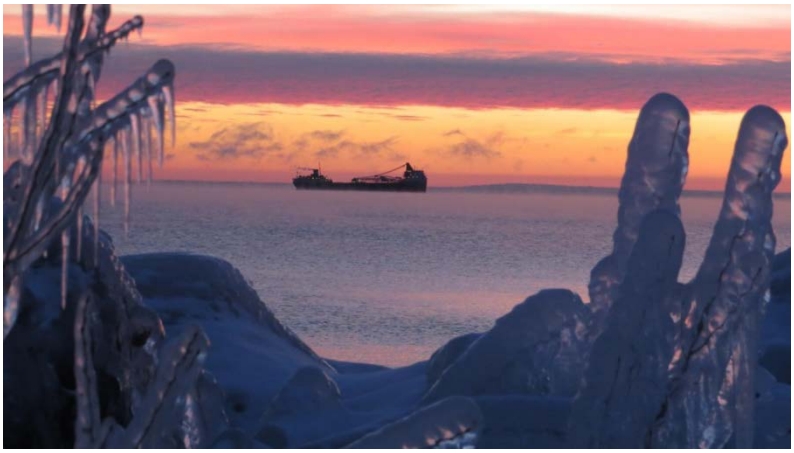
NOAA Navigation Services

Great Lakes Activities Report

Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, Wisconsin

Office of Coast Survey
Center for Operational Oceanographic Products & Services
National Geodetic Survey

June 2016



Ship transporting iron ore on Lake Superior, photo courtesy of Carolyn St. Cyr

Contents

The Great Lakes Region 4

Geography and environment 4

Economic and recreational value 4

Challenges 4

A promising future 5

Office of Coast Survey 6

Personnel & Products in the Great Lakes Region 6

Coast Survey regional navigation managers 6

Navigation response and mobile integrated survey teams 6

Chart coverage 7

United States Coast Pilot® 9

Recent Activities 10

Great Lakes stakeholder engagement 10

Center for Operational Oceanographic Products & Services (CO-OPS) 11

Personnel & Products in the Great Lakes Region 11

CO-OPS personnel 11

National Water Level Observation Network 11

International Great Lakes Datum 13

Physical Oceanographic Real-Time System (PORTS®) 13

Great Lakes real-time currents 14

Operational forecast systems 15

Recent Activities 16

Partnerships with U.S. Army Corps of Engineers 16

Harmful algal bloom forecasting 16

National Geodetic Survey (NGS) 17

Regional mission summary 17

Activities 17

Updating the International Great Lakes Datum 17

Great Lakes Region Geodetic Advisor program 17

International coordination for matters related to the Great Lakes 17

Height modernization in western Great Lakes 17

GRAV-D 18

Emergency response imagery 20

VDatum 21

The Great Lakes Region

The Great Lakes hold monumental environmental, cultural, and economic value for both the region and the nation. The Great Lakes Region spans Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin. Coverage of New York and Pennsylvania is shared between NOAA's Great Lakes and North Atlantic Regions.

Viewed as a source of great pride among those who live in the region, the Great Lakes are a draw to large populations of both Americans and Canadians. Today, the Great Lakes Basin boasts an impressive 158 counties and 13 major urban areas; about 27.3 million Americans call the region home.

Geography and environment

From their westernmost tip (Duluth, Minnesota) to easternmost point (Watertown, New York), the Great Lakes stretch about one thousand miles across the United States and Canada. The shoreline totals 9,000 miles—longer than the U.S. East and Gulf coasts combined.

In combination, the Great Lakes have a surface area of 94,000 square miles (244,000 square kilometers). Their water volume, six quadrillion gallons (22.7 quadrillion liters), is enough to submerge the continental United States in nearly 10 feet of water. This gives the Great Lakes the distinction of being the earth's largest single supply of surface fresh water; the five lakes possess 95 percent of the country's surface fresh water supply.

The Great Lakes also constitute the largest freshwater ecosystem in the world. The basin is home to 3,500 species of plants and animals, including Canada lynx, gray wolves, and bald eagles, and over 170 species of fish. These flora and fauna not only contribute to the environmental integrity, resilience, and character of the region; they also support impressive Great Lakes tourism and recreation industries.

Economic and recreational value

The Great Lakes have long been an economic driver for the nation. An analysis found that more than 1.5 million jobs are directly connected to the Great Lakes, generating $62 billion in annual wages. The Midwest has suffered economic hardships but, thanks to the Great Lakes, the region still generated 27% of the gross domestic product and 24% of country's exports in 2009.

The manufacturing industry remains a major source of employment and revenue in the region, but so, too, do recreation and tourism. Residents and tourists alike spend nearly $16 billion annually on boating trips and equipment in the Great Lakes, and the region draws an impressive 37 million anglers, hunters, and bird watchers each year. The magnificence of the area's natural resources was highlighted in 2011 when Michigan's Sleeping Bear Dunes National Seashore received the proud distinction as the "Most Beautiful Place in America."

Challenges

The Great Lakes' beauty and ecological diversity belie their vulnerability to biological and chemical stresses. In reality, years of degradation from toxic contamination, destruction of coastal wetlands, nonpoint source pollution, and invasive species have left the ecosystem at a tipping point.

Today, the United States portion of the Great Lakes includes 26 **areas of concern (AOCs)**, places suffering extreme environmental degradation. An additional five AOCs are located on the United States-Canadian border.

Non-native and invasive flora and fauna have further damaged ecosystem health. Sea lamprey, zebra mussels, and quagga mussels are among the most well-known invasive species to date. We also face the continued threat of Asian carp.

A changing climate also presents challenges for the Great Lakes ecosystem and residents. Higher global temperatures have changed patterns of seasons and precipitation at regional and local levels. Long-term studies conducted by NOAA show diminishing duration and thickness of ice cover each winter, and variable lake water levels. These changes affect Great Lakes ecology, to be sure, but the consequences also affect the viability of certain industries and the well-being of coastal communities.

A promising future

Fortunately, we know many of the solutions to the threats and challenges facing the Great Lakes ecosystem, and NOAA is working to provide the information, services, and on-the-ground action needed to achieve them.

The Great Lakes Restoration Initiative (GLRI), begun in 2010, has provided a large infusion of funding for sustainable Great Lakes restoration. NOAA is fortunate to be working with the U.S. Environmental Protection Agency and 15 additional federal agencies to fund projects that restore the Great Lakes. Target areas include:

- cleaning up Great Lakes areas of concern (AOCs)
- preventing and controlling invasive species
- reducing nutrient runoff that contributes to harmful/nuisance algal blooms
- restoring habitat to protect native species
- science-based adaptive management

NOAA's GLRI projects have already yielded tangible successes and distinct progress in ameliorating some of the most pronounced threats to the Great Lakes and region. For more information and details, visit NOAA's GLRI website.

