Planning for an Integrated Assessment on Water Level Variability and Coastal Bluffs in Northern Milwaukee County and Southern Ozaukee County, Wisconsin
Final Report – September 1, 2015

EXECUTIVE SUMMARY

The Lake Michigan coast from Shorewood to Port Washington in southeastern Wisconsin is characterized by coastal bluffs ranging from approximately 70 to 120 feet in height. Lake Michigan water levels were below the long-term average from 1999 to 2013 and have quickly jumped above that average during the past twelve months. It is anticipated that the current higher water levels in Lake Michigan coming after the extended period of low levels could have a significant impact on the stability of coastal bluffs. At the same time as the rapid change in the physical environment of the Lake Michigan shore, the enabling legislation for shoreland zoning in Wisconsin was weakened. Shoreland zoning, enabled by state law and implemented by local governments, is a primary management tool for addressing development along both inland and Great Lakes waters in Wisconsin. The combination of these two events has precipitated a need to synthesize existing bluff erosion research and engage local stakeholders and broader partners to explore policy options and decision tools for increasing resilience to coastal bluff erosion in the face of possible increases in the variability of water levels.

The key outcomes from the Wisconsin planning grant included information gathered from interviews with 19 stakeholders, partners and investigators on their perceptions of the issues, solutions, barriers, and information needs related to changing Lake Michigan water levels and coastal bluff erosion in the study area; identification of two resources – robust case studies in the Great Lakes Coastal Resilience Planning Guide and the maps, data and tools of the Wisconsin Coastal Atlas – that exist to effectively organize and present information about variable water levels and coastal bluff erosion; and a workshop was held in July to connect stakeholders, partners and investigators and better understand the issues, drivers and impacts. A discussion and vote during the last hour of the workshop indicated there is support for continued participation in the Great Lakes Water Levels Integrated Assessment.

Participants in the planning grant include the research team consisting of 10 investigators from three campuses representing a diversity of natural science, social science and policy disciplines; stakeholders that represent the two counties and seven municipalities that cover the study area; and project partners from regional, state and non-profit organizations with broader perspectives on coastal bluff erosion.

Potential next steps of Wisconsin involvement with the integrated assessment include more intensive engagement with local officials, deeper analysis of interviews, as well as the activities anticipated during the remainder of the IA (an interdisciplinary overview synthesis and report of status, trends, causes, and consequences of this issue and preparation of a report identifying and analyzing viable policies and adaptive actions that meet local objectives identified in collaboration with community partners).

INTRODUCTION

This planning grant associated with the Great Lakes Water Levels Integrated Assessment (http://graham.umich.edu/knowledge/ia/water-levels) was conducted from March to August 2015. It addressed the impact of changing water levels on an area of high coastal bluffs covering approximately 26 miles of the Lake Michigan coast of Wisconsin from the City of Port Washington in Ozaukee County on the north to the Village of Shorewood in Milwaukee County on the south (see Figure 1).

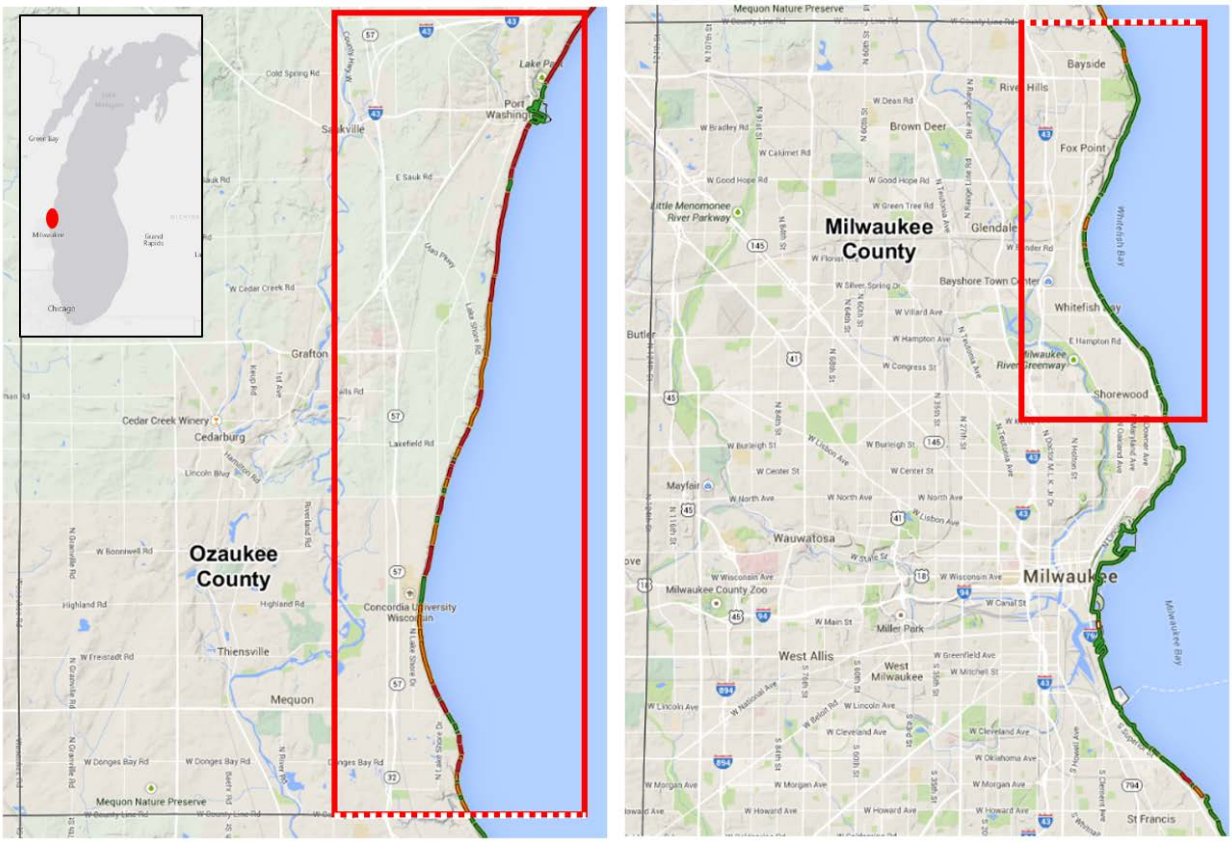


Figure 1. Project study area (map source: Wisconsin Shoreline Inventory and Oblique Photo Viewer)

The objectives of the planning grant were to: 1) engage a diverse range of stakeholders to identify and document multiple perspectives on the impacts of variable water levels on coastal bluffs in the study area; 2) collaborate among a multidisciplinary team of investigators to inventory existing data and information sources to develop a holistic understanding of improving the resilience of coastal bluffs to variable water levels; and 3) facilitate interaction between stakeholders, partners and investigators to gauge interest in identifying policy alternatives and tools to address water level impacts on coastal bluff erosion.

The primary activities associated with the planning grant included interviews with stakeholders, partners and investigators; development of an on-line bibliography of relevant research on variable water levels and coastal bluffs; authoring a white paper on finding and organizing existing research, data and decision tools; and holding a workshop to provide information about

the Great Lakes Water Levels Integrated Assessment and determine if there was support for Wisconsin to continue participation in the project.

OUTCOMES OF THE PLANNING GRANT

Description of focus area

The primary impact area covered by the planning grant relates to the influence of changing Lake Michigan water levels on coastal bluff erosion. Topics covered include regulation of coastal development, design of coastal infrastructure, and protection of nearshore and shoreland habitats. Environmental drivers include coastal processes and geomorphology, vegetation, and potential climate impacts on water levels, waves, temperature and precipitation. Social drivers include the effects of shoreline management activities on neighboring properties and receptivity to education, outreach and resilience planning efforts. Political drivers include property rights, regulations and planning processes. Economic drivers include damage to coastal property, infrastructure, and habitats, changing property values, and the costs and benefits of shore protection.

The bluffs along the Lake Michigan coast of Wisconsin from the Illinois border to the Sturgeon Bay Ship Canal have been extensively studied from a variety of perspectives over several decades. A series of technical and policy studies were conducted in the 1970s and early 1980s timed with establishment of the Wisconsin Coastal Management Program (WCMP). These studies covered bluff stability, shore erosion rates, shore erosion policy options and model ordinances to reduce coastal erosion losses (Mickelson et al. 1977; Springman and Born 1979; Yanggen 1981). A second concentration of studies occurred in the 1990s spurred by the creation of a Coastal Hazards Work Group of the WCMP. These studies included an inventory of development and additional bluff stability and shore erosion reports (Bay-Lake Regional Planning Commission et al. 1996; Southeastern Wisconsin Regional Planning Commission 1997; Keillor 1998). Extensive mapping and coastal geomorphological studies were conducted in three counties (Ozaukee, Sheboygan and Manitowoc) associated with the Lake Michigan Potential Damages Study funded by the U.S. Army Corps of Engineers. More recently, the Coastal Hazards Work Group and other large federal efforts such as the Great Lakes Coastal Flood Study and LiDAR topo/bathy mapping by USACE and NOAA have generated extensive digital geospatial data for the coast.

While extensive data on coastal characteristics and processes are available for the study area, synthesis from a multidisciplinary perspective and generation of policy alternatives guided by stakeholder engagement as envisioned by the Great Lakes Water Levels Integrated Assessment would be beneficial to increasing resilience to the effects of variable water levels on coastal bluff erosion. This planning grant helped initiate a more holistic perspective of coastal processes reaching from the nearshore to beyond the top of the bluffs.

Description of contributors

Research team

Ten investigators from Wisconsin Sea Grant, the University of Wisconsin-Madison, the University of Wisconsin-Milwaukee and Concordia University represent disciplines covering

coastal engineering, geology, urban and regional planning, law, policy studies, ecology, landscape architecture, sociology, economics and geographic information science.

- Bruce Bessert, Director, Concordia Center for Environmental Stewardship, Concordia University Wisconsin,
- Jane Harrison, Social Science Outreach Specialist, Wisconsin Sea Grant (Dr. Harrison left Wisconsin Sea Grant to become the Coastal Economist at North Carolina Sea Grant in August 2015)
- David Hart, Assistant Director for Extension, Wisconsin Sea Grant
- John Janssen, Professor, School of Freshwater Sciences, University of Wisconsin-Milwaukee
- Jenny Kehl, Assistant Professor and Director, Center for Water Policy, School of Freshwater Sciences, University of Wisconsin-Milwaukee
- Jim LaGro, Professor, Department of Urban and Regional Planning, University of Wisconsin-Madison
- Adam Mednick, Beach Health Fellow, Wisconsin Sea Grant
- David Mickelson, Emeritus Professor and Senior Scientist, Department of Geoscience, University of Wisconsin-Madison
- Brian Ohm, Professor, Department of Urban and Regional Planning, University of Wisconsin-Madison
- Chin Wu, Professor, Department of Civil and Environmental Engineering, University of Wisconsin-Madison

Stakeholders

Project stakeholders include local officials from the two counties, two cities, four villages and one town that cover the study area.

