Improving Climate Resilience in Great Lakes Coastal Communities

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Duluth, Minnesota

Introduction to NOAA

Statement from the NOAA Administrator

"*As NOAA's Administrator, it is my goal to ensure that our agency is helping these decision makers build a Climate-Ready Nation that strengthens our resilience to climate change, which will help protect lives, lifestyles, and livelihoods.*

After all, if we hope to have a prosperous society and economy tomorrow, it must begin with climate action and adaptation plans made today."

— Dr. Rick Spinrad

Coastal Zone Management Act

The U.S. Congress recognized the importance of meeting the challenge of continued growth in the coastal zone by passing the Coastal Zone Management Act (CZMA) in 1972. This act, administered by NOAA, provides for the management of the nation's coastal resources, including the Great Lakes. The goal is to "preserve, protect, develop, and where possible, to restore or enhance the resources of the nation's coastal zone."

NOAA's Office for Coastal Management

Mission:

Inspire and influence a broad base of leaders, citizens, and coastal management professionals to ensure healthy coastal ecosystems, resilient coastal communities, and vibrant and sustainable coastal economies.

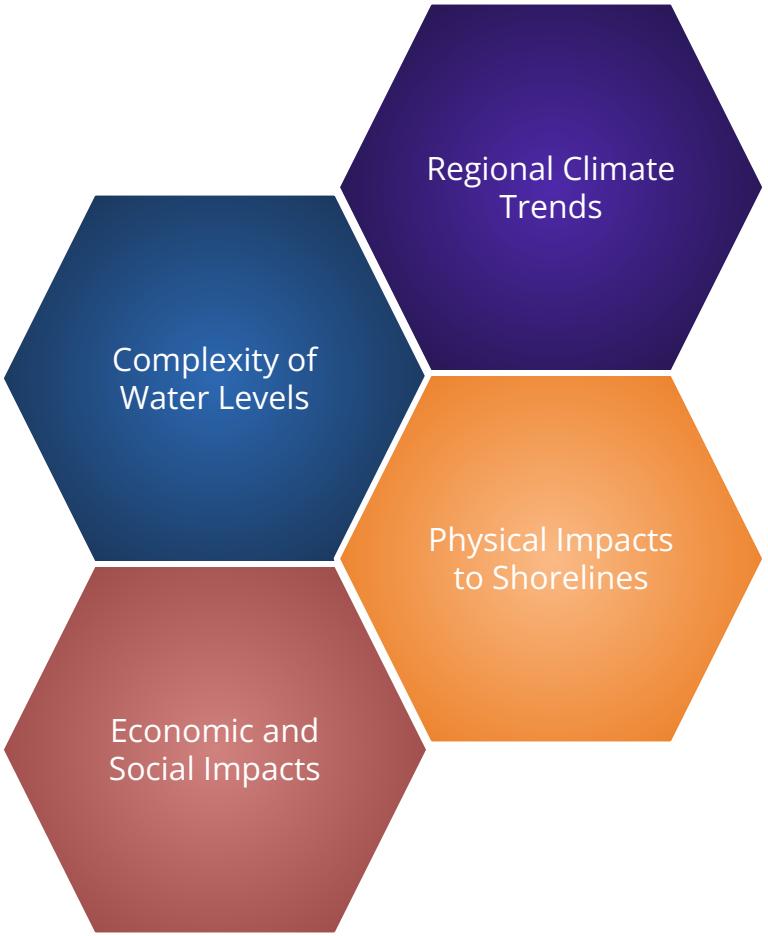
Operating Principles:

- Partner and User Focused
- High-Quality Programs, Products and Services
- Think Nationally, Empower Locally

Coastal Zone Management Partners

The Coastal Challenge

- ➔ Shorelines are naturally dynamic and complex due to the interface between land, water, and air
- ➔ Coastal management refers to actions taken to keep residents safe, the economy sound, and natural resources functioning
- ➔ Work towards protecting coastal communities and improving resiliency

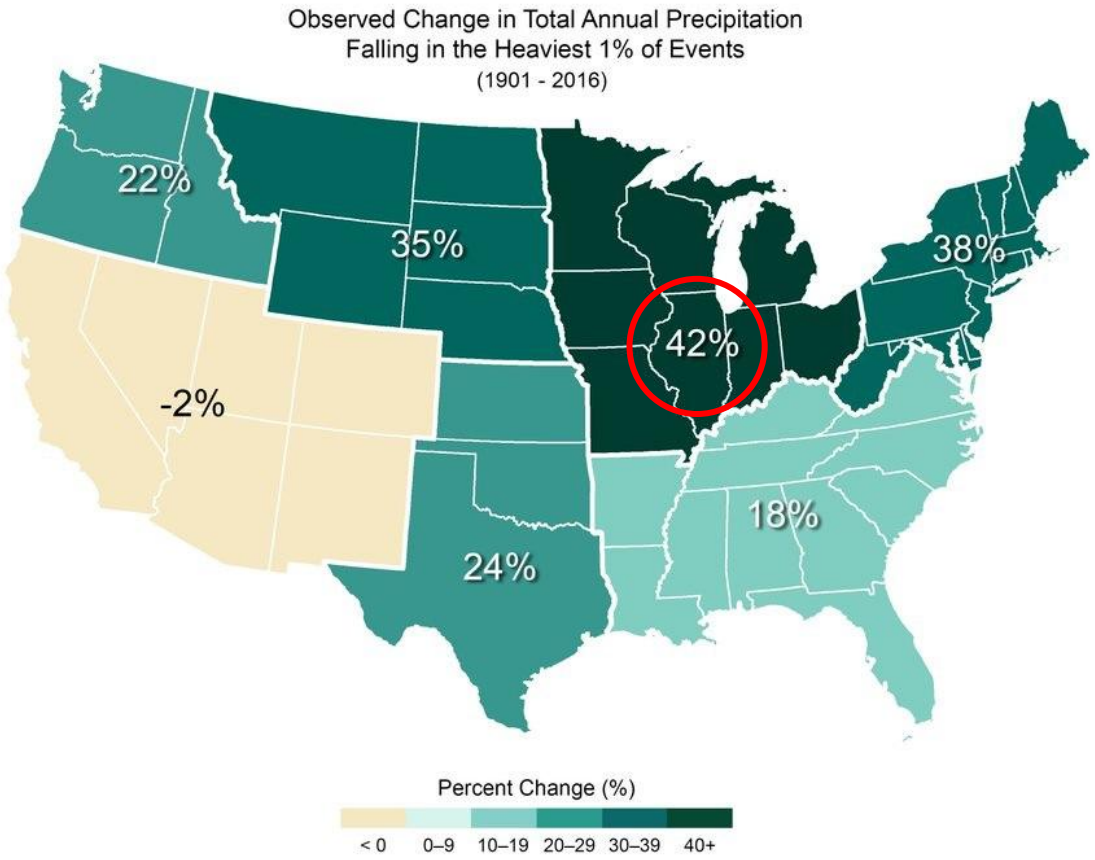


Regional Climate Trends

Notable Change

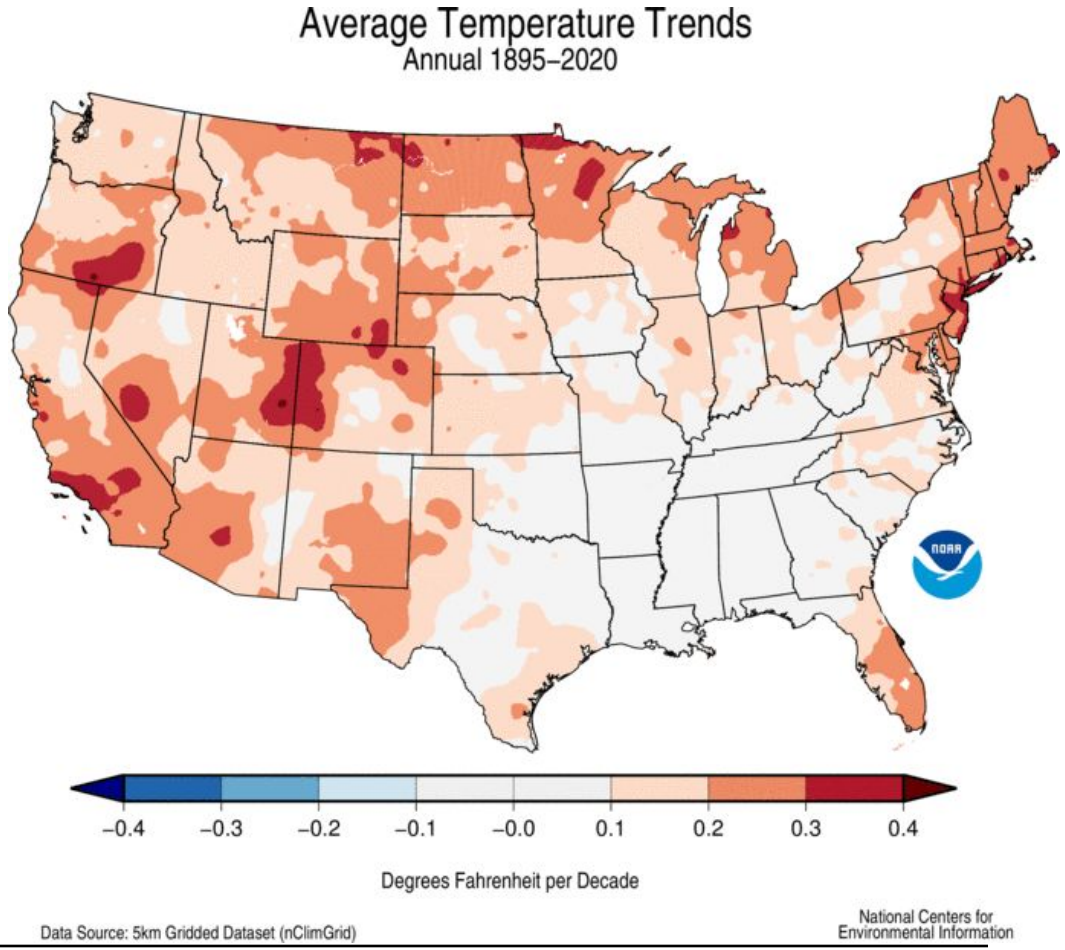
Heavy precipitation is becoming more intense and more frequent in the Northeast and Midwest.