Office of Coast Survey

Personnel & Products in the Great Lakes Region

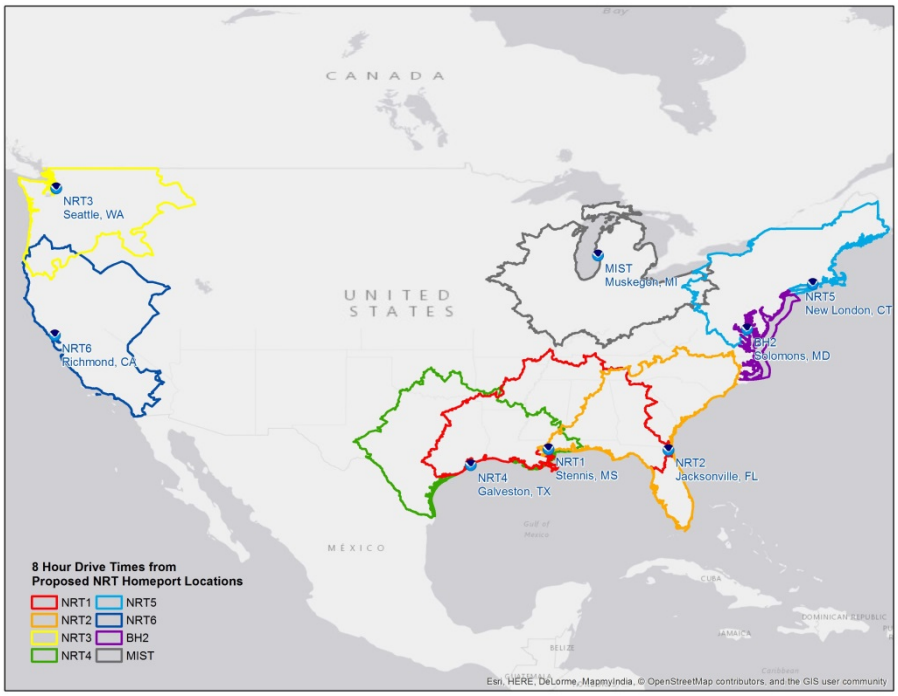
Coast Survey regional navigation managers

Coast Survey's navigation managers, stationed strategically in port areas along U.S. coasts and Great Lakes, work directly with the U.S. Coast Guard, pilots, mariners, port authorities, and recreational boaters. They help identify navigational challenges facing the marine transportation system, and provide the resources and services that promote safe and efficient navigation.

Region	Navigation manager (base of operations)	Contact information
Great Lakes	Thomas Loeper, acting (Silver Spring MD)	Thomas.loeper@noaa.gov Cell: 301-367-5680 Office: 301-713-2750 ext. 165

Navigation response and mobile integrated survey teams

Coast Survey's highly mobile navigation response teams (NRTs) provide both routine and rapid response hydrographic surveys, helping to protect life and property from underwater dangers to navigation. During emergencies, such as following a hurricane, NRTs speed the resumption of shipping that provides critical supplies to the affected area. Outside of emergencies, NRTs serve the maritime economy by identifying critical chart discrepancies and investigating emergent navigational concerns for 175 major ports within the U.S. marine transportation system.



Keeping mariners safe and commerce flowing

Coast Survey assets include six NRTs that conduct scheduled hydrographic projects in critical maritime areas. While surveying, the teams remain available to respond to emergent needs in their region, and emergencies anywhere on the nation's coasts. Working with NOAA's regional navigation managers, NRTs search for shoaling waters and submerged dangers to navigation that could slow or halt ocean shipping. They provide time-sensitive information to the U.S. Coast Guard and port officials, and transmit data to NOAA cartographers for updating Coast Survey's suite of navigational charts.

Mobile integrated survey team (MIST)

Coast Survey does not have an NRT permanently based in the Great Lakes region. However, we can rapidly mobilize and deploy our mobile integrated survey team (MIST) on a vessel of opportunity. Furthermore, any of the NRTs based in the eastern U.S. could respond within days to an emergency in the Great Lakes.

Initiating a NOAA navigation response

Requests for NRT or MIST assistance originate from the appropriate U.S. Coast Guard Captain of the Port, state pilot association, port authority, or U.S. Army Corps of Engineers office. Requesters work with NOAA's regional navigation managers to identify mission objectives and define the deliverable products.

Recapitalizing the NRT fleet from Wisconsin

Coast Survey is "recapitalizing" the NRT fleet, building new small boats specifically designed for hydrographic surveying. The first two boats, built by Lake Assault Boats of Superior, Wisconsin, were delivered in September 2015 to navigation response teams surveying ports in California and the eastern Gulf of Mexico. They are undergoing resolution of warranty items and so are not yet operational. Lake Assault Boats has built two more boats for Coast Survey, which have not yet completed acceptance testing. NRTs will continue operating their existing fleet until these new vessels are delivered and fully operational.

Chart coverage

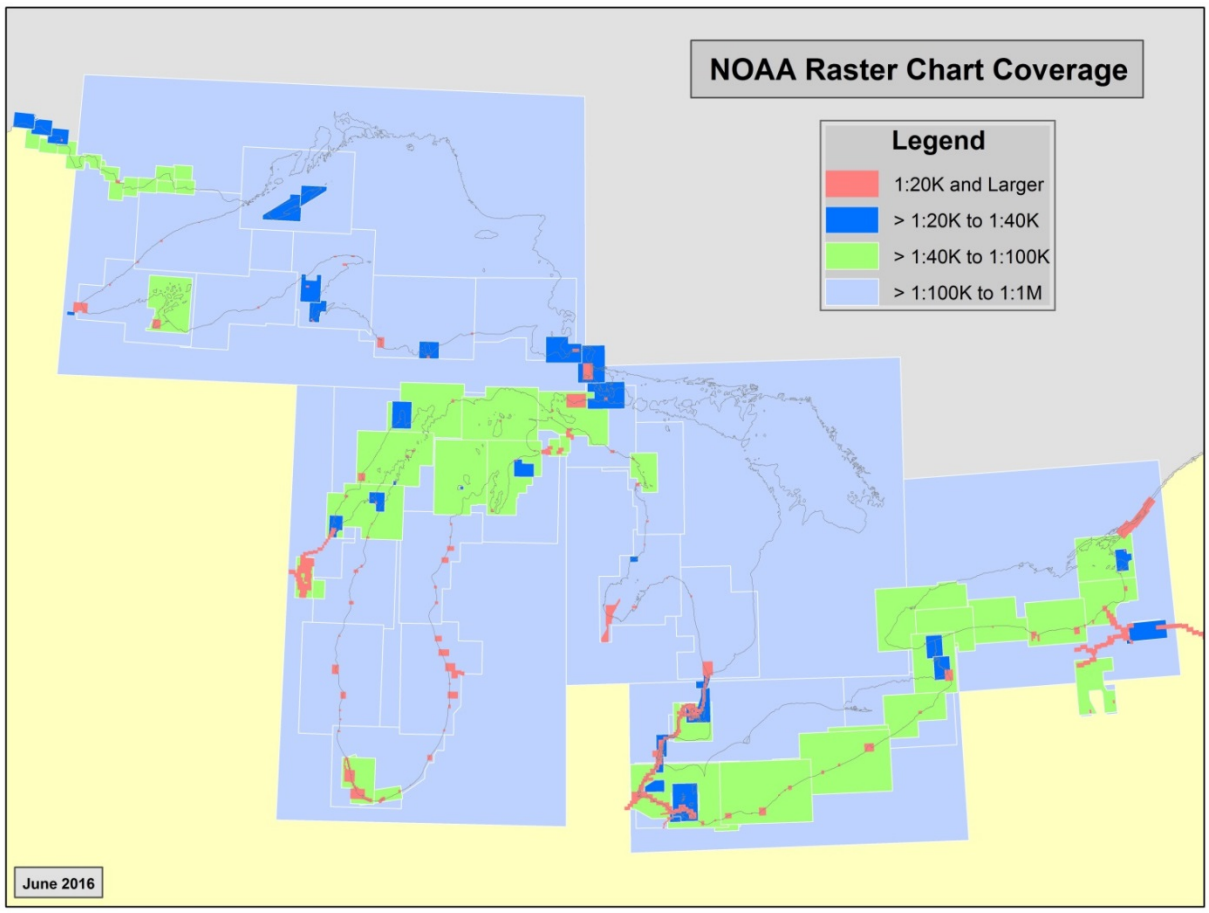
Coast Survey is transitioning nautical chart production into a single database, from the two databases that were built as we created raster (paper) charts and electronic navigational charts. The transition allows faster simultaneous updates for all NOAA chart products. We are currently loading the Great Lakes charts into the new, single database, which means that mariners will have new electronic navigational charts (NOAA ENC®) by the end of 2017. The majority of the new edition ENCs will have new or updated shoreline.

