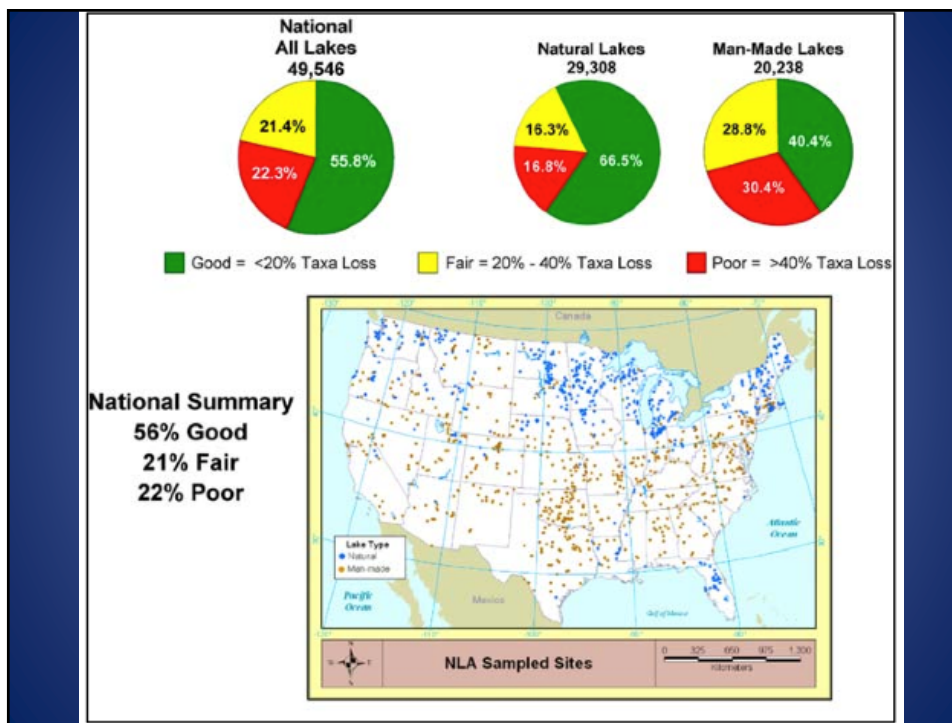
Freshwater ecosystems hold an estimated 12% of all animal species on Earth.

