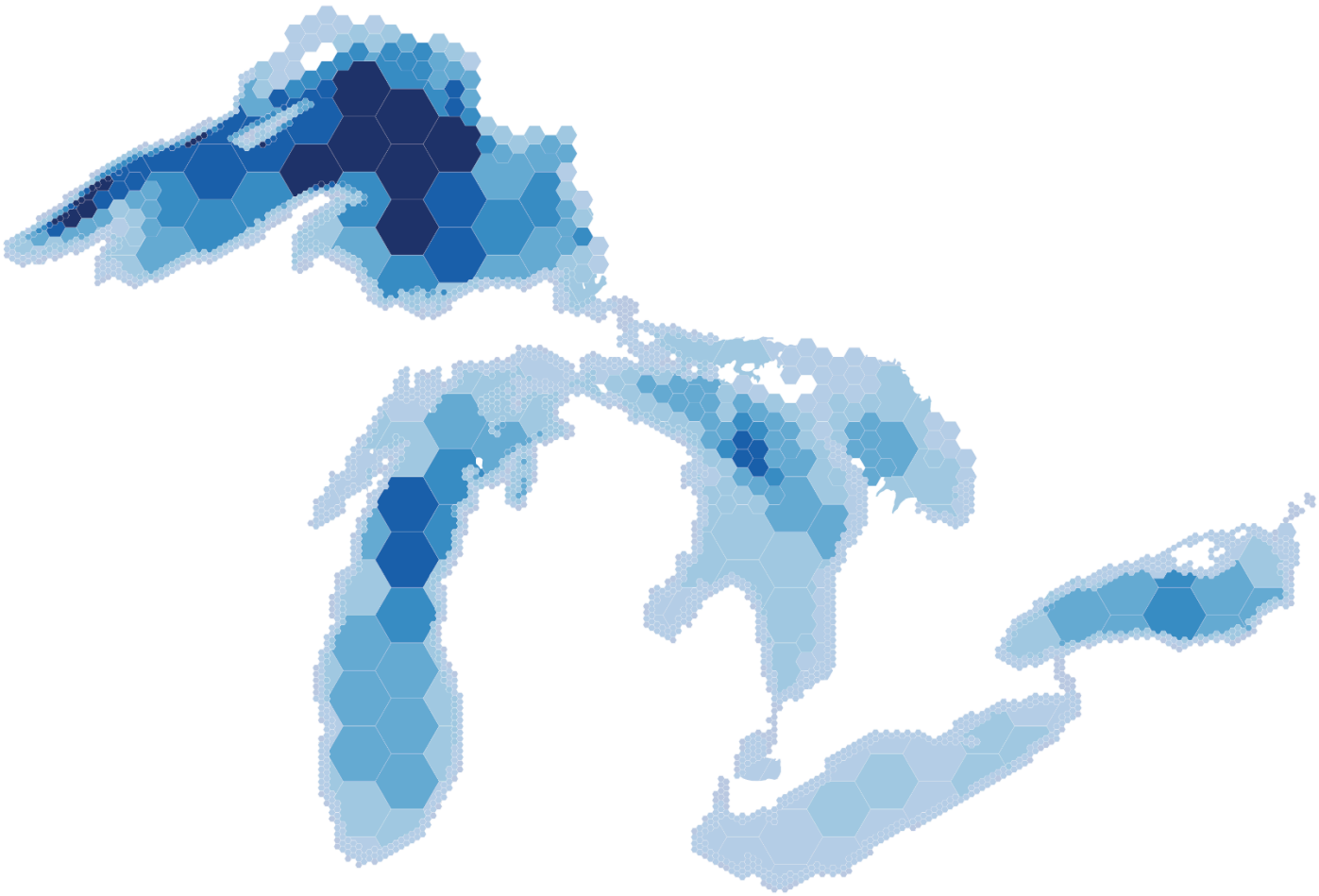

LAKEBED 2030

Regional strategy for mapping the Great Lakes

Building the Great Map

May 20, 2025

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Revision Table

Version	Date	Individual	Organization	Comments
0.0	August, 2024	Meredith Westington	NOAA	The initial first draft was derived from the Seascape Alaska governance document for circulation among key stakeholders
0.1	September, 2024	Ed Bailey	NMC	Major updates to reflect Lakebed 2030 needs
0.2	March 18, 2025	Erik Brush	NOAA	Suggested edits based on member comments. Added citations for statistics and updated campaign structure diagram.
1.0	May 20, 2025	Erik Brush	NOAA	Updated Implementation Plan timeline and formatted reference documents. **Document Finalized**