- Milwaukee County (Milwaukee County Parks, Milwaukee Metropolitan Sewerage District)
- Village of Shorewood
- Village of Whitefish Bay
- Village of Fox Point
- Village of Bayside
- Ozaukee County (Planning & Parks Department, Land & Water Management Department)
- City of Mequon
- Town of Grafton
- City of Port Washington

Partners

Project partners include organizations with broader perspectives on coastal bluff erosion, including regional and state agencies, professional associations, and non-profits.

- Southeastern Wisconsin Regional Planning Commission
- Wisconsin Coastal Management Program, Coastal Hazards Work Group
- Wisconsin Department of Natural Resources, Office of Great Lakes
- Wisconsin Initiative on Climate Change Impacts, Coastal Resilience Working Group
- Wisconsin Emergency Management
- Association of State Floodplain Managers
- 1000 Friends of Wisconsin

Description of activities/process
The activities associated with the planning grant included identification of relevant officials from local governments in the study area; conducting interviews with project stakeholders, partners and investigators; development of an on-line bibliography of relevant research; authoring a white paper on finding and organizing existing research, data and decision tools related to water level variability and coastal bluffs; and holding a stakeholder workshop.

Identifying stakeholders
A spreadsheet was developed with contact information for managers, planners, and engineers and other relevant officials from the counties and municipalities in the study area.

Interviews
Detailed interviews were conducted with 9 stakeholders, 5 partners, and 5 investigators. The interviews included the following questions:

1. How have changing Lake Michigan water levels affected the study area?
    - Please give some specific examples.
2. How do variable Lake Michigan water levels impact:
    - The siting of coastal development?
    - Storm water management?
    - Protection of coastal infrastructure like water treatment plants, marinas, transportation, and utilities?
    - Protection of coastal environments like lakebed habitat, beaches, wetlands, and coastal bluffs?
3. Are there any solutions that would help coastal communities deal with the impacts of variable water levels?
    - Please give some specific examples.
4. What are the barriers to communities being prepared for changing water levels?
5. What are the most relevant data, reports, or other information needed to understand the nature of variable water levels in the study area?
6. Are there any data or information that does not currently exist, but are needed to better understand the nature of variable water levels in the region?
7. Is there anyone you would suggest interviewing who is familiar with the impacts of water levels in the study area?

Bibliography
A bibliography of scientific studies on coastal bluffs and water levels along the Lake Michigan coast in Wisconsin was created using the Mendeley reference manager and academic social network. The "Integrated Assessment Library – Water Levels and Coastal Bluffs" group contains 89 bibliographic entries as of September 1, 2015 (https://www.mendeley.com/groups/4020161/integrated-assessment-library-water-levels-and-coastal-bluffs/).

Finding and organizing existing research, data and decision tools
The project team prepared a report that examines science bibliographies and open data archives as sources of information about coastal processes and Great Lakes water levels for the study

area. The report also describes resources to organize information about variable water levels and coastal bluff erosion so it is easy to access and use to guide decisions.

Stakeholder workshop
A workshop was held on July 27, 2015 at the Schlitz Audubon Nature Center in Fox Point, Wisconsin. The purpose of the workshop was to connect stakeholders, partners and investigators and better understand how changing water levels on Lake Michigan impact the bluffs from Shorewood to Port Washington. The agenda included an overview of the Great Lakes Water Levels Integrated Assessment, shared the results of stakeholder interviews for the Wisconsin project, and showcased resources to address changing Lake Michigan water levels and eroding bluffs.

Key findings from planning grants efforts that could contribute to the IA
The key findings from the planning grant included information gathered from the interviews with stakeholders, partners and investigators; the resources that exist to effectively organize information about variable water levels and coastal bluff erosion; and the discussion and vote during the last hour of the workshop on whether Wisconsin should continue participation in the Great Lakes Water Levels Integrated Assessment.

Summary of Interviews
Over the course of the planning grant, 19 stakeholders, partners and investigators were interviewed to explore their perceptions of the issues, solutions, barriers, and information needs related to changing Lake Michigan water levels and coastal bluff erosion in the study area. The interviews generated a large amount of information and a preliminary overview of findings was presented at the July workshop. The summary here is cursory. Additional analysis of the interviews will occur as the project moves forward.

The questions on impacts covered siting of coastal development, stormwater management, protection of coastal infrastructure, and coastal habitats and a fairly diverse set of issues. The most common concern cited was the encroachment of development closer to bluff and water's edge and the coastal management issues that arise from this trend. The interviewees offered a varied set of solutions to the issues identified. Most common among them was the need to increase educational efforts for property owners, public officials, and developers regarding the bluff issues created by changing water levels. Multiple participants also suggested the development of best management practices and tools that can be used by local officials to address all water levels as a possible solution. Funding and public perception of bluff issues were frequently mentioned as barriers to solution implementation. A changing regulatory environment and public resistance to regulations were also noted as barriers. Many reports documenting changing lake levels exist and were discussed by interviewees. However, many individuals recognized a need for new tools and strategies to develop bluff management strategies and package information that is usable for experts and understandable for the general public.

Resources to Organize and Present Information
The white paper on finding and organizing existing research, data and decision tools related to water level variability and coastal bluffs describes two resources to organize and present diverse

information about coastal resilience. Perhaps the best vehicle for consolidating resources for the Great Lakes Water Levels Integrated Assessment Wisconsin project is through a case study in the Great Lakes Coastal Resilience Planning Guide (http://greatlakesresilience.org/). The most relevant existing case study focuses on "Communicating Long-Term Bluff Erosion to Prevent Unsustainable Development – Ozaukee County, Wisconsin." Case studies include sections on awareness, understanding, analysis and strategy of coastal resilience issues and help connect people with the tools and data needed to consider natural hazards and climate change in local planning efforts. The Wisconsin Coastal Atlas (http://wicoastalatlas.net/) is an "enabling platform" that helps people better understand coastal issues, share coastal data, and inform decision-making about sustainable use of the Great Lakes. Maps and tools featured in the atlas relevant to the integrated assessment include a tool for visualizing coastal erosion and the rationale for coastal setbacks based on a segment of coastline in the study area, as well as a gallery of coastal hazards maps and tools such as the Wisconsin Shoreline Inventory and Oblique Photo Viewer and the NOAA Lake Level Viewer.

Workshop Discussion and Vote

The discussion at the end of the July workshop ended with a positive vote on whether Wisconsin should continue participation in the Great Lakes Water Levels Integrated Assessment. The vote was segmented by stakeholders (8-1), partners (4-0), and investigators (6-0), with a total result of 18-1 to voting to continue with the project. Topics discussed at the end of the workshop included questions on the intended outcome of the study and how information would be shared; the benefits of an integrated approach to addressing bluff erosion; the difficulties of finding a public role for addressing problems that are often on private property, especially when the solutions are expensive and many, but not all, property owners are wealthy; the role of bluffs as barriers to coastal access and the benefits of increasing awareness of bluff issues by increasing access and getting people more engaged in water recreation; the financial benefits of addressing development at the top of the bluff over expensive shore protection at the toe, and issues associated with filling in the flood fringe.

Potential for transferability

There is very high transferability of an element of the Great Lakes Water Levels Integrated Assessment that addresses water level variability and coastal bluff erosion for other coastal bluffs in Wisconsin. Outside the study area, but still within the service area of the Southeastern Wisconsin Regional Planning Commission, a partner on the planning grant, there are cohesive bluffs in parts of Racine and Kenosha Counties. Along the Lake Michigan coast in northeastern Wisconsin, there are cohesive bluffs in northern Sheboygan County, Manitowoc County, Kewaunee County, and part of Door County to the Sturgeon Bay Ship Canal. Along the Lake Superior coast of Wisconsin there are red clay bluffs in all four coastal counties (Douglas, Bayfield, Ashland and Iron).

There is transferability of this project for coastal bluffs in other Great Lakes states and provinces. The transferability is lower than in Wisconsin because the legal structure is somewhat different among states and between Canada and the United States, however the nature of Great Lakes coastal processes are similar. There would still be some transferability of the project for coastal bluffs outside the Great Lakes along ocean coasts with high cohesive bluffs experiencing erosion.

Feasibility of conducting a place-based analysis of a particular set of options that will contribute to the IA

The Great Lakes Water Levels Integrated Assessment comes at an opportune time. Besides the 3.79 foot increase in Lake Michigan water levels from record lows in January 2013 (576.02 feet ILGD85) to the mean level in July 2015 (579.81 feet IGLD85), the Wisconsin legislature weakened shoreland zoning provisions in July 2015. Shoreland zoning is a primary management tool for addressing development along both inland and Great Lakes waters in Wisconsin.

Stakeholder discussion and the positive vote at the workshop that supports continuation with the integrated assessment, combined with post-workshop communication with stakeholders and partners indicates high interest for a place-based analysis on coastal bluff erosion. There is concern among coastal property owners and local officials in the study area related to rapid rise in Lake Michigan water levels. With rising water levels, many coastal beaches have decreased in width and conditions where waves wash against bluff toes have increased. Conflicts on the siting and impacts of shore protection structures could intensify.

The recent changes in authorizing legislation for shoreland zoning significantly affects options for regulating coastal development. This, combined with recent legal actions resulting from impacts of coastal structures, a proactive state coastal hazards work group, ongoing research on coastal processes, and interested partners and stakeholders drives interest in a comprehensive set of policy and management alternatives to improve resilience of coastal bluffs to the possibility of increased variability of Lake Michigan water levels and intensity of storms.

The desired mid-term outcome of the continuing with the integrated assessment would be development of a comprehensive set of policy alternatives to improve resilience of coastal bluffs to the possibility of increased variability of Lake Michigan water levels and intensity of storms. The desired long-term outcome would be a measurable increase in the resilience of bluffs to coastal hazards.

LITERATURE CITED

Bay-Lake Regional Planning Commission, Chapman, J., Edil, T., & D. Mickelson. 1997. Lake Michigan shoreline recession and bluff stability in northeastern Wisconsin: 1996: Bay-Lake Regional Planning Commission Technical Report 51.

Keillor, P. 1998, Coastal Processes Manual. 2nd Edition. University of Wisconsin Sea Grant Institute. WISCU-H-98-001.

Mickelson, D., Acomb, L., Brouwer, N., Edil, T., Fricke, C., Haas, B., Hadley, D., Hess, C., Klauk, R., Lasca, N. and A. Schneider., 1977, Shoreline erosion and bluff stability along Lake Michigan and Lake Superior shorelines of Wisconsin: Shore Erosion Technical Study Technical Report, Coastal Management Program, State Planning Office, 199 p. plus appendices.

Southeastern Wisconsin Regional Planning Commission. 1997. Lake Michigan Shoreline Recession and Bluff Stability in Southeastern Wisconsin: 1995. Waukesha, WI: Southeastern Wisconsin Regional Planning Commission.

