Riverine Inputs to Long Island Sound: Variability and Effects on Water Quality

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The Pinkerton Foundation
CUNY CREST SCIENCE & TECHNOLOGY TO SUSTAIN THE EARTH
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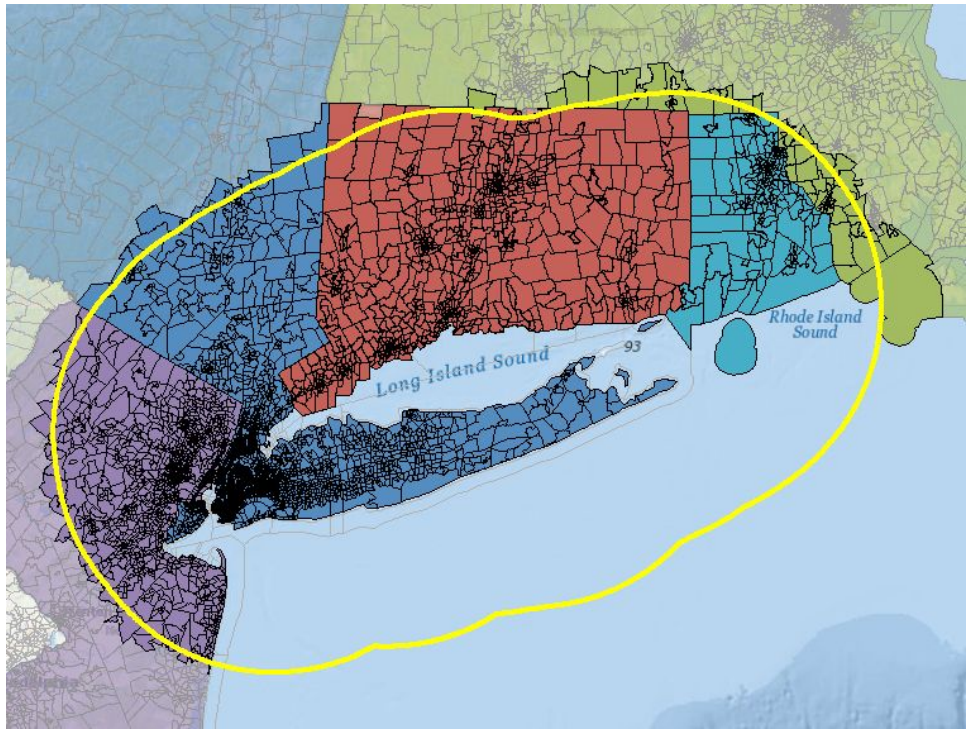
Introduction to Long Island Sound Estuary

- **What is an estuary?**
  An estuary is a coastal water body where freshwater from rivers combine with salt water from the sea.

- **Why do we study Long Island Sound?**

  The LIS estuary is one of NYC's most valuable natural resources and its water quality impacts land and aquatic organisms, humans, and the environment.

- The **population** within a 50-mile radius of the Sound is approximately **23.8 million people.**
- Strong west-to-east gradients within Long Island Sound (to the west there is a very urban endmember w/ New York City and then to the east there is a more marine endmember w/ open exchange to the Atlantic Ocean).
- The LIS is a dynamic system because it is subject to spatial gradients in water quality as well as seasonal changes and tides.



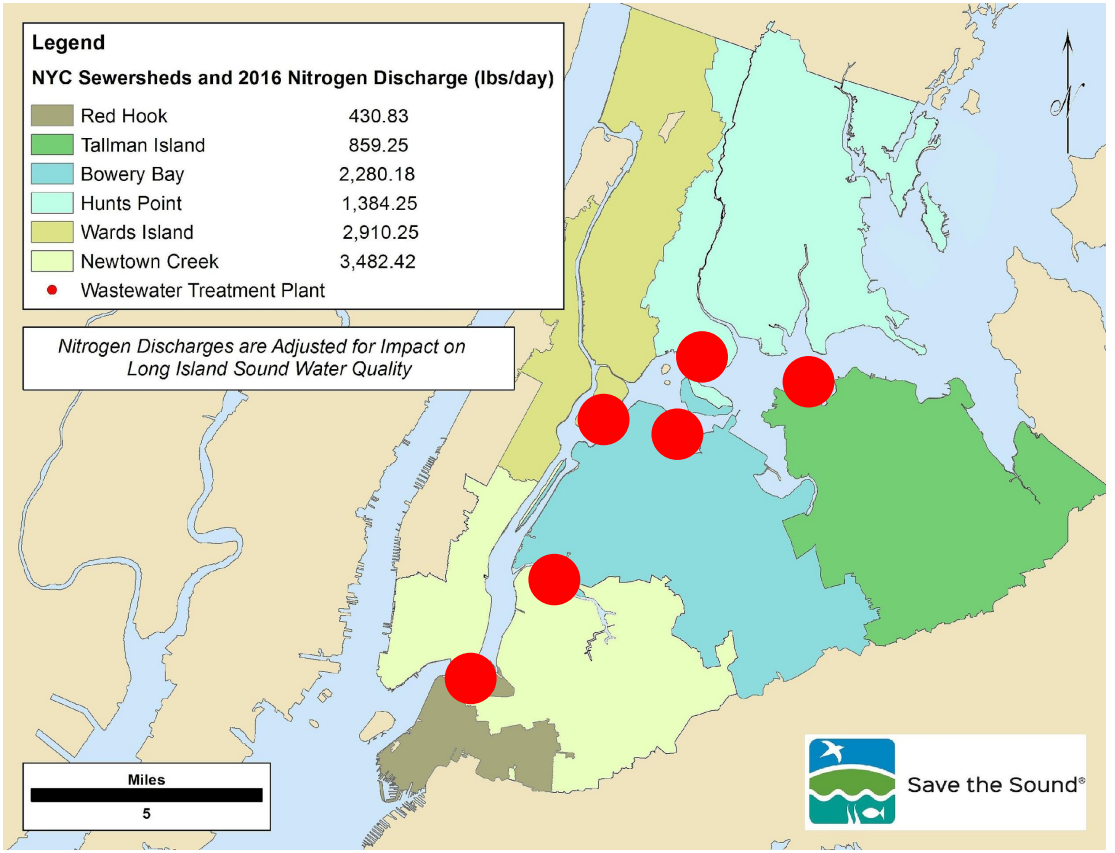
2010 U.S. Census tracts within a 50-mile radius of Long Island Sound
Source:*https://longislandsoundstudy.net*