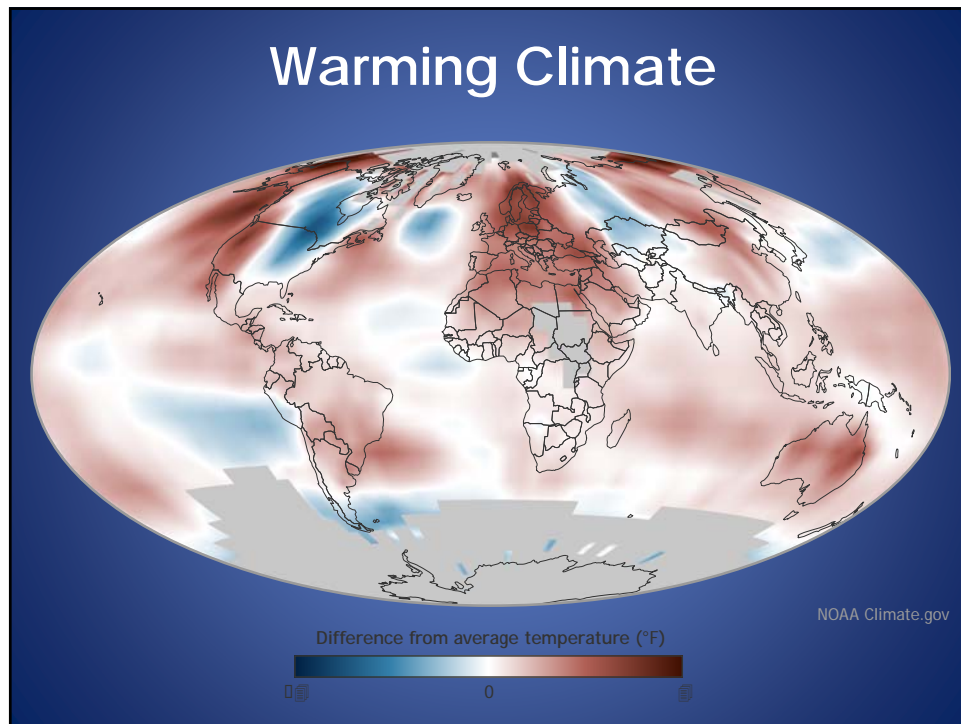
Lake Nakuru, Kenya

Globally, Lakes Are Under Threat

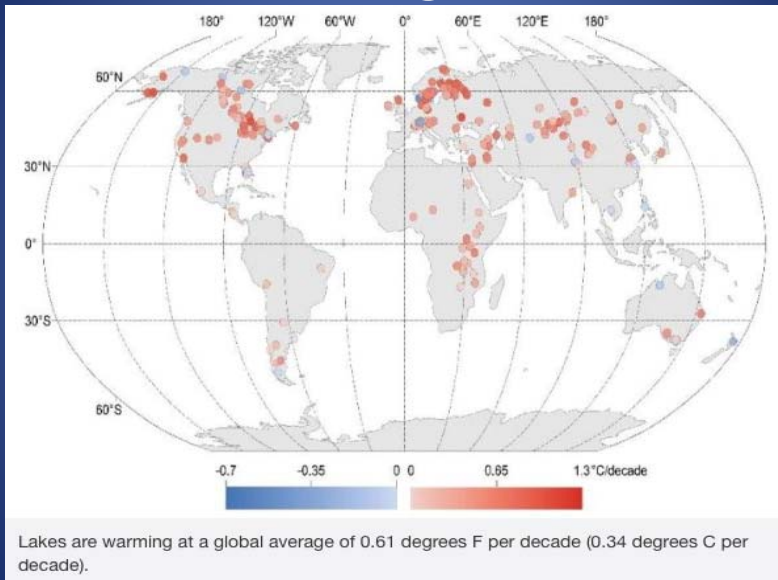


Nutrient pollution, water diversions, invasive species, toxins...climate change and HABs.