Springman, R., and S. Born. 1979. Wisconsin's Shore Erosion Plan: An Appraisal of Options and Strategies. Madison, WI: Wisconsin Geological and Natural History Survey.
Yanggen, D. 1981. Regulations to Reduce Coastal Erosion Losses. Madison, WI: University of Wisconsin-Extension.

APPENDICES

List of events and participants

Stakeholder Workshop, Schlitz Audubon Nature Center, Fox Point, WI, 7/27/15 (~30 attendees)

- Ericka Lang, Planning and Zoning Administrator, Village of Shorewood
- John Edlebeck, Director of Public Works, Village of Whitefish Bay
- Rebecca VanRegenmorter, Director of Community and Utility Services, Village of Bayside
- Kristen Lundeen, Director of Public Works, City of Mequon
- Kim Tollefson, Director of Community Development, City of Mequon
- Jac Zader, Assistant Director of Community Development, City of Mequon
- Pam Adams, City Council, District 8, City of Mequon
- Mark Gierl, City Council, District 5, City of Mequon
- Stephen Vance Strother, Property Owner, City of Mequon
- Marjie Tomter, Open Space Commission, Town of Grafton
- Randy Tetzlaff, Director of Planning and Development, City of Port Washington
- Andy Holschbach, Director, Ozaukee County Land & Water Management
- Mike Hahn, Deputy Director, Southeastern Wisconsin Regional Planning Commission
- Kate Angel, Federal Consistency & Coastal Hazards Coordinator, Wisconsin Coastal Management Program
- Kay Lutze, Shoreland Zoning Policy Coordinator, Wisconsin Department of Natural Resources
- Katie Sommers, Mitigation Section Supervisor, Wisconsin Emergency Management
- Alan Lulloff, Science Services Program Director, Association of State Floodplain Managers
- Jane Harrison, Social Science Outreach Specialist, Wisconsin Sea Grant
- David Hart, Assistant Director for Extension, Wisconsin Sea Grant
- Jenny Kehl, Assistant Professor and Director, Center for Water Policy, School of Freshwater Sciences, UW-Milwaukee
- Adam Mednick, Beach Health Fellow, Wisconsin Sea Grant
- Chin Wu, Professor, Department of Civil and Environmental Engineering, UW-Madison
- John Janssen, Professor, School of Freshwater Sciences, UW-Milwaukee
- Gene Clark, Coastal Engineering Specialist, Wisconsin Sea Grant
- Phil Rynish, Student, Department of Urban and Regional Planning, UW-Madison
- Katie Rademacher, Student, School of Freshwater Sciences, UW-Milwaukee

Key resources

- Stakeholder interview responses
- Mendeley Bibliography (https://www.mendeley.com/groups/4020161/integrated-assessment-library-water-levels-and-coastal-bluffs/papers/)
- Great Lakes Coastal Resilience Planning Guide – Ozaukee bluffs case study (http://greatlakesresilience.org/case-studies/land-use-zoning/communicating-long-term-bluff-erosion-prevent-unsustainable-development)

Publications

Hart, David. 2015. *Finding and Organizing Existing Research, Data and Decision Tools Related to Water Level Variability and Coastal Bluffs in Northern Milwaukee County and Southern Ozaukee County, Wisconsin*. Project White Paper.

Presentations

- Overview of the Great Lakes Water Levels Integrated Assessment and the Wisconsin Planning Grant, David Hart and Gene Clark, Wisconsin Sea Grant (slides)
- Results of Stakeholder Survey, Jane Harrison, Wisconsin Sea Grant (slides)
- Pending Changes to Shoreland Zoning in Wisconsin, Kay Lutze, Wisconsin DNR
- Finding and Organizing Existing Research, Data and Decision Tools about Water Levels and Bluff Erosion, David Hart, Wisconsin Sea Grant (slides)
- Southeastern Wisconsin Regional Planning Commission resources, Mike Hahn, SEWRPC
- Wisconsin Emergency Management resources, Katie Sommers, WEM (slides)
- Wisconsin Coastal Management Program resources, Kate Angel, WCMP (slides)

Timeline of project activities

- Investigators conducted interviews of project stakeholders and partners to explore the impacts of variable water levels on coastal bluffs (May-July 2015).
- Investigators prepared summary of existing relevant research, data and decision tools (May-July 2015).
- Workshop to provide information about Great Lakes Water Levels Integrated Assessment and decide whether Wisconsin should continue participation (July 27, 2015)

Students involved

- Katie Rademacher, School of Freshwater Sciences, University of Wisconsin-Milwaukee
- Phil Rynish, Department of Urban and Regional Planning, University of Wisconsin-Madison

Planning for an Integrated Assessment on Water Level Variability and Coastal Bluffs in Northern Milwaukee County and Southern Ozaukee County, Wisconsin

Date: July 27, 2015
Location: Schlitz Audubon Nature Center Conference Room, 1111 E. Brown Deer Road, Fox Point, WI

10:00 am
Welcome and Introductions

- Overview of the Great Lakes Water Levels Integrated Assessment and the Wisconsin Planning Grant, *David Hart and Gene Clark, Wisconsin Sea Grant*
- Background on Lake Michigan Water Levels

10:30 am
Results of Stakeholder Survey, *Jane Harrison, Wisconsin Sea Grant*

11:00 am
Walking Tour of the Schlitz Audubon Nature Center Lakefront, *with insights on coastal processes by Gene Clark, Coastal Engineering Outreach Specialist, Wisconsin Sea Grant and project investigators/partners*

Noon
Lunch – Catered by Larry's Market

12:30 pm
Resources for Addressing Variable Lake Michigan Water Levels and Eroding Coastal Bluffs
Lightning Talks by Investigators and Partners (time limit for talks: 10 minutes each)

- Pending Changes to Shoreland Zoning in Wisconsin, *Kay Lutze, Wisconsin DNR*
- Finding and Organizing Existing Research, Data and Decision Tools about Water Levels and Bluff Erosion, *David Hart, Wisconsin Sea Grant*
- Southeastern Wisconsin Regional Planning Commission resources, *Mike Hahn, SEWRPC*
- Wisconsin Emergency Management resources, *Katie Sommers, WEM*
- Wisconsin Coastal Management Program resources, *Kate Angel, WCMP*
- Other topics?

2:00 pm
Discussion – Should Wisconsin continue participation in the Great Lakes Water Levels Integrated Assessment?

3:00 pm
Adjourn

Finding and Organizing Existing Research, Data and Decision Tools Related to Water Level Variability and Coastal Bluffs in Northern Milwaukee County and Southern Ozaukee County, Wisconsin

David Hart
University of Wisconsin Sea Grant Institute
DRAFT
June 26, 2015

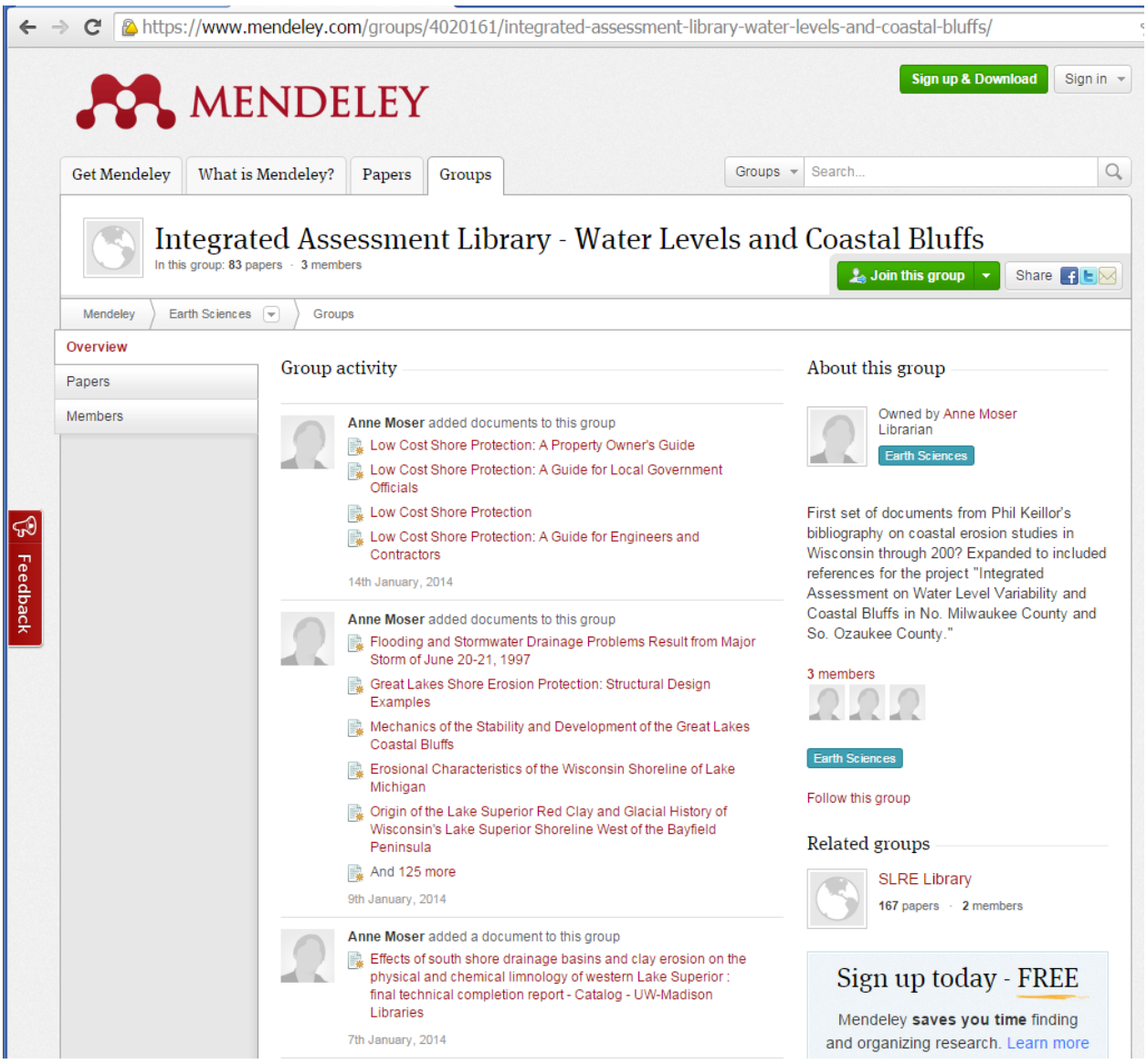
A team of Wisconsin researchers are participating in an integrated assessment on Great Lakes water levels led by the Graham Sustainability Institute at the University of Michigan. A planning grant conducted during Summer 2015 addresses the impact of changing water levels on an area of high coastal bluffs covering approximately 26 miles of the Lake Michigan coast of Wisconsin from the City of Port Washington in Ozaukee County on the north to the Village of Shorewood in Milwaukee County on the south and features a holistic perspective of coastal processes reaching from offshore to beyond the top of the bluffs. The ten investigators from Wisconsin Sea Grant, the University of Wisconsin-Madison, the University of Wisconsin-Milwaukee and Concordia University represent disciplines covering coastal engineering, geology, urban and regional planning, law, policy studies, ecology, landscape architecture, sociology, economics and geographic information science. One of the primary activities of the planning grant is inventory and organization of existing data and information sources relevant to the integrated assessment. This report examines science bibliographies and open data archives as sources of information about coastal processes and Great Lakes water levels for the study area. It also describes approaches to organize and provide access to these resources.