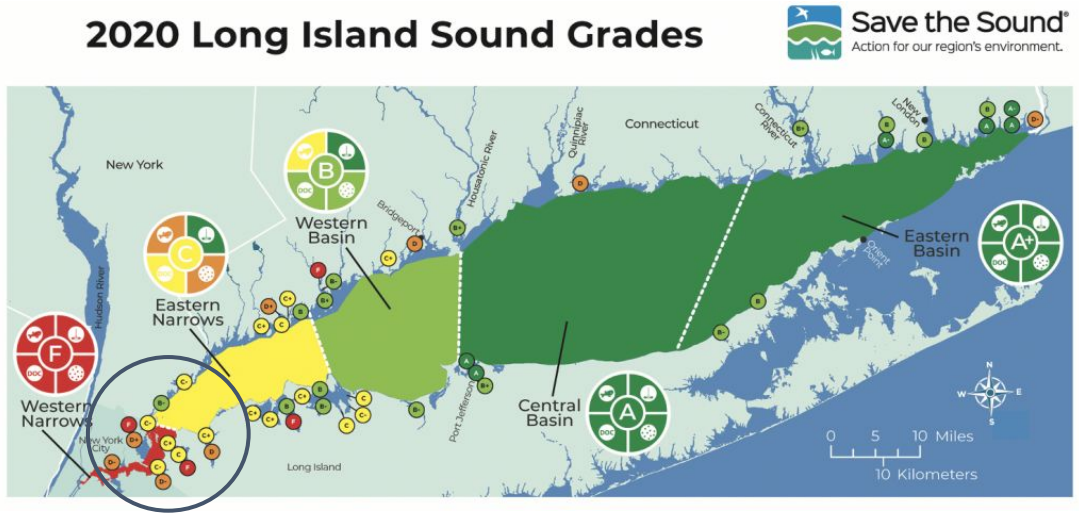
Water Quality of LIS

There have been improvements in LIS water quality as a result of policy and investments in technology, but issues still remain.

- 1960's and 1970's: chlorination to kill pathogens introduced, reduction in suspended solids, phosphate in detergents banned in some states.
- EPA Clean Water Act of 1972
- 2001 LIS TMDL established by EPA requiring a 58.5% reduction in nitrogen loads from 1990 baseline
- NYC DEP invested $1 billion for nitrogen treatment in 4 wastewater treatment plants.

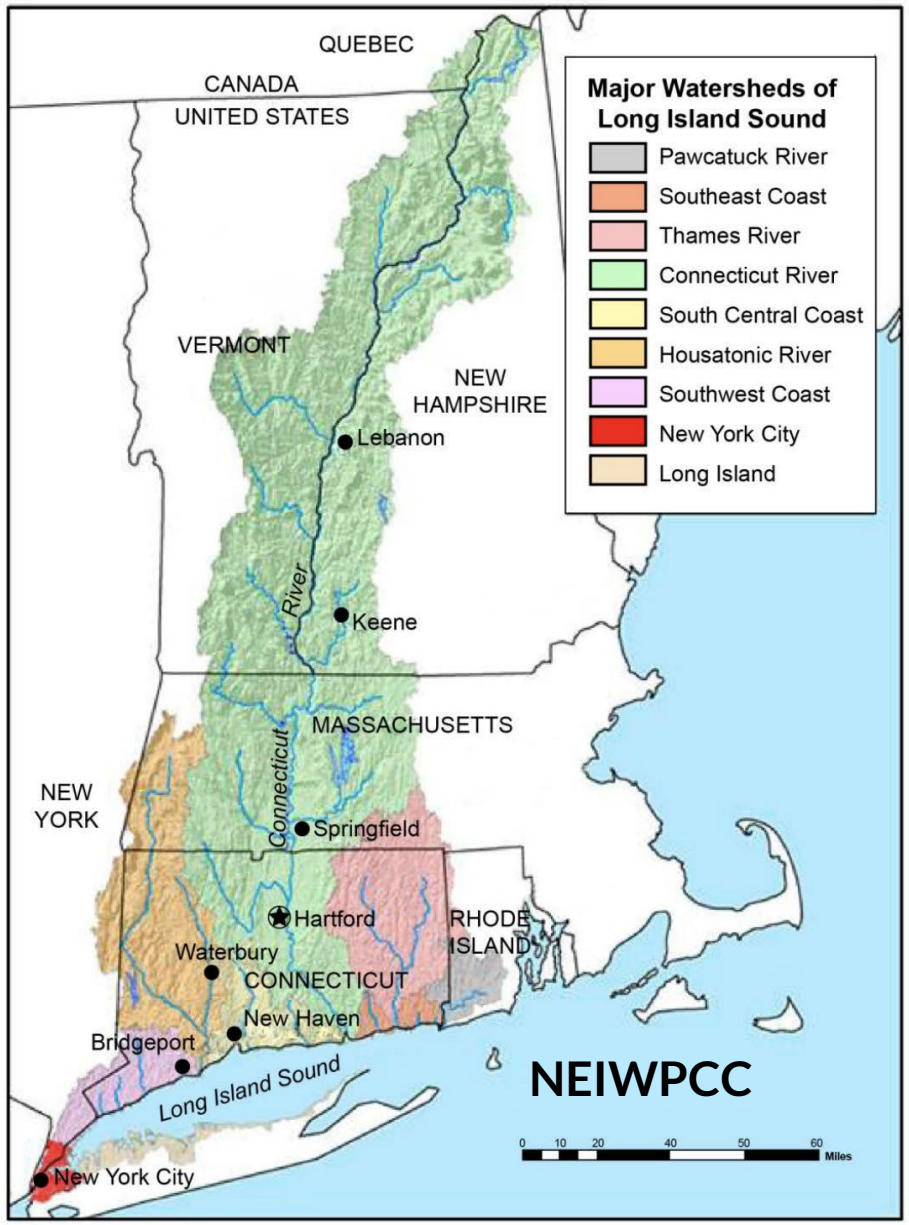
Excess nitrogen is still a concern and can lead to summertime hypoxia in western Long Island Sound.

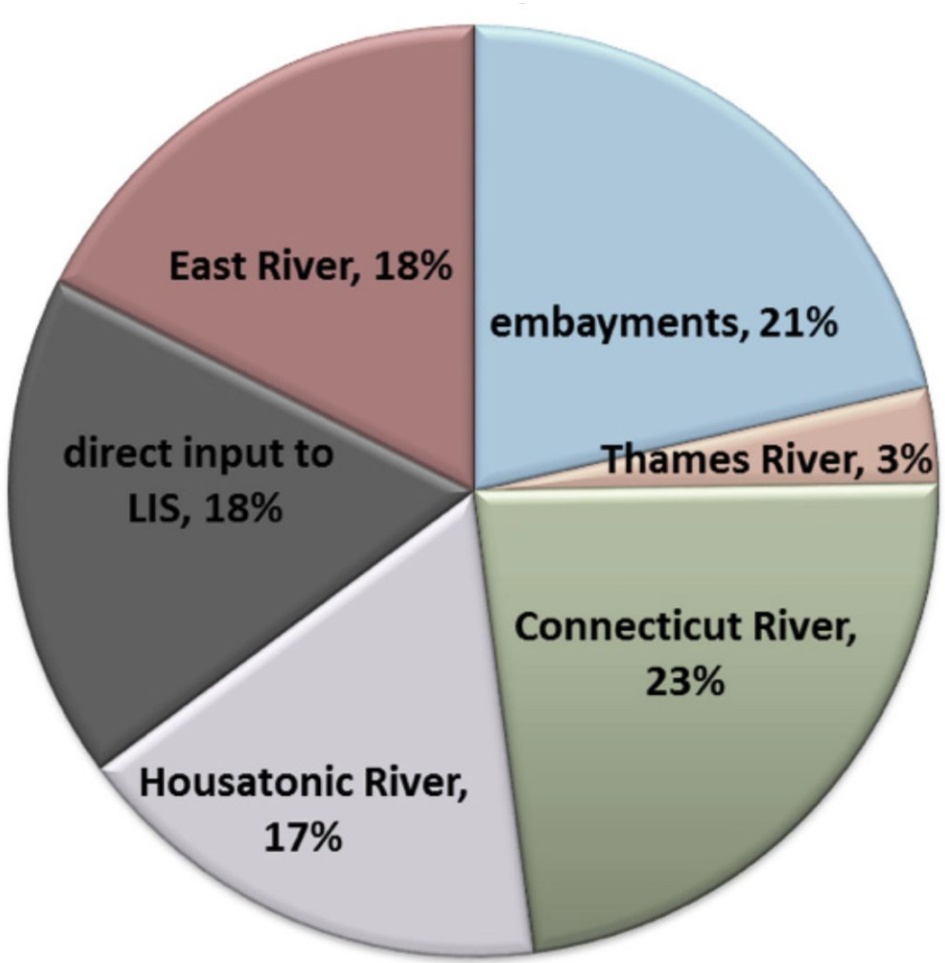




There is a decline in water quality in the western end (NYC)