In addition to new editions, we will also make more than 30 new (first edition) ENCs, including all the multi-panel book charts in the region. An ENC extension to the Erie Canal is in the works; NGS' Remote Sensing Division will provide the extension's topographic-bathymetric lidar, collected by the Joint Airborne Lidar Bathymetry Technical Center of Expertise, after they process and check the data for quality control.

Coast Survey has completed many new editions of raster charts, with more coming by the end of the year. (See the list of 43 charts, below.) With improvements in the chart production system, the raster charts are in a continual maintenance status, meaning that mariners will see shoreline and hydrographic updates more quickly, without having to wait years for a new raster edition.

FY16 Great Lakes (raster) New Editions – completed and scheduled to be complete

14500 Great Lakes, Lake Champlain to Lake of the Woods
14786 SMALL-CRAFT BOOK CHART New York State Canal System (book of 61 Charts)
14788 Oneida Lake - Lock 22 to Lock 23
14791 Cayuga and Seneca Lakes; Watkins Glen; Ithaca
14811 Chaumont, Henderson and Black River Bays; Sackets Harbor; Henderson Harbor; Chaumont Harbor
14828 Erie to Geneva (Metric)
14842 SMALL-CRAFT BOOK CHART - Port Clinton to Sandusky, including the Islands (book of 35 charts)
14844 Islands in Lake Erie; Put-In-Bay
14846 SMALL-CRAFT BOOK CHART - West End of Lake Erie from Perrysburg, OH, of the Maumee R. to Huron R., Mich., and Bar Pt., Ont. (book of 34 charts)
14848 Detroit River
14850 Lake St. Clair
14852 St. Clair River; Head of St. Clair River
14853 SMALL-CRAFT BOOK CHART - Detroit River, Lake St. Clair and St. Clair River (book of 47 charts)
14854 Trenton Channel and River Rouge; River Rouge
14860 Lake Huron
14862 Port Huron to Pte aux Barques; Port Sanilac; Harbor Beach
14901 Lake Michigan (Mercator Projection)
14902 North end of Lake Michigan, including Green Bay
14903 Algoma to Sheboygan; Kewaunee; Two Rivers
14905 Waukegan to South Haven; Michigan City; Burns International Harbor; New Buffalo
14907 Stony Lake to Point Betsie; Pentwater; Arcadia; Frankfort
14908 Dutch Johns Point to Fishery Point, including Big Bay de Noc and Little Bay de Noc; Manistique
14909 Upper Green Bay - Jackson Harbor and Detroit Harbor; Detroit Harbor; Jackson Harbor; Baileys Harbor
14910 Lower Green Bay; Oconto Harbor; Algoma
14911 Waugoshance Point to Seul Choix Point, including Beaver Island Group; Port Inland; Beaver Harbor
14912 Platte Bay to Leland; Leland; South Manitou Harbor
14913 Grand Traverse Bay to Little Traverse Bay; Harbor Springs; Petoskey; Elk Rapids; Suttons Bay; Northport; Traverse City
14916 SMALL-CRAFT BOOK CHART - Lake Winnebago and Lower Fox River (book of 34 charts)
14918 Head of Green Bay, including Fox River below De Pere; Green Bay
14919 Sturgeon Bay and Canal; Sturgeon Bay
14922 Manitowoc and Sheboygan
14925 Racine Harbor
14926 SMALL-CRAFT BOOK CHART - Chicago and South Shore of Lake Michigan (book of 30 charts)
14927 Chicago Lake Front; Gary Harbor
14929 Calumet, Indiana and Buffington Harbors, and Lake Calumet
14931 Grand River from Dermo Bayou to Bass River
14932 Holland Harbor
14934 Muskegon Lake and Muskegon Harbor
14938 Manistee Harbor and Manistee Lake
14942 Lake Charlevoix; Charlevoix, South Point to Round Lake
14961 Lake Superior (Mercator Projection)
14968 Grand Portage Bay, Minn. to Shesbeeb Point, Ont.
14976 Isle Royale



United States Coast Pilot®

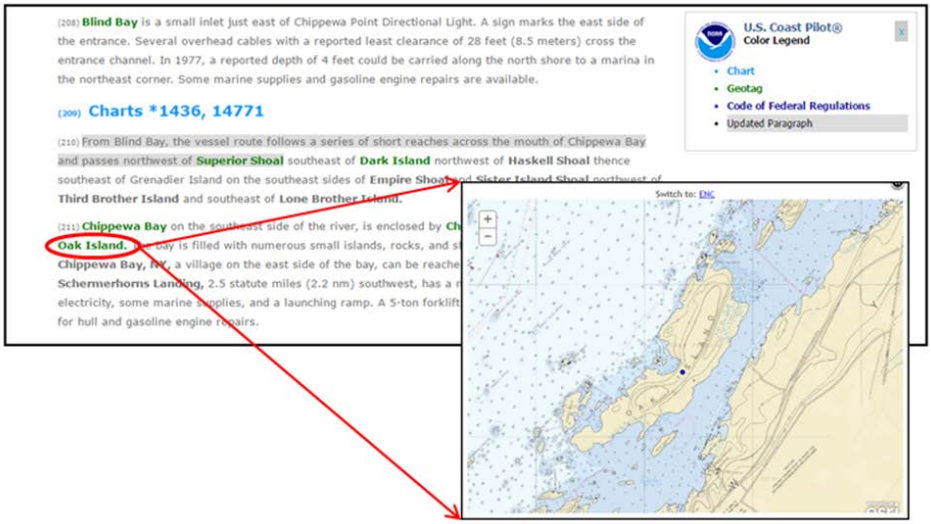
The *United States Coast Pilot* provides information important to navigators of coastal and intracoastal waters and contains supplemental information that is difficult to portray on a nautical chart. Topics in the *Coast Pilot* include channel descriptions, anchorages, bridge and cable clearances, currents, tide and water levels, prominent features, pilotage, towage, weather, ice conditions, wharf descriptions, dangers, routes, traffic separation schemes, small-craft facilities, and federal regulations applicable to navigation.