U.S. Global Change Research Program



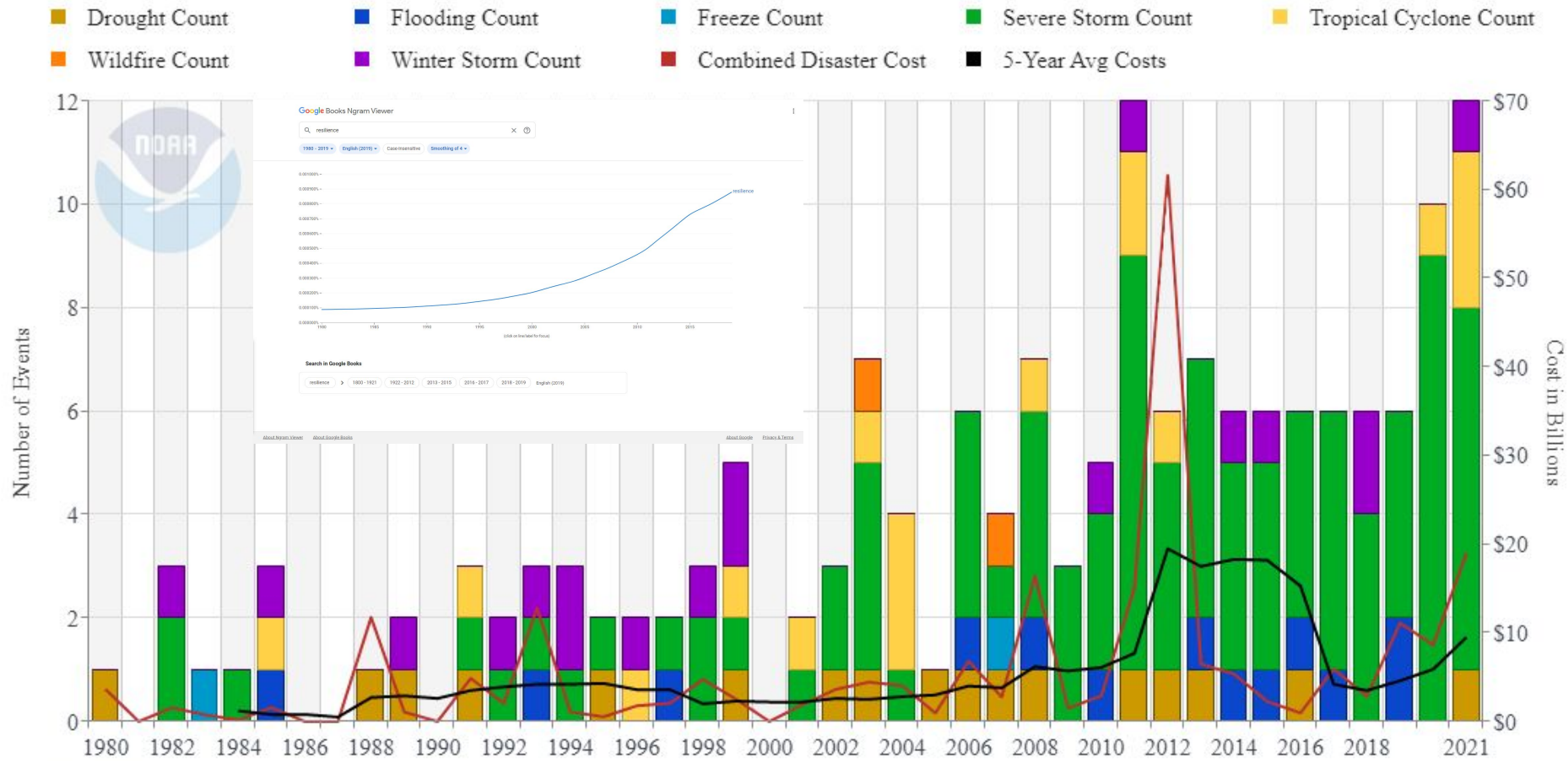
Notable Change

1 to 2°F increase per century across much of the Great Lakes region.



Great Lakes States Billion-Dollar Disaster Events 1980-2021 (CPI-Adjusted)