Role of Rivers in LIS Water Quality



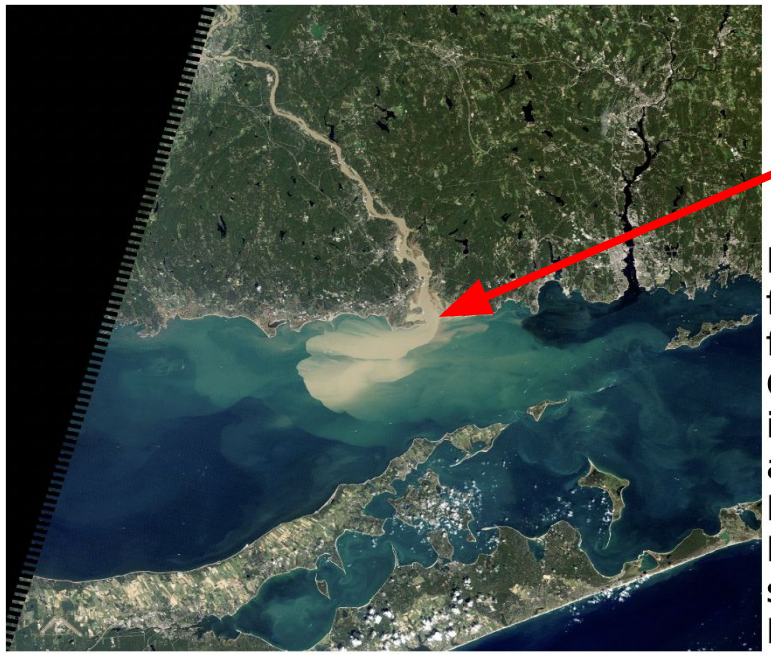


Major nitrogen inputs to the LIS, adjusted for impact on Sound.
[Save the Sound, 2017]

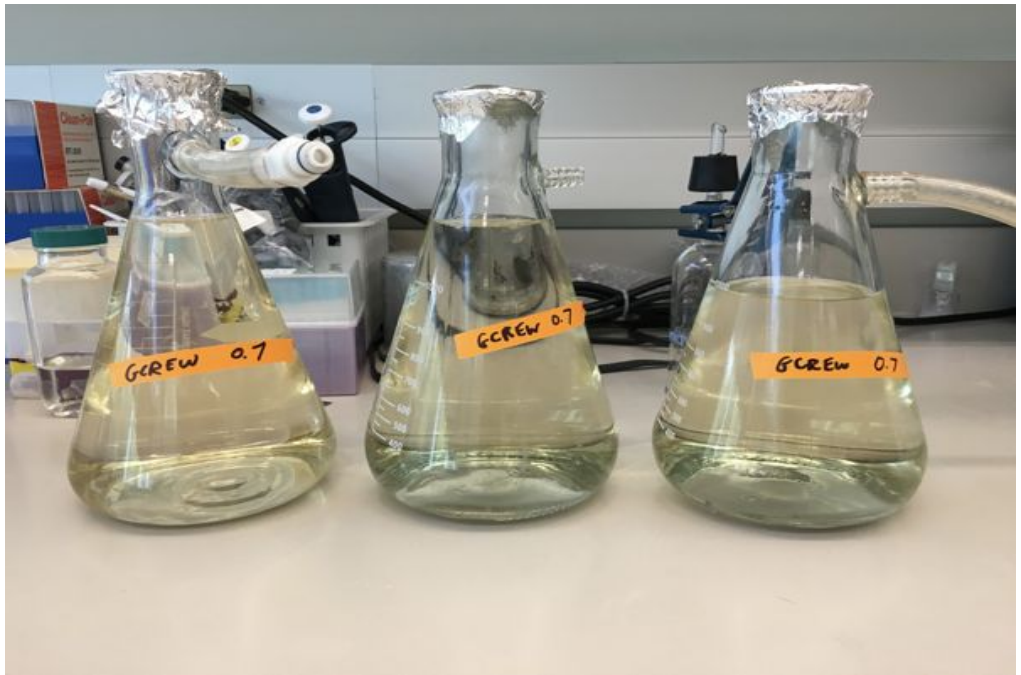
Riverine Inputs to the LIS

- In addition to nitrogen, rivers are bringing in other nutrients, sediments, and organic matter, these are all the components in riverine discharge.
- Color dissolved organic matter (CDOM) is a major component that attenuates light in the LIS. Some of the main sources of CDOM are phytoplankton, decaying plant material, and other river inputs from land and marshes [9].

***BIG IDEA:** We look at nitrogen inputs because nitrogen is essential to phytoplankton blooms in the Sound and the amount of phytoplankton affects the CDOM levels.



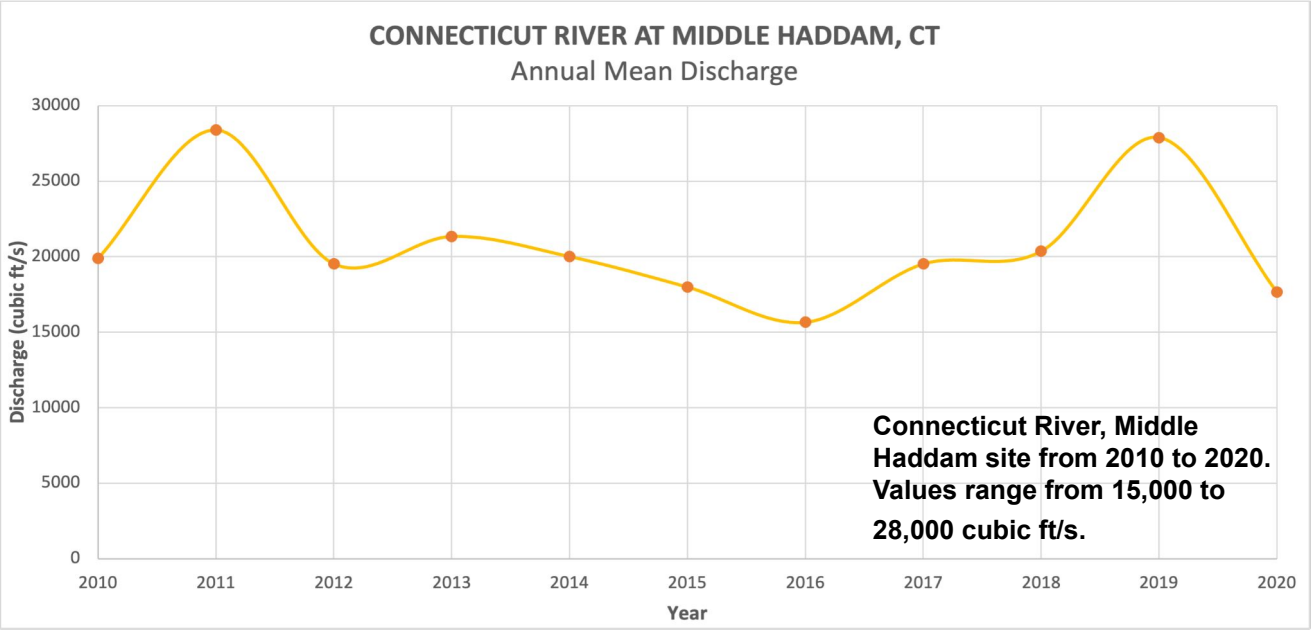
Massive freshwater fluxes from the Connecticut River into the Sound after Hurricane Irene (Sept. 2011, Landsat 5 satellite imagery; NASA).