Coast Pilot 6 (46th Edition) covers the Great Lakes system, including Ontario, Erie, Huron, Michigan, and Superior, their connecting waters, and the St. Lawrence River.

Coast Pilot now provides geotagged reference points. A geotag is simply geographical location information assigned to a type of media. In the XML version of *Coast Pilot*, certain place names and objects, highlighted in green, are now directly viewable on a nautical chart and linked to entries in the official U.S. Geographic Names database. Other features include:

- images that become larger when clicked;
- an interactive table of contents for each book;
- links to raster nautical chart, highlighted in light blue; and
- weekly changes, highlighted in gray, which are retained until the next annual version is published.

Approximately 95 percent of the nine *Coast Pilot* volumes have been geotagged, with more points available each week.



Recent Activities

Great Lakes stakeholder engagement

One of the ways that Coast Survey engages our stakeholders and partners is through interactions at industry events. The Great Lakes navigation manager routinely travels to the region to meet with different stakeholder groups, including the U.S. Coast Guard, U.S. Army Corps of Engineers, pilots associations, Lake Carriers' Association, Passenger Vessel Association Great Lakes, recreations and commercial fishermen, utility companies, environmental groups, and state and local governments.

Over the past year, the acting Great Lakes navigation manager participated in the following events:

- September 2015
    - U.S. Army Corps of Engineers meeting, in Sault Ste. Marie, Michigan
    - Enbridge Pipeline #5 Spill Drill, in St. Ignace and Mackinaw City, Michigan
- October 2015
    - Annual Great Lakes Regional Collaboration Team meeting, in Milwaukee, Wisconsin
    - Passenger Vessel Association Great Lakes meeting, in Manitowoc, Wisconsin
- November 2015
    - Regional conference call to discuss plans and implementation as well as request input from academia, industry and local, state and federal government agencies for the Lake Michigan Huron Operational Forecast System.
- February 2016
    - Great Waterways Conference, in Cleveland, Ohio
    - Lake Carriers Association's annual Captains meeting
    - Great Lakes Commission Semiannual Meeting and Great Lakes Day, in Washington, D.C.

Center for Operational Oceanographic Products & Services (CO-OPS)

Personnel & Products in the Great Lakes Region

CO-OPS personnel

CO-OPS does not have any personnel stationed in the Great Lakes region. CO-OPS has a permanent field team dedicated to the Great Lakes that operates out of an office in Chesapeake, Virginia, and spends most of the field season in the Lakes region conducting annual maintenance and emergency repairs as needed.

CO-OPS also has personnel on various bi-lateral entities chartered under the Boundary Waters Treaty that provide technical information and support for the equitable management and regulation of Lake water levels needed for navigation, power generation, and other uses. These entities are detailed in a separate document.

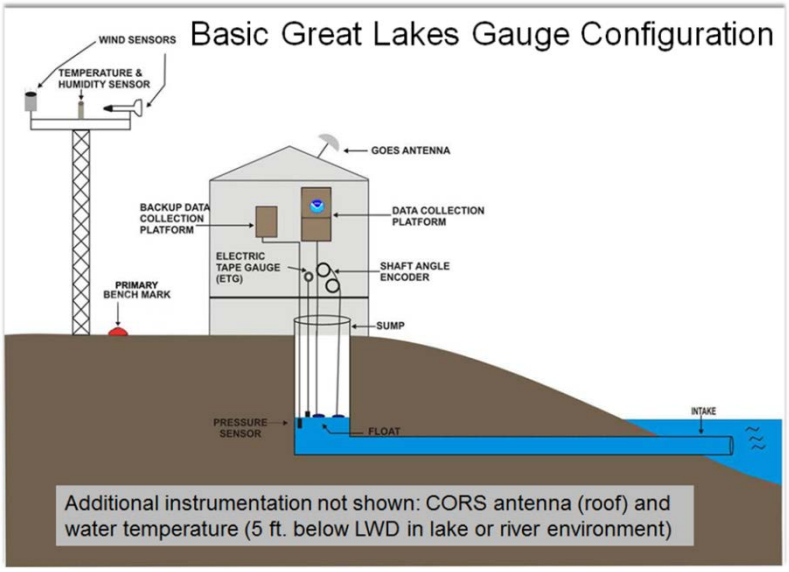
National Water Level Observation Network

CO-OPS operates and maintains the National Water Level Observation Network (NWLON), which is a network of 210 continuously operating water-level stations throughout the U.S., including its island possessions and territories. Additionally, NWLON is the foundation for reference stations supporting NOAA's tide prediction products, and serves as control stations in determining tidal datum for all short-term water-level station. NWLON provides relative sea level trends and is capable of producing real-time data for storm surge warnings. NWLON platforms collect meteorological data in addition to water level data. Entities like the U.S. Army Corps of Engineers use the NWLON data to calculate lake-wide averages of water level that is used for water management calculations.

There are 51 NWLON stations in the Great Lakes, in all five lakes and connecting channels. NWLON stations in the Great Lakes are significantly different from coastal NWLON stations. A typical Great Lakes water level station is a concrete or brick gauge house mounted on top of a six-foot diameter sump that is connected to the lake through a one-foot diameter intake pipe. This design is required to enable year-round measurements even though the lakes freeze and ice piles up along the coastline. The house contains the water level sensors and data collection platforms (DCP). Data are transmitted hourly via Geostationary Orbiting Environmental Satellite (GOES). Real-time data are acquired every six minutes by connecting to the gauge via a telephone modem. In addition to a primary and secondary water level sensor, some stations also acquire meteorological data including wind speed and direction, air temperature, water temperature, and relative humidity.

Water level gauges are tied into a network of benchmarks. Annual leveling between benchmarks is conducted to maintain geodetic control of the gauge.

Originally operated by the U.S. Army Corps of Engineers, these stations were transferred to NOAA via the Administration reorganization plan that created NOAA in 1971.



