

AN INTEGRATED HABITAT CLASSIFICATION AND MAP OF THE LAKE ERIE BASIN

Binational Map Project Summary

This project, funded by U.S. EPA – Great Lakes National Program Office, will develop an integrated habitat classification and map for the Lake Erie basin. This project will develop tools to assist the Lake Erie Lakewide Management Plan (LaMP) to develop a bi-national inventory of the status and trends in the quantity and quality of fish and wildlife habitats in the Lake Erie basin. The integrated habitat map will be used to track improvements in habitat quantity and quality resulting from preservation, conservation, and restoration efforts and to guard against further loss or degradation from land-use alterations.

Specifically, the project team will: 1) develop and implement a unified, consensus-based classification of five Lake Erie habitat zones from data available in existing habitat mapping projects that are lakewide or Great Lakes basinwide in scale; and 2) develop a geospatial database that integrates classification systems at relevant scales into map layers and eventually into a single, integrated GIS habitat map of the Lake Erie Basin for the United States and Canada. This project addresses the need for a unified, consensus-based habitat classification system and inventory, which is a fundamental prerequisite necessary to manage and conserve critical habitats and maintain ecological integrity within the Lake Erie basin.

The Principal Investigator for the project is Dr. Lucinda Johnson from the Natural Resources Research Institute, University of Minnesota - Duluth. Other members of the binational project team include: Dr. Jan Ciborowski and Dr. Scudder Mackey from the University of Windsor; Mr. Ric Lawson from the Great Lakes Commission; Dr. Nick Mandrak from Fisheries and Oceans Canada; and Mr. Dan Button from the U. S. Geological Survey.

The project team is collaborating with other ongoing habitat assessment projects in the basin, including: a Great Lakes Fishery Commission-supported project through the University of Michigan's Institute for Fisheries Research to develop a comprehensive Lake Erie GIS to provide fisheries resource managers with comprehensive geospatial datasets; and an ongoing U.S. Geological Survey Aquatic GAP project designed to evaluate the biological diversity of aquatic species and their habitats, and to identify gaps in the distribution and protection of these species and their habitats within the Great Lakes basin.

Expert's Workshop Summary

On June 6 – 7, 2005 an Expert's Workshop was held at the Franz Theodore Stone Laboratory on Gibraltar Island to identify existing geospatial datasets within the Lake Erie basin and assess habitat classification schemes currently in use within the basin. Subgroups were established to further identify geospatial datasets and explore classification schemes within five natural and semi-natural habitat zones, including: terrestrial; inland aquatic; coastal wetland; coastal margin; and open water areas of the basin. These subgroups will reconvene in early 2006 to review and reach consensus on an integrated hierarchical habitat classification scheme based on recommendations from each of the habitat zone subgroups. These expert's will form the core of a Habitat Working Group that will continue to provide guidance to the project team during the testing and validation phase of the project where the classification scheme will be tested in two pilot watersheds – the Maumee River watershed in northwestern Ohio and the Grand River watershed in southern Ontario.

June 6 – 7 Binational Workshop Recommendations

Terrestrial Zone

- 1. Use workshop proceedings to support acquisition of high-resolution Quickbird multispectral satellite imagery for critical areas of the Lake Erie Basin. Recommendations to be sent to IJC, U.S. EPA, Environment Canada and other resource management agencies.**

Inland Lakes and Streams

- 1. There is a need to establish a committee or workgroup to integrate U.S. and Canadian stream classification schemes, with a strong focus on the valley segment approach adopted by Ontario, USGS Aquatic GAP Program, and University of Michigan EPA Star grant. This group should also develop a strategy to unify (or standardize collection and processing protocols) for hydrologic, hydrographic, and elevation (DEM) geospatial coverages in the basin.**
- 2. Through the Council of Great Lakes Research Managers, recommend that the IJC (or other appropriate agency) support an integration of approaches and datasets on both sides of the border in support of a unified way to evaluate and classify tributaries in the basin. Specifically, to secure adequate funds to complete the Ohio GAP work and integrate U.S. and Ontario datasets.**

Wetlands Zone

- 1. There is a need to establish a committee or workgroup to integrate U.S. and Canadian wetland classification schemes, especially for riparian and/or inland wetland complexes. This group should also examine the potential application of a rules-based approach that would automate the wetland classification process. The objective would be to formalize a recommendation as a group and then develop a strategy to implement. Fundamental questions to be answered include:**
 - a. How do we integrate (or crosswalk) U.S. and Canadian classification systems?**
 - b. What scales will we operate at?**
 - c. How do we develop a process that is less reliant on expert opinion?**

Nearshore and Coastal Margins

- 1. There is a critical research need for updated substrate data within the nearshore zone. Potential tools include acoustic and remote sensing tools, e.g. side-scan sonar and RoxAnn, and other historical data, e.g. nearshore profiles and sediment sampling data.**
- 2. Given the dynamic nature of the nearshore zone, the existence of discrete habitat classes is unlikely. Moreover, aquatic habitats are three-dimensional, not two-dimensional. Classification scheme will be based on a geospatially based, dynamic, multi-layered aquatic habitat template.**

Open Lake/Offshore Zone

1. **Open-lake classification may be based on seasonal cluster analyses of four data layers - physical characteristics; biological characteristics; water quality/chemical characteristics; and processes/ hydrodynamic characteristics.**
 2. **Additional research and data are needed on seasonal circulation patterns and extent of zones of tributary influence on water mass characteristics in Lake Erie.**
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The composition of the environmental zone subgroups at the workshop were as follows:

Breakout Teams

Environmental Zone	Members	Other Potential Members
Terrestrial	Lawrence Spencer Chris Geddes Martin Neumann Mike Robertson Tom Hollenhorst	<i>Dan Kraus (NCC)</i> <i>Jana Stewart (USGS)</i> <i>Dave Ewert (TNC)</i>
Inland Aquatic	Stephanie Kula David Allan Warren Yerex Minako Kimura Li Wang Peter Richards Ed Bissel Nick Mandrak	<i>Laura Simonson (USGS)</i> <i>Les Stanfield(OMNR)</i> <i>Bob Bailey (Western)</i> <i>Jana Stewart (USGS)</i>
Wetlands	Laura Simonson Jennifer Vincent Ric Lawson Lucinda Johnson	<i>Doug Wilcox (USGS)</i> <i>Pat Chow-Fraser (McMaster)</i> <i>Joel Ingram (CWS)</i> <i>Glen Guntenspergen</i>
Coastal Margin/Nearshore	Chris Castiglione Dan Button Susan Doka Scudder Mackey	<i>Michele DePhilip(TNC)</i> <i>Constance Livchak (ODNR)</i> <i>Hans Biberhofer(EC)</i>
Open Water	Bob Haas Jeff Reutter Ed Rutherford Brian George Jan Ciborowski Jeff Tyson	<i>Hans Biberhofer (EC)</i> <i>Murray Charlton (EC)</i> <i>Steve Lozano (NOAA GLERL)</i>

Matthew Horvat – one-day attendance, terrestrial sub-group

Presentations 1 – LEMN Workshop Summaries - Environmental Zones

Ric Lawson, moderator

(Except where noted, 20 minute presentations and recommendations – 10 min to receive group Comments)

	<u>Topic</u>	<u>Speaker</u>
1330	Terrestrial	Mike Robertson
1400	Inland Lakes and Rivers	Nick Mandrak/Scudder Mackey
1430	Coastal Wetlands	Ric Lawson
1500	Break	
1515	Coastal Margin (Nearshore)	Scudder Mackey
1545	Open Lake	Jeff Tyson

Copies of presentations are available on the Lake Erie Millennium Network website at: <http://www.uwindsor.ca/lemn> (click on the link to previous workshops).