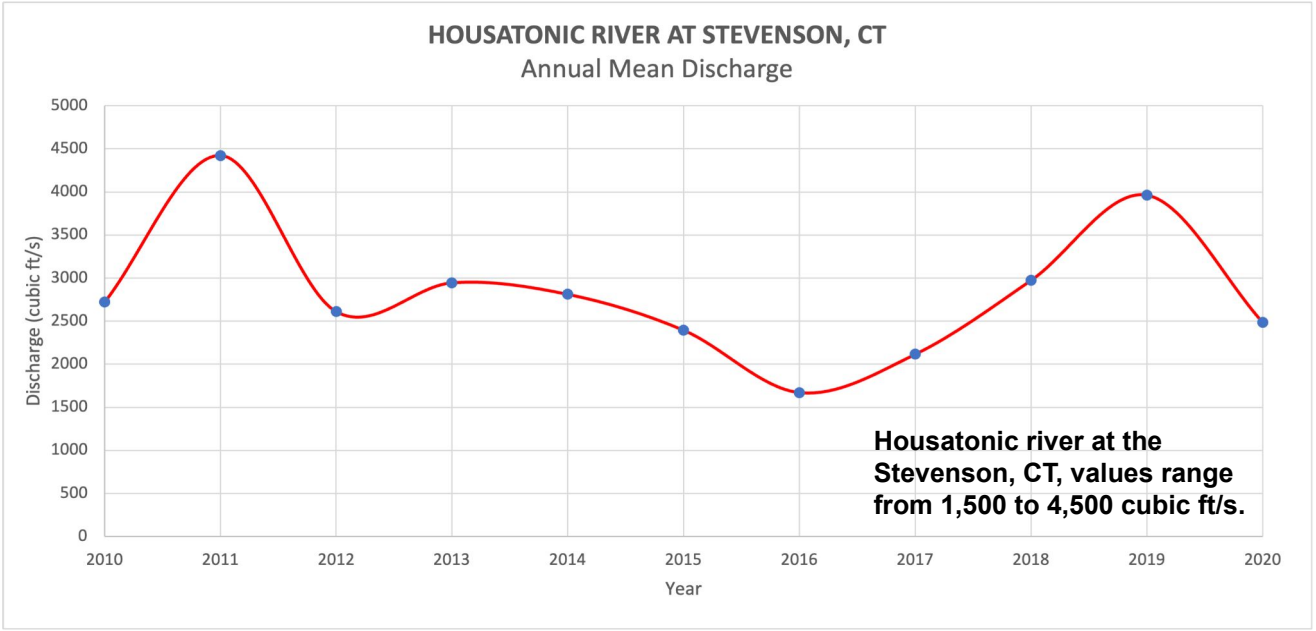


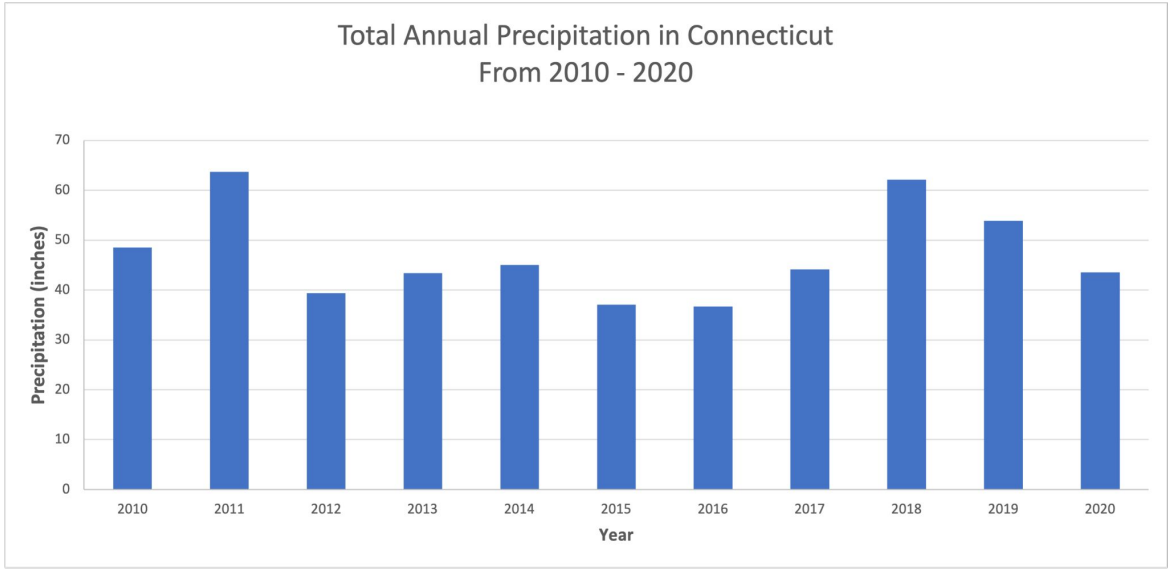
Methods/Objectives

1) Identify trends in United States Geological Survey (USGS) discharge for the Connecticut River (largest freshwater source) and the Housatonic River (second largest drainage basin).
    a) Interannual trends
    b) Seasonal trends
    c) Identify correlations to National Oceanic and Atmospheric Administration (NOAA) Connecticut precipitation data
2) Compare data on river discharge and precipitation to satellite imagery from the Sentinel-3 Ocean and Land Colour Instrumental satellite, of CDOM levels to connect the role of LIS rivers to LIS water quality. This can help tease apart natural/anthropogenic impacts in coastal regions.