Lakebed 2030 – *Regional Strategy for Mapping the Great Lakes*

Program:

The Lakebed 2030 Mapping Campaign is a regional strategy to fully map the binational waters of the Great Lakes. The campaign is and will be a grassroots-led collaboration among federal, Tribal, state, provincial, non-governmental, and private industry partners with a wide range of interests and dependencies on mapping data across the ecosystem. The multinational, multi-agency approach to the management of the Great Lakes requires enhanced coordination to improve the current state of bathymetric data collection, which consists of varying resolution, accessibility, and geography resulting from disconnected data collection efforts and policies.[1] The Lakebed 2030 Strategy seeks to coordinate this effort by focusing on three primary goals: 1) fully mapping the Great Lakes to modern standards[2] (following established protocols[3,4,5]) that enable exploration and characterization of priority areas, 2) archiving data in publicly accessible databases to enable data usability and interoperability, and 3) increasing communication to coordinate efforts and convey the importance of these data to the public. Through this organized effort, the Lakebed 2030 Initiative supports the regional implementation of the *National Strategy for Mapping, Exploring, and Characterizing the United States Exclusive Economic Zone*[6] and collaborative management laid out by the *Great Lakes Charter*[7] and subsequent *Great Lakes-St. Lawrence River Basin Water Resources Compact*,[8] providing critical baseline data that supports adaptive management of natural resources and ensures the integrity of basin ecosystems that are inherently interconnected in a single hydrologic system. This strategy will also provide critical information for and support the binational implementation of the *Great Lakes Water Quality Agreement*,[9] specifically Annexes 2 (integrated nearshore framework), 3 (chemicals of mutual concern), 4 (nutrients), 6 (aquatic invasive species), 7 (habitat and species), 9 (climate change), and 10 (science). Through acquiring foundational mapping data and coordinating across the stakeholder landscape, Lakebed 2030 also supports all priorities (basic research, monitoring, enhanced forecasting, workforce development, research infrastructure, and socioeconomic and cultural inclusion) of the International Joint Commission (IJC) *Great Lakes Science Strategy*.[10] Thus, this initiative contributes to the mitigation of current threats to the Great Lakes and a better understanding of system functioning for ecosystem restoration and economic prosperity.

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[1] Great Lakes Observing System, Bottom Mapping Working Group. *Costs and Approaches for Mapping the Great Lakes*, 2021, https://glos.org/wp-content/uploads/2021/12/Costs-and-Approaches-for-Mapping-the-Great-Lakes.pdf.
[2] Modern standards refer to the use of modern technology, such as multibeam sonar and lidar, to map the physical shape of the lake floor with high-density resolution that reveals features less than 10 meters in size.
[3] International Hydrographic Organization. *IHO Standards for Hydrographic Surveys (5th Edition), Special Publication No. 44*, 2008, https://iho.int/uploads/user/pubs/standards/s-44/S-44_5E.pdf.
[4] Interagency Working Group on Ocean and Coastal Mapping for the National Ocean Mapping, Exploration, and Characterization Council. *Standard Ocean Mapping Protocol*, 2024, https://iocm.noaa.gov/standards/SOMPFinal2024.pdf.
[5] Canadian Hydrographic Service. *Standards for Hydrographic Surveys*, 2021, https://waves-vagues.dfo-mpo.gc.ca/library-bibliotheque/41034685.pdf.
[6] National Ocean Mapping, Exploration, and Characterization Council. *National Strategy for Mapping, Exploring, and Characterizing the United States Exclusive Economic Zone*, 2020, https://www.noaa.gov/sites/default/files/2022-07/NOMECStrategy.pdf.
[7] Council of Great Lakes Governors. *The Great Lakes Charter: Principles for the Management of Great Lakes Water Resources*, 1985, https://gsgp.org/media/j1zcl0x2/greatlakescharter.pdf.
[8] Great Lakes—St. Lawrence River Basin Water Resources Compact, Pub L. 110-342 (2008).
[9] United States Environmental Protection Agency and Environment Canada, *Great Lakes Water Quality Agreement*, 1972 (amended 1983, 1987, 2012), https://binational.net/wp-content/uploads/2014/05/1094_Canada-USA-GLWQA-_e.pdf.
[10] Great Lakes Science Advisory Board for the International Joint Commission. *Great Lakes Science Strategy for the Next Decade*, 2022, https://ijc.org/sites/default/files/SAB_Great-Lakes-Science-Strategy-summary-report_2022.pdf.