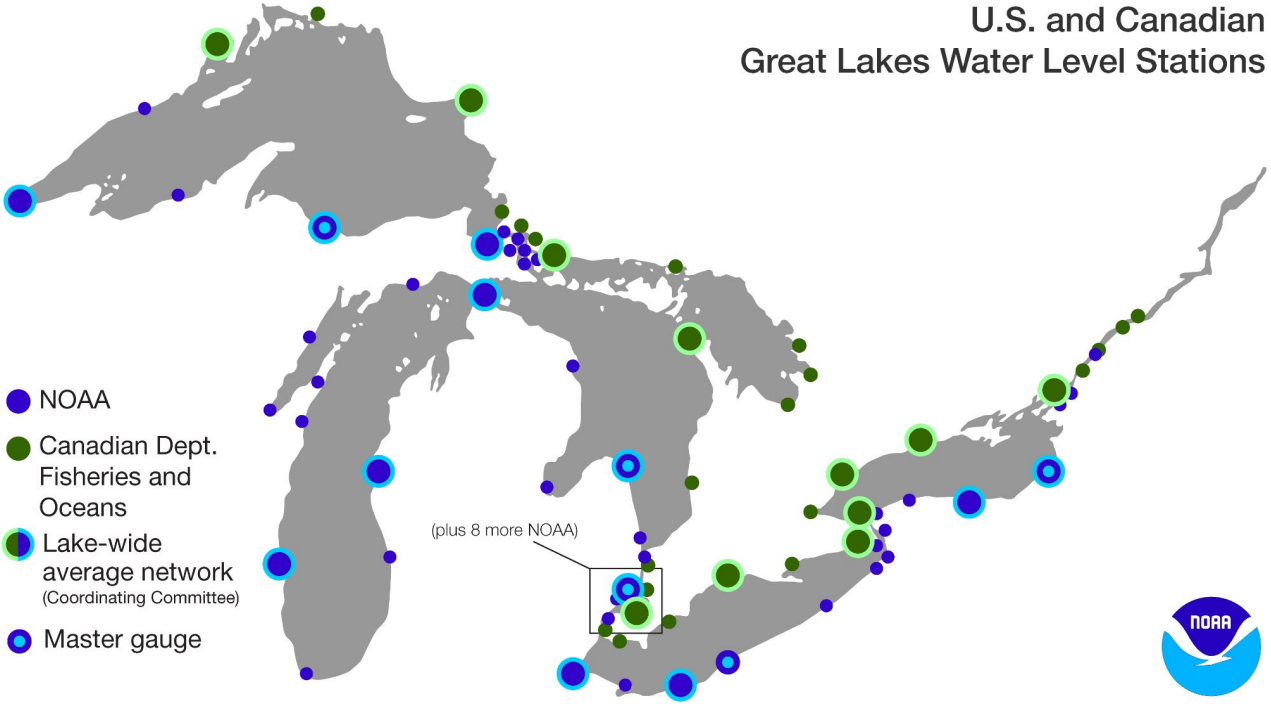
IL, IN, MI, MN, OH, PA, NY, WI

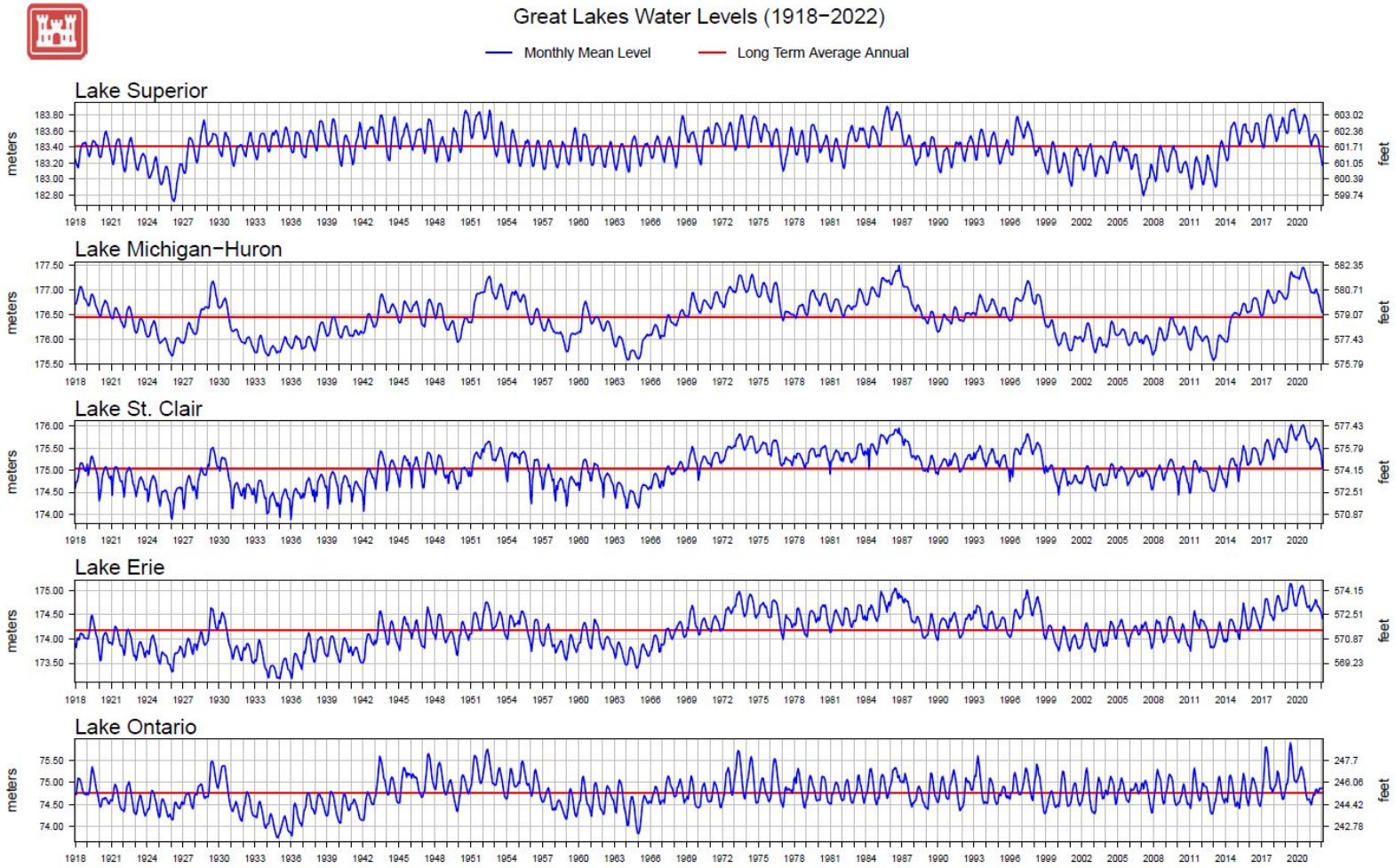


Updated: January 10, 2022

Complexity of Water Levels

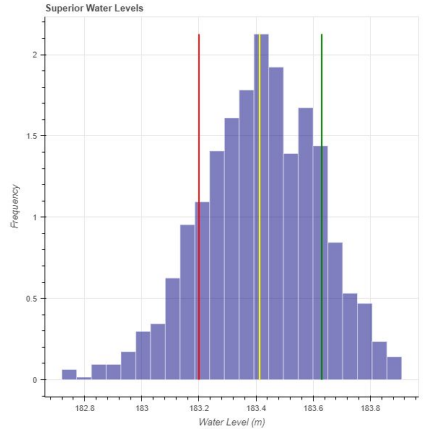
Complexity of Water Levels





Source: U.S. Army Corps of Engineers Detroit District

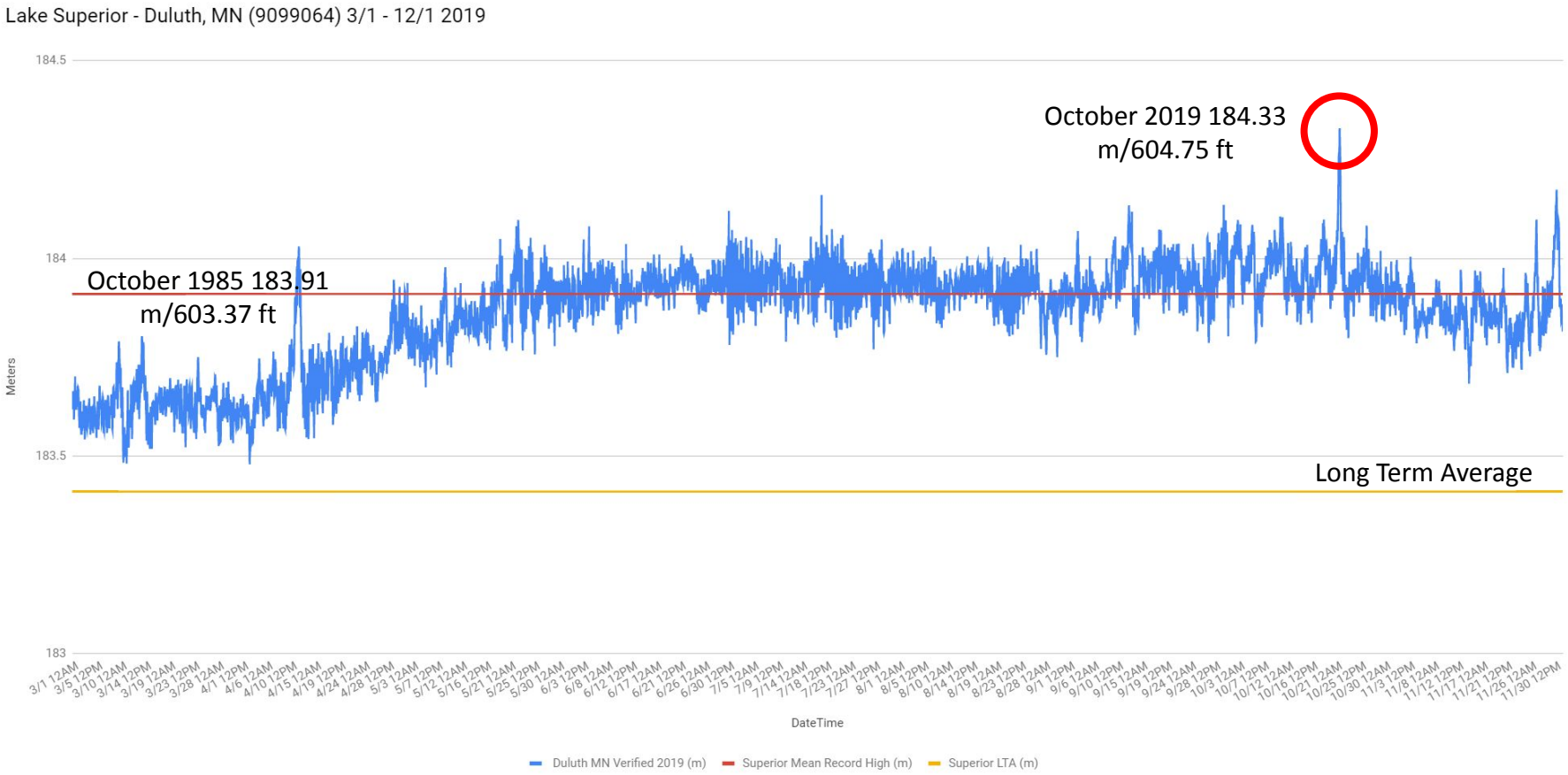
Complexity of Water Levels: Superior



Based on Lakewide Monthly Average Values:
Minimum Water Level: 182.72 meters / 599.47 feet (April 1926)
Maximum Water Level: 183.91 meters / 603.37 feet (October 1985)
Difference: 1.19 meters / 3.9 feet

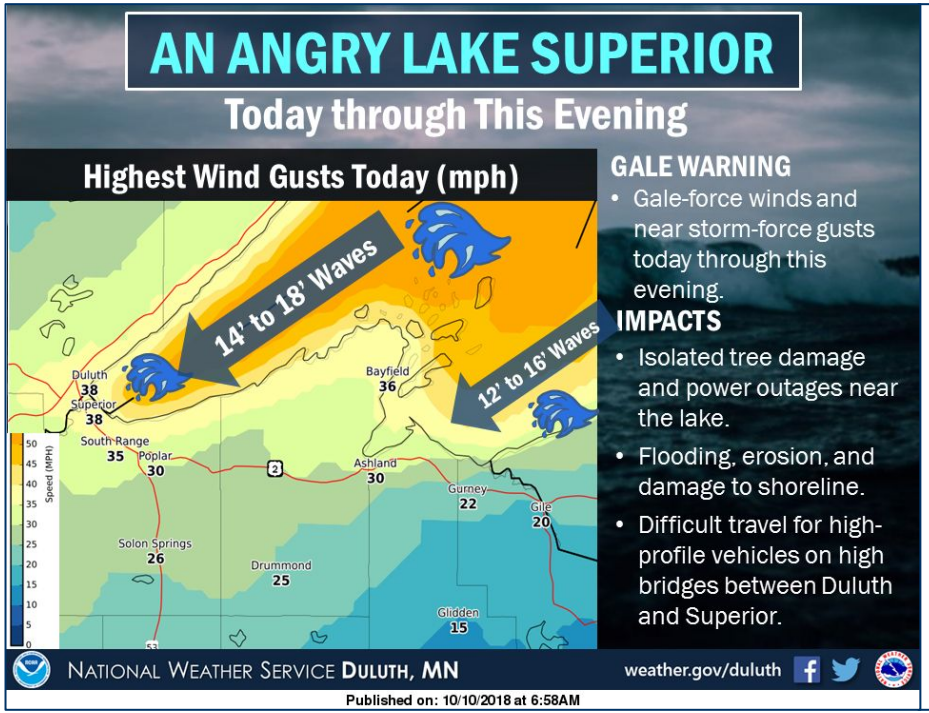
	ID	LWD (ft)	Max (ft)	Date	Min (ft)	Date	Absolute Range (ft)	Above LWD (ft)	Below LWD (ft)
Superior							**5.97**	**3.65**	**-2.32**
Point Iroquois, MI	9099004	601.1	604.46	10/4/2018	598.78	5/30/2011	5.68	3.36	-2.32
Duluth, MN	9099064	601.1	604.75	10/21/2019	598.98	2/18/2011	5.77	3.65	-2.12
Marquette C.G., MI ◄	9099018	601.1	604.06	9/30/2019	599.17	3/22/2007	4.89	2.96	-1.93
Grand Marais, MN	9099090	601.1	604.01	1/30/2019	599.28	3/19/2007	4.73	2.91	-1.82
Ontonagon, MI	9099044	601.1	604.13	7/21/2016	599.63	3/19/2007	4.5	3.03	-1.47

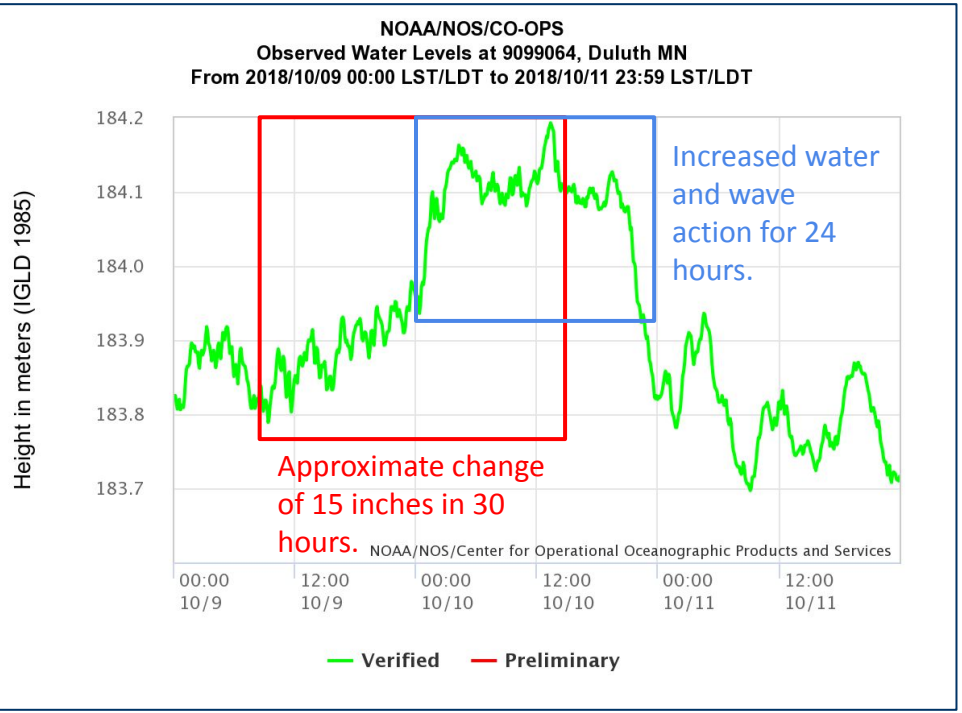
--- Low Water Datum --- Long Term Average --- Water Level December 2020



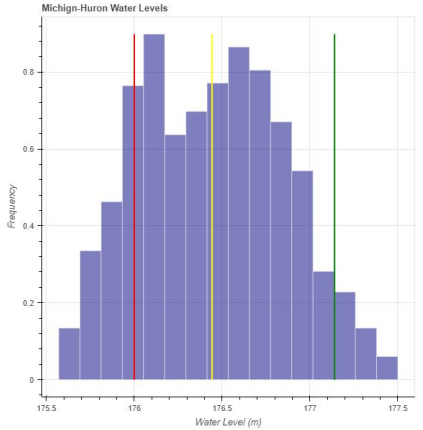
Office for Coastal Management

Complexity of Water Levels: Superior





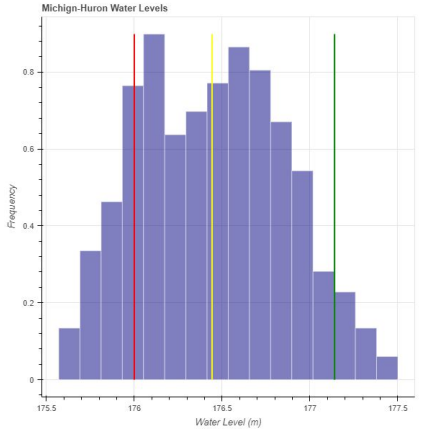
Complexity of Water Levels: Michigan



Based on Lakewide Monthly Average Values:
Minimum Water Level: 175.57 meters / 576.02 feet (January 2013)
Maximum Water Level: 177.5 meters / 582.35 feet (October 1986)
Difference: 1.93 meters / 6.33 feet

	ID	LWD (ft)	Max (ft)	Date	Min (ft)	Date	Absolute Range (ft)	Above LWD (ft)	Below LWD (ft)
Michigan							**8.99**	**5.99**	**-3.00**
Ludington, MI	9087023	577.5	583.48	6/10/2020	575.49	4/10/2013	7.99	5.98	-2.01
Milwaukee, WI	9087057	577.5	583.16	8/10/2020	575.34	1/18/2013	7.82	5.66	-2.16
Green Bay East, WI	9087077	577.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Holland, MI	9087031	577.5	583.01	4/29/2020	575.34	1/18/2013	7.67	5.51	-2.16
Kewaunee, WI	9087068	577.5	583.18	12/1/2019	575.26	1/13/2013	7.92	5.68	-2.24
Menominee, MI	9087088	577.5	583.24	6/10/2020	574.84	1/20/2013	8.4	5.74	-2.66
Calumet Harbor, IL	9087044	577.5	583.49	5/31/1998	574.50	12/23/2007	8.99	5.99	-3.00
Sturgeon Bay, WI	9087072	577.5	582.95	6/9/2020	575.43	1/20/2013	7.52	5.45	-2.07
Port Inland, MI	9087096	577.5	583.30	6/10/2020	575.09	1/17/2013	8.21	5.80	-2.41

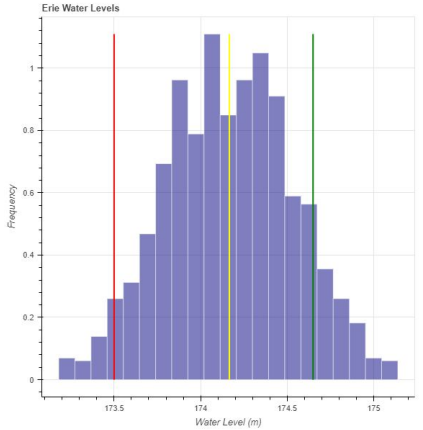
Complexity of Water Levels: Huron



Based on Lakewide Monthly Average Values:
Minimum Water Level: 175.57 meters / 576.02 feet (January 2013)
Maximum Water Level: 177.5 meters / 582.35 feet (October 1986)
Difference: 1.93 meters / 6.33 feet