Inter-annual Results





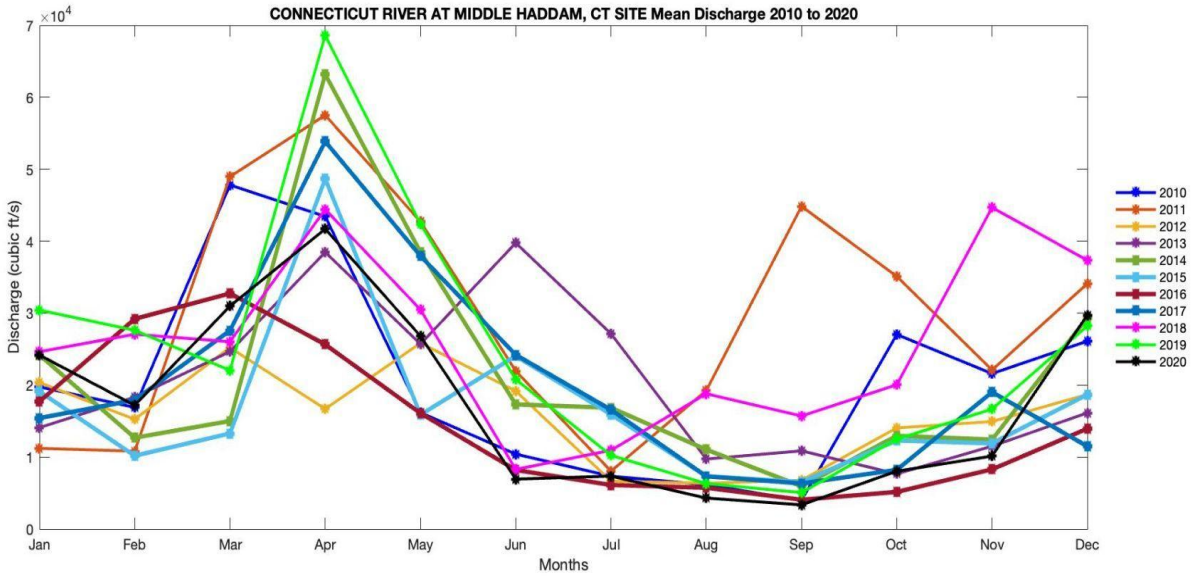


Bar graph of total precipitation in the state of Connecticut, from 2010 to 2020.

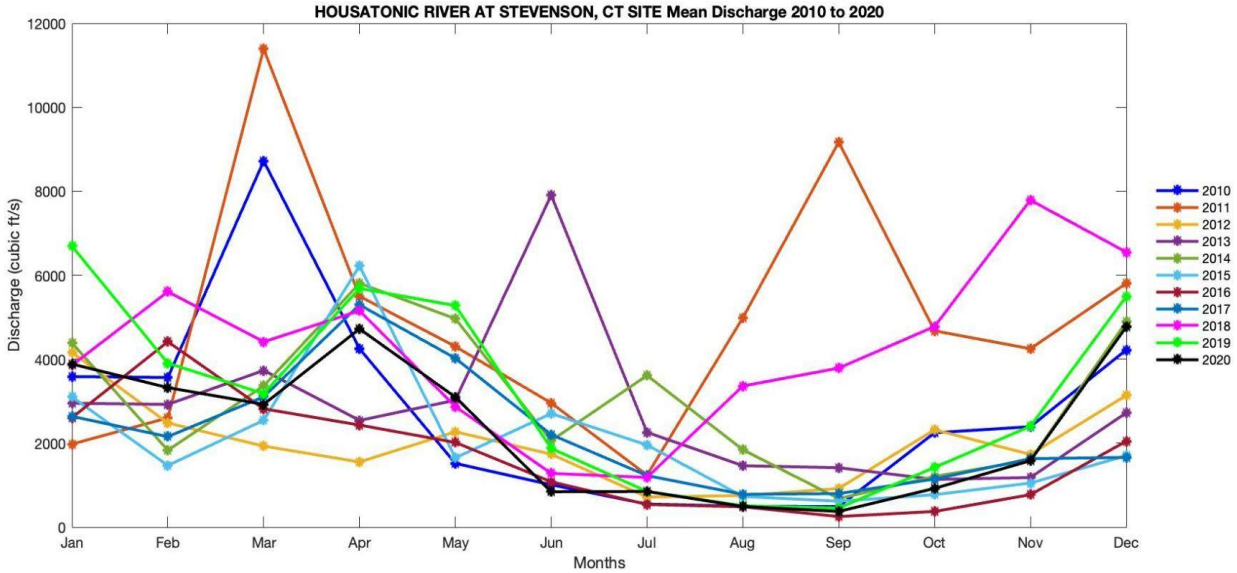
- **High Precipitation in 2011 due to Hurricane Irene.**
- **High Precipitation in 2018 due to 2018 tornado storm in CT.**

Seasonal Results

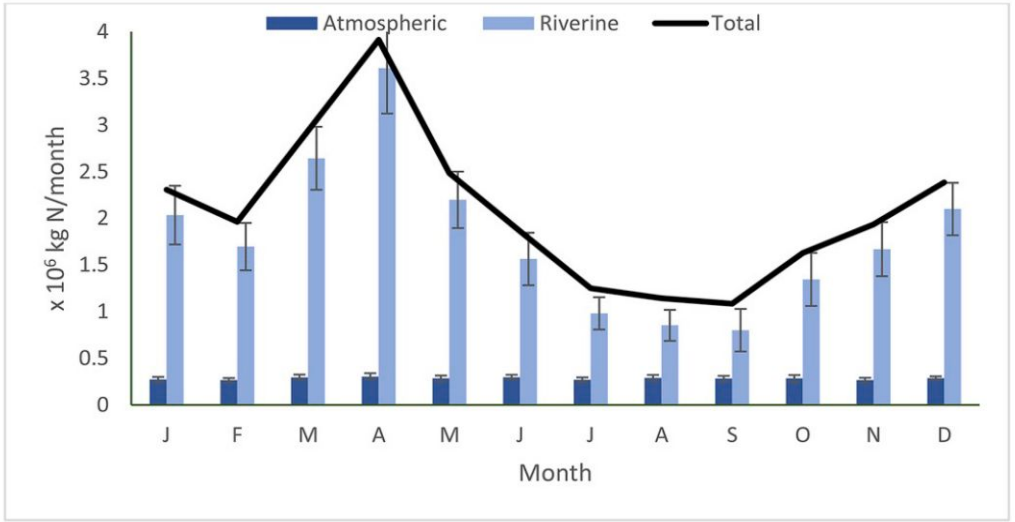
Line graphs of monthly mean discharge in each of the five sites throughout the past decade (month vs. discharge). Color variations indicate the year. Magnitude of the y-axis varies for each graph.



CT River ranges from 0 to 7 x 10^4 cubic ft/s



Housatonic River ranges from 0 to 12,000 cubic ft/s



Total nitrogen content from atmospheric or riverine influence. Seasonal nitrogen inputs to the Sound (averages 1995-2016) (Vlahos et al., 2020)