Science Bibliographies

This section leverages bibliographic tools to discover, consolidate and make accessible scientific research about Great Lakes water levels and coastal processes relevant to the study area. It builds on a bibliography on Great Lakes coastal processes in Wisconsin created by former Wisconsin Sea Grant coastal engineer Phil Keillor. The resources featured include a bibliography developed using the Mendeley software, searches in Google Scholar and an on-line library maintained for the Great Lakes Coastal Resilience Planning Guide by the Association of State Floodplain Managers.

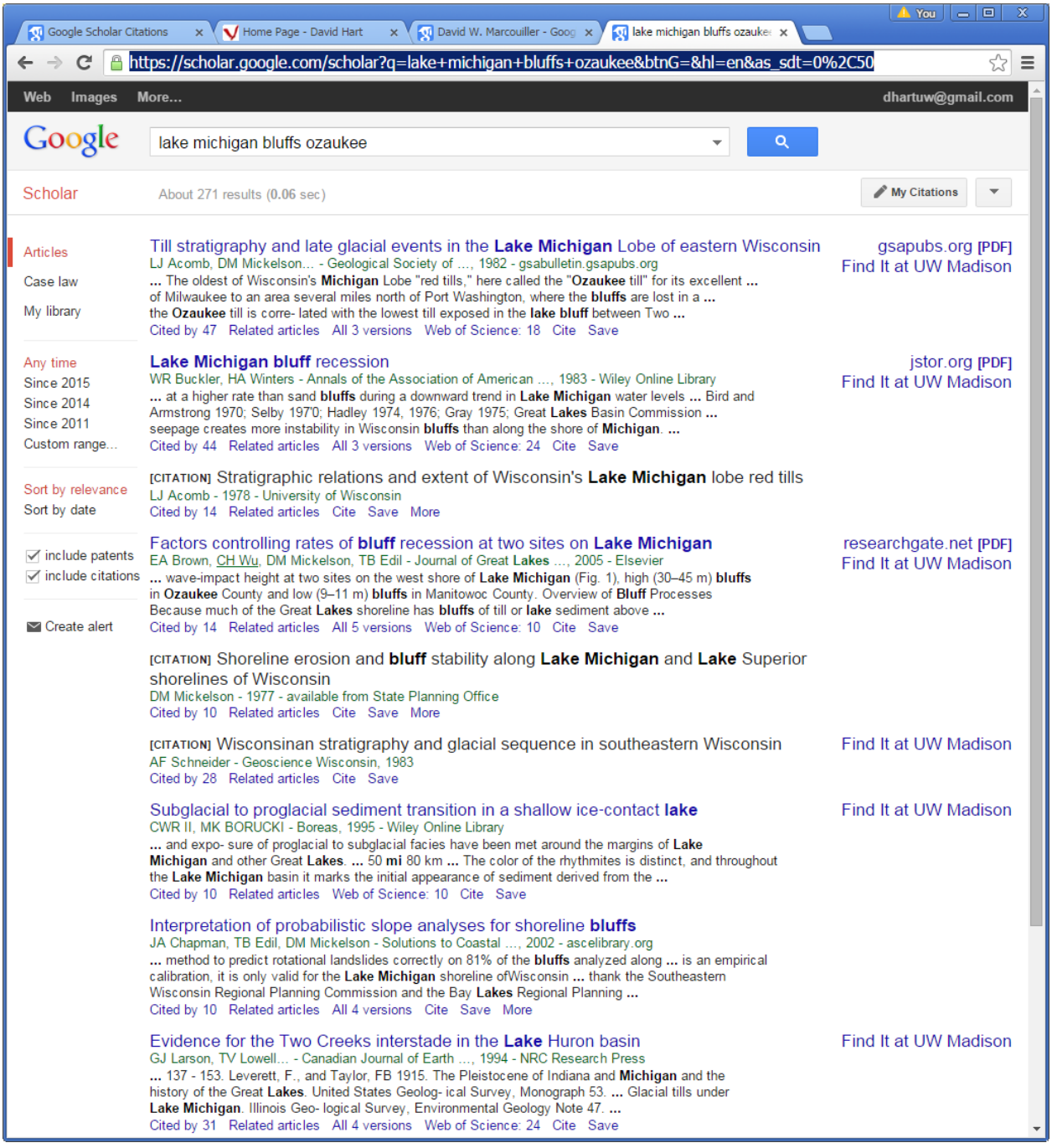
Science Bibliography – Water Levels and Coastal Bluffs - Mendeley
https://www.mendeley.com/groups/4020161/integrated-assessment-library-water-levels-and-coastal-bluffs/

A bibliography of scientific studies on coastal bluffs and water levels along the Lake Michigan coast in Wisconsin was created using the Mendeley reference manager and academic social network (http://www.mendeley.com/) in January 2014. The "Integrated Assessment Library – Water Levels and Coastal Bluffs" group contains 83 bibliographic entries as of June 2015.



Scientific Bibliography - Google Scholar

A Google Scholar search for “Lake Michigan bluffs Ozaukee” yields 271 results. A corresponding search for “Lake Michigan bluffs Milwaukee” yields 7,380 results.

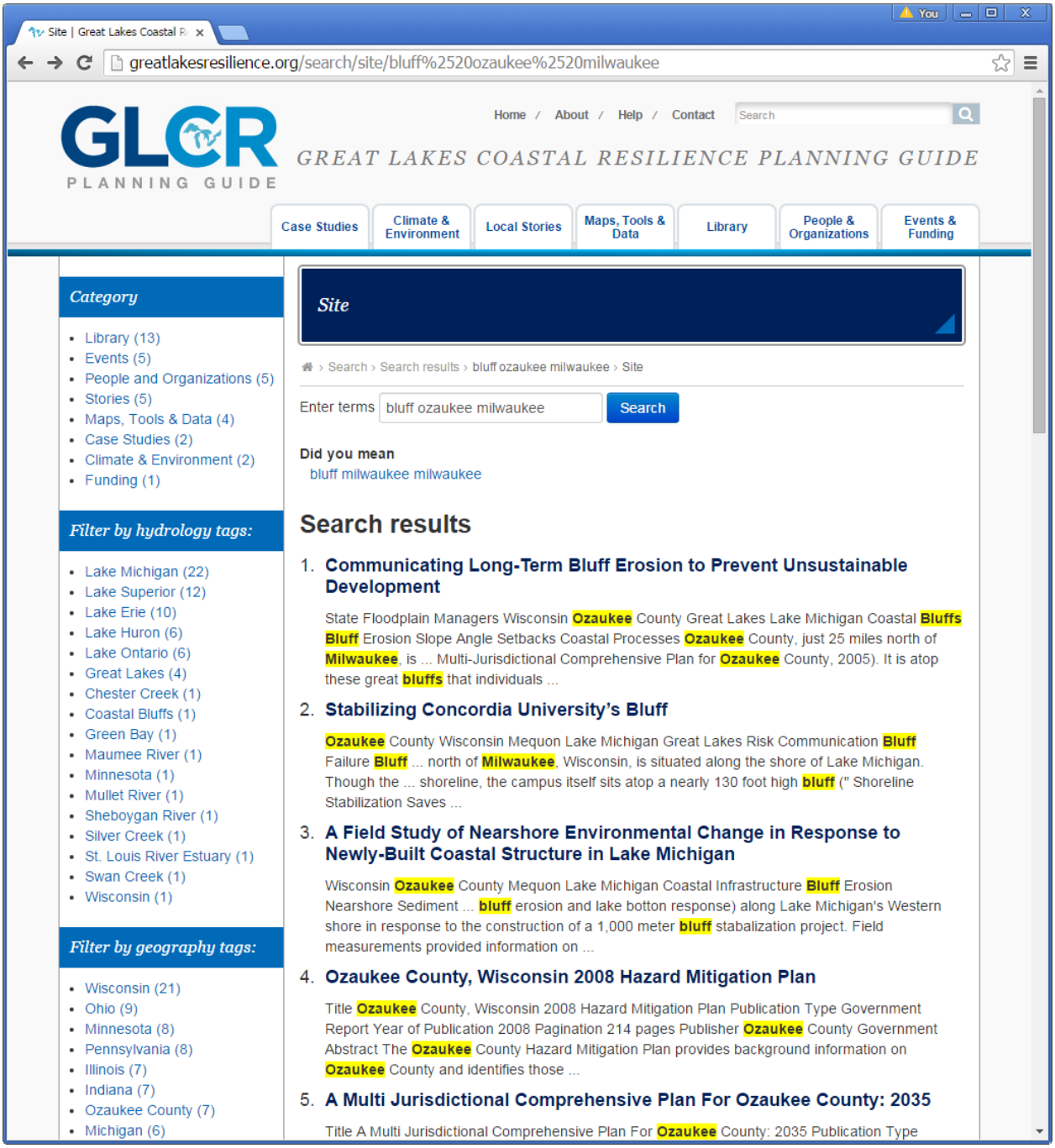


There are Google Scholar pages for three of the project investigators:

- Chin H. Wu (https://scholar.google.com/citations?user=D-2LdXEAAAAJ&hl=en)
- James A. LaGro, Jr. (https://scholar.google.com/citations?user=8GlQHMMAAAAJ&hl=en)
- David A. Hart (https://scholar.google.com/citations?user=f5uIPnYAAAAJ&hl=en)

Great Lakes Coastal Resilience Planning Guide - Library
http://greatlakesresilience.org/

The Great Lakes Coastal Resilience Planning Guide provides case studies to explore how local planners and practitioners are using data, tools, methods, and policies to help make their communities more resilient. The library tab allows a search for reports, best practices, ordinances, plans, case studies, legal guides and general references. A search on "bluffs Ozaukee Milwaukee" returns 37 results.