Brief summaries of the presentations and ensuing discussions follow:

Terrestrial Environmental Zone – **Mike Robertson** (forests, woodlots, grasslands, palustrine wetlands, and abandoned agricultural fields)

Land Information Ontario (LIO) created an infrastructure to share geospatial data across the province of Ontario. LIO initiated in 1998 with directive to integrate land information across the province, coordinate mapping efforts, increase and make use of data standards, and improve access to geospatial information to make better decisions, promote economic growth, and enhance international competitiveness. Major Components of the LIO include:

- Ontario Geospatial Data Exchange (OGDE) to share geospatial data. OGDE is made up of more than 150 member organizations as of May 2005. Data access is for public-sector (i.e. non-commercial) entities only with geospatial data distributed through a central data warehouse. Other geospatial data exchanges are being developed, including a Forestry exchange (implemented), Water Power exchange (implemented), Utilities/Infrastructure exchange (planned), and Private Sector exchange (planned). LIO and OGDE is looking to develop binational partnerships and collaboration with other Provinces, States, Academia, and public-sector organizations in the Great Lakes basin.
- Data Administration LIO using stakeholder approach to develop comprehensive data standards. Data management and collection is cooperative, with LIO coordinating data collection, maintenance, planning, access and sharing through partnerships with both public and private sector organizations.
- Fundamental data projects
 - Ontario road network
 - Ontario Parcel (property ownership and location)
 - Municipal boundaries

- Township improvements
- LANDSAT 7 imagery
- Water Resources Information Project (WRIP) Inter-Ministry water resources coordination, including: low water response, nutrient management, drinking water and source water protection planning, and water management. Future research focused on developing surface and groundwater data models to assist with watershed planning and water management in Ontario watersheds. Working to build an integrated suite of information systems and supporting infrastructure to support watershed management. WRIP can also be applied to the Inland Aquatic Environmental Zone. Extensive work being done down to 4th order watersheds whereby water flow direction is defined for every arc based on topography (DEMs) and stream channel network. Surficial geological data are also being incorporated to create fully integrated data management infrastructure focused on the hydrology of the system.
- Southern Ontario Land Resource Information System (SOLRIS) is an ongoing project that is focused primarily on landscape characterization and mapping in Southern Ontario. Phase 1 is using conventional photo-interpretive techniques and interactive editing to identify and delineate land cover and land use coverages across Southern Ontario. Phase 2 involves the assembly of all layers into comprehensive land cover and land use coverages to create comprehensive, integrated maps. These coverages can be used for landscape change detection, terrain mapping and landscape modeling, surface water flow and direction, and identification of significant groundwater recharge areas. SOLRIS mapping and modeling tools can be combined to surface and groundwater vulnerabilities.
- OMNR Partnership – Ontario Land Information Warehouse where geospatial data are stored and can be accessed. Centralized warehouse and access point that includes metadata directory, data warehouse, internet browsing, publishing/subscribing, built-in security, and other services. Provincial resource evaluations and assessments are being done at a 1:10,000 scale across the Province. Moreover, high-resolution multispectral and panchromatic QuickBird commercial imagery (0.6 m to 2.5 m resolution) is being purchased for much of Ontario. Access to this and other sites can be found at: www.lio.mnr.gov.on.ca

Comments:

Watershed management and mapping scales are comparable to 6 to 8 digit HUCs in the U.S. Geospatial datasets are broadly comparable to U.S. datasets. OMNR working closely with regional Conservation Authorities, especially on surface and groundwater quality/quantity issues (interest driven by the Source Water Protection Act). Geospatial coverages and data can be summarized at a range of scales, i.e. local, regional, landscape or Provincial.

Agricultural practices/BMPs and associated educational materials are distributed by Extension Services in the U.S. In Canada, environmental and commodity groups/associations provide equivalent educational services to the Canadian agricultural industry. OMNR and partners are working to develop web-based programs to assist these educational efforts.

Have extensive habitat and wildlife coverages, 1300+ integrated data layers in warehouse, with information on more than 50 individual species, including species-at-risk, etc. However, these datasets are currently underutilized. Also, considerable QAQC needs to be done to validate

interpretation of imagery. For example, QAQC necessary to determine if a wetland is important locally or provincially. A scoring system has been developed to determine if a wetland is provincially or locally significant. Provincially significant wetlands have strict limits on development that are applied throughout the province.

Default resource mapping scale in the Province is 1:10,000, which is similar to default 1:24,000 scale used for USGS topographic sheets. Habitat mapping scales are comparable across the basin. Additional imagery and data are available at considerably higher resolution, for example commercially available Quickbird satellite imagery can provide raster data down to a 20 cm resolution.

LIO has completed land cover classification using 1999 Landsat satellite imagery for most of Southern Ontario. Province is purchasing 2005 multiband Quickbird coverages across most of Southern Ontario, except in and around the Golden Horseshoe where high-resolution orthophotography already exists. LIO is working to develop 2005 land cover classification based on Quickbird data for comparison. LIO is looking for partners to help defray the cost of Quickbird data acquisition.

Suggestion was made to use workshop proceedings as a basis to **develop specific recommendations to IJC and other resource management agencies to support acquisition of Quickbird data** for local or basin-wide assessments.

Terrestrial Sub-Group Breakout Discussion and Summary

Members:

Tom Hollenhorst – NRRI Univ. MN Duluth

Lawrence Spencer –Ohio GAP

Christine Geddes – Univ. MI

Mike Robertson – Land Information Ontario, Ontario Ministry of Natural Resources

Martin Newman – Grand River Conservation Authority

Define boundaries of each habitat zone

We generally agreed that the boundary should include the watershed of Lake Erie plus a significant buffer (20-40 Km). We also asked if there are functional boundaries we should consider. For the shoreline and the near shore area, or the boundary between land and water, streams and wetlands where the boundary might be defined from land cover (raster data) in one data set and lines (vector) in another data set, and might not match perfectly.

We also believe contiguous patches (forest or other land cover types) that extend outside the watershed should also be included. Other significant landscape features such as the Niagra Escarpment and the Oak Ridge Moraine should also be included within the data extents.

Political boundaries and units (counties) that might be needed for area weighting data attributed to those units should be completely included (i.e. complete counties).

