LAKE MICHIGAN: STATE OF THE LAKE GREAT LAKES BEACH ASSOCIATION CONFERENCE OCTOBER 15-17,2013

2013 JOINT CONFERENCE

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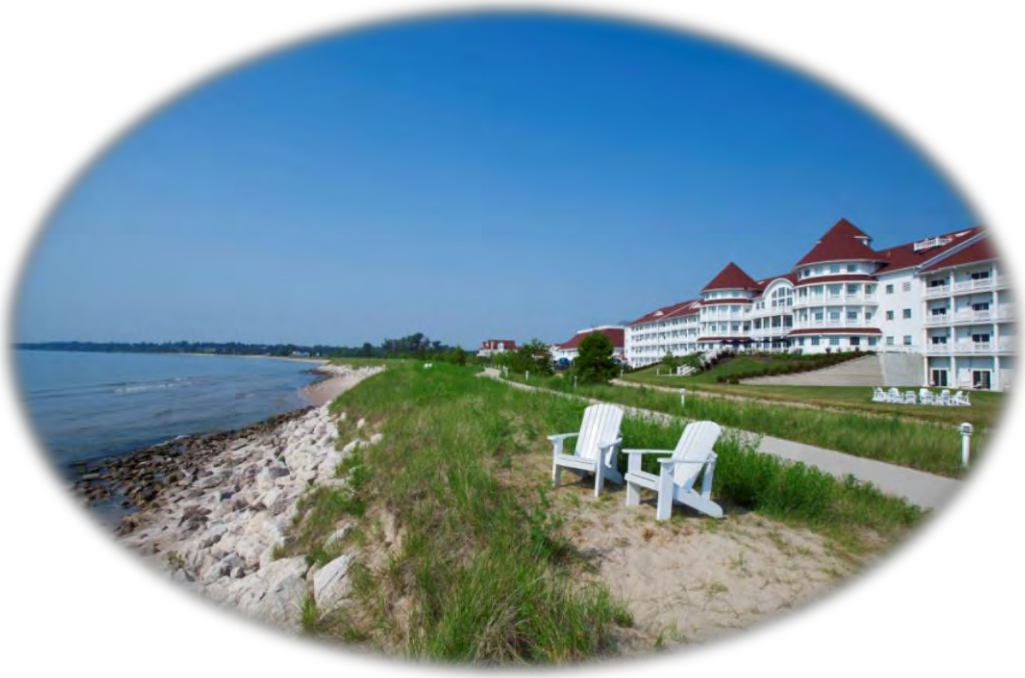

Abstracts

LAKE MICHIGAN STATE OF THE LAKE

GLBA Great Lakes Beach Association
Working together to improve recreational beach water quality

ADAMS, MARY STEWART, Program Director, Headlands International Dark Sky Park, Mackinaw City, MI, and Member, International Dark Sky Association, Darks Sky Places Designating Committee Emmet County, 200 Division St, Petoskey, MI 49770

Great Skies over the Great Lakes and why it Matters

Nocturnal habitat and boaters safety along the shores of the Great Lakes is greatly inhibited by artificial light at night. The Headlands International Dark Sky Park, which boasts two miles of Lake Michigan shoreline, and throughout the adjoining Wilderness State Park area protected by State of Michigan (which extends the dark skies along the cost another 16 miles), is an important staging area for raptors and for researching the little-known migration patterns of the saw whet owl. This presentation will demonstrate the ecological, economic, and resource management value of protecting the night sky over the shores of the Great Lakes.

ANDERSON, ERIC J.[1] and SCHWAB, D.J.[2], [1]NOAA Great Lakes Environmental Research Laboratory
4840 S. State Rd, Ann Arbor, MI 48108, [2]Water Center, University of Michigan, Ann Arbor, MI.

A Forecasting System for Flow Prediction in the Straits of Mackinac and the Implications for Water Quality and Spill Transport

The Straits of Mackinac form the connecting waterway between Lake Michigan and Lake Huron, forming the largest lake in the world by surface area and play an important role in water quality of Lake Michigan, contaminant transport, and ecological processes. Due to unique conditions, the flow within the Straits oscillates on a 3-day period with current speeds that can reach up to 1 m/s, resulting in discharges up to 80,000 m^3/s (80x the net flow). The existing hydrodynamic forecast models treat the lakes as two individual bodies of water and impart an artificial “wall” or coastline at the Straits of Mackinac. As a result, the model simulations do not include flow through the Straits, resulting in inaccurate current predictions and a gap in the real-time forecasting systems. In order to fill this gap, we have developed the first 3D hydrodynamic model of the combined Lake Michigan-Huron to predict the hydrodynamics in the Straits of Mackinac and have shown that the model is able to simulate the 3-day current oscillations, thermal stratification, and bi-directional flow observed at the Straits. In addition, through direct comparison with the individual-lake models (i.e. no-flow at the Straits), we have found that the area of influence of the Straits can extend up to 70 km into lakes Michigan and Huron. For the first time, this model provides the capability to accurately predict flow conditions in the Straits of Mackinac, which is vital to understanding and predicting water quality and spill transport. This model forms the basis of the next generation of the NOAA/GLERL Great Lakes Coastal Forecasting System, a set of hydrodynamic models that predict the physical environment of the lakes in real-time.

BARBIERO, R.P.[1], LESHT, B.M.[2], WARREN, G.J.[3] JOHENGEN, T.H. and RISENG, C.[4], [1]Computer Sciences Corporation and Loyola University Chicago, 1359 W. Elmdale Ave. Suite 2, Chicago, IL 60660, USA 773, [2] Dept. of Earth and Environmental Sciences, University of Illinois Chicago., [3] USEPA Great Lakes National Program Office., [4] University of Michigan Cooperative Institute for Limnology and Ecosystems Research School of Natural Resources and Environment, University of Michigan.

Recent Changes in the Lower Food Web of Lake Michigan

The lower food web of Lake Michigan has undergone significant change in the past fifteen years. Recent (2007-2012) May chlorophyll concentrations in the southern basin have been slightly more than half of what they were in 1998-2002, with somewhat smaller reductions seen in the northern basin. The reductions in chlorophyll have not been confined to spring, but have occurred during most of the growing season. Declines in cladoceran populations have also occurred, with August biomass of this group in 2007-2011 only about 20-25% of 1998-2002 levels. Declines in the benthic amphipod *Diporeia*, first noticed in the 1990s, have continued in recent years, and this organism currently appears to be absent from waters < 90 m. Declines in profundal populations seem to be related at least in part to the declining spring bloom. While many of these changes roughly parallel increases in populations of the quagga mussel, the fact that similar, but more sudden and pronounced, changes have been seen in Lake Huron, where quagga mussel populations have been an order of magnitude less than in Lake Michigan, suggest that other causative factors might be at play.

BAUMANN, JIM, Wisconsin Department of Natural Resources, 101 S. Webster, Madison, WI.

Phosphorus Water Quality Standards Criteria: Development and Management Implications

Wisconsin is one of the few states nationally that has adopted numeric phosphorus water quality standards criteria for lakes, streams and the Great Lakes. The criteria for the stream and river criteria were developed based on extensive statistical analysis of the relationship between phosphorus concentrations, algal growth, fish indices and aquatic insect indices conducted by US Geological and Wisconsin Department of Natural Resources researchers. Data was collected from over 240 streams and over 40 rivers. Results of the statistical analyses were compared to results of other – generally older studies. The phosphorus criteria went through extensive public review and were adopted by the Natural Resources Board in June 2010 and approved by USEPA in late 2010. The criteria are used in a number of management programs, included deriving effluent limits for wastewater treatment facilities, developing TMDLs and developing watershed management plans in the Lake Michigan Basin.

BAUMANN, JIM, Wisconsin Department of Natural Resources, 101 S. Webster, Madison, WI.
Wisconsin's Nutrient Reduction Strategy and Lake Michigan

Wisconsin's Nutrient Reduction Strategy, developed in response to a March 2011 EPA directive and the *Gulf Hypoxia Action Plan 2008*, covers both the Lake Michigan Basin and the Mississippi River Basin. As part of this strategy, a top group of watersheds was identified for each of the major basins using both the USGS SPARROW Model and in-stream nutrient concentrations. The strategy also estimates the phosphorus load reduction achieved since 1995 and projects further load reductions into the future. Trend analysis based on long-term tributary monitoring sites shows a general reduction in phosphorus concentrations since 1997. The strategy further describes existing federal, state and local phosphorus management programs, efforts needed to create a phosphorus tracking system for the state and water quality monitoring activities needed to assess progress over time.

BAUMANN, JIM, MINKS, A. and KIRSCH, K., Wisconsin Department of Natural Resources, 101 S. Webster, Madison, WI.
Innovative Permit Compliance Options for Wisconsin Wastewater Treatment Facilities with Stringent Phosphorus Effluent Limits

Wisconsin municipal and industrial wastewater dischargers with stringent phosphorus effluent limits may pursue two innovative, cost-effective compliance options to installing costly phosphorus removal technology at the treatment facility. Permittees may choose to pursue water quality trading where a greater than comparable phosphorus load reduction is obtained by controlling phosphorus from other sources, such as agricultural non-point sources. The trading framework involves trade ratios, trade thresholds and limited watershed areas. For watersheds where nonpoint source are the primary contributors of phosphorus, the permittee has a second option, a Watershed Adaptive Management project. Under this second option a watershed is managed to achieve water quality standards throughout the watershed. To pursue this option, the permittee must work with watershed partners to develop a watershed plan and implement that plan within the period of three five-year point source permit terms. The permittee is also required to accept an interim permit limit of 0.6 mg/L for total phosphorus. Permittees are given a three to four year period to choose between adding treatment processes or one of the innovative options.

BECHLE, ADAM and WU, C.H., Department of Civil and Environmental Engineering, University of Wisconsin–Madison, Madison, WI.
Meteotsunamis in Lake Michigan

Meteotsunamis (or meteorological tsunamis), are propagating water waves generated by a moving atmospheric disturbance. Meteotsunamis exhibit many similarities with seismic tsunamis, as both have wave periods of 2 minutes to 2 hours and undergo resonant amplification that transforms relatively small waves in the open water into destructive forces at the coast. The Great Lakes have a history of damaging meteotsunami events, including a 1954 wave that struck Chicago and killed 7. In this study, water level records from the last decade are analyzed to quantify the occurrence frequency of Lake Michigan meteotsunamis. Atmospheric records from the network of observation stations in the Great Lakes region, along with radar and satellite imagery, will be utilized to characterize the meteorological conditions that accompany these meteotsunami events. Focusing specifically on Lake

Michigan, a sensitivity study with a numerical model is used to determine the "worst case" conditions for meteotsunami formation and identify the locations in the lake most likely to experience large meteotsunamis. The results of this study will help mitigate the risk associated with these destructive waves.

BOOTSMA, HARVEY, A.[1], DRISCOLL, Z.[1], WILCOX, E.[1], and MAGRUDER, C.[2], [1]University of Wisconsin-Milwaukee, School of Freshwater Sciences, 600 E. Greenfield Ave., Milwaukee, WI, 53204, [2]Milwaukee Metropolitan Sewerage District.

Factors Regulating Interannual Variability of Cladophora Biomass in Lake Michigan

Nuisance Cladophora growth remains a significant management challenge throughout much of the Great Lakes. In order to consider management options, it is necessary to determine the factors and mechanisms that regulate Cladophora growth. The role of proximal factors, including light, temperature and nutrients, is reasonably well understood, and has resulted in the development of numerical models that perform quite well. However, these factors are regulated by a number of large-scale processes, including nutrient loading, lake hydrodynamics, and weather conditions, and the response of Cladophora to these drivers is less well understood. We use a multi-year empirical data set to assess the factors responsible for interannual variability in Cladophora biomass in Lake Michigan. Over the 7-year study period, maximum annual biomass varied 6-fold. We use a numerical simulation model and an empirical model to determine the causes of this variability, and its predictability. The results indicate that peak Cladophora biomass, which usually occurs in late July, is correlated to solar irradiance and water temperature in May. A multivariate regression model indicates that peak summer biomass can be predicted with a high degree of confidence if conditions in May are known, providing managers with a useful forecasting tool.

BRAVO, H.R.[1], HAMIDI, S.A. [1], KLUMP, J.V.[2], and GRUNERT, B.K.[2], [1]Department of Civil Engineering and Mechanics, University of Wisconsin-Milwaukee, P.O. Box 784, Milwaukee, WI 53201-0784, [2]School of Freshwater Sciences, University of Wisconsin-Milwaukee.

Water Turbidity Effect on Green Bay Stratification

Water turbidity affects the transfer of short wave radiation through the water column and therefore the thermal regime in the lake, particularly in shallow coastal areas. As turbidity increases the transfer of shortwave radiation to deeper waters is limited, with the result of a shallower thermocline. The effect of water turbidity was investigated using hydrodynamic modeling and field measurements. The water turbidity in Green Bay, especially in the southern bay, is higher than the lake. Increasing the turbidity and light extinction coefficients in the hydrodynamic model produce a thermal structure that better fits field measurements. Light extinction measurements made in different stations during summer 2012 enabled us to calibrate the hydrodynamic model for Green Bay and improve its predictive capability.

BREITENBACH, CATHY[1], NEVERS, MEREDITH B.[2], SHIVELY, D.[2], and WHITMAN, R.L.[2], [1]Chicago Park District, 541 N. Fairbanks, Chicago, IL 60611, [2]U.S. Geological Survey, Great Lakes Science Center, 1100 N. Mineral Springs Road, Porter, Indiana 46304.

Predictive Modeling for Water Quality in Chicago

The Chicago Park District (CPD) and the U.S. Geological Survey (USGS) partnered to develop empirical predictive models for water quality at public beaches in Chicago. Equipment was installed at several beaches to gather data on weather and surf conditions in 2011. After the 2011 beach season, USGS staff developed models using the data collected by this equipment and bacteria monitoring data from CPD. Empirical models were initially developed for five beaches using the hydrometeorological and *E. coli* data collected in 2011. Model validation in 2012 showed low predictability, resulting in refinement. Models were used to make management decisions at 15 public beaches in Chicago in 2012. Model success was variable between beaches, but the models were generally superior to the persistence method (bacteria culturing); adjusted R^2 ranged from 0.103 (Rainbow) to 0.381 (Leone) while adjusted R^2 for persistence models ranged from -0.008 (Montrose) to 0.231 (Ohio). Explanatory variables most often used were antecedent rainfall, solar radiation, and wind direction. Type 1 (false positive) and type 2 (false negative) errors were compared. The persistence models had more type 1 errors and the type 2 errors were comparable between approaches. Problems encountered with the initiation of this program included, algae build-up on turbidity meters and malfunctioning wipers, lightning strike to the weather station, low battery voltage, and telemetry signal loss. Additionally, weather conditions in the 2012 season were very different than 2011. Models are being used to make management decisions at all 24 public beaches in 2013. Introduction of the program has generated a great deal of public interest and media coverage.

BRENNAN, TODD, Alliance for the Great Lakes, 1845 N Farwell, Suite 100 , Milwaukee, WI 53202.

Helping Beach Managers Using Citizen Monitoring to Identify Potential Pollution Sources at SE Wisconsin Beaches

This presentation will explore how volunteer efforts are playing an important role in Lake Michigan beach health within Milwaukee County and the Milwaukee Estuary Area of Concern.

The Alliance for the Great Lakes Adopt-a-Beach™ program has been working with beach stakeholders on multiple levels to identify and address potential pollution sources at beaches in SE Wisconsin. This has meant developing partnerships with park administrators, University of Wisconsin-Milwaukee, Wisconsin Division of Natural Resources, health departments, and coastal management agencies to align data gaps with volunteer data and potential pollution sources.

Two examples in SE Wisconsin will be covered in demonstrating the role of citizen monitoring in identifying and managing fecal contamination. They are:

- Identifying potential pollution sources at South Shore and Grant Park Beaches in Milwaukee County –Tier Two volunteers have helped to identify bacteria contamination from several areas on or near the beach, especially those with loafing avian populations. Both beaches are on the WDNR Impaired Waters list for fecal contamination and South Shore Beach is considered by NRDC as one of the top 10 most polluted beaches in the Great Lakes. For both beaches park managers and health departments have been overwhelmed by multiple fecal contamination sources. Adopt-a-Beach™ volunteer data has helped them identify and better utilize resources for targeted monitoring and BMPs.

- Use of volunteers to gather key modeling parameters for health departments – At Bradford and Grant Park Beaches in Milwaukee County the Alliance has partnered with the WDNR and the local health departments to assess the feasibility of using volunteer data to run models in predicting bacteria quality. The project is not yet done, but thus far the partnership has proved to be a beneficial cost saving approach to monitoring bacteria contamination.

BROOKS, COLIN[1], SHUCHMAN, R.[1], GRIMM, A.[1], SAYERS, M.[1], RAYMER, Z.[1], JESSEE, N[1], BANACH, D.[1], and LESHKEVICH, G.[2], [1]Michigan Tech Research Institute, 3600 Green Ct. Suite 100, Ann Arbor, MI 48105 USA, [2] NOAA GLERL.

Remote Sensing Time Series Observations of Lake Michigan Water Quality Parameters

Remote sensing provides a method to accurately assess water quality for current and historical conditions in large lakes such as Lake Michigan. Satellite sensors such as SeaWiFS and MODIS collect data that span large geographic areas and have been in operation for more than a decade, with some satellite programs that have existed since the 1970s. This remote sensing "time machine" allows scientist to analyze a time series of data and determine how water quality conditions have changed, particularly in light of a changing climate. Augmentation of remotely sensed data with sound in-situ measurements allows scientists to gain a deeper understanding of changes in the Great Lakes. This presentation reviews a variety of methods/products produced by Michigan Tech Research Institute that aid in the assessment of changes in water quality. Using remote sensing derived data, ancillary observations (meteorological, stream-flow, etc…) that help describe the time series analysis, and in-situ measurements the water quality and water characteristics of Lake Michigan over time can be accurately assessed. Remote sensing analysis outputs included retrieving color-producing agent (CPA) products (chlorophyll, suspended minerals, and dissolved organic carbon concentrations), sediment plume extents, optical water parameters, and in areas such as Green Bay, harmful algal bloom extents.

BUNNELL, DAVID "BO, BARBIERO, R.P., MADENJIAN, C.P., NALEPA, T. and TSEHAYE, I., USGS Great Lakes Science Center, 1451 Green Road, Ann Arbor, MI 48105.

Overview of Trends in the Lake Michigan Food Web and Exploration of Key Drivers

Understanding the relative importance of different mechanisms (i.e., competition, predation) driving ecosystem dynamics is fundamental for sound fisheries and water quality management. For Lake Michigan, where nutrient inputs have been reduced and top predator biomass has been restored, we compiled data to describe trends across multiple trophic levels and explored underlying drivers. Since 1998, our analyses revealed increasing water clarity and piscivore biomass, as well as declining trends in phytoplankton, native invertebrates, and prey fish. Evidence for bottom-up regulation was revealed for phytoplankton, zooplankton, and prey fish. Evidence that piscivores exerted top-down control on prey fish was also apparent. Although nonindigenous dreissenid mussels likely have strong impacts on nutrient cycling and phytoplankton, their effects on higher trophic levels remains uncertain. We highlight gaps in monitoring and knowledge that, when filled, should improve understanding of food-web dynamics and facilitate implementation of ecosystem-based management.

CAMPBELL, TIM[1] and VENNIE-VOLRATH, E[2]., [1]University of Wisconsin Sea Grant Institute, 141 NW Barstow, Room 180, Waukesha, WI 53188., [2]Wisconsin Department of Natural Resources.

Decontamination Recommendations for Aquatic Invasive Species

The Stop Aquatic Hitchhikers! campaign and its simple, yet effective guidance of "Clean Drain Dry" has been the primary focus of aquatic invasive species prevention efforts. However, there are actions that can be taken in addition to the Stop Aquatic Hitchhikers! guidance to further reduce the probability of transporting aquatic invasive species. In Wisconsin, these actions have been termed watercraft decontamination actions and can range from a chemical treatment to a high pressure, hot water wash. In order to better define watercraft decontamination and when these actions may be appropriate, an ad hoc decontamination policy team was formed in 2012. This presentation outlines the recommendations of this policy team while also providing examples of how watercraft decontamination techniques are currently being used throughout Wisconsin.

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Avoiding Loss and Reducing Risk along Lake Michigan: Identifying, Mapping, and Mitigating Coastal Flood Hazards

This presentation will provide an overview of the Lake Michigan Great Lakes Coastal Flood Study (GLCFS) that is currently being performed under FEMA's Risk Mapping, Assessment, and Planning (Risk MAP) program. The study will result in updated flood risk information that will be delivered to state and local government and other stakeholders in a manner that will seek to enhance existing efforts in loss reduction and public safety and inspire new evaluation of hazard mitigation options and incentives.

Under FEMA's Risk MAP Program, FEMA Region V established an effort to evaluate the coastal flood hazard risks throughout the Great Lakes. The historical record of storm surge and wave observations in Lake Michigan was used to identify 150 events for use in basin wide storm surge and wave models. The results from the storm surge and wave model are being used by FEMA's mapping partner, STARR, to identify and map coastal flood hazards in Lake Michigan. The National Flood Insurance Program requires the identification of 4 coastal flood hazards: stillwater elevation, overland wave propagation, wave runup and overtopping, and primary front dunes. These 4 hazards are evaluated on a transect basis in each of the counties boarding Lake Michigan using new methods established as part of the Risk MAP program. The basin wide and transect based approaches will be presented as well as ancillary material developed and collected as part of the Great Lakes Coastal Flood Study.

This presentation will also look at opportunities for Lake Michigan communities to integrate data and information produced and gathered during FEMA's ongoing Lake Michigan GLCFS into existing community planning and hazard mitigation activities in cost-effective, efficient ways. The presentation will discuss the opportunities for technical assistance, partnerships, and collaboration between FEMA Region V, GLCFS project teams, state partners, local communities, and local champions that may arise during the course of the Lake Michigan coastal flood study, as well as how the study seeks to enhance those interactions and discussions by using study data and products to help work with stakeholders to identify natural hazard problems areas and implement activities to reduce risk.

CHIPAULT, JENNY[1], WHITE, L.[1], JENNINGS, S.[2], RAY, D.[2], LIPSCOMB, A.[2], TYNER, E.[2], VAN ZOEREN, A.[2], MCCORMICK, D.[3], CLARK, M.[4], CYR, M.[4], STROM, S.[4], DAVID BLEHERT, D.[1], NAJACHT, Z.[1], [1]US Geological Survey, National Wildlife Health Center, 6006 Schroeder Rd, Madison, WI, 53711, [2]National Park Service, Sleeping Bear Dunes National Lakeshore, Empire, MI, [3]Common Coast Research and Conservation, Hancock, MI, [4]Wisconsin Department of Natural Resources, Wildlife Health Program, Madison, WI.

Monitoring Avian Botulism Related Mortality along Northern Lake Michigan Beaches, 2010-2012

Bird mortality caused by ingestion of a toxin produced by the bacterium *Clostridium botulinum* has been periodically reported on the Great Lakes since the 1960s. Resurgence of avian botulism outbreaks since the late 1990s has brought renewed attention to this wildlife health issue. As part of the Great Lakes Restoration Initiative (GLRI), a citizen science program called Lake Michigan Volunteer AMBLE (Avian Monitoring for Botulism Lakeshore Events) began in Door County, Wisconsin in summer 2011. AMBLE was modeled after the ongoing volunteer-based monitoring program managed by the National Park Service since 2006 at Sleeping Bear Dunes National Lakeshore, Michigan. Active beach monitoring was also performed in 2010-2012 by biologists with the Wisconsin Department of Natural Resources in Door County and with Common Coast Research and Conservation in the Upper Peninsula of Michigan. Volunteers and biologists followed the same protocol and regularly walked designated sections of lakeshore during June through November. Data on species and numbers of healthy, sick, and dead birds observed were collected and environmental conditions were noted. There was year-to-year variation in species affected and timing of peak mortality. During years with overall high levels of mortality (1,500 in 2010 and 2,500 in 2012) there was an autumn peak in the number of dead birds, with mostly migratory diving and fish-eating birds affected (e.g., common loons and long-tailed ducks). In contrast, 2011 was a year with a relatively low level of mortality (500) and there was a summer peak in mortality that involved mostly shorebirds and fish-eating birds (e.g., gulls and double-crested cormorants). A subset of fresh carcasses found on beaches was tested for botulinum toxin at the US Geological Survey, National Wildlife Health Center; roughly 60% were positive for botulism type E. The GLRI supported study of avian botulism dynamics on Lake Michigan continues in 2013.

CHOY, STEVE[1], GALBRAITH. B.[2], and WARNER, S.[1], U.S. Fish & Wildlife Service, 505 Science Drive, Madison, WI 53711, [2]U.S. Fish & Wildlife Service, Green Bay Field Office.

Collaborative Efforts to Restore Ecosystems Surrounding Major Tributaries within Wisconsin's Lake Michigan Basin, Wisconsin, USA

Lake Michigan, Green Bay, and their tributaries have been historically important centers of industry in Wisconsin. As cities grew around these important shipping ports, river and harbor sediments were polluted by contaminants, and fish and wildlife habitat were lost. The impairments at several of these major tributaries, including the Menominee River, Sheboygan River, and the Lower Green Bay/Fox River, led to individual designations as an Area of Concern (AOC) by the International Joint Commission of Canada and the United States. In recent decades, various conservation partners have collaborated to implement remediation and restoration projects focused on removing contaminated sediment and improving fish and wildlife habitat at these 3 AOCs. Millions of cubic yards of contaminated sediment have been removed from these tributaries through remedial programs led by state and federal agencies. Natural Resource Damage Assessment (NRDA) activities directed by federal, state, and tribal trustees have contributed to a deeper understanding of fish and wildlife injury due to contaminants and in some instances, provided settlement funding for restoration projects. AOC conservation partners have also implemented restoration projects focused on improving fish and wildlife habitat and restoring their

populations. To achieve successes at these sites, a collaborative approach among agencies and stakeholders has improved project efficiency for restoration implementation. Case studies exploring the collaborative approach to ecosystem restoration at these three AOCs will be presented.

CHUN, CHAN LAN[1], BYAPPANAHALLI, M.N.[2], PELLER, J.[2], WHITMAN, R.L.[2], TEPP, W.H.[3], LIN, G.[3], JOHNSON, E.A.[3] and J. SADOWSKY, M.J.[1], [1]BioTechnology Institute, University of Minnesota, St. Paul MN 55108, [2]Lake Michigan Ecological Research Station, U.S. Geological Survey, Porter, IN 46304, [3]Department of Bacteriology, University of Wisconsin, Madison WI 53706, [4]Department of Soil, Water, and Climate, University of Minnesota, St. Paul, MN 55108.