	ID	LWD (ft)	Max (ft)	Date	Min (ft)	Date	Absolute Range (ft)	Above LWD (ft)	Below LWD (ft)
Huron							**11.06**	**6.53**	**-4.53**
Lakeport, MI	9075002	577.5	583.47	7/19/2020	574.72	1/30/2008	8.75	5.97	-2.78
Alpena, MI	9075065	577.5	583.04	7/20/2019	574.45	1/30/2008	8.59	5.54	-3.05
Harbor Beach, MI ◄	9075014	577.5	582.89	7/19/2020	575.36	1/30/2008	7.53	5.39	-2.14
Mackinaw City, MI	9075080	577.5	582.81	7/19/2020	575.14	1/20/2013	7.67	5.31	-2.36
Essexville, MI	9075035	577.5	584.03	1/11/2020	572.97	12/23/2007	11.06	6.53	-4.53
De Tour Village, MI	9075099	577.5	582.58	1/10/2020	574.97	12/21/2012	7.61	5.08	-2.53

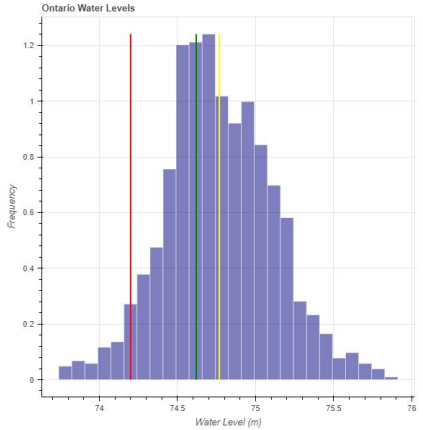
Complexity of Water Levels: Erie



Based on Lakewide Monthly Average Values:
Minimum Water Level: 173.18 meters / 568.17 feet (February 1935)
Maximum Water Level: 175.14 meters / 574.6 feet (June 2019)
Difference: 1.96 meters / 6.43 feet

	ID	LWD (ft)	Max (ft)	Date	Min (ft)	Date	Absolute Range (ft)	Above LWD (ft)	Below LWD (ft)
Erie							**17.43**	**11.05**	**-6.38**
Buffalo, NY	9063020	569.2	580.25	1/30/2008	567.00	2/2/2011	13.25	11.05	-2.20
Fairport, OH ◄	9063053	569.2	575.10	7/2/2019	568.80	1/30/2008	6.3	5.90	-0.40
Toledo, OH	9063085	569.2	576.83	4/15/2018	562.82	1/30/2008	14.01	7.63	-6.38
Sturgeon Point, NY	9063028	569.2	578.59	1/30/2008	567.37	2/2/2011	11.22	9.39	-1.83
Cleveland, OH	9063063	569.2	575.33	7/10/2020	567.77	1/30/2008	7.56	6.13	-1.43
Fermi Power Plant, MI	9063090	569.2	576.40	4/9/1998	564.05	11/13/2003	12.35	7.20	-5.15
Erie, PA	9063038	569.2	576.20	4/13/2020	568.30	2/2/2011	7.9	7.00	-0.90
Marblehead, OH	9063079	569.2	575.46	5/18/2020	565.45	1/30/2008	10.01	6.26	-3.75

Complexity of Water Levels: Ontario



Based on Lakewide Monthly Average Values:
Minimum Water Level: 73.74 meters / 241.92 feet (December 1934)
Maximum Water Level: 75.91 meters / 249.04 feet (June 2019)
Difference: 2.17 meters / 7.12 feet

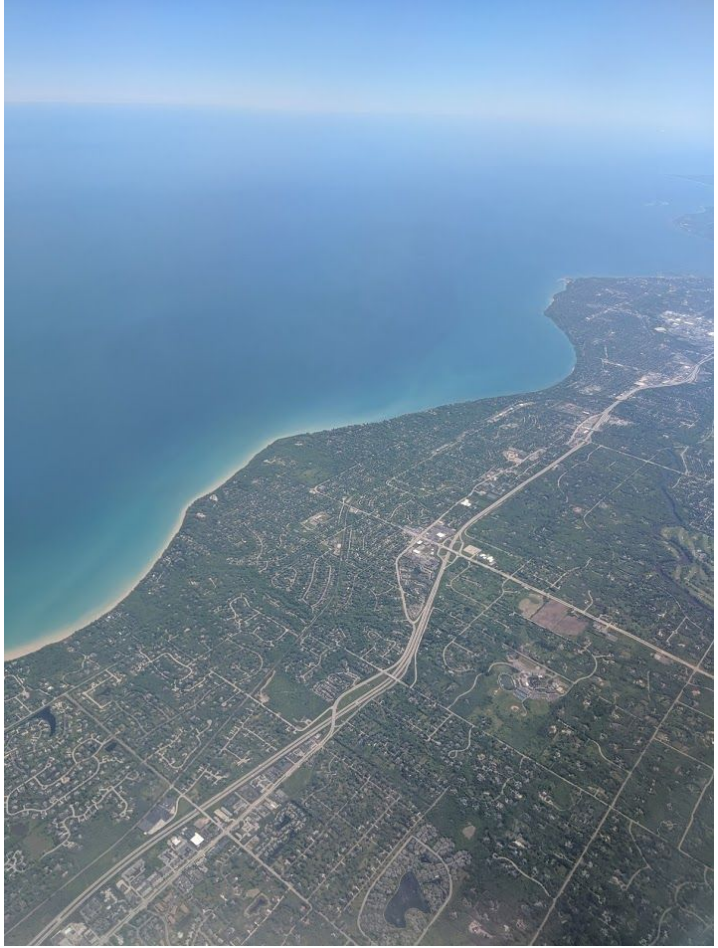
	ID	LWD (ft)	Max (ft)	Date	Min (ft)	Date	Absolute Range (ft)	Above LWD (ft)	Below LWD (ft)
Ontario							**6.50**	**6.04**	**-0.46**
Cape Vincent, NY	9052000	243.3	249.33	6/11/2019	242.84	1/2/1999	6.49	6.03	-0.46
Olcott, NY	9052076	243.3	249.30	6/4/2019	243.24	11/27/2007	6.06	6.00	-0.06
Oswego, NY ◄	9052030	243.3	249.34	5/25/2019	243.06	1/3/1999	6.28	6.04	-0.24
Rochester, NY	9052058	243.3	249.28	5/29/2019	243.10	1/3/1999	6.18	5.98	-0.20

* Note the difference in values for absolute range

Coastal Community Impacts

Physical Impacts

- Coastal Flooding
- Shoreline Erosion/Deposition
- Increased sediment transport in the littoral zone
- Alterations to stream and river mouths
- Loss of coastal terrestrial and wetland habitat
- Increased impacts when storms move through



Economic and Social Impacts

- Damage to coastal infrastructure
- Flooded marinas and docks
- Hazards to navigation
- Shrinking beaches for recreational use
- Damage and loss of private property
- Solastalgia - distress caused by environmental change*

*Albrecht, Glenn (2007). "Solastalgia: the distress caused by environmental change". *Australasian Psychiatry*. **15**: S95–S98. doi:10.1080/10398560701701288. PMID 18027145