Sentinel-3 Ocean Land Colour Instrument

esa

European Space Agency

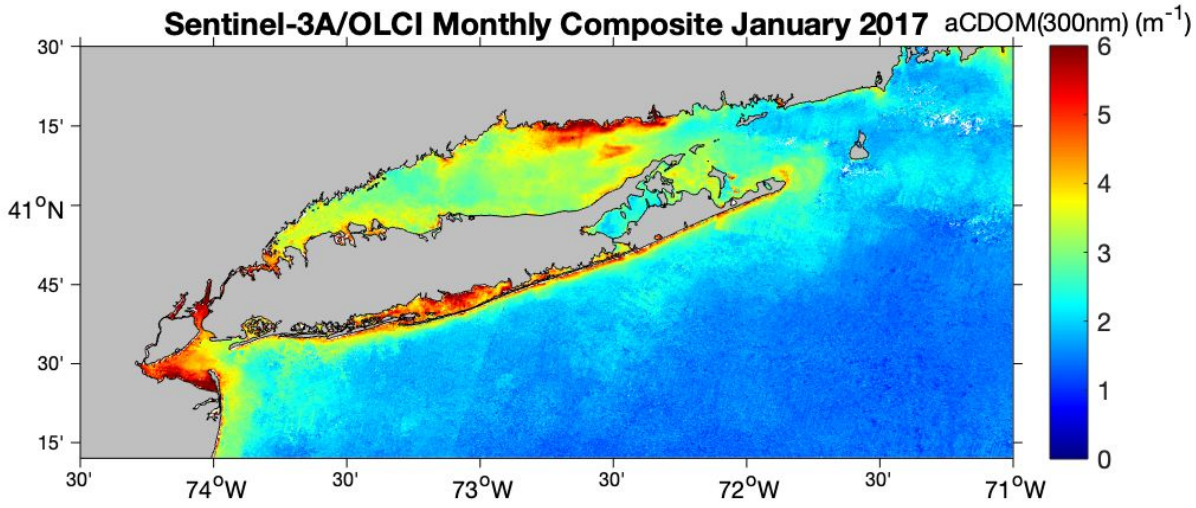
Sentinel-3A launched in February 2016

Sentinel-3B launched in April 2018

They acquire imagery of LIS every day under cloud-free conditions

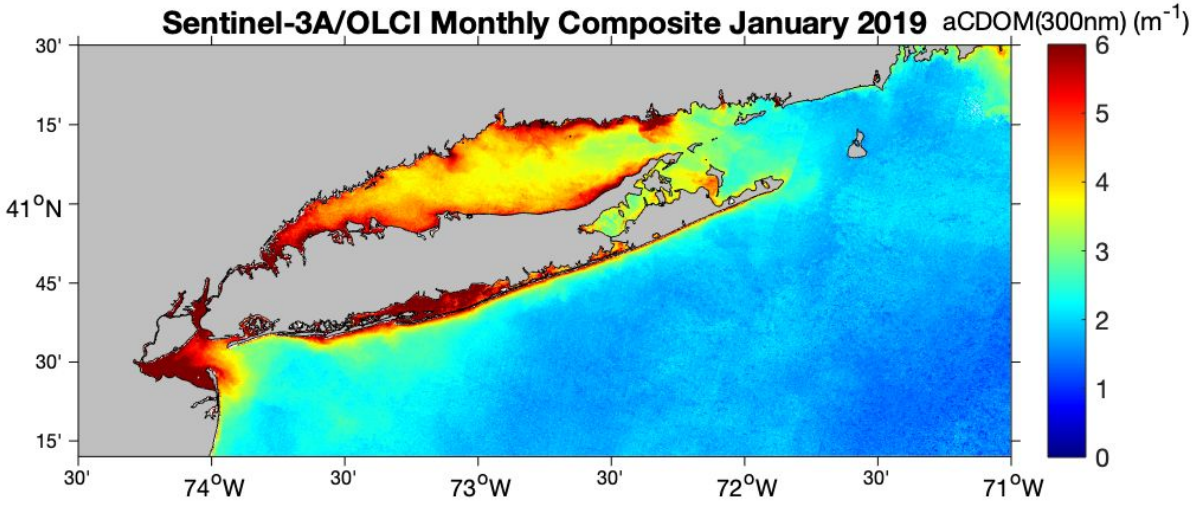
January

Low Discharge



Monthly mean discharge for CT River: 15,420 ft^3/s
Monthly mean discharge for Housatonic River: 2,637 ft^3/s

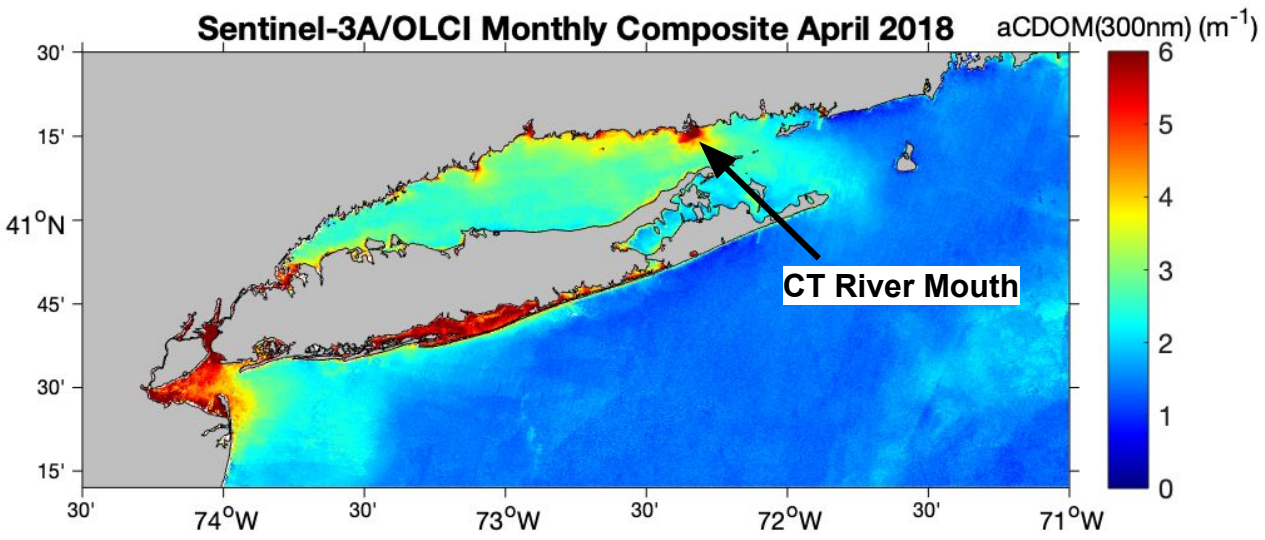
High Discharge



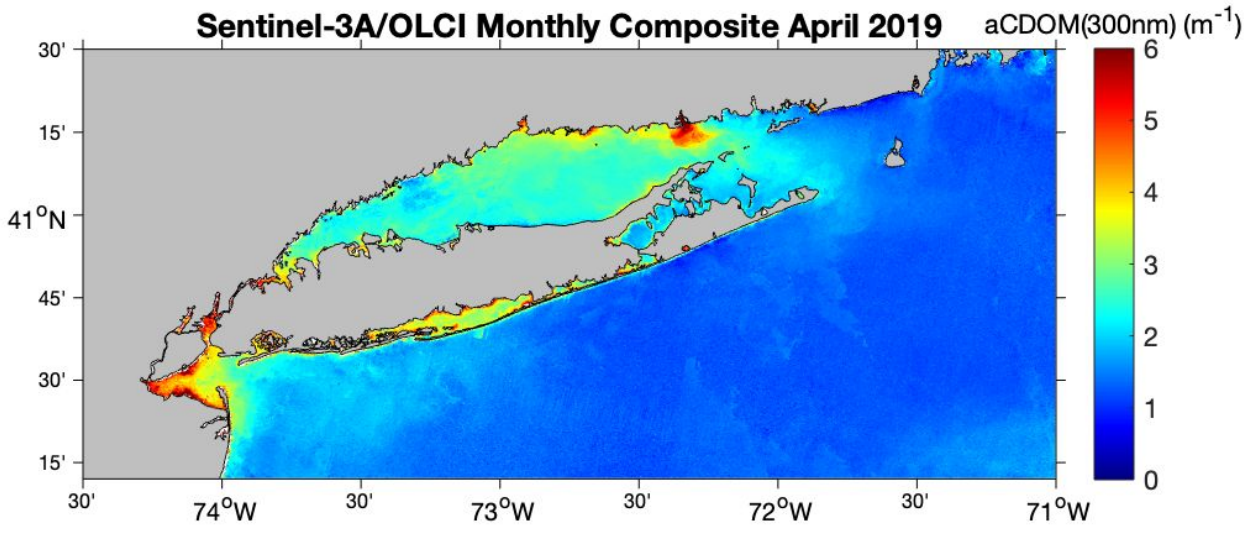
Monthly mean discharge for CT River: 30,420 ft^3/s
Monthly mean discharge for Housatonic River: 6,692 ft^3/s

