Boehme Great Lakes Mapping Act (H.R. 7020) QFR Answers

1. **Dr. Boehme**, GLOS' November 2021 report, [Costs and Approaches for Mapping the Great Lakes](), talks about the roles of different mapping technologies, including airborne LiDAR, vessel-based multibeam echosounder, and autonomous surface and underwater vessels.
    a. Can you talk about the need to use multiple technologies to effectively and timely map the Great Lakes and how industry can aid NOAA in these efforts?

Question #1 Response - The Use of Multiple Technologies for Mapping the Great Lakes and Industry Role:

Leveraging multiple technologies and approaches for mapping the Great Lakes provides the highest likelihood of complete and rapid coverage while maximizing industry contribution by leaning on multiple specialities; driving further economic benefit in the region.

There are two broad categories of approaches to achieve high density mapping in the Great Lakes, *'crewed'* and *'uncrewed'*. Crewed techniques involve aerial (helicopter and fixed wing aircraft) and surface vessels (usually small to large vessels). Uncrewed techniques typically include autonomous and semi-autonomous surface and subsurface vehicles. There are also only two methods for capturing lake floor depths, reflected light and reflected sound. Aerial methods (including aircraft and even satellite imagery) rely on reflected light (LidAR and multispectral imagery) and is usually limited to very shallow and very clear water. Reflected sound, SONAR (Sound Navigation and Ranging) is the principle method for collecting high density data via either crewed or uncrewed methods. There is a broad range of systems employed by both industry and government that are tailored for shallow or deep water collection.

The 'field season' in the Great Lakes is limited to good weather and sea state conditions. A vessel experiencing poor weather conditions on the surface will not usually collect good quality data from the lake bottom. Therefore, both crewed and uncrewed platforms need to take advantage of a relatively short weather window (May to September) for survey operations.

The most practical reason for diversifying the approaches, methods and technologies for Great Lakes lakefloor data acquisition is to maximize the resources available for the work. The US Government is limited in the hardware, personnel, and technology that it can apply. A federated group within industry is best positioned to support this effort. Few companies boast the capability to employ a wide range of mapping technologies, resulting in the reliance on a number of companies who specialize in one of the primary approaches.

Leveraging multiple approaches to Great Lakes mapping is also an efficiency gain. Costs vary based on distance from shore and water depth - requiring different platforms. Crewed vessel based operations are best suited for longer durations in the field, further from shore and deeper water. These platforms can cost anywhere from $6,000 - $60,000 per day. As of late, uncrewed vessels have typically had shorter durations, being better suited for shallower water, closer to shore and have a cheaper price point, often around $200-600 per hour ($5,000 - $15,000 per day) yielding a 15% to 75% benefit in cost savings. Uncrewed range, depth and duration is changing though, reflecting the continuing evolution and innovation in this competitive sector. Given the limited nature of crewed vessels, in terms of both skilled personnel and the vessels themselves, by utilizing a traditional survey approach in conjunction with uncrewed systems, we create a *force-multiplier*, covering more area for less money and less time. There is also an environmental benefit to leveraging uncrewed vessels; these vessels are usually smaller, requiring less power and are often battery or even solar powered, reducing carbon emissions.

Employing a multi-faceted approach to mapping, leveraging industry, utilizing different approaches, and taking advantage of a wide range of technologies, has a cumulative effect on the ability to map the Great Lakes within a short time frame. Organizations like the Great Lakes Observing System can serve as a conduit for partner coordination, mission planning, data throughput and product development. NOAA stands to gain from industry and non-industry participation by leveraging the force multiplier effect, domain expertise, innovative approaches, as well as environmental and operational efficiency.