Identify appropriate agencies / individuals that should be included in discussion

Canada:

Ontario Ministry of Natural Resources
 Land Information Ontario
 Natural Heritage Information Center
 Forest Resources Inventory
 Lake Erie Management Unit
 South Central Regional Groups
 Ontario Ministry of Agriculture and food
 Ontario Ministry of Municipal Affairs & Housing
 Ontario Ministry of public infrastructure and renewal
 Natural Resources Canada
 Environment Canada
 Agriculture Canada
 Grand River Conservation Authority
 Other watershed conservation authorities in basin
 Stewardship Councils
 Universities
 Univ. of Windsor
 University of Guelph
 McMaster University

United States:

USGS
 State & Regional GAP programs
 Great Lakes Aquatic GAP
 Great Lakes Terrestrial GAP (or Upper Midwest GAP)
 EPA
 Fish & Wildlife Service
 State DNR & Forestry
 Ohio EPA
 Pennsylvania DEQ
 State Natural Heritage Programs
 National Park Service
 National Forest Service
 The Nature Conservancy
 Ducks Unlimited
 Maumee RAP
 NRCS
 State Dept. of Transportation
 Universities
 Case Western Reserve

Other universities
 Local planning authorities
 Municipal
 County

Define data needed to classify each habitat type

Theoretical Needs:

LIDAR data
 Parcel Data
 Ability to drill down to highest resolution available for the area of interest
 Land cover change
 Multi-spectral Orthophotos
 Community level ecological land classification for entire basin (land type associations)
 Updated and Harmonized soils data
 Basin Wide Quick Bird (or priority areas)
 Maps for Riparian zones

Existing Data Sources - Canada:

Land Information Ontario – (Likely has nearly everything we'll need)
 Elevation – 30meter resolution, hydro corrected, Greater Toronto < 1meter res.
 Land use/Land cover – Landsat classified land use, 28 classes, 30 meter res.
 Vector Land cover data from orthophotos 20-30 cm res. (Grand River completed at end of year.
 Forest Resource inventory
 Patchwork of Natural Areas Inventory by county – ecological land classification
 Need to dovetail ELC with US ecoregional mapping.
 Geology – surficial and bedrock
 Climate data

Existing Data Sources – United States:

USGS National Land Cover Data Set – NLCD (and Pete Wolters updated versions)
 Additional NLCD data sets (forest cover, impervious surfaces etc.)
 USGS GAP Data – All available except Ohio which will be done soon (end of June)
 GAP vegetation/land cover (will need to harmonize classes, might be tough).
 Stewardship layers (land ownership)
 Parcel maps – some may be available (i.e. MI DNR)
 Public Land Survey System – next best thing
 TIGER DATA – standard nationwide and regularly updated.

Inland Lakes and Streams Environmental Zone (streams, palustrine wetlands, and inland lakes)

Inland Lakes and Streams - Scudder Mackey, Nick Mandrak

Physical habitats are critical and essential to great lakes ecosystem. Critical habitats are formed by features and conditions that exhibit an organizational pattern that persist and are repeatable through time. Persistence and repeatability are elements that are necessary to maintain a renewable resource. Moreover, native species have adapted to, and co-evolved with, physical conditions and patterns within the basin.

Habitats are defined by a range of physical characteristics and energy conditions that can be delineated geographically and meet the needs of a single species, biological community, or ecological function related to life stage (Mackey 2005). The pattern and distribution of habitats are controlled, in part, by the underlying physical characteristics of the Basin and interactions between energy, water, and the landscape. The intersection of geology (substrate), energy (climate), and hydrology (flow and water mass characteristics) defines ideal physical habitat for a single species, biological community, or ecological function for a given life stage.

Overall boundary will likely be the Lake Erie surface water basin, with individual polygons bound by watershed and subwatersheds. Hydrographic and hydrologic data at 1:100,000 scale (i.e. the blues lines on the 1:100,000 maps) would probably be the coarsest acceptable mapping scale.

There has been a lot of work done to develop to evaluate habitat quality and classification schemes for streams in rivers in the basin. Examples include: IBI (Ohio EPA), work by the USGS NAQWA program in Northwest Ohio and Southeast Michigan, Ongoing work by the USGS Terrestrial and Aquatic Gap Programs, and the MDNR/IFR Stream Valley Segment analyses (Paul Seelbach's work). An objective of this project would be to integrate these classification schemes into on a single approach that best meets the habitat classification needs of the basin.

In Canada, there has been a concerted effort to adopt a modified valley-segment approach. Valley segment classifications are being derived for all stream segments using available GIS data. Ecological units are derived from these data and currently there are 54 types of riverine habitat in Canada. A summary report is available for download. A similar process has been initiated for non-wetland shorelines and inland lakes. Most inland lakes within the Great Lakes basin are not natural (at least in Canada). The current classification is being tested by a student of Don Jackson; but preliminary results are that classification doesn't correlate well with fish distributions. Student is considering alternative classification schemes that may more accurately predict fish distribution in streams and rivers.

Comments:

USGS Aquatic GAP program in Ohio is based on the valley segment approach developed by Paul Seelbach, and includes classification of ecological units by fish, mussels and crayfish. Stream characteristics such as sinuosity and gradient are linked to thickness and characteristics of surficial materials and then are combined to generate a physical habitat type. Resolution of this mapping is coarse – several 100's of meters at best - because this approach was not designed for use by resource managers but rather was designed for use in fish-habitat and recruitment models.

The Great Lakes Aquatic GAP (riverine) was based on the Ohio approach, but considered more data and at different spatial scales, e.g. channels, watersheds, riparian zones, and upstream watersheds. Parameters considered include: connectivity, gradient/slope, soils, permeability, interaction with bedrock, and climate. There is a lot of macro scale GIS data available most of which is free. Each State collects data differently, so data had to be cross-walked across boundaries in order to do analyses and provide results to fish people to predict fish distributions.

There is another project at the University of Michigan funded by a EPA STAR grant focused on inland aquatic habitats for the Great Lakes. This project team is also using the valley segment approach. Dr. Li Wang indicated that most stream segments have been processed (i.e. all of blue lines on maps have been worked on) and they have cleaned up, processed, and integrated many of the GIS datasets in the basin. Moreover, they are working collaboratively and sharing resources with the USGS Aquatic GAP program. Most of the analyses are initiated at a 8 digit HUC code scale, but scale is really dependent on stream segment length (confluence to confluence), as elements are scaled to stream segments. This approach is hierarchical in that homogeneous segments are joined into larger (or longer) segments and then grouped by cluster analysis into different classes.

The valley segment analyses are generally run from watersheds derived from elevation data (DEMs). These data are available both in Canada and the U.S. Mike Robertson through Land Information Ontario has DEM data at 10 m resolution for southern Ontario. DEM data are available for U.S., and EPA STAR grant has processed DEMs for Illinois, Michigan and Wisconsin. Ohio was to have been done separately (USGS Aquatic GAP), but only partially completed as funding ran out. Estimated a year of additional work needed to complete the Ohio portion of the Lake Erie basin. Pennsylvania was included as part of the Ohio work and New York is using a similar approach for their part of the basin. Other States slated for next part of funding cycle, but funding was cut.

Based on presentation, energy is important consideration and for streams, sinuosity is one that streams reduce or expend energy. Most of the aquatic GAP work is at 1:100,000 scale which may be too coarse to incorporate sinuosity in a meaningful way. It may be necessary to map at a 1:24,000 scale in our pilot watersheds (Maumee and Grand Rivers) to get necessary detail.

Other data sets include Les Stanfield's work (OMNR) on streams. This is a much more detailed dataset that may track better with fisheries data. There was also a one-time classification project called ALICE which was done with year 2000 technology that was funded through the Nature Conservancy Canada. However, there were no continuing funds to keep the project going.

One recommendation that could be made through Council of Great Lakes Research Managers to the IJC would be support an integration of approaches and datasets on both sides of the border in support of a unified way to evaluate and classify tributaries in the basin. In particular, acquisition of funds to complete the Ohio work and integrate U.S. and Ontario datasets.

State of Michigan developing a pilot project to an Elevationally Driven National Application (EDNA) where watersheds and hydrography are generated from DEMs. State wanted to be able to click on a location and have software derive contributing watersheds and calculate (or present) local water quality data. Michigan EDNA being developed at 10 m pixel scale but data requirements have overwhelmed the project. Part of problem is that DEMs and EDNA are national, but water quality data are local and communication difficulties have hampered efforts to develop this technology. Thus, Michigan initiated pilot project to test approach locally.