Association of *Clostridium botulinum* with the Macroalga *Cladophora* in the Great Lakes

Avian botulism, a paralytic disease of birds caused by ingesting neurotoxins produced by *Clostridium botulinum*, often occurs on a yearly cycle and is increasingly becoming more common in the Great Lakes. We hypothesize that *C. botulinum* grows in the macrophytic alga *Cladophora* spp. and produces toxins which can be subsequently transferred to fish and bird, directly or via other vectors. In this study, free-floating algal mats were collected from shorelines of the Great Lakes between June and October in 2011 and 2012. We quantified the abundance of *C. botulinum* in algal mats and determined the type of botulism neurotoxin (*bont*) genes associated with this organism. Of these, 39 of 53 and 53 of 59 algal mats from shorelines of the Great Lakes contained *bont*-type E genes in 2011 and 2012, respectively. *C. botulinum* was present in up to 15,000 MPN/g dried algae. In addition, *bont*-type A and B genes which are commonly associated with human diseases were detected in a few algal samples. Mouse toxin assays of the supernatants from enrichment of *Cladophora* showed that *Cladophora*-borne *C. botulinum* were toxin-producing species. Our results indicate that *Cladophora* is a habitat for *C. botulinum* throughout the Great Lakes, warranting additional studies to better understand the relationship between this toxic bacterium and this alga, and how this interaction contributes to botulism outbreaks in birds.

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A Case Study of Protecting Critical Coastal Habitat to Protect Biodiversity: Evidence of a Remnant Lake Michigan Cisco Stock

Cisco (*Coregonus artedi*, formerly called lake herring) was historically one of the most important commercial fish species in the Great Lakes. In Lake Michigan, cisco populations were an integral component of the fish community and were a primary diet item for native lake trout piscivores. Invasive species introductions and overfishing have been identified as the primary causes of the cisco declines up to the 1960s and currently only Lake Superior supports an abundant cisco population. The objective of this study was to evaluate evidence of a remnant cisco spawning stock in Grand Traverse Bay, Lake Michigan. Adults were sampled using acoustics, midwater trawls, and gill nets during their potential spawning period (October – December). Adult cisco in spawning condition were collected mainly in weekly gill nets that were set on shallow, rocky coastal habitat. Eggs and emergent fry were also captured, indicating that adult cisco are reproducing successfully on critical spawning reefs in the coastal zone. Several threats (e.g., sedimentation, dredging, invasive species) are impacting these reefs without the awareness or management plans to address the aforementioned threats as a remnant native stock hangs in the balance.

CLARAMUNT, RANDALL, M. and CLAPP, D.F., Michigan Department of Natural Resources, Charlevoix Fisheries Research Station, 96 Grant Street, Charlevoix, Michigan 49720.

Are Management Plans for Pacific Salmonines in the Great Lakes Consistent with Recent Ecological Constraints?

Pacific salmon (genus *Oncorhynchus*) are a valuable resource, both within their native range in the North Pacific rim and in the Great Lakes basin. Understanding their value from a biological and economic perspective in the Great Lakes, however, requires an understanding of changes in the ecosystem and of management actions that have been taken to promote system stability, integrity, and sustainable fisheries. The goal of our evaluation was to highlight differences in management strategies and perspectives across the basin, and to evaluate policies for Pacific salmonine management in the Great Lakes. Currently, a potential conflict exists between Pacific salmonine management and native fish rehabilitation goals because of the desire to sustain recreational fisheries and to develop self-sustaining populations of stocked Pacific salmonines in the Great Lakes. We provide evidence that suggests Pacific salmonines have not only become naturalized to the food webs of the Great Lakes, but that their populations (specifically Chinook salmon) may be fluctuating in concert with specific prey (i.e., alewives) whose populations are changing relative to environmental conditions and ecosystem disturbances. Remaining questions, however, are whether or not "natural" fluctuations in predator and prey provide enough "stability" in the Great Lakes food webs, and even more importantly, would a choice by managers to attempt to reduce the severity of predator-prey oscillations be antagonistic to native fish restoration efforts. We argue that, on each of the Great Lakes, managers are pursuing appropriate goals, managing the aquatic resources of the lakes for the greatest public good, given the variability in conditions and likelihood for success specific to each lake.

CORSI, STEVEN R.[1], BORCHARDT, M.[2], MCLELLAN, S.[3], BALDWIN, A.[1], LENAKER, P.[1], SPENCER, S.[2], PELLERIN, B.[4], BERGAMASCHI, B.[4], MILLEN, H.[1], and GONNERING, J.[1], [1] U.S. Geological Survey, Wisconsin Water Science Center, 8505 Research Way, Middleton, WI, [2]U.S. Department of Agriculture, Agricultural Research Service, [3]University of Wisconsin-Milwaukee School of Freshwater Sciences, [4]U.S. Geological Survey, California Water Science Center.

Hydrologic and Seasonal Patterns in Waterborne Pathogens, Source-specific Bacteria, and Trace Organic Compounds and Indications of Contaminant Sources in Eight Urban and Rural Tributaries of the Great Lakes

Tributaries to the Great Lakes deliver numerous contaminants from a host of originating sources. In this Great Lakes Restoration Initiative (GLRI) study, eight major tributaries to the Great Lakes were studied over a 2-year period. The study took advantage of state-of-the-art analytical and field techniques to characterize pathogens, source-specific fecal indicator bacteria, trace organic chemicals, and optical properties of water. Samples were collected to characterize hydrologic and seasonal variability during low-flow periods (bimonthly) and during runoff event periods (3 times per quarter) in a range of watersheds with a land use gradient from forest to agriculture to urban. A total of 24 pathogens were quantified including 8 human-specific viruses, 3 pathogenic bacteria, 2 protozoa, and 11 bovine-specific viruses. Indicator bacteria included human-specific bacteria, ruminant-specific bacteria, and general fecal indicators. A total of 69 trace organic chemicals were analyzed including 15 classes of compounds to characterize wastewater influence and multiple sources of nonpoint-source contamination. Flow-weighted sampling was conducted using custom-built automatic samplers for large-volume filtration and raw water collection. Concentrations for each individual class of

microbiological and chemical contaminant was explored for hydrologic, seasonal, and land use patterns. In addition, multivariate statistics were used to characterize similarities and differences among these co-occurring contaminants based on hydrologic condition, season, and land use to gain insight into originating sources and conditions that lead to elevated contamination levels. Optical properties of water (fluorescence and absorbance) were measured and explored for utility as surrogates for efficient prediction of the microbiological and chemical parameters. Results of this study are being used to identify tributaries in need of restoration efforts and to formulate next steps for the developing efficient field techniques to identify specific areas in need of restoration.

COTNER, LISA[1], TECIC, D.[1], JOHN LEGGE, J.[1], KREILING, K.[1], RUSZAJ, A.[1], and AMBROZ. D.[1], [1] Illinois DNR Coastal Management Program, 160 North LaSalle, S-703, Chicago, IL 60601.

Mixing Minds, Monkeys and Wikis: A Technological Approach to Setting Implementation Priorities for Lake Michigan

The Illinois Lake Michigan Implementation Plan (ILMIP) is a collaborative effort to create an agenda for the restoration and protection of Lake Michigan coastal resources. It is a shared vision that will guide resource allocations and priorities for the Illinois Coastal Management Program (ICMP). The original concept for ILMIP linked implementation of the Lake Michigan Lakewide Management Plan (LaMP) and ICMP via a wiki. The aim was to use the wiki as a tool for tracking the status of Illinois' coastal projects, a reporting mechanism for a wide variety of public and private stakeholders, and as a networking opportunity to foster watershed-wide dialogues. It was also intended as a repository for information on priority issues within Lake Michigan, including invasive species, habitat and natural area restoration, priority waterways, Waukegan AOC, persistent bio-accumulative toxins, sustainable development, non-point source pollution, public access and recreation, economic development, and climate change. Our vision of how to use technology to achieve our goals evolved over the course of the project and we adopted two more technological solutions, an online survey (conducted through Survey Monkey) and an online Town Hall (hosted by Mindmixer) as tools to engage stakeholders in setting priorities for the Illinois Lake Michigan coast. We will focus on the challenges and successes we experienced in engaging stakeholders with these online tools.

CROSS, JAMIE, Adopt-a-Beach™ Manager, Alliance for the Great Lakes, 41 Washington Ave, Ste. 280D, Grand Haven, MI 49417.

Taking Action to Improve Beach Health through Education

Improving beach health goes beyond updating infrastructure and making physical changes to the beach landscape. Educating park officials and the general public is a role the Alliance for the Great Lakes is playing in an increasing way through the Adopt-a-Beach™ program. Alliance adopters are often approached during their Adopt-a-Beach™ visits by beach goers asking what they are doing or how they can help. We have built on this natural tendency of adopters to connect with beach goers to expand on the Chicago Park Districts Beach Ambassador Program developed and launched in 2011 as part of a GLRI project. Through this program individuals are trained on beach health issues and what people can do on an individual level to make a difference. As part of the training they learn how to best approach beach goers while stationed at beach locations throughout the summer. Building on this work, the Alliance worked with local partners in Cleveland to launch a similar program in 2013 using volunteers as ambassadors. Another effort will be launched in Milwaukee in 2014, which will also include training park staff as ambassadors. To expand on this work the Alliance is working in these communities to decrease

shorebird populations by working with the parks to encourage implementation of simple BMPs including educational signage to discourage people from feeding the birds and littering. Throughout the grant the Alliance has conducted interviews of park staff, food vendors at the location and adopters to gauge any behavior change in park visitors.

D'ALESSANDRO, DOMENICO, President, D'Alessandro & Associates.

Creation of Fish Refugia in Existing Marinas

A large percentage of Great lakes coastal wetlands have disappeared, many that are left are under stress and some only persist due to dike construction that prevent high water levels to flood them out, of course in these conditions they no longer function as coastal wetlands. The recent drop in lake levels is now prompting the removal of these dikes but if water rises again they will need to be rebuilt. Solutions being acted upon are the reclamation of inland wetlands to clean runoff before it enters tributaries to the lake and programs to educate farmers to stop using phosphor and nitrogen laden fertilizers; these are long term solutions. The short term solution still depends on direct applications in the lakes. My proposal utilizes existing marinas to create fish refugia. Marinas already have protective seawalls and barriers that keep large wave action from disturbing the inner harbor's tranquil waters. With some alteration, the existing floating docks would provide support to the proposed series of reef-like vertical aquatic habitats specifically designed for this purpose. These floating and submerged habitats are fitted with small solar-powered pumps and water jets to filter and aerate the water and provide aesthetic value to the marina customers. It is expected that they will also eliminate some odors associated with water stagnation. These marina conversions are not meant to replace wetland mitigation and restoration, however they do provide additional habitat creation opportunities in some of the most restricted and built up areas at a fraction of the cost of the creation of a wetland ecosystem. Where feasible and cost effective vertical watershed units will be proposed for additional habitat creation on land associated with marinas.

DAVIS, KIRA, Little Traverse Bay Bands of Odawa Indians (LTBB), 7500 Odawa Circle, Harbor Springs, MI, 49740

Paradise Lake Pilot Boat Washing Station: Preventing the Spread of AIS in the Lake Michigan Watershed and Engaging a Community

Little Traverse Bay Bands of Odawa Indians (LTBB) partnered with the State of Michigan Department of Natural Resources (MDNR) and Paradise Lake Improvement Board to minimize the spread of invasive species into and out of Paradise Lake, connected and neighboring waters including Lake Michigan through the Carp River, and Lake Huron. LTBB secured funding through a 2011 Great Lakes Restoration Initiative invasive species prevention grant. The funding was used to construct the first free pilot boat washing station at a MDNR owned public access site in Emmet County in the Northern Lower Peninsula of Michigan. The boat washing station now plays a vital role in minimizing the transfer of Eurasian Milfoil and Zebra Mussels already present and infesting Paradise Lake. This project was unique and efficient as Emmet County borders the north east shoreline of Lake Michigan and the northwest tip of Lake Huron. A survey assessed whether or not water users would use the boat wash. The surveys also assessed what types of best management practices water users employ and what prevents water users from taking action to prevent invasive species. Based on the surveys, education and outreach items were created by a public workgroup formed to increase community involvement

and collaboration. Some of the information produced through this project included, invasive species laminated ID cards, shoreline management and recreation users best practices rack cards to be displayed and available to public at a three panel kiosk to be installed at the public access and wash site. The project and workgroup enabled collaboration on future projects on this site including a greenbelt, rain garden, and site renovations. The presentation will walk through the entire project, display education outreach items, recommendations for project transferability , highlight the successes and discuss difficulties encountered along the way.

DEMARIA, ANNETTE[1], O'REILLY, K.[2] and FERNANDEZ, R.[3], [1]Environmental Consulting & Technology, Inc., 33900 Harper Ave., Suite 101, Clinton Township, MI 48035., [2]St. Clair County Health Department, [3]City of Marysville.

Chrysler Beach Stormwater Improvements: Securing Funding and Developing a Design to Reduce the Number of Beach Closures

The City of Marysville had plans to redevelop its waterfront at Chrysler Beach, but a lack of funding coupled with water quality impairments stalled their vision. Chrysler Beach is one of two public beaches located on the St. Clair River which serves as a connecting channel between Lakes Huron and Erie. The beach suffers from occasional closures due to elevated levels of *E. coli*. Beach sanitary surveys completed by the St. Clair County Health Department identified stormwater runoff and Canada Geese as the primary contributors of *E. coli* at the beach. The County subsequently conducted two Goose Round-ups at the beach and at surrounding areas which immediately reduced the number of geese at the beach. In addition, the County identified illicit connections to the city's storm sewer. Meanwhile, the City developed plans to more permanently address the *E. coli* sources. A conceptual design and cost estimate for the waterfront was completed that included green infrastructure practices to improve stormwater quality and naturalization measures to reduce the numbers of Canada Geese at the beach. The conceptual design was the basis for a successful Great Lakes Restoration Initiative grant. The design incorporates the removal of unused impervious surfaces and use of rain gardens and trees to treat runoff from the parking lots. Also, tall native vegetation will create a buffer along the beach that will capture runoff and serve as a passive bird exclusion tactic. In order to improve usage of the waterfront, the design also included several recreational elements including a water-themed playground, picnic area, fishing pier, boat ramp, wave break, and fish cleaning station. Funding for these elements is being sought from various state programs.This presentation will describe how GLRI funding is being used to kick start waterfront improvements along the Great Lakes and the planned green infrastructure practices.

DE PETRO, P.A.[1]; KREIS, R.G.[2]; ROWE, M.D.[3]; MELENDEZ, W.[4] and PAUER, J.J.[2], [1]ICF International. 9311 Groh Road, Grosse Ile, MI 48138, [2]USEPA/ORD/NHEERL/MED Grosse Ile, Michigan, [3]NRC Research Associate, NOAA, GLERL, Ann Arbor, Michigan, [4]CSC, Grosse Ile, Michigan.

One Size Fits All? Nearshore and Offshore Responses to Phosphorus Loadings in a Changing Lake Michigan

Historically, the water quality in the Great Lakes has been described on a lake-wide basis. The Great Lakes Water Quality Agreement (GLWQA) established a lake-wide spring total phosphorus (TP) goal of 7 ug/L for Lake Michigan, with target TP loading of 5600 metric tons. In recent years, TP loads have been significantly less the GLWQA target load (estimated range: 2472- 4705 metric tons for 1994-2008) resulting in lake-wide TP around 4 ug/L. As the offshore zones of Lake Michigan have become increasingly oligotrophic, the nearshore has increasingly shown signs of eutrophication, such as the reemergence of cladophora. Since the nearshore and offshore zones of Lake Michigan appear to be responding differently to changes in the food web (i.e. invasive species), a water quality model is applied to evaluate the merit of using a single loading target for a complex system. Both lake-wide and nearshore zones were examined, looking at ways to quantify nutrient dynamics under variable loading scenarios. Our analysis supports the idea that while the existing GLWQA target loading results in offshore TP concentrations less than the goal, site-specific nearshore loading targets may be needed to mitigate reemerging nearshore problems in the face of a changing ecosystem.

EDGE, THOMAS and HILL, S., National Water Research Institute, Environment Canada, 867 Lakeshore Road, Burlington, Ontario, Canada L7R 4A6

Gradients of *Escherichia coli* numbers and antimicrobial resistance at urban beaches in southern Ontario

Beaches throughout the Great Lakes are commonly found to have gradients of *Escherichia coli* concentrations. High *E. coli* concentrations in foreshore beach sand (interstitial sand pore water) progressively decline in beach water moving offshore from ankle depth out to chest depth. A better understanding of the significance of these gradients of *E. coli* concentrations is needed. Do elevated *E. coli* concentrations in beach sand represent potential health risks? Does resuspension of *E. coli* in beach sand through wave action contribute significantly to beach postings? To contribute to this research need, field studies were conducted over several years to characterize the numbers of *E. coli* in foreshore beach sand (interstitial pore water) and adjacent ankle and chest depth water at nine urban beaches in Toronto, Hamilton, and Ottawa. High concentrations of *E. coli* were found in interstitial pore water at some beaches, and *E. coli* concentration gradients varied considerably between beaches. The variation in *E. coli* concentration gradients will be described between transects within a beach, between beaches, and over time at beaches. Installation of a curtain system at one Toronto beach allowed comparison of *E. coli* concentration gradients between locations outside the curtain to those inside the curtain with freshly deposited beach sand and continuous UV water treatment. At a subset of beaches, *E. coli* isolates were analyzed for resistance to 12 different antimicrobials. Those isolates from beach sand generally showed a lower frequency of antimicrobial resistance than adjacent beach water.

EGGOLD, BRADLEY, T. Wisconsin Department of Natural Resources, 600 E. Greenfield Avenue, Milwaukee, Wisconsin, 53204.

Using a Streamside Rearing Facility on the Milwaukee River for Lake Sturgeon Rehabilitation

Lake Sturgeon, *Acipenser fulvescens,* historically were abundant in Lake Michigan, with spawning populations using many of the major tributaries and several shoal areas of the lake (Auer 1999, Holey et al. 2000). Their rapid decline in Lake Michigan coincided with habitat destruction, degraded water quality, and intensive commercial fishing associated with European settlement in the region. A streamside rearing facility was designed, constructed and installed on the Milwaukee River to begin the rehabilitation of Lake Sturgeon. This streamside rearing was put into operation in 2006 and has now been in operation for seven years with the eighth year underway. Information compiled during these seven and a half years of operation will be discussed including information on construction and installation of the streamside trailer, number of fish stocked and comparison to other hatchery stocked fish, problems and solutions to rearing Lake Sturgeon in a streamside facility, cooperation and involvement of Riveredge Nature Center and volunteers to operate the facility and the long-term goals of the project.

EICHELKRAUT, SUSAN, MANZ, C. and MADSEN, L., Lake Michigan Ballast Water Inspector, Wisconsin Department of Natural Resources, 2300 N DR MLK JR DR, Milwaukee, WI 53212.

Wisconsin's Ballast Water Program Implementation: Step 1 in the Fight against New Aquatic Invasive Species Introductions to the Great Lakes

The Great Lakes have been devastated by over 180 non-native aquatic species, many of which are invasive and were introduced by ballast water discharges. For any part of an aquatic invasive species (AIS) strategy to work, we need to prevent the introduction of new species and the spread of existing AIS. This prompted the Wisconsin Department of Natural Resources to issue its own permit regulating ballast water discharges from large vessels in 2010, because federal regulations were not stringent enough to protect Wisconsin waters. Implementation of the new ballast water program includes issuing permits along with conducting outreach and inspections aboard vessels. Our presentation will provide a review and update of Wisconsin's ballast water program and summarizing results of our inspections. We will also discuss the importance of continuing to regulate ballast water as the first step in preventing new AIS from infesting Lake Michigan and provide an update on the current status on state and federal regulations.

ELLIOTT, ROBERT F.[1], HOLTGREN, M.[2], BAKER, E.[3], SMITH, K.[3], CAROFFINO, D.[3], EGGOLD, B.[4], BAUMGARTNER, M.[4], DONOFRIO, M.[4], ALOISI, D.[1], SCRIBNER, K.[5], REUTZ, C.[6], and SLOSS, B.[7], [1]U.S. Fish and Wildlife Service, Green Bay Fish and Wildlife Conservation Office, 2661 Scott Tower Drive, New Franken, WI 54229. [2]Little River Band of Ottawa Indians, [3]Michigan Department of Natural Resources, [4]Wisconsin Department of natural Resources, [5]Michigan State University, [6]Grand Valley State University, [7]US Geological Survey, WI Cooperative Fishery Research.

Population Status and Efforts towards Rehabilitation and Restoration of Lake Sturgeon, *Acipenser fulvescens*, in Lake Michigan and its Tributaries.

Lake sturgeon was a dominant component of the historic Lake Michigan fish community. Large populations spawned in tributaries throughout the basin and contributed significantly to the culture and sustenance of native peoples. In the late 1800s habitat loss, degraded water quality, and intense fishing associated with increased settlement of the region led to rapid range-wide declines and extirpation of many populations. Throughout the last century, most populations have remained severely depressed, though natural reproduction has sustained small populations that currently spawn in at least 9 Lake Michigan tributaries. Annual abundance of spawners in each river ranges from <50 to several hundred fish with lake-wide abundance estimated at approximately 5000 adults, less than 1% of historic levels.

Growing interest in sturgeon rehabilitation and restoration in recent decades has spurred development of management and rehabilitation plans, strategies, and guidelines that now facilitate efforts by management agencies to increase abundance and distribution of this species. Consistent with genetic stocking guidelines, streamside rearing was first initiated in 2004 on the Manistee River and has since expanded to 6 rivers with funding assistance from the GLFT, GLRI and GLFWRA. Streamside facilities use river water to incubate and culture young fish to promote imprinting, thus reducing unwanted genetic consequences associated with straying of stocked fish. Since 2004, >14,000 fingerling lake sturgeon have been released from these streamside facilities. In addition, sturgeon are now protected in all Lake Michigan and lower tributary waters, and chemical treatments to control lamprey follow new protocols that ensure survival of young sturgeon. Riverine habitat restoration and improved regulation of river flows is enhancing spawning and early life stage production, and the removal of dams and installation of purpose built fish passage structures designed to accommodate sturgeon should further improve the success of Lake Michigan's lake sturgeon populations.

ENDRES, SARAH, BOURGEAU-CHAVEZ, L.L., LAUBACH, Z., MILLER, M.E., BANDA, E., BATTAGLIA, M., LANDON, A., and SCARBROUGH, K., Michigan Tech Research Institute, 3600 Green Ct. Suite 100, Ann Arbor, MI 48105, USA.

Mapping Coastal Great Lakes Wetlands and Adjacent Land Use through Hybrid Optical-Infrared and Radar Image Classification Techniques

In the U.S., the National Wetland Inventory (NWI) is the most contiguous and current wetland map available, yet it lacks information on lands adjacent to wetlands and the distribution of invasive plants. Existing Canadian maps are comprised of a mosaic of mapping techniques, sources, and resolutions. A consistent baseline map is needed to monitor change in coastal ecosystems. Short falls in long-term monitoring is in part caused by reliance on dated, static, and inconsistent maps. Use of SOLEC or GLEI indicators is impeded by limitations of current maps, impacting the ability to monitor and detect effects from significant wetlands stressors; urban development and invasive plant species.

Current work is underway to produce an international and contemporary baseline map for the Great Lakes Basin. Due to the complexity of wetland ecosystems, detection of species and extent as well as adjacent land use can be accomplished using sensor fusion approach.

Synthetic Aperture Radar (SAR) is sensitive to flood condition as well as structure and biomass. Optical sensors, such as Landsat TM, are complementary in the classification and monitoring of wetland ecosystems. Previous research demonstrated the capability of ALOS PALSAR L-band data for detecting and mapping invasive *Phragmites australis*. The international wetlands map is being produced from a fusion of PALSAR and Landsat data and aims at detection of large stands of problematic plant species such *Phragmites australis* and *Typha spp*. A Random Forests classifier is used to create a land cover map through the integration of field and air photo interpreted data with underling sensor fusion data. The Lake Michigan map is complete and is being evaluated for accuracy through randomly selected field and air photo interpreted validation data. The basin wide maps will provide the first ever international Great Lakes coastal land cover map suitable for coastal wetland assessment and management.

FERMANICH, KEVIN, BAUMGART, P. and HEIM, A., University of Wisconsin – Green Bay, 2420 Nicolet Drive, Green Bay, WI 54311.

Event Driven Loads in the Fox River Basin: Science, Awareness, and Management

Overall annual loading in the Fox River and other Lake Michigan tributaries is dominated by snowmelt and spring runoff. However, summer and fall storms also contribute a significant portion of the annual load. Phosphorus and sediment export from Lower Fox River watersheds is highly event driven. For all but the larger East River, more than 65% of the annual P load and 80% of the annual TSS load is exported to the Fox River in only 14 days. Eight events per year accounted for 92% of annual TSS export and 79% of annual P export from the Plum Creek watershed in water years 2011 and 2012. The second largest daily load of TSS and P occurred on April 11, 2011. Dramatic aerial photos of sediment plumes in Green Bay taken the following day have captured people's attention and resulted in renewed efforts to address runoff pollution originating in the Fox River watershed. For any particular event, the vulnerability of the agricultural landscape with respect to erosion and P sources greatly influences the magnitude of pollutants exported from a watershed. Event driven loads, like those in April 2011, can be significantly reduced if land and watershed management practices are focused on reduced vulnerability and resilience to these types of climatic forcings.

FITZPATRICK, FAITH A., RENEAU, P. and WESTENBROEK, S., U.S. Geological Survey Wisconsin Water Science Center, 8505 Research Way, Middleton, WI, 53562.

Taking into Account Lake Level Changes and Seiche Effects in Designing Habitat Improvements in Lake Michigan Rivermouths -- Sheboygan River Area of Concern

In 2011 and 2012, the U.S. Geological Survey collected detailed data on the hydrologic, hydraulic, and geomorphic of the lower 3 kilometers of the Sheboygan River for the Sheboygan River Area of Concern. These data were collected to assist WI Department of Natural Resources in the design and assessment of three large habitat improvement projects. Data included georeferenced bathymetry, velocity, bank, and substrate measurements as well as continuous water level measurements. The water level measurements were referenced to river flows and lake levels. The geomorphic history and stability of an ecologically important island complex was studied to determine the age of the island complex and the effects of inundation of island surfaces on riparian vegetation. A 2-D channel hydraulics model was developed for simulating the interplay of riverine flows with lake levels and sieche effects to determine the resiliency of hydraulic, geomorphic, and habitat conditions for both existing and possible future habitat conditions under future climate scenarios, including decreased water elevation in Lake Michigan and increased frequency and magnitude of sieche-driven water level changes related to storm surges and and frontal systems.

