Issue 3, March 2009

on the LEVEL

International Upper Great Lakes Study

IN THIS ISSUE:

Great Lakes Water Levels on the Rise

As International Upper Great Lakes Study (IUGLS) researchers continued to collect information and analyze findings, lake levels continued their recent upward trend. Thanks to a cold and wet winter, at the beginning of March 2009, the level ofLakes Michigan-Huron was 28 centimeters (11 inches) higher than one year ago and 6 cm (2.4 in) above chart datum (the level of water that charted depths displayed on nautical charts are measured from, sometimes called "low water datum"). Superior is 11 cm (4.3 in) above last year's level and 10 cm (3.9 in) below chart datum. Experts say the most probable forecast scenario has Lakes Michigan and Huron peaking in July at 37 cm (14.6 in) above chart datum with Superior peaking in August at 22 cm (8.7 in) above chart datum.

Lake researchers also noted that in early March, Lake Superior was almost fully iced over *(see photo above, black areas are open water)*. This marks only the sixth time that Superior has frozen over since the U.S. National Oceanic and Atmospheric Administration's Great Lakes Environmental Research Laboratory in Ann Arbor, Michigan, began keeping records in 1973. Increased ice cover prevents evaporation and helps maintain water levels.

See page 9 for more detailed lake level charts.

Draft St. Clair River Report to be released for Public Comment on May 1

Following meetings with the International Joint Commission, the Study Board has announced a new schedule for release of the draft St. Clair River report. The draft will be released for public comment on May 1, 2009. To allow for an extended 60 day comment period — as urged by the Public Interest Advisory Group — the final report will be transmitted to the International Joint Commission in October, 2009.

Following the May 1 release, the public will have extensive opportunities to ask questions and comment on the draft report, including public meetings throughout the Study Area. Visit www.iugls.org for the schedule of public meetings.

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Mapping morphology and flow in the Upper St. Clair River

Jim Best, Jon Czuba, Kevin Oberg, Dan Parsons

In the summer of 2008, researchers at the U.S. Geological Survey (USGS) and University of Illinois at Urbana – Champaign collaborated on an investigation of the upper St. Clair River. Our aims were to produce a bathymetric map of the bed of the river and Lake Huron near the entrance to the river, investigate the nature of any sediment transport in the reach, and link the bathymetry to flow patterns measured within this upper section of the river. Using specialized instruments, we were able to produce the most detailed bathymetric map ever obtained in this region and link this to the three-dimensional flow velocities at several cross-sections along the river.

Two boats were used in July of 2008 to map the bed and flow within the river. Both boats were accurately located within the river using a high-precision differential Global Positioning System (dGPS), which allowed us to keep track of the boat's location to an accuracy of several centimeters. A multi-beam echo sounder (MBES) was mounted on one boat; the MBES projects a fan of 256 acoustic beams from a transmitter located just below the water surface. The MBES measures the strength of the acoustic reflections of each of the beams as they pass through the water and bounce back off the bed. This return signal is then used to measure the depth of the water along the path of each beam.

The resulting data are used to construct a map of the depth of the river bed with unprecedented detail. Objects of only a few decimeters in size (about the size of a candy bar!) were detected and mapped. In addition to the MBES survey, an acoustic Doppler current profiler (ADCP) was used to measure the velocity of flow within the river. An ADCP also uses high frequency acoustics but measures the 'Doppler shift' of sound that bounces back off small particles within the flow. In this manner, the ADCP can obtain vertical profiles of three-dimensional water velocity, from just below the water surface to just above the channel bed. When the ADCP moves transverse (perpendicular) to the flow along a cross-section located using the dGPS, three-dimensional water velocities can be quantified for the entire cross-section. A minimum of six transects, or passes, were used to measure the water velocity for each transect and then the velocities for each cross-section were calculated using a spatial averaging technique.