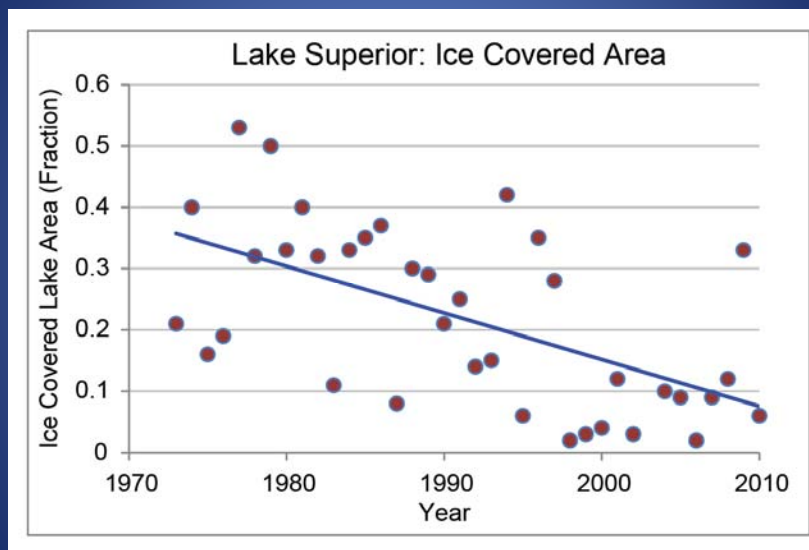


Warming Lakes

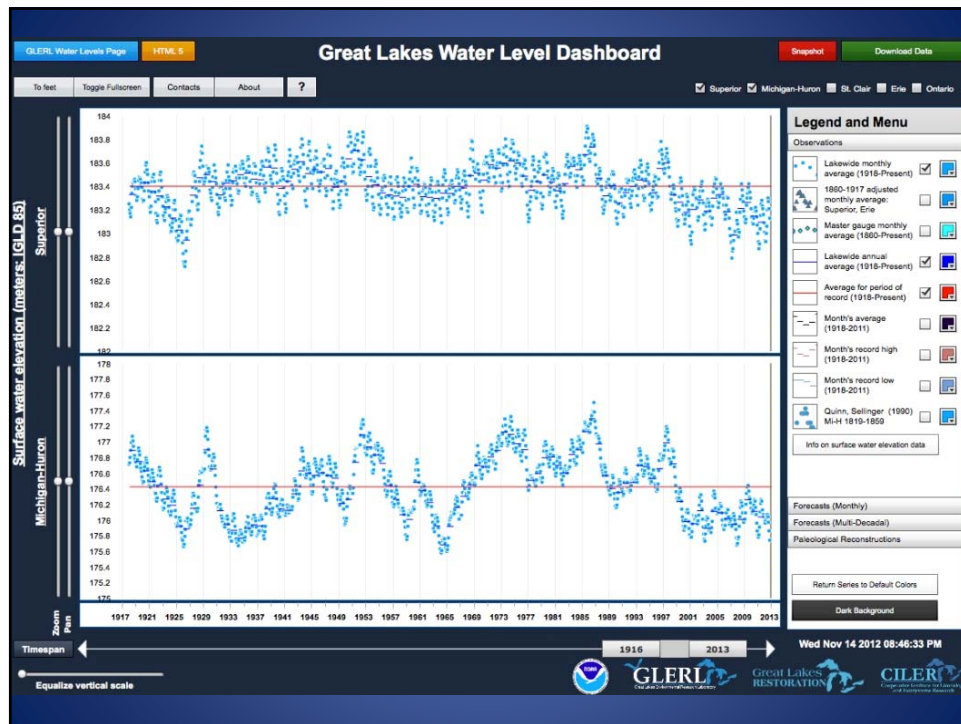


Source: O'Reilly et al. 2015

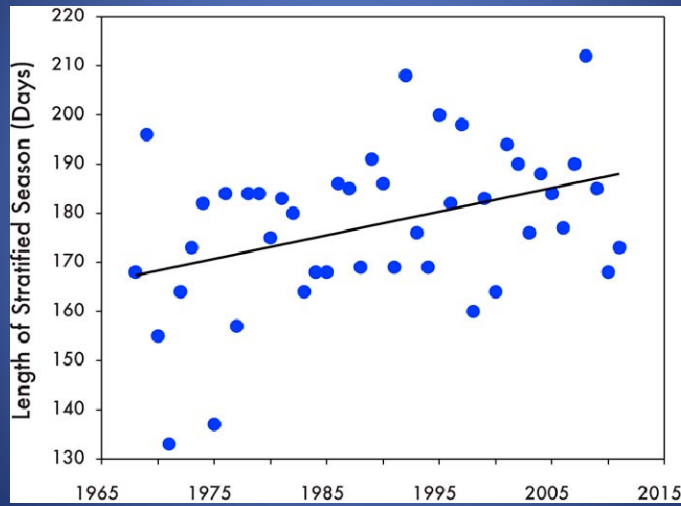
Ice Cover Decreasing



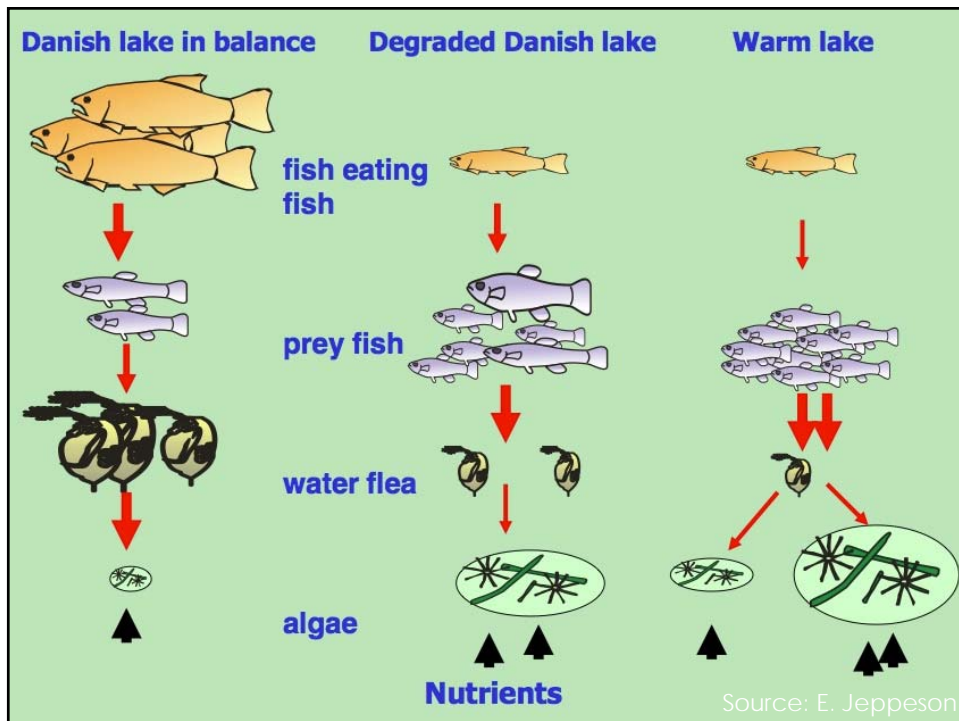
Source: National Climate Assessment 2014