Illinois Beach State Park

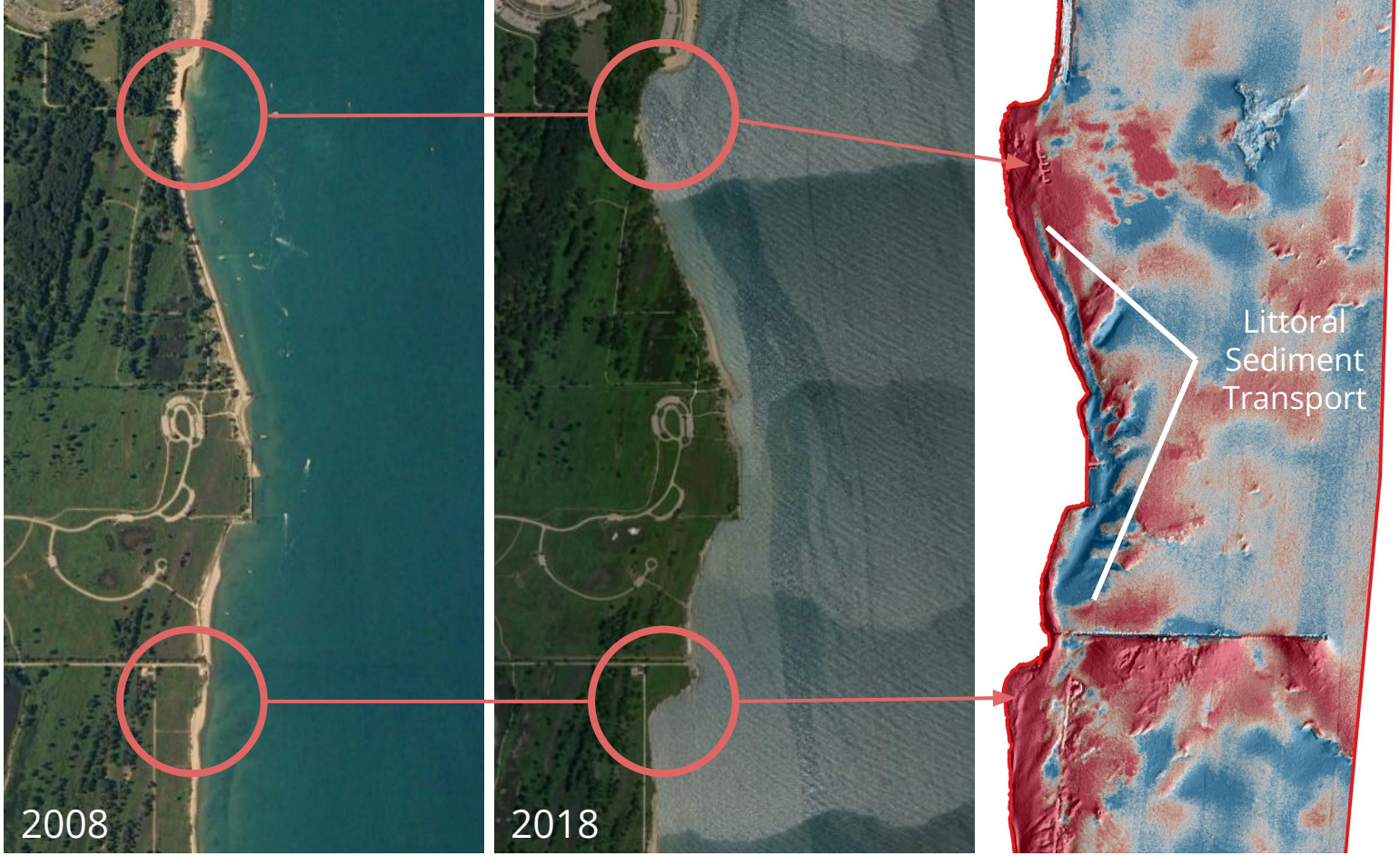
Coastal Erosion

Impact to coastal wetlands

Littoral sediment transport

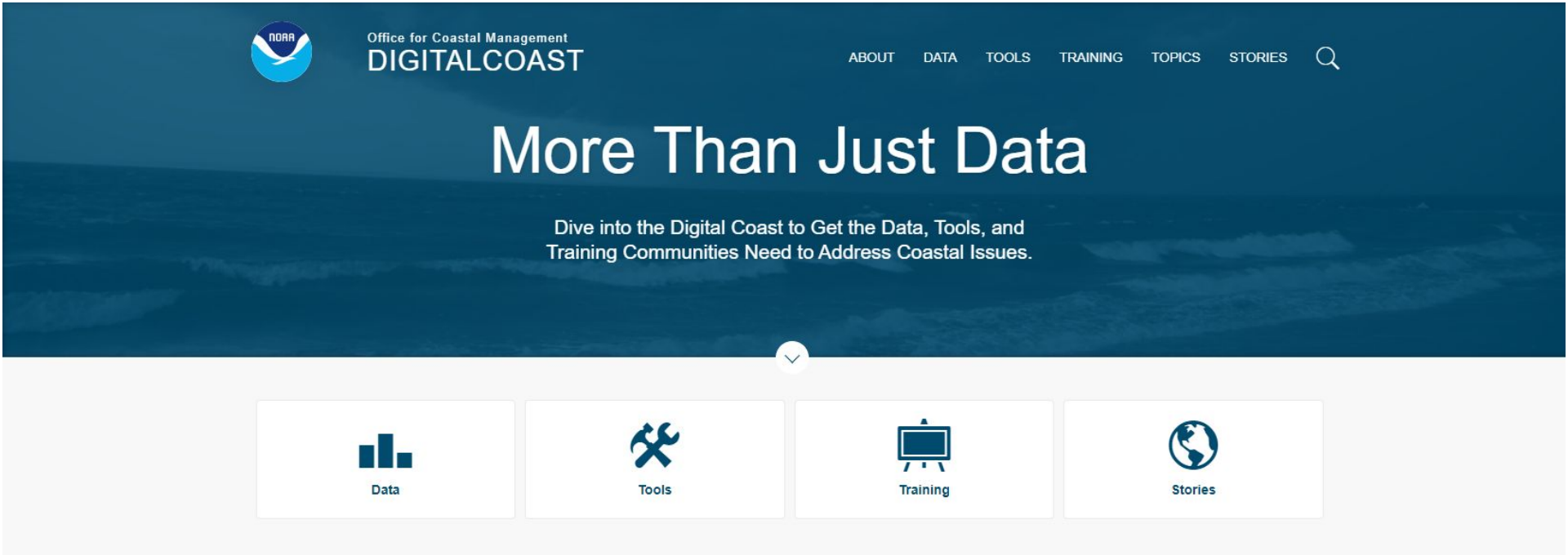
Red - erosion

Blue - deposition



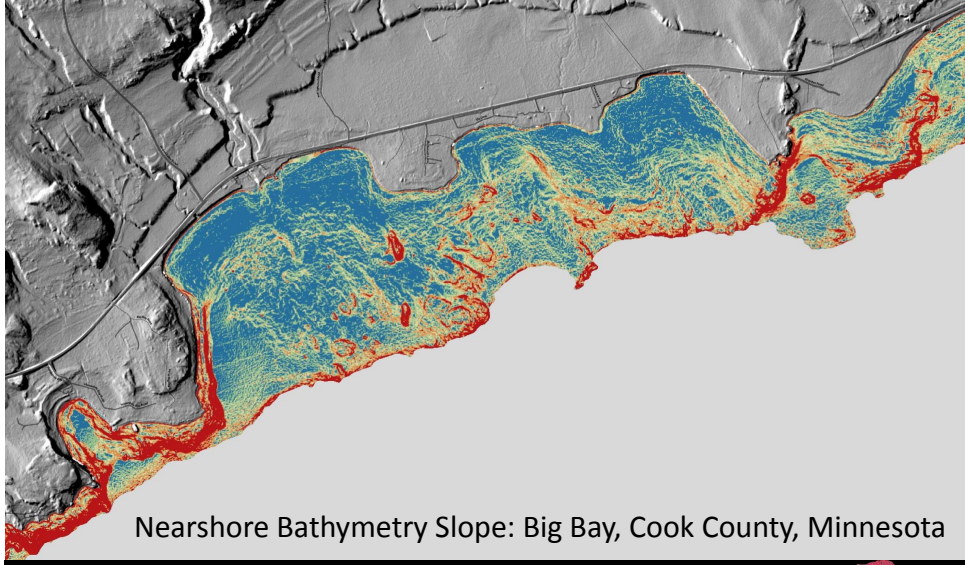
NOAA Resources for Great Lakes Coastal Communities

Digital Coast

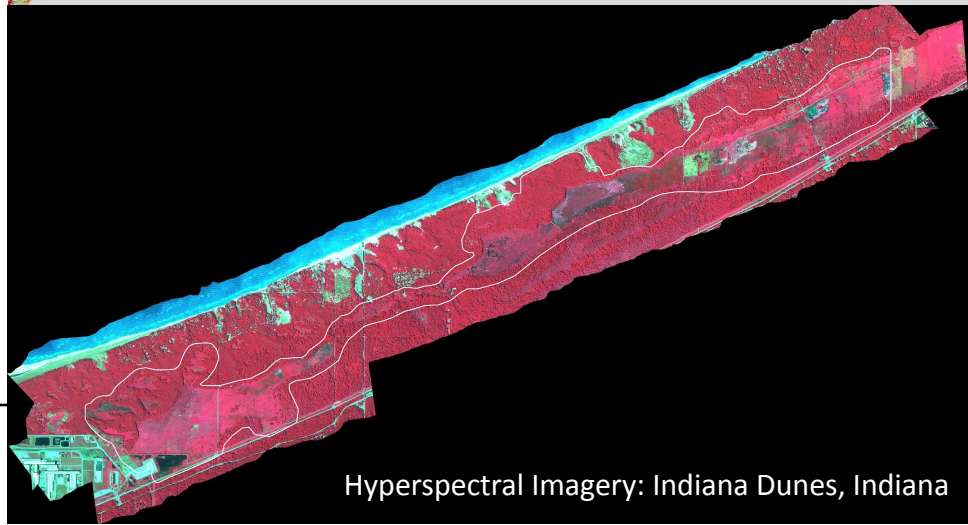


Digital Coast: Data

- Coastal Elevation / Lidar
- Land Cover
- Shoreline Classification
- Imagery
- 3000+ Datasets



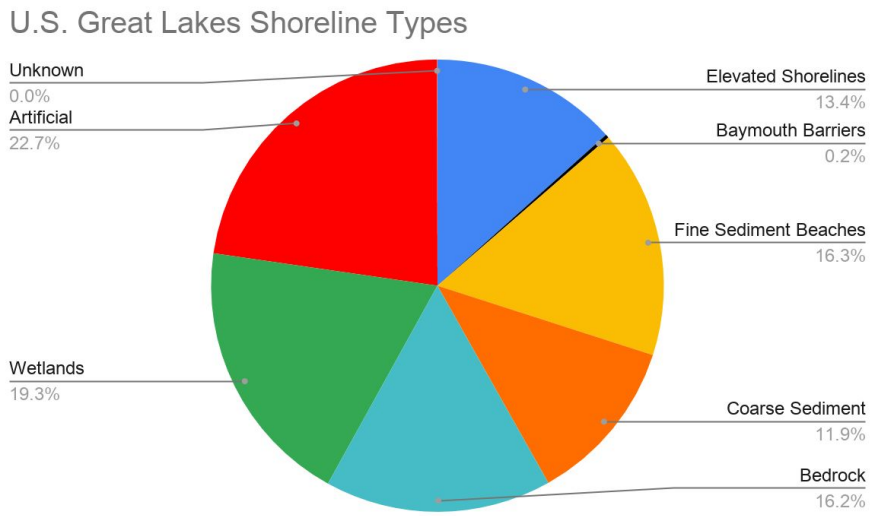
Nearshore Bathymetry Slope: Big Bay, Cook County, Minnesota



Hyperspectral Imagery: Indiana Dunes, Indiana

U.S. Great Lakes Shoreline

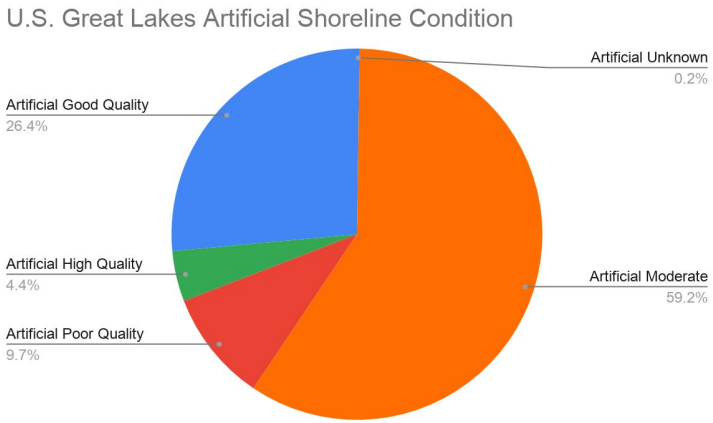
Shoreline Type	Percentage
Elevated Shorelines (Bluffs, Banks, Low Plains)	13.4%
Baymouth Barriers	0.2%
Fine Sediment Beaches	16.3%
Coarse Sediment Beaches	11.9%
Bedrock	16.2%
Wetlands	19.3%
Artificial	22.7%
Unknown	0.0%

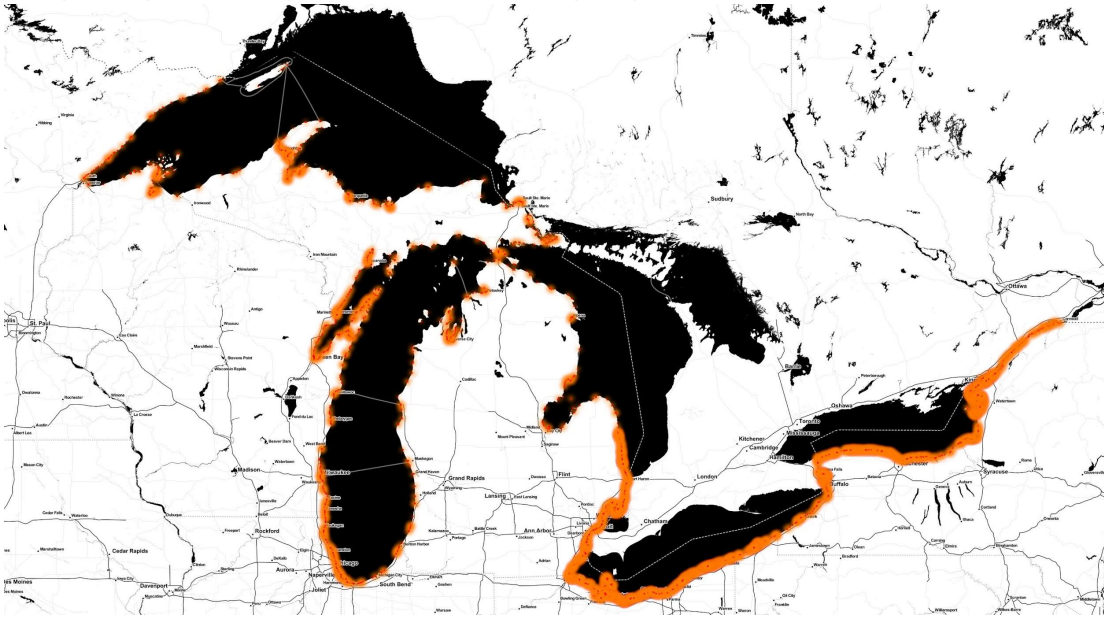


Source: Summarized from 2019 US Great Lakes Hardened Shorelines Classification Dataset

U.S. Great Lakes Shoreline: Artificial

Over 1/5 of the U.S. Great Lakes shoreline is classed as artificial or hardened by coastal infrastructure