April

**April had consistently high river discharge each year

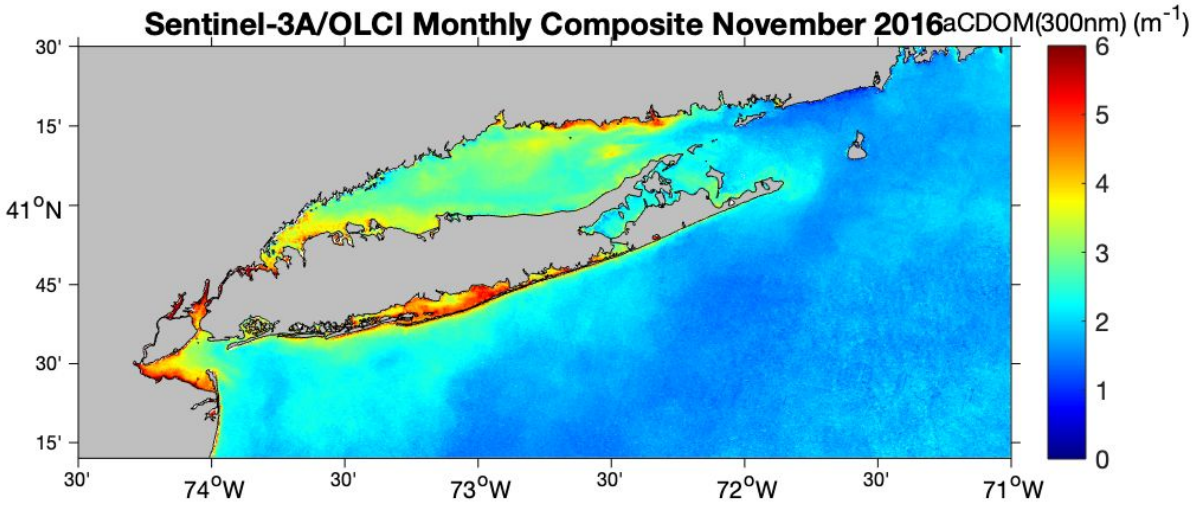


Monthly mean discharge for CT River: 44,420 ft^3/s
Monthly mean discharge for Housatonic River: 5,153 ft^3/s

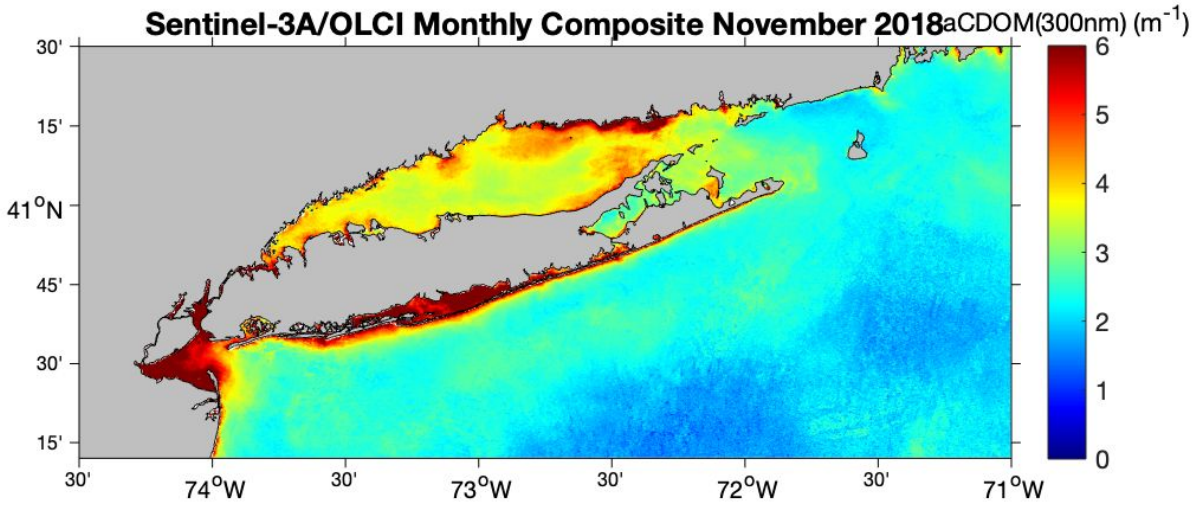


Monthly mean discharge for CT River: 68,610 ft^3/s
Monthly mean discharge for Housatonic River: 5,685 ft^3/s