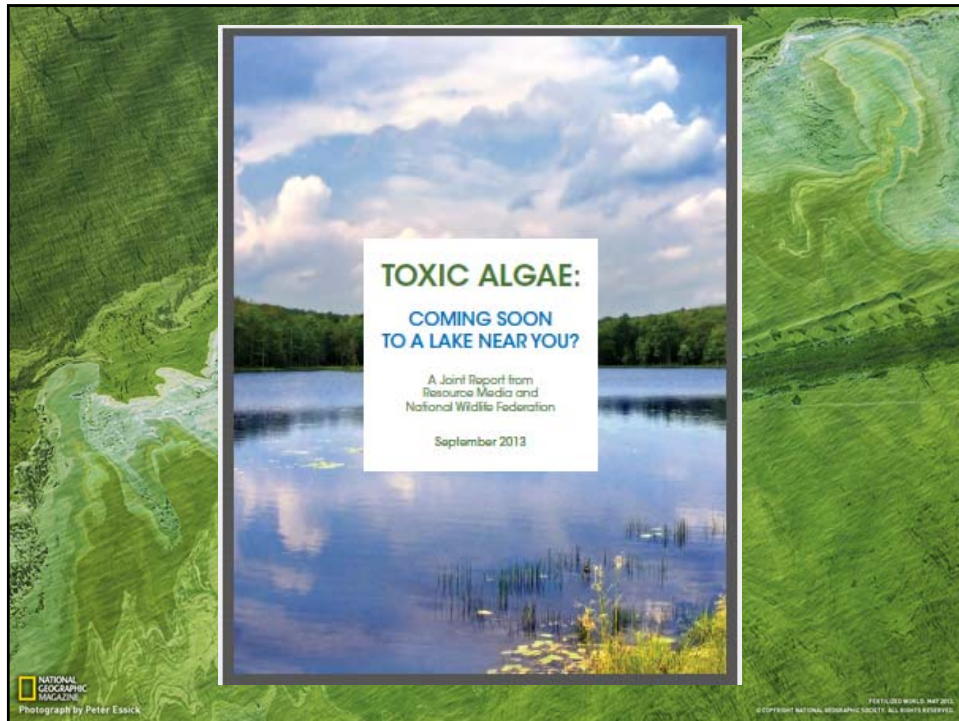


Stratification Season Becoming Longer



Source: State of Lake Tahoe 2012

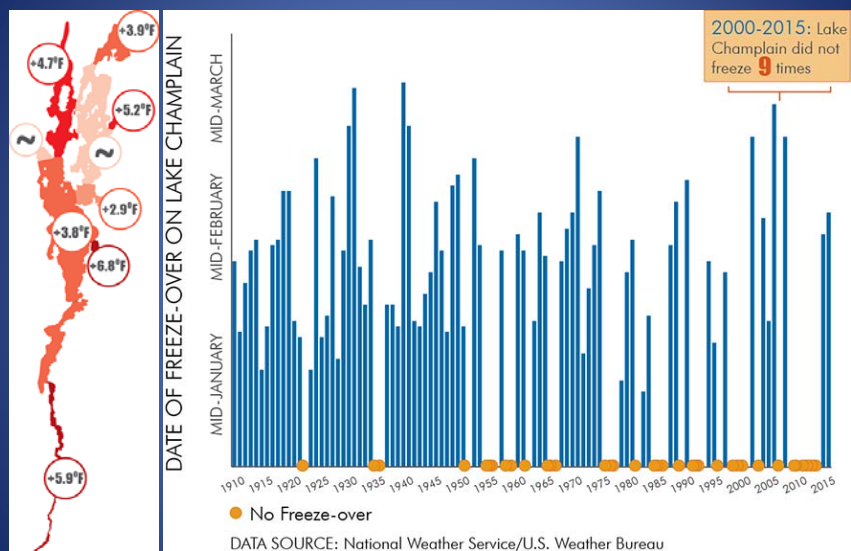




A warmer and wetter Northeast

REGIONAL TRENDS

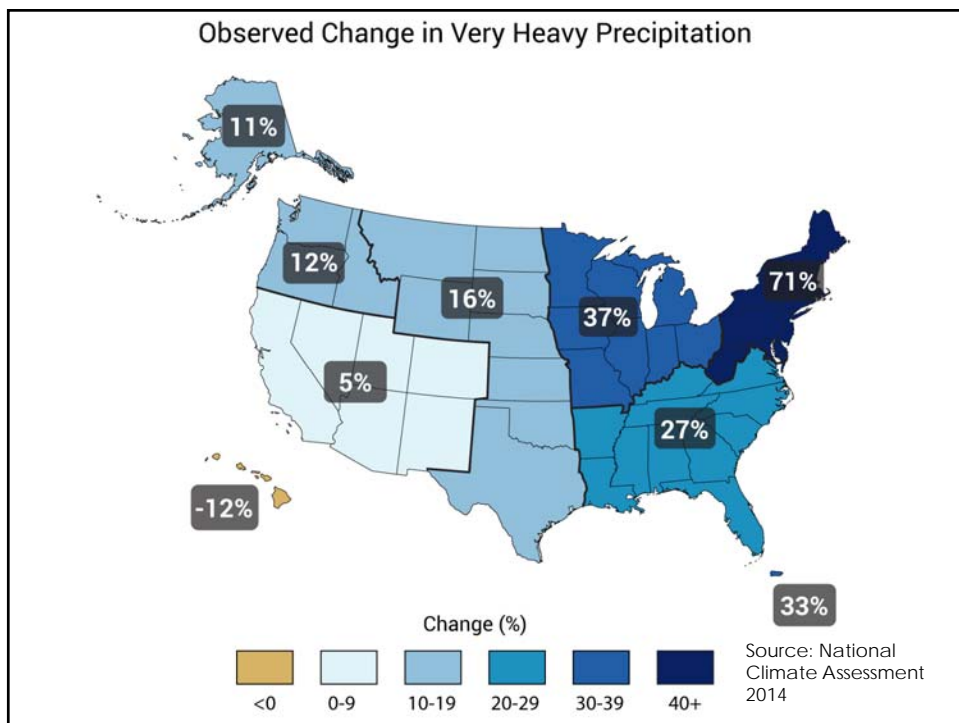
Warming Lakes: Champlain



Credit: Lake Champlain State of the Lake 2015

Lake Sunapee, NH

Surprising find: blue-green algal blooms of "Gloeo" began to appear in 2004 in this oligotrophic (clear water) lake.



Flooding and Extreme Rain Events Becoming More Frequent



Photo credit: LCBF



GLEON

Networked lake science

Global Lake Ecological Observatory Network

... and a network people, lakes and data

Publications

2011

Fragoso, C. R., Motta Marques, D. P., & de Lencastre, F. (2011). Software. 26, 1337-1348.

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Read, J. S., Shade, A., Wu, C. H., Gorzalski, A., & McMahon, K. D. (2011). "Gradual Entrainment Lake Inverter" (GELI): a novel device for experimental lake mixing. *Limnology and Oceanography: Methods*, 9, 14-28. doi:10.4319/lom.2010.9.14.

Sadro, S., Melack, J. M., & MacIntyre, S. (2011). Depth-integrated estimates of ecosystem metabolism in a high-elevation lake (Emerald Lake, Sierra Nevada, California). *Limnol. Oceanogr.*, 56(5), 1764-1780.