Our MBES map *(Figure 1)* reveals the bathymetry of the lake and river as never seen before, with the dredged channel from the lake being clearly evident *(see black arrow on Figure 1)*. The river is deepest near the exit of the dredged channel and at the outside of the first downstream

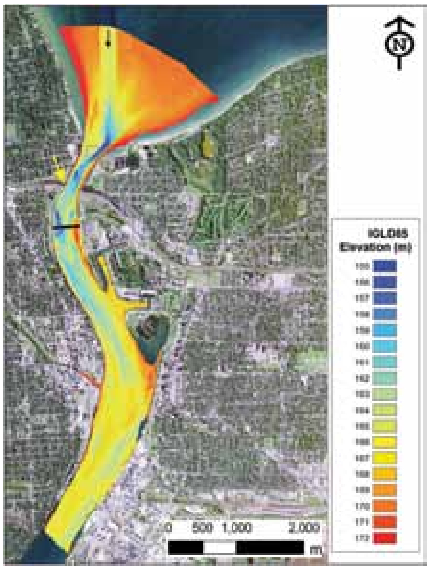

Figure 1. *Bathymetry of the Upper St. Clair River, July 2008, as revealed by MBES surveying, with the location of the ADCP cross-section indicated by the black line. The United States side of the Blue Water Bridge is indicated by the yellow arrow. The top of the dredged channel and the principal flow direction are indicated by the black arrow. Note the regions of deep water (blue) and shallower areas (red).*

bend. Shallower areas occur near the Canadian bank near the Point Edward casino, with average flow depths decreasing towards, and downstream, of the Black River. The MBES map reveals superb detail, such as the wreck of the schooner Fontana, with sand dunes around the wreck *(Figure 2)*. Results from the ADCP show flow at a cross-section downstream of the Blue Water Bridge *(Figure 3)*. The St. Clair River constricts to its narrowest under the Blue Water Bridge *(see yellow arrow, Figure 1)* and, as the channel narrows, the velocity of the flow increases. The channel then expands abruptly downstream of the bridge *(Figure 1)* where there is a deep pool at the outside of the bend and a sand bar on the inside of the bend. As the flow moves around this bend, it forms a region of recirculating flow on the Canadian side of the river with flow moving upstream near the bank *(negative velocities, Figure 3)*. Flow velocities are fastest within the main channel, and a circulation cell is set up that moves flow near the bed from the U.S. side towards the Canadian side; flow near the surface is moving in the opposite direction (*Figure 3)*. Ongoing analysis of this integrated bathymetric and flow dataset is examining the detailed morphology of the bed, the movement of sediment, and role of the bed morphology in dictating the patterns of flow within the river.

(Note: Any use of trade, product, or firm names is for descriptive purposes only and does not constitute endorsement by the U.S. Government.)

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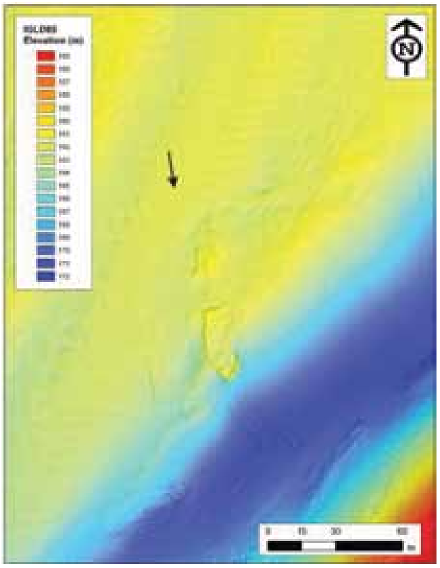


Figure 2. *Detail of the bathymetry indicated by the area shown by the dotted box in Figure 1 at the entrance to the Upper St. Clair River. This image shows the wreck of the 231 ft long schooner, the Fontana, that sunk around midnight on the evening of August 3, 1900, and a field of sand dunes (indicated by the black arrow) in the shallower water around the wreck.*

Why bathymetry and flow velocity are important to understanding Lake Levels

Water depth, or bathymetry, is critical to our understanding of changing lake levels. Sound waves are used to measure the depth of a river or lake bed using sonar technology. The time it takes for the sound to travel to the bottom of the lake or river, and return to the surface of the water tells us how far the bed is from the surface. Bathymetry, taken with other measurements such as the velocity of the water flow, and sediment transport, help us understand how the bed of the river may change over time. In addition, these measurements help researchers verify and calibrate models of the St. Clair River that may explain how those changes affect water levels.