Oral question asked during the hearing by Rep. Cliff Bentz, Chairman of the Subcommittee on Water, Wildlife and Fisheries: (Rep. Bentz)

2. "I wanted to shift to Dr. Boehme for a moment and go to the mapping, and there's been, there's much discussion about the value of mapping but we never seem to quite get to what that value actually is. I know that ranking members suggested that finding the Edmund Fitzgerald would be a valuable thing, but there must be more to it than that. So, what is it? And lake currents, depth of water, where's the value come from?" - *Rep. Bentz*

   Dr. Boehme oral response:
   i. "Part of the value here is understanding how the depth of the lakebed are shifting so that we have better models for wave action to predict shore impact during severe storm and this would enable us to better protect coastal communities, it would allow public and private infrastructure to be better protected from the flood risk that comes from these high impact storms in the region. The Great Lakes is experiencing these more and more often, and so, this is the type of information that we're so, as we said, 13% mapping, we are quite a bit far behind and so this foundational dataset would better protect our coastal communities from flood risk.

   b. **Follow-up from Rep. Bentz**: "And I'm out of time, but if it's extremely interesting to me if you could provide a very very narrowly constructed list of the benefits, I would very much appreciate that."
   Dr. Boehme oral response:
   i. "We would be happy to follow up."

Questions #2 Response - The Value of Mapping the Great Lakes:

The value proposition for mapping the Great Lakes is extensive and touches many aspects of the broader economy in the region.

It has *intrinsic value* - a better understanding of the world's largest freshwater ecosystem is aligned with the U.S. National Strategy For Mapping, Exploring, And Characterizing The United States Exclusive Economic Zone (NOMEC); and *investment value* - by creating an environment for increased flow of businesses, educated resources and tourism to the region, as well as *economic value* - by creating jobs, benefitting the commercial fishery, savings through prevention of marine accidents, and increased shipping & trade in the region.

Humans have long had an instinctive nature to explore and discover their surroundings. This interest in exploration also extends to the Great Lakes. Never having been fully explored in high density before, our insatiable desire to map these waters goes beyond basic human traits. While national interests may not demonstrate immediate or direct economic benefits in the short term, they help protect and document a national boundary that straddles Canada, which is home to tens of millions of people and supports a region-wide $6 trillion economy. There are over 6,000 wrecks in the Great Lakes, most of them undiscovered, unexplored and

undocumented. Discovery, preservation and documentation of these wrecks is important for the historical record, but also for the families of the missing seeking closure for their loved ones.

Mapping the Great Lakes is not only about documenting and exploring the depths. It is also about investing in the region. Boasting a massive economic output and a burgeoning economy centered solely around maritime and marine related activities, this effort has the opportunity to help transform the region from the *rust belt* to the *blue belt*. Mapping the Great Lakes will require an army of knowledge workers, thus spurring increased educational offerings in the region, who will reduce the *brain drain* of the Great Lakes and rather enable the *brain gain* of the Great Lakes. These educated professionals will settle in the area, have families, contribute to the economy and support local businesses and communities.

While the fundamental technologies exist at present for surveying the depths of the lakes, innovation in this exploration sector is blossoming. LiDAR and SONAR systems, uncrewed & autonomous platforms, artificial intelligence, data processing, vessel positioning, data transmission are all just some of the technologies that are ripe for continued development. Investing in mapping the Great Lakes will yield growth in the region's blue economy with a wide range of beneficiaries.

It is not just the act of mapping the Great Lakes that will yield investment value. It is also the *data itself*. One of NOAA's Integrated Ocean and Coastal Mapping core principles is, "map once, use many times." This refers to the recurring value that is derived from data collected via a single investment. In the Great Lakes, this translates into *investment potential* ranging from applications of the data, increased tourism from scuba diving[1] and cruise ships[2], future infrastructure development, resource extraction, coastal resilience and all of the subsequent spinoff industries. This data also increases the situational awareness for vessel operators (both recreational and commercial) both by creating efficiencies and by reducing risk, saving Americans' lives and insurance companies' financial exposure.