Comparison of results with fisheries data has met with limited success. Approach works better for some species and less well for others. This has been observed on sides of the border. Need to use additional statistical approaches (correlograms) to tease out subtle relationships. Students in both U.S. and Canada are working to compare and test results of the valley segment analyses with fisheries data to evaluate usefulness of approach. Point was made that results may be scale-dependent. For practical reasons, may be best to start initially at a coarse scale, then accommodate finer scales as needs (and available datasets) develop and/or become available.

Subgroup discussion and summary comments:

Inland Lake/Stream Break-out Group

Members:

Nick Mandrak – Fisheries and Oceans, Canada
 David Allan – University of Michigan
 Ed Bissel – USGS
 Minako Kimura – University of Michigan
 Stephanie Kula - USGS
 Pete Richards – Water Quality Laboratory, Heidelberg College
 Li Wang – University of Michigan
 Warren Yerex. – Grand River Conservation Authority

Define boundaries of each habitat zone

- fuzzy boundary with drowned river mouth, nearshore
 - proposed solution: lowest segment classified based on interactions with lake = transitional boundary segment w/ seiche influences (potential gap in habitat categories)
 - Grand River – Dunnville Dam
 - Maumee – Waterville gauging station
- fuzzy boundary with land, e.g. floodplains, riparian, valley
 - proposed solution: line, or channel width predicted from upstream catchment
- fuzzy identification first-order streams, intermittent stream missing on 1:100K

Identify appropriate agencies / individuals that should be included in discussion

- Aquatic GAP project
- STAR project
- TNCC (Nature Conservancy Canada)
- OMNR (Les Stanfield; WRIP)
- TNC (Great Lakes office) (courtesy call mkhoury@tnc.org)
- OhioEPA (Jeff Decshon) or Midwest Biodiversity Institute (Yoder, Rankin)
- Conservation Authorities
- DFO

Define data needed to classify each habitat type

- geomorphology, chemistry, thermal, flow, substrate, biotic (to test classification)
- Mini-workshop
- use GAP/STAR model as straw man
- do data inventory
- identify data gaps

Approach

- List theoretical needs first, then...
- Identify existing classification schemes and data sources (list spatial and classification resolution)
 - there are A LOT of different riverine classifications
 - at basin-wide scale: GAP/STAR, TNCC, OhioEPA
 - identify data sources at mini-workshop
- Identify data gaps
- Identify appropriate methods for achieving standardized data
 - Data comparability (collection and analysis)
 - Metadata
- Identify action items to acquire appropriate data
 - Define needs
 - all at workshop
 - if GAP/STAR model adopted, then Minnesota, Ohio, and Ontario will have additional GIS needs
 - Identify appropriate agencies and funding sources
 - Identify programmatic initiatives that can be used to leverage future funding and activities
 - Identify critical data gaps and constituent groups for action by IJC, e.g.,

Take home “to do” message

- What to do with drains?
 - Clarify the goal of our classification
 - Strengthen justification for 5 categories
-

Coastal Wetland Environmental Zone

Ric Lawson: Classifying and Mapping Great Lakes Coastal Wetlands

Objective of the Coastal Wetlands Consortium was to develop a consensus-based single inventory and classification system for all coastal wetlands within the Great Lakes basin. The approach was to bring together wetlands experts and specialists from across the basin, and have them reach consensus on a common classification scheme that incorporated elements from numerous previous classification schemes. These efforts were coordinated with various Federal and State wetland programs.

The Consortium developed a standard classification scheme based on hydrogeomorphic characteristics (combination of biological and physical information) and a list of hydrologic or physical modifiers that potentially influence the wetland system. Once developed, the consortium applied the classification protocol to delineate Great Lakes coastal wetland areas. Moreover, the Consortium is developing a long-term program to monitor these coastal wetlands. A limitation of this protocol is that it is focused on coastal wetlands, i.e. wetlands that have a direct hydrological connection to a Great Lake. A summary of the wetlands classification will be published in the Nearshore and Coastal Habitat Special Issue of the Journal of Great Lakes Research (in press).

The fundamental definitions of the hydrogeomorphic classification are as follows:

1. **Lacustrine** - controlled directly by waters of a Great Lake
2. **Riverine** – controlled or influenced by streams or rivers
3. **Barrier protected** - separated from lakes by a barrier (typically sand) with periodic breaches.

Each of these basic types are modified by descriptors of exposure, hydrologic connection, and/or geomorphic feature that directly influences the wetland (10 major classes total).

Open Lacustrine

- open shoreline (directly exposed to wave action)
- open embayment (within a large bay)

Protected Lacustrine

- protected embayment
- sand spit embayment

Riverine

- Drowned river mouth
 - open but strongly influenced by river flow
 - protected by a sand spit blocking direct lake influence
- Deltaic (e.g. St. Clair delta)
- Connecting Channel

Barrier

Lagoons (behind some larger barrier, but periodic lake connections)
 Sand-spit swales
 Ridge and swales
 Tombolo [only found on Great Lakes Islands; protected e.g. by island mass]

Hydrologic Modifiers

Examples include: Dikes, Dams, Roads, Dredging, Shoreline modifications (shore protection, navigation structures), Waste/sewage, Ditches/canals, Marinas, Fill areas.

The wetlands inventory was developed using existing data from U.S. and Canada, including aerial photography. Two teams performed the evaluation – U.S. data by Dennis Albert & Laura Simonson; Canadian data by Joel Ingram and Brian Potter. These teams manually examined and classified all coastal wetland areas using a variety of data sources. However, there is still a large data gap on the Canadian side of Lake Superior. Supporting base data for this effort included:

- Herdendorf Inventory (centroids and hardcopy maps).
- OBM unevaluated wetland polygons (OMNR)
- Ontario coastal wetlands atlas (OMNR)
- other image data for confirmation

These data have been integrated and are available at GLC website <http://www.glc.org/wetlands>

Comments:

Unclear as to how we are going to define and what we're going to include as Lake Erie wetlands. For example, on the Grand River (Ontario) there is only one major wetland complex identified. Certainly there are other wetlands upstream from the mouth of the Grand River.

This approach described here seems to be conservative (in terms of what is a coastal wetland). The classification doesn't include groundwater fed wetlands that empty into rivers or the lakes. There is no provision for these types of wetlands in the current classification scheme. Will probably have to engage some other folks to "bring in" these types (and riparian) wetlands.

The Ohio GAP has 6 different wetland types, 3 of which occur in the Great Lakes. How does this crosswalk with the Wetland Consortium classification scheme? Also, some wetland mapping based on new (Landsat) data, but Wetland Consortium maps are based on existing (older) data. This has been a major criticism of the Consortium's maps as they may be "out of date".

The Wetland Consortium came up with 10 major classes by locking people in a room until they agreed, an alternative strategy would be to develop a classification scheme based on the data themselves - how comfortable are you with the number of classes? Within the experts group, there were lumpers and splitters. The objective was to come up with a compromise that everyone could agree on and would be useful.

Once rules are developed, it may be possible to automate the classification process. However, interpretation is difficult and more than likely will require manual examination of each wetland, even though it is a subjective process (i.e. a function of the individual doing the analyses). As a template, may be able to build on river classification processes which are unsupervised, i.e. once the rules are made, the computer does the rest...