FRY, LAUREN[1], ANDERSON, E.[2], CAMPBELL, K.[3], KRAMER, E.[3], RITZENTHALER, A.[3], and GRONEWOLD, D.[2]
[1]Cooperative Institute for Limnology and Ecosystems Research (CILER), University of Michigan, 4840 S. State Rd, Ann Arbor, MI 48108, [2]National Oceanic and Atmospheric Administration, Great Lakes Environmental Research Laboratory, [3]Cooperative Institute for Limnology and Ecosystems Research (CILER), University of Michigan.

Representation of Spatial and Temporal Variability in Beach Water Quality Using a Bacteria-Hydrology-Hydrodynamics Modeling Framework

Regression models have demonstrated relationships between hydrometeorological variables and presence of fecal indicator bacteria (FIB), and represent a significant advancement over the persistence model in which beach closures are determined using nearly day-old water quality observations. However, the spatial and temporal variability of hydrometeorological variables, and presumably their resulting impacts on water quality, likely occur at scales for which representation by regression equations may be limited. We investigate the potential for forecasting beach water quality using a linked modeling framework in which a watershed loading model is coupled with a 3D hydrodynamic model and 3D particle tracking model to simulate FIB occurrence along the Lake St. Clair Metropark beach, which is impacted by two outlets of the primarily urban and agricultural Clinton River watershed. The FIB loadings are determined by simulating the accumulation, wash-off, and die-off of bacteria on a landscape, where wash-off is determined by the amount accumulated on the landscape in a previous timestep and effective rainfall (simulated by the IHACRES hydrological model), and accumulation and die-off are affected by a first-order decay coefficient. The resulting loadings are then used to scale simulated particles for the 3D particle tracking model (P3D) in which neutrally-buoyant particles are released hourly from the river outlets and advected by currents simulated by the Finite Volume Coastal Ocean Model (FVCOM) within the Huron-Erie Connecting Waterways Forecasting System (HECWFS). Incorporation of the particle tracking allows for representation of large spatial and temporal gradients. The spatial and temporal variability in the resulting water quality simulations will be compared with that demonstrated by observations at the Lake St. Clair Metropark beach.

GREB, STEVEN and GARRISON, PAUL, Wisconsin Dept. of Natural Resources, 2801 Progress Rd. Madison, WI 53716.

Spatial and Temporal Variability of Water Quality in Nearshore Areas of Western Lake Michigan

Six systematic nearshore water quality surveys have been conducted from 2004 to 2013 by the Wisconsin Department of Natural Resources. Eighteen stations from Kenosha, WI to the Garden Peninsula (including bay of Green Bay) in Lake Michigan were established along the 10-meter contour. The objective of this ongoing work is to measure physical, biological and chemical parameters to improve our understanding of this dynamic nearshore area with particular focus on parameters important to Cladophora growth, which in recent years has reemerged as a significant localized issue along Lake Michigan's west shore. This effort will eventually provide a decision support tool for possible corrective management. In addition, a nearshore continuous water quality monitoring station was established in 2010 in the nearshore off Kewaunee WI. These high-frequency measurements capture the dynamic nature of water quality (e.g. episodic events and changing currents).

GUNN, JOSH, LAPORTE, E. and SAMPLES, A., Michigan Sea Grant, 21885 Dunham Rd. Suite # 12, Clinton Township, MI 48036.

Great Lakes Clean Marina Network: Collaborative Efforts to Protect the Triple Bottom Line

The Great Lakes Clean Marina Network has evolved significantly throughout the life of the Green Marina Education and Outreach Project, a Great Lakes Restoration Initiative (GLRI) grant funded project. The network has facilitated the development and distribution of tools and resources intended to assist Clean Marina programs from all eight great lakes states in a joint effort to reduce the impact of boating and related activities in Great Lakes coastal areas. By minimizing this impact, long-term functioning of coastal areas as places for recreation and wildlife habitat can occur. These functions support the "triple-bottom line" by improving quality of life of Great Lakes coastal residents, supporting coastal community and boating economies, and protecting the environment.

As the Green Marina project nears completion, multiple successes due to the project have become evident; including the development of three additional certification programs in the Great Lakes, regional agreement on best practices at Great Lakes marinas, and savings from the development of signage and literature that can be used by Clean Marinas from all Great Lakes states. Additionally, there have been some lessons learned, especially in regard to what can be achieved with Clean Marina programs that are so vastly different from one another. Both the successes and lessons learned will guide the Great Lakes Clean Marina Network into the future, as this network evolves once again and becomes the primary method for industry, academia, and government from all Great Lakes states to interact with one another as they continue to share tools and resources. Collaborative efforts within the network will also ensure a return-on-investment from grant funding that goes beyond the life of the GLRI grant.

HANSON, S. DALE, HOLEY, M.E., TRESKA, T.J., and BRONTE, C.R., U.S. Fish and Wildlife Service Green Bay Fish and Wildlife Conservation Office, 2661 Scott Tower Drive, New Franken, Wisconsin 54229.

Natural Reproduction of Lake Trout in Lake Michigan …Finally Some Good News!

Lake trout were extirpated in Lake Michigan by the mid-1950s as a result of the invasive sea lamprey and fishing exploitation. Once sea lamprey numbers were reduced efforts to restore self-sustaining populations of lake trout began with stocking of hatchery-reared lake trout in 1960 and upwards of two million lake trout yearlings have been stocked each year since 1970. Stocked lake trout were marked with a fin-clip prior to their release to designate their hatchery origination. Despite fifty years of lake trout stocking, very few unclipped lake trout had been recovered as fishing exploitation, continued sea lamprey predation, pollution, unsuitable stocking practices, and thiamine deficiencies attributed to alewife consumption continued to hinder natural reproduction among the stocked lake trout. However, in recent years a new winter gill-net survey in deep-water habitats of western Lake Michigan found that roughly 20% of the young lake trout were unclipped and of wild origin. Wild fish spanned a range of age-classes indicating natural reproduction occurred in consecutive years between 2006 – 2010. Spring and fall assessment surveys, and creel monitoring of the recreational fishery provides further support that lake trout are naturally reproducing, albeit at low levels, in other areas of the lake but natural reproduction appears to be most concentrated in the southern waters of Lake Michigan. Harvest regulation, sea lamprey management, improvements to water quality, and offshore fish stocking practices were all necessary actions leading up to natural reproduction, but evidence suggests declining alewife populations may be the trigger behind these recent observations of wild lake trout.

HARRIS, VICTORIA[1], QUALLS, T.[1], AND HARRIS, H.J. [2], [1]UW Sea Grant Institute, 2420 Nicolet Drive, Green Bay, WI 54311-7001, [2] University of Wisconsin-Green Bay, Green Bay, WI.

Diving Duck Use in Lower Green Bay Before and After Dreissenid Mussels

HARRISON, JANE, University of Wisconsin Sea Grant Institute.

Economics Benefits of AOC Remediation & Restoration: Improved Recreation & Business Growth in the Great Lakes

In August 2012, the U.S. Environmental Protection Agency targeted up to $57 million in Great Lakes Restoration Initiative funds for five projects in the Sheboygan River. Projects undertaken include dredging contaminated sediment from the river and habitat restoration. The State of Wisconsin, the City of Sheboygan, and Sheboygan County contributed $5 million to the dredging projects, and two Superfund dredging projects have also been completed, resulting in a total of $80 million spent to improve the Sheboygan River (EPA 2013).

This presentation will describe a study to estimate the economic benefits of restoration and remediation of the Sheboygan River AOC. Economic benefits are estimated by revenue from improved water-based recreation and waterfront business growth. A number of studies have estimated the economic benefits of *proposed* restoration and remediation of AOCs throughout the Great Lakes (Austin et al. 2007; Braden et al. 2008a; Braden et al. 2008b; Lichtkoppler and Blaine 1999; McMillan 2003). No studies are known to estimate the economic benefits post-restoration and remediation for any Great Lakes AOCs. This presentation will provide an overview of economic benefits from AOC remediation and restoration throughout the Great Lakes.

HAUGLAND, RICHARD A.[1], DUFOUR, A. [1], BRENNER, K.[1], WADE, T.[2], and SAMS, E.[2], [1]U.S. Environmental Protection Agency, Office of Research and Development, National Exposure Research Laboratory, 26 West Martin Luther King Drive, Cincinnati, OH, 45268, [2]U.S. Environmental Protection Agency, Office of Research and Development, National Health Effects and Environmental Effects Research Laboratory.

Estimation of *Enterococcus* qPCR Target Sequence Recoveries from the EPA NEEAR Study Calibrator Samples

Recently released beach action values from the U.S. Environmental Protection Agency (EPA) for recreational water quality monitoring results of a quantitative polymerase chain reaction (qPCR) method are expressed as *Enterococcus* calibrator cell equivalents (CCE). The CCE reporting unit stems from the calibration model that was used by EPA to quantitatively estimate water sample *Enterococcus* cell densities in a series of Great Lakes and marine beach epidemiological (NEEAR) studies from which health relationships and the beach action values were derived. This calibration model assumes that the recoveries of the qPCR assay target sequences are similar for different preparations of *E. faecalis* cells that are used to make the calibrator samples employed in the model. Recent results from several studies have challenged this assumption and raised questions about the potential comparability of CCE estimates from different laboratories to the EPA guidelines. To address this issue, an analysis was conducted to estimate the mean recovery of target sequence copies and sequences per calibrator cell for the calibrator samples from the NEEAR studies. This presentation outlines the importance of establishing a standard target sequence to calibrator cell ratio and summarizes the development of this ratio for the NEEAR studies. The estimate of the sequences/cell can be used as a benchmark for establishing comparability of other CCE estimates from the qPCR method with the EPA beach action values.

HRON, STACY[1], PAPPAS, V.[1], WILLIAMS, H.[2], PELISHEK, C.[3], BRAULT, A.[4], and BEYER, D.[5], [1]Wisconsin Department of Natural Resources, 1155 Pilgrim Road, Plymouth, WI 53073, [2]USEPA, [3]City of Sheboygan, [4]Sheboygan County, [5]UW-Extension.

Progress Towards Delisting the Sheboygan River: Area of Concern to Area in Recovery

GLRI resources have been focused in the Sheboygan River Area of Concern (AOC) in order to accelerate the pace at which actions such as contaminated sediment removal and habitat restoration can take place in order to address impairments. Over $83 million in public and private funding has kick-started restoration activities that have languished for decades with little or no funding and achieve objectives of the GLRI Action Plan and Sheboygan River AOC Remedial Action Plan. This presentation shares insights on the successful implementation and coordination of numerous and concurrent large scale remediation, restoration and assessment projects. These diverse projects include two Superfund remedial actions, Great Lakes Legacy Act contaminated sediment dredging, navigational dredging, seven diverse habitat restoration projects (riparian corridor fish and wildlife habitat restoration, wetland restoration, habitat restoration in an island complex, shoreline stabilization in problem areas, in-stream habitat improvements, targeted invasive species control, conservation planning for 180 acre remnant natural area) and four assessment projects (fish and wildlife surveys and contaminant monitoring, waterfowl consumption advisory evaluation, fish tumor rate evaluation, plankton and benthic community assessment). Learn about the extraordinary amount of progress that was made from fall 2010 through spring 2013 in this AOC. These comprehensive efforts represent all “on-the-ground” management activities necessary in the Sheboygan River AOC. From planning through execution, the complex pathway to move the river from impaired to in recovery will be detailed. The important role of

partnerships, community outreach, maintaining quality under tight timelines, management support in integrating multiply programs and engaging stakeholders will be highlighted.

HUMMER, JOHN, Contractor, Great Lakes Commission, 2805 S. Industrial Hwy., Suite 100, Ann Arbor, MI 48105.

Evaluating and Enhancing Lake Michigan Nearshore Monitoring

Nearshore sampling and monitoring is a key component of the Lake Michigan LaMP; however, monitoring efforts can be enhanced to be more comprehensive and efficient. The LaMP explicitly states "…*Current monitoring challenges in the Lake Michigan basin include: incomplete inventories of federal, state/provincial and municipal observation and monitoring*."

This presentation will summarize the key highlights from a recently completed *Lake Michigan Nearshore Monitoring Status Report and Assessment*. This document drew its conclusions from an inventory of Lake Michigan nearshore monitoring activities conducted in winter/spring 2013 by the Great Lakes Commission. The document and the this presentation assess Lake Michigan nearshore monitoring activities and metadata over the past several years gleaned from the inventory and provides recommendations for improving efficiencies and collaborative monitoring opportunities throughout the basin. The presentation will address four main criteria set forth in the GLRI Action Plan for nearshore monitoring in the Great Lakes: (1) Did the nearshore monitoring program provide the necessary scientific basis to assess the physical, chemical, and biological integrity of the nearshore environment?; (2) Did the nearshore monitoring help target future restoration and protection efforts needed?; (3) Did the assessment establish baseline conditions of environmental quality and variability of the nearshore waters, bottom substrate, and biota?; and (4) Did the nearshore monitoring build on U.S. EPA's National Coastal Assessment framework? The presentation will also identify nearshore monitoring gaps that may exist in the Lake Michigan nearshore zone.

This work will help address stresses on the nearshore zone of Lake Michigan by promoting a more effective use of nearshore monitoring data that will result in more informed management decisions and strategies, increased identification and implementation of priority restoration and protection projects, and improved management of monitoring programs and resources. Collectively, this work will advance a more effective and efficient management regime for Lake Michigan.

JANSSEN, JOHN, School of Freshwater Sciences, University of Wisconsin-Milwaukee, 600 East Greenfield Ave., Milwaukee, WI 53204.

The King is Dead, Long Live ?????

The Lake Michigan fishery appears to be heading towards disarray. Again. There have been two ecosystem-changing invasions to Lake Michigan. The first was the "top-down" sequence of the parasitic sea lamprey extirpating predators such as the lake trout, with the alewife invasion close on its heels. The second was the "bottom-up" dreissenid invasion, the major component of the Ponto-Caspian invasions, that has redirected pelagic primary production to the benthos. The management response to the sea lamprey/alewife invasions was a major rethinking of the fishery and ecosystem that culminated in the introduction of two Pacific salmons, the coho and the Chinook (king) salmons, that controlled the alewife while creating what was termed a "fish farm" by the managers who proposed the introductions. While introductions of non-native fishes is controversial by today's management standards that favor native species, the program was a two-pronged success by economic standards through creation of a

major sport fishery that controlled a nuisance invader. The dreissenid invasions have undermined the fish farm by consuming the phytoplankton base of the pelagic food web that drives alewife production and subsequent salmon growth. In this pelagic vacuum benthic coastal production has increased in importance. From a fishery perspective this can be thought of as either catastrophe or opportunity. Regardless, a new ecosystem is emerging rapidly forcing rethinking of the ecosystem and how it is managed. That managed ecosystem will need to be framed with respect to regional variation in benthic habitat, spawning tributaries, and Lake hydrodynamics. If we are clever, the fishery will be different, but more diverse and accessible.

JONES, PHILLIP and EDDY, M.C., RTI International, 3040 E Cornwallis Road, PO Box 12194, Research Triangle Park, NC 27709.

Using a Probabilistic TMDL Framework to Characterize *E. coli* Source and Transport Mechanisms for IL Lake Michigan Beaches

Lake Michigan beaches and their coastal waters are highly valued societal and ecological resources. These beaches are widely popular, heavily used, and frequently monitored by stakeholders and local governments to ensure that water quality conditions support safe and healthy recreation. 51 Lake Michigan shoreline segments located in Cook and Lake Counties, IL, were identified by the Illinois Environmental Protection Agency (IEPA) to be in nonattainment of their designated use of primary contact recreation due to Escherichia coli (*E. coli*) bacteria. The Clean Water Act (CWA) and the U.S. Environmental Protection Agency (U.S. EPA) require states to develop Total Maximum Daily Loads (TMDLs) for all waters that do not attain their designated uses.

To complete TMDLs for all 51 segments under a single assessment RTI International worked with IEPA and U.S. EPA Region 5 to develop a multilevel statistical framework to characterize *E. coli* concentrations at monitored beaches using observed data. A key component of the IL Beaches TMDL was the identification of likely non-point source and transport mechanisms contributing *E. coli* loadings to the impaired shoreline segments. This data-driven approach allowed us to make beach-specific predictions while using commonalities across sampling sites to improve model performance within a known range of uncertainty. We then used statistical simulation to estimate the impact of potential beach management practices on the source and transport mechanisms identified in each regional model. To promote stakeholder involvement, RTI also created an interface tool based on the statistical models that allows users to gauge the impact of management actions at specific beaches. This presentation will highlight the advantages and disadvantages of a probabilistic framework for TMDL development as well as the significant non-point source and transport mechanisms identified in the models.

KHOURY, MARY[2], PEARSALL, D. R. [1], PASKUS, J.[3], KRAUS, D.[4], DORAN, P.J.[2], SOWA, S.P[2], FRANKS TAYLOR, R.[2], and ELBING, L.K,[2], [1]The Nature Conservancy, 101 E. Grand River Ave., Lansing, MI 48906, 517-316-2259, [2]The Nature Conservancy, [3]Michigan State University, Michigan Natural Features Inventory, [4]Nature Conservancy of Canada.

Biodiversity in and Along Lake Michigan – How is it Faring and What can the Biodiversity Conservation Strategy do for you?

Management and restoration of the Great Lakes has been a priority for the last few decades, yet previous efforts have placed little emphasis on biodiversity within the lakes. To develop biodiversity conservation strategies for four of the Great Lakes, we have worked closely with the Lakewide Action and Management Plans (LAMPs) of Lakes Ontario, Michigan, and Erie and the Lake Huron Binational Committee and engaged hundreds of experts and stakeholders in producing "blueprints" for biodiversity conservation. A fifth blueprint is underway for Lake Superior. All of the blueprints focus on biodiversity in the lakes and coastal areas, and some include tributaries and migratory species. The status of biodiversity in each lake was found to be fair but restorable, with some exceptions and considerable spatial variability. Aquatic invasive species was ranked a top threat to biodiversity in all blueprints. Other highly ranked threats included incompatible development, climate change, terrestrial invasive species, dams and barriers, and non-point source pollutants.

Six themes characterize the recommended strategies: coastal conservation, invasive species, connectivity and hydrology, fish restoration, nearshore water quality, and climate change. While each blueprint highlights high-priority strategies, successful conservation of Great Lakes biodiversity and abatement of its key threats requires revisiting these priorities in an adaptive approach. In this presentation, we compare the completed blueprints—using examples from Lake Michigan—and explore challenges to conservation planning for large ecosystems. We also assess the extent to which earlier blueprints are being adopted and implemented and offer suggestions for more effective implementation.

KHOURY, MARY[1], SOWA, S.P.[2], MYSOREKAR, S.[2], BOGERT, R.[3], JUDGE, S.[4], DORAN, P.[2], SEELBACH, P.[5], POTTER, B.[6], and CZARNECKI, C.[6], [1] The Nature Conservancy, 8 S. Michigan Ave., Suite 2301, Chicago, IL, [2]The Nature Conservancy, Lansing, MI, [3]Shedd Aquarium, Chicago, IL, [4]The Nature Conservancy, Madison, WI, [5] U.S. Geological Survey, Ann Arbor, MI, [6] U.S. Fish and Wildlife Service, East Lansing, MI.

The Great Lakes Information Management and Delivery System: Fostering Shared Goals and Collaborative Solutions

The Great Lakes Information Management and Delivery System (IMDS) is a powerful new web-based platform designed to support well-informed, impactful decision making. Created by The Nature Conservancy, USGS Great Lakes Science Center, and the Upper Midwest-Great Lakes Landscape Conservation Cooperative, the IMDS brings together core knowledge; efficient search of data, interactive maps, and decision tools; project tracking; and shared goal dashboards.

The vision for the Great Lakes Information Management & Delivery System (IMDS) is to get the right information to the right place in the right format at the right time to facilitate collaborative landscape-scale conservation and achieve meaningful outcomes. This information management system offers transparency and credibility for tracking shared regional goals and developing collaborative solutions for pressing Great Lakes landscape-scale issues. Reaching beyond the conservation community to the public and business sectors, the IMDS will also increase support for collaborative landscape-scale conservation efforts, such as the Lake Michigan Lakewide Action and Management Plan.

Landscape-scale conservation issues have grown increasingly complex as we address more species, ecosystems, and stakeholders, and as drivers of landscape-scale change occur at an unprecedented rate. We have the conceptual frameworks, scientific expertise, and collaborative mindset to address this increased complexity, but we lack the information supply chain needed to effectively manage natural resources at a landscape scale. Although regional information management systems do exist, until now we have not had a comprehensive system to operationalize adaptive management in the Great Lakes ecosystem.

In the session, we will share the IMDS prototype and examples where the IMDS could foster shared goals and collaborative solutions for biodiversity conservation. We will also highlight the significant and urgent challenge to bring about a governance structure that assures long-term development and maintenance of the IMDS.

KLUMP, J. VAL[1], LABUHN, S.[1], GRUNERT, B.[1], WAPLES, J.[1], ANDERSON, P.[1], BRAVO, H.[2], HAMIDI, S.[2], VALENTA, T.[3], KENNEDY, J.[3], and ZORN, M.[4], [1]School of Freshwater Sciences, Great Lakes WATER Institute, [2]College of Engineering and Applied Science, University of Wisconsin-Milwaukee, Milwaukee, WI 53204, [3]Green Bay Metropolitan Sewerage District, NEW Water, Green Bay WI, [4]University of Wisconsin-Green Bay, Green Bay WI.

Developing a Summertime Oxygen Budget for Green Bay

Southern Green Bay has suffered a history of summertime bottom water hypoxia (< 2mg/L dissolved oxygen) going back decades, yet the forcing mechanisms controlling the oxygen balance in the system are complex and, until recently, little studied. We are attempting to better understand the dynamics of hypoxia in the bay via linking watershed inputs, hydrodynamics, biogeochemical cycling and climate change. In this presentation, we will examine the major components of a simple oxygen budget for the lower bay: short term deposition of labile organic matter, sediment oxygen demand, thermal stratification, water column primary production and respiration, and air-water exchange. Data from continuous monitoring instruments, water column profiling, sediment incubations and sediment traps are employed. Ultimately, we would like to integrate the various model components of the system at a level sufficient to project how the bay will behave under a changing climate, and how water quality conditions, particularly hypoxia, will respond to future changes in both climate and land use.

KOHRING, MARGARET A., The Conservation Fund, PO Box 506, Sawyer, MI 49125

Greenseams: Milwaukee River Flood Reduction Program

The Milwaukee Metropolitan Sewerage District's innovative Greenseams Program permanently protects key undeveloped lands in the Milwaukee River Watershed, a tributary to Lake Michigan. The Milwaukee River Basin is nearly 900 square miles and home to over a million people. Greenseams targets land to reduce future flooding and damages by buying and restoring wetland habitat. These undeveloped lands contain important water absorbing (hydric) soils that hold and slowly release rainwater and snowmelt, slowing and capturing nutrients in the water as it flows downstream. The Greenseams Program focuses on restoring wetland vegetation that once covered 18 % of the Milwaukee River Basin and today is less than 7%.

The Greenseams Program focuses on urban, suburban and rural areas. Since Greenseams' inception in 2001, 87 properties have been purchased, conserving over 2,500 acres of land. Both acquisitions and restorations have been conducted in partnership with the Knowles-Nelson Stewardship

Fund, the Wisconsin Coastal Management Program, and the North American Wetland Conservation Act. Over 500 acres have been restored to forest, prairie or wetland habitat through support from the USFWS Partners for Fish and Wildlife Program and the Fund for Lake Michigan. Greenseams 2013 highlights include reaching the 100,000 trees goal for native trees planted and 1.6 billion gallons of water retained on the landscape.

KOSKEY, A.M., FISHER, J.C., TRAUDT, M.F., NEWTON, R.J., and MCLELLAN, S.L., University of Wisconsin - Milwaukee, School of Freshwater Sciences, 600 E. Greenfield Ave, Milwaukee, WI 53204,

Community Analysis of Gull Fecal Microbiome Reveals Dominance of *Catellicoccus marimammalium* in Relation to Culturable Enterococci

Gulls are prevalent in beach environments and can be major sources of fecal contamination in the beach environment. Gulls have been shown to harbor high abundances of fecal indicator bacteria, *E. coli* and enterococci, which can readily be detected as part of routine beach monitoring. Despite the ubiquitous presence of gull fecal material in beach sands and waters, the associated microbial community is relatively poorly characterized. We generated comprehensive microbial community profiles of gull fecal samples using the Roche 454 and Illumina Mi-Seq platforms to investigate the composition and variability of the gull fecal microbiome and measure the proportion of fecal indicator bacteria. Next generation sequencing data showed that *Enterococcaceae* and *Enterobacteriaceae* were the two most abundant families in our gull samples, respectively comprising 57% and 32% of the total obtained sequences. Sequence comparisons between the short-read data and nearly full-length 16S rRNA gene clones generated from the same samples, revealed *Catellicoccus marimammalium* as the most numerous taxon among all samples. The identification of bacteria from gull fecal pellets cultured on membrane-Enterococcus indoxyl-β-D-glucoside (mEI) plates revealed that the dominant sequences recovered in our sequence libraries did not represent organisms that grew on mEI. Based on 16S rRNA gene sequence analyses of 342 gull fecal isolates cultured from mEI, 98.8% were identified as *Enterococcus* spp., and 1.2% as *Streptococcus* spp.; none were identified as *C. marimammalium*. Illumina deep sequencing indicated that gull fecal samples harbor significantly higher proportions of *C. marimammalium* 16S rRNA gene sequences (~1,500-fold), relative to sequences recovered from typical mEI culturable *Enterococcus* spp., suggesting that *C. marimammalium* can be utilized as a genetic marker to identify gull fecal pollution that results in high fecal indicator bacteria levels in the beach environment.

KOSKI, ADRIAN J., City of Racine Health Department. 730 Washington Avenue, Racine, WI 53403.

Unsafe for Swimming by Order of Health Officer: Optimizing Coastal Recreation at an Impaired Location

Frequent and persistent poor recreational water quality has led to a permanent swim ban at Samuel Meyers Beach in an urban area of Racine, Wisconsin. In addition to poor water quality, habitat within the park is degraded and is comprised primarily of invasive *Phragmites*. Three years of water quality monitoring as part of a Great Lakes Restoration Initiative grant has identified multiple factors contributing to poor water quality including: the embayed nature of the beach limiting circulation, siltation promoting elevated bacteria levels in sediments and water, resident wildlife populations and stormwater runoff/outfalls. Although factors such as resident wildlife populations and stormwater runoff can be managed to improve water quality, other factors cannot be ameliorated. Intrinsic properties of the beach such as the embayed nature and fine sediment particle size cannot feasibly be modified at this location. Due to the inability to alter inherent properties of the beach to improve water quality, alternative uses for this location have been proposed. A redesign plan has been crafted with the goals of optimizing recreational uses, restoring costal habitat and improving water quality. Although redesign elements do include best management practices to improve water quality, it is unlikely that shoreline water quality will improve enough to allow full immersion recreational uses on a regular basis. Water quality monitoring has revealed that bacteria concentrations decrease significantly with increased depth within the embayed basin, thus swimming in an offshore area accessible by boats is being proposed based upon future monitoring results. Further, habitat restoration, inclusive of wetland and dune environments, will provide recreational activities including hiking and wildlife viewing. The restoration of this area will provide beneficial uses and represents an approach for providing recreational opportunities at coastal locations with inherently poor water quality.