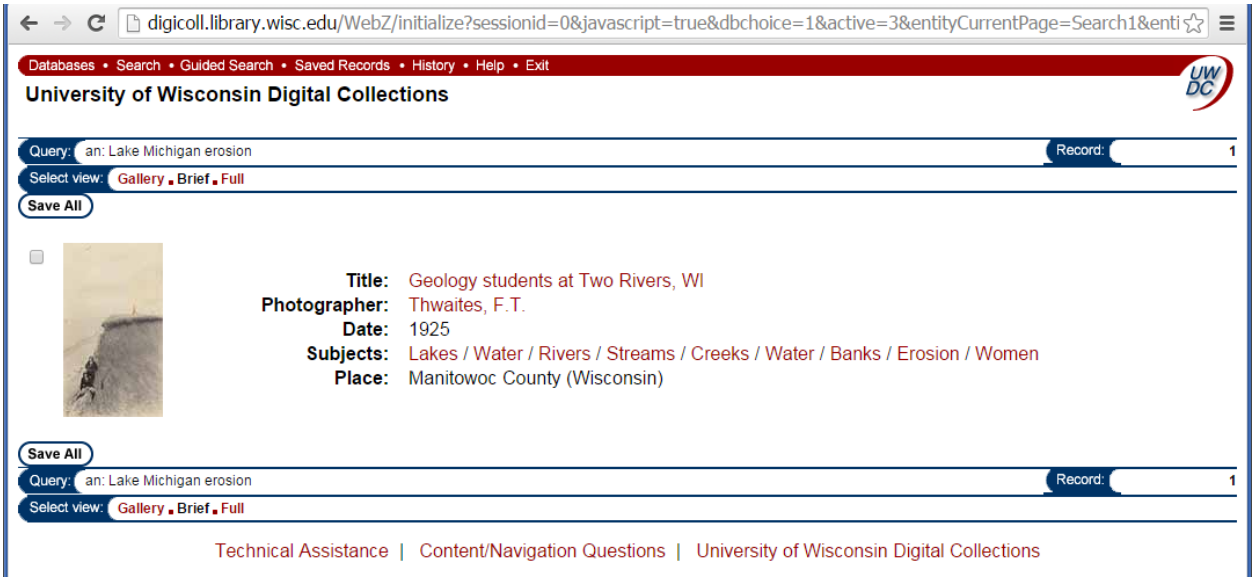


Science Data Archives

Digital archives accessible at the University of Wisconsin-Madison were reviewed as a means to provide distributed access to the publications, data and maps relevant to bluff erosion and Lake Michigan water levels. These include UW Digital Collections (http://uwdc.library.wisc.edu/), Minds@UW (http://minds.wisconsin.edu) and the Hathi Trust (http://www.hathitrust.org/). The Hathi Trust is a digital repository being developed to support many of the large research libraries in the nation. Several searches were conducted in June 2015 to discover materials relevant to Lake Michigan erosion.

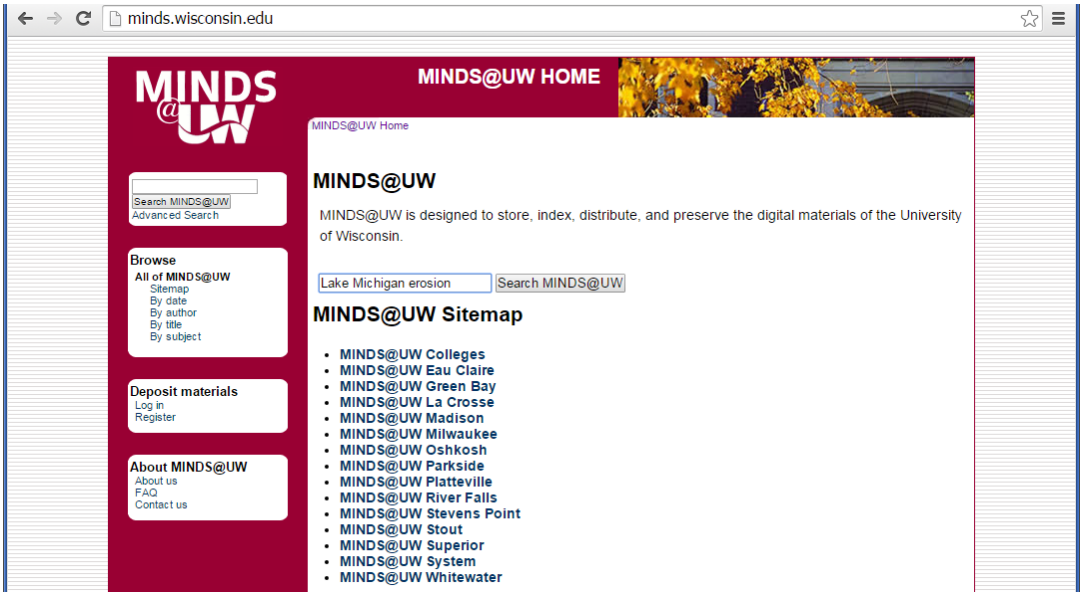
Science Data Archive - UW Digital Collections

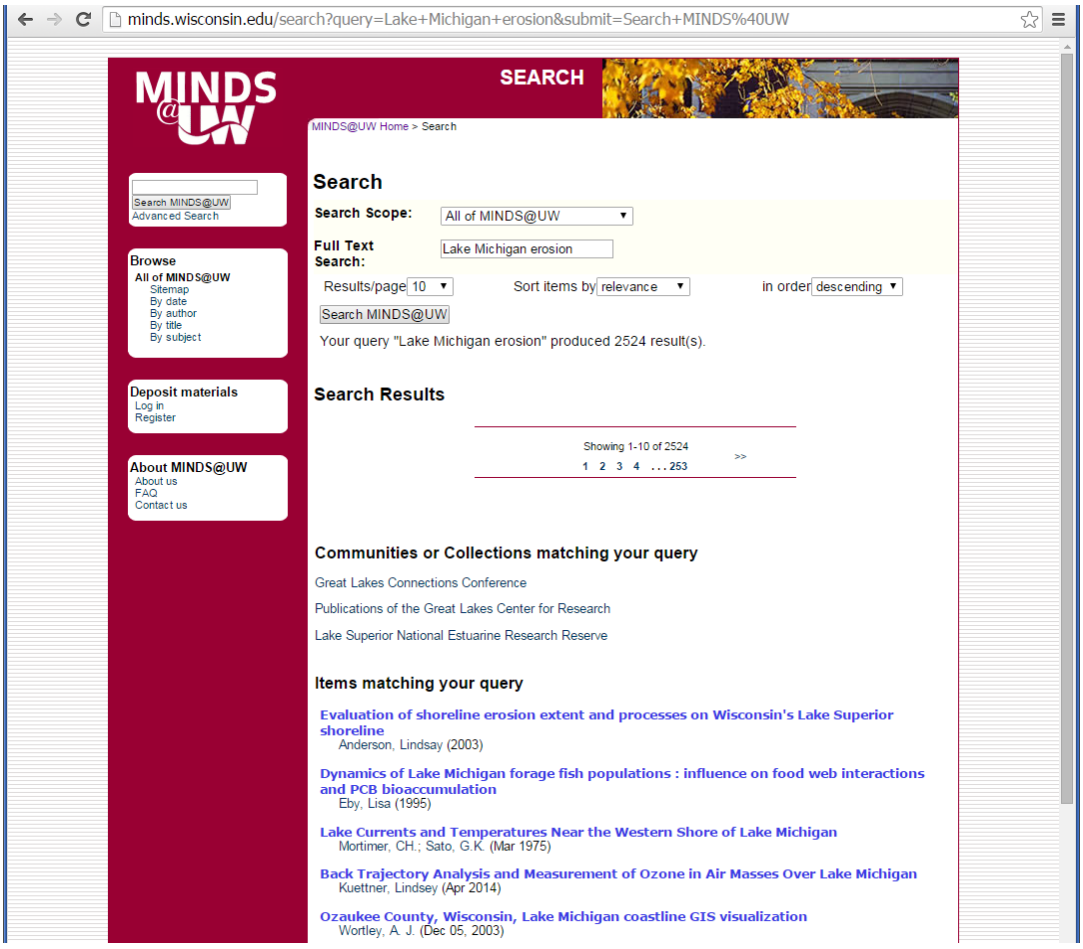
A search for "Lake Michigan erosion" through UW Digital Collections (http://uwdc.library.wisc.edu/) yielded 1 entry.



Science Data Archive - Minds@UW

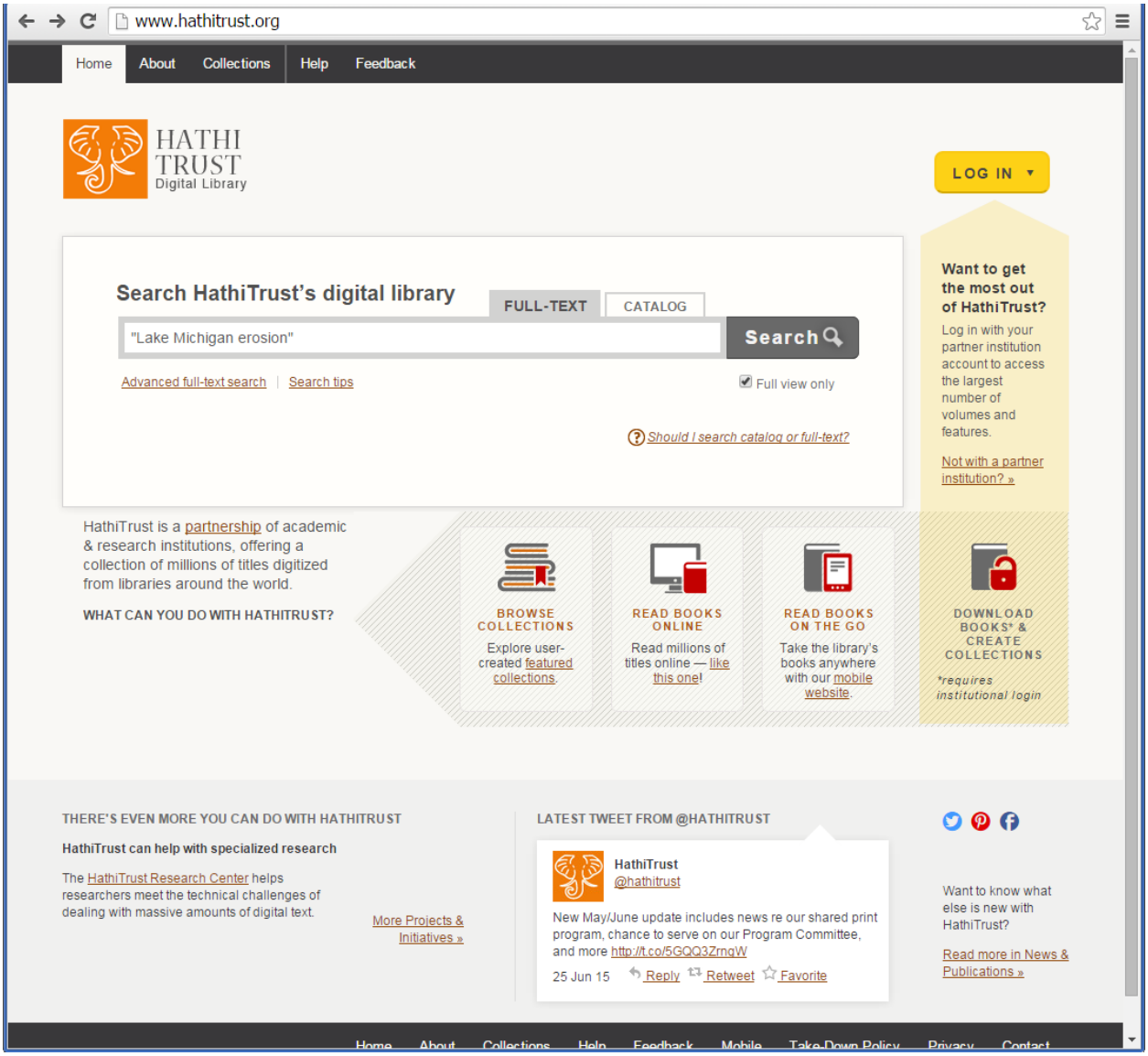
A search for "Lake Michigan erosion" through Minds@UW (http://minds.wisconsin.edu) yielded 2,524 entries.