In terms of the approach developed, all people in the room (i.e. the Wetlands Consortium room) felt that experts had to be involved because there are always exceptions to the rule. Some experts even thought it was pointless to develop a classification system at all as each wetland is unique. However, some generalities could be automated but the Consortium agreed that experts would be needed to make subtle distinctions. In terms of rule-based implementation, there have been attempts to go straight from the NWI to the hydrogeomorphic classification but it has not worked well. **However, it may be possible to implement an automated approach at a coarse level, which would probably require the development of step-by-step decision tree analysis...**

There are significant differences in the way U.S. and Canadian wetlands are delineated. **It is likely that some additional work will be needed to develop a unified wetland classification scheme (and/or crosswalk existing classification schemes) between the U.S. and Canada.** There is a complex scoring system in place to define Canadian wetland systems. Basically, a series of nested polygons are generated and various attributes are used to develop a score. Wetlands are delineated based on those polygons and prioritized based on the resulting scores.

Within a coastal context, the rationale for choosing the hydrogeomorphic approach was that it would not result in the loss of biological information as a result of classification process. It is still possible to define biological zones within the vegetative zones, even though the system is highly dynamic.

Fundamental questions to be answered include:

- 1. How do we integrate (or crosswalk) classification systems?**
- 2. What scales will we operate at?**
- 3. How do we develop a process that is less reliant on expert opinion?**

There is a need to establish a **committee or workgroup to develop a proposed solution or plan to integrate U.S. and Canadian wetland classification schemes, especially for riparian and/or inland wetland complexes. This group should also examine the potential application of a rules-based approach that would automate the wetland classification process. The objective would be to formalize a recommendation as a group and then develop a strategy to implement.**

Subgroup discussion and summary comments:

Members:

Ric Lawson, Great Lakes Commission

Laura Simonson, US Geological Survey

Lucinda Johnson, University of Minnesota-Duluth

Tom Hollenhorst, University of Minnesota-Duluth (for second part)

The breakout group discussed development of a consensus classification scheme for coastal wetlands following the discussion guide distributed at the workshop.

Define boundaries of each habitat zone

- There are two relevant boundaries used to define coastal wetlands: the lakeward extent and landward extent.

Lakeward extent

- Great Lakes Coastal Wetlands Consortium (GLCWC) utilized existing delineated wetland polygons and defined the lakeward extent to the limit of emergent vegetation as determined from aerial photos and other supporting data.

- The Great Lakes Environmental Indicators project (GLEI) defined the boundary to the extent of submergent vegetation, but no further than 2 m depth

Landward extent

- GLCWC: no further than 500 m inland due to buffered clip of wetland coverages. Otherwise wetland extent was defined by direct hydrologic connection leading to influence by lake processes.

- GLEI set arbitrary limit of no farther than 2 km.

- seiche effects can go miles upstream in some cases.

- a geologic boundary defines lacustrine and barrier-protected wetlands and many riverine wetlands as well, so there may not be an issue.

- need a definition that can be automated.

Consensus:

Lakeward: extent of emergent vegetation.

Landward: geologic barrier for lacustrine and barrier-protected. Extent of seiche effect for riverine.

Data need: good shoreline elevation and bathymetry for coastal zone

Research need: operationally define the extent of seiche effect in the Lake Erie basin.

Identify appropriate agencies / individuals that should be included in discussion

Pat Chow-Fraser, McMaster University

Denny Albert, formerly with Michigan Natural Features Inventory

Doug Wilcox, USGS – Great Lakes Science Center

Joel Ingram, Canadian Wildlife Service

Carol Johnston, University of Minnesota-Duluth

Joy Zedler, University of Wisconsin
 John Mack, Ohio DNR
 Janet Keough, US EPA – Duluth lab
 Glen Guntenspergen, Patuxent Wildlife Research Center
 Jim McKenna, ?
 Brian Huberty, US Fish and Wildlife Service

Define data needed to classify each habitat type

- completed digital NWI (only OH is not completed)
- Updated photography of entire shoreline
- Quickbird or other sufficient remote imagery of wetlands – GLCWC funded investigation assessing combined Landsat and radar
- high resolution bathymetry
- high resolution topography
- substrate mapping
- regular updates of extent of emergents and vegetation mapping (from satellite?)
- prevailing fetch data
- hydrologic model of climate change impacts on Great Lakes

Existing classification schemes: GLCWC, Pat Chow-Fraser's, GLEI, NWI (and derivatives)

Gaps: all data on the wish list and

- Shoreline boundary map
- Seiche influence extent map or interpretation

Standardization

- standard coding
- training for applying classification
- method to automate wetland inventory/delineation and classification

Action Items

- get bathymetry from NOAA
- get shoreline from Army Corps or NOAA
- get coastal LIDAR or other high resolution topography
- approach NASA for satellite and radar, but not Quickbird.
- establish Canadian partnership to encourage quickbird purchase. With whom? EPA? NOAA? GLOS?
- obtain GLNPO, Lake Erie Commission or other grant to automate classification process

Broad Items:

- reasonable substrate mapping
- shoreline imagery

- coastal bathymetry and topography

To move forward:

- compile classification documentation into one location
- finalize boundary and consensus classification
- cross-walk GLCWC and GLEI inventories

Response from plenary:

- emphasize the need to digitize the NWI for Ohio to improve the coastal wetlands inventory. Small amount of funding (<\$100k?) needed to do this with big improvement in data. Even if it is just to scan and georeference the current hard copies, that would be an improvement.

Coastal Margin Environmental Zone (embayments and nearshore);

Scudder Mackey - **Coastal Margins**

Nearshore and coastal habitats are critical and essential to the Lake Erie ecosystem. Anthropogenic activities have altered nearshore substrate characteristics, water depth, water quality, and energy dynamics. In particular, the energy and water mass characteristics are highly variable and are dynamic. Due to the dynamic nature of nearshore zone, nearshore biological processes and linkages to nearshore structural habitats are not well studied. Much of the sampling work is done during the day, but more recent work suggests high levels of nocturnal activity in the nearshore zone.

Understanding nearshore zone important because every day regulatory decisions are being made that directly, or indirectly, affect the nearshore zone. These decisions are made without adequate scientific data. Moreover, biologists are starting to ask what elements of the nearshore Lake Erie ecosystem are habitat limited. Unfortunately, inadequate data exist to evaluate or answer this question.

Earlier workshop defined the shoreward boundary as the ordinary high water mark which generally includes beaches and physical alterations to the shoreline, e.g. shore protection, navigation channels and structures, marinas, etc.). The lakeward limit would be defined by the 10 meter water depth contour or a maximum offshore distance of 4 km in the Central and Eastern basins. The lakeward limit would be defined by the 5 meter depth contour or a maximum offshore distance of 4 km in the Western basin. Watershed or tributary influences would be centered on 2nd order or larger river mouths and would extend halfway to the next 2nd order river mouth on either side. Tributary zones of influence also extend well offshore, e.g. a significant portion of Maumee Bay and the Western basin are influenced by flows from the Maumee River and the Detroit River. The Grand River in Ontario also has a zone of influence on the Central Basin of Lake Erie.