KRAMER, BILL, Manager eBEACHES System, U.S. Environmental Protection Agency, 1200 Pennsylvania Avenue NW, Mail Code 4305T.

Data Mining to Identify Beaches with Advisories and Closures using the Modernized BEACON Webpage

This presentation will describe how the modernized BEACON 2.0, a webbased mapping and report application, can be used to identify beaches with advisories and closures and the possible reasons for and sources of those advisories or closures. This project was funded in part by the Great Lakes Restoration Initiative. The Beaches Environmental Assessment and Coastal Health (BEACH) Act requires the EPA to collect, store, and display beach public right-to-know pollution occurrence data. The EPA meets this requirement with BEACON (BEach Advisories and Closings Online Notification system), http://watersgeo.epa.gov/beacon2/. Underlying BEACON is eBeaches, the electronic data transmission, storage and publishing system that allows EPA to securely receive and display beach location, water quality and swimming advisory data within two hours of state, tribe, territory and local agencies sending the data.

KRAMER, EVA L.[1], FRY, L.M.[2], ANDERSON, E.J.[3], RITZENTHALER, A.[2], and GRONEWOLD, A.D.[3], [1]Cooperative Institute for Limnology and Ecosystem Research (CILER), 4840 S. State Rd, Ann Arbor, MI, 48108, [2]CILER, Ann Arbor, MI, [3]NOAA Great Lakes Environmental Research Laboratory (NOAA GLERL), Ann Arbor, MI.

Comparing Output from a Linked Hydrologic-Hydrodynamic-Particle Model with Real World Bacterial Concentrations

As part of NOAA's Center of Excellence for Great Lakes and Human Health's focus on beach health, we are developing a linked hydrologic-hydrodynamic-particle model of the Clinton River for use as a decision support tool for beach water quality. The Clinton River, a river with an urban and agricultural watershed, flows into Lake St. Clair near one of the most heavily used public beaches in the Detroit metropolitan area. The linked model uses real-time tributary flows, bacterial loads, and meteorology to track 3D particle trajectories on an hourly time-step. The particles, which represent *E. coli* organisms, are released at the mouths of the Clinton River and advected using real-time model-predicted currents in Lake St. Clair. In order to compare model results to real world bacterial concentrations (observed), we have developed a framework in which the modeled bacteria particles are converted into a concentration for each model grid cell (e.g. number of organisms per 100 milliliters). Using two years of nearshore *E. coli* monitoring results to calibrate the model, we can assess the temporal and spatial variability of *E. coli* concentrations. The calibrated linked hydrologic-hydrodynamic-particle model will be implemented into the suite of real-time NOAA forecasting products.

KREIS, R.G. JR.[1], ZHANG, X.[2], MURPHY, E.[3], RYGWELSKI, K.R.[1], WARREN, G.[3], HORVATIN, P.J.[3], MELENDEZ, W.[4], BECK, S.J.[3], and HOLSEN, T.M.[5], [1]USEPA, ORD/NHEERL/MED, 9311 Groh Road, Grosse Ile, MI, 48138, [2]Z-Tech/ICF Corporation, Grosse Ile, MI, [3]USEPA/GLNPO, Chicago, IL; [4]Computer Sciences Corporation, Grosse Ile, MI; [5]Clarkson University, Potsdam, NY.

Lake Michigan Lake Trout PCB Model Forecast Post Audit

Scenario forecasts for total PCBs in Lake Michigan (LM) lake trout were conducted using the linked LM2-Toxics and LM Food Chain models, supported by a suite of additional LM models. Efforts were conducted under the Lake Michigan Mass Balance Study and the post audit represents the period 1995-2011, since the conclusion of the study. Forecasts of 5 to 6-year old lake trout for two LM regions indicated that total PCB concentrations will continue to decrease and the Sports Fish Advisory Task Force's goal for unrestricted consumption could be achieved in coming years, during the early to mid-2030s. Compared to PCB data for lake trout from the Great Lakes Fish Monitoring Program, the model forecasts and data exhibit good agreement, suggest that the model forecasts are reasonable, and that concentrations should continue to decline. Results are consistent with long-term decreases in other media and together indicate a considerable weight of evidence for continued decreases and improvements in the ecosystem from various actions. These are subject to assumptions and we will present some information on issues that may accelerate or exacerbate the anticipated future. This abstract does not necessarily reflect EPA policy.

LABUHN, SHELBY, and KLUMP, VAL, University of Wisconsin-Milwaukee School of Freshwater Sciences, 600 E. Greenfield Ave, Milwaukee, WI 53204

Evaluation of Benthic Exchanges in Green Bay Sediment

Green Bay is a hypereutrophic system that experiences intermittent hypoxia during the stratified season, particularly in the lower region. It is believed that the benthic region of Green Bay may be a controlling factor on oxygen depletion through high benthic metabolism rates. In order to evaluate the effects of the sediment on oxygen exchanges we measured gas fluxes using radon-222 and performed sediment oxygen uptake experiments. Porewater nutrient concentrations were also measured to identify biogeochemical gradients. Preliminary eddy correlation benthic metabolism rates will also be presented.

LAFRANCOIS, BRENDA MORASKA[1], BOOTSMA, H.[2], CHIPAULT, J.[3], EDLUND, M.[4], ESSIAN, D.[5], HAACK, S.[6], ISAACS, N.[6], JENNINGS, S.[7], LEONARD, J.[5], and STEPHEN RILEY[8], [1]National Park Service, 2800 Lake Shore Drive East, Ashland, WI 54806, [2]University of Wisconsin-Milwaukee, Great Lakes WATER Institute, [3]U.S. Geological Survey, National Wildlife Health Center, [4]Science Museum of Minnesota, [5]Northern Michigan University, [6]U.S. Geological Survey, Michigan Water Science Center, [7]National Park Service, Sleeping Bear Dunes National Lakeshore, [8]U.S. Geological Survey, Great Lakes Science Center.

Lake Michigan Botulism Drivers: Historical and Modern Insights

The resurgence of Lake Michigan botulism outbreaks has resulted in thousands of bird deaths since 2006 and generated substantial public concern. Although research and media reports have focused on recent species invasions (dreissenid mussels and round gobies) as drivers of these outbreaks, botulism has occurred in Lake Michigan periodically since at least the 1960s, suggesting that alternate factors may also be important. Here we review historical data, paleolimnological studies, and recent research to more fully examine suspected botulism drivers, focusing on the roles of *Cladophora*, invasive species, and large-scale climate factors. *Cladophora* was abundant during historical outbreaks and has increased in northern Lake Michigan since the 1990s; peak *Cladophora* abundance (inferred from *Cladophora* epiphytes in nearshore sediment cores) occurred in the mid-2000s, coincident with the onset of large botulism outbreaks. The role of *Cladophora* in botulism outbreaks may relate to its decay on beaches, in shallow waters, or in nearshore depositional areas. Invasive mussels may relate to botulism outbreaks directly (via toxin transfer) or indirectly (via effects on *Cladophora* growth), but their absence during historical outbreaks and results from recent food web studies suggest that alternate invertebrate-based pathways also exist. Invasive fish (alewife and gobies) were abundant in historic and modern outbreak eras, respectively, and given their prevalence in affected bird stomachs these seem likely to be involved in toxin transfer. Finally, historic and modern outbreak periods share common climatic and hydrologic features such as warm water temperatures and low lake levels. Taken together, our review suggests that Great Lakes botulism outbreaks, both recent and historic, may be the product of multiple interacting factors and a generalized pattern of ecosystem dysfunction (i.e., nuisance algal growth, species introductions, thermal stress, and low lake levels). Managing botulism outbreaks will require attention to multiple potential drivers and broader ecosystem health objectives.

LAUMANN, JASON[1] and MICKELSON, D.M.[2], [1]Northwest Regional Planning Commission, 1400 S. River St., Spooner, WI 54801, [2]Geo-Professional Consultants, LLC.

Calculating and Mapping Stable Slope Setbacks on Wisconsin's Lake Superior Shore Bluffs using LIDAR.

There is increasing development pressure on this part of the Lake Superior shoreline. Bayfield County completed their safe setback mapping in 2011. Much of the shoreline of Iron and Douglas counties has bluffs from about 30 to almost 100 feet (10-30m) high. As in Bayfield County, our setback line is based on stable slope angle, rate of past recession, and a facility setback. The bluffs consist almost entirely of clayey till, sandy, stony till or sand and gravel. The geology of the bluff has been described in two earlier studies, and we use that vertical distribution of sediment, modified by field observations in 2011, as the basis for interpretation of sediment type. Stable slope angles for each sediment were established by measuring natural slopes in the area and determining what angle appears to separate stable from unstable slopes. Bluff geometry is determined using LIDAR, and we believe that this is generally more accurate than measuring angles and distances in the field because vegetation often complicates on-the-ground measurements. The stable slope component of setback is the horizontal distance from the base of the bluff to where the stable slope angle intersects the bluff top. This is calculated in a GIS. Most past shoreline recession rates range from almost zero to about 6 feet (2 m) per year. Past annual recession rates, determined in a separate study by comparison of orthophotos taken at least two different times in the past, are multiplied by 50 years. These are added to the stable slope setback and a 75 foot facility setback to produce a total setback line.

LESHKEVICH, GEORGE[1], SHUCHMAN, R.[2], BROOKS, C.[2], SAYERS, M.[2], and NGHIEM, S.V.[3], [1] NOAA Great Lake Environment Research Laboratory, 4840 S. State Rd., Ann Arbor, MI 48108 USA, [2] Michigan Tech Research Institute, [3] Jet Propulsion Laboratory, California Institute of Technology.

Creating and Distributing Great Lakes Satellite Remote Sensing Products

Satellite remote sensing provides a method to accurately assess water quality and ice cover for current and historical conditions in large lakes such as Lake Michigan. Satellites with optical, thermal, and microwave sensors collect data that span large geographic areas and have been in operation for over a decade. These long-term data sets, once processed and classified into products, allow the analysis of time series of data to determine how water quality and ecosystem conditions have changed, particularly in the light of a changing climate. Based on in-situ measured data (IOPs), retrieved color producing agent (CPA) concentrations, and radar backscatter signals, a number of Great Lakes specific algorithms for the retrieval of water quality parameters including chlorophyll, CDOM (DOC), suspended mineral, HABs, water temperature, and ice type from satellite data have been developed. Algorithms vary from supervised classification for ice type to non-linear multivariate (bio-optical model) analyses approaches for chlorophyll, CDOM, and suspended mineral. The time series analysis can be used to monitor long-term changes in water quality, shorter term development and tracking of episodic events, input into a newly developed model for estimating primary productivity, and assessing the impacts of climate change on the Great Lakes ecosystem. A main portal for distribution of the operationally derived products to the user community occurs via the CoastWatch Great Lakes program. As part of a nationwide National Oceanic and Atmospheric Administration (NOAA) program, the goals to obtain, produce, and deliver environmental data and products for near real-time and retrospective monitoring of the Great Lakes to support environmental science, decision making, and supporting research are achieved by providing Internet access to satellite observations, in-situ data, derived, and modeled

products via the CoastWatch Great Lakes web site (http://coastwatch.glerl.noaa.gov). Examples of time series data and animations are shown for selected water quality and environmental parameters.

LULLOFF, ALAN R., Association of State Floodplain Managers, 575 D'Onofrio Dr, Madison, WI 53719.
Water Levels are Low - Why is FEMA Updating Flood Mapping on the Great Lakes Now?

Coastal flooding in the Great Lakes is the result of the combined action of elevated still water and storm waves. The Great Lakes are unique in that they are subject to changes in water level which act over three distinctly different time scale - long term, decadel and seasonal. This presentation will provide some history of water levels and storms on the Great Lakes and some information on the influence of climate change, glacial isostatic rebound and anthroprogenic activities.

In addition to flood inundation and waves FEMA's Risk MAP initiative will be attempting to address all natural hazards facing Great Lake communities. Potential additional hazards include coastal erosion, bluff instability, riverine flooding in watersheds along the coast, dam failure and others.

While updated flood elevations and mapping will be provided to communities, beyond that FEMA will be working with communities to identify actions that can be taken to help mitigate risks within their community.

The first studies to be complete on the Lake Michigan will be in Kenosha, Racine, Milwaukee and Ozaukee counties. This presentation will provide information on when the maps will be coming out, what they will look like, and the on-going process of community engagement.

LUPI, FRANK[1], CHEN, M.[2], KAPLOWITZ, M.[3], and WEICKSEL, S.[2], [1] Professor, Dept. of Ag., Food and Resource Economics & Dept. of Fisheries and Wildlife, Agriculture Hall, Michigan State University, East Lansing, MI, 48824, [2]Graduate Student, Department of Ag., Food & Resource Economics, Agriculture Hall, Michigan State University, East Lansing, MI, 48824, [3]Professor, Department of Community Sustainability, Natural Resources Bldg., Michigan State University, East Lansing, MI, 48824.
Economic Values for Great Lakes Beach Recreation

With over 600 public beaches and attendance in the millions each year, beach visitation is among the most popular recreational uses of the Great Lakes. Great Lakes beaches face threats and stresses from many sources, such as nuisance algae, closures from high levels of E.coli, and development. Since addressing these stressors is costly, information on the economic benefits of efforts to maintain and improve the health of Great Lakes beaches can be used to improve management and decision making. Despite the importance of Great Lakes beaches, there are almost no published studies of the value a day at a Great Lakes beach or the economic value of changes in water quality at Great Lakes beaches (with the exception of Murray, Sohngen, and Pendelton 2001). We conducted a survey of 32,000 Michigan residents to identify beachgoers and collect information on all Great Lake beach visits during the summer of 2011. Using the data on trip destinations, we estimated a spatially and temporally explicit economic demand model that forecasts Great Lake beach trips to over 400 public beaches in Michigan's Lower Peninsula. Beach visits depend significantly on economic factors such as the travel cost from a person's home to a particular beach, as well as on environmental factors such as the water temperature and the history of beach closures at a site. The economic demand model is used to generate contemporary estimates of the economic value of a beach day as well as economic benefits associates with water quality improvements. Resource managers can use these values to predict the benefits of quality improvements, or to estimate the damages caused by decreases in beach quality.

MAREK, MIKE, Marek Landscaping, LLC, 820 E. Knapp St., Milwaukee, WI 53202.

Beaches and Bluffs: A New Method for Slope Stabilization and Native Vegetation Restoration at Atwater Park in the Village of Shorewood, Wisconsin

Atwater Park is located on Lake Michigan within the Village of Shorewood, a suburb just north of the City of Milwaukee. Because of its urban location, it provides thousands of city dwellers and tourists with a secluded beach and coastal dune experience. The park consists of an upper terrace which sits on top of a clay bluff, dropping 90 feet to the beach. The original vegetation on the slope was comprised of non-native turf grasses, ornamental plantings, and broad-leaf weed species. In July 2010, heavy rains caused slope failure in several areas of the park due to excessive surface water runoff. A multi-disciplinary team devised a solution for the failing slope, focusing on surface and near-surface drainage and erosion management, removal of unstable fill soils, and improved vegetation on the slope face. Stormwater infiltration measures were introduced at the top of the bluff to reduce the amount of surface water flowing over the slope. Marek Landscaping developed a new steep slope restoration technique at the site using a compost-based bio-engineered matrix in conjunction with regularly spaced slope interrupters. Native plants were seeded into the matrix to enhance stabilization. In addition, a bio-stabilized dune was built at the toe of the slope to increase infiltration into the dune and to capture any remaining surface runoff. A switchback walkway and service drive were reconstructed to improve their stability and to provide universal access to the beach. Additional funding was obtained from the Fund for Lake Michigan to restore deep-rooted native coastal dune and beach vegetation to the remainder of the park in order to enhance slope stability, restore habitat, increase biodiversity, and to improve water quality in Lake Michigan. The Lake Michigan bluff stabilization project at Atwater Beach is an incredible recreational, educational, and habitat resource for nearby residents.

MARTINKA, JEFF, Executive Director, Sweet Water – the Southeastern Wisconsin Watersheds Trust, Inc., 600 E. Greenfield Avenue.

Milwaukee's Four New Third Party TMDLs: New Approaches, New Challenges

This presentation will summarize progress being made to complete Total Maximum Daily Load (TMDL) analyses on four water bodies in the Milwaukee River basin. In a unique approach, the Milwaukee Metropolitan Sewerage District (MMSD) requested and received four Great Lakes Restoration Initiative grants from the U.S. Environmental Protection Agency (EPA) to complete the work on a third party basis. The pollutants being examined in this work are fecal coliform bacteria, phosphorus, and sediments (total suspended solids/TSS). In addition to the TMDLs themselves, the effort will also include creation of implementation plans. Using a variety of presentation materials, the workshop will offer an overview of the project, its progress, and its challenges.

These TMDLs are focused on the Kinnickinnic, Menomonee and Milwaukee Rivers and the Milwaukee River estuary (approximately 950 square miles of watershed). In 2010, MMSD selected the engineering firm CDM Smith as its lead consultant for all four TMDLs. CDM Smith has extensive national experience in TMDL work, including efforts on behalf of the Wisconsin Department of Natural Resources (WDNR) for the recently completed Rock River TMDL. CDM Smith began initial work on the Milwaukee area TMDLs that June. MMSD has also contracted with the Southeastern Wisconsin Regional Planning Commission as technical consultants on the four efforts. Sweet Water – the Southeastern Wisconsin Watersheds Trust, Inc. is providing MMSD with stakeholder involvement and public outreach support. The project has also benefitted from ongoing project team guidance by both WDNR and EPA staff.

The four TMDL studies are being completed concurrently and are to be finished in late 2013. Once completed, the TMDLs will be submitted by MMSD to the Wisconsin Department of Natural Resources and then provided to EPA Region 5 for its approval. The TMDL implementation plan work will then start, with completed implementation plans expected by late 2014.

MCGLYNN, CATHY, Northeast Illinois Invasive Plant Partnership, 1000 Lake Cook Road, Glencoe, IL.
Clean Boats Crew: Aquatic Invasive Species Education and Outreach in Illinois and Indiana

Aquatic invasive species (AIS) can cause serious problems in the Great Lakes and inland water bodies. AIS, which include zebra mussels and Eurasian watermilfoil, are often spread among lakes via boats and fishing equipment. In 2011 Illinois-Indiana Sea Grant (IISG) and the Northern Illinois Invasive Plant Partnership (NIIPP) began an aquatic invasive species education and outreach program called "Clean Boats Crew (CBC)" to help protect Illinois and Indiana lakes and ponds from being invaded by AIS. Since that time our site leaders have worked in five counties along Lake Michigan and talked with thousands of people. A survey conducted at several of our sites in 2012 indicated that an increase in public awareness about AIS and a sense of personal responsibility for preventing transport of AIS were associated with exposure to the Clean Boats Crew program. In addition, the Illinois Boat Registration and Safety Act has been amended and further supports our mission. The program is still in the preliminary stages and finding new ways to adapt to the current financial climate.

MCMANUS, MAUREEN, The Watershed Center Grand Traverse Bay, 13272 S. West Bay Shore Drive, Traverse City, MI, 49684.
Aquatic Invasive Species Education and Outreach in the Grand Traverse Bay Watershed; Encouraging Public Participation

The Watershed Center's (TWC) mission is advocating for clean water in Grand Traverse Bay and protecting and preserving the Bay's watershed. Since 2010, TWC, along with many partners, have implemented an early detection and rapid response invasive species network in the Grand Traverse Bay Region. Funding for this work has been provided by a Great Lakes Restoration Initiative grant to the Grand Traverse Conservation District. TWC focuses on *Phragmites australis* in Grand Traverse County, as well as a large-scale public education campaign about aquatic invasive species. This multi-faceted campaign uses radio and newspaper advertisements; educational signs at boat launches; and one-on-one interaction by giving boat owners educational brochures at boat launches and marinas. Brochures encourage average citizens to stop the spread of invasive species by doing simple things like washing their boats between water bodies. The brochures also ask them to "Be a Great Spotter" by looking out for "watch list" species that are not yet in the Grand Traverse Bay region.

MCMANUS, MAUREEN, The Watershed Center Grand Traverse Bay, 13272 S. West Bay Shore Drive, Traverse City, MI, 49684.

***Phragmites australis* Reduction in Grand Traverse County: a GLRI Success Story**

The Watershed Center's (TWC) mission is advocating for clean water in Grand Traverse Bay and protecting and preserving the Bay's watershed. Since 2010, TWC along with multiple partners throughout the watershed, have reduced the amount of invasive *Phragmites australis*, also known as the common reed. Funding for this work is part of a larger Great Lakes Restoration Initiative grant obtained by the Grand Traverse Conservation District. TWC works in Grand Traverse County with Grand Traverse Bay and inland lake riparian owners to reduce the spread of Phragmites. This grant also funds a large-scale public education campaign about aquatic invasive species. TWC works with local stakeholders – local government, environmental groups and riparian owners – to coordinate surveying, treatment and policy options to reduce this threat to shoreline biodiversity. Between 2010 and 2011 we reduced Phragmites on Grand Traverse Bay in Grand Traverse County by 78 percent. This work is now being extended to inland lakes, where we hope to have the same success, while entering into a maintenance phase on the Great Lakes shoreline. We have many tips, tricks and lessons learned along the way with our early detection and rapid response strategy, and we can share them with other communities who are looking to reduce the impacts of Phragmites.

MEDNICK, ADAM. Wisconsin Department of Natural Resources, 101 S. Webster St., Madison, WI 53707.

Wisconsin Beach Nowcast 2013: Results and Lessons Learned

This presentation will report the results of water-quality "nowcasts" (early warning systems) developed for the 2013 beach season in Wisconsin. A number of nowcasts were implemented for beaches along the state's Lake Michigan and Lake Superior coasts, using the updated Virtual Beach 3.0 software together with the Environmental Data Discovery and Transformation (EnDDaT) web portal. These included "two-tier" nowcasts that estimated water quality conditions on non-sampled days (using all automated data), as well as sampled days (using field observation plus automated data). Key enhancements to these systems will be discussed, along with practical lessons learned and the outlook for continued nowcasts in the event that resources for water-quality monitoring continue to decline.

MENGLER, JEFFREY L.[1] and WILLIAMSON, N.[2], [1]Hey and Associates, Inc., 1444 N Farnsworth Ave, Suite 400, Aurora, IL 60505, [2]Illinois Department of Natural Resources.

Chicago Wilderness Green Infrastructure Vision as a Tool to Protect Lake Michigan

Chicago Wilderness is a regional alliance of more than 300 organizations and spans 38 counties, with over 500 municipalities and more than 10 million people. Within this region, a significant portion is within the Lake Michigan watershed. In 2004, Chicago Wilderness completed its first Green Infrastructure Vision (GIV) that provided a regional vision, in the form of a green infrastructure network map. In 2011, Chicago Wilderness worked with CMAP, the Donnelley Foundation, The Conservation Fund, and Applied Ecological Services to complete an update, and a more quantitative refinement of that GIV. This product compiles myriad natural resource data into one comprehensive geospatial dataset that has already addressed many of the data quality issues that often come with this type of mapping exercise. Now this data set is being utilized by many localities in the region to do "stepped

down" community or watershed-scale green infrastructure planning. One example is a project underway in Michigan City Indiana that will use the GIV as an initial starting point to create a green infrastructure map and plan for the Michigan City/Trail Creek watershed area. Ultimately this will be used to help Michigan City prioritize on-the-ground projects to address biodiversity, water quality, flood risk, and climate change risks in the Trail Creek/Lake Michigan watershed.

MORGAN, KATE[1] and SANDS, K. [2], [1]1000 Friends of Wisconsin, 16 N. Carroll St., Suite 800, Madison, WI 53703, [2]Milwaukee Metropolitan Sewerage District.

Beyond the Audit -- Tackling Barriers to Green Infrastructure

Green infrastructure (GI) is an effective means to improve water quality and aquatic habitat by reducing stormwater runoff – the primary source of pollutants entering our waterways -- yet critical barriers in municipal codes, zoning ordinances, and review standards discourage or prohibit use of GI in public and private projects. The Menomonee (MN) River Watershed Green Infrastructure Code & Ordinance Project demonstrates how this issue can be addressed by employing GIS mapping and watershed restoration plans to prioritize needed changes.

In Phase 1, an update of the Milwaukee Metropolitan Sewerage District's (MMDS) 2005 codes and ordinances audit was conducted for nine participating MN watershed municipalities which identified specific barriers in codes, ordinances and policies. In Phase 2, codes and ordinances identified as barriers are prioritized for revision.

Using the MN watershed restoration plan and GIS mapping of zoning districts, percent imperviousness, and pollutant hotspots; prohibitive codes and ordinances will be identified that, if amended, have the greatest potential to reduce pollutants. In Phase 3, the project team, working with the municipal partners, will develop alternative language for revisions, outline strategies for adoption, and develop materials to support the adoption of the recommendations by the municipalities.

The project models an approach to address barriers to GI at a time when municipalities are facing restricted budgets and staff reductions. By prioritizing revisions based on watershed restoration plans, modeling and GIS analysis, municipal efforts can be focused on advancing changes that will have the greatest beneficial impact.

The project team includes 1000 Friends of Wisconsin, Milwaukee County Environmental Services Department, MMSD, Birchline Planning LLC, Southeastern WI Watersheds Trust, and the nine participating MN River watershed municipalities: Germantown, Menomonee Falls, Brookfield, Elm Grove, City of Milwaukee, Wauwatosa, West Milwaukee, Butler and Greenfield. The project is funded through the generous support of the Fund for Lake Michigan.

MURPHY, ELIZABETH[1], HOLSEN, T.[2], HOPKE, P.[2], CRIMINS, B.[2], PAGANO, J.[3], and MILLIGAN, M.[4], [1]U.S. EPA Great Lakes National Program Office, 77 W. Jackson Boulevard, Chicago, IL 60604, [2]Clarkson University, Potsdam, New York 13699, [3]SUNY Oswego, Oswego, New York 13126, [4]SUNY Fredonia, Fredonia, New York 14063.