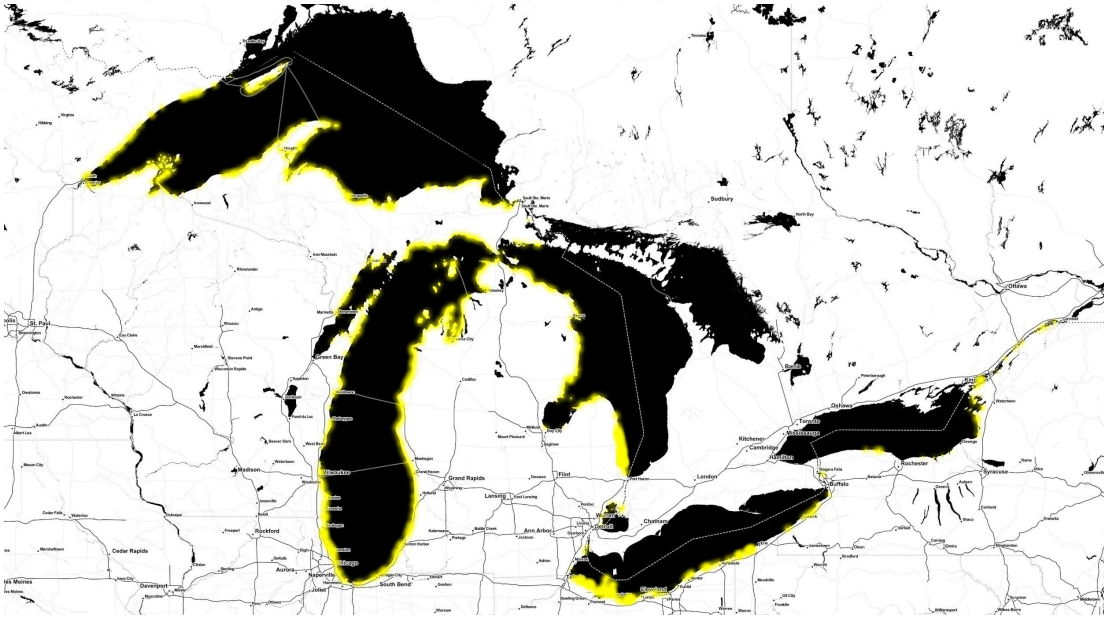




Source: 2019 US Great Lakes Hardened Shorelines Classification Dataset

U.S. Great Lakes Shoreline: Beaches

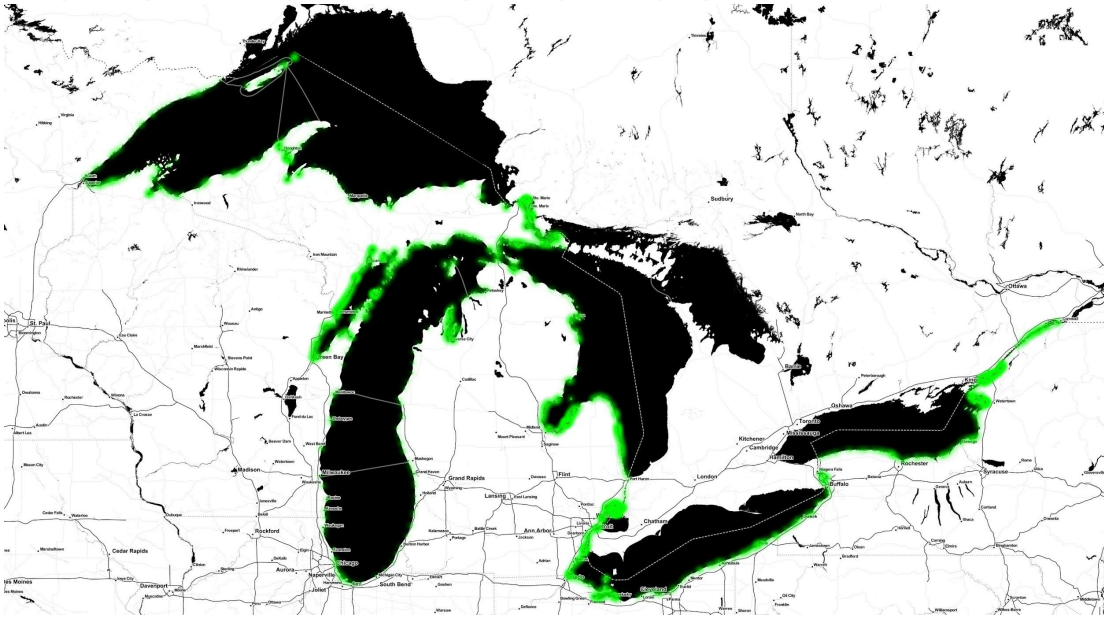
- Over 16% of the U.S. Great Lakes shoreline is classed as fine sediment beaches
- High concentration in Lake Michigan
- Highly dynamic and susceptible to changes in water levels, storms and longshore (littoral) drift



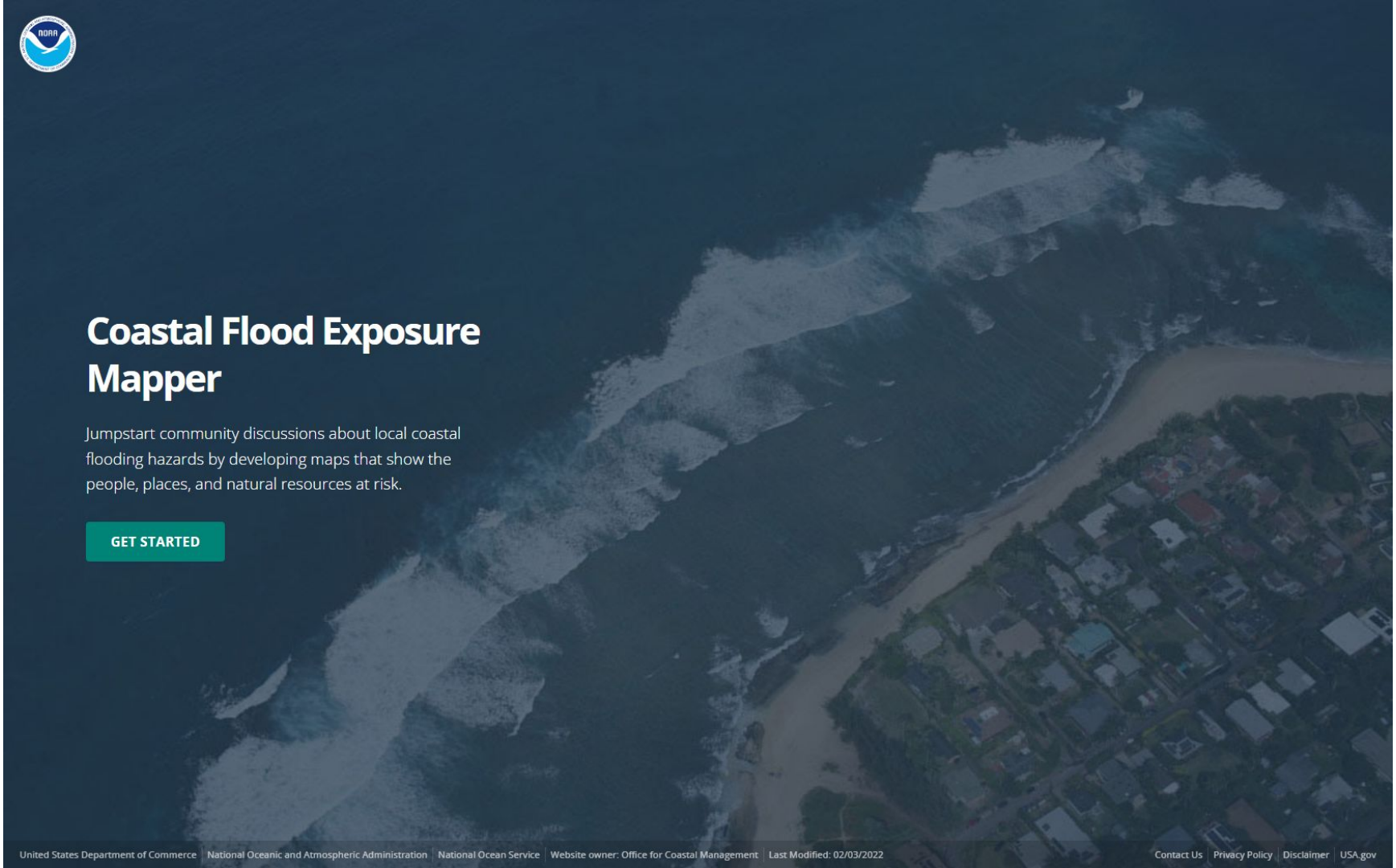
Source: 2019 US Great Lakes Hardened Shorelines Classification Dataset

U.S. Great Lakes Shoreline: Wetlands

- Almost 1/5 of the U.S. Great Lakes shorelines are classed as coastal and river mouth wetlands
- These wetland extents are dynamic in response to changes in water levels



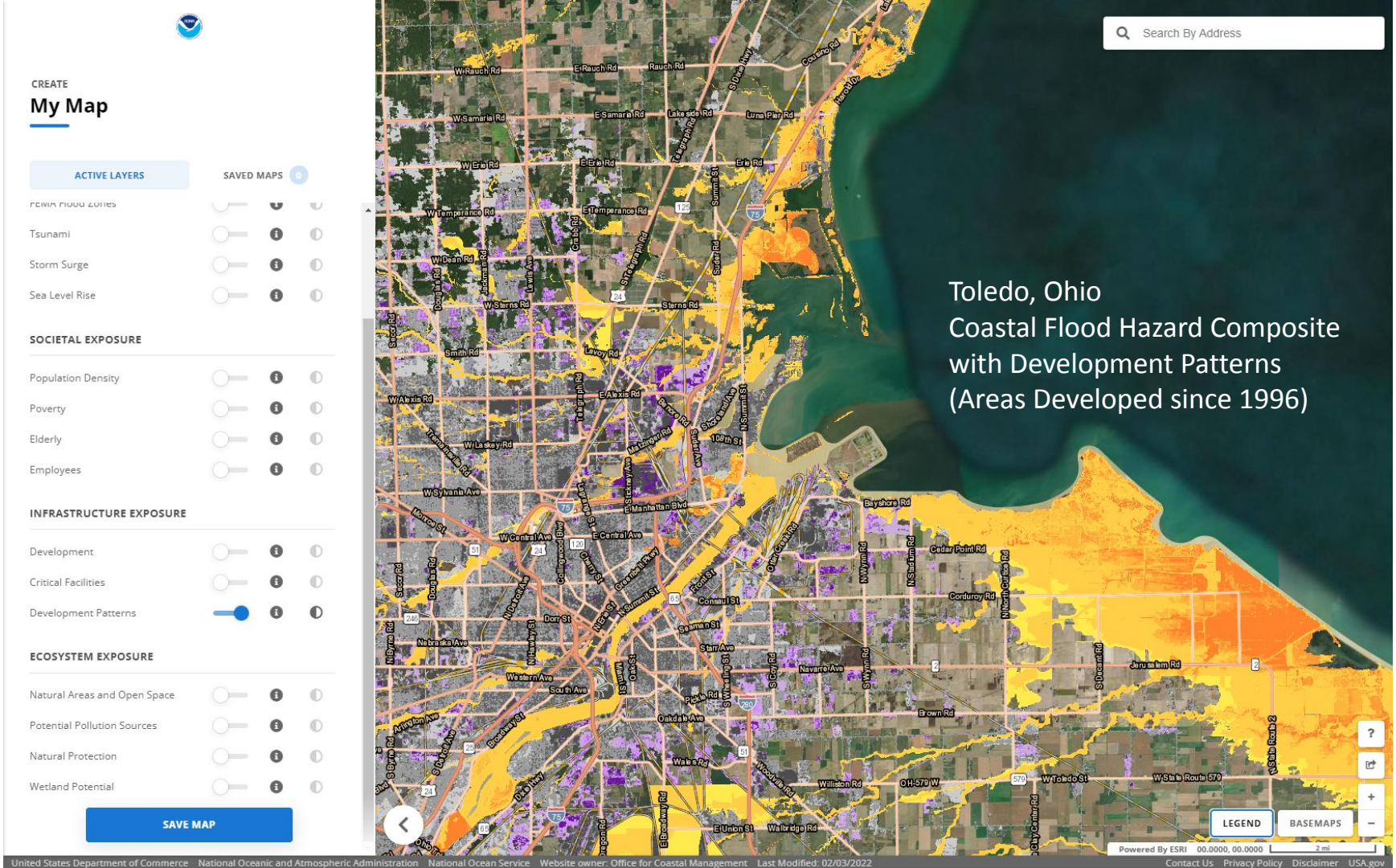
Source: 2019 US Great Lakes Hardened Shorelines Classification Dataset



Coastal Flood Exposure Mapper

Jumpstart community discussions about local coastal flooding hazards by developing maps that show the people, places, and natural resources at risk.