Fortunately, there is more information available now than previously. ODNR Geological Survey has existing substrate surveys of Ohio nearshore zone to 4 km offshore based on sidescan sonar data. ODNR (Geological Survey) and the USACE (Potential Damages Study) have generated data on shoreline armoring and coastal recession, and similar datasets may exist for the Ontario coastline of Lake Erie. Melissa Haltuch integrated substrate information and produced a sediment distribution map for Lake Erie as part of an evaluation of the spread of dreissenid mussels across soft-substrates in Lake Erie. Minnesota has used a RoxAnn acoustic system to systematically map nearshore substrates in Lake Superior at a 1:24,000 scale. This approach (and scale) may be appropriate for the Lake Erie nearshore zone as well. Roger Thoma with Ohio EPA has developed a coastal QHEI index based on biological and physical data from the nearshore. The Nature Conservancy also developed a nearshore classification based on a combination of physical characteristics (shoreline type, inferred substrate) and biological data.

In Canada, the Environmental Sensitivity Atlas provides information at a 1:10,000 scale of shoreline and nearshore bottom features. Additional data may also be available from site-specific studies by CCIW, Environment Canada (e.g. Coakley, Biberhofer, Rukavina, Minns et al.), but generally not as detailed as the substrate work in Ohio.

To summarize, the types of information needed include:

- **substrate distribution and characteristics**
- **kinetic energy in nearshore zone (low med, high – related to fetch distance and depth)**
- **water mass characteristics**
- **biota-specific habitat variables (function, life stage)**

Given the dynamic nature of the nearshore zone, the existence of discrete habitat classes is unlikely. Moreover, aquatic habitats are three-dimensional, not two-dimensional. **Classification scheme will be based on a dynamic, multi-layered aquatic habitat template that can be adapted to specific needs (species, communities, function, or life stage).**

Comments:

In 1978/79 U.S. EPA did intensive nearshore surveys. Even though chemical and biological characteristics may have changed, it may still be a useful source of information especially if we are attempting to establish baseline data. As to defining the boundaries of the nearshore zone and/or sub-zones within the nearshore, could you refine by looking at patterns of flow from the tributaries? Most tend to flow eastward and may be influenced by wave-driven (littoral or longshore currents) as well. We need to incorporate current data about nearshore circulation patterns and the effects on tributary zones of influence as part of the nearshore classification scheme. It is also likely that these patterns may change seasonally with changes in flow and open-lake circulation.

Canadian efforts are sporadic, even though have a collaborative 5-year rotating monitoring schedule where detailed data are collected along certain shoreline reaches. Focus had been on population and density information for dreissenids. Where information is and who has it is unclear..

For the USGS Aquatic GAP Program, we are still working on preliminary framework that is focused coarse level information from the nearshore. One major obstacle is that in trying to develop a classification scheme for all of the Great Lakes, the scheme may be too coarse for Lake Erie, but it's a start. The 10 m depth contour the whole basin is OK, and USGS would like to collaborate with investigators who have Lake Erie side-scan sonar and fish habitat data.

Substrate data are a critical need. We have collected literally thousands of samples but still don't have decent substrate maps of the nearshore zone. Although we can classify streams by segment, habitat variability and heterogeneity is high even over very small scales. There are no external parameters (such as valley segments) upon which to build relationships to predict this heterogeneity, i.e. there is no easy fix to this problem. LIDAR is a great tool that provides detailed bathymetric information and may be able to provide some limited information on substrate, but the tool needs clear water to be effective and Lake Erie is not necessarily known for clear water conditions – especially in the nearshore.

Subgroup discussion and summary comments:

Nearshore Breakout Group

Members:

Chris Castiglione

Dan Button

Susan Doka

Scudder Mackey

Define boundaries of each habitat zone

- 10 meter depth zone irrespective of distance from shore would likely capture the photic zone better than 5 meter depth zone despite the fact that we would capture all of the western basin and Lake St. Clair
- shoreline processes are important – sediment transport is driven by littoral processes along the shoreline, sediment movement within the western basin is more circular, and not necessarily due to littoral transport.
- Anything less than 10 meter water depth considered nearshore; 0 –3 meters called the shoreline zone which would be consistent with Michigan; 3 –10 meter water depths can be justified based on process, wave, and photic-based criteria; recommend elimination of the distance based measurement criteria (less than 4 km from land)..
- Nearshore zone may include the zone of lake influence in river mouths. Riverine group using a “fuzzy boundary” to identify lower limit of riverine environments.

- There is a need to identify the vector dataset that would be used to define the coast. Likely the NOAA medium resolution vector dataset will likely be our guide; but landward limit would be the ordinary high-water mark (or elevation) for Lake Erie.
- “Zone of influence” from a river (plumes) should not affect the nearshore boundary zones – riverine water mass characteristics (plumes or zones of influence) will become a component of the nearshore classification scheme.
- The Open Water sub-group is considering water mass characteristics in water depths greater than 10 meters. If the wetland group is going to establish a lakeward boundary at the edge of emergent vegetation, then the nearshore group should “pick-up” lakeward submergent vegetation zones.

Identify appropriate agencies / individuals that should be included in discussion

Ontario Ministry of Environment – Resources Road – Todd Howell
 Reuben Goforth – MDNR
 Jonathan Higgins, Michelle DePhilip. – Nature Conservancy
 Greg Kennedy; Ed Roseman; - USGS Ann Arbor
 John Janssen – Great Lakes Water Institute, University of Wisconsin- Milwaukee
 Minnesota DNR – Substrate Classification People
 Jim Grazio – Pennsylvania DE
 Hans Biberhofer – Environment Canada
 GLERL Lab – NOAA Ann Arbor
 U.S. Army Corps of Engineers – Buffalo District, Tony Fiona, Tom Bender
 Baird and Associates – Rob Nairn, Pete Zuzek
 Julie Letterhos would know the Chladophora people.
 Rex Lowe – Bowling Green State University

Define data needed to classify each habitat type

- **Substrate characterization, distribution, and stability**
- **Nearshore Energy distribution**
- **Nearshore bathymetry**
- **Water mass characteristics; water circulation patterns (predictive models)**
- Littoral transport direction and rates
- Wave data
- Fetch distance
- Shoreline classification
- **Shoreline armoring, characteristics of the shoreline.** – Ohio only
- Water Intake pipes and discharge pipes.
- Nearshore land cover, land use. – CCAP, NLCD
- Distance to river mouth
- **ODNR nearshore fisheries data from 0-10 meters.**
- **USGS Nearshore Trawl data.**

- **Intermittent biological sampling data from Roger Thoma (U.S. EPA), Bob Haas (MDNR), Tom McDougall (OMNR)**
- Nearshore biological information from 2004 – Vi Richardson (Ontario)
- **Plant distribution, biomass, coverage**
- Organic Content of sediment
- Dredging and disposal of dredge spoils - USACE.
- Sediment contaminant data – type, concentration, and distribution. Effect on benthic habitats.

Existing Habitat Classification Schemes

Minnesota DNR – Nearshore substrate mapping

ODNR nearshore substrate mapping – Constance Livchak

The Nature Conservancy Great Lakes program

John Janssen's UofW shop.

John Shaw – Shoreline erosion study. – Conservation Authorities.

Marine nearshore habitat classification systems.\

USGS Aquatic GAP

Environment Canada substrate mapping - Hans Biberhofer

Fish distribution/community based classification - Ed Rutherford University of Michigan)

Probable nearshore classification would be based on physical parameters (geology, hydrology) with an overlay of biological parameters (plant, benthic, and fish community distribution).