What is mapping, exploration, and characterization?

Mapping: The terms "map" and "mapping" mean activities that provide comprehensive data and information needed to understand seafloor characteristics, including bathymetry (depth), topography, bottom type, sediment composition and distribution, underlying geologic structure, and benthic flora and fauna.

Exploration: The terms "exploration", "explore", and "exploring" mean activities that provide—(A) "a multidisciplinary view of an unknown or poorly understood area of the sea floor, sub-bottom, or water column"; and (B) "an initial assessment of the physical, chemical, geological, biological, archaeological, cultural, or other characteristics of such an area."

Characterization: The terms "characterization", "characterize", and "characterizing" mean activities that provide comprehensive data and interpretations for a specific area of interest of the sea floor, sub-bottom, water columns, or hydrologic features, such as water masses and currents, in direct support of specific research, environmental protection, resource management, policymaking, or applied mission objectives.[11]

Why map, explore, and characterize the Great Lakes?

The Great Lakes are an economic and environmental asset for the United States and Canada. The lakes fuel a nearly $8 trillion economy,[12] making the region the 3rd largest economy in the world by GDP.[13] With over 10,000 miles of coastline,[14] they also contain over 3500 unique plant and animal species,[15] making lakeshore ecosystems comparable in biodiversity to ocean coasts. The many industries supported by the Great Lakes provide more than 1.5 million U.S. jobs[16], generating $62 billion in wages annually.[17]

Yet, despite the critical importance of and dependence on the Great Lakes, they have never been fully mapped and explored. The majority of bathymetric data collected in the Great Lakes consists of early depth soundings from weighted lines and low-density single-beam sonar measurements collected prior to 1960. According to a 2025 report on unmapped U.S. waters produced by the federal Interagency Working Group on Ocean and Coastal Mapping, only 15% (5850 sq nm) of the Great Lakes under U.S. jurisdiction have been mapped to modern

[11] Definitions taken from: Pub. L. 111-11, title XII, §12007, as added Pub. L. 117-263, div. J, title CIII, §10305(h), 136 Stat. 3974 (33 U.S.C. §3407).
[12] "Great Lakes St. Lawrence Governors & Premiers." Great Lakes St. Lawrence Governors & Premiers. Accessed April, 2025. https://www.gslgp.org/.
[13] "The Great Lakes Economy: The Growth Engine of North America." Council of the Great Lakes Region. Accessed April, 2025. https://councilgreatlakesregion.org/the-great-lakes-economy-the-growth-engine-of-north-america/.
[14] International Joint Commission. *Great Lakes Science Strategy for the Next Decade*.
[15] Great Lakes Observing System. *Costs and Approaches for Mapping the Great Lakes*.
[16] Great Lakes Commission. *Great Lakes General Factsheet*, 2024, https://www.glc.org/wp-content/uploads/GLC-FactSheet-General-20240917.pdf.
[17] Ibid.

standards.[18] Additionally, only ~14% (3745 sq nm) of Canadian waters in the Great Lakes and St. Lawrence River has been mapped with full bottom coverage[19], which together results in tens of thousands of square nautical miles of lake floor remaining unmapped. Currently, the surfaces of Earth's moon and Mars have been more extensively studied than the lakebeds of the Great Lakes. This lack of high-resolution baseline information has astounding consequences, impacting maritime commerce and safe navigation, natural and cultural resource management, public health and safety, and Great Lakes infrastructure and security.