Status and Trends of Legacy and Emerging Contaminants Identified through the Great Lakes Fish Monitoring and Surveillance Program

U.S. Environmental Protection Agency's Great Lakes National Program Office funds and administers the Great Lakes Fish Monitoring and Surveillance Program (GLFMSP). This program focuses on monitoring contaminant trends in the open waters of the Great Lakes using fish as biomonitors. This program has routinely collected and analyzed legacy and emerging chemicals since 1972 and maintains one of the longest running tissue archives in the Great Lakes. Results from this program continue to indicate a declining trend in legacy chemicals, such as PCBs and DDT, the program has recently incorporated the surveillance for emerging contaminants into routine work. This presentation will highlight status and trend of both legacy chemicals and newly-detected emerging contaminants. Additionally, the presentation will examine how GLFMSP data, and data from other monitoring programs, can be used to improve collaboration and increase knowledge of emerging contaminants such as inter-laboratory studies, sharing of standards, alerting other monitoring programs when emerging contaminants are detected and coordinated sample site selection to get a top-to-bottom look at contaminants. The importance of communication of results to other monitoring programs and management agencies will also be emphasized. This sharing of information will result in a better and more complete understanding of the state of emerging contaminants in the Great Lakes and allow for the incorporation of these contaminants into other monitoring programs as well as management decisions.

MUSHINSKI, MIKE, Brown County Land & Water Conservation Department, 1150 Bellevue St., Green Bay, WI 54302.

Northern Pike Restoration in the Bay of Green Bay

The northern pike (*Esox lucius*) is Wisconsin's second largest native predator fish and is an important part of the Green Bay ecosystem. Over 70% of wetland habitat along the west shore of Green Bay has been lost. Many of these areas were once important spawning marshes for northern pike. In addition to the loss of suitable spawning habitat, fish encounter passage obstacles when leaving Green Bay to find spawning marshes or when migrating back. Since 2007 the Brown County Land and Water Conservation Department has been assessing tributaries within the watershed for restoration potential, evaluating properties suitable for restoration, and preparing site designs for wetland creation, enhancement, or protection. Currently construction costs are covered at 100% through a cooperative agreement with the USFWS. To date, nearly 17 miles of stream corridor have benefited from this project of which 10 miles were made accessible for fish migration by replacing perched culverts. Over 30 acres of wetlands (spawning marshes) were created, 41 acres of buffers and 45 acres of critical area planting were installed, and 8 perched culverts removed. Annually, spring spawning numbers are collected through both visual observation and fry trapping at the outlets of installed projects. Monitoring results indicate that pike migrate up to 17 miles inland to spawn and prove that these constructed sites have been producing young of the year pike where previously no pike fry were present. These results further prove the need to provide spawning habitat throughout the west shore system.

OSTER, RYAN J.[1], WIJESINGHE, R.[1], HAACK, S.K.[1], DURIS, J.W.[1], FOGARTY, L.R.[1], TUCKER, T.R.[2], and RILEY, S.C.[2], [1] U.S. Geological Survey, Michigan Water Science Center, 6520 Mercantile Way, Suite 5, Lansing, MI, 48911, [2]U.S. Geological Survey, Great Lakes Science Center, 1451 Green Rd, Ann Arbor, MI, 48105.

Quantitative Assessment of Bacterial Pathogens at Great Lakes Beaches

Great Lakes beaches have both cultural and economic significance and some of these beaches are often closed due to poor water quality resulting from bacterial contamination. Determining the abundance, sources, and persistence of disease-causing (pathogenic) microorganisms may improve our understanding of their risk to human health. The abundance of genes specific for pathogenic bacteria known to cause gastrointestinal illness in humans was assessed in this study. Quantitative PCR (qPCR) assays for *Shigella* (*ipaH*), *Campylobacter* (*mapA*), *E. coli* (*Stx2* and *eae*), and *Salmonella enterica* were optimized and used to assess the abundance of these pathogen genes at Great Lakes beaches. Approximately 300 samples from three environmental matrices including water, sediment, and *Cladophora* were compared at seven beaches sampled from June through August 2012. Beaches were located throughout the Great Lakes including Lakes Michigan, Huron, Erie, and Superior. The detection of each pathogen gene was site specific and *Cladophora* and sediment seem to be a sink for some of these microbes. The abundance of these genes was calculated to be two to three orders of magnitude greater among quantifiable *Cladophora* and sediment samples than their equivalent volume in water. Fecal indicator bacteria (FIB) were correlated with average *Campylobacter* abundance in water among the seven beaches. *Stx2* at Brimley State Park was also related to *E. coli* abundance, but none of the other genes were correlated with FIB. This study is thought to be the first comprehensive quantitative geographic assessment of bacterial pathogens at Great Lakes beaches and will be important for the development of tools such as quantitative microbial risk assessment.

PELLER, JULIE[1], BYAPPANAHALLI, M.[2], WHITMAN, R.L.[2], SHIVELY, D.[2], SADOWSKY, M.[3,4], and CHUN, C.L.[3], [1]Indiana University Northwest, Department of Chemistry, 3400 Broadway, Gary, IN 46408, [2]Lake Michigan Ecological Research Station, U.S. Geological Survey, Porter, IN 46304, [3]BioTechnology Institute, University of Minnesota, St. Paul MN 55108, [4]Department of Soil, Water, and Climate, University of Minnesota, St. Paul, MN 55108.

In Vitro Aqueous Chemistry of Great Lakes Decaying/Decomposing *Cladophora*

Cladophora mats that accumulate and decompose along the beaches of the Great Lakes have been widespread and often problematic over the past few decades, creating potential threats to human and wildlife health. The depleted oxygen environment in the decaying mats supports growth and sustenance of a range of microbial populations, potentially including *Clostridium botulinum,* the causal agent of botulism in birds. In addition, the biologically-mediated chemical transformations lead to numerous organic and inorganic substances, many of which are odorous, noxious and likely selective for particular microbial populations. Mesocosm studies were conducted for the determination of the predominant chemical components associated with the different stages of algal decay. The three-month experiment of the *Cladophora* decay led to the identification of numerous organic compounds, including compounds with potential industrial use and toxic components. After a few hours of simulated algal mat assemblage, the dissolved oxygen was largely exhausted. Low molecular mass organic acids, malodorous products of fermentation, peaked on day 7 and corresponded to the lowest pH reading; these organics and many others were consumed in further biochemical reactions, with the exception of three persistent aromatic compounds. Ammonia concentrations were mostly above the accepted safe levels for aquatic organisms, and increased in the later stages of the decomposition,

months 2 and 3, to 85 mg $N\text{-}NH_3$/L. Knowledge of the fundamental chemical composition and microbial milieu of decaying *Cladophora* mats is critical for the responsible management of the material, and for the recognition of its potential as harvestable resources.

PITTNER, PETER G., Vice President, Miller Engineers & Scientists, 5308 S 12th Street, Sheboygan, WI, 53081.

Methodology for Designing Beach Naturalization

A wide range of physical factors affect the health and aesthetics of beaches. This presentation describes the methodology used to measure the characteristics of each beach and how that information is used to design effective improvements to mitigate bacterial and other contamination.

Water levels of the Lakes Michigan, Huron, Erie, and Ontario periodically fluctuate throughout a range of about five feet. This means the storm wave erosion limit and beach width along the shores of these lakes may vary as much as several hundred feet between periods of low and high water. The amount of wave energy that each beach is exposed to depends on the distance of open water where storm waves (which sometimes exceed 20 feet height out in deep water) can build. The near shore bottom profile determines where deep water waves successively break as they approach the shore. These factors, in combination with irregularities in the shoreline or any man-made structures projecting into the lake, affect patterns of sediment migration along the shore as well as the tendency for pathogens in the water to concentrate or disperse.

Storm water drainage (especially storm sewers discharging near beaches) and land surfaces that attract shore birds are major sources of contamination. Beach slope and sand grain size determine to what level capillary water rises under the beach, which affects bacteria survival as well as where beach grass is able to grow.

While each beach is unique, all of the characteristics that control its particular physics can quickly and economically be measured to provide the basis for planning enhancements that rely on natural systems and will function throughout a wide range of water levels.

PREY, JEFF[1], TORNES, ANGIE[2], and LEMBERG, DAVE[3], [1]Wisconsin Department of Natural Resources, Wisconsin State Parks (Madison, WI), [2]National Park Service - Rivers, Trails and Conservation (Milwaukee, WI), [3]Michigan Heritage Water Trails, Western Michigan University (Kalamazoo, MI).

The Lake Michigan Water Trail Partnership

Agencies and stakeholder groups in the four states bordering Lake Michigan are working to expand on the Lake Michigan National Recreation Water Trial designation that exists on part of the lake. The partnership supports the American Great Outdoors priorities and Lake Michigan LAMP goals by enhancing recreational access and opportunities and engaging citizens in conservation and the great outdoors. This session will explore how the states have approached planning and implementation to obtain a National Recreation Trail and National Water Trail Designation. Highlights of this session will include access inventory methodologies, stakeholder engagement techniques and implementation highlights.

RIPLEY, MIKE, Inter-Tribal Fisheries and Assessment Program, Chippewa Ottawa Resource Authority, 179 West Three Mile Road, Sault Sainte Marie, MI 49783.

Contaminants Declining in Tribal Commercial Fish Harvest

Twenty two years of monitoring by the Inter-Tribal Fisheries and Assessment Program (ITFAP) indicate that most contaminants have significantly declined in tribal commercial fish harvest in Lake Michigan. Recent studies also indicate that whitefish and lake trout from the Great Lakes contain significant amounts of omega-3 fatty acids that are being recognized as vital nutrients for nervous system and cardiovascular development and maintenance. ITFAP will present on the results of contaminants in tribal commercial fish harvest from Lake Michigan and our efforts to communicate the balance between consumption of nutritious Great Lakes fish while avoiding chemical contaminants.

RITZENTHALER, ALICIA[1], KRAMER, E.[1], FRY, L.[1], GRONEWOLD, D.[2], and ANDERSON, E.[2], [1]Cooperative Institute for Limnology and Ecosystem Research (CILER), 4840 S State Rd, Ann Arbor, MI, [2]NOAA Great Lakes Environmental Research Laboratory (NOAA GLERL), Ann Arbor MI.

Spatial, Temporal, and Analytical Variability in Near-Shore Water Quality and its Implications on Model Development and Beach Management Decisions

Utilizing a robust data set, including both high temporal and spatial samples, collected from tributary and nearshore environments in Macomb County, Michigan during the 2012 and 2013 swimming seasons, we explore the variability in spatial and temporal distribution of fecal indicator bacteria (FIB) as well as the analytical variability between two U.S. EPA approved FIB enumeration methods, membrane filtration and IDEXX Colilert. Although beach management decisions are guided by FIB monitoring results, the collection and analysis of near-shore water quality samples is hardly uniform within or between beach monitoring programs. For instance, if County A was to implement their sampling and analysis protocols at one of County B's beaches would they make the same management decision County B did, or would following an alternative protocol lead them to a different management conclusion? By understanding where variability exists we can better understand the implications that sampling and analysis variation between beach monitoring programs has on management guiding results. Facing budget constraints, many beach managers are also relying on water quality models as decision-support tools. Are currently used models which provide a daily water quality result for an entire length of beach high enough resolution to capture water quality variability? Understanding the scale at which spatial and temporal variability acts also helps to inform the scale at which water quality models need to operate in order to provide meaningful outputs for use as decision support tools.

ROBERTSON, DALE, M. and SAAD, D.A., U.S. Geological Survey, Wisconsin Water Science Center, 8505 Research Way, Middleton, Wisconsin 53562.

Recent Progress and Future Plans for SPARROW Watershed Modeling in the Lake Michigan Basin

To help address eutrophication problems in the Great Lakes, SPARROW (SPAtially Referenced Regression On Watershed attributes) models were recently developed to simulate phosphorus (P) and nitrogen (N) loading in streams throughout the Upper Midwest part of the United States. Results from these SPARROW models were used to: 1) estimate P and N loads to each Great Lake; 2) rank all U.S. tributaries with drainage areas greater than 150 km^2, based on total loads and relative yields; and 3) determine the relative magnitude of P and N inputs from major sources (atmospheric, point sources, fertilizers, manure, fixation, and forested and urban lands). Updated SPARROW models are now being developed using much smaller catchments (delineated using the National Hydrography Dataset Plus–NHD Plus) to enable improved spatial descriptions of the location and origin of the P and N sources. The updated models are being developed using more accurate loads estimates, more data from site with smaller drainage basins, and more up-to-date (2012) nutrient source information, than used to develop previous models. A binational modeling effort is also underway with Canada to develop SPARROW models for P and N for the entire Great Lakes Basin. A new model that links SPARROW with outputs from water-quantity models, called HydroSPARROW, has been developed and is being used to forecast changes in nutrient loads associated with various future climate and land-use change scenarios projected to occur by the about 2050.

ROBINSON, CLARE[1], EDGE, T.[2], VAN CAPPELLEN, P.[3], O'CARROLL, D.[1], REZANEZHAD, F.[3], STALEY, Z.[1,2], VOGEL, L.[1,2], MALOTT, S.[1], COOK, A.[1], DURR, H.H.[3], SALERNO, J.[3], and THRASHER, K.[3], [1]Department of Civil and Environmental Engineering, Western University, London, ON, [2]Environment Canada, [3]University of Waterloo, Ecohydrology Research Group, Department of Earth and Environmental Sciences.

Characterization of the Groundwater, Nutrient and Microbial Conditions at Four Great Lakes Beaches

The contribution of groundwater to microbial and nutrient pollution at beaches of the Great Lakes is poorly understood. Although widely established that groundwater and sediment in the foreshore area act as a reservoir for fecal contaminants, the processes by which these contaminants accumulate in the groundwater and sediment and those by which they are transferred to nearshore waters are unclear. Further, the impact of landward groundwater pollutant sources (e.g., septic systems, agriculture) on beach water quality is not well understood. This requires understanding of the conditions underlying the behavior and movement of pollutants and their discharge to the shallow waters. This paper presents simultaneous assessment of the groundwater, nutrient and microbial conditions at four Great Lakes beaches in an attempt to link together the factors governing the contribution of groundwater to degrading water quality at Great Lake beaches. The beaches studied cover a range of conditions: two urban and two non-urban beaches that range from highly polluted and degraded (i.e., frequent beach advisories, algae, wet sand conditions) to more pristine. Detailed measurements were obtained at each site three times over the 2013 bathing season (May, July, September) with this data augmented with biweekly microbial and nutrient water quality sampling. The combined field observations are discussed with recommendations provided for more detailed measurements at these sites.

ROEBBER, PAUL J., Distinguished Professor, Associate Dean, School of Freshwater Sciences, University of Wisconsin at Milwaukee.

Why Lake Michigan Water Levels Have Dropped and What It Means for the Future

Over the past 30 years, and especially the last 15 years, Lake Michigan has been an exemplar of how a slowly changing climate can lead to dramatic shifts in characteristics of the Great Lakes. In particular, a relatively small atmospheric warming has led to a dramatic warming of the waters of Lake Michigan, principally through an ice feedback mechanism. Owing to this warming, there have been substantial increases in the loss of water through evaporation during the summer. As a result, over the past decade, despite near or above normal precipitation during that period and a net increase of water flowing into the lake relative to historical norms (i.e., reduced inflow from the St Marys River has been more than compensated by reduced outflow through the St Clair River), Lake Michigan-Huron water levels dropped to an all-time low. In this presentation, I will show how a changing climate has driven these changes to Lake Michigan, and how these factors will likely drive lake levels in the future. Finally, using this knowledge, I will discuss possible future strategies to anticipate, adapt to, and potentially mitigate future lake level fluctuations.

ROWE, MARK D.[1], VANDERPLOEG, H. A.[2], and NALEPA, T. F.[3], [1]NRC Research Associate, Great Lake Environmental Research Laboratory, NOAA, Ann Arbor, MI, 48108, [2]Great Lake Environmental Research Laboratory, NOAA, Ann Arbor, MI, 48108, [3]Great Lake Environmental Research Laboratory (emeritus), NOAA, Ann Arbor, MI, 48108, and Graham Environmental Sustainability Institute, University of Michigan, Ann Arbor, 48109.

Estimating the Spatial Distribution and Lakewide Biomass of Quagga Mussels in Lake Michigan from Point Observations

Quagga mussels (*Dreissena rostriformis bugensis*) were first found in Lake Michigan in 1997. Coincident with its spread throughout the lake and increase in densities, reduced spring phytoplankton concentrations and altered nutrient cycles were observed. An ongoing benthic ecology monitoring program at NOAA GLERL documented the expansion of quagga mussels with ponar surveys annually for southern Lake Michigan, and every five years lakewide. While quagga mussels are suspected to be a major contributor to recent changes in the Lake Michigan food web, other changes have occurred that complicate the picture; for example, long term declines in phosphorus loads and concentrations. One of our goals is to apply models of varying complexity to diagnose and predict quagga mussel impacts on the Lake Michigan food web and nutrient cycles. Such models require quality estimates of lakewide mussel biomass and spatial distribution from point observations. Conventional spatial interpolation methods fail to take advantage of bathymetric depth as a predictor of mussel biomass, and of nearshore-offshore survey designs. We present a method to combine depth-dependent models of mussel biomass with spatial interpolation to achieve improved estimates of mussel spatial distributions. The ability of the method to predict mussel biomass at locations distant from observations was tested with cross-validation. Spatial distribution of the quagga mussel population in Lake Michigan will likely shift over time as the population responds to changing conditions. Hence, models to better assess and predict these shifts will provide more realistic input for future management plans.

SCHLEIZER, WILLIAM, JOSEPH BRITT[2], and WINSTEN, J.[3], [1]Delta Institute, 35 E. Wacker Dr., Suite 1200, Chicago, IL 60601, [2]Sand County Foundation, 16 N. Carroll St., Suite 450 Madison, WI 53703, [3]Winrock International.

Reducing Phosphorus from Agriculture: Creating a Pay-for-Performance Program using Field-Specific Information in the West Branch of the Milwaukee River Watershed

Starting in 2003, the Sand County Foundation (SCF) launched its *Agricultural Incentives Program* to find creative ways to address the degradation of surface waters by agricultural runoff. Focusing on reductions on nitrogen and phosphorus runoff, these projects bring together partners and stakeholders throughout the Upper Midwest. The *Milwaukee River Watershed Project* works with the agricultural community in the West Branch of the river to manage nutrients and improve water quality; SCF is working with local residents to identify the sources and importance of all types of non-point pollution (agricultural fields, storm water, non-farmed land, including woodland, grasslands, etc.) and provide research-based solutions to the challenges facing landowners and operators. Through a grant from the Great Lakes Protection Fund, a team comprised of SCF, the Delta Institute, and Winrock International, is now building off this work in the West Branch to apply a pay-for-performance system to incentivize producers to seek out the most cost-effective reductions in phosphorus. The project will form a farmer-led watershed council that establishes producers as leaders and partners in developing the incentive structure. The project will also explore ways of generating demand for pay-for-performance conservation by POTWs and other regulated point sources in the Great Lakes Basin. As a final goal, the project will train conservation groups to serve as aggregators of phosphorus loss reductions that can expedite a water quality trading transaction process – with the potential to expand local learnings throughout the Great Lakes.

SHUCHMAN, ROBERT[1], SAYERS, M.[1], MARTIN AUER[2], COLIN BROOKS[1], AMANDA GRIMM[1], and NATHANIEL JESSEE[1], [1]Michigan Tech Research Institute, 3600 Green Ct. Ste. 100, Ann Arbor, MI 48105, [2]Michigan Technological University.

Mapping *Cladophora* and Other Submerged Aquatic Vegetation in the Great Lakes Using Satellite Imagery

Under EPA GLRI funding, the Michigan Tech team has developed and verified a remote sensing algorithm to map the extent of *Cladophora* and other submerged aquatic vegetation (SAV) in the nearshore zone of the Great Lakes using an index that corrects for the effect of water depth. With this algorithm, maps of SAV were generated from recent Landsat satellite imagery for all areas of the lower four Great Lakes that are shallow enough to detect the lake bottom. The area mapped varies depending on water clarity, with maximum mapping depth ranging from >20 m in Lake Michigan to 7 m in Lake Erie. The maps show that 28%, 15%, 30%, and 40% of the visible bottom of Lakes Michigan, Huron, Erie and Ontario, respectively, are colonized by SAV. The total mapped area of SAV is estimated to represent between 130,000 and 260,000 metric tonnes dry weight based on published biomass density measurements. This new mapping approach was validated using field data for an overall map accuracy of 83%. The archive of Landsat imagery dating back to 1973 was also utilized to document historic changes in SAV extent and water clarity, showing increases in SAV extent in most areas following the introduction of invasive mussels. The time series analyses also captured the observed increases in water clarity in all four lakes. Overall, the effects of invasive zebra and quagga mussels on water clarity and phosphorus availability in the Lakes are enabling benthic vegetation to grow more densely and in deeper water than was previously possible, resulting in nuisance blooms even in areas without strong point

sources of nutrients. These new maps will support *Cladophora* management efforts and help to prioritize areas for nutrient abatement programs.

SEAR, THOMAS[1], MELCHIOR, M.[2], HRON, S.[3], ISAACS, S. [4], and BRAULT, A.[5], [1]Short Elliott Hendrickson, 5395 North 118th Court, Milwaukee, Wisconsin 53225, [2]Inter-Fluve, [3]Wisconsin Department of Natural Resources, [4] City of Sheboygan, [5]Sheboygan County.

Sheboygan River Area of Concern Habitat Restoration Projects, Sheboygan, Wisconsin

In 1985, the lower Sheboygan River and Harbor was designated an Area of Concern (AOC) by the U.S. Environmental Protection Agency because of water quality and habitat degradation that occurred due to urbanization and the historical discharge of pollutants into the AOC. The City of Sheboygan, Sheboygan County and the Wisconsin Department of Natural Resources (WDNR) are currently implementing three habitat restoration projects along the lower Sheboygan River that address the elimination of habitat related Beneficial Use Impairments (BUIs) associated with the AOC designation. Between October 2011 and April 2012, a Short Elliott Hendrickson (SEH) project team that includes Inter-Fluve developed related conceptual, preliminary and final habitat restoration designs, while working with a variety of local stakeholders and participating in public information meeting.

Three sites, encompassing 73 acres and nearly 2 miles of shoreline, were targeted for restoration along the lower Sheboygan River, which include the: (1) Kiwanis Park Shoreline Site, (2) Wildwood Island Area Site, and (3) Taylor Drive/Indiana Avenue Site. The causes of the BUIs include stream bank erosion, sedimentation, habitat fragmentation, invasive plants, urban land use, and urban storm water impacts. Restorative measures include shoreline stabilization and development of habitat using woody debris; bioeningeered bank stabilization; removal of invasive plants and replacement with native species; and strategic placement of boulders and gravel banks within the stream to provide fisheries habitat and address sediment issues. The Taylor Drive / Indiana Avenue Project Area includes the development of a restored wetland within a 6 acre stormwater pond.

Project improvements are designed to enhance migratory and shore bird stopover and breeding, herptile breeding, warm water fisheries, fish and wildlife populations, and developing connectivity between the Sheboygan River and riparian wetlands. Major improvements were constructed in fall 2012, with planting activities continuing through summer 2013.

SEILHEIMER, TITUS[1], ZIMMERMAN, P.L.[2], STUEVE, K.M.[3], and PERRY, C.H.[4], [1]Wisconsin Sea Grant, UW-Manitowoc, 705 Viebahn St, Manitowoc, [2]University of Minnesota, [3]Natural Resources Research Institute, [4]U.S. Forest Service.

Prioritizing Lake Michigan Watersheds for Protection and Restoration Using Landscape Indicators and Forest Disturbance Metrics

The watershed of Lake Michigan has a large influence on the water quality of the nearshore environment, therefore, watershed characteristics can be used to prioritize watersheds for protection of nearshore water quality. We used novel landscape information describing the forest cover change, along with forest census data and established land cover data (e.g. agriculture and urban) to predict total phosphorus and turbidity in Lake Michigan streams. Models were developed to rank watersheds based on landscape conditions relative to the amount of phosphorus or turbidity produced. Phosphorus was modeled as a function of ecoregion, the proportion of forest disturbed during 1984-1999, watershed storage, and the proportion of urban land, and turbidity was modeled as a function of ecoregion, the

proportion of forest disturbed during 2000-2009, and the proportion softwood forest. Our phosphorus model and an existing Great Lakes nutrient model (SPARROW) agreed on identifying watersheds with highest levels of phosphorus. We used the models to estimate water quality in watersheds without observed instream data to prioritize those areas for management. These relationships were used to identify priority areas for restoration in west central and southwest watersheds of the Lake Michigan basin. Prioritizing watersheds will aid effective management of the Great Lakes watershed and result in efficient use of restoration funds, which will lead to improved nearshore water quality.
Research funded by the Great Lakes Restoration Initiative.

SHAFER, KEVIN L., Executive Director, Milwaukee Metropolitan Sewerage District, 260 W. Seeboth Street, Milwaukee, WI 53204.

Greenseams®: A Sustainable Approach to Watershed Management

Lake Michigan faces many challenges – invasive species, nonpoint pollution, sewer overflows, and climate change to name a few. Proper management of the land surface along the Lake and its tributaries helps to reduce the impact of these challenges. The Milwaukee Metropolitan Sewerage District's Greenseams® Program fosters good land management by acquiring wetland and floodplain properties, protecting the land with a conservation easement, and, in the future, rebuilding these properties to help improve the ecosystem and reduce nonpoint pollution. Greenseams® provides a framework by which the Milwaukee region can mend our impacts of the past and fortify our efforts to prepare for future changes.

STONE, JEFF, Association of State Floodplain Managers, 575 D'Onofrio Drive, Suite 200, Madison, WI 53719.

Coastal Resilience Planning in the Great Lakes

In recent years, coastal hazards have occupied the headlines repeatedly, most often because of hurricanes, but also because of other storms and water-related phenomena. Less attention has been paid to chronic but serious and often costly threats to communities along the Great Lakes. Effective and well-informed planning can reduce those threats, but it requires specific knowledge among the planners and managers who serve those communities.

Stories and photos about coastal hazards, such as bluff failures or flooding, have a powerful impact because they are easy to comprehend and remember. These stories and photos can then be connected to the underlying locally relevant, science-based data that identify why and where these coastal hazards may occur. This knowledge then helps local decision makers understand the effects of proposed projects in terms of community risks and liabilities.

The Great Lakes Coastal Resilience Planning Guide is a web-based resource developed for coastal managers, floodplain managers, and planners to address existing hazard-related threats and potential impacts of climate change on Great Lakes communities. The Planning Guide integrates local stories; geospatial data; science-based information and visualizations; and policy and regulatory solutions in support of the goals set forth in the Great Lakes Restoration Initiative.

This presentation will highlight this approach by walking listeners through a coastal risk communications example from stories to solutions. It will illuminate the role of Digital Coast partners, including the American Planning Association, the Association of State Floodplain Managers (ASFPM), NACo, and The Nature Conservancy, in supporting the Planning Guide led by NOAA's Coastal Services

Center and ASFPM. The Digital Coast Partnership operates under the aegis of NOAA's Coastal Services Center, and this project is its major initiative currently in the Great Lakes region. Learn why and how planners and their communities can benefit from the resources assembled under the Planning Guide.