- The Editors

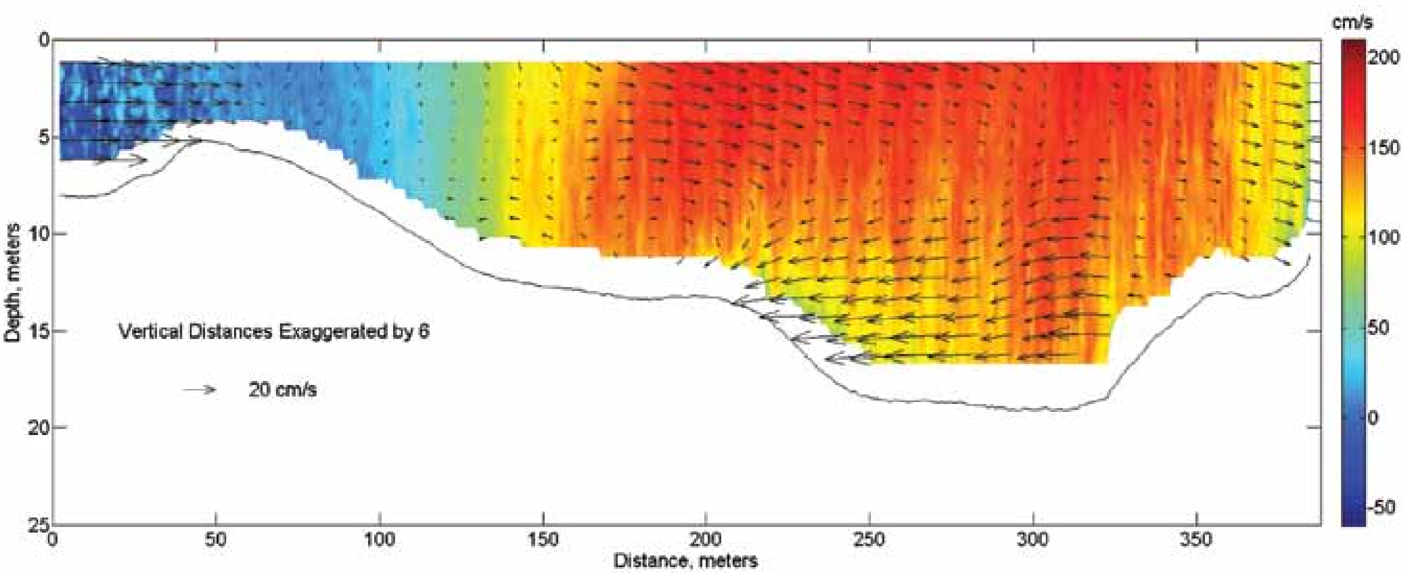


Figure 3. *Flow at a cross-section downstream of the Blue Water Bridge (see Figure 1 for location), as measured using an ADCP. The color contours depict downstream/upstream velocity (cm/sec); the arrows show the transverse and vertical velocities. The view is looking downstream, with the Canadian (East) bank on the left and the United States (West) bank on the right. The solid black line a few meters below the color contours and arrows is the channel bed.*

Hydraulic Modelling

By Dr. Syed Moin, co-manager, IUGLS

After in-depth analysis and evaluation of one-dimensional (1-D) and two-dimensional (2-D) modelling, the consensus view of the Study Board and a wide range of experts, including peer reviewers, is that the use of three-dimensional (3-D) models, although appropriate in some circumstances, will not help address the immediate core science question: "Has the conveyance capacity of the St. Clair River changed?" Moreover, the wide range of 1-D and 2-D modelling efforts already completed or underway continue to produce consistent results.

A comprehensive suite of Acoustic Doppler Current Profiler (ADCP) measurements in the upper reach of the St. Clair River has shown that vertical (upward and downward) velocities are relatively small near the channel bottom compared to the horizontal component. Typically, the vertical velocities were less than 10 percent of the horizontal, indicating that a third dimension in the model, i.e. vertical velocity, is not an important factor in sediment dynamics or in conveyance determinations.