Maritime Commerce: Mapping the Great Lakes is critical for detecting and avoiding unmapped and unforeseen hazards, which cause accidents, shipping delays, and threats to public safety and infrastructure, especially during times of low lake levels. In 2022, the U.S. maritime economy in the Great Lakes St. Lawrence Waterway supported over 350,000 jobs[20] and over $23 billion in wages,[21,22] contributing to more than $50 billion in economic activity for the U.S. and Canada[23]. This results from over 250 million tons of goods shipped annually[24] and $278 billion in bilateral trade between the United States and Canada.[25] Iron ore made up 42% of all tonnage shipped through the Great Lakes in 2020,[26] significantly contributing to the U.S. steel industry. Shipment of this critical resource by lake freighter is also 10× more fuel efficient[27] and produces 10× less CO_2[28] than by truck. This is a stark reminder of the importance of supporting safe navigation within the Great Lakes, as the Great Lakes Navigation System contained 15 of the top 100 harbors in the United States by tonnage in 2021.[29]

Natural and Cultural Resource Management: Great Lakes ecosystems and natural resources are inherently linked to the biological processes of the lake floor. These ecosystems are currently home to over 170 fish species,[30] enabling a collective fishery valued at over $7 billion[31] and supporting 75,000 jobs.[32] Yet, 61 fish species are currently threatened or endangered[33] due to climate change, pollution, habitat degradation, and invasive species. Comprehensive ecosystem management requires high-resolution data for bathymetry and bottom type, informing our

[18] Interagency Working Group on Ocean and Coastal Mapping. *2025 Progress Report: Unmapped U.S. Waters*, 2025, https://iocm.noaa.gov/documents/mapping-progress-report2025.pdf.
[19] Canadian Hydrographic Service. *Bathymetric Gap Analysis 2024 report*. 2024.
[20] Martin Associates. *Economic Impacts of Maritime Shipping in the Great Lakes - St. Lawrence Region*, 2023, https://greatlakes-seaway.com/wp-content/uploads/2023/07/eco_impact_full_2023_en.pdf.
[21] Ibid.
[22] All references to money in this document are in USD.
[23] Ibid.
[24] Ibid.
[25] Kadar, Isabel. The International Supply Chain of the Great Lakes Region, 2017, https://globaledge.msu.edu/blog/post/54492/the-international-supply-chain-of-the-gr.
[26] Library of Congress. *Shipping on the Great Lakes and St. Lawrence Seaway: An Update*, 2023, https://www.congress.gov/crs-product/R47550.
[27] U.S. Army Corps of Engineers. *Great Lakes Navigation System: Economic Strength to the Nation*, 2013, https://www.lcaships.com/wp-content/uploads/2015/07/GLN_Strength-to-the-Nation-Booklet2013v2_final2w.pdf.
[28] Ibid.
[29] U.S. Army Corps of Engineers. *Great Lakes Commercial Navigation Summary FY 2023*, 2023, https://lre-ops.usace.army.mil/OandM/GLNAV/Main_Page/FY23_GLCNS_FINAL_20FEB2024.pdf.
[30] "The Great Lakes Fishery: A world-class resource!" Great Lakes Fishery Commission. Accessed April, 2025. https://www.glfc.org/the-fishery.php.
[31] Ibid.
[32] Ibid.
[33] Ibid.

understanding of critical habitat types, distributions of economically important fisheries, benthic mineral resources, and invasive species distributions. These data enable sustainable resource management, critical habitat conservation and protection, invasive species mitigation, and restoration. Additionally, the Great Lakes are home to over 6,000[34] shipwrecks. Mapping and exploration efforts lead to the discovery of these cultural resources for historical preservation, safe navigation, and tourism.