NOS operates the following NWLONs in the Great Lakes:

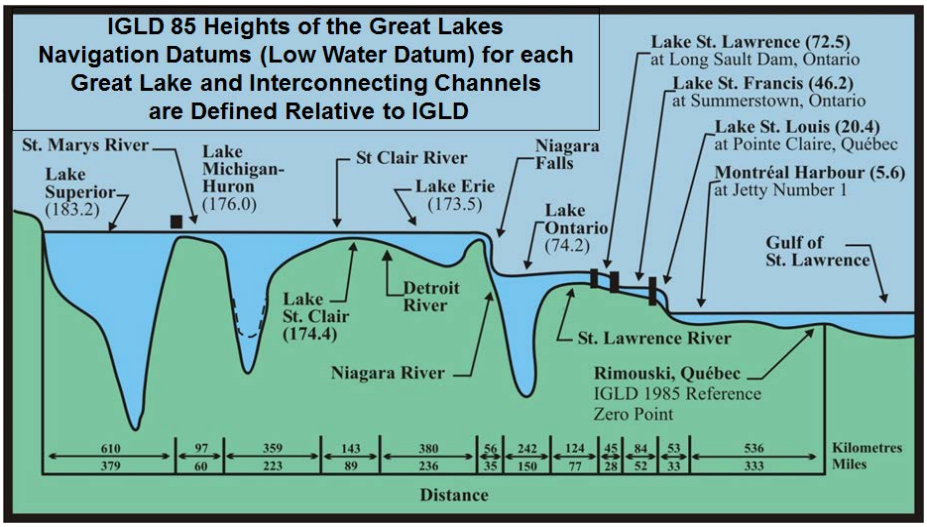
- Eleven in New York: Ogdensburg, Alexandria Bay, Cape Vincent, Oswego, Rochester, Olcott, Ashland Ave, American Falls, Niagara Intake, Buffalo, Sturgeon Point
- One in Pennsylvania: Erie
- Four in Ohio: Fairport, Cleveland, Marblehead, Toledo
- Twenty-eight in Michigan: Fermi Power Plant, Gibraltar, Wyandotte, Fort Wayne, Windmill Point, St Clair Shores, Algonac, St Clair State Police, Dry Dock, Mouth of the Black River, Dunn Paper, Fort Gratiot, Lakeport, Harbor Beach, Essexville, Alpena, Mackinaw City, De Tour Village, Rock Cut, West Neebish Island, Little Rapids, Ludington, Holland, Menominee, Port Inland, Point Iroquois, Coast Guard Station Marquette, Ontonagon
- One in Illinois: Calumet Harbor
- Four in Wisconsin: Milwaukee, Kewaunee, Sturgeon Bay Canal, Green Bay
- Two in Minnesota: Duluth, Grand Marais

International Great Lakes Datum

The first common vertical datum between the United States and Canada was the International Great Lakes Datum of 1955 (IGLD 1955). It was recognized that over time, datum reference systems might need to be updated due to wide-ranging and significant physical changes. In the Great Lakes region, in addition to hydrologic change, this dominant physical change is one of ongoing vertical crustal movement. The crustal movement is in response to the loss of the weight of the ice sheets and the collapse of the glaciers since the last ice age, a process known as glacial isostatic adjustment (GIA). As a result, there is general vertical land uplift in the northern lakes and vertical land subsidence in the southern lakes and there is variation in the rates of vertical land motion along the shorelines of each lake. In order to keep pace with the rates of movement of the earth's crust, the "datum" or elevation reference system used to define water levels within the Great Lakes-St. Lawrence River system, must be adjusted every 25 to 30 years. IGLD 1955 was updated in 1985 to IGLD 1985, and is due to be updated again. The next update will be released in 2025; it will be referred to as IGLD 2020.

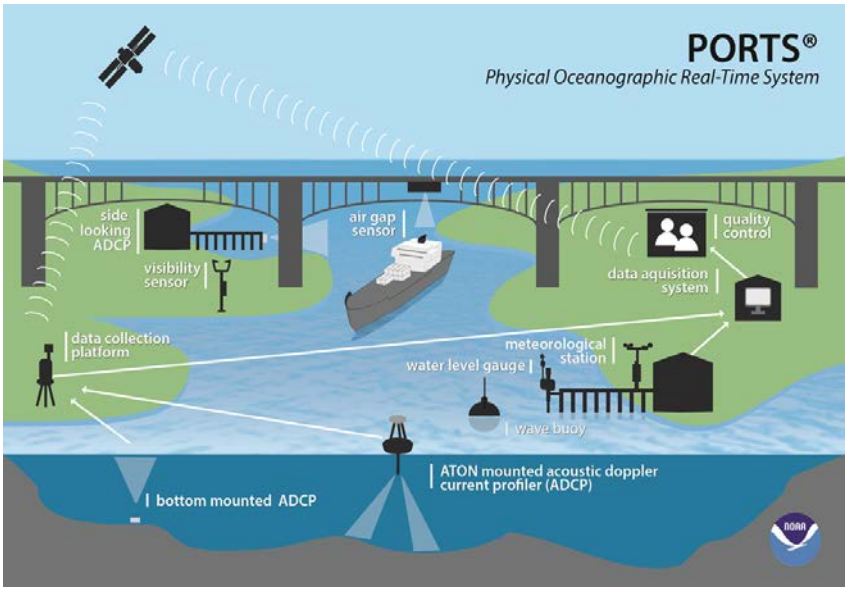
CO-OPS and NGS both maintain responsibility on the U.S. side for updating and maintaining the International Great Lakes Datum. They work together with Canadian agencies, under the auspices of the Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data, to coordinate the update, as both countries need the geodetic leveling and water level information to properly update the datum.

CO-OPS has received funds through the NOAA Coastal Storms Program (CSP) and the EPA-funded Great Lakes Restoration Initiative to collect water level measurements in several small ports and harbors to support the update of the IGLD. CO-OPS collected data at seven locations in 2014 and 2015 via CSP, and will be collecting data at select EPA Areas of Concern in 2017 via the GLRI funding.



Physical Oceanographic Real-Time System (PORTS®)

PORTS is a decision-support tool that improves the safety and efficiency of maritime commerce and coastal resource management through the integration of real-time environmental observations, forecasts and other geospatial information. PORTS measures and disseminates observations and predictions of water levels, currents, salinity, waves and meteorological parameters (e.g., winds, atmospheric pressure, visibility, and air and water temperatures) that mariners need to navigate safely. NOS operates 27 PORTS, one of which is in the Great Lakes, with a second in development at Cleveland.



Soo Locks PORTS

A Physical Oceanographic Real-Time System is operated cooperatively with the U.S. Army Corps of Engineers and provides real-time data quality-controlled and disseminated to local users for safe and efficient navigation. Real-time data are available for water levels from seven stations and meteorological data from six locations.
http://tidesandcurrents.noaa.gov/ports/index.shtml?port=sl

Cuyahoga PORTS

A Physical Oceanographic Real-Time System is operated cooperatively with the Lake Carriers and provides real-time data quality-controlled and disseminated to local users for safe and efficient navigation. Real-time data are available for water levels at Cleveland and a current meter on the Cuyahoga River.
http://tidesandcurrents.noaa.gov/ports/index.shtml?port=cy

Great Lakes real-time currents

CO-OPS installed three currents meter stations in the Great Lakes as part of a demonstration project with congressionally specified funding. The goals of the project were to demonstrate the ability to collect data year round in the ice challenged environment. Locations were selected based on ensuring safe, efficient and environmentally sound maritime commerce, to support environmental needs such as HAZMAT response and determining river flow so support bilateral water management studies and decisions.