The Study Board's hydraulic modelling strategy was endorsed by an independent peer review team *(see related article on page 6)*, who noted:

> "The [Study's] strategy contemplates the need for 3-D modelling. 3-D modelling is required if there are significant vertical velocities in the reach. 3-D modelling is also required to resolve local scour and/or secondary currents in bends. 3-D models are not generally employed over long reaches of river due to excessive computational demands. There is not currently sufficient evidence of vertical velocity or vertical transport in the reach that would necessitate the use of a 3-D numerical model. If 3-D modelling is eventually considered to assess erosion/deposition at a specific location in the reach, it would be prudent to weigh the relative merits and costs of 3-D numerical versus physical modelling."

From a purely scientific perspective, there are scientists who consider 3-D modelling to be interesting work and a useful addition to our knowledge of the Great Lakes; yet, they recognize such analysis is not necessary to answer the specific questions being addressed by the Study. Moreover, the costs of calibrating and "ground-truthing" a 3-D model for the whole length of the St. Clair River with the necessary data from field measurements would be very high and would delay the Study without improving the reliability or certainty of the results.

However, the Study Board has always emphasized that if physical

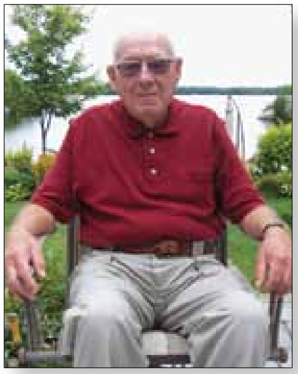
A 1-D model simulates the average velocity and overall stream flow down the river, as if one were traveling in a downstream direction with it. However, it cannot describe how velocity varies from one side of the river to the other, or how the velocity may vary horizontally along the depth of water as one crosses the river. A 2-D model allows estimating river velocity in two directions — along the river's downstream direction and across it, from one bank to the other. A 3-D model allows the estimation of velocity in all three directions, meaning at any point in the water column anywhere in the stream.

remedial actions are recommended, then 3-D modelling might be appropriate to study the details of flow, hydraulic behavior and sediment processes as part of an overall design and feasibility phase of such action. But this analysis would have to be at the request of, and funded by, both governments, as a separate action because detailed studies of remediation are not currently within the mandate of the IUGLS.

The Study Board has informed the IJC that a team of researchers at the University of Illinois is running a 3-D model but only for the upper two kilometers of the St. Clair River. The Study is providing support to this effort by making available all bathymetric, discharge and sediment data for calibrating the model and has been reviewing the results. These researchers are applying an open source model (Open FOAM) and building in sediment transport routines that are applicable for gravel bed streams *(see related story on page 2)*. Preliminary results for the upper reach indicate very little difference in results from a 2-D model and the Open FOAM 3-D model.

See page 7 for a profile of Dr. Moin.

PIAG Profile: Ken Higgs, Passionate about the Environment



He has a degree in forestry, decades of involvement with conservation authorities and a home near beautiful Georgian Bay. Understandably, Kenneth Higgs has long been passionate about environmental and ecological issues. He loves nature and is concerned about the future of the Great Lakes. So it was with enthusiasm that Mr. Higgs accepted an appointment to the Public Interest Advisory Group (PIAG). Mr. Higgs and his wife Joan live on the Severn River less than a kilometer from Georgian Bay and about 15 kilometers northeast of Midland. The river is part of the Trent-Severn Waterway connecting Lake Ontario with Georgian Bay. He has spent summers on the Severn River since he was a child, and in 1992 the Higgs had their home renovated and winterized for year-round living. Ken said he and his neighbors have experienced both high and low water levels in Georgian Bay, and he wants to make the consequences clear to PIAG. "Shoreline properties are endangered by high water, while low water levels sometimes restrict access to properties," he said. He cited the example of one neighbor who, 20 years ago, had water lapping nearly up to her doorstep, but now has plenty of land outside her cottage and an island just off shore is now part of the mainland.

In recent years, Mr. Higgs frequently has heard of fellow boaters who have damaged a propeller or had to be towed or pushed off of an unforeseen shoal. Despite the Canadian Coast Guard installing additional navigational aids in the bay — red and green buoys indicating channel parameters, plus white ones signifying shallow water — boaters don't always follow them or even notice them. "You've got to be so careful in Georgian Bay; there are so many rocks," he said.