Public Health and Safety: The Great Lakes hold over 6 quadrillion gallons of water,[35] accounting for 21% of the world's surface freshwater[36] and providing drinking water for more than 40 million people.[37] However, as an interconnected and closed hydrologic system, the lakes have a troubled history of acute, large-scale pollution as recent as the 1960s. Science and management over the last 50 years have predominantly focused on understanding the effects of excessive nutrients and toxins, as well as effective measures for elimination. While water quality has substantially improved,[38] the Great Lakes remain vulnerable to emerging contaminants, agricultural pollution, harmful algal blooms, and spills of human-caused pollutants. Fine-scale mapping provides critical data to inform models that improve our understanding of sediment, water, and contaminant transport, predict the incidence of harmful algal blooms, and enlighten wetlands restoration efforts, all of which improve water quality.

Infrastructure and security: Lake levels rise and fall due to a variety of factors, including season, rainfall, and climate variability. At low levels, issues related to dredging and established infrastructure become apparent, while high levels can lead to flooding and coastal erosion. From 2020 to 2025, the effects of climate change, including rising water levels, severe storms, coastal erosion, and flooding, is expected to cost an estimated $2 billion in damage to Great Lakes cities.[39] High-density mapping provides necessary baseline data for water level forecasts, inundation modeling and mapping, damage assessment and emergency response, and coastal erosion mitigation efforts.

[34] Great Lakes Observing System. *Costs and Approaches for Mapping the Great Lakes.*
[35] "About the Lakes." Great Lakes Commission. Accessed April, 2025. https://www.glc.org/lakes/.
[36] "Great Lakes Facts and Figures." United States Environmental Protection Agency. Accessed April, 2025. https://www.epa.gov/greatlakes/great-lakes-facts-and-figures.
[37] Great Lakes Commission. *Great Lakes General Factsheet*, 2024.
[38] International Joint Commission. *Great Lakes Science Strategy for the Next Decade*.
[39] Cusick, Daniel. *Cities along the Great Lakes Face Rising Water and Costs*, 2021, https://www.scientificamerican.com/article/cities-along-the-great-lakes-face-rising-water-and-costs/.

Strategy and Goals:

The Lakebed 2030 Mapping Campaign strategy has two primary goals:

1. Coordinate the use of modern technology and tools to fully map the Great Lakes lake floor, as well as explore, and characterize priority areas.
   - Establish a bi-national prioritization process and strategy that supports and meets the needs and goals of the United States and Canada
   - Develop a mechanism to fully fund, map, and provide publicly available data using modern high-resolution mapping technology of the Great Lakes. Projected costs: $200,000,000 (budget number assumes 1% of water depth (approx) to the 5-meter contour for all 5 lakes and only bathymetry)

2. Provide accessible, high-quality, modern lakebed hydrographic data for the Great Lakes seafloor to support research, resource management, sustainable economic growth, health, and security, as well as ensure that:
   - All high-quality mapping data and products are publicly accessible to the extent allowable under the federal, state, provincial, and tribal jurisdictions
   - Best practices for data and products are followed
   - Forge collaborative partnerships and sharing of information
   - Members work together to achieve more than the sum of individual activities
   - Campaign plans and progress are shared broadly

3. Facilitate communication and collaboration among Lakebed 2030 participants and with external stakeholders and the public to:
   - Improve accessibility to and use of Great Lakes lake floor data and information
   - Advance a unified messaging strategy to effectively communicate the importance, need, and purpose of mapping the Great Lakes to a wide array of constituents (i.e. governmental officials, environmental organizations, economic enterprises, etc.) and the public
   - Coordinate and cooperate among a wide spectrum of stakeholders, including governmental bodies, academic research institutions, non-profit organizations, and local communities to establish strong partnerships and collaboration to leverage collective expertise and use resources efficiently
   - Encourage the innovation of new technologies and workforce development

Implementation Plan:

Objective	Organizations (proposed)	Task	Date
Stakeholder engagement	NMC, GLOS, IJC, NOAA, CHS	Develop a complete list of stakeholders for inclusion	Ongoing
Campaign messaging	GLOS, IJC, GLC, GLFC, NOAA IOCM, CHS	Create messaging to emphasize funding needs for Great Lakes mapping	Great Lakes Day (March 6, 2025 and annually)
		Define a messaging framework of critical reasons for and current and future needs of mapping the Great Lakes	Aug. 2025, Ongoing
		Develop a common set of communication tools in support of expressing these needs	Dec. 2025, Ongoing
Spatial priorities	GLOS, IJC, GLC, GLFC, NOAA IOCM, CHS	Define the spatial priorities for mapping (i.e., lake, high-priority areas, water depth)	Oct. 2025
		Determine high-priority areas for mapping and prioritize for mapping execution	Dec.. 2025
		Develop a timeline for executing mapping operations based on spatial prioritization	Feb. 2026
Coordinate agencies working in the Great Lakes	GLOS, CHS, IJC	Create a database of parties conducting mapping efforts, methods used, frequency, and to what standards	Sep. 2025
		Maintain database as mapping efforts continue	Ongoing
		Coordinate work plans for all involved parties to ensure efficient mapping data collection and minimize duplicative effort	Ongoing

Funding strategy	GLOS, CHS	Develop a strategy to fully fund mapping activities (donations, incentives, Brennan Ocean Mapping Fund)	Mar 2026
Data accessibility	GLOS, NOAA National Centers for Environmental Information (NCEI), CHS	Develop a strategy and mechanism to make the data fully accessible and publicly available Mapping data is regularly uploaded to the NCEI bathymetry database to ensure accessibility, equitable use, and interoperability	Mar. 2026 Ongoing
Map the Great Lakes		Fully map the lake floors to modern standards	Ongoing Dec. 2040

Organization Acronym List

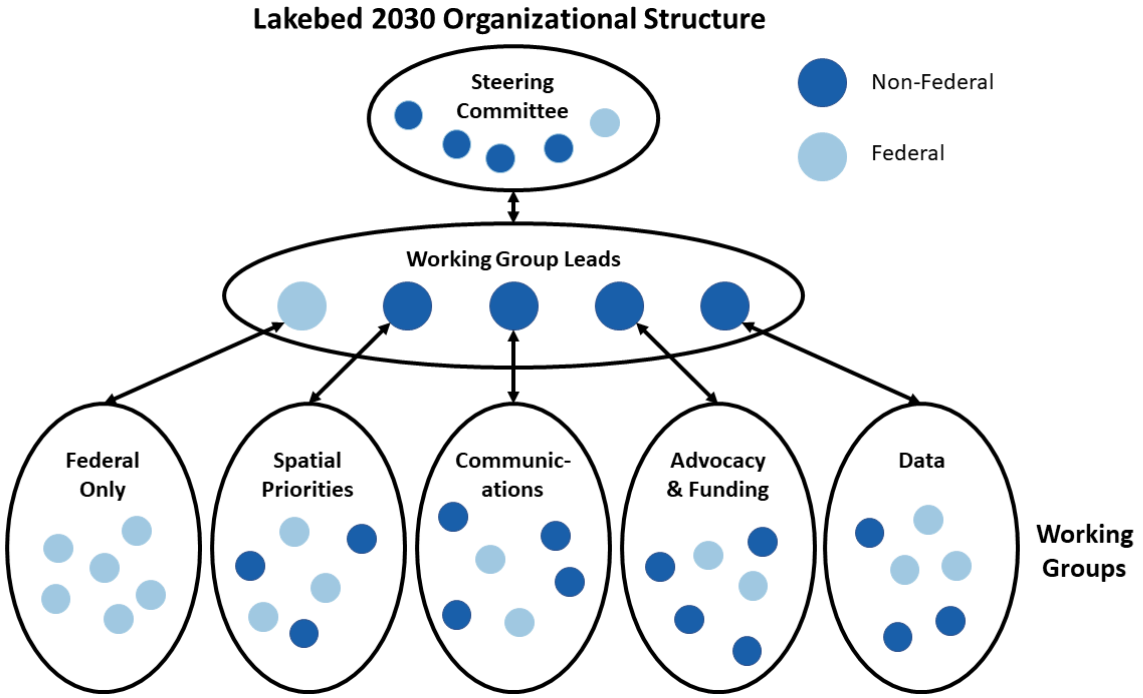
GLOS	Great Lakes Observing System
IJC	International Joint Commission for the Great Lakes
NMC	Northwestern Michigan College
GLC	Great Lakes Commission
GLFC	Great Lakes Fisheries Commission
NOAA	National Oceanic & Atmospheric Administration
IOCM	NOAA Integrated Ocean and Coastal Mapping
NCEI	NOAA National Centers for Environmental Information
CHS	Canadian Hydrographic Service