GET STARTED


CREATE
My Map
ACTIVE LAYERS
SAVED MAPS
0
FEMA Flood Zones
Tsunami
Storm Surge
Sea Level Rise
SOCIETAL EXPOSURE
Population Density
Poverty
Elderly
Employees
INFRASTRUCTURE EXPOSURE
Development
Critical Facilities
Development Patterns
ECOSYSTEM EXPOSURE
Natural Areas and Open Space
Potential Pollution Sources
Natural Protection
Wetland Potential
SAVE MAP
Search By Address
Toledo, Ohio
Coastal Flood Hazard Composite
with Development Patterns
(Areas Developed since 1996)
LEGEND
BASEMAPS
Powered By ESRI
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National Oceanic and Atmospheric Administration
National Ocean Service
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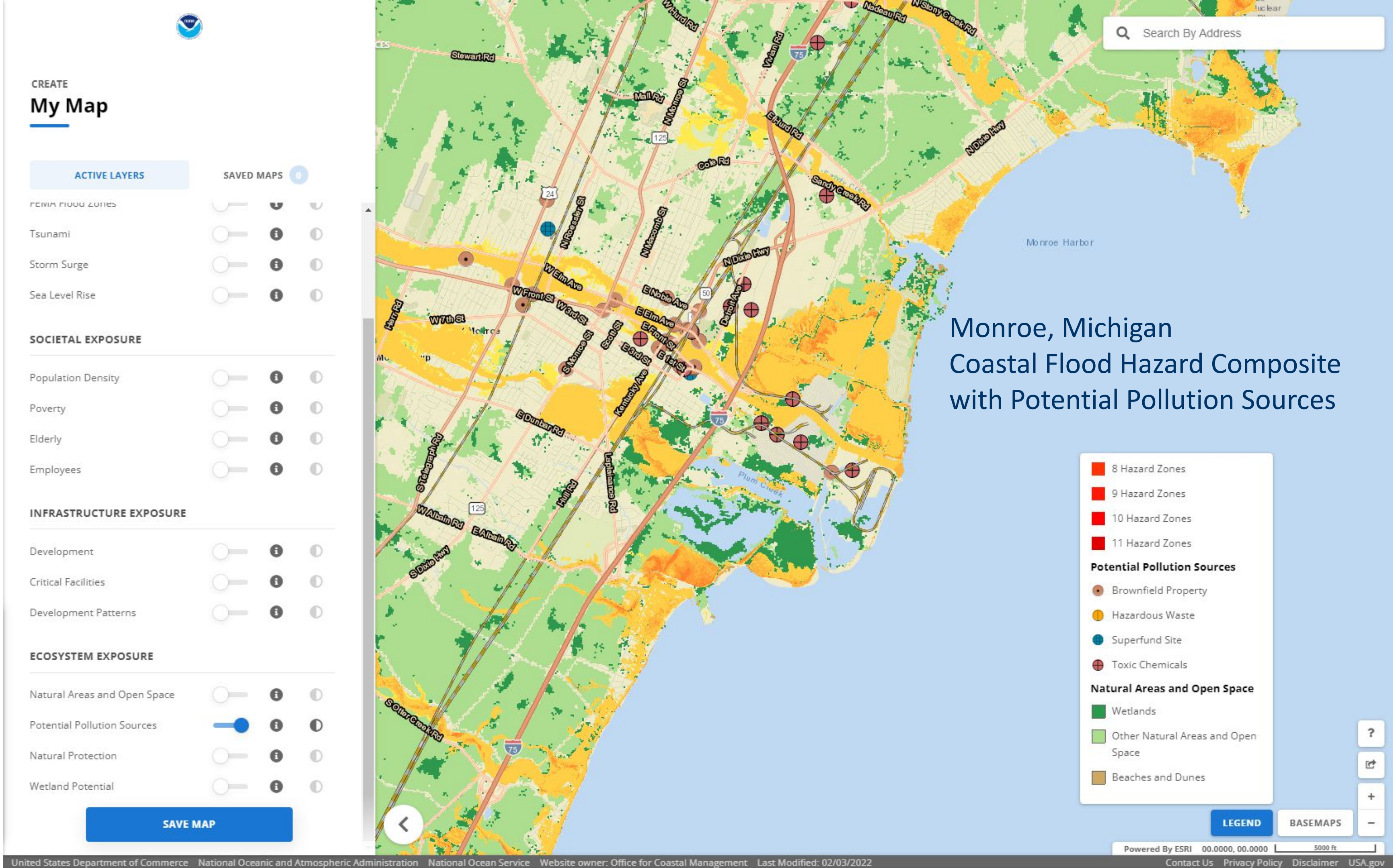
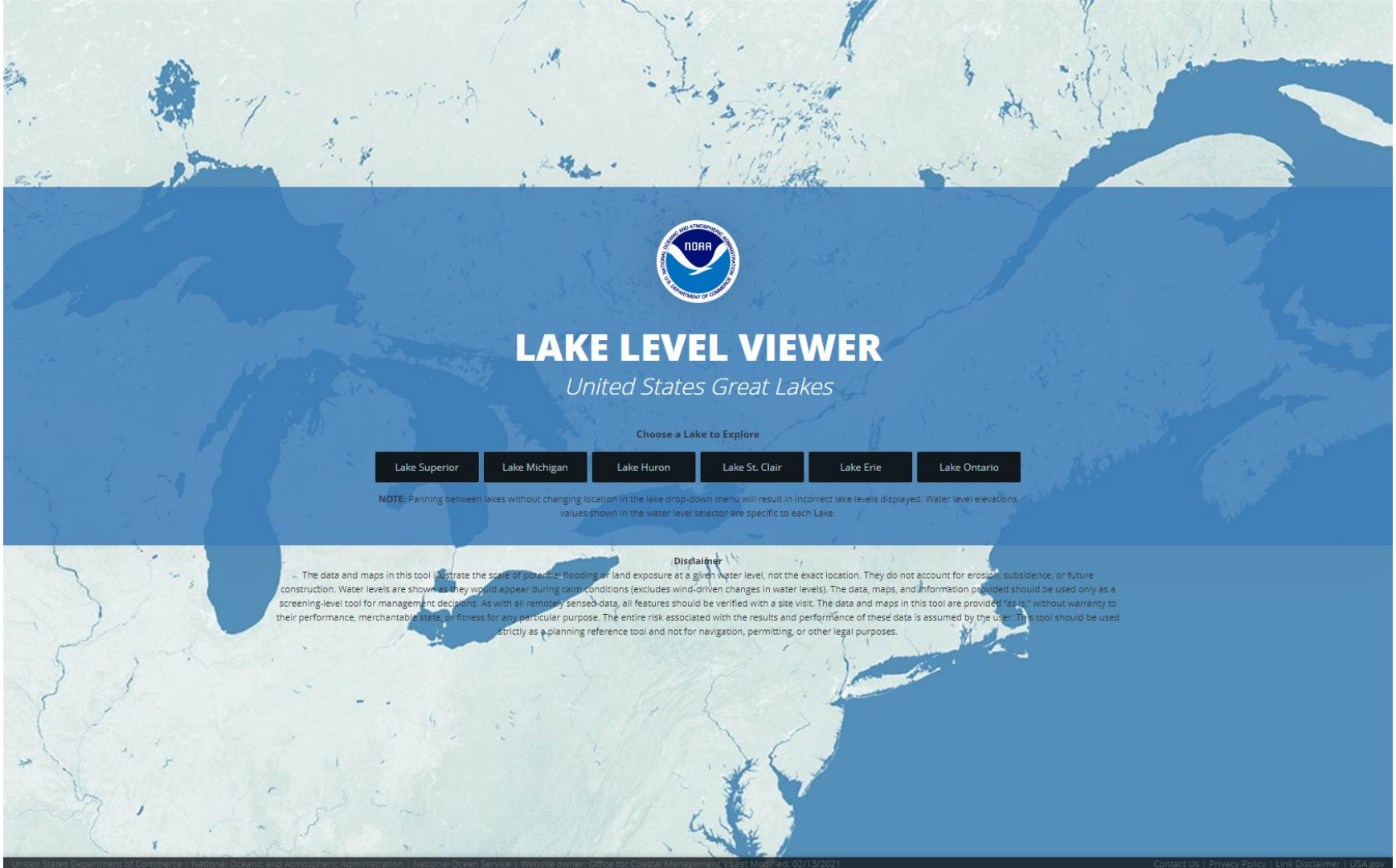
Monroe, Michigan
Coastal Flood Hazard Composite with Potential Pollution Sources





LAKE LEVEL VIEWER

United States Great Lakes

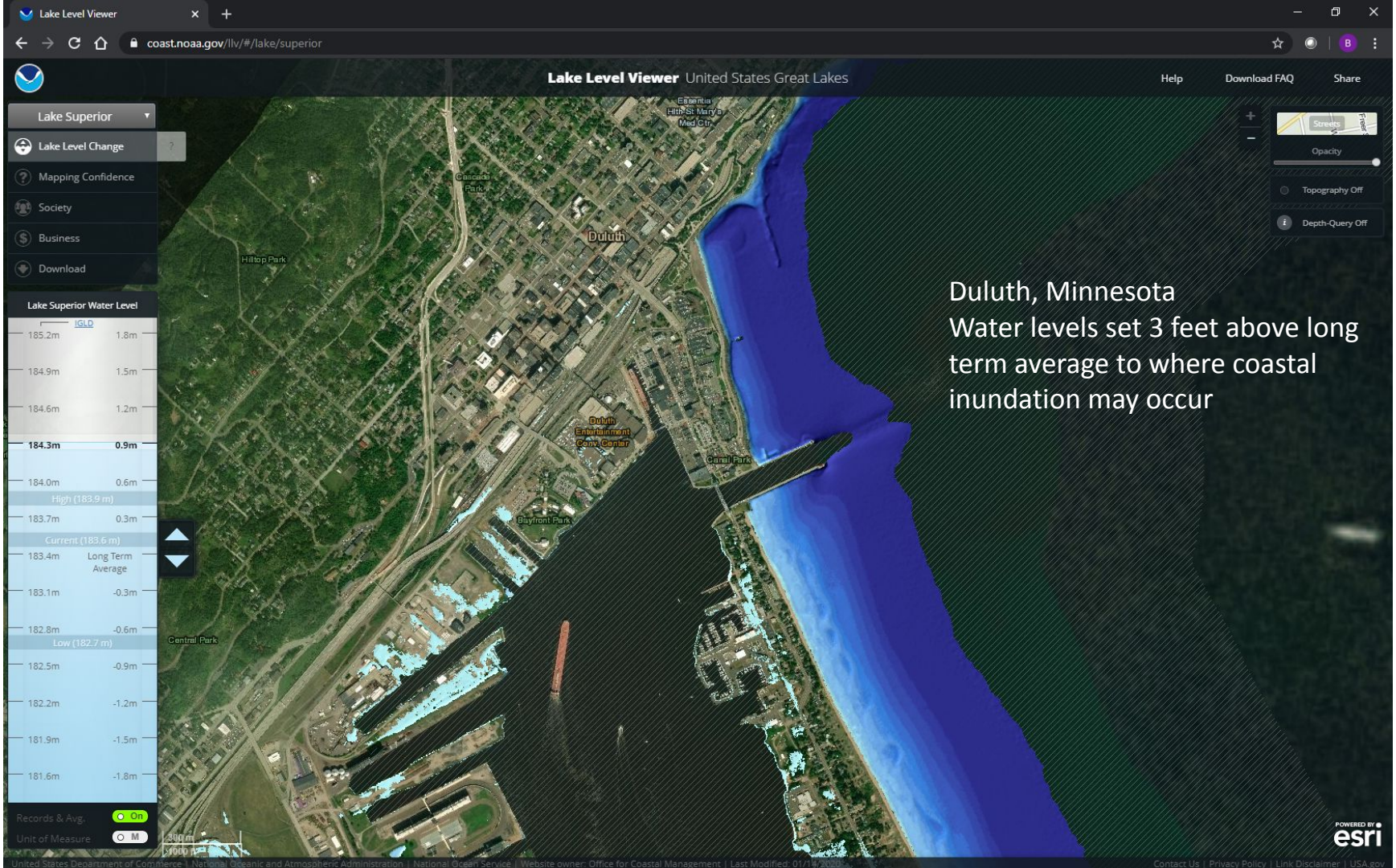
Choose a Lake to Explore

Lake Superior | Lake Michigan | Lake Huron | Lake St. Clair | Lake Erie | Lake Ontario

NOTE: Panning between lakes without changing location in the lake drop-down menu will result in incorrect lake levels displayed. Water level elevations values shown in the water level selector are specific to each Lake.