Critical classification parameters are:

- **Water depth** (bathymetry - energy)
- **Substrate**
 - Texture
 - Composition
 - Hardness
 - Stability
- **Water mass characteristics**
 - Flow/circulation, Littoral currents (predictive hydrodynamic models?)
 - Zones of tributary influence
- **Biological Data** (cluster analyses – tied to open-lake/offshore analyses/data)
 - Fish
 - Benthos
 - Macrophytes (submergent)
- **Anthropogenic alterations**
 - Shoreline modifications/Armoring
 - Altered flows

Data standardization:

Need to develop common substrate classification based on attributes that biological organisms or communities will respond to, e.g. texture, composition, hardness, and stability. Historical samples (cores, grabs, jetted holes) with grain size analysis may not be ideal in that some of the necessary attributes (above) are not measured, even though it may be possible to infer these parameters.

Mapping scales - 1:100,000 scale analogous to 30 meter pixel sized and 1:24,000 scale is analogous to 10 meter pixel size. Sub-group consensus was 1:24,000 scale (or Canadian equivalent) was the most appropriate mapping scale for binational nearshore habitat map as subtle patterns and details could be visualized without losing regional patterns. Where available, higher-resolution data at finer scales could be incorporated over site of particular biological significance (western basin reefs, Lake Erie islands, tributary mouths, etc.).

There is a critical research need for updated substrate data within the nearshore zone. Potential tools include acoustic and remote sensing tools, e.g. side-scan sonar and RoxAnn, and other historical data, e.g. nearshore profiles and sediment sampling data.

The groups discussed the potential of using Quickbird data to assist with nearshore substrate identification, but 10 meter resolution is too coarse. High-resolution aerial photography may be useful, especially if used to evaluate water-mass characteristics within a particular area of interest, (e.g. zone of influence for the Maumee and the Grand Rivers).

Open Water Environmental Zone (water column and the substrate beneath)

The objective is to develop a spatially dynamic open-water/offshore habitat classification scheme that incorporates seasonal changes in water mass characteristics and flows (i.e. zones of influence) from tributary mouths. Habitat distribution in open lake system is complex and dynamic. In the offshore region, fish habitat is largely controlled by external sources that may, or may not, be within the “public trust”. There are several relevant ecological and management scales – broad regional scale (lake basin), meso-scale (watershed), and fine-scale (feature based).

An example of broad scale habitat structure was proposed during Lake Erie habitat task group meetings (after Saylor and Miller 1987). Regional circulation patterns suggest two major central basin gyres, two major eastern basin gyres, longshore (shore-parallel) currents in the nearshore zone influenced by riverine flows, and two major water masses in the western basins driven by flows from the Maumee and Detroit Rivers.

Follow-on work has been designed to integrate fisheries data with these physical patterns of flow. These patterns approximate the 9 box model which has been used to manage fishery resources in Lake Erie for the past three decades (e.g. Mullen 1976). Fish trawl and water quality data have been compared (and “clustered”) to identify water-mass affinities. The spatial distribution of habitat units appears to be tied to riverine systems that have a major influence on Lake Erie water masses. Generally, these rivers have mean discharges $> 20 \text{ m}^3/\text{sec}$. The distribution of organisms appears to be tied to seasonal patterns of flow in the tributaries and the

Lake. Examples include crustacean and zooplankton densities in August, 1996 and distribution data for yellow perch in 1997. Unfortunately, the spatial resolution of biological datasets is inadequate to determine linkages with fine-scale physical features. An exception (or an example) would be the large school of fish associated with an outwelling event from Sheldons' marsh in July 1997 (based on hydroacoustic data).

Comments:

To detect zones of influence, it may be appropriate to sample the five or six major tributaries with mean discharges $> 20\text{m}^3/\text{sec}$ on a regular basis to identify water quality patterns and flow. This could be a possible research and monitoring recommendation. We must also consider flow dynamics from streams. Major effects are going to depend on peak flows, not mean flows and there may be a linkage to the dominant hydrology, i.e. is the watershed surface or groundwater dominated and how flashy is the system. Moreover, water quality is dependent on flow rate as water chemistry changes as water moves downstream.

We should think of classification scheme that has predictive value for biology. If we subdivide too far, we miss the point. It would seem as if we two major components in this system: 1) three lake basins and 2) major tributary zones of influence. Within the basins, we also have seasonal hydrodynamic patterns of flow (i.e. gyres). Suggestion was made to consider age, turnover, and mixing of water within subunits. There was agreement that this would be useful, but data may not exist to perform the analyses.

Following the comment about making this a biologically based classification scheme: Heath and Culver have sampled along transects that range from eutrophic to oligotrophic conditions. These data would complement fisheries data and could potentially be used to tie biological productivity to seasonal water mass characteristics and patterns of flow. Benthic data also suggest that the distribution of benthic communities may also be affected by water mass characteristics and tributary zones of influence.

Members: Bob Haas , **Jeff Tyson**, Jeff Reutter, Ed Rutherford, Jan Ciborowski

Subgroup discussion and summary comments:

Define boundaries of each habitat zone

Western basin - 5 meter water depth or 4 km distance, whichever is closer to shore

Central and Eastern basins - 10 m water depth or 4 km distance, whichever is closer to shore

Identify appropriate agencies / individuals that should be included in discussion

Limnologists: Murray Charlton; Dave Schwab; Hunter Carrick; Dave Culver; Tim Johnson; Keith Bedford, Ram Yarubundi; Lars Rudstam; EPA GLNPO → Glen Warren/Dave Rockwell;

US EPA; George Leshkovich (EPA GLERL → data gathering).

Central basin hypoxia team at NOAA: Stu Ludsin;

Others: Ora Johannssen; Gary Sprules; Moh Munawar; Hans Biberhofer; Ron Dermott; Bob Heath; Ken Krieger; Jeff Ram (Wayne State Univ); Gerry Matisoff; Steve Lozano. .

Define data needed to classify each habitat type

Features or Processes that Structure Habitat in Open-Lake Environmental Zone

Water mass characteristics: 1) regional circulation patterns (gyres) predominately wind-driven or 2) tributary flows (plumes) from large watersheds that drain into the basin. Plumes from large rivers may extend beyond the nearshore zone (4 km distance) well into central regions of the basin. For example, the influence of the Sandusky River can be extended past the 4 km zone.

Discussion:

Maumee, Sandusky, and Grand Rivers are so big that they have major influences on both nearshore and open-lake environmental zones. Other (smaller) tributaries don't have this effect. There is a clear distinction in watershed influence between the nearshore zone and everything upstream (highly influenced); and the open lake. For example, health of central basin probably doesn't depend on all of the watersheds flowing into it, but the health of the western basin may be highly dependent on adjacent watersheds.

If thinking of this as habitat, the habitat characteristics is going to be different at the mouth of major (and minor) tributaries, but the work hasn't been done to fully understand their significance. However, we do understand the importance of the Sandusky River.

In other Great Lakes, water masses as defined in Jeff Tyson's presentation could also be defined, in part by proximity and number of watersheds that contribute to a single water mass in the Lake. The interaction of these water masses will affect local productivity (plankton), thermal characteristics, and other factors that affect how organisms use habitat. Specific organisms (or communities) will respond and use these conditions in different ways.

Fisheries data for the six largest watersheds (in terms of discharge into the lake) suggest they are big enough to influence the lake. These watersheds have evidence of distinct or extinct spawning stocks of walleye. Randy Eshenroder's work showed that if the nearshore zone of influence isn't large enough, larvae just die in the lake. For example, many streams have good spawning habitat but don't support walleye, as they don't have an influence on the lake (there may be thermal limitations as well). Cattaraugus Creek flows clear as does the Grand River in Ohio, but neither of these systems have spawning stocks of walleye. In addition to discharge, what's being carried as load (sediment; nutrients, etc.) is a function of the individual watershed and may also limit utilization as fishery habitat.