Mr. Higgs is a strong advocate for letting the scientists do their work and not jumping to conclusions prematurely. "Our role as PIAG members is to be as objective as we can," Mr. Higgs said. "I don't think we should allow bias in the process. Until we have the experts' opinions, we cannot arrive at any conclusions."

Study Promotes a High Level of Scientific Credibility through Independent Peer Review

Results Posted Online for Public Transparency

By Dr. Paul Pilon and Dr. Mark Colosimo

For the first time in the history of the IJC, a binational study is benefiting from an ongoing independent scientific review of work plans and reports. Even though there are many levels of review within the IUGLS, because of the importance of this Study, it is being subjected to the highest level of independent scientific scrutiny.

The IJC has negotiated contracts with the Environmental and Water Resources Institute (EWRI) of the American Society of Civil Engineers (ASCE) and with the Canadian Water Resources Association (CWRA) to review the work of the IUGLS. Over the duration of the Study, these two national organizations will provide experts to review five methodological reports, 14 to 18 scientific reports, six to seven synthesis documents and the two final reports. More information regarding the peer review process, the names and biographies of the review team, and review documents are available at the EWRI website, http://content.ewrinstitute.org/committees/IUGLS.cfm.

Experts from both countries have already been engaged to conduct three methodological reviews:

- Hydraulic and Sediment Modelling Strategy;
- Hydroclimatology Methodology; and
- Scientific Uncertainty Framework.

In all cases, the reviewers have been supportive of Study strategies and endorsed the work plans with various modifications.

For example, the experts recommended study of additional factors which may affect the conveyance of the St. Clair River (e.g. ice retardation, weed growth, and shoreline hardening), and also suggested that, in addition to focusing on uncertainty analysis in specific research areas, there be an overarching focus on uncertainty as the various aspects of the Study are integrated.

Drs. Pilon and Colosimo are both professional engineers and IJC Liaisons to IUGLS, consultants from Canada and the United States, respectively.

SOURCE: *Lake Superior shore and beach near Brimley, MI, UP. Credit to Ted Lawrence, Great Lakes Fishery Commission.*

Dr. Syed Moin — Study Manager, Respected Scientist, Teacher, Modelling Expert

A world renowned hydrologist and civil engineer, Dr. Moin has held major positions in his native country of India, the United States, and Canada, as well as short-term assignments all around the world.

Dr. Moin has extensive experience working in key roles on previous Great Lakes studies, including the Lake Ontario and St. Lawrence River Study and the 1993 Levels Reference Study. For these landmark studies, he was a specialist modeller and also supervised such study components as climate change, stochastic analysis, and hydraulics. Dr. Moin earned a bachelor's degree in civil engineering (emphasis on structural and hydraulic engineering) in India and worked there for two years before enrolling at the University of Nevada at Reno, where he earned a master's degree in civil engineering (emphasis on water resources). He immigrated to Canada in 1974 to further his education and pursue job opportunities. While working for Environment Canada (his employer for the past 34 years), Dr. Moin earned a Ph.D. in civil engineering at McMaster University in Hamilton, Ontario. His research concentrated on dam-break hydraulics. The more Moin studied, the more interest he developed in the science of hydrology. "The focus of my teaching and research has always reflected my desire to get closer to nature," he said. He has done so by dedicating his life's work to water resources management. As a Study Co-Manager and Co-Chair of the St. Clair Task Team, he helps oversee more than 100 scientists, dozens of separate projects, and complicated budgets. Dr. Moin also teaches a four-unit design course on flood plain management at McMaster University, where he is an adjunct professor. Given his level of expertise and extensive teaching and working in the field, it is not surprising that when questions about complicated modelling issues arise, the common refrain from other experts is "talk to Dr. Moin; he is the expert."

SOURCE: *NOAA, Great Lakes Environmental Research Laboratory. Washington Park Beach, Michigan City, IN, part of the Indiana Dunes National Lakeshore. Photograph by Eric Chenault, Greenwood, IN.*

Water Uses Technical Work Group Playing Important Role in Study

Jeff Vito, PIAG

As part of the International Upper Great Lakes Study, Technical Work Groups (TWGs) play an important role in helping to gather the needed data and conduct the scientific analysis to develop an improved regulation plan for Lake Superior outflows. The Water Uses TWG has the responsibility of gathering information pertaining to municipal, domestic, and industrial water uses. Members of this TWG are committed to providing the study team and the International Joint Commission with their expertise as professionals in their respective areas and not as a representative of their respective agencies or countries.