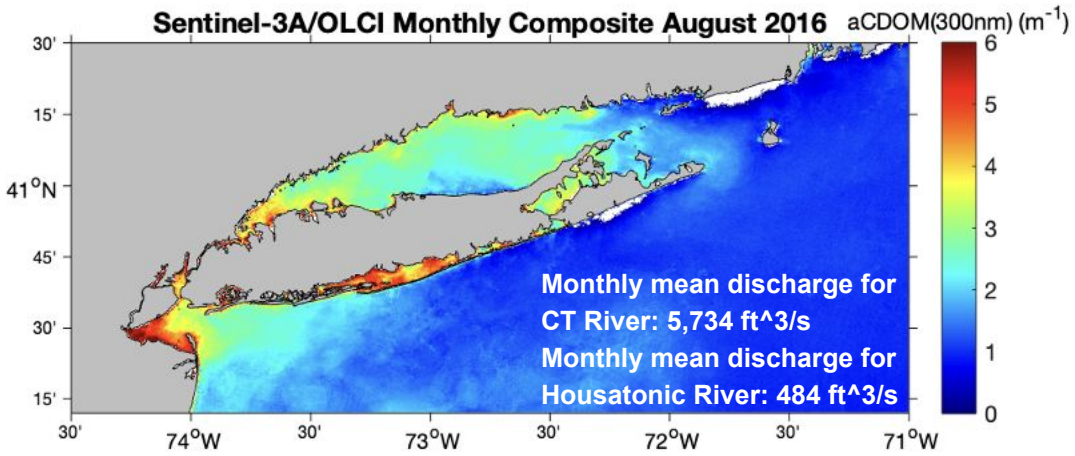
November

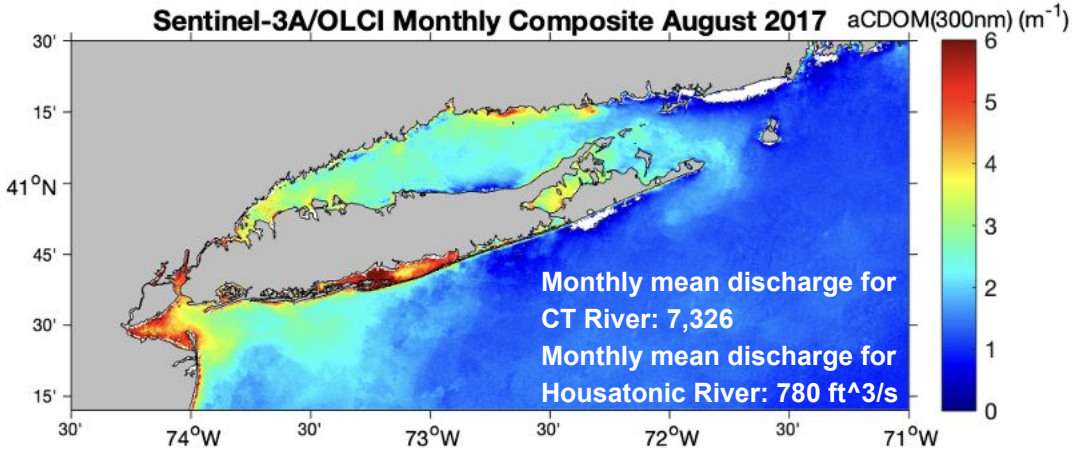


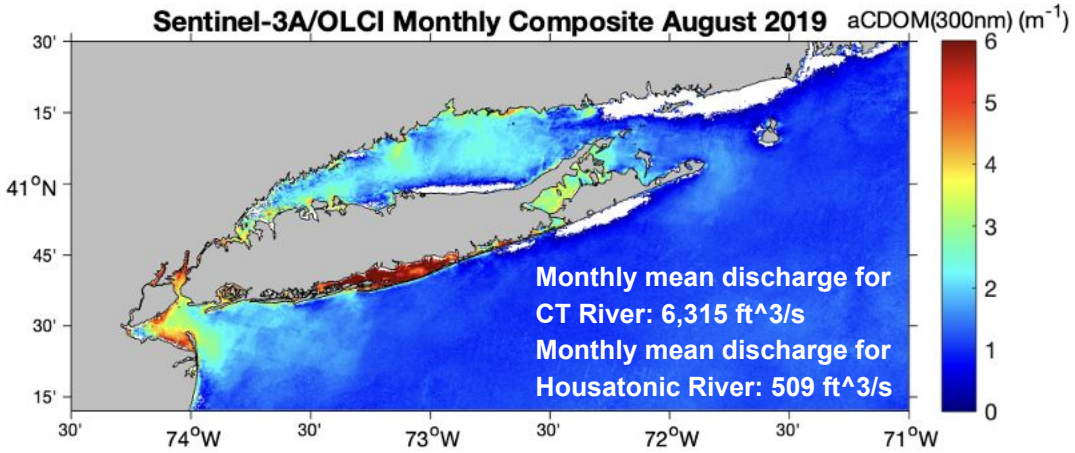
Monthly mean discharge for CT River: 8,294 ft^3/s
Monthly mean discharge for Housatonic River: 771 ft^3/s



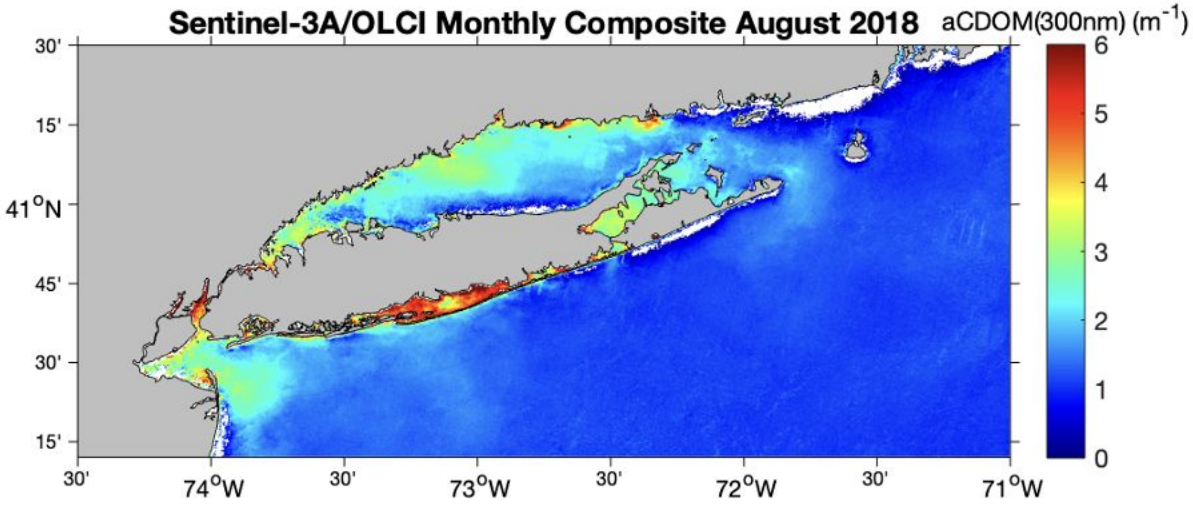
Monthly mean discharge for CT River: 44,680 ft^3/s
Monthly mean discharge for Housatonic River: 7,789 ft^3/s







August



Monthly mean discharge for CT River: 18,790 ft^3/s
Monthly mean discharge for Housatonic River: 3,361 ft^3/s.

****August had overall low discharge compared to other months, therefore no distinct plumes.**

Conclusion/Discussion

We can conclude from our data that there is an inter-annual variability and seasonal component in river discharge and precipitation.

Our satellite data also suggest that river discharge seems to be a better proxy for CDOM levels than precipitation alone, even though precipitation influences discharge.

With higher discharge, we can expect larger inputs of nutrients and organic matter to Long Island Sound, which affects LIS biogeochemistry.

Ultimately, this research can be useful for climate modelling and in the long run, benefit local residents of the LIS, commercial and recreational fishermen, and natural resource managers because it will improve our understanding of the drivers of LIS water quality.

The Fourth National Climate Assessment (NCA) predicts wetter winters and springs in Northeast, U.S., which may amplify seasonality in discharge, and the role of these rivers in LIS water quality.

In the near future, we hope to analyze the effect of temperature and other climatological factors that may impact CDOM levels in the LIS.

References

[1] *Population within 50-mile buffer of long island sound*. Long Island Sound Study. (2020, March 16).https://longislandsoundstudy.net/ecosystem-target-indicators/population-within-50-mile-buffer-of-long-island-sound/.

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[4] Nitrogen management found online: https://longislandsoundstudy.net/about/our-mission/management-plan/introduction/

[5]Usgcrp. (1970, January 1). *Fourth national Climate ASSESSMENT: Chapter 18: Northeast*. NCA4. https://nca2018.globalchange.gov/chapter/18/.

[6] Screenshot of estuary health from: https://soundhealthexplorer.org/fishable/

[7]https://longislandsoundstudy.net/about/our-mission/management-plan/introduction/

[8] Background image on slide 3 found online: https://www.northforkrealestateinc.com/peconic-bay-vs-long-island-sound/

[9]https://www.fondriest.com/environmental-measurements/parameters/water-quality/chromophoric-dissolved-organic-matter/#2

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