Finally, the direct economic value to mapping the Great Lakes is already well documented. NOAA and partners have done many studies showing the direct impact of the value of nautical charts (derived from depth mapping), the importance of hydrography (the science of depth mapping), and the value of the maritime transportation system and its relationship to economic benefit. NOAA's report on 'Value to the Nation'[3] from 2018 cites that there is a 15x direct benefit and 30x indirect benefit from coastal mapping in the U.S. As the GLOS written testimony documented, the existing $7B commercial fisheries in the Great Lakes stands to gain economically from this effort. Better understanding of the benthic habitat and spawning grounds for lake fish, from which the fishery is dependent upon, will lead to more efficient operations, higher yields and increased profits. A 2024 report[4] from NOAA's Office for Coastal Management details the economic profile in the region by state (eight of them) and by ocean sector category including three new categories; power generation, state & local government, and research and education. All told, this new report boasts over 15,000 businesses with hundreds of thousands of employees earning over $11 billion in wages supporting a $22.6 billion gross domestic product (GDP) annually. Tourism and recreation are two of the largest categories, producing over half of the GDP. Both are poised to grow in the coming years, collecting comprehensive and high density data, shared publicly, will further fuel this economic growth.

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[1] https://www.michiganseagrant.org/wp-content/uploads/2018/08/11-715-Lake-Huron-Scuba-Diving.pdf

[2] https://www.nationalgeographic.com/travel/article/cruises-on-the-great-lakes-are-giving-new-life-to-the-rust-belt

[3] https://www.noaa.gov/sites/default/files/legacy/document/2019/Nov/NOAA-by-the-Numbers-Accessible-Version-Corrected-17-JUL-18%20%281%29.pdf

[4] https://coast.noaa.gov/data/digitalcoast/pdf/marine-economy-great-lakes-profile.pdf

Question 2(b) Response: Narrowly Constructed List of the Benefits

To be succinct in the benefits of Great Lakes Mapping, they are:
- Economic impact
    - Job creation
    - Investment
    - Innovation
    - Education & workforce development
- Business relevance
    - Commercial shipping / transportation
    - Ports and harbors
    - Fishery / aquaculture
    - Tourism
        - Boating, coastal activities
        - Scuba diving
        - Cruise / passenger vessels
    - Technology innovation / startups
    - Company migration
- Science / Research
    - Climate adaptation
    - Coastal resilience / erosion
    - Renewable resource site identification
    - Benthic habitat
    - Invasive species
    - Pollution effects
    - Modeling (elevation, coastal processes, ice, temperature, wave, current, storm surge, volume)
- National / Regional benefits
    - Ship / aircraft wreck discovery & documentation
    - Ancient civilization / cultural significance & documentation
    - National security considerations
    - Supports national strategic initiatives
    - Underwater hazards

Additional Support for the Great Lakes Mapping Act

"High resolution lakebottom mapping has been essential to our conservation efforts within the sanctuary and is leading to the discovery of new, nationally-significant cultural sites. The maps also provide up-to-date nautical charts for commercial and recreational vessels. Equally important, this type of mapping enables the creation of high resolution lakebed habitat maps, which do not currently exist for the sanctuary or much of the Great Lakes. Such maps are an essential tool for our academic, local, state, and federal partners as they look for solutions to the devastating impacts of invasive species on fisheries, beaches, and the general health and well-being of Lake Michigan."

Russ Green
Superintendent, Wisconsin Shipwreck Coast National Marine Sanctuary
One University Ave.
UW Green Bay, Sheboygan Campus
Sheboygan, WI 53081

"A critical knowledge gap exists in our understanding of the Great Lakes, and that limits our ability to effectively manage this important resource. Comprehensive, high-resolution mapping would be a transformative investment, supporting the development of a sustainable blue economy and providing the information needed to ensure safe drinking water, resilient coastlines, sustainable fisheries, and accessible recreation."

Céline B. Gerson
Group Director, Americas and President USA
Fugro

"The Nature Conservancy is a global organization with the mission of conserving the lands and waters on which all life depends. TNC has a long history in the Great Lakes region with a focus on fisheries, aquatic invasive species, coastal resiliency, climate, and sustainable agriculture. The high-resolution bathymetry data that would result from the Mapping the Great Lakes Act is not only relevant to all of these management issues, but would help us and our myriad of partner better protect and restore this globally important resource."

Scott Sowa
Juli Plant Grainger Great Lakes Program Director
Wisconsin chapter of The Nature Conservancy