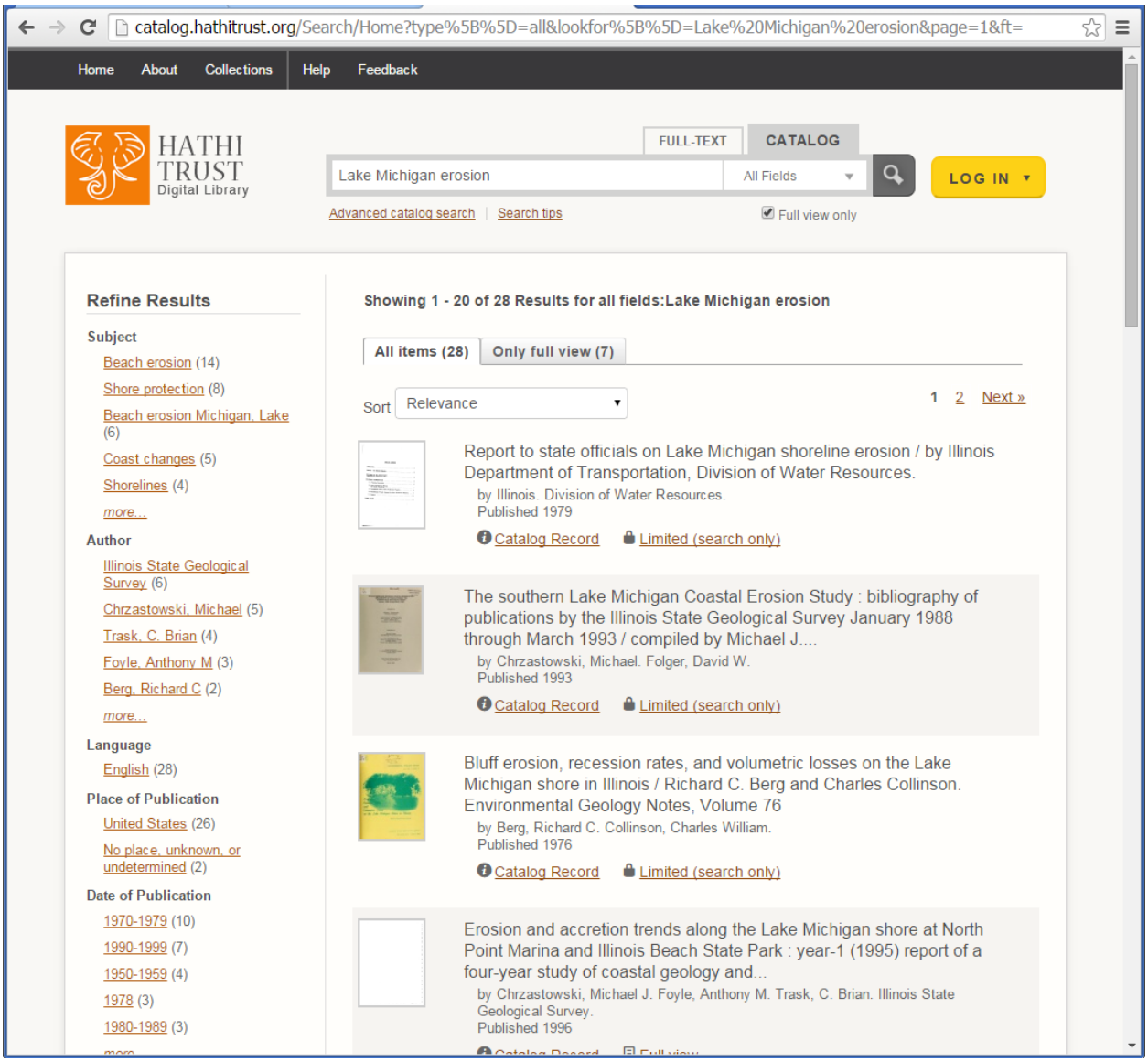




Science Data Archive - Hahti Trust

A catalog search for "Lake Michigan erosion" using Hathi Trust (http://www.hathitrust.org/) yielded 28 entries and a full-text search for "Lake Michigan erosion" using Hathi Trust yielded 167 entries.




catalog.hathitrust.org/Search/Home?type%5B%5D=all&lookfor%5B%5D=Lake%20Michigan%20erosion&page=1&ft=
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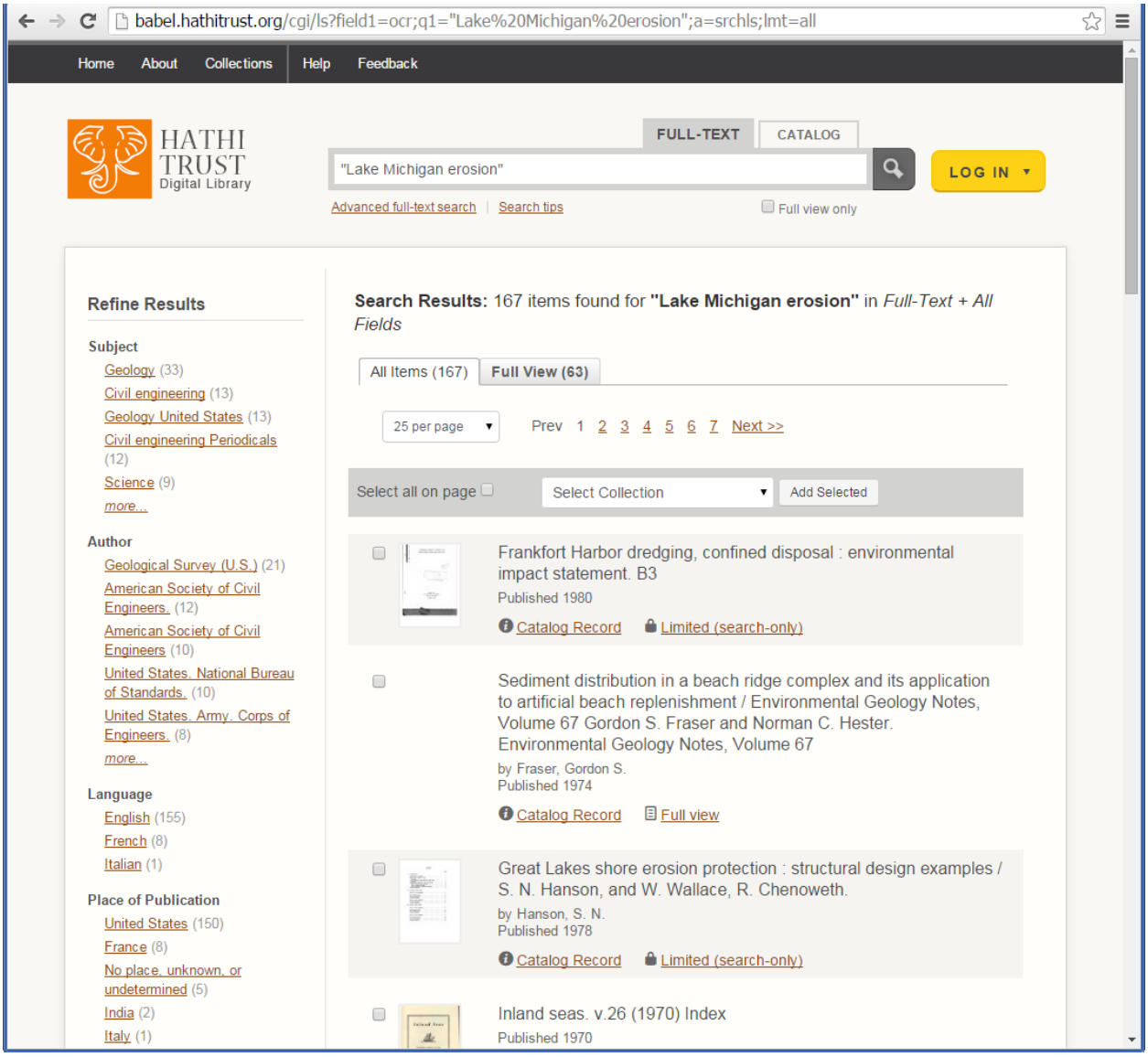
Refine Results
Subject
Beach erosion (14)
Shore protection (8)
Beach erosion Michigan, Lake (6)
Coast changes (5)
Shorelines (4)
more...
Author
Illinois State Geological Survey (6)
Chrzastowski, Michael (5)
Trask, C. Brian (4)
Foyle, Anthony M (3)
Berg, Richard C (2)
more...
Language
English (28)
Place of Publication
United States (26)
No place, unknown, or undetermined (2)
Date of Publication
1970-1979 (10)
1990-1999 (7)
1950-1959 (4)
1978 (3)
1980-1989 (3)
Showing 1 - 20 of 28 Results for all fields:Lake Michigan erosion
All items (28)
Only full view (7)
Sort Relevance
1 2 Next »
Report to state officials on Lake Michigan shoreline erosion / by Illinois Department of Transportation, Division of Water Resources.
by Illinois. Division of Water Resources.
Published 1979
Catalog Record
Limited (search only)
The southern Lake Michigan Coastal Erosion Study : bibliography of publications by the Illinois State Geological Survey January 1988 through March 1993 / compiled by Michael J....
by Chrzastowski, Michael. Folger, David W.
Published 1993
Catalog Record
Limited (search only)
Bluff erosion, recession rates, and volumetric losses on the Lake Michigan shore in Illinois / Richard C. Berg and Charles Collinson.
Environmental Geology Notes, Volume 76
by Berg, Richard C. Collinson, Charles William.
Published 1976
Catalog Record
Limited (search only)
Erosion and accretion trends along the Lake Michigan shore at North Point Marina and Illinois Beach State Park : year-1 (1995) report of a four-year study of coastal geology and...
by Chrzastowski, Michael J. Foyle, Anthony M. Trask, C. Brian. Illinois State Geological Survey.
Published 1996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Civil engineering (13)
Geology United States (13)
Civil engineering Periodicals (12)
Science (9)
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Author
Geological Survey (U.S.) (21)
American Society of Civil Engineers. (12)
American Society of Civil Engineers (10)
United States. National Bureau of Standards. (10)
United States. Army. Corps of Engineers. (8)
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Language
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French (8)
Italian (1)
Place of Publication
United States (150)
France (8)
No place, unknown, or undetermined (5)
India (2)
Italy (1)
Search Results: 167 items found for "Lake Michigan erosion" in Full-Text + All Fields
All Items (167)
Full View (63)
25 per page
Prev 1 2 3 4 5 6 7 Next >>
Select all on page
Select Collection
Add Selected
Frankfort Harbor dredging, confined disposal : environmental impact statement. B3
Published 1980
Catalog Record
Limited (search-only)
Sediment distribution in a beach ridge complex and its application to artificial beach replenishment / Environmental Geology Notes, Volume 67 Gordon S. Fraser and Norman C. Hester. Environmental Geology Notes, Volume 67
by Fraser, Gordon S.
Published 1974
Catalog Record
Full view
Great Lakes shore erosion protection : structural design examples / S. N. Hanson, and W. Wallace, R. Chenoweth.
by Hanson, S. N.
Published 1978
Catalog Record
Limited (search-only)
Inland seas. v.26 (1970) Index
Published 1970