The majority of the municipal and industrial water intake within the Great Lakes Basin is not greatly affected by changing water levels. However, locations outside of urban areas depend on shore wells that were not designed or built with fluctuating water levels in mind and may possibly have a significant impact on cottages, campers, and permanent homes on the Upper Great Lakes.

In order to fully understand the potential impacts and be able to formulate recommendations to the Study Board, the Water Uses Technical Work Group has formulated a task list, including:

- use existing state and provincial agency inventories to identify major municipal and industrial intakes, including those vulnerable to extreme water level fluctuations;
- compile current municipal and domestic uses and estimate future expected water demands, in terms of quantity and quality;
- assess the effects of the current regulation plan on these water uses, assuming present and future use projections;
- conduct pilot studies of selected urban and rural areas if more detailed assessments prove necessary;
- investigate, and wherever suitable, adapt evaluation techniques;
- assist in identifying any changes to regulation plans to improve operations to benefit municipal, industrial, and domestic water uses; and,
- evaluate the effects of alternative regulation and supply scenarios on municipal, industrial, and domestic water interests.

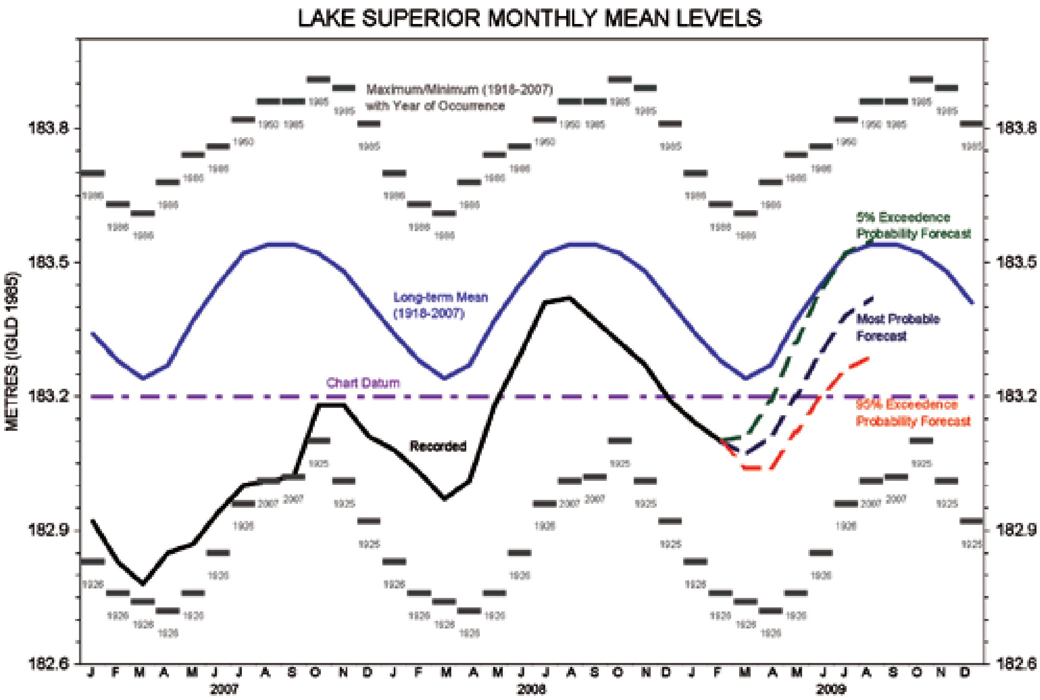
The members of the team are highly motivated professionals in their respective fields and are strongly committed to their work on the task team as it relates to the overall study. With such experts working on this plan, one might think that it would be an easy task to collect and analyze data and make a recommendation. But, the task has proven to be quite difficult.