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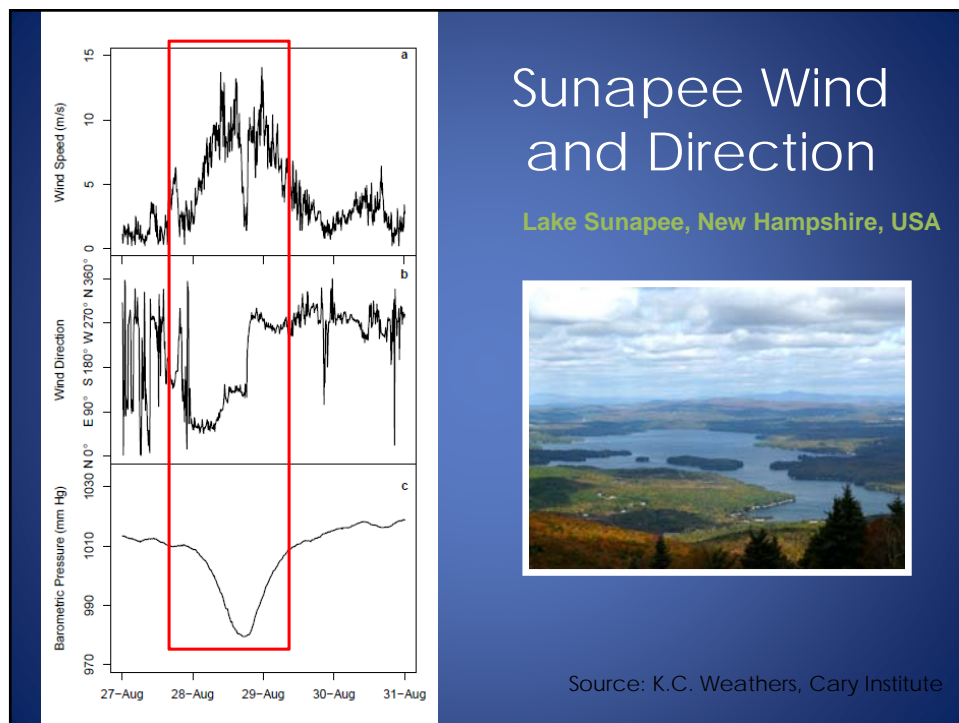
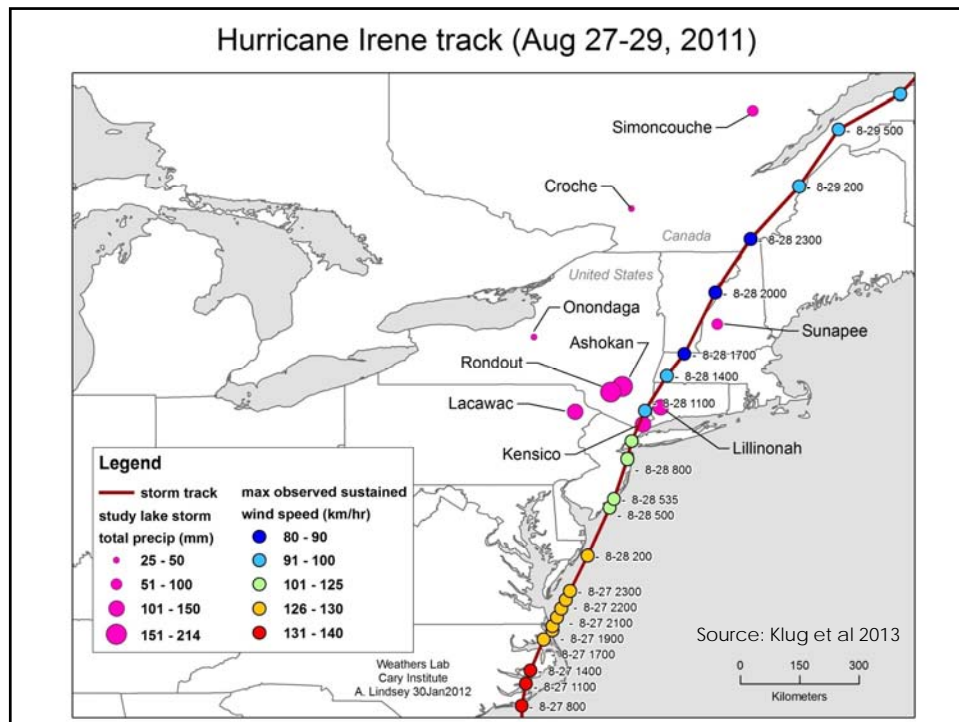
Han, R. (2010). Perspectives on next generation technology for environmental sensor networks. *Environmental Monitoring and Assessment*, 174(1-3), 1769-1779.

Wang, Y. (2010). Anguillicoloides crassus infection of European eel, *Anguilla anguilla* (L.), in inland waters of China. *Journal of Parasitology*, 140(1), 1-10.