Geospatial Data Archives

The University of Wisconsin Sea Grant Institute maintains geocatalogs that promote discovery and access to geospatial data. It utilizes GeoNetwork software (http://geonetwork-opensource.org/), where data custodians can author interoperable catalog services that adhere to standards adopted by the Open Geospatial Consortium (http://www.opengeospatial.org/). UW Sea Grant's geocatalog (http://maps.aqua.wisc.edu/geonetwork) is a component of the Wisconsin Coastal Atlas (http://wicoastalatlas.net/) and includes 57 datasets as of June 26, 2015, 8 of which are specific to the coastal processes in the study area. Additional geospatial data sets that are relevant for the integrated assessment can be accessed through the catalog section of the Wisconsin Coastal Atlas (http://wicoastalatlas.net/Default.aspx?tabid=63) and the federal government portal at (http://data.gov).

GeoNetwork - Wisconsin Coastal Atlas, University of Wisconsin Sea Grant
http://maps.aqua.wisc.edu/geonetwork/

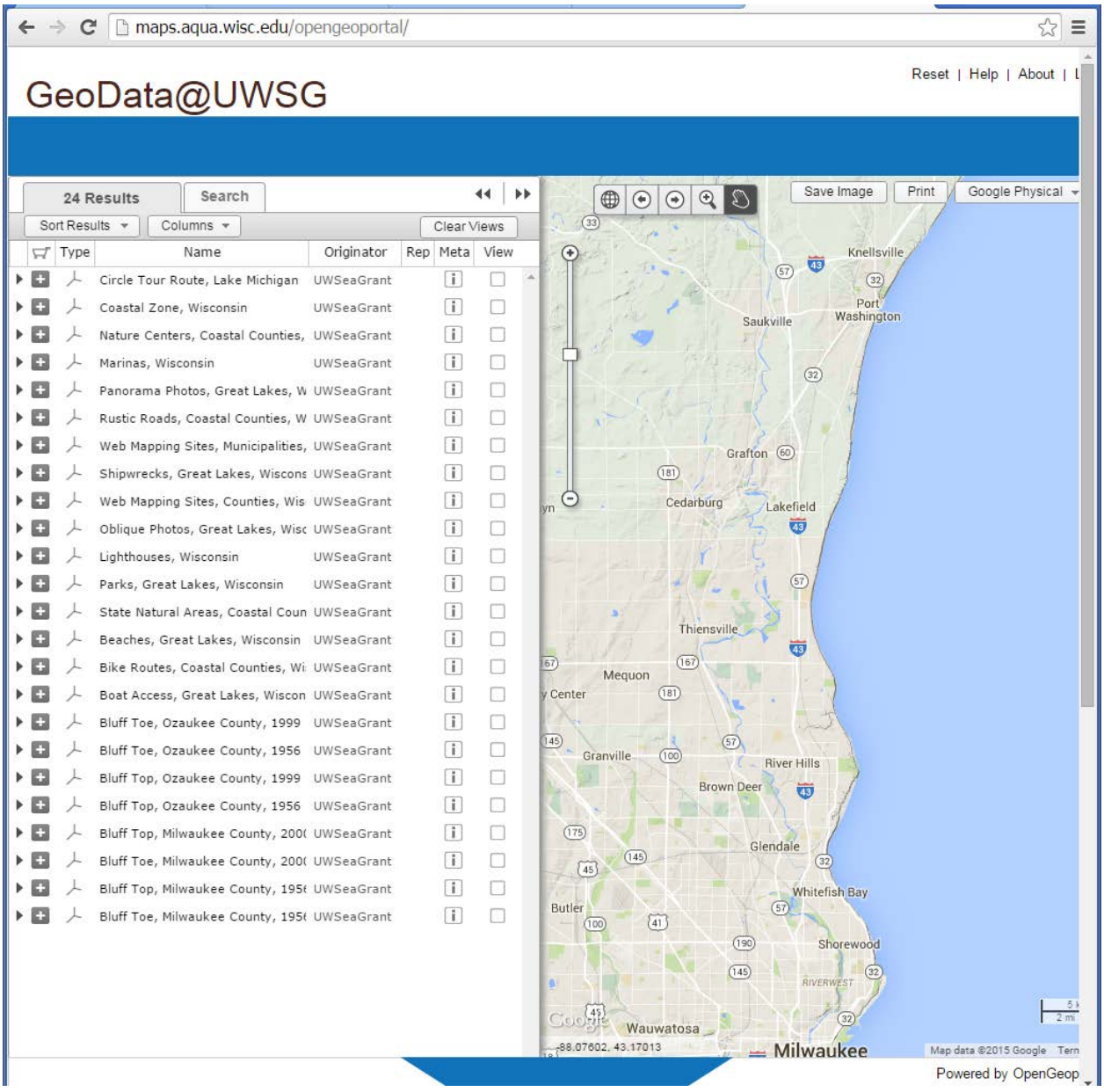
GetCapabilities Request
http://maps.aqua.wisc.edu/geonetwork/srv/en/csw?request=GetCapabilities&service=CSW&Version=2.0.2

DescribeRecord Request
http://maps.aqua.wisc.edu/geonetwork/srv/en/csw?request=DescribeRecord&service=CSW&version=2.0.2

GetRecords Request (searched for records containing “bluff” returned 28 records)
http://maps.aqua.wisc.edu/geonetwork/srv/en/csw?request=GetRecords&service=CSW&version=2.0.2&namespace=xmlns(csw=http://www.opengis.net/cat/csw)&resultType=results&outputSchema=http://www.opengis.net/cat/csw/2.0.2&outputFormat=application/xml&maxRecords=10&typeNames=csw:Record&elementSetName=summary&constraintLanguage=CQL_TEXT&constraint_language_version=1.1.0&constraint=AnyText+LIKE+%27%25bluff%25%27

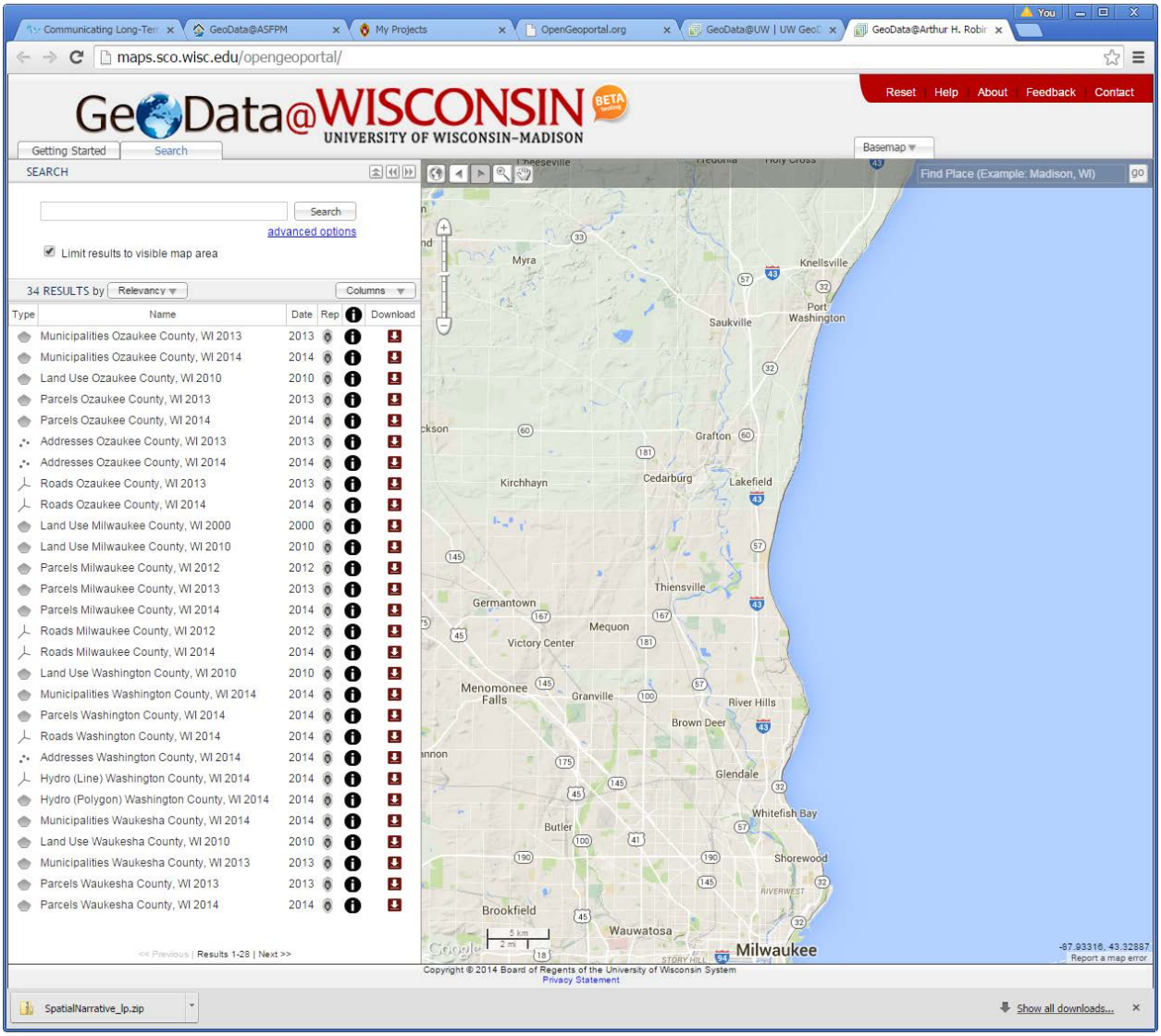
Open GeoPortal – Wisconsin Sea Grant
http://maps.aqua.wisc.edu/opengeoportal/

OpenGeoPortal (http://opengeoportal.org/) is a “collaboratively developed, open source, federated web application to rapidly discover, preview, and retrieve geospatial data from multiple repositories.” The OGP instance at Wisconsin Sea Grant leverages metadata in the WISG GeoNetwork and provides a map interface to make searches easier. A search on the study area yields 24 results.