STRAKOSH, TIMOTHY R[1] and HENSLER, S.R.[2], [1]U. S. Fish and Wildlife Service, Green Bay Fish and Wildlife Conservation Office, 2661 Scott Tower Drive, New Franken, WI 54229, [2]U. S. Fish and Wildlife Service, Alpena Fish and Wildlife Conservation Office, Waterford Substation.

Aquatic Invasive Species Early Detection Monitoring Program Development in Lake Michigan

Aquatic invasive Species (AIS) pose one of the greatest threats to Great Lakes ecosystem stability and human benefit from ecosystem services. The U. S. Fish & Wildlife Service, in collaboration with partners from the United States and Canada, is developing a new monitoring program to rapidly detect and report invasive species basin wide. This monitoring program will employ both traditional and non-traditional (e.g., environmental DNA) sampling methods to detect new AIS. Compilation of all current assessment activities in the Great Lakes has begun (e.g., sampling gears, locations, times of year) to identify gaps that may be filled by targeted AIS monitoring efforts. This task was initiated in 2012, and preliminary sampling will occur subsequently during 2013 to help refine sampling plans and techniques. The monitoring program will be implemented during the 2014 field season and will strengthen protection of the Great Lakes from AIS.

STRUCK, ANDREW, Director, Ozaukee County Planning and Parks Department, 121 W. Main Street, Port Washington, WI 53074.

Restoration of Degraded Fish and Wildlife Habitat and Populations in the Milwaukee Estuary AOC

The Ozaukee County Planning and Parks Department has implemented a comprehensive effort to restore aquatic habitat connectivity and improve the ecological function of existing riparian habitats throughout the County portion of the Milwaukee Estuary AOC, Milwaukee River Watershed and Lake Michigan Basin. The watershed downstream of Ozaukee County is highly urbanized, with little of the formerly-abundant wetland and riparian habitat remaining in its natural state, resulting in reduced native species abundance and diversity. Ozaukee County has significant contiguous tracts of relatively intact, high quality, and/or protected, suitable spawning and rearing habitat, if hydrologically connected and, in some cases, improved. Enhancing the ecological productivity of aquatic and terrestrial riparian habitat directly supports sustainability and/or population recovery for remnant desirable, native, and/or imperiled fish and wildlife species in the AOC.

Since 2006, the Department's Fish Passage Program and partners have identified and removed/remediated over 180 impediments to aquatic organism passage, reconnecting over 100 stream miles and thousands of wetland and floodplain acres. These activities include large-scale dam removal and restoration projects. The Program is also developing a GIS-based fish and wildlife decision-support tool to prioritize in-stream and riparian habitat improvement and restoration projects for the maximum benefit of multiple target and keystone species. Tool outputs are guiding ongoing, large-scale habitat projects that include stream remeandering, floodplain and wetland reconnection, and invasive vegetation control. Together, these activities constitute a landscape scale effort to restore the ecological productivity of fragmented and/or formerly degraded riparian habitat to benefit several native, remnant and/or imperiled fish, wildlife, herptiles and bird species.

SWART, STEPHANIE, HOBRLA, R., RILEY, J., and BAKER, S., Michigan Department of Environmental Quality, Office of the Great Lakes, 525 W. Allegan Street, Lansing, MI 48909.

Statewide Assessment of Beneficial Use Impairments in Michigan's Areas of Concern

In 2010, with support from the Great Lakes Restoration Initiative, the Michigan Department of Environmental Quality (MDEQ), Office of the Great Lakes Areas of Concern (AOC) program began systematically assessing the status of four Beneficial Use Impairments (BUIs) in a subset of the 14 Michigan AOCs that have those impairments. The BUIs are: Beach Closings, Restrictions on Dredging Activities, Degradation of Aesthetics, and Bird or Animal Deformities or Reproductive Problems. By instituting a uniform approach to BUI assessments, the AOC program was able to realize efficiencies in data collection, technical review, and BUI removal document preparation.

The statewide assessment approach was facilitated by having standardized criteria in place for most of the BUIs. In 2006, the MDEQ finalized a comprehensive set of removal criteria for all 14 BUIs on a statewide basis. The criteria were established with federal and state agency partners and local Public Advisory Council (PAC) collaboration. In some cases, the PACs developed local criteria to tailor BUI removal criteria to specific local needs. The four BUIs that the MDEQ chose for the statewide assessments were selected based on their suitability to a uniform review process and consistency of any local criteria with the state criteria. For the Beach Closings and Dredging BUIs, existing data were reviewed to determine next steps. For the Aesthetics and Bird or Animal BUIs, the MDEQ identified a need to implement systematic monitoring and data collection.

In several cases, these assessments identified needs for additional remedial activities and/or monitoring. As a result of these efforts, the AOC program removed nine BUIs to date, five of which were in AOCs in the Lake Michigan basin. Additional BUI removals are expected in the near future.

TUCHMAN, MARC L., U.S. Environmental Protection Agency – Great Lakes National Program Office. 77 W. Jackson Blvd. Chicago, IL 60604.

The Great Lakes Legacy Program: Cleaning Up Contaminated Sediments in Lake Michigan AOCs

The Great Lakes Legacy Act (GLLA) is a program specifically designed to clean-up contaminated sediments in Great Lakes Areas of Concern. To date, 13 projects have been completed, resulting in the remediation of over 2 million cubic yards of contaminated sediments. The GLLA is a cost-share program and requires a minimum of a 35% cost-share for projects. Non-federal sponsors have included state agencies, industry, municipalities, and NGOs. GLLA projects conducted in the Lake Michigan basin will be highlighted, including sites in: Muskegon Lake, the Grand Calumet River, Sheboygan River, and the Milwaukee Estuary AOCs.

U'REN, SARAH, The Watershed Center Grand Traverse Bay, 13272 S. West Bay Shore Drive, Traverse City, MI, 49684.

Successful GLRI Beach Restoration Projects on Grand Traverse Bay

The Watershed Center's (TWC) mission is advocating for clean water in Grand Traverse Bay and protecting and preserving the Bay's watershed. During the past six years we have implemented our Healthy Beaches Program, which includes bacteria monitoring; source tracking work at local beaches; education via advertising and social media; and large-scale Best Management Practices at beaches to reduce bacterial contamination. In June 2012 TWC completed the first GLRI-funded beach remediation project in Michigan at Bryant Park in Traverse City in partnership with the Michigan Department of Environmental Quality. The project involved installing a large-scale underground infiltration system on one of two major storm drains at the park to reduce bacterial contamination at the beach. In 2011 TWC was awarded two GLRI grants to protect public health and reduce bacterial contamination from runoff at East Bay Park Beach in Traverse City and two beaches in the Village of Suttons Bay. The East Bay Park project was completed spring 2013, and the Suttons Bay project is on track for completion by fall 2013. The East Bay Park project utilized a large, end-of-the-pipe stormwater treatment system featuring a proprietary antimicrobial filter. The Suttons Bay project showcases how green infrastructure such as rain gardens and underground infiltration trenches can be used to eliminate a large percentage runoff from reaching the Bay. Results from the 2013 beach monitoring season will be compared to previous years' data for Bryant and East Bay Park to determine initial success of these projects.

VALENTA, TRACY[1], DOLAN, D.M.[2], KLUMP, V.[3], KENNEDY, J.[1] and SAGER, P.[2], NEW Water, 2231 N. Quincy Street Green Bay, WI 54302, [2]University of Green Bay, [3]University of Milwaukee.

Hypolimnetic Intrusions in Southern Green Bay

Data collected by continuous water quality monitoring devices deployed in southern Green Bay show intrusions of cold, hypoxic water sporadically move in to lower Green Bay throughout the summer. These intrusions are thought to have originated in the thermally stratified waters of the mid-bay. They have been documented moving as far south as the mouth of the Fox River. Analysis of the NEW Water's Entrance Light continuous monitors shows a drop in dissolved oxygen is accompanied by a drop in temperature and specific conductivity. This is an indication the water most likely originated in thermally stratified waters of the mid-bay. Analysis of continuous monitoring data has shown an increase in the number of hypoxic days occurring in lower Green Bay. Data was analyzed from 1986 -2011 for the years that were available. From 1986 to 2008, the number of hypoxic days occurring in Green Bay varied from zero to 18 days. From 2009 to 2011, the number of days increased from 28 to 43, raising concern for this alarming trend.

WALTER, MARK, Brown County Port & Resource Recovery Department, 2561 S. Broadway, Green Bay, WI 54304.

Restoring the Cat Island Chain in Lower Green Bay

The Cat Island Chain of islands historically protected extensive coastal wetlands in the lower Green Bay from high energy wave and storm effects. Surveys in the 1990s documented that Cat Islands provided habitat for 13 species of colonial nesting waterfowl. Extremely high water levels in the mid-1970s and a series of severe storms during ice breakup resulted in catastrophic erosion and ice damage to the islands. While remnant islands and wetland habitat remain, most of this habitat has been lost or degraded. The Cat Island Chain restoration project developed from the 1988 Lower Green Bay Remedial Action Plan.

The project will reconstruct the Cat Islands protecting and restoring 1,225 acres of shallow water and wetland habitat. The three islands total 272 acres and will restore island habitat and reestablish aquatic plant beds in the lower bay. Restoring the islands will lead to recovery of lower bay habitat and benefit fisheries, colonial nesting birds, shorebirds, waterfowl, marsh nesting birds, amphibians, turtles, invertebrates, and furbearing mammals. The wave barrier will provide long term protection to the barrier islands and wetlands from storm and ice damage.

The total project cost is estimated at $22 million with 35 % being provided by Brown County. The project is a partnership between the Port of Green Bay, Brown County, USACOE, USEPA, USF&WLS, WisDOT, WDNR, Lower Fox River/Green Bay Natural Resources Trustee Council, UW Sea-Grant, UWGB and port terminal operators. Funding is being provided from EPA Great Lakes Restoration Initiative grants, a WisDOT Harbor Assistance Program grant, a Natural Resources Damages Assessment grant, and funds collected by the port of Green Bay. The wave barrier and side dikes of the three islands are expected to be completed by 2016 and the islands will be filled by the Corps of Engineers over the next thirty years.

WAPLES, JAMES T. and KLUMP, J. VAL, School of Freshwater Sciences, University of Wisconsin-Milwaukee, Milwaukee, WI, USA. 53226.

Horizontal Pqarticle Transport in Nearshore Lake Michigan

The horizontal and vertical flux of particulate material in the nearshore of southern Lake Michigan (0 – 40 m) was estimated with the naturally occurring radionuclide thorium-234. Calculated onshore transport of particulate material through a shore-parallel (vertical) plane in 40 meters of water (5.4 km from shore) was as high as 1.1×10^6 g m^{-1} d^{-1}, and exceeds estimates of terrigenous (riverine and bluff erosion) loading. Cross-shore fluxes showed a periodicity of ~ 4 days and correlated strongly with a topographic vorticity wave that is present throughout the year in southern Lake Michigan. The impact of this wave (as a driver of bidirectional cross-shore flux) on biogeochemical cycling and both nearshore and offshore foodwebs has not yet been explicitly considered.

WARREN, GLENN J. and MAY, J.C., U.S. EPA, GLNPO, 77 W. Jackson Blvd., Chicago, IL 60604.
Synoptic Nearshore Monitoring of Lake Michigan Using Towed Sensors

The nearshore area of the Great Lakes is one affected by terrestrial input as well as physical, chemical and biological in-lake processes. It is an especially difficult region to sample. In an attempt to develop a monitoring program that can characterize the variability and provide a synoptic assessment of the state of the nearshore, in 2011 we towed a sensor array (Triaxus) around Lake Michigan at the 20 meter depth contour. A number of instruments were included in the Triaxus that allowed nearly continuous recording of nearshore water properties including chlorophyll a, particles and zooplankton, nitrate, and others. Lakewide nearshore averages of properties will be presented as a baseline for future comparisons. The relationship between watersheds or segment sheds and the values of properties averaged over the length of nearshore associated with a segment will be presented. We expect to repeat the Lake Michigan 20 meter contour tow in 2014 and 2015 as part of the Cooperative Science and Monitoring Initiative field year.

WATHEN, JOHN, Assistant Chief, Fish Shellfish, Beaches and Outreach Branch, U.S. EPA Office of Water, Office of Science and Technology-Standards and Health Protection Division, 1200 Pennsylvania Ave, NW MC 4305T, Washington, DC 20460.
Implementing EPA's 2012 Recreational Water Quality Criteria at Great Lakes Beaches

EPA issued new Recreational Water Quality Criteria (RWQC) in December 2012. The RWQC are applicable to all waters in the US and provide revised criteria values and other thresholds for *E. Coli* and enterococcus determined by culture methods for fresh water, enterococcus by culture for marine waters, and enterococcus determined by qPCR for both fresh and marine waters, all for two illness rates, to be selected by states. As part of the implementation of the RWQC, EPA is also revising it *Beach Guidance and Required Performance Criteria for Grants* to include the greater use of statistical models and other tools, the widespread adoption and use of beach sanitary surveys, and the use of rapid molecular methods to determine densities of fecal indicator bacteria in recreational waters. The revised guidance document describes an integrated approach to beach monitoring that includes the ranking and prioritization of beaches by the level of use of a beach and the risk of impact from sources of contamination, the development of appropriate monitoring approaches, communication of advisory information by a variety of media, and of course, the application of the 2012 RWQC to recreational beaches. The guidance focuses on implementation to achieve maximum public health benefit in an era of uncertain availability of resources at both the state and federal levels.

WATHEN, JOHN, STAHL, LEANNE, MURPHY, E., FISHER, J., SMITH, E., OLSEN, A., SNYDER, B., and MCCARTY, H.

EPA's Great Lakes Human Health Fish Tissue Study

EPA's Office of Water, Great Lakes National Program Office, and Office of Research and Development are collaborating to conduct the Great Lakes Human Health Fish Tissue Study. This is the first statistically based study of fish contamination in the Great Lakes, and it adds a human health component to the ecological assessments EPA is conducting under the statistically designed National Coastal Condition Assessment (which includes the Great Lakes). This assessment of contaminants in Great Lakes fish for human health applications involved collecting one fish composite sample from 157 randomly selected nearshore sites (depths up to 30 m or distances up to 5 km from shore) throughout U.S. waters in the five Great Lakes (about 30 sites per lake). Sampling efforts targeted five similarly sized adult fish of the same species that are commonly consumed by humans. Fillet tissue from each composite sample is being analyzed for total mercury, 13 perfluorinated compounds [PFCs] (including perfluorooctanoic acid [PFOA] and perfluorooctanesulfonic acid [PFOS]), 52 polybrominated diphenyl ether [PBDE] congeners, 209 polychlorinated biphenyl [PCB] congeners, and 5 omega-3 fatty acids (including alpha-linolenic acid [ALA], eicosapentaenoic acid [EPA], and docosahexaenoic acid [DHA]). EPA collected fish from mid-May through mid-November in 2010 and received support from several Great Lakes states for the sample collection effort. Fish were collected from 38, 31, 29, 27, and 32 nearshore locations in Lakes Superior, Michigan, Huron, Erie, and Ontario, respectively. Three recommended target species -- lake trout, smallmouth bass, and walleye -- collectively accounted for nearly 60% of the composite samples. Analytical results formed a regionally representative sample, the results of which can be extrapolated to an estimated Great Lakes nearshore surface area of 11,086 km^2. Results from Lake Michigan sample sites will be compared to the statistical summary data for the Great Lakes as a whole.

WELCH, LYMAN C., Water Quality Program Director, Alliance for the Great Lakes, 17 N. State Street, Suite 1390, Chicago, IL 60602 USA.

Algae and Nutrient Control in the Great Lakes– The Need for Innovative Regulatory Approaches

Excessive runoff of phosphorous is one of the leading causes of massive and recurring algal blooms in the Great Lakes when the nearshore waters are overloaded with this essential nutrient. Agricultural sources are typically the major source of phosphorus loadings with urban runoff and discharges from waste water treatment plants also contributing to the problem.

Great Lakes states, with the exception of Wisconsin, have failed to adopt enforceable nutrient water quality standards. Even when standards are instituted, states often lack the regulatory tools necessary to ensure phosphorus reductions from nonpoint pollution sources such as agricultural operations.

Innovative regulatory approaches are now being used in Wisconsin to address nonpoint nutrient pollution. Under Wisconsin's new phosphorus rule, Clean Water Act "point source" permittees such as sewage plants and industrial facilities may choose a compliance strategy that involves restoring water quality through phosphorus reductions by nonpoint sources in the same watershed. By accounting for reductions of phosphorus from nonpoint sources, water quality limits of the point source dischargers may be relaxed. Permittees who choose this option may avoid high-cost technology upgrades that would not improve water quality on any significant scale. By making the point source community a

collaborative partner, this new rule can resolve a shortcoming of the Clean Water Act and drive successful watershed restoration projects.
This presentation will provide:

- An overview of the traditional sources/factors that have strained the health of Great Lakes beaches and near-shore waters;
- A closer look at the problem of phosphorus pollution and algae growth, and why the problem has again become such a high priority in the Great Lakes region; and
- A review of some of the innovative and promising approaches being taken in the Great Lakes basin to address the problem of phosphorus pollution and algae growth, with a particular emphasis on Wisconsin.

WILLIAMS, HEATHER, USEPA GLNPO, 77 West Jackson Boulevard, Chicago, Illinois.

Sediment Remedial Action: The Great Lakes Legacy Act and Great Lakes Restoration Initiative Dredging Projects at the Sheboygan River Area of Concern

The Sheboygan River Great Lakes Legacy Act (GLLA) project completed in 2012 removed 148,000 cubic yards of contaminated sediment from the Sheboygan River. River sediments were contaminated with PCBs and petroleum compounds associated with two Superfund sites. GLLA remedial action was performed as a betterment to CERCLA required action. Project partners for the GLLA remedial action included the Wisconsin Department of Natural Resources, the City of Sheboygan, Sheboygan County, as well as two responsible parties, Wisconsin Public Service Corporation and Pollution Risk Services. A second dredging project was also performed through the Great Lakes Restoration Initiative which removed over 153,000 cubic yards of low-impact PCB-containing sediment in the navigation channel of the downstream harbor area of the river.
The Sheboygan River Area of Concern was identified as a priority Area of the Concern for USEPA, requiring all actions leading to delisting be performed by 2012. All aspects of the GLLA and Harbor sediment project were performed on an accelerated timeframe. From summer of 2010 to summer of 2012, GLNPO performed site characterization, feasibility studies, remedial design and initiated remedial action on both dredging projects, with extensive Superfund project coordination.
Both the Legacy Act and Harbor dredging projects were initiated in summer of 2012, with two sediment processing facilities being constructed along the river. As Superfund work was ongoing through October 2012, three sediment dredging projects were in progress simultaneously within the downtown area. The GLLA and Harbor projects were performed 24/7 from August through December 2012. Extensive outreach efforts by the project partners was performed in preparation for the around-the-clock work and approximately 300 trucks moving in and out of the City every day.
Multiple challenges existing in the planning and implementation for the dredging projects in Sheboygan associated with the timeframe for completion, development of the betterment project, permit requirements, available funding, continuous coordination with Superfund projects, location of work performed, heavy recreational boat traffic, significant design considerations and record-low water levels. The challenges throughout implementation of the project through December 2012 will be present with a strong emphasis on the critical role of successful partnership and teamwork project by all project partners.

WU, CHIN H., and ROZNIK, W., UW Department of Civil and Environmental Engineering, University of Wisconsin–Madison, Madison, WI.

Comparison of Sediment Budgets of Nearshore Environment for Two High Bluffs on Lake Michigan

The sediment budget concept is critical to the dynamic evolution of coastal bluff and nearshore environments. In this talk, we report sediment budget at two high-bluff (30-45 m) sites, i.e., the recently stabilized coast of Concordia University and that of the equilibrium coast surrounding Port Washington, along Lake Michigan in Ozaukee County, WI. Historical aerial photos and topographic surveys of bluffs and beaches were conducted to obtain the recession rate of bluff crest and toe, shoreline position, and beach width. Successive nearshore surveys of sediment substrates were performed to obtain bottom sediment erosion and deposition. Longshore sediment transport driven by waves and currents were measured to characterize littoral transport of cohesive bluffs.

At the equilibrium coast, the bluff crest recession ranged from 0.05 to 0.6 m/yr. In contrast, the bluff toe experienced a net deposition up to 1.1 m/yr. Field observations of beach width and sediment availability agreed with calculated trends of sediment accretion, which in turn protected bluff. At the Concordia University site, no beaches existed in front of the newly-built coastal structures, suggesting that natural sediment pathways may be disrupted. Over the six-year study period, distinct spatial variation of bluff slumping occurred which was most severe on the south bluffs, average on the north bluffs, and nonexistant within the structured area. The occurrence of severe bluff recession on the south bluff can be explained by the unbalanced longshore sediment transport. Comparison of sediment budgets for the two high-bluff sites aids in understanding the impacts of shore protection structures on the nearshore environment, leading to regional integrated bluff management (IBM) for coastal bluffs along Lake Michigan.

ZETTS, COREY, Associate Director, Menomonee Valley Partners, 301 W. Wisconsin Avenue, Suite 400B, Milwaukee, WI, 53203.

Milwaukee's Menomonee Valley: A Sustainable Redevelopment Story

In the last decade, Milwaukee's Menomonee Valley has transformed from one of the most blighted areas in Wisconsin to a national model of sustainable redevelopment. The Valley story demonstrates that economic development and environmental restoration are not mutually exclusive goals, but rather strengthen one another.

In just 10 years, 300 acres of brownfields have been remediated; 35 companies have moved here; and 5,000 family-supporting jobs have been added. By complying with the Valley's Sustainable Design Guidelines, companies have built 1,000,000 square feet of energy-efficient buildings and 45 acres of contaminated soil has been replaced with native landscapes and innovative shared stormwater treatment areas and other green infrastructure. The Hank Aaron State Trail now travels 14 miles, serving as a commuting and recreation route as well as a vegetated riparian buffer throughout most of the Valley. More than a mile of riverbank has been restored, ending a decades-long problem of eroding banks depositing contaminated sediment, while in-stream improvements have improved aquatic habitat. This summer, a 24-acre park along the river opens, recreating 24 acres of native vegetation, public access to the river, and serving as an outdoor science classroom for the newest branch of the Urban Ecology Center.

The Valley's revitalization is a story of partnership; many collaborations have been necessary to address its complicated interconnected issues. The range of stakeholders includes residents, property owners, local and state government, civic leaders and specialists in environmental stewardship,

sustainable building and landscape design, and workforce development. This collaborative and comprehensive approach has led to the implementation of many best management practices, leveraged funding sources, and developed the community buy-in that provides momentum to keep the effort moving forward. Together, stakeholders demonstrate that an economically and ecologically healthy Menomonee River Valley is essential for the region and of critical importance to the entire watershed.

ZORN, MICHAEL E.[1], WAPLES, J.T.[2], VALENTA, T.[3], KENNEDY, J.[3], and KLUMP, J.V.[2], [1]University of Wisconsin – Green Bay, 2420 Nicolet Drive, Green Bay, WI 54311, [2]University of Wisconsin – Milwaukee, [3]NEW Water (formerly Green Bay Metropolitan Sewerage District).

Continuous Monitoring of Phosphate, Nitrate, Dissolved Oxygen and Temperature in Green Bay, Lake Michigan

In nearly every instance in which the environment has been sampled on a higher resolution in time or space, fundamental processes have come to light that were previously undetected or observed. With periodic grab sampling, the full impact of key environmental parameters may be overlooked, obscuring their importance, and hindering their management. In a recent study, concentrations of phosphate, nitrate, dissolved oxygen and temperature were determined from summer through mid-fall 2012 at a location in lower Green Bay using continuous monitoring, *in situ* sensors. These continuous monitoring data strongly suggest that wind (velocity and direction) has a direct effect on temperature, dissolved oxygen and dissolved nutrient concentrations. Additional causes for observed variations could include: changing inputs, forms, and stoichiometry of nutrients from the Fox River, internal biological or chemical transformations, periodic stratification and destratification in lower Green Bay, sediment nutrient regeneration processes, or changes in physical mixing patterns resulting in advective movement of bulk water masses. In this presentation, the interaction between relevant environmental parameters will be explored.

ALM, E.W., JORDAN, D., and GEHRING, T., Central Michigan University, 157 Brooks Hall, Mt. Pleasant, MI 48859.

Using Border Collies to Exclude Gulls at Great Lakes Beaches

Gulls at Great Lakes beaches impair water quality and are an emerging public health and economic issue for coastal communities. In particular, Ring-Billed Gull populations have shown a dramatic increase in the Great Lakes region with the population growing an estimated 10% each year since the 1970s. Research suggests that gull feces may be one source of the fecal indicator bacterium *E. coli* to beach water at times when *E. coli* levels exceed guidelines, leading to swim advisories and beach closings. In addition, gull feces may contain bacteria with the potential to cause human disease. Therefore we have been investigating the effectiveness of border collies as a non-lethal management tool to reduce gull presence at public beaches. The study was designed to address two primary questions: 1) are border collies effective for excluding gulls from beaches? 2) will gull exclusion from beaches result in lower levels of *E. coli* in beach water and sand? Two hundred meter beach sections along Lake Michigan were randomly assigned as control or dog treatment. A crossover design converted controls to treatments and treatments to controls during the 2nd half of the summer. During the summers of 2012 and 2013, we recorded the number of gulls at each beach section, with dogs used 8 am to 6 pm 7 days/week for 38 days on treatment sections in 2012, and with dogs for 4 hours morning and evening Monday through Friday in 2013. Gull numbers and *E. coli* in water and sand were compared between control and treatment sections. Border collies on beaches reduced the presence of gulls and the densities of *E. coli* in beach sand.

ANAN'EVA, TAMARA[1], KURDAS, S.[2], CREEKMUR, J.[2], and KINZELMAN, J.[2], [1]U.S. EPA Office of Water, ORISE Research Intern, U.S. EPA Office of Water, 730 Washington Ave, Room 8, Racine WI 53403, [2]City of Racine Health Department Laboratory.