There is one real-time current meter operating in Michigan on the St. Clair River and two real-time current meters operating in Ohio on the Maumee and Cuyahoga Rivers.

Funding for the project has been long exhausted and CO-OPS is seeking local partners to fund the continued operations of these current meters. CO-OPS is partnering with the Lake Carriers on the Cuyahoga meter as part of the Cuyahoga PORTS mentioned above. There is partner interest in the Maumee meter as well but no partnership in place yet.

http://tidesandcurrents.noaa.gov/cdata/StationList?type=Current+Data&filter=active
http://glakesonline.nos.noaa.gov/moncurrent.html

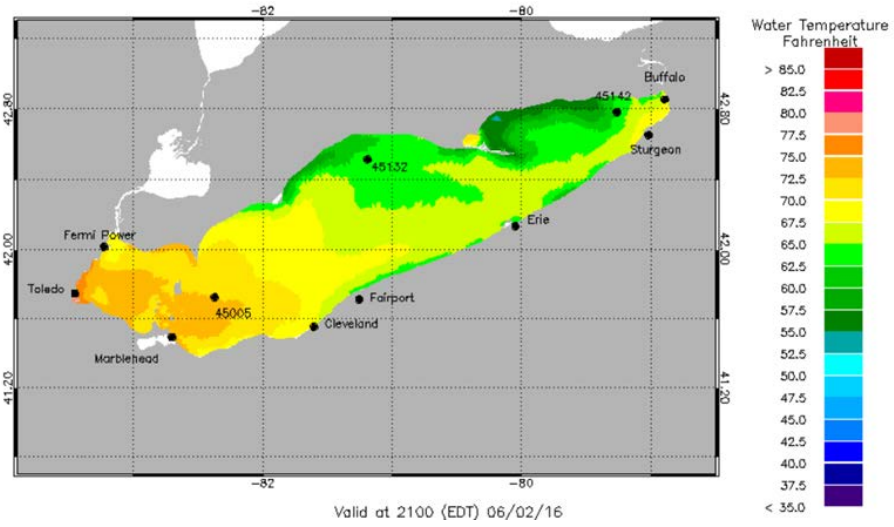
Operational forecast systems

Operational nowcast and forecast hydrodynamic model **s**ystems support NOAA's mission goals and priorities by providing automated integration of observing system data streams, hydrodynamic model predictions, product dissemination**,** and continuous quality-control monitoring. State-of-the-art numerical hydrodynamic models driven by real-time data and meteorological, oceanographic, and/or river flow rate forecasts, form the core of these end-to-end systems.

The OFS will perform nowcast and short-term (0 hr. – 48 hr.) forecast guidance of pertinent parameters (e.g., water levels, currents, salinity, temperature, waves) and disseminate them to users.

NOS transitioned the five Great Lake OFS models into operation first, in 2003. The NOAA Great Lakes Environmental Research Laboratory and Ohio State University developed them. The Lake Erie OFS was just upgraded and enhanced to forecast out to 120 hours among other enhancements, with the rest of the Great Lakes models to follow. A planned upgrade to join the Lake Huron and Michigan models is planned for FY19. Similar updates to the Lake Superior and Ontario models are planned for FY20 and FY21 concurrently. In FY22, a new Huron-Erie Corridor model is schedule for release.

Below are links to the currently operating models.



Lake Erie Operational Forecast System (LEOFS)

Recent upgraded to provide forecasts out to 120 hours. This model will also help drive harmful algal bloom (HAB) forecasts in the FY17. See HAB forecasting section below.

http://tidesandcurrents.noaa.gov/ofs/leofs/leofs.html

Lake Huron Operational Forecast System (LHOFS)

http://tidesandcurrents.noaa.gov/ofs/lhofs/lhofs.html

Lake Michigan Operational Forecast System (LMOFS)

http://tidesandcurrents.noaa.gov/ofs/lmofs/lmofs.html

Lake Ontario Operational Forecast System (LOOFS)

http://tidesandcurrents.noaa.gov/ofs/loofs/loofs.html

Lake Superior Operational Forecast System (LSOFS)

http://tidesandcurrents.noaa.gov/ofs/lsofs/lsofs.html

Recent Activities

Partnerships with U.S. Army Corps of Engineers

CO-OPS worked with the United States Army Corps of Engineers (USACE) to have ice shields designed to protect the current meters that were noted above. CO-OPS also partnered with the USACE when congressional add-on funds were made available between 2002 and 2007 to modernize the network, including rebuilding eight water level stations whose platform infrastructure had substantially deteriorated. The design work first started in 2003, first construction awarded in 2005 and the last rebuild was finished in 2011. The rebuilt stations were West Neebish, Little Rapids, Mackinaw City, Alpena, MBR, Holland, Menominee, and Algonac. All stations were upgraded to the present day data collection platform technology.

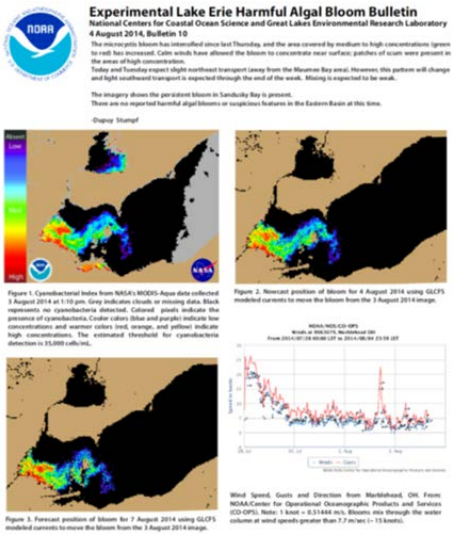
More recently, CO-OPS has provided funding to USACE to complete an engineering assessment of the infrastructure at other aging NWLON stations in the Lakes to identify where replacement is needed or life extension strategies that can be implemented.

Harmful algal bloom forecasting

Advance warning of harmful algal blooms (HABs) increases the options for managing impacts resulting from these events. In the Great Lakes, this is particularly important as HABs can threaten the availability of safe drinking water. NOAA's Harmful Algal Bloom Operational Forecast System (HAB-OFS) provides information on the location, extent, and potential for development or movement of harmful algal blooms. In FY17, Western Lake Erie weekly/biweekly HAB forecasts (currently in experimental mode) will be transitioned to operations from NOS National Centers for Coastal Ocean Science to CO-OPS.

http://www.glerl.noaa.gov/res/HABs_and_Hypoxia/

http://tidesandcurrents.noaa.gov/hab/



National Geodetic Survey (NGS)

Regional mission summary

NGS supports a wide variety of programs and activities in the Great Lakes, focused on monitoring elevation changes, improving accuracy of the National Spatial Reference System, and producing a gravity-based vertical datum. This will be accomplished with the help of the regional geodetic advisor that will improve coordination between NGS and our partners. The regional value of implementing these programs and activities will essentially provide accurate geodetic and water level products that ultimately improve the NSRS and activities between Canada and the United States.