Stakeholders:

Membership of the Lakebed 2030 campaign consists of anyone who shares the campaign values and can contribute to the campaign vision. This membership may include international government representatives, Federal employees, Federal contractors, State representatives, Tribal and Indigenous representatives, academia, members of regional associations, private industry representatives, and the general public.

Governance:

The governance structure to be used in the Lakebed 2030 Mapping Campaign involves breaking the key stakeholders and organizations interested in the effort into a set of functioning working groups. Outlined below is an overview of the structure, with the role of each of these working groups aligned with the key elements of the implementation plan.



<u>Steering Committee</u>

Lead Organizations: NMC / IJC

The role of the Steering Committee is outlined below:

- Establishment of the regional campaign strategy
- Coordination of the committee and working group efforts
- Communication with stakeholders
- Meeting coordination and logistics support for the campaign

<u>Working Groups</u>

<u>Advocacy & Funding</u>, Lead Organization: GLOS

Develop a strategy to fully fund mapping activities as outlined in the implementation plan

<u>Prioritization & Coordination (Spatial Priorities)</u>, Lead Organization: NV5

Define the spatial priorities for mapping (i.e., lake, high-priority areas, water depth), determine high-priority areas for mapping and prioritize for mapping execution as outlined in the implementation plan, and develop a timeline for executing mapping operations based on prioritization

Communication, Messaging, & Stakeholder Engagement, Lead Organization: GLOS
Define a messaging framework of critical reasons for and current and future needs of mapping the Great Lakes. Develop a common set of communication tools in support of expressing these needs and the messaging to emphasize funding needs for Great Lakes mapping as outlined in the implementation plan

Data & Data Accessibility, Lead Organization:
Develop a strategy and mechanism to make the data fully accessible as outlined in the implementation plan

Nothing in the governance or operations of the Lakebed 2030 regional mapping campaign should be construed to commit any participating federal or state agency to obligate agency funds, property, or services; enter into any contract or binding obligation; spend funds on any particular project or purpose; or limit or affect in any way the authority or legal responsibilities of the federal or state parties.

Participation and Meeting Format:

The campaign is established to provide individual comments on mapping opportunities and strategies, through the exchange of information. The group meets monthly via teleconference to permit its members to:

- Exchange information on mapping accomplishments and contributions to national repositories;
- Share mapping updates, including plans, present status, and opportunities, and provide individual advice to reach mapping goals;
- Identify available mapping data and collect, analyze, and interpret mapping data;
- Discuss current and future capabilities within the mapping community and identify opportunities to align contributions;
- Provide comments on effective ways to coordinate mapping projects;
- Provide comments on outreach and communications activities;
- Exchange information about national and international mapping activities;
- Documentation of challenges, roadblocks, and successes

The campaign's role is to facilitate the exchange of information and to create a forum for the provision of individual input and advice. Individuals providing advice may speak on behalf of their organization.

Reference Documents and Drivers:

National Ocean Mapping, Exploration, and Characterization Council, *2024 Update to the Implementation Plan for the National Strategy for Ocean Mapping, Exploring, and Characterizing the United States Exclusive Economic Zone*, 2024, https://www.noaa.gov/sites/default/files/2025-01/2024%20NOMEC%20Implementation%20Plan_FINAL.pdf.

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Transport Canada, *National Framework for Assessing the Cumulative Effects of Marine Shipping*, 2022, https://tc.canada.ca/sites/default/files/2023-03/tc_marineshipping_en.pdf.

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