Disclaimer

The data and maps in this tool illustrate the scale of potential flooding or land exposure at a given water level, not the exact location. They do not account for erosion, subsidence, or future construction. Water levels are shown as they would appear during calm conditions (excludes wind-driven changes in water levels). The data, maps, and information provided should be used only as a screening-level tool for management decisions. As with all remotely sensed data, all features should be verified with a site visit. The data and maps in this tool are provided "as is," without warranty to their performance, merchantable state, or fitness for any particular purpose. The entire risk associated with the results and performance of these data is assumed by the user. This tool should be used strictly as a planning reference tool and not for navigation, permitting, or other legal purposes.


Lake Level Viewer
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Share
Lake Superior
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Mapping Confidence
Society
Business
Download
Lake Superior Water Level
IGLD
185.2m 1.8m
184.9m 1.5m
184.6m 1.2m
184.3m 0.9m
184.0m 0.6m
High (183.9 m)
183.7m 0.3m
Current (183.6 m)
183.4m Long Term Average
183.1m -0.3m
182.8m -0.6m
Low (182.7 m)
182.5m -0.9m
182.2m -1.2m
181.9m -1.5m
181.6m -1.8m
Records & Avg.
On
Unit of Measure
M
Duluth
Hilltop Park
Cascade Park
Central Park
Bayfront Park
Canal Park
Duluth Entertainment Conv. Center
Opacity
Topography Off
Depth-Query Off
Duluth, Minnesota
Water levels set 3 feet above long term average to where coastal inundation may occur
esri

DATA ACCESS VIEWER

Discover, customize, and download authoritative land cover, imagery, and lidar data.

Powered by *Digital Coast*

Choose a Data Type to Explore

Imagery | Land Cover | Elevation/Lidar

ABOUT THIS TOOL

TRAINING

Digital Coast Academy offers a wide range of learning resources.

FIND mapping, sea level rise, etc.

View all 172 trainings

Scheduled Training

Classroom, Instructor-Led
Bring these courses and our instructors to your location.

Online, Instructor-Led
Learn at your desk, or a coffee shop, with sessions taught in real time by our instructors.

Upcoming Offerings

The NOAA Office for Coastal Management has a training curriculum devoted to coastal resource management. Courses are scheduled throughout the year.

Browse Course Calendar

Additional Resources

You may also be interested in additional training resources from our Digital Coast and Contributing Partners.

On-Demand Products

Self-Guided Resources
Develop and practice new skills on your own time with interactive guides and structured courses.

Case Studies
Learn from these peer-to-peer case studies how other coastal practitioners have tackled thorny issues.

Publications
Explore the digital library of topical publications and studies.

Quick References
Access helpful worksheets, checklists, and tip sheets.

Videos And Webinars
View short videos that make difficult topics easier to understand. View recorded webinars to learn from experts in the field.

Displaying 77 trainings sorted by A>Z

Climate Adaptation ×

Clear All

Browse Course Calendar

Training Type

- Classroom, Instructor-Led
- Online, Instructor-Led
- Self-Guided Resources
- Case Studies
- Quick References
- Publications
- Videos and Webinars

Skills Desired

- Program and Project Planning
- Community Engagement
- GIS and Mapping
- Social Science Methods

Focus Area

- Climate Adaptation
- Coastal Conservation
- Coastal Economy
- Coastal Hazards
- Community Resilience
- Green Infrastructure
- Land Use Planning
- Ocean Planning
- Water Quality

Funding and Financing Coastal Resilience

Provides information about both traditional and emerging funding and financing approaches for coastal resilience projects

Videos and Webinars

A Community Resource Guide for Planning Living Shorelines Projects

Provides communities with key information and resources for moving forward with living shoreline projects in New Jersey

Publications

A Guide for Planning for Meaningful Evaluation

Outlines a process for planning evaluations that can improve any project or program

Publications

A Seat at the Table: Training for Whole-Community Climate Resilience Planning

Provides resilience planning practitioners with information and resources for identifying and engaging socially vulnerable populations through a whole-community planning approach

Self-Guided Resources

Adaptation Planning for Coastal Communities

Provides a thorough introduction to adaptation planning, including practical skills, in-class exercises, and local speakers and discussions (2-day course)

Classroom, Instructor-Led

Adapting Stormwater Management for Coastal Floods

Provides guidance and methods to identify current and future coastal flood risk, examine impacts on stormwater systems, and explore appropriate actions to respond

Self-Guided Resources

Advancing Preparedness of Climate Change Impacts on Coastal Communities in the Mid...

Documents an assessment of climate change impacts on the Mid-Atlantic region and suggestions for addressing those impacts at a state and regional scale

Publications

Building Risk Communication Skills

Increases understanding of risk response and helps participants connect with diverse audiences to motivate action to reduce risk (1-day course)

Classroom, Instructor-Led

Coastal Adaptation Planning Essentials

Engages participants in individual and group activities to introduce a five-step planning process for adaptation (2 day course)

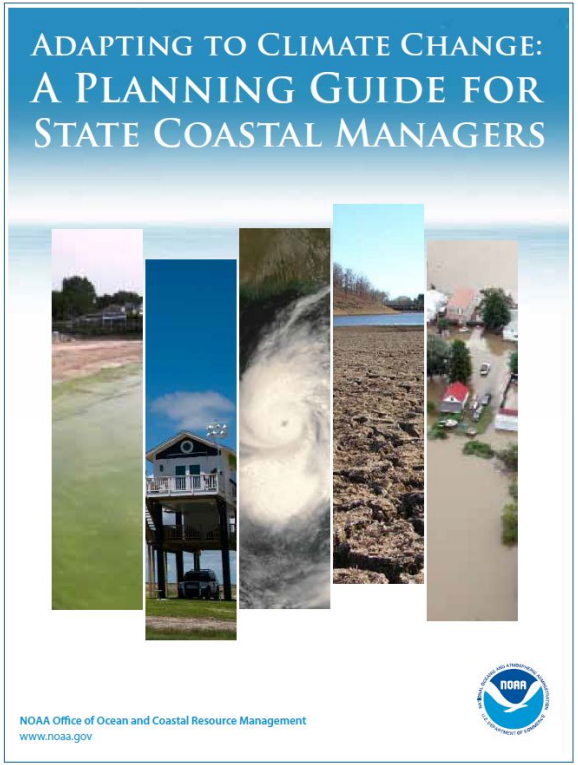
Online, Instructor-Led

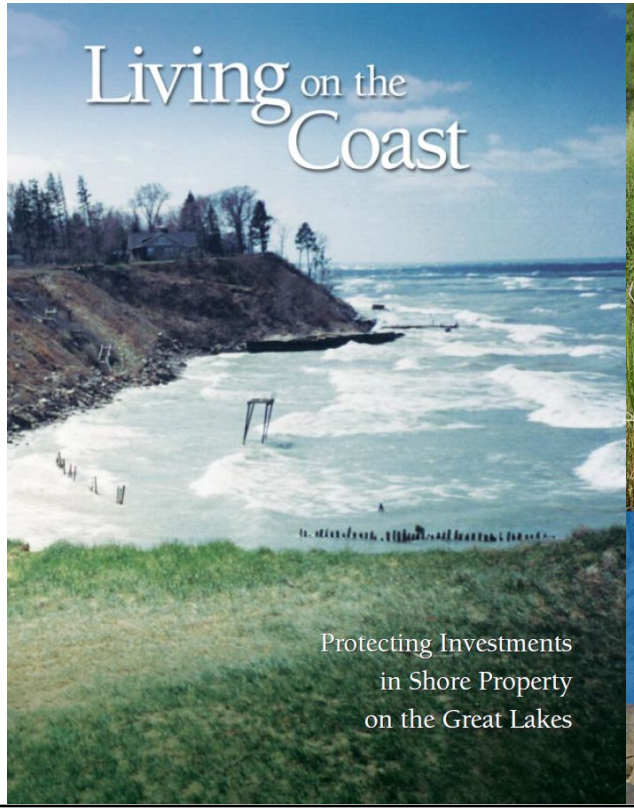
Coastal and Waterfront Smart

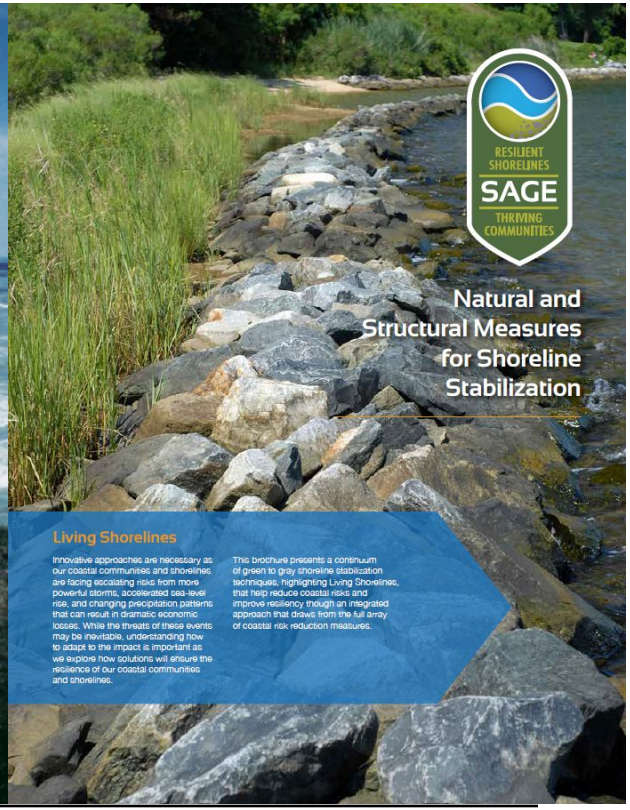
Coastal Ecosystem Services

Coastal Hazard Resilience

Adaptation Strategies







Digital Coast Act

The Digital Coast Act was signed into law in December 2020, solidifying formal congressional support for the Digital Coast program.

Specific Requirements in the Legislation include:

- Filling data information gaps
- Developing publicly available tools that integrate various data products
- Providing greater focus on underserved areas
- Documenting best practices in product and service delivery

Power of Partnerships in the Great Lakes

COASTAL STATES CSO ORGANIZATION

GREAT LAKES AND ST. LAWRENCE CITIES INITIATIVE

Great Lakes RESTORATION

Final Thoughts:

Consider the Cost of Inaction

Move from Reactionary to Proactive

Thank You

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