Activities

Updating the International Great Lakes Datum

The purpose of the IGLD survey is to monitor elevation changes across the Great Lakes to facilitate the development of a revised International Great Lakes Datum (IGLD). Recent activities include data analysis and upcoming activities include internal additional data analysis by November 2016. The IGLD (1985) will be updated to IGLD (2020) over the course of the years from 2015 to 2025, with an expected release date of 2025. The update is essential to provide accurate geodetic and water level products and services to the Great Lakes community.

POC: Dave Conner, Dave Rigney, John Ellingson, CO-OPS Canada Fisheries, Natural Resources and ECCC

Great Lakes Region Geodetic Advisor program

NGS has transitioned from a state advisor program to an improved regional advisor program that enhances coordination between NGS and federal, state, and local partners with matters related to the Great Lakes. The creation of the Great Lakes Region advisor will occur in FY17, which started on October 1, 2016.

POC: Ross Mackay and John Ellingson

International coordination for matters related to the Great Lakes

Participation with the coordinating committee on the Great Lakes basic hydraulic and hydrologic data is ongoing. The unique regional value will provide consistency between Canadian and United States activities, information, and regulations with all matters connected to the Great Lakes.

Height modernization in western Great Lakes

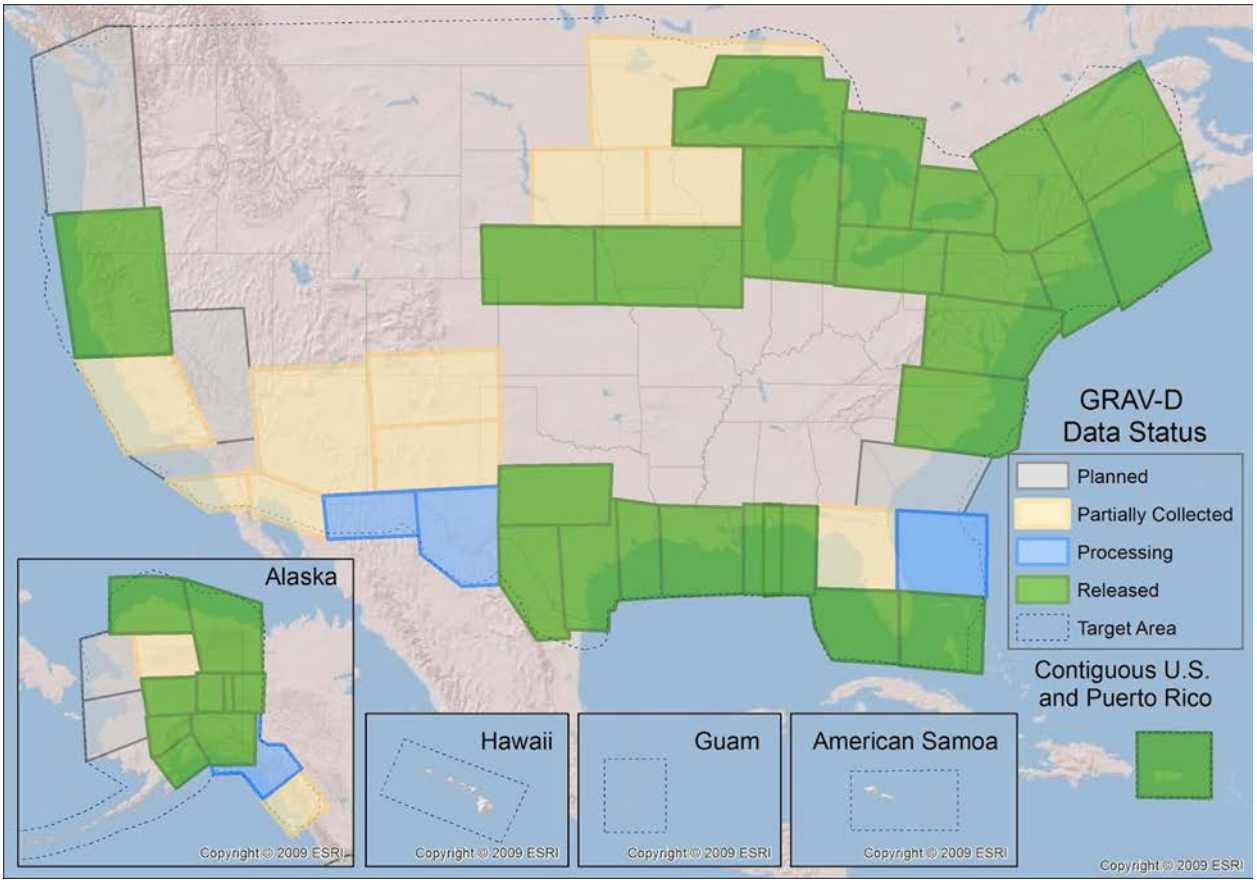
Extensive height modernization work is being completed in the area between Lake Superior and Lake Michigan to improve accuracy of the National Spatial Reference System in the area of Lake Superior and Lake Michigan. This will aid in establishing heights in the Great Lakes to provide densification of the National Spatial Reference System that improves the availability of precise control needs for most projects on the Great Lakes. Completion is expected to take place in FY17.