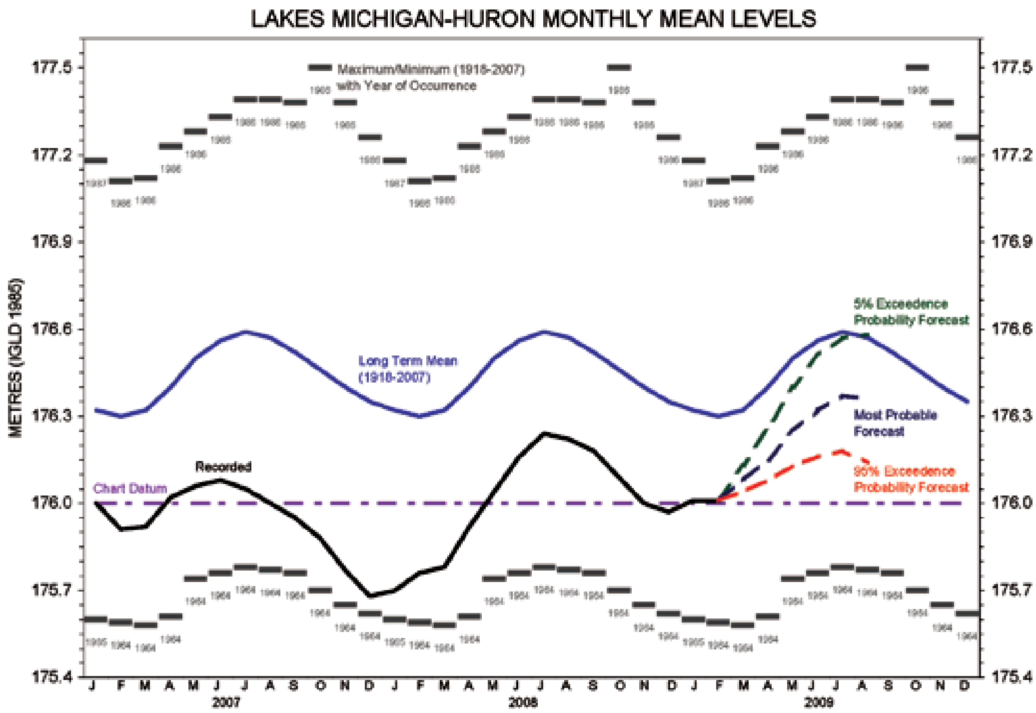
The collection of data from local, state, provincial, and federal agencies presents a wide array of complications. Information coming from various governments often varies in how it is compiled and formatted. Our challenge is to take this data, in all the formats, and compile a single, user-friendly database that provides a complete picture of the entire upper Great Lakes that helps the Study experts develop and recommend improved regulation plans.

Some of the challenges in gathering this information are wide ranging. Responses to requests for data range from reluctance to provide specific intake locations due to concerns of potential terrorist use, to the bureaucratic response: "This is not my area of responsibility; you need to contact so and so." Of course, that answer often leads to the proverbial runaround. In addition, different jurisdictions have different procedures and protocol to go through in order to obtain information. For example, in my state of Wisconsin, the team members were required to submit a "Request for Sensitive Information" before local officials could release their information.

The bottom line is that despite the many challenges in gathering the information needed, I am extremely confident that because of the professionalism of the experts on this TWG, they will nail down solid and reliable information that will play a major role in the overall Study.

Mr. Vito is Director of Development & Government Affairs for the City of Superior, Wisconsin and a member of the IUGLS Public Interest Advisory Group.





SOURCE: *Great Lakes-St. Lawrence Regulation Office, Environment Canada; and Detroit District, U.S. Army Corps of Engineers*

Each month, Canadian and U.S. experts jointly prepare these charts showing both historic, current and projected water levels.

The solid blue line shows average or mean monthly water levels based on records collected from 1918 to 2007.

The solid black line shows actual monthly water levels, starting in January of 2007 through the current month (March 2009).

The dotted lines represent projected water levels, with the center dotted line being the most likely scenario, while the upper dotted line reflects very wet conditions and the lower dotted line (in red) reflects very dry conditions. There is a one in ten chance that the level will be outside the range formed by these two more extreme scenarios.

The short bars above and below represent record high or record low monthly mean levels and the year in which the record occurred.