Use of Predictive Modeling in Conjunction with QPCR Rapid Molecular Testing to Assess Recreational Water Quality at the North and Zoo Beaches in Racine, WI

A number of epidemiological studies conducted by the USEPA have revealed a relationship between elevated levels of fecal indicator bacteria (FIB) and increased incidents of swimmer related illness. Currently approved culture based methods require 18 to 24 hours of sample processing before obtaining a reportable result. The newly released recreational water quality criteria (RWQC 2012) recommendations approve the use of quantitative polymerase chain reaction (qPCR), a rapid molecular method, for enumeration of FIB in recreational waters. QPCR, a DNA-based test, can provide a result in less than 3 hours from the time of the sample collection. However, wide-spread implementation of qPCR method may be hindered by the high start-up cost, lack of technical knowledge, and/or site-specific conditions. Alternatively, predictive models, such as those constructed using Virtual Beach, could provide useful real-time information based on environmental variables for evaluation and managing recreational waters at a minimal cost. For example, models may be used to screen water quality conditions and determine when qPCR should be performed to confirm FIB estimations. In 2012, two recreational beaches were monitored by City of Racine Health Department using qPCR, IDEXX Colilert and a predictive model constructed using Virtual Beach v.2.1. Beach management decision agreement between qPCR and the predictive model was 76.9% and 89.7% at North and Zoo Beaches, respectively. There were no Type I errors. Type II errors occurred at a frequency of 23.1% and 10.3%, (North and Zoo Beaches respectively). Beach action agreement between IDEXX Colilert and the model was similar; 82.5% and 87.5% with no Type I errors occurring and Type II errors occurring 23.1% and 10.3% of the

time (North and Zoo respectively). While the number of correction beach action decisions was better than the persistence model (culture alone) a reduction in Type II errors, as determined by the model, is necessary. Once resolved, the use of qPCR and models in tandem may help achieve maximal public health protection in a timely and cost-effective manner.

ARENSON, J.[1], COHN, M.[1], HARRISON, L.[1], BUSSE, K.[1], KLEINHEINZ, G.K.[1], MCDERMOTT, C.M.[1], CORSI, S.[2] and CARVIN, R.[2], [1]University of Wisconsin Oshkosh, Oshkosh, WI 54901, [2]USGS, Madison, WI.

Comparison of Predictive Models, Persistence Models, and Microbiological Enumeration of *E. coli* at Beaches in Manitowoc County, 2013.

Monitoring beach water for fecal indicator bacteria (FIB) by traditional microbiological techniques requires 18-24 hours to obtain results. Beaches, therefore, are opened or closed based on yesterday's *E. coli* concentrations. In order to accelerate the enumeration of the FIB and better protect public health, two options have been developed, predictive mathematical models and rapid molecular techniques (qPCR). This study compares the *E. coli* concentrations in beach water at six Manitowoc County, WI beaches using the mathematical predictive models developed by USGS, the persistence model (yesterday's *E. coli* concentration determined by defined substrate method), and that day's actual *E. coli* concentration (based on defined substrate method). Both models routinely correctly predict "negative" *E. coli* concentrations (those that do not exceed the advisory threshold of 235/100 ml)(i.e. "Correct Negative"). The predictive model's specificity ranged from 0.93-1, while the persistence model's specificity was more variable (range=0.57-0.92). The number of predicted false negatives by both models was troublesome for adequate protection of public health. Effectiveness of models was beach dependent, with the predictive model for Point Beach most often correctly predicting if exceedances would occur.

BRADY, AMIE[1], BUSHON, R.[1], KANNAPPAN, V.[2], ALBRECHT, S.[3], COALE, C.[4], and BRIGGS, S.[5], [1]U.S. Geological Survey, Ohio Water Science Center, [2] Work performed at Ottawa County Health Department (currently works at Michigan Department of Environmental Quality), [3]Chippewa County Health Department, [4]Northern Michigan Regional Laboratory, [5]Michigan Department of Environmental Quality.

Comparison of the IMS/ATP Rapid Method and Culture-Based Method for *E. coli* at Great Lakes Beaches in Michigan

Rapid detection methods for monitoring indicator bacteria in recreational waters are a widely-recognized need due to the delay in obtaining results from traditional culture methods. One such method, immunomagnetic separation/adenosine triphosphate (IMS/ATP), provides bacterial indicator results within 2-3 hours of sample collection and has been tested for use in recreational waters. This method has also an advantage over current molecular based methods such as quantitative polymerase chain reaction (qPCR) since the initial start up is more cost-efficient. The application of the method requires only a basic initial training with a basic QA/QC knowledge whereas qPCR needs more complicated technical expertise and strict QA/QC, making IMS/ATP a promising rapid method for user-friendly applications; particularly for health department laboratories.

During the recreational season of 2012, the Michigan Department of Environmental Quality and three Michigan Health Departments (Chippewa County, Ottawa County, and the Northern Michigan Regional Laboratory) collaborated with the U.S. Geological Survey (USGS) in a study that compared results of the IMS/ATP method to the traditional culture method for *E. coli*. A total of 352 samples were

collected at 15 beaches and analyzed using both methods. Preliminary examination of the results showed a statistically significant relationship between the methods at 6 of the beaches, making them promising locations for the use of this rapid method. The Pearson's correlations coefficient (r) between results from the IMS/ATP and culture method ranged from 0.58-0.86 at the 6 locations. Funding for this study was provided by the Great Lakes Restoration Initiative.

BRUNNER, JOEL, City of Racine Health Department – Laboratory, 730 Washington Ave, Room 8, Racine, WI 53403.

Using Microbial Source Tracking to Increase Water Quality at Beaches in Kenosha, WI and the Economic Impact of Restored Beaches

Beaches are a vital asset to any coastal community, keeping them open for use and protecting public health are paramount. The City of Racine was awarded Great Lakes Restoration Initiative (GLRI) grants to pinpoint sources of microbial contamination for 19 impaired beaches in southeastern Wisconsin. Routine Sanitary Beach Surveys were used as a guideline to conduct microbial source-tracking at each beach. From those results, redesign plans are proposed for each beach, along with recommendations for best management practices to improve water quality at the beach by decreasing the microbial load. Mitigating the bacterial load can be accomplished by; grooming the sand to promote bacteria die-off, infiltrating stormwater that discharges near the beach, planting dunes to deter avian wildlife from loafing, removal of *Cladophora* and unwanted debris, and beach nourishment to lessen wave action to keep the majority of the beach dry. The City of Kenosha has two urban beaches where a redesign plan has been developed to increase water quality. With implementation of redesigns, beach advisories and closures should be significantly reduced thus improving beach perception and usage. Beaches are one of America's top tourist destinations and can positively impact the local economy when used to its full potential. Beaches provide direct and indirect benefits to the community such as; enhanced property values, employment opportunities, increased sales, prevent loss of sediment, and provide habitat for animals and vegetation. These benefits from the redesign and other mitigation strategies should outweigh the cost of implementation, funding a sound investment at the beach for the environment, economy, and local citizens.

COLTON, DAVE, Goosinator.com, 86 Carr St., Lakewood Co., 80226.

Don't Feed the Gulls; In the Great Lakes; During the Summer of 2013; How many Times will Parents have to Tell their Children that they can't Swim or Play at the Beach Today, IT'S CLOSED!

During the summer of 2012, many Great Lakes beaches were closed to swimming. Families other option was to stay and play in the sand. Digging down a mere eight inches in the sand exposes humans to *e-coli* counts forty times higher than that of what it would take to issue a "no swimming" health advisory. Recent studies have proved that beach sand is an incubator for *e-coli.*

The USGA, have confirmed the main causes contributing to the high numbers beach closures and the frightening high levels of *e-coli* in beach sand throughout the Great Lakes region are, the thousands of beach loafing gulls, and gulls, geese and ducks roosting on storm water detention ponds. Studies have confirmed that many storm water detention ponds have over ten times the e-*coli* bacteria counts it takes to close beaches.

Gull fecal contamination is by far the most toxic. An example; *e-coli* bacterial counts of duck and goose droppings are typically in the range of 15,000 particles of e-coli bacteria per gram. Gull droppings

have counts in the range of 278 million per gram of *e-coli* bacteria and other pathogens that pose serious health risks.

Our company has a patented system that can and will keep all the *e-coli* contributing storm water detention ponds clear of all migratory waterfowl and relocate large flocks of beach loafing gulls and geese; subsequently reducing or eliminating beach closures throughout the Laurentian Great Lake Basin.

The GOOSINATOR offers an affordable and viable solution to these reoccurring problems. It's a fear imprinting, all- terrain, radio controlled mimic predator, which can disperse and relocate large flocks of loafing gulls and geese from any Great Lake beach, and rout migratory waterfowl from storm water detention ponds that in many cases, empty directly into tributary rivers or into the Great Lakes themselves.

DIEDERICHS, B., BUSSE, K., KLEINHEINZ, G.T., and MCDERMOTT, C., University of Wisconsin Oshkosh. 800 Algoma Blvd. Oshkosh, WI 54901.

Beach Management of Crescent Beach and Monitoring of Non-Point Source Pollutants in the Ahnapee River Watershed in Algoma, WI

Crescent Beach (Algoma, WI) is located in the southern region of the Door Peninsula in northern *Terrace*Kewaunee County. It is listed as an Impaired Water (CWA Section 303d) due to elevated *E. coli* concentrations. Routine beach sanitary surveys (BSS) were conducted by UW-Oshkosh from 2010-2012 as part of a UW-Oshkosh Great Lakes Restoration Initiative (GLRI) project; "*Cladophora* blooms significantly impact water quality". The Bay-Lake Regional Planning Commission has funding to develop beach redesign plans. Unfortunately, BSS data, directed at coastal water quality (inclusive of the river mouth), does little to identify upstream non-point sources in the Ahnapee River Watershed, a likely contributor to poor water quality. It is essential to evaluate the surrounding watershed and determine tributary contributions affecting coastal water quality. This project sampled 20 upstream locations on the Ahnapee River and adjacent storm water drains during periods of base and high volume flow for a suite of water quality parameters capable of characterizing pollutant loading (*E. coli*, phosphorous, turbidity, conductivity, pH, dissolved oxygen (DO; open water sites only) and targeting non-point pollution sources. Physical parameters (i.e. stream bank erosion and river morphology) and the efficacy of removal of *Cladophora* using mechanical equipment and volunteers for hand raking were also assessed. Finally, Algoma High School students were educated (Chemistry/Research) to increase their awareness of the impacts of phosphorus and *Cladophora* on Lake Michigan water quality. This project evaluated a watershed-based targeted mitigation strategy for the Ahnapee River, to develop a better understanding of ecosystem stressors, increased stewardship, and volunteer-supported enhanced *Cladophora* removal Best Management Practices at Crescent Beach in the Algoma, WI.

DUNCKER, JAMES J.[1], JACKSON, P.R.[1], JOHNSON, K.K.[1], and RENEAU, P.C.[2], [1]USGS-Illinois Water Science Center, 1201 W. University, Urbana, IL 61801, [2]USGS-Wisconsin Water Science Center.

Synoptic Survey of Near Shore Water Quality and Circulation in Lake Michigan Along the Chicago Lakefront

Researchers studying the fate and transport of bacteria in the near shore environment of southern Lake Michigan have focused efforts primarily on individual beaches susceptible to bacteria – related closings. On July 17-18, 2012 the U.S. Geological Survey, in cooperation with the Chicago Park District, completed a near shore survey of water quality and water circulation along a 20-mile reach of the Lake Michigan shoreline near Chicago, Illinois. The survey data was collected using an EcoMapper autonomous underwater vehicle (AUV). The AUV was programmed to swim a series of short transects (from offshore to onshore) while repeatedly undulating between the lake bed and the water surface and continuously logging it's position and water quality data from onboard sensors. The surveys started near Evanston, Illinois on July 17, 2012 and near the Illinois-Indiana state line on July 18, 2012 and both moved toward Chicago Harbor as the days progressed. A manned boat was used to launch and retrieve the AUV while also collecting acoustic Doppler current profiler (ADCP) data along each of the transect lines. Meteorological conditions such as wind speed and direction were recorded to document the relatively stable lake conditions during the 2-day survey.

DÜRR, HANS H.[1], MITCHELL, K.[1], DRIEDGER, A.[1], BRANCAZI, E.[1,2], and VAN CAPPELLEN, P.[1], [1] Ecohydrology Research Group, University of Waterloo, ON, [2] University La Sapienza, Rome, Italy.

Remote Sensing of Plastic Debris

Plastic litter is a global problem affecting all surface water bodies and their littoral zones, with far-reaching economic, ecological, public health and aesthetic impacts. Plastic pollution is a global, international and trans-boundary issue. It has been identified as a potential carrier for pathogens. Micro-plastics, largely invisible to the human eye, can accumulate in the food chain. Humans produce over 260 million tons of plastics per year, of which only about one percent is recycled. Plastic litter is found in increasing amounts in the Great Lakes, and even in remote areas such as parts of Lake Huron. Existing estimates of plastics pollution are generally based on limited shipboard or aerial observations of large debris patches, and inferences from beach surveys. Reliable regional and global surveys of the amounts, nature and fate of plastics in large water bodies are largely missing. At the present time, remote sensing and the deployment of in situ sensors appear to be the only viable options to assess the spatial extent and temporal variability of plastic distributions in surface waters and associated littoral zones. Plastics have characteristic absorbance and reflectance spectra in the near infrared (NIR) domain that are used, for instance, to sort plastic debris in recycling facilities and assess plastic mulch on agricultural lands. We carry out a feasibility study to analyze and evaluate the diagnostic capabilities of remote sensing, together with in situ options for the identification of micro-plastics, for quantitative and qualitative surveys of plastics distribution in surface waters and littoral zones. Preliminary field trials focus on the Great Lakes as a testing ground for remote sensing surveys.

DÜRR, HANS H.[1], REZANEZHAD, F.[1], VAN CAPPELLEN, P[1], ROBINSON, C.[2], SMEATON, C.[1], BACCA-CORTES, G.F.[1], SALERNO, J.[1], and THRASHER, K.[1], [1] Ecohydrology Research Group, University of Waterloo, ON, [2] Department of Civil and Environmental Engineering, Western University, London, ON.

Biogeochemical Investigation of Groundwater – Lake Interactions at Beaches of the Great Lakes: First Results

This research is part of a larger study designed to examine the interactions of groundwater and lake water and their contribution to fecal and nutrient pollution at four beaches of the Great Lakes (see Robinson et al., session 4). In beach environments, waves and variations in lake level plus groundwater recharge create a dynamic subsurface biogeochemical reaction zone that may strongly influence the nature and discharge of nutrients into lakes. To elucidate the role of human impacts on nutrient speciation and fluxes, four beaches were selected on Lake Ontario (Marie Curtis, Toronto and Burlington) and Georgian Bay (Ossossane and Balm). These beaches encompass a range of relatively pristine to heavily human-impacted environments. Groundwater monitoring transects were installed perpendicular to the shoreline at each beach with additional monitoring on either side to assess alongshore variability. Sampling took place during three periods: early, mid and late summer. Pore-water and surface water samples were analyzed for nutrients (nitrate, ammonium, phosphate, silica, sulphate) and other water quality parameters, including temperature, pH, chloride, redox potential, dissolved organic and inorganic carbon, and total alkalinity. The more heavily impacted beaches are characterised by high ground water chloride, sulphate and nitrate concentrations, while lower concentrations were observed in the less-impacted environments. Significant differences in redox potential, dissolved organic carbon and active microbial biomass were observed between the sites. (Note: adenosine triphosphate, or ATP, concentrations were used as a proxy for predicting microbial biomass.) The spatial and temporal variability of the measured water quality indicators, and their potential implications for fecal bacteria contamination at the four beaches will be discussed.

EBERT, S. ROTHE, J., BOHR, M., MUELLER-SPITZ, S., KLEINHEINZ, G., and MCDERMOTT, C., University of Wisconsin Oshkosh, 800 Algoma Blvd. Oshkosh, WI 54901.

Managing Fecal Contamination through Beach Remediation Efforts-Door County, WI

Routine monitoring of water quality has illustrated that rainfall and storm water runoff introduces microbial contaminants to the beach environment. The human health risk and economic losses due to recreational beach closures supports efforts to redesign beach environments that should improve water quality and decrease the exposure to water borne pathogens. Current redesign efforts include increasing native plants, adding construct wetlands, and adding beach sand nourishment. . It remains undetermined if these changes correlate with decreased fecal pollution and the subsequent bacterial fecal indicators. The beaches of Door County, WI have been monitored since 2004 providing a wealth of historical data about water quality. Historically, Sunset Park and Egg Harbor beaches had an average of 9.8 and 5 advisory/closures per season between 2004-08, which prompted renovation. The non-remediated comparisons, Ephraim and Fish Creek beaches, only had 2-4 advisory/closures per season during the same time frame. For the recently redesigned beaches, it remains unknown how these changes have impacted beach water quality. This research focused on characterization of fecal indicators at non-remediated (n=2) and remediated (n=2) beaches through measuring *E. coli* and enterococci concentrations. Preliminary data for the 2013 season indicated that both remediated beaches were lower than non-remediated beaches for culturable *E. coli* concentrations. A similar trend was also seen with the molecular detection of enterococci.

GAO, LEI, ZHOU, Z. and GUO, L., School of Freshwater Sciences, University of Wisconsin-Milwaukee, 600 E Greenfield Avenue, Milwaukee, Wisconsin 53204, USA.

Dynamics of Inorganic and Organic Nitrogen at the River-Lake Interface in Southwest Lake Michigan

Water samples were collected monthly/seasonally between December 2012 and June 2013 along a transect from the Milwaukee River to open Lake Michigan for the measurements of dissolved inorganic nitrogen (DIN, including NO_3^-, NO_2^-, and NH_4^+), dissolved organic nitrogen (DON), and colloidal organic nitrogen (CON) to examine nitrogen dynamics at the river-lake interface in Lake Michigan. Concentrations of DIN in river waters decreased from ~80 μM during winter to ~40 μM during spring, while in Lake Michigan, DIN varied from ~14 μM during spring/summer to ~18 μM during winter, showing a general decrease from river to lake waters, but homogeneous or slightly increase from surface to deep water in Lake Michigan. Within the DIN pool, NO_3^- is the predominant species comprising >84%. Concentrations of DON also decreased from river (20-80 μM) to open lake waters (<20-40 μM), but less variable or slightly decreased from surface to deep waters in Lake Michigan (<10-20 μM). These variation trends highlighted the importance of terrestrial contribution of DIN and DON to the lake and potential production of DIN species in bottom waters. While DIN predominated the total dissolved nitrogen (TDN) pool in both river and lake waters during winter, DON became dominant throughout the entire water column during spring/summer. The unbalance between DON increase and DIN decrease during summer suggested that DON could be derived from particulate nitrogen pool in the water column. Colloidal organic nitrogen contributed up to 22-56% of the DON pool or 12-32% of the TDN pool in river/coastal waters. Similar to DIN and DON, the abundance of CON also decreased from the Milwaukee River to Lake Michigan. Further time-series observations with detailed chemical and phase speciation measurements are needed to elucidate the source, transport and transformation of nitrogen species across the river-lake interface and in the water column of Lake Michigan.

LIN, PENG and GUO, LAODONG

Spatial Variations in Chemical Speciation of Phosphorus across the River-Lake Interface in Southwest Lake Michigan

Water samples along a gradient from the Milwaukee River to Lake Michigan and from a vertical profile at an open-water station were collected for measurements of dissolved, colloidal and particulate inorganic and organic phosphorus (P) during June 2013. Dissolved inorganic P (DIP) was the dominant species in the total dissolved P (TDP) pool at river and nearshore stations reaching a concentration as high as 3.15 μM showing a strong anthropogenic influence. However, the DIP concentration decreased rapidly to undetectable levels in open lake waters, suggesting a P-limitation ecosystem in Lake Michigan. Concentrations of dissolved organic P (DOP) also decreased from 0.1-0.27 μM in river waters to <0.1 μM in Lake Michigan. While DOP contributed only <10% of the TDP pool in river waters, it became predominated in lake waters comprising up to >80% of the TDP pool. Within the DOP pool, high-molecular-weight or colloidal organic P was the predominant form in river waters but less important in lake waters. Concentrations of particulate P species, including particulate inorganic P (PIP) and particulate organic P (POP) were generally low (<0.6 μM) compared to those of DIP. Similar to dissolved P, both PIP and POP also decreased consistently from river to nearshore and to open lake waters, while the %POP increased from river to lake waters. The increase in both DOP and POP abundance in open lake waters pointed to the effect of biological processes on the distribution and partitioning of P in Lake Michigan. At open-water stations, DIP showed a general increase with depth although somewhat variable, but both DOP and POP decreased in general from surface to deep waters with a subsurface

maximum between 10-20 m and an elevated concentration toward the sediment-water interface, suggesting the influence of primary production on subsurface layer and benthic organisms on bottom waters.

MALOTT, SPENCER, COOK, A., ROBINSON, C., and O'CARROLL, D., Department of Civil and Environmental Engineering, Western University, London, ON.

Quantification of Water Exchange across the Sediment-Water Interface at Beaches of the Great Lakes

Groundwater and sediment may be important non-point sources of microbial and nutrient contamination at beaches of the Great Lakes, yet these sources are not well understood. Quantification of the dynamic exchange of water across the sediment-water interface is needed to evaluate the transport of microbial contaminants and dissolved constituents, including nutrients, between the groundwater and nearshore lake waters. Field data was collected at four beaches on Lake Ontario and Lake Huron over multiple deployments between May-September 2013 in an effort to simultaneously quantify groundwater, nutrient and microbial conditions (see Robinson et. al., Session 4). Regional groundwater discharge rates were quantified through measurement of the inland water table hydraulic gradient. Localized water exchange rates were determined by high frequency vertical pressure and temperature vertical gradients measured via sensors installed in vertical arrays below the sediment-water interface near the shoreline and offshore. Results show that the exchange of water is driven primarily by high and low frequency fluctuations in lake levels including waves and seasonal variations. Localized water exchange rates depend on the beach morphology and measurement location relative to the shoreline. The impact of the water exchange rates, including spatial and temporal variability, on the movement of contaminants across the sediment-water interface will be discussed.

MAREK, MIKE, Marek Landscaping, LLC, 820 E. Knapp St., Milwaukee, WI 53202.

McKinley Marina North: An Integrated Concept that Celebrates Milwaukee's Place at the Waterfront

McKinley Marina is located along the waterfront just north of downtown Milwaukee and owned by Milwaukee County. The marina serves a variety of uses, including a public boat launch, boat washing, charter fishing, yacht club facilities, seasonal and transient slip rentals, facilities rentals, dry sail storage beach access, public lakefront parking, and pedestrian access to government pier (a 1/2 mile long accessible break-wall). Issues with traffic flow and aging pavement prompted Milwaukee County to pursue a conceptual plan for improving the marina. Sigma and Marek Landscaping entered a partnership to design a conceptual plan for the McKinley Marina North and were awarded the project.

After a comprehensive review of existing conditions and multiple stakeholder meetings we developed a conceptual plan that is rooted in ecological performance while achieving the functional and aesthetic objectives of the County and its constituents.

By laying out clear conceptual design objectives and building an informed stakeholder group through newsletters and meetings, we generated several options for layout, and prioritization. From those plans we developed a consolidated framework graphic that addresses the priorities of the users, public, and the County. Only then, with everyone's buy in, we generated a site civil layout and concept illustration from which detailed construction documents can be created.

Along the way we developed a stormwater strategy that does much more than simply meet the current regulated pollutant reductions but showcases active water stewardship. Our grading, drainage,

and storm sewer concept works at every elevation to address pollutants including trash, invasive species, sediment, antifreeze, motor and hydraulic oils, and E. coli.

This contemporary marina plan implements sustainable stormwater practices, while providing safe intermodal traffic flow; it enhances waterfront connectivity, and creates a year-round waterfront passage between the City and the Lake.

What better place to demonstrate water stewardship than at a marina?

MEDNICK, ADAM[1], CYTERSKI, M., GALVIN, M., WOLFE, K., BROOKS, W., CORSI, S., RODDICK, T., and ROCKWELL, D., [1]Wisconsin Department of Natural Resources, 101 S. Webster St., Madison, WI 53707.

Advanced Decision-Support for Coastal Beach Health: Virtual Beach 3.0

Virtual Beach is a free decision-support system designed to help beach managers and researchers construct, evaluate, and operate site-specific statistical models that can predict levels of fecal indicator bacteria (FIB) based on environmental conditions that are more readily measured, estimated, or forecast. Since its first operational use in 2009, Virtual Beach has been updated several times based on feedback from users in the field. These updates have improved the efficiency of the model-building and evaluation process and made the process of operating a predictive model faster and more user-friendly. Virtual Beach 3.0 includes significant enhancements, including new statistical methods and the integration of hydro-meteorological data accessed through the Web-based Environmental Data Discovery and Transformation (EnDDaT) system. New statistical methods include partial least squares (PLS) regression and gradient boosted modeling (GBM), which provide alternatives to the standard multiple-linear regression (MLR) approach, optimized using a genetic algorithm. This poster will illustrate the functionalities of the enhanced software and highlight applications in the Great Lakes.

MILLER, JENNIFER, SAICHEK, R., THAI, L., and SEMMLER, J., USACE Chicago District, 111 N. Canal, Suite 600, Chicago, Illinois 60606.

Indiana Harbor and Canal Dredging Up-date

The Indiana Harbor and Canal (IHC) is the downstream end of the Grand Calumet River Area of Concern (AOC), and is outlets into Lake Michigan. This AOC is considered impaired for all 14 beneficial uses identified by the International Joint Commission. Due to the extremely high concentrations of contaminants (including metals, PAHs, PCBs, VOCs, and nutrients) in the sediment the canal has not been dredged since 1972. After 10 years of construction, the IHC Confined Disposal Facility (CDF) for the sediment is complete and began receiving dredged sediment in 2012. This CDF is unique in that it is sited on a former petroleum refinery property with open RCRA status and PCB contaminated oil on the groundwater. The CDF incorporates RCRA corrective action and closure requirements for the property, including a groundwater cut-off wall and groundwater gradient system to prevent off-site migration of contaminated groundwater and oil. The sediment being dredged is approximately 1.8 million cyds of heavily contaminated material, including some TSCA regulated material. As of early June 2013, approximately 250,000 cyd of dredged sediment had been placed in the CDF. The dredging is mechanical dredging with an environmental bucket, followed by hydraulic placement into the ponded CDF. In short, this is a complex dredging and disposal project that has been in the works for several decades, and that has enormous beneficial environmental impacts (although the project is not a

'remediation' project). The presentation will cover the CDF features, unusual requirements including monitoring, and the dredging and sediment placement operation.

MILLER, ROGER G., President, Miller Engineers & Scientists, 5308 S 12th Street, Sheboygan, WI 53081.

Sheboygan Harbor Centre South Pier District: A Case Study of Sustainable Coastal Redevelopment

The Harbor Centre South Pier District, where the Sheboygan River enters Lake Michigan, supported a busy commercial port for over a century. By the mid-1970's the coal yards and bulk oil tanks occupying the 40 acre peninsula were vacated, and the area had become an eyesore. Perceived environmental impairment and the real need for major infrastructure reinvestment became barriers to redevelopment for many years. Through City initiative, the "South Pier" peninsula is now the crown jewel of Sheboygan, and is the host site to this conference. This poster will show how thorough site characterization was utilized to create a sustainable design, transforming this peninsula from a blighted brownfield to naturalized beaches, a revitalized harbor, and contemporary mixed use of land.