Given the shallow waters and limited volume of Lake Erie, water mass characteristics, circulatory patterns, and significant influences of tributary flows into the lake may be much more important in Lake Erie than in the other Great Lakes. Additional work is needed to document the

zones of influence of Lake Erie tributaries and how biological communities actually use these zones of influence as habitat.

Within the Central basin, there are three distinct structuring features – the Sandusky sub-basin (defined by bathymetry), and the north and south water circulation gyres. The Sandusky sub-basin is generally less than 15 meters deep and is bounded to the east by the N-S Pelee/Loraine ridge. The sub-basin often has low DO and may also have a distinct circulation pattern. Many limnologists would suggest that within open-water areas within Lake Erie (exclusive of the Western basin), the Sandusky sub-basin may be the most productive.

Types of data necessary to characterize water mass and/or circulation patterns include:

- Temperature
- Flow (magnitude and direction)
- Conductivity
- Secchi (transmissivity or light penetration)
- DO
- Chlorophyll A
- Water depth
- Wind stress gradient (wave energy, water circulation)
- Substrate/sediment distribution

There is a need for biological information on a lakewide basis. Perhaps Quick Bird technology could be used to provide a remote sensing capability for the lake, e.g., Chlorophyll A.

Additional Discussion on Data Needs:

First thing that's important is to understand the data; metadata are extremely important. We also have different levels of spatial resolution for different data sets; working at finest spatial resolution that can manage; process of going from point data to attributes for polygons, that's what is done with spatial modelling tools and techniques.

Data standardization and comparability are important. Fishery and limnological data are pretty well standardized. Acoustics data are standardized across sampling programs from the present going forward. Coordination between countries and agencies is OK, but could be significantly improved.

Do we need to design long-term sampling programs for purposes of classification?

Current sampling plan is to sample every 4 - 5 years, and update water quality data as often as the data permit. Sampling guidelines shouldn't be constrained by cost; 5-year turnover is best; but need additional background information. Many parameters are sampled annually, but zooplankton and the benthos are underrepresented in these sampling programs.

This demonstrates the need for long-term observation systems (observation buoys) that provide a continuous stream of data: e.g., Temp; DO; Chlorophyll A; vertical profiles (surface to bottom).

However, we still need boat observations for spatial coverage to complement the buoy readings. Fisheries data are being collected systematically on a regular basis by the resource management agencies.

Ed Rutherford is working on project funded by the Fishery Commission to build a Lake Erie GIS. As a result of these discussions, will explore ways that data layers can be used to statistically test water-mass boundaries and test various spatial modelling tools in order to develop an open-lake classification scheme. May be possible to combine this work with data generated by G.L. Forecast Model, i.e. backcast wave climate and water circulation patterns based on historical daily weather patterns. It may be possible to run model backwards for the last 25 years ~200 days each year.

It may be possible to use results from the hydrodynamic models to calculate average summer circulation patterns to help define gyre boundaries (or polygons), and then ask how well do all the data collected across the lake correspond to those clusters. May be able to add fish, benthos, and substrate to these analyses and bring back to group to explain linkages and processes as part of habitat classification scheme.

Classification:

Is the classification based on the physical environment or the biological correlates?

Stratification of water masses is important. We have to think about areas that are within vs. outside the hypolimnion. For example, there are areas that are never inside the hypolimnion; there are areas that are intermittently exposed (or transiently within) the hypolimnion; and there are areas that are always within hypolimnion. These areas will have different exposures to hypoxia. The exposure pattern may be analogous to the 9-box model. Seiche and wind set-up effects are really important. But when not in the middle of a seiche, can define circulation pattern of gyre and circ pattern must drag the hypolimnion along.

Do we include biological components: benthos, phytoplankton, and fish? The distribution of these organisms and these organisms respond to local conditions may provide clear signals of environmental or ecological condition (or health). However, we need biological data. The role of biological data in the classification scheme can only be determined after we've collected the data, i.e. allow us to test for significance.

Classification based on cluster analyses of four data layers physical characteristics; biological characteristics; water quality/chemical characteristics; and processes/hydrodynamic characteristics.

RESEARCH NEEDS WORKSHOP 3.11

Planning for an Integrated Habitat Classification System and Map for the Lake Erie Basin

June 6-7, 2005
F.T. Stone Lab
Ohio State University
Gibraltar Island, OH

AGENDA

Monday – June 6, 2005

1200 **Early Arrivers' Lunch** (Provided - Stone Laboratory Dining Hall)

1300	Welcome and Introductions	
	Background – History of the LEMN	Jeff Reutter
	Day 1 Purpose, Review, Organizational Framework, and Goals	Jeff Reutter
	Synopsis of LEMN Habitat Workshops – Overview	Jan Ciborowski
		Scudder Mackey

Presentations 1 – LEMN Workshop Summaries - Environmental Zones

Ric Lawson, moderator

(Except where noted, 20 minute presentations and recommendations – 10 min to receive group Comments)

	<u>Topic</u>	<u>Speaker</u>
1330	Terrestrial	Mike Robertson
1400	Inland Lakes and Rivers	TBA
1430	Wetlands	Ric Lawson
1500	Break	
1515	Coastal Margin (Nearshore)	Scudder Mackey
1545	Open Lake	Jeff Tyson
1615	Break Out Session I (by zones) – Planning Integrated Classification Scheme for the Lake Erie Basin	
	<ul style="list-style-type: none"> • Review summary recommendations and group comments by environmental zone • Develop outline/approach to discuss implementation of recommendations and filling gaps during tomorrow's session 	

1700 **Break**

1730 **Dinner** (provided – Stone Laboratory Dining Hall)

1900 **Presentations 2 – Introduction to Pilot Watersheds; Ongoing Related Habitat Mapping/
Characterization Projects** Nick Mandrak, moderator

<u>Topic</u>	<u>Speaker</u>
Lake Erie watershed features	Tom Hollenhorst
Lake Erie nearshore	Chris Castiglione
Attributes of the Grand River Watershed	Martin Neumann, Warren Yerex
Maumee Watershed	Dan Button

2000 **Adjourn**

Tuesday – June 7, 2005

0700 **Breakfast** (provided – Stone Laboratory Dining Hall)

0800 Recap of Day One information Purpose, Organizational Framework, and Goals Scudder Mackey
Jan Ciborowski

0815 **Breakout Session 2 (by zones) - Integrated Classification Scheme for the Lake Erie Basin**

- Identify key participants/programs and form subgroups by Environmental Zone
- Review technical recommendations and explore potential implementation strategies
- Set provisional meeting timeline
- Begin initial integration/consensus building
 - Terrestrial
 - Inland Lakes and Rivers
 - Wetlands
 - Coastal Margin (Nearshore)
 - Open Lake

1015 **Break**

1030 **Report Out**

1115 **Discussion – Subgroups, Participants, and Timelines** Jeff Reutter, moderator

- Identify subgroup leaders and core subgroup members by Environmental Zone
- Summarize goals, objectives, and timelines for subgroups
- Develop list of specific products to be developed prior to Fall workshop

1145 **Summary and Next Steps** Lucinda Johnson

1200 **Lunch** (provided – Stone Laboratory Dining Hall)

1300 **Adjourn**