PIAG Profile: Roger Smithe, Lake Michigan Expert

PIAG member and chair of the International Great Lakes Coalition, Roger Smithe has lived in west Michigan all his life, with the exception of a few years in the 1950s when he was stationed in Germany while serving in the U.S. Army.

From beautiful sunsets and the relaxing sound of the surf at night, to houses toppling off eroding bluffs during the high water era of the 1980s, to frustrated homeowners haggling with bureaucrats over permits for property improvements, Smithe is well versed in the history and the impacts of fluctuating water levels.

Mr. Smithe has watched Lake Michigan's levels rise and fall ever since his parents built a lakefront home in 1950. He emphasizes that seeing the homes of neighbors fall into the lake because they couldn't afford shoreline protection led him to the conclusion that the ideal goal of regulation should be a lake level consistently within 1.5 feet of the long-term average.

"People I talk to are petrified with fear that if anything is done on the St. Clair River that would raise lake levels by, say, one foot, then when high levels return, they would be a foot higher than they were in the 1980s, and that would be disastrous." Besides the physical damage, such high levels might revive other states' efforts toward out-of-basin diversion, he said.

Smithe said west Michigan's riparian landowners share some key beliefs:

- The economic value and enhanced quality of life provided by thriving beaches and clean water must never be underestimated.
- Extreme caution should be exercised regarding St. Clair River mitigation that could exacerbate future high water levels.
- The permitting process with respect to how riparians can manage their lakefront property needs streamlining.

Smithe points out that recreation, commercial shipping and other interests can bounce back once high water levels return to normal, "But when a property owner loses his/her home or land, it never comes back."

Mr. Smithe earned a bachelor's degree in chemical engineering, and a master's in industrial engineering, both from the University of Michigan. He worked for 30 years in the pulp and paper industry as an environmental manager.

SOURCE: *GLNPO. Lake Michigan beach, Petoskey, Michigan. Michigan Travel Bureau.*

continued from page 1

The new schedule allows for further examination of hydraulic and sediment modelling results; more thorough data evaluation, verification and quality control; and, additional time for the Study Board and Technical Work Groups to integrate the findings from more than forty research projects conducted in support of the IUGLS. If needed, the revised schedule will also allow for additional data collection during a partial field season to corroborate the results.

Even with the change, the St. Clair River portion of the IUGLS still remains well ahead of the original schedule, which called for publishing the draft report in 2010. The IJC commissioners fully supported the change in the schedule.

New Gauging Stations Provide Critical Data

Critical data needed by Study experts to complete the draft report on the St. Clair River are being provided by new hydrometric stations on the Detroit, St. Clair and St. Marys Rivers. Following field work during the 2008 summer season to site the stations properly, three Acoustic Doppler Current Profiler (ADCP) gauges were installed last fall. These state-of-the-art, solar-powered, digital gauges measure water velocity, which is then used to calculate river discharge. The information provided by these stations is also vital to the development of new plans for the regulation of Lake Superior outflows — the next phase of IUGLS.

The velocity data gathered from each gauge are transmitted to the National Oceanic and Atmospheric Administration Geostationary Operational Environmental Satellite (NOAA GOES), which then relays them to a USGS Water Science Center in Michigan.

The IJC has requested that after completion of the Study the governments provide for ongoing operation and use of the gauges as International Gauging Stations. This could be accomplished by USGS and Water Survey of Canada (WSC) with coordination and support from the U.S. Army Corps of Engineers. WSC and USGS already operate about 60 International Gauging Stations from coast to coast that assist the governments in monitoring trans-boundary flows.

While a fourth ADCP gauge station, already located at the Blue Water Bridge, was initially considered, it proved not to be ideally located for use by the Study. This gauge is operated by NOAA and is mainly used for navigational purposes.

The deployment of these gauges follows the installation of the first-ever evaporation monitoring instrumentation (an eddy covariance monitor) on Lake Superior to take high frequency measurements of vertical wind and water vapor pressure. A second evaporation monitor is expected to be installed on Lake Huron in 2009. Taken together, data collected from the ADCP gauges and the eddy covariance monitors will provide key information about the extent to which water levels are influenced by interconnecting channel flows and lake evaporation.

on the LEVEL

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