GeoData @ UW-Madison
http://maps.sco.wisc.edu/opengeoportal/

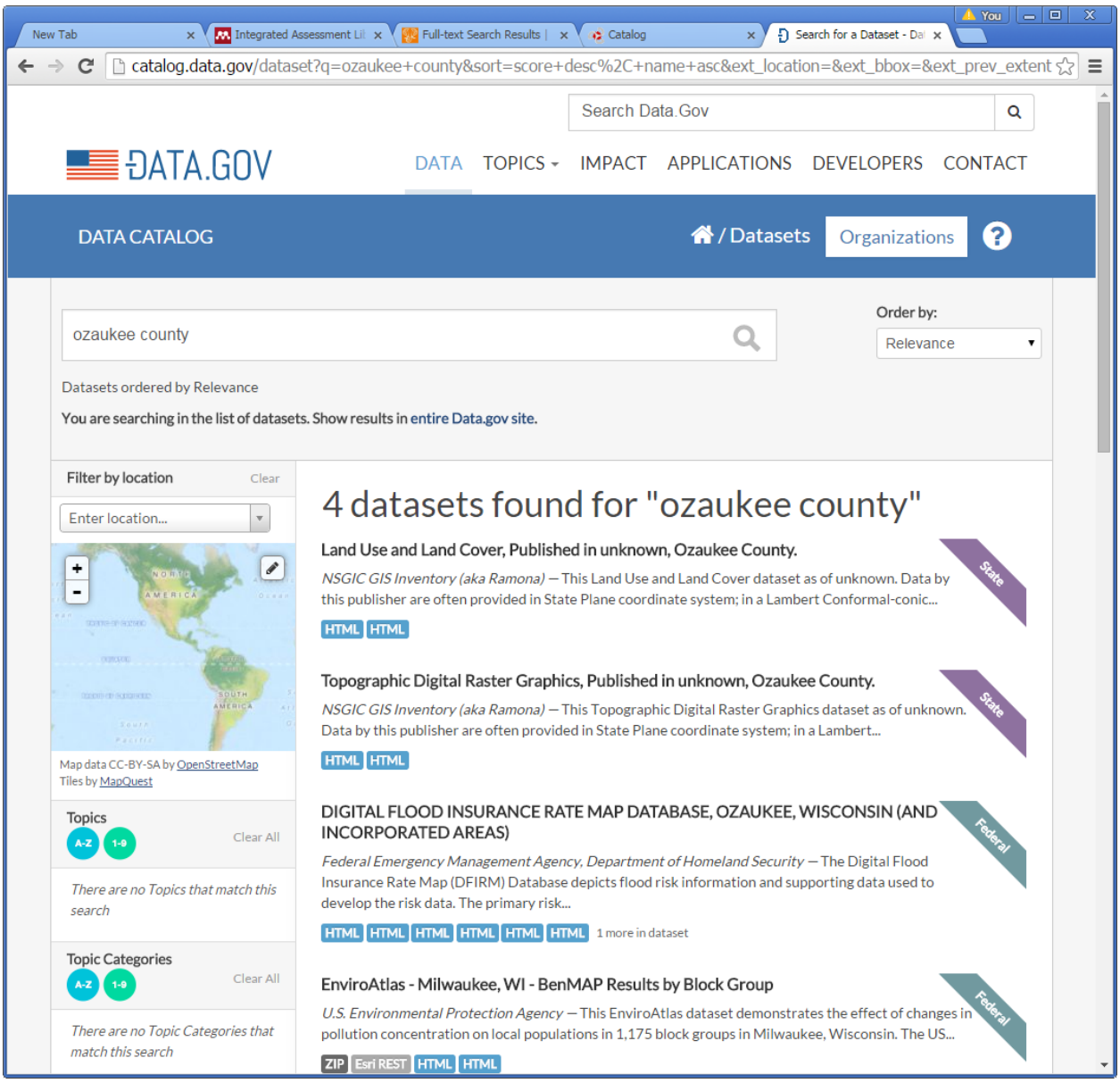
This is an OGP instance maintained by the Wisconsin State Cartographer's Office and the Robinson Map Library at UW-Madison. It allows search, discover, and retrieval of geospatial data from the Robinson Map Library's Data Archive. A search on the study area yields 34 results.



Data.gov
http://data.gov

Data.gov allows searches for a broad range of federal government data resources.

Search on Great Lakes. 691 datasets found.
Search on Lake Michigan. 316 datasets found.
Search on Milwaukee County. 28 datasets found.
Search on Ozaukee County. 4 datasets found.



Pulling the Pieces Together

So far, this report has focused on searching on-line bibliographies and data archives to find resources relevant to the topic and study area of the integrated assessment. This section describes two resources to organize the information so it is easy to access and use. The first is through a case study in the Great Lakes Coastal Resilience Planning Guide (http://greatlakesresilience.org/) and the second is through the Wisconsin Coastal Atlas (http://wicoastalatlas.net/).

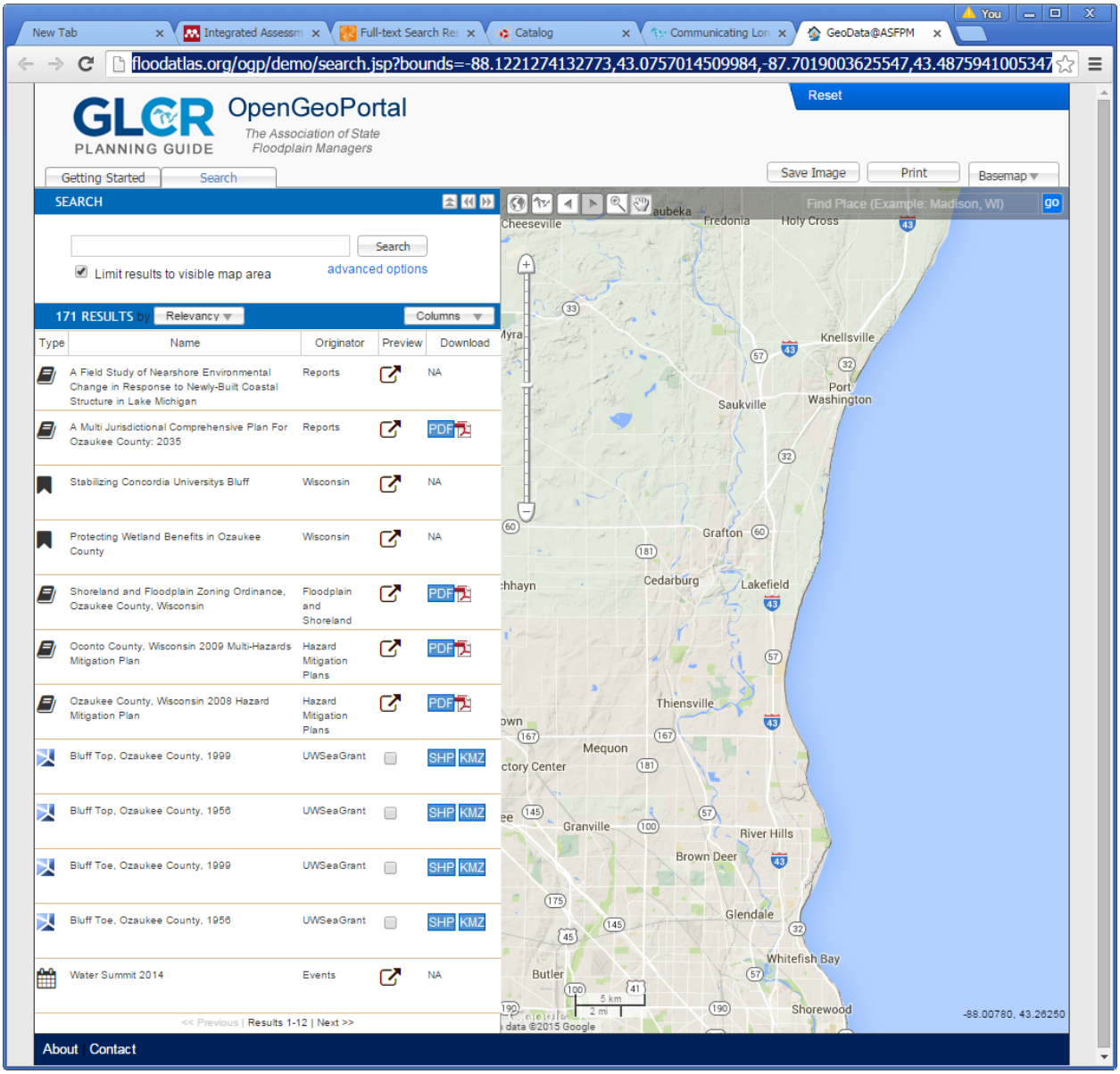
Great Lakes Coastal Resilience Planning Guide – Case Study

Communicating Long-Term Bluff Erosion to Prevent Unsustainable Development – Ozaukee County, Wisconsin

http://greatlakesresilience.org/case-studies/land-use-zoning/communicating-long-term-bluff-erosion-prevent-unsustainable-development

Perhaps the best vehicle for consolidating resources for the Great Lakes Water Levels Integrated Assessment Wisconsin project is through a case study in the Great Lakes Coastal Resilience Planning Guide. The most relevant existing case study focuses on "Communicating Long-Term Bluff Erosion to Prevent Unsustainable Development – Ozaukee County, Wisconsin." Case studies include sections on awareness, understanding, analysis and strategy. Clicking on the search map opens a customized map interface in OpenGeoPortal that consolidates resources based on the bounding box of the study area. Results include relevant items from the ASFPM library, along with geo-referenced contacts, events, funding sources, tools and geospatial data. The Ozaukee case study query yields 171 results as of June 26, 2015.

GLCRPG Open Geo Portal – ASFPM
http://floodatlas.org/ogp/demo/search.jsp?bounds=-88.1221274132773,43.0757014509984,-87.7019003625547,43.4875941005347&keyword[]=&keyword[]=&keyword[]=&keyword[]=
yields 171 results as of June 26, 2015



Wisconsin Coastal Atlas
http://wicoastalatlas.net/

Maps, data, tools and place-based learning approaches can be accessed through the Wisconsin Coastal Atlas. Maps and tools featured in the atlas relevant to the integrated assessment include the Wisconsin Shoreline Inventory and Oblique Photo Viewer, Lake Level Viewer and Visualizing Coastal Erosion on the Great Lakes.