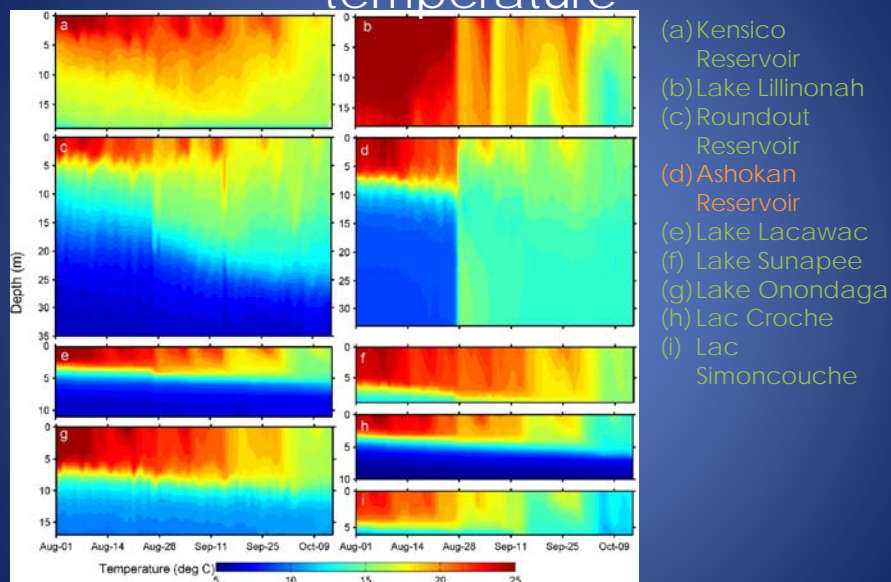
Hu, Y. H. (2010). Control of dissolved oxygen in northern temperate lakes over scales ranging from minutes to days. *Aquatic Biology*, 9, 193-202.





Temporal variation in water temperature



Source: Klug et al. 2013



Ashokan Reservoir before and after Irene showing the brown inputs of terrestrial material.

Photo credit: Perri Paul and Tom Mills, NYC DEP

A Renewed Focus on Shoreline and Riparian Zone
Management

TIME FOR ACTION

Lake Champlain: Shoreline and Riparian Zone Management



Photos courtesy of LCBP

A combination of green and gray infrastructure.

Lake Sunapee, NH Road Culvert Re-sizing



Photos by Midge Eliassen

Planning based on past storms no longer adequate.

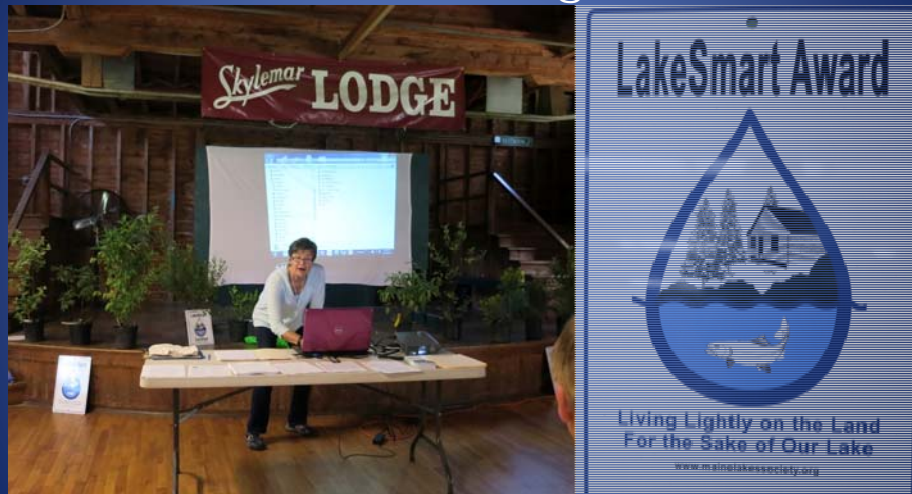
Lake George, NY “Lake-saving Projects”



Photos courtesy of LGA

Erosion control and stormwater management

Maine Lakes Society: LakeSmart Program



Award program for installing shoreline protection measures.

Build resilience with sound shoreline and riparian zone management

- Establish shoreline buffer zones, with larger and wider buffer zones on steeper slopes.
- Incorporate the use of green stormwater infrastructure and low impact development techniques.
- Place greater emphasis on shoreline and riparian zone management practices such as restoring natural shorelines and floodplain corridors.
- Establish greater connectivity amongst tributaries, floodplains, and wetlands to mitigate flood risk.
- Reconsider design standards for culvert sizing and backroads management (decision making based on the probabilities of past events is no longer adequate).
- Take into account recent precipitation and temperature trends, as well as the most likely projected future climate trends.

Keep sediments and nutrients from washing into the lake!



Join the 2016 Secchi Dip-In!