POC: NGS and Wisconsin Department of Transportation

GRAV-D

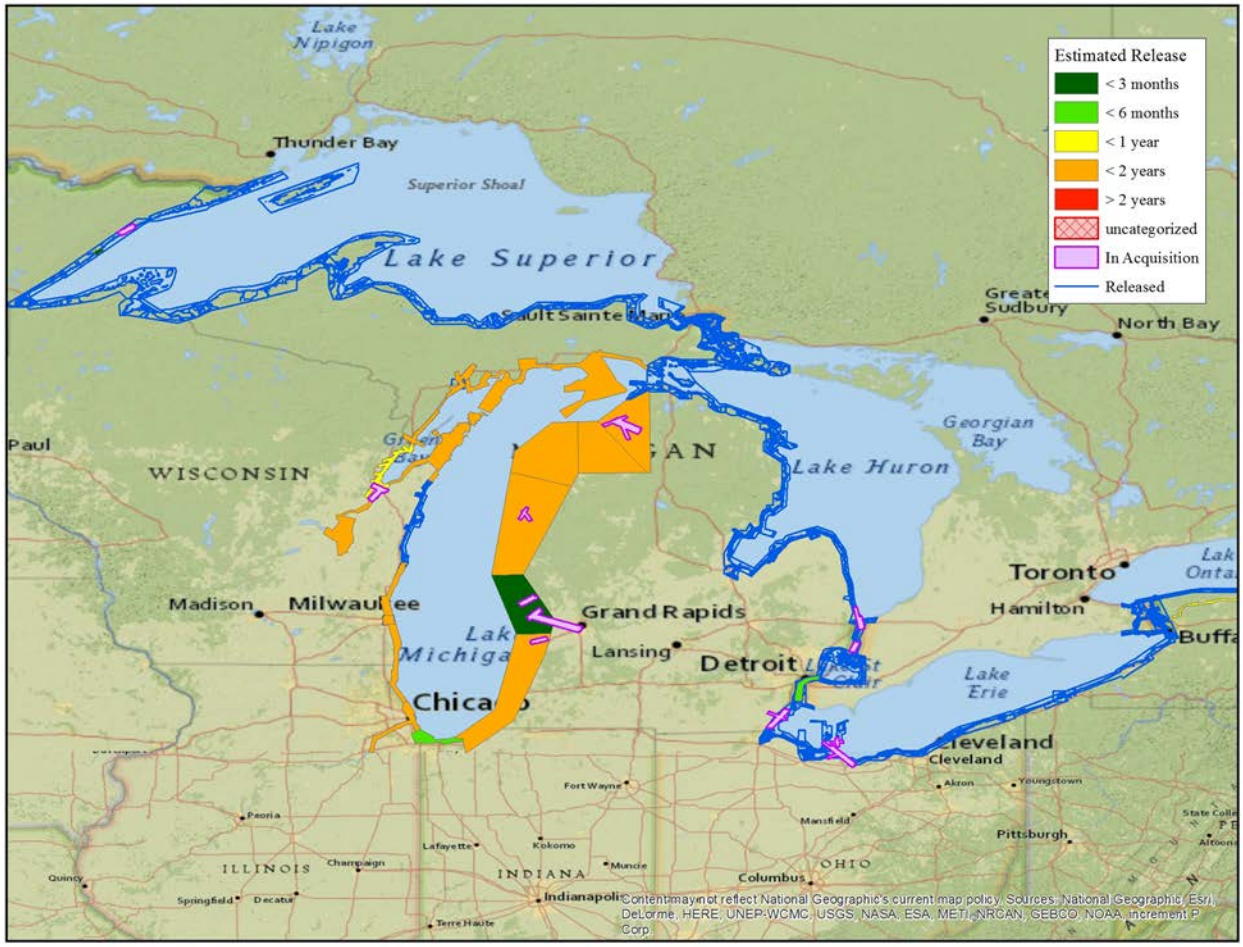
The GRAV-D program is producing a gravity-based vertical datum that will be accurate at the 2cm level where possible. GRAV-D flights over the Great Lakes region have been completed and each new XGEOID will now include that information. This is an extremely valuable asset for development of the next International Great Lakes Datum. The GRAV-D program will produce a more accurate model of the geoid in the Great Lakes area. This will resolve some areas where the existing geoid model is marginal.

POC: Monica Youngman



Status of GRAV-D data

NOAA continues to acquire and compile the Great Lakes' shoreline. Compilation should be complete in the areas near Grand Rapids, Michigan, and Gary, Indiana, within 3 months and 6 months, respectively. The remainder of Lake Michigan's shoreline will be compiled in less than two years (see image below). NOAA plans to collect RGB aerial imagery for 15 CSCAP Great Lakes ports in FY16.



Also, JALBTCX surveyed the Great Lakes with topographic-bathymetric (topo-bathy) lidar last year (see image below) and NOAA Remote Sensing Division's JALBTCX liaison will provide this data to Coast Survey for charting after the data has been processed and quality controlled. RSD's JALBTCX liaison has made past collections of topo-bathy available to Coast Survey to use as secondary updates on the NOAA charts in the Great Lakes.

NOAA's Continually Updated Shoreline Product (CUSP) provides the most current shoreline representation of the U.S. and its territories. CUSP is built upon NGS National Shoreline data and uses both NOAA and non-NOAA contemporary sources to replace vintage shoreline areas. The goal of CUSP is to represent the dynamic interface between land and water therefore CUSP has been designed to deliver continuous shoreline with frequent updates. The image below shows the available CUSP data for the Great Lakes region.

Emergency response imagery

NGS conducts flights to collect imagery after natural (hurricane, earthquake, tsunami, flood and tornado) and man-made (oil spill) disasters.

- To support homeland security and FEMA requirements
- High resolution, geo-referenced airborne imagery using NOAA aircraft supports NGS' Coastal Mapping Program.
- NGS posts images on the web, often within hours, to make these images available to the public.
- The imagery is used to determine impacts to NOAA as well as federal, state, local, and public interests.

NGS has been called on to collect imagery following many different types of disasters, including the 2016 flooding in the Midwest, 2015 flooding on the East Coast due to a nor'easter and hurricane Joaquin, and all major hurricanes since 2003. From the imagery, those in charge of response and restoration can determine the effect of disasters on the land; for example they can determine where flooding has wiped out parts of barrier islands and affected their formation. In 2013, NGS enhanced its imagery collection by developing hardware, software, and processes to allow for the collection of oblique aerial imagery. In 2015, NGS began collecting pre-event imagery along most of the U.S. shoreline using oblique imagery.

NGS plans to collect oblique imagery around the Great Lakes this summer. Using oblique imagery data set provides an accurate snapshot of what the "normal" shoreline and its associated infrastructure look like prior to an event, making it easier to assess the extent of damage cause from a single event.
http://storms.ngs.noaa.gov/eri_page/index.html

VDatum

In 2010, NGS, CO-OPS and Coast Survey made available the first edition of NOAA's Vertical Datum Transformation (VDatum) for the entire contiguous United States. This online tool enables users to seamlessly transform geospatial data – based on different vertical reference systems – into one uniform surface or "datum."

Transforming data to a single vertical datum removes the most serious impediments to data sharing and is necessary to harmonize the differences between the vertical reference systems of land- and water-based spatial data.

VDatum is a free software tool jointly developed by NGS, CO-OPS and Coast Survey. It was first introduced to support a seamless bathymetric-topographic digital elevation model (DEM) for Florida's Tampa Bay region. The DEM that resulted from the VDatum demonstration project has not only solved the problem of inconsistency among diverse datasets that causes difficulty in mapping coastal regions, but also provides standard geospatial data for multiple applications, such as inundation modeling, monitoring sea level change impacts, coastal management, and more.

VDatum Grid Updates for Great Lakes

VDatum will install a to-be-determined number of temporary tide gauges in the Great Lakes in 2019 and 2020 in support of IGLD2020. The VDatum team will implement the IGLD2020 transformations developed by the IGLD project team in the VDatum software tool.

In addition to the support of IGLD2020, VDatum will be releasing the following updated models:

- San Francisco Bay released in May of 2016
- NY Bight/Long Island Sound early FY18
- West Coast in FY19