The South Pier is bounded on the north by the Inner Harbor of the Sheboygan River and a Federal breakwater forming Sheboygan's Outer Harbor. The breakwater reflects open coastal reach wave energy, so the coastal restoration design creates a gradual transition from that to the wide, flat beaches that border the site one-half mile to the south. Past and future periodic navigational dredging of sand that historically accumulates at the entrance to Sheboygan's Outer Harbor mimics the former natural north-to-south littoral migration of sand to the project area and beaches southward. A buried revetment was incorporated along the lakeshore of the peninsula to provide protection to inland development and support natural beach dynamics. This revetment was designed to mimic coastal dune features, and became a naturalized environment for public recreation.

Other aspects of peninsula redevelopment included environmental cleanup, replacement of utility and road infrastructure, replacement of bulkheads along the river, and grading plans that contain ultra-light weight fill materials. These fill materials allow economical construction of buildings on this peninsula, which is underlain by deep deposits of soft, compressible soil.

OXLEY, TONY, Project Engineer, Miller Engineers & Scientists, 5308 S 12th Street, Sheboygan, WI 53081.

Methodology for Designing Beach Naturalization

A wide range of physical factors affect the health and aesthetics of beaches. This poster describes the methodology used to measure the characteristics of each beach and how that information is used to design effective improvements to mitigate bacterial and other contamination.

Water levels of the Lakes Michigan, Huron, Erie, and Ontario periodically fluctuate throughout a range of about five feet. This means the storm wave erosion limit and beach width along the shores of these lakes may vary as much as several hundred feet between periods of low and high water. The amount of wave energy that each beach is exposed to depends on the distance of open water where storm waves (which sometimes exceed 20 feet height out in deep water) can build. The near shore bottom profile determines where deep water waves successively break as they approach the shore. These factors, in combination with irregularities in the shoreline or any man-made structures projecting into the lake, affect patterns of sediment migration along the shore as well as the tendency for pathogens in the water to concentrate or disperse.

Storm water drainage (especially storm sewers discharging near beaches) and land surfaces that attract shore birds are major sources of contamination. Beach slope and sand grain size determine to

what level capillary water rises under the beach, which affects bacteria survival as well as where beach grass is able to grow.

While each beach is unique, all of the characteristics that control its particular physics can quickly and economically be measured to provide the basis for planning enhancements that rely on natural systems and will function throughout a wide range of water levels.

QUALLS, THERESA[1], HARRIS, H.J.[2], and HARRIS, VICTORIA[1], [1]UW Sea Grant Institute, 2420 Nicolet Drive MAC 212, Green Bay, WI 54311-7001, [2]University of Wisconsin-Green Bay, Green Bay, WI.

State of Green Bay: An Environmental Assessment Report

The Lower Green Bay and Fox River have been designated a Great Lakes Area of Concern (AOC) by the International Joint Commission because persistent pollution or degraded habitats have restricted many activities. While water-quality problems and public use restrictions are most severe in the AOC, water resources of the entire basin are affected by runoff pollution from urban and rural areas, municipal and industrial wastewater discharges, and degraded habitats. The objectives of the State of the Bay report are to identify chemical, physical, biological, and social indicators of the "health" of the bay and assess the current status and long-term trends for each indicator.

Twenty years have passed since the last State of the Bay report was published. Many changes have occurred during this period, and we now have considerably more information. The third edition of the State of the Bay Report (2013) presents new data on the quality of the water, as well as data on fish and wildlife populations, aquatic invasive species, beach conditions and status of contaminants in the region. The advantage of having data over such a long period of time is that it allows scientists and citizens to see if conditions are getting better, worse, or staying about the same.

Based on the status and long-term trend assessments, the state of Lower Green Bay is mixed. Water quality in the AOC, particularly as measured by phosphorus, nitrogen, total suspended solids (TSS), chlorophyll *a* and Secchi disk has on averaged not improved over time. Phosphorus and TSS variation since 2000 variation remains unexplained. Nitrate nitrogen has been increasing over the past thirty years. Several of the bay's biological indicators have shown improvements. The State of the Bay report continues to be an important and useful summary of the overall health of lower Green Bay and evaluates ecosystem responses to remedial actions.

ROCKWELL, DAVID[1], BEACHER, D.[2], CAMPBELL, K.[1], FENELON, E.[2], MANN, G.[3], WAGONMAKER, R.[3], NEVERS, M.[4], and GRONEWOLD, D.[5], [1]CILER, University of Michigan and NOAA-GLERL, Center of Excellence for Great Lakes and Human Health, [2]National Weather Service Office Chicago, [3]National Weather Service Office Detroit-Pontiac, [4]USGS, Great Lakes Science Center, Lake Michigan Ecological Research Station, [5]NOAA, Great Lakes Environmental Research Lab(GLERL).
Collaborators: Bay, Macomb, and Ottawa County Michigan Health Departments, Chicago Park District, Cook County Illinois, Allen Burton, CILER, University of Michigan, Greg Lang, NOAA, GLERL, Sonia Joseph Joshi, Michigan Sea Grant Extension and CEGLHH, NOAA GLERL.

2013 Swimming Season NOAA Beach Water Quality Experimental Forecasts

Accurate forecasts of beach water quality several days in advance are useful to inform swimmers for their recreational planning. NOAA's Center of Excellence for Great Lakes and Human Health, Great Lakes Environmental Research Laboratory, the National Weather Service office located in Chicago and Detroit Pontiac, and the Cooperative Institute for Limnology and Ecosystems Research, University of Michigan are developing and testing beach management forecast decision support systems (FDSS) at ten beaches located in Michigan and the City of Chicago. The NOAA Beach Water Quality Experimental Forecasts are possible because Bay, Macomb, and Ottawa County Health Departments in Michigan and the Chicago Park District have provided their *E. coli* monitoring data. Recent developments in operational Ocean Observing Systems in the Great Lakes allow the National Weather Service to use model generated parameters as independent explanatory variables of *E. coli*. These variables include rainfall, wind direction, velocity and gusts, lake currents, air temperature, surface water temperature, cloud cover, and time of sampling. *E. coli* has been modeled at Bay City State Rec. Area, Bay Co. MI, Metro and Memorial Beaches, Macomb Co. MI, North Beach Park and Grand Haven State Park, Ottawa Co. MI, Jackson Street Beach, Foster, Oak, Calumet, and Montrose in the City of Chicago. These beach FDSS were tested during the 2013 swimming season between Memorial and Labor Day. The strengths and weakness of the beach water quality forecasts will be presented. The overall accuracy and forecasting skill will be discussed.

ROCKWELL, DAVID[1], MEDNICK, A.[2], WIRICK, H.[3], and JOSEPH JOSHI, S.[4], [1]CILER-University of Michigan and Center of Excellence for Great Lakes and Human Health (CEGLHH) NOAA-GLERL , [2]Bureau of Science Services, Wisconsin DNR, [3]Water Division, Region V, USEPA , [4]Michigan Sea Grant Extension and CEGLHH, NOAA GLERL.
Collaborators: 65/85 (at time of abstract submission), Municipal or County Health Departments, Tribal Governments, Wastewater Utilities, Universities, National Parks, Recreation Departments.

Beach Information Needs Survey 2013

This survey is a timely follow-up to the 2005 Beach Health Research Needs Workshop at the Great Lakes Beach Association Conference in Green Bay. Approximately 85 collaborators received the on line questionnaire. Information was requested in five areas (number of questions): Background (12), Federal Funding (6), Basic Research Needs (7), Adoption of New Methods (8), Tools and Training (14), and Communication (5). Response from collaborators will be used to advise the Federal agencies in their planning regarding Agency direction for beach health R&D. 75% of the collaborators were from municipal or county health departments. 39% of the collaborators were responsible for 10 or more beaches. 68% of the organizations responding indicated their overall staff time devoted to beach management was less than 10%. The percentage of organizations that will continue to monitor and report the results for their beaches was approximately 1/3. The relative importance of 14 research

subject areas for the collaborators will be presented. The usefulness of information services in five areas will be presented. Satisfaction of information series provided by the Federal Agencies resulted in 80% of the respondents having their information needs met with 13 suggestions for improvements. Other results will be presented.

RUSZAJ, ANIA[1], AMBROZ, DUANE, TECIC, D., LEGGE, J., and COTNER, L., [1]Illinois DNR Coastal Management Program, 160 North LaSalle, S-703, Chicago, IL 60601.

Progress on Removing Beneficial Use Impairments in Waukegan Harbor Area of Concern

Waukegan Harbor, located in northeastern Illinois, was designated as an area of concern (AOC) in 1981 due to presence of high levels of polychlorinated biphenyls (PCBs) in harbor sediments. Six Beneficial Use Impairments (BUIs) identified for the harbor include: restrictions on fish and wildlife consumption; degradation of benthos; restrictions on dredging activities; beach closings; degradation of phytoplankton and zooplankton populations; and loss of fish and wildlife habitat.

The source of the PCB pollution was linked to the discharge of PCB-containing hydraulic fluids from manufacturing activities around the harbor, with over 300,000 pounds of PCBs discharged into the harbor during a 23-year period. Dredging completed in 1993 removed approximately 95% of the PCBs in the harbor. Standards were made more stringent when elevated contaminant levels continued to show up in fish caught from the harbor after the initial cleanup phase. Plans were developed to remove remaining sediments that exceeded these new standards, and to clean up soil-based contamination found during subsequent investigations.

This presentation will discuss progress that has been made through the cooperation and coordination of local, state and federal agencies towards removing BUIs in Waukegan Harbor and delisting the harbor as an AOC. Dredging projects are ongoing, with plans to remove approximately 175,000 cubic yards of PCB-contaminated sediment from the harbor during 2012-2013. Pre-dredging sampling of fish, phytoplankton, and benthos populations have been performed to establish baseline data for biological BUIs. A habitat management plan has been prepared for the AOC, including monitoring and management of coastal habitat formed since the AOC designation. The beach closings BUI has been removed and beach assessments are ongoing. As a result of the ongoing work, an "AOC in Recovery" designation is being considered for the AOC.

SAMPLES, AMY, LAPORTE, E., MARSEE, T., ARIGANELLO, S., and GUNN, J., Michigan Sea Grant, 520 E. Liberty Rd. Suite #310, Ann Arbor, MI 48104.

Clean Marina Classroom: Online Training as an Additional Vector of Education

The use of the internet as a medium for educators to reach people across a large geography like the Great Lakes to educate on sustainable practices is examined through the efforts of the Green Marina Education and Outreach Project. Marinas as an industry are key stakeholders that have a significant impact on water quality. Though in person interactions remain vital, the ability to use online training tools as an additional vector of education for marinas increases the potential to protect and enhance water resources. The Clean Marina Classroom provides marina operators with a flexible learning environment and provides program managers a cost-savings through reduced printing and administrative costs. The Classroom was developed through a collaborative process, including representatives from industry, regulatory and academic sectors. Content is based on the Great Lakes Clean Marina Best Management Practices Guide, which also serves as a suggested standard for Clean

Marina program certification requirements. The course is modeled on an online training tool introduced by the Michigan Clean Marina Program in 2009 that fulfills an educational component of their program's certification requirements. In developing the regional Classroom, lessons learned pertain to content management and review processes.

SCHRANK, CANDY, RASMUSSEN, P., and WEAVER, M., Wisconsin Department of Natural Resources, Madison, WI 53707-7921.

Trends in PCB Concentrations in Lake Michigan Salmonids, 1975 – 2010

The manufacture and use of total polychlorinated biphenyls (PCBs) was banned in the United States in 1977, after it was determined that these compounds adversely affect animals and humans. The Wisconsin Department of Natural Resources has collected data on PCB concentrations in Lake Michigan Chinook (n=765) and Coho (n=393) salmon since 1975. We analyzed these data to estimate trends in PCB concentrations in these fish (1975-2010). Analyses were conducted on the log scale to best satisfy assumptions of models. We used generalized additive models to determine the form of the time trends. Using iterative methods, we estimated the intersection between the two linear trends was 1984 for Coho salmon and 1985 for Chinook. We identified a candidate set of models that included time trend and other predictor variables such as fish length, % fat content, season caught, location caught, and condition. We fit the same set of models using linear regression with $\log_{10}$(PCB) as the response and using generalized linear models assuming a Gamma error distribution and log link function with PCB concentration as the response. Using AIC to select among models we found the best model for both species included piecewise linear time trends, fish length, % fat, and season in which the fish was caught as predictor variables. PCB concentrations in both species increased with body length and % fat, and were higher for individuals caught in the fall. Our data reveals a dramatic decline in PCB concentrations in the first ten years after the PCB ban and then a slower decline in the later period of study. We estimate that from the mid-1980s to 2010, PCB concentrations declined at a rate of -3.9% (95% CI: -5.3% to -2.5%) and -2.5 (95% CI: -6.4% to 1.6%) for Chinook and Coho, respectively.

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Concentrations of Fatty Acids in Wisconsin Sport Fish: Preliminary Implications for Consumption Advice

WI Departments of Natural Resources (DNR) and Health Services (DHS) have analyzed fish tissues for contaminants (mercury, PCBs) and issued warnings about eating fish since the 1970s. DHS recently received a Great Lakes Restoration Initiative grant for improving fish consumption advice and analysis of beneficial long-chain polyunsaturated omega fatty acid concentrations in commonly eaten fish species. The DNR annually collects fish from both inland waters and the Great Lakes, and a subset of fillets from this collection was analyzed for fatty acid content by the WI State Lab of Hygiene. We found that salmon and trout species contained the highest concentration of fatty acids, although a 0.5-lb serving of most species sampled provided the Recommended Daily Intake of beneficial fats. However, a serving of most species sampled also exceeded the mercury health protection value for men and older women and all species exceeded this value for young women and children. Therefore, advice for consuming fish from PCB and mercury-contaminated sites should still be followed, although choosing to consume fish with high fatty acids may provide increased benefits of fish consumption.

SCUDDER EIKENBERRY, B., BELL, A., BURNS, D., and TEMPLAR, H., US Geological Survey, 8505 Research Way, Middleton, WI 53562.

Baseline Data for Potential Delisting of Benthos and Plankton in Wisconsin AOCs

A study of benthos (benthic invertebrate) and plankton (zooplankton/phytoplankton) communities in four Lake Michigan river mouths and harbors that were designated by the USEPA as Areas of Concern (AOCs) is being done by the U.S. Geological Survey (USGS), in cooperation with the Wisconsin Department of Natural Resources (WDNR) and U.S. Environmental Protection Agency (USEPA). The study will provide the WDNR and USEPA with data needed to assess the status of these communities and, when appropriate, support removal or "delisting" of the "Degraded Benthos" and "Degraded Plankton" beneficial use impairments (BUIs). In 2012, the USGS sampled benthos and plankton at the four AOCs as well as at six non-AOCs with similar land use/land cover, watershed size, geology, and other characteristics. The four AOCs are the Menominee River, Fox River/Green Bay, Sheboygan River, and Milwaukee Estuary; the six non-AOCs for comparison are the Escanaba River, Oconto River, Ahnapee River (Algoma), Kewaunee River, Manitowoc River, and Root River (Racine). Benthos and plankton samples were collected 4-6 weeks apart during three time periods in 2012: Spring (May/June), Summer (July), and Fall (late August). Using EPA methods, the benthos were sampled using Ponar dredges and artificial substrate samplers, and the plankton were sampled using tow nets and water-column samplers. Abundance and distribution of benthos and plankton species, as well as diversity, pollution tolerance, and other ecological measures, are compared within and between AOCs and non-AOCs to evaluate the status of these aquatic communities and whether they differ significantly. Use of non-AOCs as comparison sites is a key aspect of this evaluation because historic "baseline" data is generally lacking in AOCs. Characterization of current benthos and plankton communities is a critical first step that must occur before these BUIs can be considered for delisting.

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Quantification of Fecal Indicator Bacteria at the Surface-Water Interface at Four Great Lakes Beaches

The beaches of the Great Lakes (GL) are extremely important recreationally, ecologically and economically. However, fecal contamination results in over 10% of beach advisories, resulting economic loss and increased risk to human health. Non-point sources, such as groundwater and beach sand, can act as a reservoir for *E.coli*, harboring concentrations orders of magnitude higher than those found in adjacent waters. However, the microbial contribution of these sources to FIB concentrations in adjacent waters is not well characterized. This project is part of an interdisciplinary team investigating the hydrological, biogeochemical, and microbial processes which influence the fate of pollutants. In this aspect of the study, the concentrations of fecal indicator bacteria (FIB; *E. coli* and enterococci) were examined in the water column and sand/sediment of four GL beaches. Beaches included two urban and two non-urban beaches that ranged from degraded to more pristine. Three-four transects were sampled at each beach including a spatial range of water and sand/sediment samples. Water samples included a pore sample and samples taken from ankle- and waist-depth. Sand/sediment samples on each beach included upshore sand, saturated and unsaturated foreshore sand, and sediments taken from ankle- and knee-depth in the adjacent water. Samples were taken bi-weekly at each beach from May-September 2013 (n=7). The FIB concentrations within the sand/sediment reservoir and water

column will be discussed along with variation as a result of groundwater flows, wave events, stormwater discharge, and fecal contribution from wildlife.

STOKES, Y.F., WAGNER, C.A. and WILLIAMS, V.A., Wild Goose Chase, Inc., 106 W. Calendar Court PMB 171, LaGrange, IL, 60525.

A Comparison of Case Studies: What Impacts Whether Summer Gull Management Programs can be Effective at Improving Levels of *Escherichia coli* in 3 Chicago Beaches

Historically, beaches in Chicago, IL have been plagued with excessive *Escherichia coli* levels. Sources of *E. coli*, often used as an indicator of the presence of fecal and possibly pathogenic bacteria, have been studied throughout the Great Lakes and have linked the high levels in gull feces with levels in sand and water samples. Wild Goose Chase, in conjunction with the Chicago Park District, implemented a gull management program with the objective of reducing exceedances for 63rd St. and 57th St. Beaches every summer from the end of May through August since 2007 (except 2009), with Montrose Beach added in 2012. The program included daily patrols of varying levels using trained Border collies and handlers to mimic a natural predator, preventing gulls from foraging or loafing. Handlers also educated patrons feeding gulls and picked up trash to reduce food attractants. This can, for the duration of the program, condition gulls to choose another site entirely, leading to significantly reduced levels in *E. coli* ($p < 0.05$), and therefore exceedances in some beaches. However, the site specific conditions of some beaches, like Montrose Beach, which has a unique ecosystem, may make programs like this ineffective at improving water quality and other sources of *E.coli* should be determined and managed.

STRAKOSH, TIMOTHY R.[1], ANDERSON, K.R.[2], HENSLER, S.R.[3], and CHAPMAN, D.C.[2], [1]U. S. Fish and Wildlife Service, Green Bay Fish and Wildlife Conservation Office, 2661 Scott Tower Drive, New Franken, WI 54229, [2]U. S. Geological Survey, Columbia Environmental Research Center, [3]U. S. Fish and Wildlife Service, Alpena Fish and Wildlife Conservation Office, Waterford Substation.

Dreissenid Veligers as a Food Source for Silver and Bighead Carp in Lakes Erie and Michigan: a Bioenergetics Model

The Laurentian Great Lakes have experienced dramatic ecosystem changes within the past 200 years. Two Asian carps (bighead carp *Hypophthalmichthys nobilis* and silver carp *H. molitrix*) have colonized the Mississippi and Ohio River basins of central North America and are poised to infiltrate the Great Lakes. Many risk assessment models for Asian carps have focused on zoo- and phytoplankton food sources, but have not included invasive zebra and quagga mussels (Dreissena spp.) veligers in the models. The objective of this study is to assess the potential of dreissenid veligers as a potential food source. Fish Bioenergetics 3.0 was used to model silver and bighead carp growth. The bioenergetics model parameters for both species followed published values with modifications found in other literature. Proportion of maximum consumption was used at the level where fish maintain their weight. Based on the newly developed models Asian carps were able to sustain condition and grow when veliger densities approached and surpassed 1,600 veligers per liter. Previous bioenergetics models that indicate Asian carps may not have an adequate food supply in large portions of lakes Erie and Michigan should be reconsidered with this alternative food source in mind.

VALENTA, TRACY[1], DOLAN, D.M.[2], KLUMP, VAL[3], KENNEDY, J.[1], and SAGER, P.[2], [1]NEW Water, 2231 N. Quincy Street Green Bay, WI 54302, [2]University of Green Bay, [3]University of Milwaukee.

Oxygen Depletion in Green Bay

The majority of the research that has been conducted on the Green Bay ecosystem has focused on documenting the impact of nutrient loadings from the Fox River on water quality in lower Green Bay. To date, very little is known about oxygen depletion in the deep waters of the mid-bay and to what extent hypoxia may be occurring. In order to gain a better understanding of oxygen depletion in the hypolimnion of the mid-bay, vertical profile data were collected on several cruises throughout the summers of 2010 and 2011 by the Great Lakes Water Institute (GLWI) and Green Bay Metropolitan Sewerage District (GBMSD). Analysis of vertical profile data shows the mid-bay was thermally stratified by mid-July until turn over in early September. A well-defined hypolimnion was present in both years of the study. Hypolimnetic depletion rates were calculated for the study area. In 2010, depletion in the hypolimnion was variably throughout the study area resulting in an overall depletion rate that was approximately 50 percent that of 2011. In 2011, depletion occurred throughout study area. A strong oxygen depletion rate was calculated, resulting in a significant amount of loss of oxygen from the hypolimnion.

VARMA, MANJU[1], SIEFRING, S.[1], WADE, T.[2], SAMS, E.[2], COCHRAN, S.[3], BRAUN, S.[3], SIVAGANENSAN, M[4], and HAUGLAND, R.A.[1], [1]U.S. Environmental Protection Agency, Office of Research and Development, National Exposure Research Laboratory, 26 West Martin Luther King Drive, Cincinnati, OH, 45268, [2]U.S. Environmental Protection Agency, Office of Research and Development, National Health Effects and Environmental Effects Research Laboratory, [3]Ohio River Valley Water Sanitary Commission, [4]U.S. Environmental Protection Agency, Office of Research and Development, National Risk Management Research Laboratory.

Comparison of EPA Guideline-Based Beach Action Decisions from *Enterococcus* qPCR Target Sequence-Adjusted Cell Density Estimates and Culture Methods

The U.S. Environmental Protection Agency (EPA) has recently released beach action values for recreational water quality monitoring results from *Enterococcus* and *E. coli* culture methods as well as for a quantitative polymerase chain reaction (qPCR) method for *Enterococcus*. Reported values for single sample analyses are 235 CFU or MPN for *E. coli* culture and 70 CFU or MPN for *Enterococcus* culture and 1000 CCE for *Enterococcus* qPCR, based on an acceptable illness rate of 36/1000. Studies were conducted in which beach action decisions resulting from standard culture-based analyses for both enterococci and *E. coli* were compared to those based upon *Enterococcus* CCE estimates, adjusted to a benchmark target sequence to cell ratio corresponding to the EPA beach action values, for 234 water samples from seven major rivers in the midwestern United States. Beach action decisions from *Enterococcus* qPCR agreed with those from the *Enterococcus* culture methods in 86% of the method comparisons (N=149) and with those from the *E. coli* culture methods in 92% of the method comparisons (N=367).

WIJESINGHE, RASANTHI U.[1], OSTER, R.J. [1], FOGARTY, L.R. [1], HAACK, S.K. [1], TUCKER, T.R. [2], and RILEY, S.[2], [1]United States Geological Survey, Michigan Water Science Center, 6520, Mercantile Way, Suite 5, Lansing, MI 48911, [2]USGS-Great Lakes Science Center.

Detection and Quantification of *Clostridium botulinum* Type E Toxin Gene (*bontE*) in *Cladophora* at Great Lakes Beaches

Clostridium botulinum type E toxin is responsible for the death of thousands of birds and fish in the Great Lakes. Previous studies have suggested that the green alga *Cladophora* may support the survival and persistence of *Clostridium* species. This study was conducted to determine the occurrence of *C. botulinum* type E at 10 beaches found along Lake Michigan, Lake Erie, Lake Superior and Lake Huron, where stranded *Cladophora* was present. A total of 150 *Cladophora* samples were collected from 10 beaches in Michigan, Ohio, Indiana, Wisconsin and Illinois from June 2012 to November 2012. Quantitative polymerase chain reaction (qPCR) was used to quantify the *bontE* gene of *C. botulinum*, which is responsible for the production of type E toxin. In addition to the *Cladophora*, 74 sediment and 37 water samples were evaluated to determine if the gene was present in different matrices. The *bontE* gene was detected most frequently in *Cladophora* at Jeorse Park Beach and Portage Lakefront Beach at Lake Michigan and Bay City State Park Beach at Lake Huron. Comparison of these three matrices indicated that *bontE* concentration in *Cladophora* was significantly higher than other two matrices ($P<0.05$); these results suggest that *Cladophora* mats provide better ecological niches for the prevalence of *C. botulinum* than other matrices. Ultimately, quantitative assessment of *bontE* gene is important for understanding the distribution of these bacteria in different matrices and different geographical locations.

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Source and Composition of Dissolved Organic Matter in Southwest Lake Michigan as Characterized by Fluorescence EEM and PARAFAC Techniques

To examine the quantity and quality of dissolved organic matter (DOM) and their controlling processes at the river-lake interface in Lake Michigan, water samples were collected along a transect from the Milwaukee River (MR) to a 100m-deep station east of Fox Point (FP) from July-2012 to June-2013. During April 2013, dissolved organic carbon (DOC) concentration decreased from MR (10.9 mg-C/L) to FP (1.7mg-C/L). Within the bulk DOC pool, the high-molecular-weight (>1kDa) DOC was the major component in both MR (~70% of the DOC) and open lake waters (53%). Humification index of DOM decreased in general from the river (e.g., 3.3 in MR during April) to open lake station (1.3 at FP), indicating DOM source change from mostly terrestrial in river waters to mixed sources in lake waters. Using parallel factor analysis (PARAFAC) applied to all fluorescence excitation/emission matrix data, two major DOM components could be identified. Component-1 had maximum fluorescence intensity at excitation/emission wavelengths of 344/440 nm, showing characteristics of terrestrial humic-like DOM. Component-2, with maximum Ex/Em at 272/350 nm, was identified as protein-like DOM. Ratio of component-2 to component-1 increased from MR (0.11 in April) to FP (0.44), suggesting increasing autochthonous DOM inputs from in-situ production in lake waters. Vertical distributions of DOC showed a well-mixed water column during winter (December/January) with an average DOC concentration of 1.58 mg-C/L (January 2013), but stratified during summer (June 2013), with higher DOC in surface (2.18 mg-C/L) and lower in bottom waters (1.49 mg-C/L), suggesting a strong influence from in-situ biological production in surface-water during summer and detectable DOM respiration in deep-water between seasons. River inputs, primary-production, and hydrological and microbial processes seem all important at different seasons in controlling the distribution, source and composition of DOM in coastal waters of Lake Michigan.