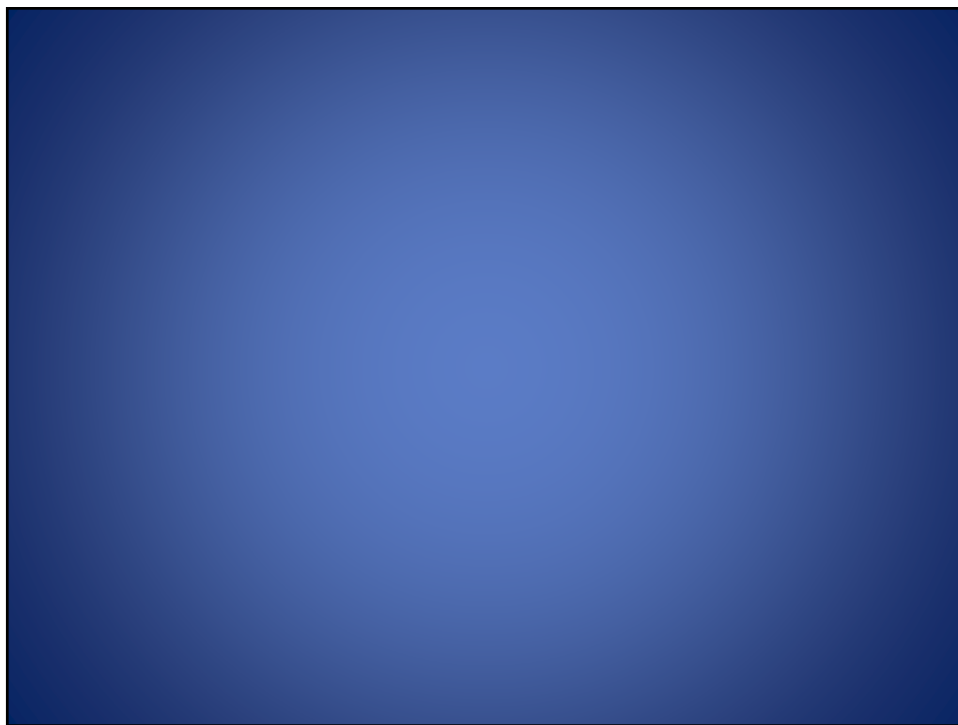
www.secchidipin.org



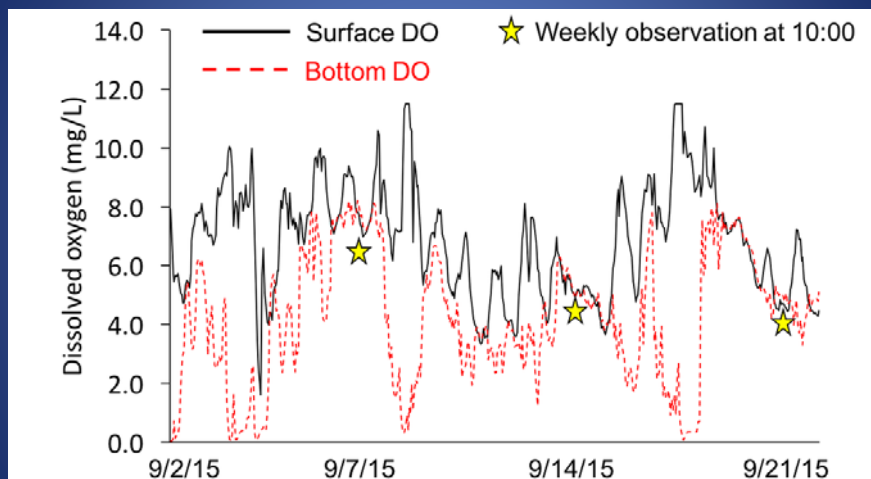
The image is a promotional banner for the 2016 Secchi Dip-In. It features a dark blue background. On the left, a hand holds a smartphone displaying the GLEON Lake Observer Mobile App interface, which includes options for 'Water' and 'Ice Cover / Break'. On the right, a person in a red kayak, wearing a yellow life vest and a hat, is using a Secchi disk to measure water clarity. A circular logo with the text 'The Secchi Dip-In' is positioned in the upper left corner of the banner.

Try the GLEON Lake Observer Mobile App!

www.lakeobserver.org



Why High Frequency Data?



DO measurements from sensors and weekly observations on Shelburne Pond, VT
Source: Jason Stockwell, @dvm_uvm